

Birds

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Objectives

The original objective of the avian monitoring program at Organ Pipe Cactus National Monument was "...to detect changes in abundance and/or distribution of birds that may be influenced by, or are the result of, changes in monument resources, adjacent land use, or management practices." (Johnson 1995).

Introduction

At OPCNM, as elsewhere, bird communities provide a valuable subject for long-term ecological monitoring. As a group, bird species span a wide range of ecological functions, from ecological generalists of broad geographic distribution to specialists of very limited distributions. In the Sonoran Desert in southwestern Arizona, bird species range from nectivores weighing several grams to predators weighing over 5 kg. Between those extremes are many species of insectivores, granivores, predators, and omnivores, exploiting niches on the ground, in all vegetation, in rocks, and high in the air. Birds' ability to fly and to construct nest sites allow them to forage widely, and use mechanisms to cope with extreme heat that are not available to less mobile organisms. Finally, birds as a group are a relatively conspicuous fauna, as a result of their mobility and vocal behaviors. This is especially true in the relatively open habitat of Sonoran desertscrub. As a result of all these factors, birds present a valuable group for gaging the productivity, diversity, and complexity of ecosystems.

Interest in quantifying bird populations has increased recently, due to a consensus that declines in some Neotropical migrants are occurring (Robbins et al. 1989, Finch 1991, Sauer and Droege, 1992, Rappole and McDonald 1994, Peterjohn et al., 1995). Decline in a particular species of Neotropical migrant (species that migrate from wintering grounds at low latitude

to breeding grounds at higher latitude) is likely due to a combination of factors. These factors are in general associated with human land use practices and resulting impacts on habitat quality and quantity on the breeding and wintering grounds. Opinions vary as to whether impacts on wintering grounds or summering grounds are experiencing the most significant impact (Rappole and McDonald 1994, Sherry and Holmes 1995).

Although quantification of avian populations has been the subject of much study (see, for example, Ralph and Scott 1981, Sauer and Droege 1990, Ralph et al. 1993), there are no universally applicable standard techniques to determine bird population numbers (Verner 1985, Bibby et al. 1992). However, over the last 20 years the ornithological community has given considerable attention to the use of point-counts as a means of monitoring birds, with two major symposia being held regarding this survey method (Ralph and Scott 1981, Ralph et al. 1995). Point counts have emerged as the method of choice when monitoring objectives are to gauge relative abundances of the diurnal breeding bird community over large geographic areas.

Paradoxically, although it is relatively easy to observe desert birds, they are difficult to accurately count because: 1) vocalizations carry great distances in the open landscape, making estimating distances and pinpointing locations problematical, 2) some species maintain large home ranges, making double-counting a possibility, 3) some species are small, cryptically colored, vocally and/or behaviorally inconspicuous, making detection difficult.

Avian population trends are often difficult to detect with only 3 or 4 years of data. Short-term data sets are usually inadequate to determine

long-term trends that are often masked by year to year variability; long-term studies are required to identify population trends (Ralph et al 1981, Perrins et al. 1991; Bibby et al. 1992). Possible long-term declines in some neotropical migrants cannot be easily detected until many years of data have been collected (Verner 1985; Ralph et al. 1993).

This report covers a new method of point counts introduced to OPCNM in 1997. The previous method of belt transects (Johnson 1995) was discontinued after 1995. The methods section of this report provides extensive descriptions of the new point count methods, study sites, and concerns about the protocol.

History of Avian Monitoring Studies at Organ Pipe Cactus National Monument

There are about 280 species of birds known to occur, either presently or historically, within OPCNM. Of that number, 75 species are known to breed here (Groschupf et al. 1988, and Monument records). Modern bird studies in OPCNM began with Huey's (1942) annotated checklist of 150 species. Subsequent studies focused on the ecology and general habitat relationships of breeding birds within OPCNM (Philips and Pulich 1948; Hensley 1959). Other studies were conducted through the early 1980s, examining the ecology and distribution of selected species or populations (Cole and Whiteside 1965, Beck et al. 1973, Inouye et al. 1981). A contracted project titled "Ecology of Special Status Avian Species" documented 75 species of birds, which were thought to represent the majority of permanent and summer residents in OPCNM (Johnson and Hiatt 1992). From that project, a monitoring protocol was developed for 15 "indicator" species and 7 "sensitive" species based on walking belt transects (Johnson and Hiatt 1992). This protocol was implemented in 1994-1995. In 1995 and 1996, other contracted researchers investigated the distribution and ecology of brown-headed cowbirds (*Molothrus ater*) in OPCNM (Haltermann et al. 2000). That project included sampling 95 point-count stations distributed across 8

transects in xeroriparian habitats. Also during the 1990s, the Monument was included in the state-wide Arizona Breeding Bird Atlas surveys, carried out by the Arizona Game and Fish Department, with some field work completed by monument staff. Finally, from 1992 to the present, monument personnel have continued to inventory and monitor the endangered cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*).

Avian Monitoring Protocol, 1997-2004

No avian monitoring was done in 1996, due to changes in staff, work priorities, and questions regarding the monitoring protocol. In 1997, a new avian monitoring protocol was developed. This change in technique was motivated by two factors: 1) a desire to move closer to the more broadly-accepted standard of point-count transects, and; 2) concerns that the previous belt-transect protocol was ill-suited to Sonoran desertscrub avian communities. The revised monitoring protocol was developed by OPCNM staff biologists with ornithological backgrounds (J. Petterson, T. Tibbitts, and L. Dickson). The revised protocol was carried out as a pilot project in 1997, then slightly adjusted in both 1998 and 1999. A summary of the genesis and evolution of avian monitoring protocols is presented in Table 8-1. Expanded discussion of the methods used from 1997 to 2001 follows Table 8-1.

Methods

The methods presented below describe the final form of the protocol, as it was implemented unchanged from 1999 through 2004.

1997-1998

Eight transects were established in 4 major habitat types: mountain slopes, xeroriparian corridors, bajadas, and valley floors. Two transects were placed in each habitat type. These were placed through or adjacent to existing Ecological Monitoring Program sites where possible; at Growler Canyon, East Armenta, Bull Pasture, Senita Basin, and Middle Bajada. Three transects (Growler Canyon, Cuerda de Leña, Kuakatch)

Table 8-1. History of methods for general avian monitoring at Organ Pipe Cactus N.M., Arizona.

Years	Methods
1994-1995	Protocol of Johnson and Hiatt (1992 and 1995) implemented: 7 belt transects located at "Core I" Ecological Monitoring Program sites. Observers walked transects of up to 1.5 km in length, continually counting all birds seen or heard along route, within a variable width of 20 m to 60 m. Three replicates of each transect were sampled during the spring breeding season.
1996	No monitoring was done, due to staffing shortages.
1997	New protocol developed by ORPI staff (see text for full discussion). Eight transects were established in 4 major habitat types: mountain slopes, xeroriparian, bajadas, and valley floors. Two transects were placed in each habitat type, overlaying existing EMP sites where possible. Each transect consisted of 16 point-count stations spaced at 250 m intervals. Each point-count was an unlimited-radius count of 5 minutes' duration. Bird detections were separated into two distance categories: those less than 50 m from observer and those greater than 50 m. Point-count transects were begun at (or within 10 minutes after) sunrise, and all stations within a transect were completed consecutively, separated only by walking time between them. Each transect was sampled only twice in 1997, due to the late date at which new personnel reported to work.
1998	The 1997 protocol modified as follows (see text for full discussion): <ol style="list-style-type: none"> 1. The detection distance separation was increased to 100 m, because few birds are detected within 50 m of the observer 2. Each transect/point-count station was sampled three times, to span the majority of the long Sonoran Desert breeding season (late February to early May).
1999-2004	1997-1998 protocol modified as follows (see text for full discussion): <ol style="list-style-type: none"> 1. The interval between point-count stations was increased from 250 m to 500 m, and the number of point-counts per transect reduced from 16 to 8. These changes were made due to time constraints and double-counting some individual birds at closer intervals between point-counts. 2. The segregation of detections into distances from observer was changed to distance bands of: <50m, 50m-100m, 100m-150m, >150m, and birds flying overhead in transit. 3. One valley floor transect was discontinued, and an additional transect established in each of the mountain slope, xeroriparian, and bajada habitat strata. These changes made to maintain adequate data collection for statistical analysis. 4. Point-count duration was lengthened from 5 to 7 minutes. 5. Final protocol: 10 transects of 8 point-counts each, sampled 3 times per spring

used the transects established by Halterman et al. (2000), to allow some degree of continuity with a pre-existing data set, and for the logistical advantage of using point-count stations that had already been marked and mapped. Each transect consisted of 16 point-count stations spaced at 250 m intervals. Each point count was an unlimited-radius count of 5 minutes' duration (Reynolds et al. 1980, Hutto et al. 1986). In 1997, bird detections were separated into two distance categories: those occurring less than 50 m from the observer and those greater than 50 m. In 1998, this distance separation was increased to 100 m, due to the low numbers of birds typically detected within 50 m. Point-count transects were begun at (or within 10 minutes of) sunrise, and all stations within a transect were completed consecutively, separated only by walking time between them. Counts were not conducted during rain or with winds >10 mph. Each transect was

sampled twice in 1997 (due to the late date at which new personnel reported to work) and three times in 1998. The three visits of 1998 and later years were timed to span the majority of the long Sonoran Desert breeding season (late February to early May) (Table 8-2).

1999-2004

The methods of 1997-1998 were modified slightly in 1999, and then continued unchanged through 2004. Experiences in 1997-1998 showed that the 250 m interval between point-counts was too close, resulting in double-counting many individual birds. Also, the 16-point transects took so long to sample that the later point-count stations in each transect were sampled after morning bird activity had substantially declined. Therefore, beginning in 1999, only every-other point-count station was sampled in each transect. This resulted in transects of 8 point-counts at

Table 8-2a. Sampling periods and observers, 1997-2004 avian monitoring, Organ Pipe Cactus N.M.

	Visit 1	Visit 2	Visit 3	Observers
1997		Apr 30 to May 22	May 23 to Jun 5	Petterson, Tibbitts & Dickson
1998	Feb 18 to Mar 3	Mar 23 to Apr 10	May 12 to Jun 1	Petterson, Tibbitts & Dickson
1999	Feb 22 to Mar 1	Mar 17 to Mar 29	Apr 28 to May 9	Petterson & Tibbitts
2000	Feb 25 to Mar 10	Mar 22 to Apr 1	Apr 23 to May 2	Tibbitts
2001	Feb 21 to Mar 9	Mar 23 to Apr 13	Apr 28 to May 9	Tibbitts
2002	Feb 21 to Mar 7	Mar 22 to Apr 3	Apr 25 to May 4	Tibbitts
2003	Feb 22 to Mar 7	Mar 21 to Apr 7	Apr 26 to May 9	Tibbitts
2004	Feb 24 to Mar 7	Mar 23 to Apr 7	Apr 25 to May 5	Tibbitts

intervals of 500 m. Another related modification was the addition of an additional transect in each of the mountain slope, xeroriparian, and bajada habitat strata, to maintain a total number of point-count stations that would generate adequate data for statistical analysis. Also, one valley floor transect was discontinued, because bird detections in that habitat type were too low for statistical treatment. Point-counts were also lengthened to 7 minutes, after a trial period indicated this longer period more accurately sampled bird species and numbers. Finally, detections were segregated into nested distance bands, concentric radii centered on the observer. Distance bands were <50m, 50m-100m, 100m-150m, and >150m. Birds flying over the observer and appearing to be in transit to or from areas lying outside a 200 m radius from the observer were tallied separately. Thus, from 1999-2004, the protocol consisted of the following key elements:

- 10 transects, distributed across four habitat types (Figure 8-1; see descriptions below).
- Each transect consists of 8 point-count stations at 500m intervals.
- Each point-count sampled for 7-minutes' duration per visit.
- Each transect sampled three times each spring. In each of these three sampling periods, all 10 transects are done in as few consecutive mornings as possible (Table 8-2) The ideal of sampling all 10 transects in 10 consecutive days (assuming only one observer) is usually not achieved, typically

due to windy conditions.

- 80 point-counts sampled three times per year for a grand total of 240 point-count station samples per year.

Data collection did not occur in 2005, due to higher-priority activities for staff, and border-related safety issues. The second and third visits (out of 3) to Senita Basin could not be accomplished in 2004 due to border-related safety concerns.

Additional guidelines for carrying out OPCNM avian monitoring point counts:

1. Do not do sampling in inclement weather (raining or winds > 8 mph). Birds will tend to be much less vocal, plus your ability to hear them is diminished.
2. Do not wear a broad-brimmed hat – these obscure and/or deflect sound. Wear a ball cap, visor cap, or no hat. It helps to clip a broad-brimmed hat on your daypack, so you can wear it after the line is completed, while you're walking back to the vehicle.
3. If there is a breeze, face 90 degrees away from it. Breeze creates a lot more sound in your ears, from turbulence, if you are facing directly into or away from it. If you turn 90 degrees from the breeze, it is blowing straight into one ear, instead of blowing across both. It is much quieter that way.
4. In practice, it is usually most productive to census birds by ear for the first 5 minutes

of the point, then scan visually the last 2 minutes. In many habitats, it will take most of 5 minutes to sort out all the audible birds. Then in the final 2 minutes, you can scan with binoculars, picking up birds that are less vocal but more visually conspicuous (Phainopeplas perched high and exposed, or flying; loggerhead shrikes, perched high and exposed; red-tailed hawks and kestrels, perched on top of saguaros; ravens and turkey vultures, flying at up to great distances; black-throated sparrows quietly moving around in foreground).

5. Wear cotton clothing, not nylon or other synthetic Gore-Tex type fabrics. These can be very noisy, creating “swish” sounds every time you move. Even minor foreground sounds like that can substantially reduce what birds you can hear.
6. Point counts are best done alone. If another person is present, they must stand still and quiet while the observer records detections. The sounds created by shifting feet, opening zippers on packs, whispering, eating food, etc., can all mask bird vocalizations.
7. Transects located in xeroriparian areas can be very cold at sunrise, even during the 2nd survey visit. Dress in layers and remember gloves.
8. Record data at each point count, then move quickly to next point. In most cases, the 500m between points can be walked in 4 to 5 minutes. Thus each point takes 12 minutes – 7 to survey the point and 5 to walk to the next. After surveying the 8th (final) point at each transect, sit down and transcribe all data from the front of each data sheet to the back. Doing this immediately reduces transcription errors, because each point is still fresh in memory. This method also assures that the transcription gets done in a timely manner.

Data Recording, Compiling, Entry, and Quality Control

Data consistency was maximized, and observer variation was minimized, by several means. To the maximum extent possible transects were

sampled within the same time period for each of the three visits, across all years (Table 8-2.). Also, to the maximum extent possible transects were sampled in the same order (lowest elevation to highest) during each sample period. Variations in these two strategies occurred, due mainly to weather conditions. For example, windy weather could result in a morning’s sampling being postponed, or that morning’s efforts being redirected to a transect known to be less windy. For 2000 through 2004, one observer sampled all transects on all visits, resulting in very low observer variation. For 1997-1999, three observers of comparable abilities sampled the transects – including the observer who sampled from 2000 – 2004.

Data are recorded onto a standard data sheet. Four-letter codes for birds are written on the data sheet in a spatial representation of where they are detected within the area of each point count. This allows the observer to track where individuals are, to reduce double-counting and to record species as they are detected. At the end of each transect (8 point counts), the observer sits down and transcribes data from the spatial representation on the front page, to a summary on the reverse page, which tallies each species by number of individuals detected within each distance band. During this field transcription, for each sheet (point) the observer checks for transcription errors by any of several methods. The total number of birds listed on the front and back of the data sheet may be compared. Or as a random and partial quality check, the total number of birds in one or more distance bands on page one will be compared with the total number listed in the tally on page two. A similar alternative is that the total numbers for a given species (all distance bands) may be compared. This sometimes partial field data checking was backed up by a complete checking for data transcription and entry errors, at the time of data entry. After data entry, total numbers for each species, for each distance band, for each point were compared. The final totals in the database were compared with the totals reported on both

sides of the data sheets. Where discrepancies were found, the front page of the data sheet was taken to be the true number. This quality checking detected an error of approximately one bird per 8 to 12 point counts. (This translates into about 1 bird of 100 to 200 counted, or an error rate of about 0.5% to 1%) In virtually all cases, the error was a transcription error made when data were transferred from the front page to the back. This error of one bird per 8 to 12 points took one of several forms: a) bird missed - not included on page two; b) extra bird reported on page two; c) bird tallied in wrong distance band on page two; d) bird tallied under wrong species on page two.

Data Analysis

In this report, annual monitoring results for each transect are summarized for 1999-2004. Summaries for 1997-1998 are not comparable without conversion and will be treated in a later report. Equal detectability among sites and years was assumed for all analyses and equal detectability among species was also assumed for analyses involving total detections, species richness, and diversity. Concerns with equal detectability are discussed below under Protocol: Challenges, Limitations, and Potential Biases. Summaries for total detections, species richness, and diversity were calculated as described below.

Total detections – All birds detected during the 7 minute observation period at each point count station. This includes both auditory and visual detections.

Species richness – The number of species detected on a given transect during a given visit.

Diversity - $H' = - \sum (p_i * \ln[p_i])$

where p_i is, for each species i , the total detections for that species divided by the sum of total detections for all species, and \ln is the natural logarithm.

To use all sites and compare relative abundance, species richness, and diversity among years, each

transect was standardized to zero mean and unit standard deviation. Then all transects were averaged for each season and a standard error computed.

Trend Analysis - For each species, total counts for each visit at each transect were calculated. Only the 1999-2004 data were used. Trends were modeled independently for each species by using a generalized linear mixed model (PROC GLIMMIX; SAS) with a year covariate to estimate trend, a visit factor (1, 2, or 3) to control for seasonality, and a random transect effect. The model was specified to have a log link function based on a Poisson distribution with overdispersion.

For some relatively common migratory species, the algorithm failed to converge when all observations were concentrated at one or two visits, with sparse occurrences at the other two or one visits. To determine the trend for those species, we excluded certain visit(s) from the modeling of that species. For example, WWDO was observed 4, 2, and 1607 times during visits 1, 2, and 3, respectively, and the algorithm failed to determine a trend based on the three visits; therefore we determined a trend based on visit 3 only. Similarly, we determined trends for BCFL, BHCO, WETA, and TOWA based on visit 3, trends for HOOR, TUVU, WEFL, PYRR, BHGR based on visits 2 and 3, a trend for DEJU based on visits 1 and 2, and trends for LASP and HOLA based on visit 2.

Habitat Types and Study Sites

Four general bird habitat types were identified, based on differences in vegetation associations, physiography, and other factors affecting the makeup of avian communities. Bird transect site locations are shown in Figure 8-1.

Mountain and rocky slopes - Areas with steep, upland slopes with very shallow, rocky soil and bedrock outcrops varying in elevation from 511 m to 1036 m. Three transects were established at separate sites:

1. Bull Pasture. The transect follows the Bull

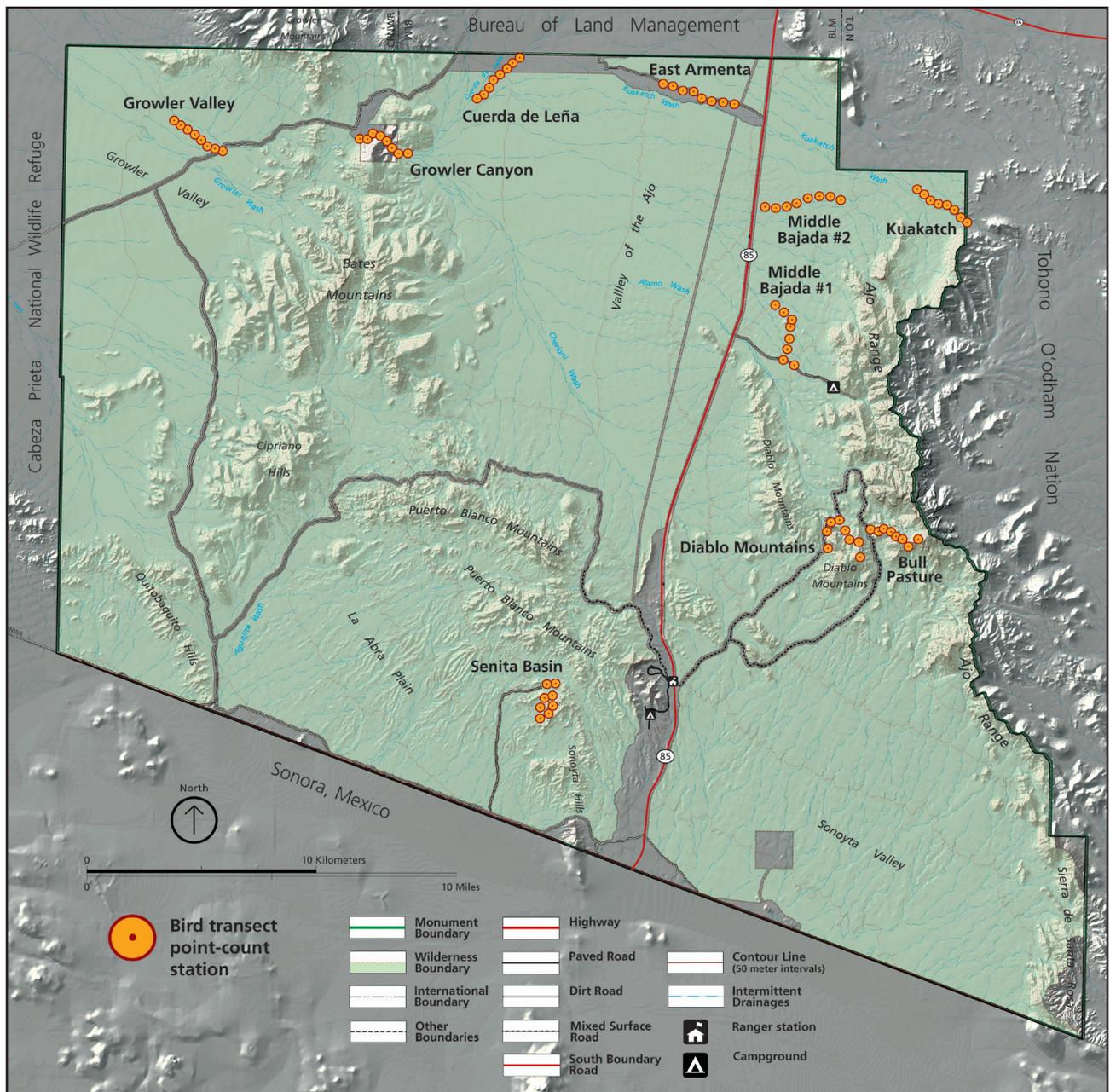


Figure 8-1. Bird transect locations, Organ Pipe Cactus N.M.

Pasture Trail from its origin, continuing approximately 4 km and passing through the Bull Pasture EMP site. The area is characterized by steep mountain slopes, extensive rock outcrops and bouldery areas. Vegetation community is Arizona Uplands desertscrub, with prominent presence of jojoba, jumping bean, agaves, grasses. Notable and distinguishing bird species include: rock wren, canyon wren, Say's phoebe, rufous-crowned sparrow, prairie falcon.

2. **Diablo Mountain.** The transect begins on the Ajo Mountain Drive approximately one-half mile south of the mouth of Diablo Canyon. The transect then follows the Ajo Mountain Drive to Stop 12 near Wild Horse Tank, then ascends along ridgelines, following the east rim of Diablo Canyon. The area is characterized by steep mountain slopes, extensive rock outcrops and bouldery areas. Vegetation community is Arizona Uplands desertscrub, with prominent presence of jojoba, jumping bean, agaves, grasses. Notable and distinguishing bird species include: rock wren, canyon wren, Say's phoebe, rufous-crowned sparrow, prairie falcon.
3. **Senita Basin.** The transect begins just east of the Senita Basin EMP site, at the terminus of the Senita Basin Road. From that point it follows the Victoria Mine Trail eastward approximately 500 m. Then the transect follows a southerly route over the north end of the Sonoyta Hills, eventually curving west and then north again. Vegetation consists of Arizona Uplands Sonoran Desertscrub, with much jatropha, elephant tree, and brittlebush. Notable and distinguishing bird species include: rock wren, canyon wren, Say's phoebe.

Xeroriparian corridors - Identified by major ephemeral desert washes, some with multiple channels, draining large watersheds. Greater availability of water results in extensive stands of large individuals of ironwood, palo verde, catclaw acacia, and mesquite. Large phreatophytic shrubs such as desert broom and canyon ragweed are

also present. Vegetation structure of this strata is more diverse than other habitat types, with bird communities being more diverse also. The three point-count transects are:

4. **Kuakatch.** The transect begins in Kuakatch Wash near OPCNM's northeastern corner, then continues downstream approximately 4 km. The area is characterized by an extensive xeroriparian woodland, passing through middle-bajada desertscrub communities with high densities of saguaro cactus. Avian community is one of the highest density and diversity of all transects. Notable and distinguishing species include: hooded oriole, crissal thrasher, Bell's vireo, Lucy's warbler, numerous neotropical migrants, ferruginous pygmy-owl, zone-tailed hawk, high densities of brown-crested flycatchers.
5. **Cuerda de Leña.** The transect begins in Cuerda de Leña Wash near the point where this drainage enters OPCNM from the north, then continues downstream approximately 4 km. The area is characterized by well-developed xeroriparian woodland, passing through creosote flats. Avian community is relatively diverse. Notable and distinguishing species include: hooded oriole, crissal thrasher, Bell's vireo, Lucy's warbler, neotropical migrants, and vermilion flycatcher.
6. **Growler Canyon.** The transect begins in Growler Wash in Growler Canyon, at a point just south of the Bates Well ranch house, then continues upstream approximately 4 km. The area is characterized by a well-developed xeroriparian woodland passing between basalt hills. Avian community is correspondingly diverse, with high abundances of many species. Notable and distinguishing species include: hooded oriole, crissal thrasher, Bell's vireo, Lucy's warbler, numerous neotropical migrants. Ferruginous pygmy-owl often detected nearby if not on transect.

Bajadas - Consists of broad alluvial deposits with an east-west elevational gradient that drain to the

Valley of the Ajo in the west from their upslope connection to the Ajo Mountains in the east. Soils are well drained and vegetation is dominated by palo verde-bursage-mixed cactus association. The three transects are:

1. East Armenta. The transect begins on the Armenta Road, approximately 500 m west of the powerline, and continues west along the Armenta Road approximately 4 km. The area is characterized by deep sandy loam soils, and a very arborescent expression of Arizona Uplands desertscrub. Avian community is very diverse, with high abundances of many species. Notable and distinguishing species include: purple martin, loggerhead shrike, ferruginous pygmy-owl, Harris' hawk, high densities of cactus wren, ash-throated and brown-crested flycatcher.
2. Middle Bajada #1. The transect begins on the Alamo Road, near the rehabilitating old road to Copper Mountain. The transect follows this old road northward through the "Middle Bajada" EMP site, passing just to the east of Copper Mountain, then curving northwest, and ending approximately 1 km northwest of Copper Mountain. Vegetation community consists of classic Arizona Uplands desertscrub, with extensive saguaro stands. Avian community is relatively diverse, with high abundances of many species. Notable and distinguishing characteristics of avian community are: high densities of all "cactus forest" species: cactus wren, ash-throated flycatcher, brown-crested flycatcher, Gila woodpecker, northern flicker, verdin, black-throated sparrow.
3. Middle Bajada #2. The transect begins approximately 300 m east of Highway 85, on the rehabilitating old road starting at highway mile 61.75 ("Wall's Well Road"). The transect follows this old road eastward approximately 4 km. Vegetation community consists of classic Arizona Uplands desertscrub, with extensive saguaro stands. Avian community is relatively diverse, with high abundances of many species. Notable and distinguishing

characteristics of avian community are: high densities of all "cactus forest" species: cactus wren, ash-throated flycatcher, brown-crested flycatcher, Gila woodpecker, northern flicker, verdin, black-throated sparrow

Valley Floor – Consist of flat topography, sandy loam soils, and low density and diversity of vegetation, typically a simple creosote-bursage community.

1. Growler Valley. The transect begins at the junction of the Bates Well Road and the rehabilitating Paloverde Camp Road, approximately 7.2 km west of Bates Well. The transect follows the Paloverde Camp Road northwestward into Growler valley for a distance of approximately 4 km. Habitat is structurally simple, dominated by a creosote bush-bursage vegetation association (Lower Colorado River subdivision). Most cactus and trees are limited to shallow arroyos which dissect the plain. Avian community is relatively simple, with low abundances of most species. Notable and distinguishing species are: black-throated sparrow; mixed flocks of wintering sparrows. Greater roadrunners often detected here at great distances (>1 km), due to lack of bird sounds within 200 m.

Protocol: Challenges, Limitations, and Potential Biases

No method for sampling organisms in their natural habitat is wholly accurate, nor is any without inherent weaknesses and potential biases. This avian monitoring protocol is no exception. However, the value of an imperfect protocol is increased when the limitations, potential biases, and challenges are identified and acknowledged. The following discussion highlights some of the confounding factors to take into account when implementing this protocol, and when analyzing the results.

Challenges

Like all point-count systems, this protocol relies

heavily on accurate hearing and identification of birds. Over 80% of all detections are made by ear alone, so observers must have normal (or corrected to normal) hearing, and must be competent in identifying vocalizations of all species that breed, winter, or migrate through the study area.

Myiarrchus flycatchers: One of the greatest challenges in identifying Sonoran desert birds is distinguishing the vocalizations of ash-throated (*Myiarrchus vociferans*) and brown-crested flycatchers (*M. tyrannulus*). Observers should take extensive training and practice in making this distinction before using this protocol. This is important because both species are very common in the study area, in part of the breeding season. In most years, only ash-throated flycatchers are present up until the end of March. However, by the 3rd sampling visit in April-May, brown-crested flycatchers may equal or outnumber ash-throated flycatchers in many areas.

Large finch distinctions: Another demanding distinction between species' vocalizations is distinguishing the northern cardinal (*Cardinalis cardinalis*) and the pyrrhuloxia (*C. sinuatus*). Once again, observers should invest extensive study time with tapes or other recordings to learn to distinguish the vocalizations of these species. To a lesser extent, one of the call vocalizations of the canyon towhee (*Pipilo fuscus*) can also be confused with the cardinal and pyrrhuloxia, particularly for less-experienced observers. Finally, the green-tailed towhee (*P. chlorurus*) is a common migrant in some areas (e.g. Kuakatch, Growler) and can be confused with the resident canyon towhee. Calls of the rare vagrant catbird (*Dumetella carolinensis*) may be mistaken for the green-tailed towhee.

Mockingbird noise: In some years, northern mockingbirds (*Mimus polyglottus*) are very common, a combination of both resident breeders and migrants. During these years, mockingbirds can substantially confound this and any other aural-based protocol. Mockingbirds sing loudly, incessantly, and may mimic vocalizations of

virtually any resident bird, migrants, and birds that essentially never occur in the Sonoran Desert. As few as 2 or 3 mockingbirds within 100 m of the observer can result in a "wall of sound" effect that drowns out the vocalizations of most other birds. Furthermore, the mockingbird's repertoire creates the hazard of mistaking its imitated calls with those of the real species.

Limitations

This protocol takes advantage of the ability to detect numerous bird species during the dawn hours, when their vocalizations and general behavior make them relatively obvious. However, nocturnal birds such as owls, nighthawks, and poorwills are sampled poorly by this protocol, if at all. Those species (approximately 9 total) range from uncommon to very common. Some, such as elf owls (*Micrathene whitneyi*) and lesser nighthawks (*Chordeiles acutipennis*), occur at fairly high densities and are probably of substantial ecological influence.

Some diurnal birds are detected infrequently, either because of low population densities and/or life history characteristics. Of recurring interest is the question of gaging populations of resident raptors, e.g. red-tailed hawk (*Buteo jamaicensis*), Harris' hawk (*Parabuteo unicinctus*), American kestrel (*Falco sparverius*), prairie falcon (*F. mexicanus*), turkey vulture (*Cathartes aura*), and golden eagle (*Aquila chrysaetos*). Also, several raptors are present in the Monument for 6 months or more each year, as winter residents and/or migrants. These include: sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*A. cooperi*), red-tailed hawk (*B. jamaicensis*), and northern harrier (*Circus cyaneus*). In general, both resident and migrant raptors occur at fairly low densities and are not vocally conspicuous, except in the immediate nest area. All are detected by the current protocol, but infrequently. As predators and scavengers, these birds exert significant ecological influence, and should be of interest in long-term ecological monitoring. This ability of this protocol to accurately sample raptors has not been tested.

Potential Biases

Most potential biases associated with this protocol arise from probabilities of detection that vary between species, and between survey conditions. Several examples follow.

Gnatcatcher undercounts. The black-tailed gnatcatcher (*Polioptila melanura*) is among the most common and abundant species in OPCNM. However, its vocal characteristics probably result in it being undercounted or underestimated in aural surveys. The gnatcatcher is detected at virtually all 80 point-count stations, on all visits. But its relatively soft vocalizations do not carry well, especially through other, louder vocalizations and background noise. As a result, several individuals of this species are typically detected within the 50-meter distance band, but few or none beyond that. In reality, gnatcatchers probably occur at relatively high densities throughout the area covered by each point, but are only detectable close to observers.

Roadrunner population “dynamics”. The greater roadrunner (*Geococcyx californianus*) is irregularly detected using this protocol. We have become aware of a general trend in the pattern of detections. The converse of the black-tailed gnatcatcher, the “cooing” call of the roadrunner is a low-frequency sound that carries in excess of a kilometer under quiet, calm conditions. However, this sound is often masked when the acoustic foreground is busy with loud, highly various vocalizations of other birds. As a result, the roadrunner is detected fairly often on the Growler Valley transect, where bird densities are low and there is little interfering noise. Conversely, the roadrunner is rarely detected in more productive habitats where the density and diversity of other birds are high. Even though the roadrunner would be expected to be more abundant in the more productive habitats, the data would suggest it is less common. Perhaps illustrating this effect further is the observation that in very dry years (e.g. 2002, unpubl. data), when all transects had greatly reduced bird detections, the detections of roadrunners actually increased. This may

be because roadrunners simply become more detectable under any conditions where there are fewer general bird vocalizations near the observer.

Black-throated sparrow undercounts: The black-throated sparrow is among the most common and abundant birds on virtually all transects. And although it is usually detected readily, this species tends to vocalize more through the heat of the day (after transects have been completed) than at dawn. For this reason, and also acoustic factors similar to those for the black-tailed gnatcatcher, this protocol may under-represent true densities of black-throated sparrows.

Results

A summary of transect completion is presented in Tables 8-2a and 8-2b. We sampled 11 transects a total of 216 times from 1997 through 2004. One transect (Growler Valley 2) was discontinued after 1998. Three transects (Diablo, East Armenta, Kuakatch) were not initiated until 1999. Apart from these modifications, sampling was missed on only 4 occasions over the 8 years. The 3rd sample visits were missed at both Growler Valley transects in 1997, possibly due to timing (too late in the year). In 2004, the 2nd and 3rd sample visits to Senita Basin were cancelled due to high levels of border-related illegal activity in the area. Our efforts to complete all transects in as few days as possible, for each of the three annual visits, were successful considering weather and other limitations. Our efforts to complete each of the three annual visits on approximately the same dates from year to year were similarly successful.

Average detections, species richness, and diversity are summarized in Table 8-3 for each transect for each year. Total bird detections increased slightly through those years, with a low point in 2002 (Figure 8-2). Bird species richness and diversity were fairly constant from 1999 through 2004 (Figure 8-3 and 8-4).

Discussion

This monitoring protocol has been in place for

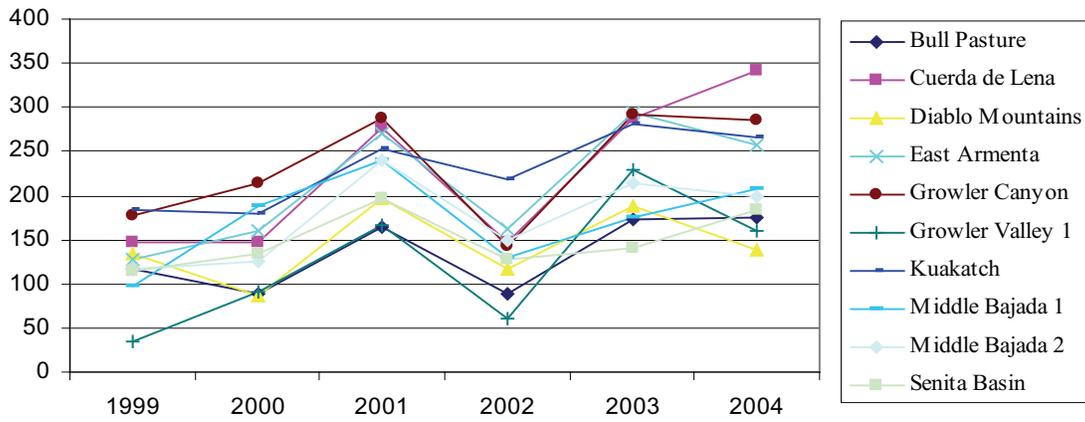


Figure 8-2. Mean detections among 3 visits to avian monitoring transects at Organ Pipe Cactus N.M.

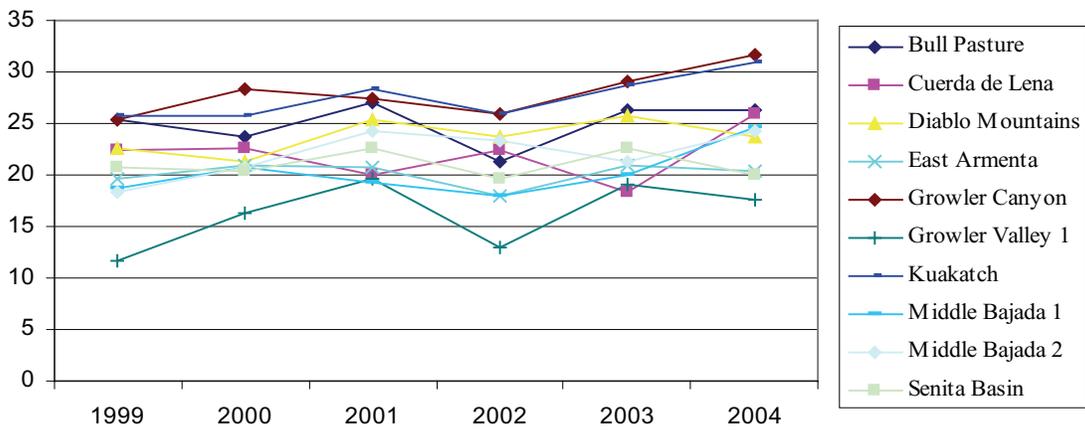


Figure 8-3. Mean species richness among 3 visits to avian monitoring transects at Organ Pipe Cactus N.M.

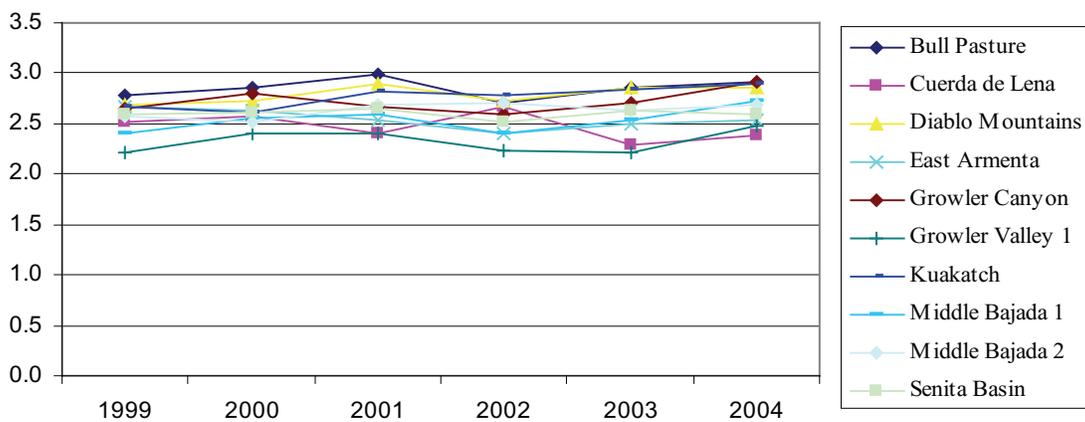


Figure 8-4. Mean diversity among 3 visits to avian monitoring transects at Organ Pipe Cactus N.M.

a relatively short period of time. We are still in the process of building baseline information. Long-term population trends cannot be identified yet, however good examples of year-to-year variation are accumulating. Fortunately, observer consistency has been very high (Table 8-2), so observer variation between transects and between years is correspondingly low. As a result, year-to-year changes in abundances of some species should already be identifiable.

Selecting the four broad habitat types for sampling did result in the transects yielding patterns in bird species composition. The total number of bird detections varied considerably between transects and habitat types (Figure 8-2). Not surprisingly, transects located in areas with greater density and diversity of vegetation yielded greater avian density and diversity. The greatest number of total detections were in xeroriparian areas (Growler Canyon, Kuakatch, Cuerda de Leña), followed closely by bajada habitats (East Armenta, Middle Bajada 1 and 2) (Figure 8-2). The lowest numbers of detections were generally in Growler Valley, although rocky mountain slope habitats were also low (Senita Basin, Diablo Mts, Bull Pasture). Detection numbers in the most productive habitats were generally about three times those for the least productive sites.

Species richness varied considerably between transects (Figure 8-3). The variation followed a pattern similar to that of total detections, with an interesting difference. The open, structurally simple, sparsely vegetated habitat of the Lower Colorado River Subdivision on the Growler Valley transect had the lowest species richness. Conversely, the large, well-developed Arizona Upland xeroriparian habitats (Growler Canyon, Kuakatch) yielded the highest species richness. Interestingly, although rocky mountain slope habitats (Bull Pasture, Diablo, Senita Basin) yielded low total detections, species richness on those transects usually equaled or exceeded that of the highly-productive bajada habitats. In fact, species richness on the rocky slope transects equaled and sometimes exceeded that of the

smaller xeroriparian transect (Cuerda de Leña). High species richness of the rocky mountain slope habitats is likely because they often contain almost all the species present on bajadas (just in lower numbers), but then also support other species that are closely associated with the rocky habitat and are not present on bajadas (e.g. rock wren, canyon wren, rufous-crowned sparrow, Say's phoebe). Species richness at the highest-ranking sites was approximately twice that of the lowest ranking sites.

Mean diversity also varied among transects (Figure 8-4). Two of the three rocky mountain slope transects (Bull Pasture, Diablo) ranked highest for mean diversity. The reason for this is likely the same as for species richness; the rocky slope transects detected most bajada species plus some that occur exclusively on rocky slopes. The Growler Canyon and Kuakatch xeroriparin transects ranked just below rocky slopes in mean diversity. And again, the valley-floor habitat of the Growler Valley transect ranked lowest.

Data from 1997-2004 indicate an increase in total bird detections over those years. This apparent increase is difficult to evaluate without a better measure of the typical year-to-year variance. Additional years of data collection, spread over years of varying climatic conditions, would better define the normal variance. Even so, it appears that increased detections are statistically significant, for some species (Table 8-4.) Before discussing possible increases, it should be noted that increased detections may or may not equate to increased numbers of real birds on the transects. The fact that a single observer sampled all transects in 2000 through 2004 probably reduced observer variation. However, if the observer's skills increased over time (likely), that may have resulted in greater numbers of detections. For example, "Unknown bird" detections declined by 65.6% annually. It is likely there was a corresponding increase in the number of birds successfully identified to species. This alone could account for some apparent increase in bird detections.

Among the species showing a pronounced increase were Brewer's sparrow, white-crowned sparrow, lesser goldfinch, green-tailed towhee, and ferruginous pygmy owl. Considering the sheer numbers involved, the increases in Brewer's and white-crowned sparrows are likely real (Figure 8-7). These wintering seedeaters appeared to respond to the two moist winters following the extreme drought year of 2002 (See Climate chapter), by wintering in OPCNM in large numbers. While the increase in lesser goldfinches was statistically significant, the real increase was from about 40 detections in 1999 to about 70 in 2004. This is not a large number of detections from which to make conclusions about the species' status. Similarly, the 89.4% annual increase in green-tailed towhees (Table 8-4) was statistically significant, but may not have been ecologically significant. The real increase was from almost no detections in 1999 to slightly fewer than 50 in 2004. Once again, these are not many detections from which to draw conclusions. Increasing observer skills could have resulted in increased detections of this species (see above). Also, like many other wintering and migrant birds, this one typically occurs in a few fairly specific habitats (xeroriparian in this case). Occurrence of migrant birds in such habitat patches on a given day is likely affected by numerous factors such as weather, landscape-scale habitat conditions, random chance, and other factors independent of conditions on that transect on that particular day. Migratory species also tend to exhibit wider variation between visits within each year.

A species' natural history must also be considered in interpreting trend data. The 79.4% annual increase in ferruginous pygmy-owls is statistically significant and sounds substantial. However, that apparent trend is based on fewer than 15 detections in the final year, after that significant increase. In reality, the appearance of one new territory near a transect in 2004 resulted in some increased detections, and was perhaps a positive indicator of this sensitive species increasing in numbers. But at the same time, pygmy-owl males

tend to be more vocal, for longer in the spring, if they are having poor success attracting mates. So increased aural detections, particularly in April and May, might actually suggest trouble for the local population.

The monument's avifauna can be separated into three major categories of birds, according to residency status. These are:

- Permanent residents: Present year-round and breed here.
- Migrant breeders: Species that breed here but migrate out of the monument for part of the year.
- Migrants: Species that migrate through the monument and/or winter here, but do not breed here.

These categories are useful for considering changes in the avian community over time. However, these categories are not perfectly discrete. Some species fall into more than one of these categories. For example, some species include both individuals that breed here, and also some that occur in the monument in winter and/or migration, but breed farther north. These species include: red-tailed hawk, northern mockingbird, loggerhead shrike, northern cardinal, turkey vulture, Bell's vireo, phainopepla, mourning dove, and others.

These residency categories may be useful to gage changes in the monument's ecosystems. For example, global climate change or other habitat changes may affect the migratory or residency behaviors of some species. Residency categories provide a useful framework to consider the year-to-year variations in detections recorded between 1999 and 2004.

The most apparent pattern in the avian monitoring data is for the year 2002, when total detections, mean detections, species richness, and (to a lesser extent) mean diversity all declined (Figures 8-2, 8-3, 8-4). A recent, severe drought peaked in 2002 (see "Climate" chapter). In 2002,

birds may have avoided the drought-affected region that year, due to the severe conditions. Numbers of permanent residents, migrant breeding birds, and migrant/wintering birds were lower in 2002, probably due to a combination of real reductions in presence and reduced activity levels among birds. Reduced activity, particularly singing, would make birds less likely to be detected. Birds may be present but not vocalizing or engaging in other obvious activities, making them largely undetectable by point count methods.

Permanent residents also strongly showed a decline in detections in 2002 (Figure 8-5). This group includes many of the most common species in OPCNM. The decline in 2002 was observed for almost all permanent residents. One apparent trend was that the decline was perhaps less pronounced in species detected in the lowest numbers. Presented graphically (Figure 8-5), the decline appears most severe in the most abundant species (e.g. Gambel's quail, mourning dove, phainopepla). Many of these species experienced declines to approximately one-third the number of detections in other years.

Few permanent residents appeared to have an opposite trend, with detections increasing or remaining constant in 2002 (e.g. cactus wren and black-tailed gnatcatcher). This may have been an artifact of the acoustic environment. When the overall number and variety of bird sounds are greatly reduced, several types of vocalizations become more audible. These include low-frequency calls at great distance (common raven, greater roadrunner), and soft, high-frequency calls nearby (black-tailed gnatcatcher). We suspect detection rates for some of these species were enhanced in 2002 by this effect, possibly even to the point of masking actual declines in these species in that year. A greater proportion of common permanent residents exhibited a downward spike in detections in 2002, compared to migratory breeders and wintering/migrant species (Figures 8-5 to 8-7). This may be intuitive in that, as permanent residents, they were in the

monument throughout the drought, experiencing physiological stresses without departing to other areas for relief.

A smaller proportion of common migrant birds that breed in OPCNM exhibited a downward spike in detections in 2002, compared permanent residents (Figure 8-6). As noted above, migratory species may have been able to cope with the drought better because they can move to other areas, perhaps less drought-stricken, for a large part of the year. The two migratory breeders with the greatest declines in 2002 were white-winged dove and brown-crested flycatcher. Both species are very closely tied to saguaro cactus, so their status might be of particular interest in long-term drought continues. The white-winged dove is one of the most abundant species in the monument during the months it is present, with detections comparable to Gambel's quail and mourning dove. This is also a relatively large bird, meaning it accounts for a substantial portion of bird biomass through the spring-summer months. White-winged doves appeared to have rebounded in 2003.

Several migrant-breeder species apparently increased in 2002 and/or in the years after. These included turkey vulture, Lucy's warbler, ladder-backed woodpecker, and Scott's oriole. Turkey vultures may have increased because of the availability of drought mortality of many wildlife species. However, turkey vulture detections include migrants that do not breed in OPCNM. So sighting a single kettle of 50 migrant vultures could have substantially affected this apparent trend. The increase in Lucy's warbler is of considerable interest. This species is almost completely restricted to mesquite habitats (Corman and Wise-Gervais 2005). Mesquite may be recovering in some parts of OPCNM, following the cessation of livestock grazing in the late 1970s. However, mesquite mortality is also being observed throughout the monument as a result of the continuing drought. Lucy's warblers thrive in mesquite stands that include standing dead trees. The relationship between

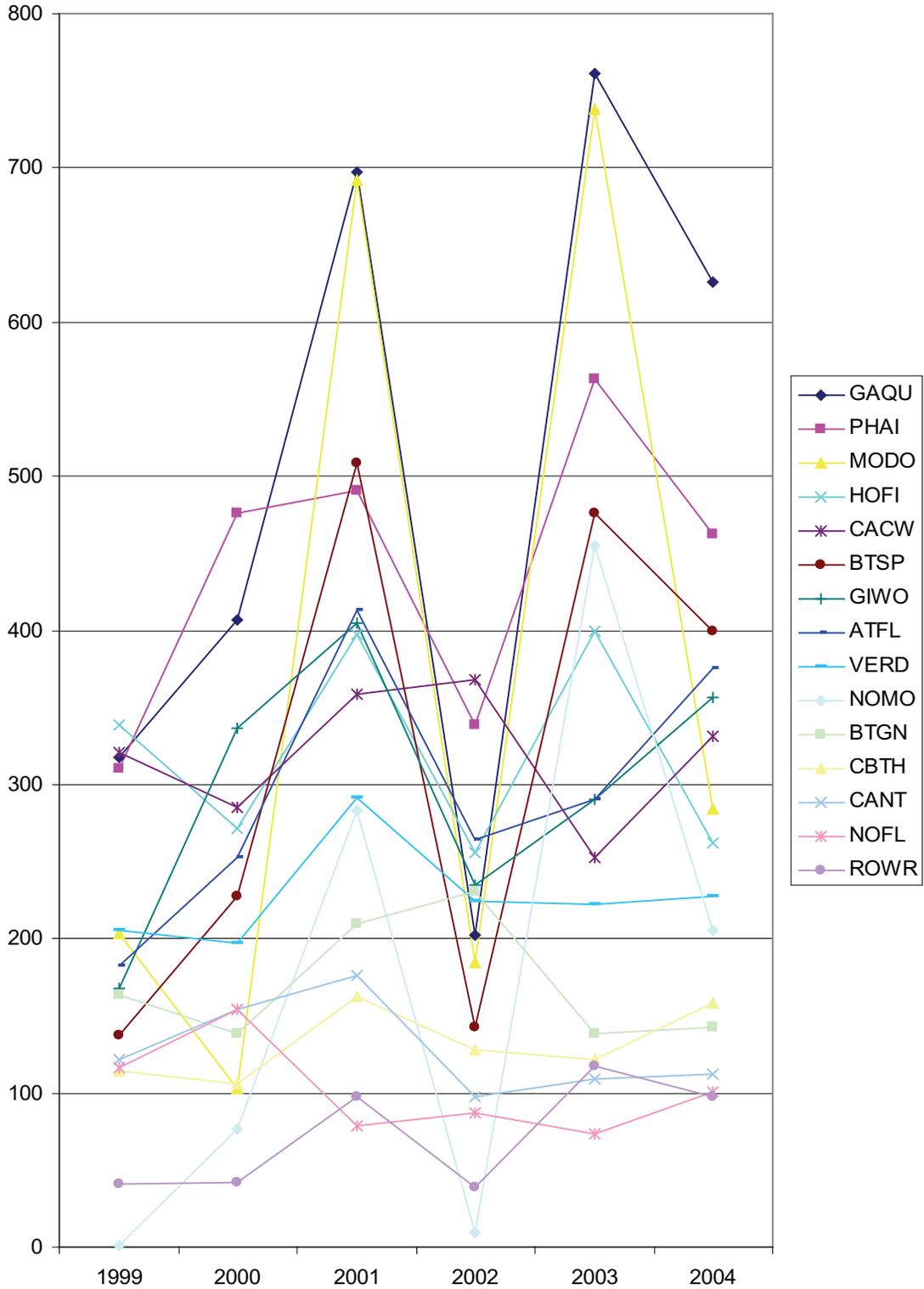


Figure 8-5. Total detections of the 15 most common permanent resident bird species on avian monitoring transects at Organ Pipe Cactus N.M., 1999-2004.

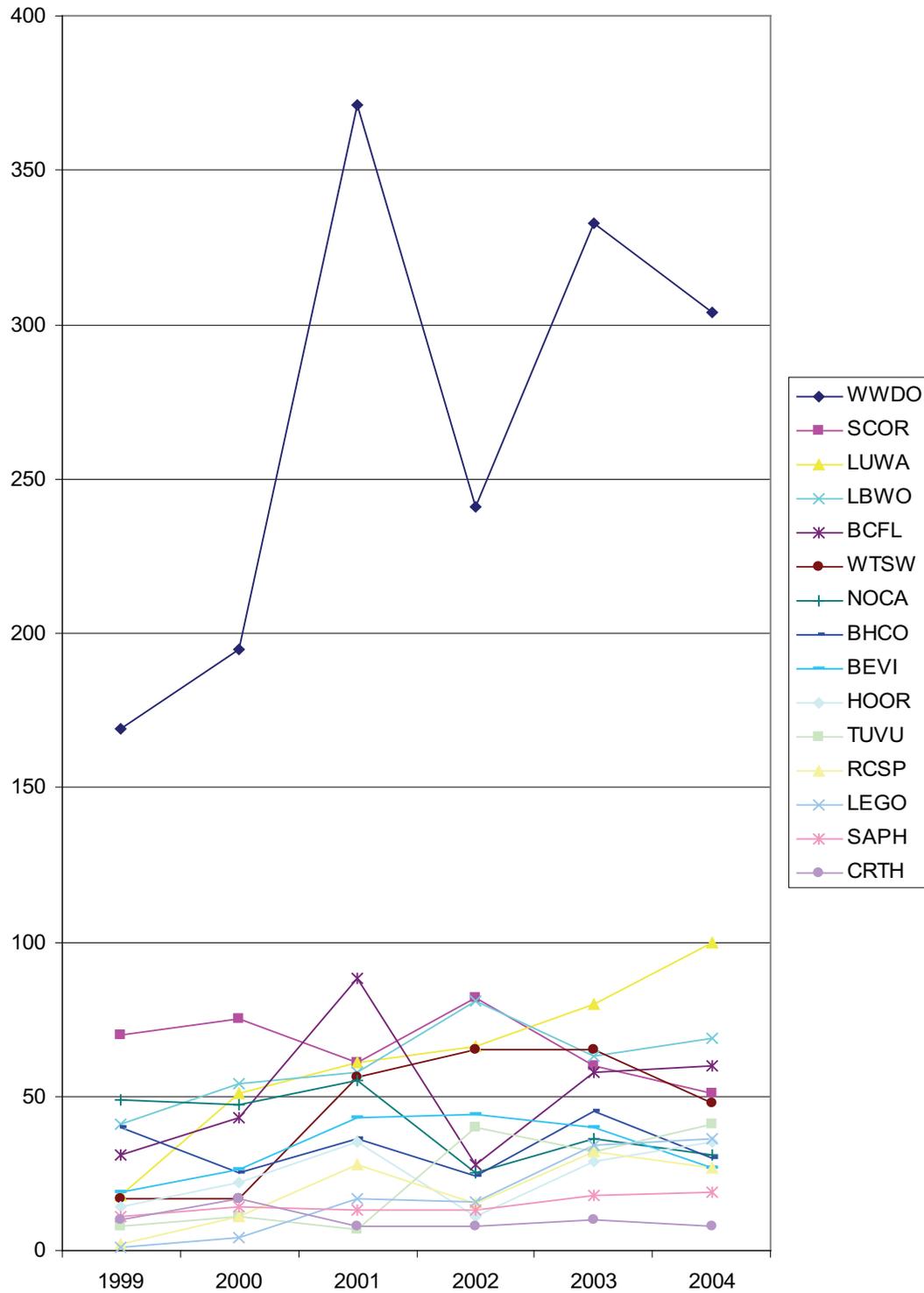


Figure 8-6. Total detections of 15 migrant breeding bird species on avian monitoring transects at Organ Pipe Cactus N.M., 1999-2004.

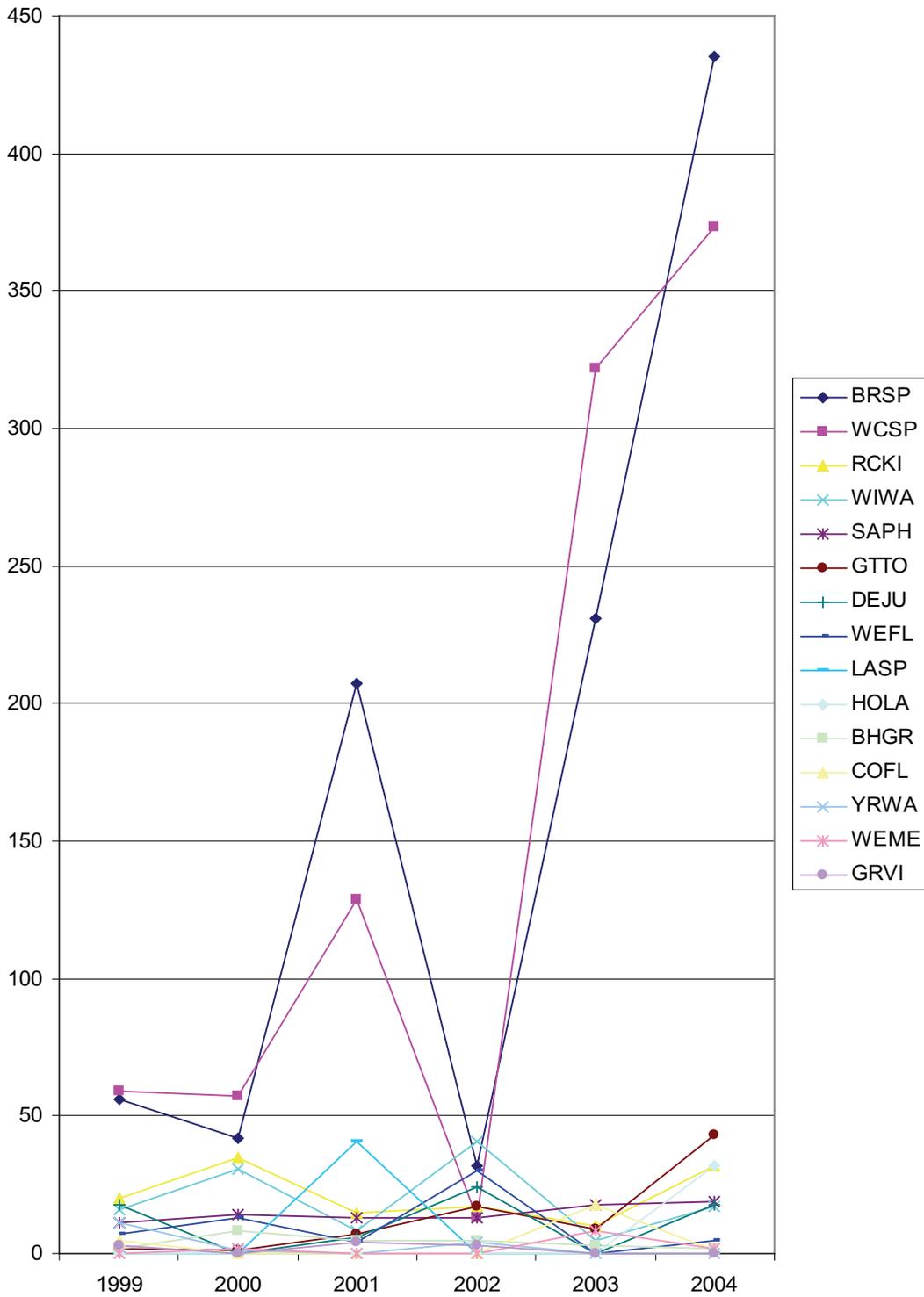


Figure 8-7. Total detections of the 15 most common migrant wintering bird species on avian monitoring transects at Organ Pipe Cactus N.M., 1999-2004.

the trend of mesquite and Lucy's warbler in OPCNM could be a very interesting component of long-term change in vegetation and climate. Finally, the increased detections of Scott's oriole and ladder-backed woodpecker in 2002 elicit no obvious explanations. Neither increase is readily explained by the acoustic factors discussed above, and there are no apparent characteristics of habitat or natural history to explain the increases.

With two notable exceptions, wintering/migrant birds that do not breed in OPCNM did not decline in 2002 (Figure 8-7). Almost all wintering/migrant species were detected fewer than 50 times in any year. Most showed no change or modest increases, all of which could be explained by the normal variance in migration. The two exceptions were Brewer's sparrow and white-crowned sparrow. These two finches can winter in large numbers in OPCNM. Ironically, they favor open, lower-bajada and valley-floor habitats where overall bird detections, species richness, and diversity are lowest. These sparrows are typically detected in large numbers on the Growler Valley transect, and the Cuerda de Leña xeroriparian transect which is framed by open creosote flats. In these settings, these sparrows appear to be attracted to the expansive growths of low-stature winter annual plants (e.g. *Plantago insularis*) that appear after adequate winter rains. As wintering birds, they can opportunistically occupy areas that have winter annual growth, and avoid those without. It is not surprising then that they exhibit a typical boom-and-bust occurrence (Figure 8-7), almost absent in dry years but abundant in years of adequate winter rains (e.g. 2001, 2003, 2004).

Sonoran Desert Network

Terrestrial bird monitoring was selected as one of 25 vital signs by the Sonoran Desert Network (Mau-Crimmins 2005). Network and OPCNM staff met in October 2005 to discuss integration of the EMP with the regional network. A copy of OPCNM bird data was provided to SODN to aid in protocol development. It is possible that SODN

may use point counts along with mist netting and banding, nest searching and monitoring, and periodic vegetation sampling. Monument biologists will continue to work with the network on protocol development and integration of EMP and SODN bird monitoring projects. Network objectives for bird monitoring include:

1. Determine annual changes in species composition and abundance of land birds in grassland, riparian, and upland communities in SODN parks.
2. Determine annual changes in the productivity of land birds in SODN parks.
3. Determine if trends in land bird species composition or abundance in SODN parks differ from regional trends.

Recommendations

1. Complete data analysis and interpretation.
2. Evaluate whether the existing data and protocol meets management and monitoring objectives.
3. Establish transects along and near the south boundary, to monitor for increases in nonnative and/or anthropogenic species associated with human activities in Mexico (e.g. European starling, English sparrow, brown-headed cowbird, great-tailed grackle, domestic fowl, black vulture).
4. Establish monitoring programs for other species most likely to be affected by changes (e.g. common raven, turkey vulture).
5. Establish monitoring programs for species most closely tied to the monument's fundamental purposes (Sonoran Desert): brown-crested flycatcher, elf owl, white-winged dove, verdin, Harris' hawk, gilded flicker, Gila woodpecker, cactus wren.

Acknowledgements

The avian monitoring program reported here

was established largely by former OPCNM Ecological Monitoring Program Manager Jim Petterson (1997-1999). This monitoring protocol was patterned after, and uses some of the same transects as, a study carried out in the mid-1990s by researcher Lara Dickson. During her subsequent tenure as an OPCNM Biological Technician in 1997-1998, Lara also assisted with field data collection. Volunteers Beverly and Luther Walls did extensive data entry and data checking in 2005. Julie Yee (Statistician, U.S. Geological Survey, Western Ecological Research Center) provided the trend analysis.

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Figure 8-2b. Date of each visit to each avian monitoring transect at Organ Pipe Cactus N.M., 1997-2004.

Year-visit	Bull Pasture	Cuerda de Lena	Diablo Mountains	East Armenta	Growler Canyon	Growler Valley 1	Growler Valley 2	Kuakatch	Middle Bajada 1	Middle Bajada 2	Senita Basin
1997-2	Apr 30	May 8			May 4	May 8	May 11		May 7	May 14	May 22
1997-3	May 23	May 23			Jun 1				May 17	May 26	Jun 5
1998-1	Mar 3	Feb 25			Feb 18	Feb 23	Feb 18		Feb 25	Feb 19	Feb 25
1998-2	Apr 10	Mar 23			Mar 28	Mar 27	Apr 3		Apr 7	Mar 27	Mar 24
1998-3	Jun 1	May 17			May 19	May 29	May 12		May 18	May 15	May 11
1999-1	Mar 1	Feb 24	Feb 28	Feb 25	Feb 26	Feb 22		Mar 1	Feb 24	Feb 23	Feb 25
1999-2	Mar 24	Mar 20	Mar 29	Mar 27	Mar 19	Mar 17		Mar 28	Mar 23	Mar 25	Mar 22
1999-3	May 7	Apr 28	May 4	Apr 28	May 9	May 3		May 9	May 7	Apr 30	May 8
2000-1	Mar 1	Mar 4	Mar 10	Feb 25	Mar 3	Mar 5		Feb 27	Mar 9	Feb 26	Mar 2
2000-2	Apr 1	Mar 26	Mar 31	Mar 24	Mar 23	Mar 27		Mar 25	Mar 28	Mar 22	Mar 30
2000-3	May 3	Apr 21	May 2	Apr 24	Apr 28	Apr 29		Apr 30	Apr 26	Apr 23	Apr 25
2001-1	Mar 8	Feb 25	Mar 9	Feb 21	Mar 5	Mar 4		Mar 6	Feb 23	Feb 22	Feb 26
2001-2	Apr 11	Apr 4	Apr 12	Mar 26	Mar 30	Mar 27		Apr 13	Apr 1	Mar 23	Mar 28
2001-3	May 9	Apr 30	May 8	May 5	Apr 29	Apr 28		May 6	May 3	May 4	May 1
2002-1	Mar 7	Feb 23	Mar 6	Feb 25	Feb 22	Feb 21		Mar 3	Feb 27	Feb 8	Feb 26
2002-2	Apr 3	Mar 25	Apr 2	Mar 26	Mar 24	Mar 22		Apr 1	Mar 30	Mar 27	Mar 31
2002-3	May 4	Apr 27	May 3	Apr 28	Apr 26	Apr 25		May 2	May 1	Apr 30	Apr 29
2003-1	Mar 7	Feb 26	Mar 6	Feb 27	Feb 23	Feb 22		Mar 2	Mar 3	Feb 28	Mar 1
2003-2	Apr 7	Mar 23	Mar 31	Mar 24	Mar 22	Mar 21		Mar 27	Mar 25	Mar 26	Apr 1
2003-3	May 9	Apr 28	May 7	Apr 29	Apr 27	Apr 26		May 8	May 2	Apr 30	May 1
2004-1	Mar 7	Feb 26	Mar 2	Feb 28	Feb 25	Feb 24		Mar 6	Feb 29	Feb 27	Mar 1
2004-2	Apr 7	Mar 25	Apr 5	Mar 26	Mar 24	Mar 23		Apr 4	Apr 1	Mar 30	
2004-3	May 5	Apr 28	May 4	May 1	Apr 26	Apr 25		May 3	May 2	Apr 30	



Table 8-3. Annual summaries (average of 3 visits) of total detections, species richness, and diversity from avian point count transects at Organ Pipe Cactus N.M., 1999-2004.

Year	Bull Pasture	Cuerda de Lena	Diablo Mountains	East Armenta	Growler Canyon	Growler Valley 1	Kuakatch	Middle Bajada 1	Middle Bajada 2	Senita Basin*
Total detections										
1999	117.7	147.3	133.0	128.0	176.3	34.3	183.7	97.0	116.0	115.0
2000	89.3	147.0	87.3	161.0	213.0	90.3	179.3	189.0	125.0	134.7
2001	164.3	277.3	197.0	270.0	287.3	166.3	252.0	239.3	241.0	196.0
2002	88.3	148.0	116.7	162.3	143.0	61.3	217.7	129.3	149.3	128.0
2003	173.0	287.7	187.3	294.0	292.0	228.7	280.7	176.0	215.0	139.7
2004	176.0	341.0	138.7	258.3	284.3	159.0	265.0	207.0	200.0	184
Mean	134.78	224.72	143.33	212.28	232.67	123.33	229.72	172.94	174.39	149.56
Species richness										
1999	25.3	22.3	22.7	19.7	25.3	11.7	25.7	18.7	18.3	20.7
2000	23.7	22.7	21.3	21.0	28.3	16.3	25.7	20.7	20.7	20.3
2001	27.0	20.0	25.3	20.7	27.3	19.7	28.3	19.3	24.3	22.7
2002	21.3	22.3	23.7	18.0	26.0	13.0	26.0	18.0	23.3	19.7
2003	26.3	18.3	25.7	21.0	29.0	19.0	28.7	20.0	21.3	22.7
2004	26.3	26.0	23.7	20.3	31.7	17.7	31.0	24.7	24.3	20
Mean	25.00	21.94	23.72	20.11	27.94	16.22	27.56	20.22	22.06	21.00
Diversity										
1999	2.78	2.52	2.68	2.67	2.65	2.22	2.67	2.40	2.58	2.59
2000	2.86	2.58	2.73	2.63	2.80	2.41	2.62	2.56	2.53	2.61
2001	2.98	2.40	2.90	2.54	2.68	2.39	2.82	2.59	2.69	2.65
2002	2.71	2.67	2.72	2.41	2.60	2.23	2.78	2.40	2.71	2.51
2003	2.86	2.28	2.86	2.50	2.71	2.22	2.84	2.54	2.63	2.64
2004	2.91	2.38	2.86	2.54	2.92	2.48	2.90	2.72	2.69	2.60
Mean	2.850	2.471	2.790	2.550	2.724	2.325	2.771	2.534	2.637	2.598

* Only one visit in 2004.

Table 8-4. Estimated percent annual change in the 50 most common bird species on point count transects at Organ Pipe Cactus N.M., based trend model.

Species	4-letter Code	Annual Change (%)	Standard Error	95% Confidence Interval	Significance (p)
American Kestrel	AMKE	4.4	7.8	-10.0 to 21.1	0.564
Ash-throated Flycatcher	ATFL	11.8	2.8	6.4 to 17.4	<.001
Bell's Vireo	BEVI	7.5	4.2	-0.5 to 16.0	0.066
Black-tailed Gnatcatcher	BTGN	-0.6	2.7	-5.8 to 5.0	0.840
Black-throated Sparrow	BTSP	18.5	3.9	11.1 to 26.4	<.001
Brewer's Sparrow	BRSP	55.9	11.5	34.8 to 80.4	<.001
Brown-crested Flycatcher	BCFL	9.7	5.8	-1.4 to 22.1	0.088
Brown-headed Cowbird	BHCO	0.7	6.1	-10.9 to 13.7	0.914
Cactus Wren	CACW	1.3	2.7	-3.8 to 6.7	0.627
Canyon Towhee	CANT	-5.2	2.7	-10.3 to 0.2	0.060
Canyon Wren	CANW	11.1	4.6	2.3 to 20.6	0.013
Common Raven	CORA	11.0	6.7	-1.5 to 25.1	0.085
Costa's Hummingbird	COHU	0.9	4.4	-7.4 to 9.9	0.835
Crissal Thrasher	CRTH	-8.4	5.2	-18.1 to 2.5	0.125
Curve-billed Thrasher	CBTH	6.4	3.3	0.0 to 13.2	0.049
Dark-eyed Junco	DEJU	4.9	14.4	-20.1 to 37.7	0.728
Ferruginous Pygmy Owl	FEPO	79.4	18.6	46.2 to 120.2	<.001
Gambel's Quail	GAQU	13.3	3.1	7.3 to 19.7	<.001
Gila Woodpecker	GIWO	7.9	2.7	2.8 to 13.3	0.002
Greater Roadrunner	GRRO	37.2	10.0	18.8 to 58.5	<.001
Green-tailed Towhee	GTTO	89.4	16.1	60.2 to 123.9	<.001
Hooded Oriole	HOOR	13.1	6.5	0.9 to 26.6	0.034
House Finch	HOFI	0.5	3.1	-5.3 to 6.8	0.859
Ladder-backed Woodpecker	LBWO	10.9	4.2	3.0 to 19.4	0.006
Lark sparrow	LASP	-15.9	16.3	-43.1 to 24.2	0.377
Lesser Goldfinch	LEGO	64.0	15.0	36.9 to 96.5	<.001
Loggerhead Shrike	LOSH	-0.1	6.7	-12.5 to 13.9	0.986
Lucy's Warbler	LUWA	26.7	3.9	19.2 to 34.7	<.001
Mourning Dove	MODO	16.3	4.8	7.1 to 26.3	<.001
Northern Cardinal	NOCA	-9.2	4.4	-17.5 to -0.0	0.049
Northern Flicker	NOFL	-8.0	3.2	-14.0 to -1.5	0.017
Northern Mockingbird	NOMO	40.0	7.4	26.2 to 55.4	<.001
Phainopepla	PHAI	6.0	2.4	1.3 to 10.9	0.011
Pyrruloxia	PYRR	4.6	9.0	-11.8 to 24.1	0.604
Red-tailed Hawk	RTHA	7.3	9.2	-9.4 to 27.2	0.412
Rock Wren	ROWR	22.5	4.6	13.8 to 31.8	<.001
Ruby-crowned Kinglet	RCKI	-1.7	4.9	-10.8 to 8.5	0.737
Rufous-crowned Sparrow	RCSP	32.0	7.2	18.6 to 47.0	<.001
Say's Phoebe	SAPH	11.1	6.7	-1.2 to 25.1	0.079
Scott's Oriole	SCOR	-3.7	3.1	-9.7 to 2.6	0.245
Townsend's Warbler	TOWA	-13.4	8.1	-28.3 to 4.5	0.131
Turkey Vulture	TUVU	43.8	16.0	15.3 to 79.2	0.001
Unknown Bird	UNK	-65.6	8.8	-79.3 to -43.0	<.001
Verdin	VERD	2.7	2.1	-1.3 to 6.8	0.190
Western flycatcher	WEFL	-6.4	6.2	-17.9 to 6.7	0.316
Western Tanager	WETA	-7.5	10.6	-26.5 to 16.5	0.501
White-crowned Sparrow	WCSP	58.3	12.3	35.8 to 84.5	<.001
White-throated Swift	WTSW	22.4	6.2	10.8 to 35.3	<.001
White-winged Dove	WWDO	12.2	3.9	4.6 to 20.3	0.002

