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PLAYBACK RECORDINGS AS A SPECIAL AVIAN CENSUSING TECHNIQUE

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Abstract.—The literature on the efficiency of tape recorders in detecting relative or absolute population densities of birds is reviewed. This review and field investigations by the authors showed at least 51 species that are responsive to the use of playback recordings as a census technique. This represents only a small percentage of the species which could be censused by this method. Examples of detailed field techniques and their results are outlined for several species that present particular censusing problems, such as nocturnal species and others, e.g., Lucy's Warbler, found in the rich riparian avifauna of the southwestern United States. The highest breeding density of Screech Owls in North America, reported herein, was discovered by this technique.

Tape-recorded bird calls have been used as an avian censusing technique for more than two decades. Although this technique has been most commonly used to census species which present special problems, our findings demonstrate that it can and should be in much wider usage. This applies to a large percentage of the species that are standardly censused by conventional methods. In fact, both the literature and our research demonstrate that thorough, accurate breeding censuses are rarely conducted without the aid of this research tool.

Counts of spontaneous auditory signs, or call counts, of birds have been used since Stoddard (1931) reported the use of counts of male vocalizations as a technique for measuring the relative abundance of quail. Call-count censusing differs from tape-recorded censusing in that a call count does not use a playback recording to elicit responses but instead counts the number of spontaneous calls. This technique was originally used as a population index of game birds along established survey routes. Call-count sampling has been used in censusing the wild Turkey (*Meleagris gallopavo*) (Overton and Davis 1969), Ruffed Grouse (*Bonasa umbellus*) (Hungerford 1953), quail (Phasianidae) (Smith and Gallizioli 1965), Chukar (Williams 1961), Ring-necked Pheasant (*Phasianus colchicus*) (Kimball 1949), American Woodcock (*Philohela minor*), and doves (Columbidae) (McClure 1939, Foote et al. 1958).

Although it has been noted that vocally imitated calls could be used to detect the presence of nocturnal species such as owls (Bent 1938, Miller and Miller 1951, Foster 1965), the use of tape-recorded calls as a count technique was not experimented with until the late 1950's. Earlier recordings depended on reel-to-reel tapes and heavy, expensive recorders and equipment. It was not until the 1960's that compact, lightweight cassette recorders with tape counters were developed to provide reference points for specific recordings. Thus, only during the last decade has the technology developed to economically allow investigators to routinely carry playback recording equipment to the field for use in a count.

Bohl (1956) originally carried game farm Chukars to the field in portable pens, anticipating that their calling would stimulate answering calls from Chukars in the wild. However, he discovered it was more practical to locate and census the wild Chukars by the use of tape recordings of their calls. This technique soon found acceptance in censusing several game species that had previously been censused by the call-count method (Levy et al. 1966, Stirling and Bendell 1966). Tape-recording census techniques are now widely used for both game and nongame species. The special applications of playback recordings in avian censusing include the following: (1) nocturnal species (e.g., owls); (2) species found in inaccessible habitats or habitats with limited visibility, such as marshes, tropical forests, or dense brushland (e.g., rails or Plain Chachalacas); (3) species which may occur in low densities (e.g., Yellow-billed Cuckoos in southwestern riparian habitats); (4) species occurring in high densities (e.g., Lucy's Warblers, Screech Owls, and Elf Owls, in southern Arizona velvet mesquite, *Prosopis velutina*, bosques [woodland] and saguaro, *Cereus giganteus*, forests); (5) species with large territories (e.g., most raptors); and (6) species with soft or barely audible calls (e.g., Least Bittern, *Ixobrychus exilis*, and Black-tailed Gnatcatchers, *Polioptila melanura*).

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Although we speak here primarily in terms of the use and application of playback recordings, it is recognized that mimicry and noisemakers, both generalized and specific, are applicable for avian censusing under varying circumstances. This includes vocal mimicry and manufactured squeakers and calls, with duck (Anatidae), crow (*Corvus* spp.), and Turkey calls being the most commonly used.

EXAMPLES OF SPECIAL FIELD TECHNIQUES

The playback recording techniques used to census birds may differ, depending on the species and its behavior patterns, response traits, and territory size. Techniques share a high degree of similarity within families, for example within the families Rallidae and Strigidae. Table 1 illustrates the wide application of these techniques, with examples from the literature and the authors' field investigations. As there is not space here to give detailed techniques for each species listed under authors' experience, some of the more cogent points regarding the specific techniques for two sample species are outlined below. The following remarks refer to territorial breeding birds unless noted otherwise.

As playback recording census techniques will vary for different species under different conditions, we shall generalize regarding techniques we have found to be the most accurate from our experience during the past 11 years. For most species, one person with a portable tape recorder can conduct an accurate census. Standard censusing rules should be followed. Comparable times should be kept for various plots. However, when conducting breeding bird censuses, times are academic if one is not recording all of the birds present. That is, keeping a predetermined schedule is secondary to an accurate census. Stops should generally be made every 25 to 100 m, depending on the thickness of cover and avian densities. Taped refrains of bird calls should be separated by intervals of time comparable to those for the species. Intervals should be even longer, if necessary, to allow the observer to listen for answering songs between the recorded songs. At regular intervals it is often desirable to set the tape recorder on the ground or in a tree or shrub and allow it to play while walking around it at a distance of 20 to 30 m and listen for answering calls. The volume for playing the tape recorder can be determined by trial and error. Ideally, an optimum volume would be used where birds answer from the greatest possible distance while still allowing the observer to hear responses above the noise of the tape recorder. With species which exhibit a supernormal response (Tinbergen 1960) where "the louder the tape, the better," the tape recorder can be turned to nearly full volume and set down at frequent intervals while the observer walks away from the recorder to listen for responses.

Nocturnal Birds

Nocturnal birds are commonly not included in figures of population densities. This is because of both the mechanical difficulty of censusing the birds and the lack of the necessary technical knowledge of most investigators. Caprimulgids, for example, seem to be vocal enough so that playback recordings are rarely needed. This is especially true for species which seem to call regularly on successive nights, e.g., Poor-wills (*Phalaenoptilus nuttallii*), Whip-poor-wills (*Caprimulgus vociferus*), and Ridgeway's Whip-poor-wills (*C. ridgwayi*). Common and Lesser Nighthawks (*Chordeiles minor, C. acutipennis*) are often seen in flight during crepuscular hours and are very vocal during the breeding season.

The most often overlooked avian species in censusing are the owls. This is due in part to the fact that owls often are vocal only if censused with the use of playback recordings or vocal imitations (Table 2). In addition, few researchers enjoy tramping around in the dark in rattlesnake country. Table 2 shows a Screech Owl breeding density of 9 pairs/4 ha (90 pairs/40 ha). This high density is from extremely productive riparian woodland habitat in southern Arizona. This is the habitat type in which Screech Owls have been reported to occur "100 yards" apart (Phillips et al. 1964) or less (Miller and Miller 1951). On the Salt River in central Arizona, a cottonwood, *Populus fremontii*—mesquite grove measuring 125 × 50 m was censused with playback recordings on March 24, 1972 (J. M. Simpson and I. Simpson), and again on March 30, 1972 (J. M. Simpson and R. R. Johnson). Nine Screech Owls were found on five territories. A nearby grove, 100 × 60 m, contained eight owls on four territories. Adjacent mesquite bosques had paired Screech Owls spaced as closely as 50 m apart. This is the highest reported breeding density for Screech Owls in North America.

These extreme population densities in mesquite bosques of central and southern Arizona necessitate special efforts to obtain accurate counts. The dense riparian woodland presents a visibility problem, even near full moon in the spring when vocal activity is at its peak. We commonly use two persons, one near the tape recorder, which is played at high volume, and another to walk in a circle around the recorder and count owls. The second observer usually stays approximately 50 to 100 m from the recorder. The reason for this unorthodox method

TABLE 1
SPECIES RESPONSIVE TO PLAYBACK RECORDINGS AS A COUNTING TECHNIQUE

Family	Species	Type of census[a]	Source
Podicipedidae			
	Pied-billed Grebe (*Podilymbus podiceps*)	b	authors' experience[b]
Ardeidae			
	Least Bittern (*Ixobrychus exilis*)	b	authors' experience[b]
Accipitridae			
	Goshawk (*Accipiter gentilis*)	b	James Mosher, pers. comm.[c]
	Cooper's Hawk (*A. cooperii*)	b	James Mosher, pers. comm.[c]
	Red-tailed Hawk (*Buteo jamaicensis*)	b	James Mosher, pers. comm.[c]
	Red-shouldered Hawk (*B. lineatus*)	b	James Mosher, pers. comm.[c]
	Broad-winged Hawk (*B. platypterus*)	b	James Mosher, pers. comm.[c]
Cracidae			
	Plain Chachalaca (*Ortalis vetula*)	b	Marion 1974b
Tetraonidae			
	Blue Grouse (*Dendragapus obscurus*)	b	Stirling & Bendell 1966
	Spruce Grouse (*Canachites canadensis*)	b	MacDonald 1968
	White-tailed Ptarmigan (*Lagopus leucurus*)	b	Braun et al. 1973
Phasianidae			
	Masked Bobwhite (*Colinus virginianus ridgwayi*)	b	Gallizioli 1964, Tomlinson 1972, Brown & Ellis 1977
	Scaled Quail (*Callipepla squamata*)	b	Levy et al. 1966
	Gambel's Quail (*Lophortyx gambelii*)	b	Levy et al. 1966
	Montezuma Quail (*Cyrtonyx montezumae*)	b	Levy et al. 1966
	Chukar (*Alectoris chukar*)	b	Bohl 1956, Oelklaus 1976, Mudd et al. 1979 & 1980
Aramidae			
	Limpkin (*Aramus guarauna*)	b	Marion et al. 1981
Rallidae			
	King Rail (*Rallus elegans*)	b	Maehr 1980
	California Clapper Rail (*R. longirostris obsoletus*)	b, w	Gill 1979
	Sonora Clapper Rail (*R. l. rhizophorae*)	b, w	Tomlinson & Todd 1973
	Yuma Clapper Rail (*R. l. yumanensis*)	b, w	Tomlinson & Todd 1973, Smith 1974, Jurek 1975, Gould 1975, Todd 1976
	Virginia Rail (*Rallus limicola*)	b, w	Glahn 1974, Todd 1976, Griese et al. 1980, authors' experience
	Sora (*Porzana carolina*)	b, w	Glahn 1974, Todd 1976, Griese et al. 1980, authors' experience
	Black Rail (*Laterallus jamaicensis*)	b, w	Jurek 1975, Todd 1976, Manolis 1977 & 1978, Repking & Ohmart 1977
Cuculidae			
	Yellow-billed Cuckoo (*Coccyzus americanus*)	b	Gaines 1974a & 1974b, Gaines 1977 (unpubl. rpt., Calif. Game and Fish Dept., Sacramento)
Strigidae			
	Screech Owl (*Otus asio*)	b	Heintzelman 1979, authors' experience
	Great Horned Owl (*Bubo virginianus*)	b	Springer 1978; Fuller & Mosher, this volume
	Pygmy Owl (*Glaucidium gnoma*)	b	authors' experience
	Ferruginous Owl (*G. brasilianum*)	b	authors' experience

TABLE 1. (CONTINUED)

Family	Species	Type of census[a]	Source
	Elf Owl (*Micrathene whitneyi*)	b	Cardiff 1978, Gould 1979, authors' experience
	Barred Owl (*Strix varia*)	b	Fuller & Mosher, this volume
	Spotted Owl (*Strix occidentalis*)	b	Gould 1974, 1977, 1979; Whisler and Horn 1977, Forsman et al. 1977, Marcot 1978 (unpubl. rpt., Six Rivers Natl. Forest, Calif.), Cardiff 1978, Delamore 1979, Garcia 1979
	Boreal Owl (*Aegolius funereus*)	b	authors' experience
	Saw-whet Owl (*A. acadicus*)	b, w	authors' experience
Trogonidae			
	Elegant (Coppery-tailed) Trogon (*Trogon elegans*)	b	Taylor 1978 & 1979 (unpubl. rpt., Coronado Natl. Forest, Ariz.)
Tyrannidae			
	Least Flycatcher (*Empidonax minimus*)	b	Oech & Oech 1960
	Eastern Wood Pewee (*Contopus virens*)	b	Oech & Oech 1960
Troglodytidae			
	Long-billed Marsh Wren (*Cistothorus palustris*)	b	authors' experience
Mimidae			
	LeConte's Thrasher (*Toxostoma lecontei*)	b	Rea 1977
Turdidae			
	Veery (*Catharus fuscescens*)	b	Oech & Oech 1960
Vireonidae			
	Bell's Vireo (*Vireo bellii*)	b	authors' experience
	Gray Vireo (*V. vicinior*)	b	Barlow & Johnson 1969
	Red-eyed Vireo (*V. olivaceus*)	b	Oech & Oech 1960
Parulidae			
	Lucy's Warbler (*Vermivora luciae*)	b	authors' experience
	Yellow Warbler (*Dendroica petechia*)	b	authors' experience
	Ovenbird (*Seiurus aurocapillus*)	b	Oech & Oech 1960
	Mourning Warbler (*Oporornis philadelphia*)	b	Oech & Oech 1960
	Common (Salt Marsh) Yellowthroat (*Geothlypis trichas*)	b	Foster 1977a, authors' experience
	Yellow-breasted Chat (*Icteria virens*)	b	authors' experience
Icteridae			
	Hooded Oriole (*Icterus cucullatus*)	b	authors' experience
Thraupidae			
	Summer Tanager (*Piranga rubra*)	b	authors' experience
Fringillidae			
	Cardinal (*Cardinalis cardinalis*)	b	Dow 1970
	Blue Grosbeak (*Guiraca caerulea*)	b	authors' experience

[a] b = breeding, w = wintering.

[b] Authors' personal experience. The length of this paper prohibits a detailed explanation of each species and the technique used in the authors' investigations. Researchers should use this as a guide to species which are responsive, while devising their own methods based on available literature.

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is that so many owls may answer at once that one stationary person cannot ascertain how many individuals are responding. In optimum habitat Screech Owls are commonly spaced at intervals of approximately 50 m. Thus, a single person may be listening to a dozen or more pairs (with both birds calling) from any given spot. It is impossible for a single observer to accurately census Screech Owls in this situation. On occasions we have used two tape recorders and three or four observers to help determine densities. In addition, territorial boundaries may be determined by persons with playing recorders moving toward each other. Excited territorial

TABLE 2
SAMPLE OWL BREEDING CENSUSES FOR COMPARING VARIOUS TECHNIQUES

	Transect[a]	Transect size (m)	Species	Censusing technique	No. of territories identified
Transect 1[b]	a.	400 × 100	Screech Owl	Playback recording	9
	b.	400 × 100	Screech Owl	Call count	0
Transect 2[b]	a.	200 × 100	Screech Owl	Playback recording	5
	b.	200 × 100	Screech Owl	Call count	0
	c.	200 × 100	Screech Owl	Vocal mimicry	4
Transect 3[c]	a.	400 × 50	Screech Owl	Call count	0
	a.	400 × 50	Screech Owl	Playback recording	4
Transect 4[d]	a.	400 × 100	Screech Owl	Playback recording	4
	a.	400 × 100	Screech Owl	Vocal mimicry	3[e]
	a.	400 × 100	Screech Owl	Call count	0
	a.	400 × 100	Screech Owl	Playback recording	3[e]
Transect 5[d]	a.	200 × 100	Elf Owl	Call count	0
	b.	200 × 100	Elf Owl	Playback recording	5

[a] When transect "a" appears more than once under a given number, the same transect was censused repeatedly by the different methods.
[b] Cottonwood-mesquite (*Populus fremontii—Prosopis velutina*) habitat, Blue Point Cottonwoods on the Salt River near Phoenix, Arizona, April 27 (Transect 1) and May 25 (Transect 2), 1980. One census was conducted on this and all the following transects.
[c] Riparian mesquite woodland habitat, Saguaro National Monument (East) near Tucson, Arizona, June 28, 1980.
[d] Palo verde-saguaro-mesquite (*Cercidium* spp.—*Cereus giganteus—Prosopis velutina*) habitat, Saguaro National Monument (East) near Tucson, Arizona, July 1, 1980. The Screech Owl transects were censused at 20:15, 20:30, 20:40 and 21:00 respectively.
[e] Adult calling on two territories, "stationary" young on one of those territories and scattered young on a third territory.

owls commonly follow the recorder through their own territories until they meet, often engaging in fierce disputes.

SPECIES OCCURRING IN HIGH DENSITIES

The use of tape recorders in censusing riparian and other wetland habitats is particularly important as bird densities in these habitats may exceed 1000 nesting pairs/40 ha in the Southwest (Carothers and Johnson 1971). Lucy's Warbler is an example of a species which may occur in high breeding densities in optimum habitat. Densities of approximately 12.5 pairs/ha (500 pairs/40 ha) reported by Russell and Johnson (1973) were verified by the use of playback recordings on the lower Verde and Salt rivers near Phoenix, Arizona, in mature mesquite bosque. In this situation, territorial disputes can be triggered by playback recordings between two or more males approximately every 20 to 35 m, with territories averaging approximately 30 m in diameter. These populations seem difficult to explain but similar densities for Yellow Warblers were found on plots of mature cottonwood forest by Carothers and Johnson (1971) in the Verde Valley of central Arizona. In willow-alder (*Salix-Alnus* spp.) brush near Old Crow, Alaska, Irving (1960) found a territorial pair of Yellow Warblers every "50 feet" for a distance of 100 m along the Yukon River system.

Lucy's Warbler exhibits a supernormal response to playback recordings and under optimum conditions in dense mesquite bosques occurs in even greater densities than Screech Owls. Since censusing is done during the day for the former, it is not so difficult to follow the movements of individual birds. We found that by walking 50 m between stops under these conditions one might move through segments of two to four territories between stops. In addition, birds on adjacent territories were drawn into territorial squabbles by the tape recorder, thereby adding to the confusion. Our eventual technique used two persons. One would play the tape recorder at high volume, stopping at 30 m intervals, while the second would range out from the recorder at distances of approximately 20 to 40 m. Both observers counted responding birds in conjunction with one another.

DISCUSSION OF CENSUS TECHNIQUES

REASON FOR AND VALIDITY OF METHODS

A playback recording census can increase the total number of species counted or increase the total numbers of birds seen or heard for a given species in comparison to a conventional census. This is especially true for species with low song activity (Robbins 1978a). Dow (1970) reported an increase of 37 to 160 percent in the numbers of Cardinals responding to playback recordings over the use of call count sampling without recordings. However, he noted that spontaneous singing during this period decreased as the season progressed from April to July, while the responses to recordings remained about the same.

Oech and Oech (1960) documented an increase of 40 to 370 percent in the response of six common passerines in Minnesota with playback recordings compared to the use of call-count sampling. Stirling and Bendell (1966) obtained population densities for male Blue Grouse on Vancouver Island that were essentially the same for both a conventional call count and a playback recording census, but the taped census was four times as fast as the conventional search. Glahn (1974) found that a playback recording census of Sora and Virginia Rail populations increased the number of territories located by 71 percent in comparison with a standard nest survey.

Problems with the Playback Technique

In rare instances, the use of playback recordings has not been advantageous. Robbins (1978a) stated that indiscriminate use of tape recordings on repeated visits during the breeding season can bias the results as birds may alter their habits or their territorial boundaries if they believe a competing member of the same species is holding territory nearby. Although this may be true in some instances, we would like to see better evidence for this hypothesis. Preliminary information from some of our Screech Owl studies suggests that if censused too often some individuals and/or species may become less responsive. In an Oregon study area, four Spotted Owl pairs were located through extensive ground searches and the pairs subsequently located through radio telemetry (Forsman et al. 1977). A simultaneous census with playback recordings located only three of the four pairs. Springer (1978) reported similar findings in Ohio populations of Great Horned Owls. With the Ohio owls, the relative effectiveness of a foot survey (95 and 95.8%) was higher than with a playback recording survey (72 and 87.5%) in locating 66 pairs of owls. Marion (1974) found that between 44 and 59% of Plain Chachalacas being censused by playback recordings were not responding to the recordings. A correction factor of 2.0 was then necessary to adequately estimate Plain Chachalaca numbers. It is not known if experimental manipulation in one of these three cases (Spotted Owl) affected the playback censusing. Conventional census techniques, however, in these rare instances prove no better. The only remaining technique is a series of methodical, time-consuming visual searches.

Conversely, the use of playback recordings can result in supernormal responses in some species resulting in exaggerated territorial activity. The use of playback recordings can also attract some individuals away from their territories, as in Elegant (Coppery-tailed) Trogons (Taylor 1978 and 1979—unpubl. rpt., Coronado Natl. Forest, Ariz.), and result in inflated population density estimates. Further work is needed to identify the reliability of the technique with many species. For example, little is known concerning differences in density estimates that may occur when censusing with alarm calls versus territorial song.

Factors Influencing Response Rates

Factors which may influence the rates of response to tape-recorded songs include wind, rain, time of day, temperature, seasonality, species response traits, lunar cycles, and disturbance by man or predators. These factors are often interrelated in various combinations. Climatic factors that act as probable influences of vocal response are wind and rain (Dow 1970, Oelklaus 1976, Whisler and Horn 1977). Observed responses decrease as winds increase due to the facts that both bird activity and the observer's hearing ability are decreased. Likewise, rain seems to inhibit singing and can make listening impossible (Dow 1970). Dow also found that very dense fog appears to have had no influence on male Cardinal responses, although spontaneous singing may have been suppressed. Stirling and Bendell (1966) noted the positive response of male Blue Grouse to recordings of a female grouse whinny call even during a snowstorm.

Oech and Oech (1960) and Robbins (1978a) suggested that birds will respond to tape recordings at times when they would otherwise remain silent. We have found this to be especially true in the fall with Screech Owls at Saguaro National Monument in Arizona and to a lesser extent with Elf Owls. Importantly some species may be censused by this method late in the breeding season or later when spontaneous vocalizations normally decline. Spring and summer response for the Cardinal reaches a peak in the early morning, drops to a low level in the mid-afternoon and rises slightly in the evening (Dow 1970). Optimum censusing time for most species seems to be at sunrise. This response pattern of a morning peak, a mid-afternoon low, followed by a rise in evening activity which is not quite as high as the morning peak is similar to the pattern of spontaneous singing noted in many passerine birds by Van Tyne and Berger (1959). However, the daily response patterns of some passerines and nonpasserines will differ slightly. A recording of the female Blue Grouse whinny call is effective at all times of day in eliciting a response from territorial males (Stirling and Bendell 1966). The optimum response of Gambel's and Scaled Quail to tape recordings was in the morning and evening, while Monte-

zuma Quail answer tape recordings equally well throughout the day (Levy et al. 1966). However, male Gambel's Quail with their mates present will not respond to tape recordings of a female call.

The use of tape recordings is normally confined to a census of males in the breeding season, although Tomlinson and Todd (1973) reported the usefulness of recordings in censusing breeding and wintering populations of both male and female Yuma Clapper Rails, for a minimum population index. Both male and female Elf Owls (Cardiff 1978) and Screech Owls are known to respond to taped recordings. Owls are apparently affected by lunar cycles with the optimum response to taped recordings occurring on nights with a bright, waxing moon (Johnson et al. 1979). The daily peaks of response by owls to tape recordings generally coincide with their crepuscular activity patterns, in that just after dark and just before sunrise are the best times to elicit responses. In censusing Chukars with tape recordings, Oelklaus (1976) found that disturbance by avian predators, coyotes, or man was followed by a short period in which the Chukars' response rate to tape recordings was not consistent, necessitating a lapse in the census.

Research Considerations

Several comments should be made regarding the use of recorders, results and special techniques. The use of playback recordings, as with any other tool, is only as accurate as the person carrying out the census. Secondly, the source and quality of the recorded vocalizations used are important. Due to racial and dialectual variations, the use of local recordings is best. In the absence of local recordings, the use of good commercial recordings such as Cornell's *Field Guide to Bird Songs* and *A Field Guide to Western Bird Songs* are adequate. Even then the observer will have varying degrees of success, depending on the species used. One of the drawbacks of most commercial or mass produced recordings is the limited repertoire for a given species. For example, the above recordings have two basic sounds for the Saw-whet Owl, where we know of at least five clearly distinguishable sounds (Johnson et al. 1979). The most successful tape we have used in several dozen attempts with Screech Owls during the past 11 years is of a caged female. Background noise in this taped recording, including parakeets and street noise, is ignored by Screech Owls in the mesquite bosques as they come to investigate the recording itself which varies from soft, coy, and coaxing to loud, strident, and aggressive. On at least one occasion using this tape, a Screech Owl landed on the ground a few feet from the recorder and stomped demandingly up to this "territorial invader," strutting like a miniature turkey gobbler. Although background noise in the above Screech Owl recording apparently had no ill effect, excessive background noise may have a negative influence on the response of some species, as Mudd et al. (1979) suggested occurs in Chukars.

Our findings suggest that only a fraction of the responsive species have been censused by playback recordings. Many non-colonial territorial birds which rely on song as a territorial proclamation should be censused or have supplemental data gathered about them using this method. The literature on bird song, while not directly related to the application of tape-recorded censuses, can provide important background information regarding the response of certain species to this method. There is enough auditory response information available, for example, regarding crows and gulls (*Larus* spp.) (Frings et al. 1958), to suggest that they could be censused using recordings of the appropriate attractant call. Sonograms and observations on the structure and function of many bird songs exist and are too numerous to present.

For some species which are more easily and accurately censused by tape recorded methods, the taped call technique could be useful in obtaining an annual or periodic index to a species' abundance. This possibility was mentioned by Tomlinson and Todd (1973) for Yuma Clapper Rails along the lower Colorado River, although other methods such as habitat inventories were noted as being less expensive. Taped censusing may also be useful to supplement the information provided through a conventional breeding bird census. Owls, commonly not included in even some of the better population studies, could be standardly censused with these techniques.

Management and Conservation Implications

Playback recordings are widely used by both professional and amateur ornithologists as they are so effective in calling out secretive birds. However, a certain amount of controversy exists over the use of tape recordings. The Coronado National Forest in southeast Arizona has banned the use of playback recordings in locating the Elegant (Coppery-tailed) Trogon, as it is thought their use causes nest failures (R. Taylor 1978 and 1979, unpubl. rpt., Coronado Natl. Forest, Ariz.) and other problems (Glinski 1976). The male trogons are highly responsive to taped recordings and may be lured long distances from the nest. As males share in the in-

cubation responsibilities, any male that leaves the eggs to fight a tape recording of another male trogon risks loosing the year's clutch.

Several rare species mentioned previously are threatened or endangered (sensu U.S. Fish and Wildlife Service). Often these species are found in inaccessible habitats or in low densities. The use of playback recordings for responsive endangered species would be an important management tool. For example, the Washington State Game Department is presently experimenting with the use of playback recordings to census breeding Peregrine Falcons (*Falco peregrinus*) (Frederick Dobler, pers. comm.). If successful, this would provide information for the management of the species.

CONCLUSIONS

The use of playback recordings is probably the most overlooked major technique for avian censusing. It has been used primarily for augmenting conventional censuses in searching for problematic species (e.g., nocturnal birds) or birds in dense vegetation (e.g., marsh and woodland). Demonstrated advantages of the playback technique include: (1) increased numbers of individuals detected, both per single census and per census area over time; (2) time efficient sampling; and (3) detection of the aforementioned problematic species.

The lack of use of this technique apparently is attributable to the need for additional equipment such as recorders and tapes, and the necessity of mastering the mechanics of the playback technique. Neither of these is an overly difficult problem. The necessary equipment can be purchased for less than a pair of medium-priced binoculars and is roughly comparable in weight to carrying a gun for collecting. The real problem, as with any other technique, is in becoming proficient through practice. The J. T. Emlen (1971) technique, for example, is excellent when used by John Emlen. However, the results of many of the "modified Emlen techniques" are questionable, to say the least. Thus, as with other techniques, the results are only as good as the user.

The idea that birds come from territories some distance away to the recorder, thereby biasing the results, is generally false. Where are the birds that should be defending their territories as these distant intruding males "flock to be counted" by the census taker? It is true that the use of the recorder can increase the number of birds counted. We maintain that this increase is the result of heightened responses from otherwise silent or hidden birds, those that would have been overlooked by a more conventional census.

If standardization is a goal for a particular censusing program, it is argued that unless everyone uses it, no one should use it. Granted, that philosophy does help to "standardize" the system, a system already fraught with variables, e.g., weather, time of day and year, moon cycles and behavioral peculiarities of specific species or individual birds. In our judgment, however, standardization is rarely an acceptable substitute for using every available tool to increase censusing accuracy and efficiency. The best all-around tool that we have used thus far is the playback technique.

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