Comparison of Techniques for Monitoring Riparian Birds in Grand Canyon National Park

David L. Felley[1]
Mark K. Sogge

National Biological Service
Colorado Plateau Research Station
P.O. Box 5614
Northern Arizona University
Flagstaff, Arizona 86011

Abstract.   The construction of Glen Canyon Dam has had profound effects on the ecology of the riparian habitat of the Colorado River in Grand Canyon National Park. Future changes in water management will continue to affect this environment and long-term monitoring is needed to assess associated changes in riparian resources. We compared the results of point count surveys to walking surveys in these riparian habitats to test their usefulness for monitoring avian populations. Similar numbers of species were detected on walking and point count surveys. Our results show that 5-min point counts are as reliable as walking surveys for detecting species occupying a site. Abundance estimates from point counts and walking surveys were highly correlated ($r^2 = 0.98$). Both point count surveys and walking surveys were effective at generating species lists and providing an index of abundance for birds using riparian habitats in the canyon. However, because the point count survey strictly controls survey effort and reduces observer variability, it is a more appropriate technique to monitor long-term trends in species composition and abundance for many species of riparian-breeding birds in the Grand Canyon.

Key words: Avian monitoring, Colorado River, point counts.

In recent years, much attention has been focused on the conservation and management of southwestern riparian habitats for several important reasons. First, though they cover only a small percentage of the landscape, they provide habitat for a disproportionately large amount of the Southwest's wildlife. For example, 51% of the region's breeding bird species are closely associated with riparian habitats (Johnson et al. 1977). Second, these areas are heavily affected by human influences including livestock grazing, urban

---

[1]Present address: 415 East 25th Street, Cheyenne, Wyoming 82001.

development, and water management (Knopf et al. 1988). The riparian habitat of the Colorado River in Grand Canyon National Park is one of the largest riparian corridors in the Southwest under the management of a conservation-oriented agency, the National Park Service (Anderson and Ruffner 1988). For these reasons, this area is of special importance for conserving wildlife in the arid Southwest.

Management of Glen Canyon Dam has had profound effects on this riparian environment. Vegetation that was limited by annual flooding before the dam to a band high above the current average river stage is referred to as old-high-water-zone (OHWZ) vegetation, while vegetation that has become established since closure of the dam below the OHWZ is referred to as the new-high-water-zone (NHWZ) vegetation. The OHWZ vegetation consists mainly of mesquite (*Prosopis glandulosa*), acacia (*Acacia greggii*), and hackberry (*Celtis reticulata*). The NHWZ vegetation is dominated by salt cedar (*Tamarix chinensis*), seepwillow (*Baccharis salicifolia*), and coyote willow (Salix exigua) (Turner and Karpiscak 1980). The addition of the NHWZ vegetation has greatly increased available avian habitat, altering the riparian breeding bird community by increasing both bird abundance and species richness (Brown et al. 1987:106–117).

Changes in both the NHWZ and OHWZ vegetation will continue for many years, due to changes in water management and the dynamics of plant populations. The OHWZ is slowly dying off and moving down slope as successful reproduction of mesquite and acacia shifts closer to the river (Anderson and Ruffner 1988). The NHWZ has changed under the interim flow regime begun in 1991 (Stevens and Ayers 1994), and will probably continue changing as seral processes take place even if water management remains consistent.

The effects these changes have on the bird species using the riparian habitat will be difficult to understand without quantitative data from long-term monitoring. In the past, walking surveys were used to monitor breeding birds in the Grand Canyon (Brown and Johnson 1985, Brown 1988). We found this method to be fairly accurate (Sogge et al. 1994) in the relatively small patches of vegetation in the Grand Canyon. However, it is labor intensive and lacks strict methodology (straight-line transects, constant travel speed, etc.) to control observer variability or maintain constant survey effort (Emlen 1971). The point count survey has become a generally accepted method of avian monitoring, and has some advantages over walking surveys. By revisiting permanent sites every year and observing a designated area for a specified amount of time, point count surveys control survey effort, minimize observer bias, and collect a sample adequate for statistical analyses of population trends (Hutto et al. 1986, Ralph et al. 1993).

As part of a comprehensive avian monitoring program, we compared the results of point count surveys and walking surveys. Our purpose was to evaluate the utility of point counts for long-term avian monitoring in the Grand Canyon and learn the relationships between the two techniques. Our

objectives were to: (1) compare the species lists produced by the two methods, (2) compare species-abundance estimates of the two methods, and (3) compare the reliability of each method to detect a species known to occur at a site.

Methods

We conducted point counts and walking surveys at 11 sites, each a discrete patch of riparian vegetation, between Lee's Ferry and Diamond Creek on the Colorado River in 1995 (Table 1). Sites varied in size from 1.3–7.4 ha. Point counts and walking surveys were conducted once per month at each site, March–June 1995. On each visit to a site, a walking survey was conducted on one morning and a point count survey was conducted on another. For statistical analyses, walking and point count surveys were paired by site and visit. Walking surveys consisted of one observer walking slowly through the riparian habitat, recording species and numbers of all birds observed during the survey (Brown 1988, Sogge et al. 1994). The survey was considered complete when all parts of the site had been visited. Survey length was constant for each visit to a site. Point count survey methods generally follow the recommendations of Ralph et al. (1993), consisting of repeated 5-min counts from fixed locations. A 50-m radius was used to separate bird detections into two classes– detections within 50 m (50-m point count), and detections within or beyond 50 m (unbounded point count). We located points systematically, 125 to 150 m apart, roughly paralleling the river. We located points along the center of the strip of riparian vegetation, approximately half way between the river and the upland edge of the riparian vegetation. We surveyed as many points as would fit into each site using these criteria. Number of points varied from one to five per site, depending on area, and there were 37 points altogether. Point counts lasted for 10 mins in March and 5 mins from April–June. The total time from the start of the first point count to the end of the last in each site was recorded for comparison of survey effort with walking surveys. All surveys were conducted between one-half hour before sunrise and 10:00. Analyses involved only riparian breeding birds, excluding migrants and upland breeders.

To determine the most efficient point count duration, we calculated the accumulation of new species and new individuals in successive 2-min intervals of a 10-min count period in March (Hutto et al. 1986). We made comparisons between three methods: walking surveys, 50-m point counts, and unbounded point counts. The mean number of species detected per survey and the mean number of species in common were compared using paired t-tests. We compared the reliability of each method to detect a species at a site given that we knew it occupied that site during the breeding season. We defined reliability of a method as the number of sites at which a species was detected by that method divided by the total number of sites at which that species was

Table 1. Location of study sites for paired walking and point count avian surveys, Grand Canyon National Park, 1995. Location is in river mile below Lee's Ferry, river right (R) or left (L), based on Stevens (1983).

Location	Number of point count stations	Average ($\bar{x}$) walking survey duration (min)
1.0 R	2	35.7
1.6 R	3	26.0
46.0 L	7	81.0
46.7 R	4	29.8
197.2 L	3	43.5
197.6 L	1	22.7
198.0 R	3	29.8
198.2 L	3	40.2
198.3 R	2	22.3
204.1 R	4	53.0
204.5 R	5	89.8

Fig. 1. Mean number of new bird species added in successive 2-minute intervals of point counts in the Grand Canyon, 1995. Error bars = S.E.

detected by any method (including casual observations). Reliability was compared using the Wilcoxon signed-rank test. We compared the abundance estimates of each technique by summing counts from all surveys in the canyon for each technique and each species. Spearman rank-correlation was used to quantify the relationships between abundance estimates of the three methods, for the 12 most common species. All means are shown ± SE.

Results

Average numbers of new species decreased steeply from 2.4 (53% of cumulative total) in the first 2-min interval and then tapered off more gradually during successive intervals (Fig. 1). The same pattern was evident for April–June. The total number of new individuals also declined in the same manner, from 2.1 (55% of cumulative total) in the first 2 mins (Fig. 2). This led us to adopt a standard 5-min count period.

Average survey duration did not differ for walking and point count surveys (walking surveys = 45 ± 3.8 mins; point count surveys = 44 ± 4.1 mins; $t = 0.15$, 77 df, $P = 0.88$). We conducted 40 pairs of walking and point
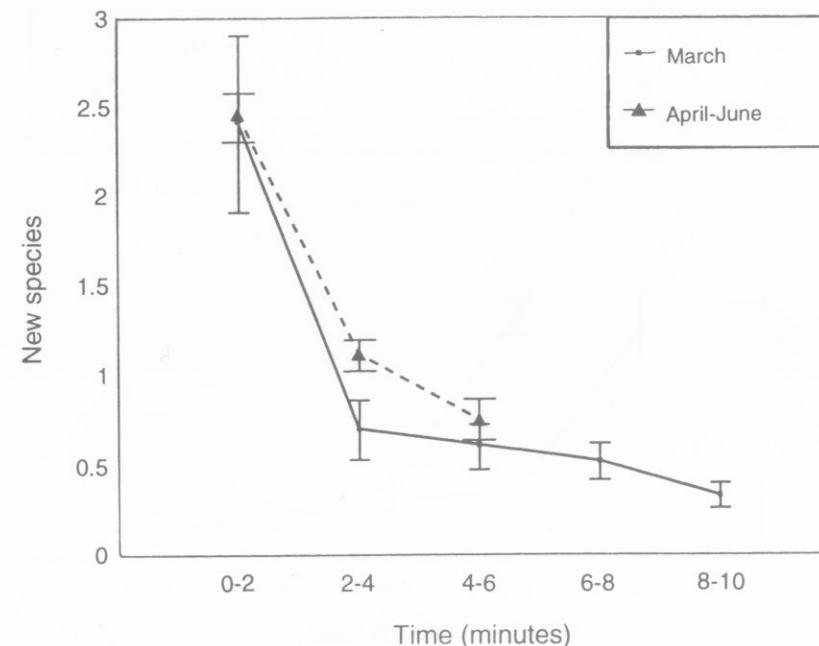
count surveys. The mean number of species detected on walking surveys (7.2 ± 0.5) was greater than on 50-m point counts (5.5 ± 0.4; $t = -4.25$, 39 df, $P < 0.001$), but not on unbounded point counts (6.7 ± 0.5; $t = -1.1$, 39 df, $P = 0.25$). Not surprisingly, fewer species were detected on 50-m point counts than on unbounded point counts ($t = -5.51$, 39 df, $P < 0.001$). Number of species common to paired walking and point count surveys was low; 4.3 species (60% overlap) for 50-m point counts, and 4.8 species (67% overlap) for unbounded point counts.

Of the 22 riparian breeding species present, 10 were observed on fewer than eight point counts. These included the Costa's hummingbird (*Calypte costae*), brown-crested flycatcher (*Myiarchus tyrannulus*), phainopepla (*Phainopepla nitens*), northern mockingbird (*Mimus polyglottus*), blue grosbeak (*Guiraca caerulea*), indigo bunting (*Passerina cyanea*), lazuli bunting (*P. amoena*), brown-headed cowbird (*Molothrus ater*), northern oriole (*Icterus galbula*), and summer tanager (*Piranga rubra*). Because the appearance of such rare species on a survey has more to do with chance than the effectiveness of the survey method, they were excluded from further
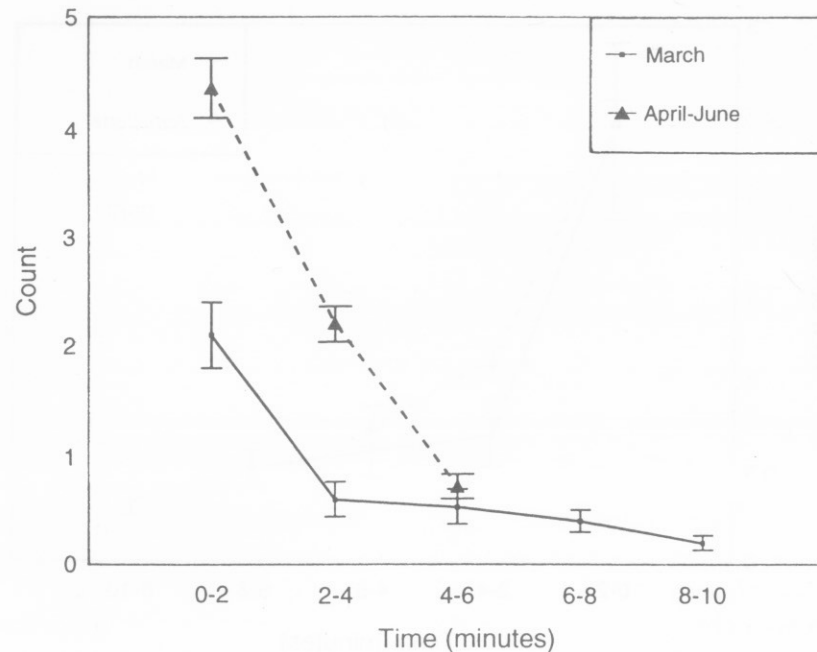
Fig. 2. Mean number of birds counted in successive 2-minute intervals of point counts in the Grand Canyon, 1995. Error bars = S.E.

comparisons. The 12 common species used for comparisons were black-chinned hummingbird (*Archilochus alexandri*), ash-throated flycatcher (*M. cinerascens*), Bewick's wren (*Thryomanes bewickii*) blue-gray gnatcatcher (*Polioptila caerulea*), Bell's vireo (*Vireo bellii*), Lucy's warbler (*Vermivora luciae*), yellow warbler (*Dendroica petechia*), yellow-breasted chat (*Icteria virens*), common yellowthroat (*Geothlypis trichas*), song sparrow (*Melospiza melodia*), house finch (*Carpodacus mexicanus*), and lesser goldfinch (*Carduelis psaltria*).

Overall walking survey reliability was 0.90, ranging from 1.0 to 0.73 for different species (Table 2). Point count survey reliability was 0.76 for 50-m point counts, ranging from 1.0 to 0.40 for different species, significantly different from walking surveys (Wilcoxon signed-rank test, $Z = 2.24$, $P = 0.025$). Point count survey reliability was 0.89 for unbounded point counts, ranging from 1.0 to 0.50. This was not significantly different from walking surveys ($Z = 0.25$, $P = 0.80$).

Table 2. Reliability of walking and point count surveys to detect bird species in Grand Canyon National Park, 1995. Reliability of a method = # of sites at which the species was detected by that method/# of sites at which the species was detected by any method.

Species	Walking	50-m radius point count	Unbounded point count
Lucy's warbler	1.0	1.0	1.0
Bell's vireo	1.0	1.0	1.0
Blue-gray gnatcatcher	0.91	1.0	1.0
Bewick's wren	0.73	0.73	1.0
House finch	1.0	0.82	1.0
Black-chinned hummingbird	0.91	0.91	0.91
Lesser goldfinch	1.0	0.86	0.86
Song sparrow	0.89	0.67	0.78
Ash-throated flycatcher	0.91	0.54	1.0
Yellow-breasted chat	0.89	0.56	0.89
Yellow warbler	0.78	0.75	0.75
Common yellowthroat	0.80	0.40	0.50
Overall	0.90	0.76	0.89

Total abundance for each species from walking surveys was highly correlated with abundance estimates from 50-m point counts ($r^2 = 0.97$, $b = 0.88$; Fig. 3) and from unbounded point counts ($r^2 = 0.94$, $b = 1.14$).

Discussion

Details of an avian monitoring program must be tailored to the geographic area under consideration and project objectives (Verner 1985, Ralph et al. 1993). These include the type of survey, duration, use of detection distances, and other variables. A primary variable of point counts is the time length of the counting period. The appropriate time length must be a compromise between efficiency (to maximize sample size) and return on effort (based on abundance of the species of interest). Hutto et al. (1986) recommended a period long enough to detect 75–80% of all species present. Ralph et al. (1993) recommend 10-min counts for general inventory surveys
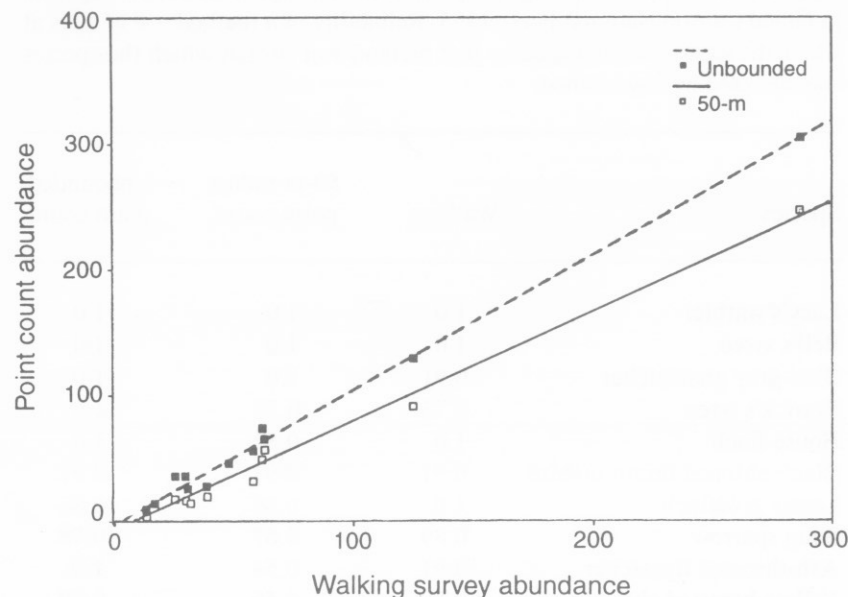
Fig. 3. Abundance estimates of birds from walking surveys in relation to abundance estimates from point count surveys of the 12 most common species, pooled for all sites surveyed in the Grand Canyon, 1995.

when distances between points are large. We detected 81% of the species observed at a site in the first 5 mins of 10-min counts. While this may not represent 81% of all species present, given the relatively low number of breeding species in the canyon's riparian environment and the great extent and remote nature of habitat in the canyon, we feel that 5-min counts represent a good compromise between completeness and efficiency. Because the time to get between points is sometimes greater than 15 mins, 10-min counts recommended by Ralph et al. (1993), would be preferable if manpower and river logistics permit.

As expected, point count detections within the 50-m fixed radius were significantly fewer than detections within and beyond 50 m. Despite this, there are several advantages to using a fixed radius. First, it helps reduce observer variability. Most competent observers will hear birds equally well within a small fixed distance, while beyond this distance individual differences cause variability to increase rapidly (Ramsey and Scott 1981). Given the small size of most habitat patches in the canyon, we believe that 50 m is appropriate for most riparian breeders.

Second, an important assumption to all survey methods is that individuals are not counted more than once. Such "double-counting" leads to positive bias in abundance estimates (Verner 1985). When the distance separating survey points is small, a small (relative to point separation) fixed detection radius can reduce the probability of counting one individual at a 2-point count station. To this end, Hutto et al. (1986) placed points 200 m apart, and Ralph et al. (1993) recommend 250 m separation. In this study, the distance between survey points, 125–150 m, increased the possibility of double-counting, especially for birds with large territories. In the small riparian patches of the canyon where counting stations may need to be closely spaced, use of a 50-m detection radius can help control this source of bias.

Differences between walking survey and point count results were probably not due to differences in survey efforts, as measured by mean survey length for the two methods. Similar numbers of species were observed during walking surveys and unbounded point counts. However, the number of species in common for the walking and point count surveys was low. This lack of agreement was largely due to observations of rare species. A statistically powerful test to compare the ability of these methods to detect rare species would require many more detections than we obtained (i.e., more visits, more points, or more surveys; Dawson 1981), justifying our exclusion of these rarer species for comparing the reliability of the methods. Also because of this limitation, monitoring population trends of rare species in the Grand Canyon will require more species-specific methods, rather than a general monitoring effort.

Excluding rare species, the reliability of the unbounded point counts and walking surveys to detect a species was similar overall, higher than the reliability of 50-m point counts. Also, certain species-specific differences were evident (Table 2). Common species with small territories, such as the Lucy's warbler and Bell's vireo were equally well detected by all three methods, because their territories were likely to fall entirely into the 50-m detection radius. The yellow-breasted chat and ash-throated flycatcher, both loud species with larger territories, were poorly detected by only the 50-m point counts. This may be because individuals within their territories were likely to be beyond the 50-m radius during the count period. The relatively quiet and rare yellow warbler was poorly detected by all methods, and probably approaches the lower limits of abundance for effective monitoring under our methodology. Finally, the common yellowthroat, a habitat specialist nesting in emergent vegetation, was especially poorly detected by both point count methods due to a methodological bias. We located point count stations halfway between the river and the upland edge of the riparian vegetation, shifting survey attention away from the river's edge where this species is usually found. Thus, survey methodology must be tailored to reflect the life history of the species to be monitored.

The preceding analyses dealt only with presence-absence data. While this may provide the most accurate way to monitor population trends, it is not as

precise as abundance estimates. However, both walking and point count methods can provide only an index of abundance rather than an accurate estimate (Verner 1985). The question is whether point counts provide as good an index of abundance as walking surveys. Abundance estimates from walking and point count surveys were highly correlated. The closer b (slope of the relationship) is to 1.0, the closer the two variables are to a 1:1 relationship. Both point count methods were near 1:1 with the walking surveys, with 50-m point counts undercounting and unbounded point counts overcounting relative to walking surveys. The overestimate of abundance by the unbounded point counts may be due to double-counting and could be decreased by moving count stations farther apart (Hutto et al. 1986, Ralph et al. 1993).

These results show that the point count method can provide data of similar quality to walking surveys in the Grand Canyon. Both methods can detect the common riparian breeding species and give comparable estimates of abundance with the same amount of survey effort. The advantages of the point count method to standardize survey effort between years, control observer bias, and provide a sample suitable for statistical analyses, suggest that this is the better method for long-term avian monitoring in the Grand Canyon. Given the tenuous status of riparian habitats in the Southwest, of which the riparian corridor of the Colorado River in Grand Canyon National Park is a considerable fraction, monitoring riparian avian populations in the park should be given a high priority. Finally, understanding the effects of Glen Canyon Dam management on these populations can be most accurately done through such a carefully planned long-term monitoring effort.

Acknowledgments

Literature Cited

Anderson, L. S., and G. A. Ruffner. 1988. The effects of recent flooding on riparian plant establishment in Grand Canyon. U.S. Department of Commerce. National Technical Information Service. NTIS #P88-183504/AS. Springfield, Va. 54 pp.

Brown, B. T. 1988. Monitoring bird population densities along the Colorado River in Grand Canyon: 1987 Breeding Season. U.S. Department of Commerce. National Technical Information Service. NTIS #P89-103311. Springfield, Va.

Brown, B. T., S. W. Carothers, and R. R. Johnson. 1987. Grand Canyon birds. University of Arizona Press, Tucson. 302 pp.

Brown, B. T., and R. R. Johnson. 1985. Glen Canyon Dam, fluctuating water levels and riparian breeding birds: the need for a management compromise on the Colorado River in Grand Canyon. Pages 76–80 in U.S. Forest Service, General Technical Report RM-120. Fort Collins, Colo.

Dawson, D. G. 1981. Experimental design when counting birds. Pages 392–398 in C. J. Ralph and J. M. Scott, editors. Studies in Avian Biology No. 6.

Emlen, J. T. 1971. Population densities of birds derived from transect counts. Auk 88:323–342.

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

Johnson, R. R., L. T. Haight, and J. M. Simpson. 1977. Endangered species vs. endangered habitats: a concept. Pages 68–74 in R. R. Johnson and D. A. Jones, technical coordinators. Importance, preservation and management of riparian habitat: Proceedings of a symposium. Tucson, Arizona. U.S. Forest Service General Technical Report RM 43. Fort Collins, Colo.

Knopf, F. L., R. R. Johnson, T. Rich, F. B. Samson, and R. C. Szaro. 1988. Conservation of riparian ecosystems in the United States. Wilson Bulletin 100:272–284.

Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. U.S. Forest Service General Technical Report PSW-GTR-144. Albany, Calif. 41 pp.

Ramsey, F. L., and J. M. Scott. 1981. Tests of hearing ability. Pages 341–345 in C. J. Ralph and J. M. Scott, editors. Studies in Avian Biology No. 6.

Sogge, M. K., D. Felley, P. Hodgetts, and H. Yard. 1994. Avian community monitoring in the Grand Canyon - 1993–94 progress report. National Biological Service Colorado Plateau Research Station report. Flagstaff, Ariz. 33 pp.

Stevens, L. W. 1983. The Colorado River in Grand Canyon: a guide. Red Lake Books, Flagstaff, Ariz. 114 pp.

Stevens, L. W., and T. J. Ayers. 1994. The effects of interim flows from Glen Canyon Dam on riparian vegetation along the Colorado River in Grand Canyon National Park, Arizona: draft 1994 annual technical and administrative report. U.S. Department of the Interior, National Biological Service, Colorado Plateau Research Station. Flagstaff, Ariz. 45 pp.

Turner, R. M., and M. M. Karpiscak. 1980. Recent vegetation changes along the Colorado River between Glen Canyon Dam and Lake Mead, Arizona. U.S. Department of the Interior. USGS Professional Paper #1132. U.S. Government Printing Office, Washington, D.C. 125 pp.

Verner, J. 1985. Assessment of counting techniques. Current Ornithology 2:247–302.