MONITORING BREEDING BIRD POPULATIONS IN GRAND TETON NATIONAL PARK: 1995-1997

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✦ INTRODUCTION

In summer 1997 our NPS-funded project # CA-1460-5-0010, covering a 3-y period from summer 1995 through summer 1997, was completed. The immediate goals of the project were to instigate a system for monitoring the densities of breeding bird species, by establishment of fixed sites as a basis for a long term monitoring plan and of census protocols that can detect changes of breeding species and their densities over successive years. The monitoring scheme is conducted largely within Grand Teton National Park (GTNP), but covers habitats and an avifauna representative of the Greater Yellowstone Ecosystem (GYE) and the central-northern Rocky Mountains in general.

The project emphasizes the need for long-term and on-going studies on breeding bird species and densities and their importance as a tool for evaluating the impact of both local and distant influences on breeding bird populations. For residents, species that remain all year in or near the breeding habitat, local effects include those operating on-site during the non-breeding season as well as during the breeding season. For migrant species, those that breed on-site but leave to spend the non-breeding season in other locations, often distant and usually of quite different habitat composition, there are both on-site influences on breeding population densities, such as inter-year changes in vegetation structure and productivity, and off-site or distant influences, including factors that affect over-wintering success in the non-breeding habitat and others that influence a successful transit between wintering and breeding grounds.

The assessment of long-term trends in bird densities may be used as a form of bioassay of the state of the local environments. Information from such studies can provide region-wide indicators that, given a sufficiently comprehensive data base, can segregate local from distant influences on populations. Such indicators can be incorporated into management strategies to aid in determining which local strategies may be necessary (and feasible) to help maintain the biota.

✦ MONITORING MIGRANT BIRD POPULATIONS

MIGRANTS VERSUS RESIDENTS

There is no simple dichotomy between resident and migratory birds, rather there is a continuum of strategies to cope with the non-breeding season. At one extreme, populations may

be truly resident and spend the non-breeding season wholly within the breeding habitat; at the other, populations are wholly migratory, overwinter in quite different habitats that are reached by long-distance travel of sometimes thousands of kilometers. Between these two extremes are species that overwinter locally but in different habitats, perhaps at different elevations, and species that undertake short-distance migrations and/or perhaps overwinter in similar habitat elsewhere, perhaps distant some hundreds rather than thousands of kilometers from the breeding grounds.

Often, related species that share a breeding area such as GTNP have quite different migration strategies. This is illustrated in three taxonomic groups that are common constituents of the breeding avifauna of GTNP: the thrushes Turdinae, the sparrows Emberizinae, and the warblers Parulinae (Fig. 1a-c). Overall, there is a considerable array of migration strategies, classified by both latitudinal position, range (extent), and wintering habitat. Species that may share breeding habitat in GTNP are likely to encounter very different conditions, in different regions and different habitats, in the non-breeding season, and degree of taxonomic relationship is correlated apparently more with differences in migration modes than with similarities.

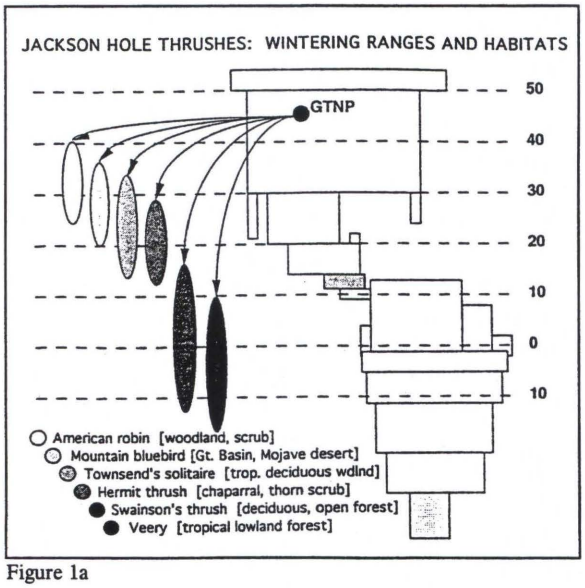

Figure 1a

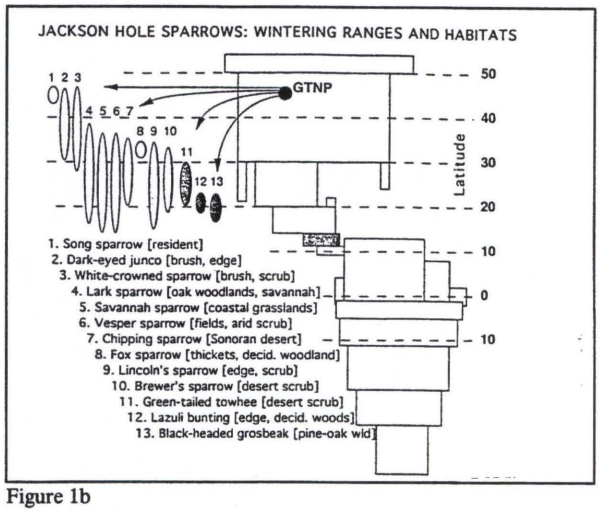

Figure 1b

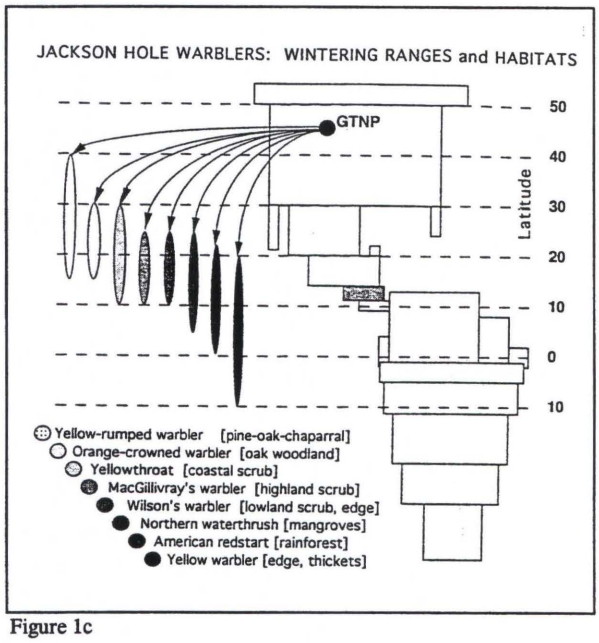

Figure 1c

ON-SITE VS OFF-SITE EFFECTS

Population regulation in species that spend part of the annual cycle in breeding habitat and another part in distant and different wintering habitat pose some interesting but challenging questions. These were recently addressed in some detail by Sherry & Holmes (1995). Individuals surviving overwinter and reaching the breeding

grounds in GTNP are potentially affected by the type, areal extent and quality of breeding habitat they find in spring. Breeding and recruitment ensue in GTNP, and following the return migration to South America a similar set of factors potentially affect the overwinter survival of the population. The challenge is to understand changes year to year in breeding populations in GTNP, this being the only component of the system that is measured and monitored.

A further point is a potential for on-site interspecific interactions, and their influences on breeding population sizes. Often this comes down to whether population sizes in two or more coexisting species show positive or negative covariation. For example, if two species within a community are mutually strong competitors and both minimally affected by the other species present, there is a good prospect that such influences will be detectable in their breeding population densities. However, where competition is diffuse, as well it might be in communities of generalized insectivorous birds breeding in GTNP, interspecific effects may be difficult to disentangle from breeding population censuses. Long-term census data are required to render the problem somewhat more tractible.

✦ DESIGN OF THE GTNP BREEDING BIRD MONITORING PROGRAM

The project established a total of 30 monitoring sites within (28 sites) or immediately adjacent to (2 sites) GTNP, covering all of the major habitat types within GTNP. The sites are listed in Table 1, and span a range of elevations from 1900-3000m, and cover the park over practically its full N-S and E-W extent.

Table 1: GTNP MONITORING SITES, #'s1 - 30

Site Name	Habitat	Yr.Estab.	Elev
Wolf Ranch	Grazed meadow	1994	2045
Jackson Lake Junction	Grass-sedge meadow	1992	2053
Elk Refuge	Wet meadow	1994	1895
Jackson Lake Junction	Grass-sagebrush	1966	2043
Antelope Flats	Sage burn	1995	2000
Antelope Flats	Sage unburned	1995	2000

Table 1: Con't

Site Name	Habitat	Yr.Estab.	Elev
Triangle X Ranch	Aspen-scrub	1996	2090
RKO/Snake R. Bottoms	Dry willow flats	1992	2003
Jackson Hole Junction	Wet willow flats	1966	2049
RMNP Onahu Ck	Wet willow flats	1995	2450
GNP Coonsa Creek	Wet willow flats	1996	1540
Oxbow Bend	Willow-aspen	1992	2040
Elk Ranch West	Low aspen woodland	1968	2109
Elk Ranch East	Mid aspen woodland	1968	2152
Signal Mountain	Tall aspen woodland	1968	2091
Spread Creek	Cottonwoods	1992	2085
Schwabacher Landing	Cottonwoods	1992	1988
Lower Granite Canyon	Lodgepole-aspen wdland	1995	1965
Timbered Is. Moraine	Lodgepole-spruce	1994	2060
AMK Ranch	Lodgepole pine forest	1991	2055
Taggart Lake	Successional lodgepole	1995	2090
Signal Mountain	Lodgepole-fir forest	1992	2258
Spaulding Bay	Douglas fir-spruce forest	1995	2121
Lizard Creek	Lodgepole-spruce-fir	1992	2195
Bradley Lake	Spruce-fir-lodgepole forest	1995	2180
Jenny Lake	Spruce-fir forest	1992	2197
Upper Granite Canyon	Spruce forest	1994	2365
Rendezvous Mountain	Lodgepole-whitebark pine-fir	1994	2970
Cody Bowl	Arctic-alpine tundra	1994	2900
Heron Pond/Swan Lk	Waterfowl ponds survey	1995	2052
Blacktail Ponds	Aerial foragers survey	1995	2040

Sites 1-3 are in grassland; site 4, grass-sage, is a long-term monitoring site (since the 1960's); site 5 is established half and half across the edge of the Antelope Flats 1994 sagebrush burn; site 6 is tall sagebrush, site 7 a brushy forb meadow, and site 8 is scrubby aspen. Three sites (9-11) have a dominant willow component, three sites (12-14) are low-tall aspens; sites #15 and #16 are cottonwoods, with site #17 mixed aspen-

conifers. Sites 18-21 are situated in lodgepole pine forest, the latter within a recent (1988) burn and undergoing succession. Other conifer sites are #22 with a large douglas fir component, #23 with much Engelmann spruce, #24 mixed lodgepole pine-fir-spruce, and #25 with some of the tallest old-growth timber in the park, including douglas fir and Engelmann spruce. Site # 26 is located within pure spruce forest, while #27 is mixed whitebark pine-lodgepole pine-subalpine fir; site #28 is located nearby, in Cody Bowl just outside the park boundary, and represents the alpine tundra habitat. Two additional sites (# 29, 30) are included specifically to monitor wildfowl populations and aerial foragers respectively.

In addition to the 30 GTNP sites, two additional sites are included in the monitoring program. These duplicate a GTNP Wet Willows site (#10), to the north in Glacier National Park, and to the south in Rocky Mountain National Park.

Census criteria were established with a view to enhancing census uniformity and replicability, and observer independence. We use a method that is a combination of three techniques, territory mapping, transect counts, and point counts (Bibby et al, 1992). It is termed an "areal count", similar to the "spot-mapping" technique first described by Kendeigh (1944). It maximizes accuracy and the facility with which different observers can duplicate each other's results and observations, while minimizing the work required to plot actual territories and the difficulties with transcribing transect or point census data to real breeding densities. Each site is censused a minimum of three times during the breeding season, with visits spread over at least two weeks. One visit is made early am (0600-0800h), one later in the morning (0800-1100h), and one late afternoon (1500-1800h). The intent of this procedure is to account for potential differences among species in diurnal activity periods. Each census is made with a site map in hand, with most sites on the order of 5 ha in size. With the site map, an observer can always identify his/her position within the site, and locate permanent markers within the site. The observer spends around 2h within the site on each visit. Day, time, and observer identification are marked on the map sheet. All birds located and identified within the site are marked on the map if singing on territories, listed on the map if moving through the site, or foraging within or over the site but nesting elsewhere. The intent is to confirm identities and derive density estimates of all species that utilize the site.

For each census/visit, species are tallied and density estimates appended in units of numbers of breeding pairs. In species for which a 5 ha site is a small fraction of a larger territory, for non-territorial species, for smaller species nesting offsite and including a fraction of the territory within the site, reasonable estimates are made of the contribution of the e.g. 5 ha site to the requirements of the pair/ species in question. Densities ultimately recorded in the data set are the averages of the two highest counts of the several made at a site during the season.

THE GTNP AVIFAUNA

Some 300 bird species have been recorded in Jackson Hole, about the same as in Yellowstone National Park (YNP; McEneany 1996). Of these, some 270 species have been recorded in GTNP (Johnsgard 1986, Raynes 1995), around 250 in spring-summer, and about 175 species (90 passerines, 85 non-passerines) breed within the park. Common and Latin names of bird species so far recorded on the monitoring sites are given in Appendix A.

A good number of species that have been recorded as breeding within the park, or else may be classed as likely breeding species (but breeding is unconfirmed), are rare. Rare breeding species form into several distinct categories: species have large territories or are not easily detected; species are rare because suitable breeding habitat is rare; species are on the edge of their geographic ranges in GTNP. Of our list of 21 rare species, >75% have occurred on GTNP monitoring sites. Some undoubtedly breed in GTNP on a regular basis but not every year, and their use of GTNP seems a response to suitable conditions that occur irregularly. For example, Northern waterthrush and Virginia rail have bred in the Wet Willows monitoring site (#10) several times in the 1990's, in wet, cool years. The same sorts of conditions also bring Gray catbirds to Aspen-willow edge (site #11) and our Dry Willows sites (#'s 9, 11), and Least flycatchers to aspen or cottonwood sites (#'s 14, 15). Other species listed breed practically every year, but in rather scarce habitat (e.g. Sora in wet, brushy sedge marshes, Sage thrasher in tall sagebrush, and Bobolink in tall, forb-rich grassland in the Elk Refuge, site # 3).

It is considered to be a fortunate circumstance that so many species are at the edges of their breeding ranges in GTNP, for here it is likely that populations will be far more sensitive to year-to-year variations in local conditions than would be the case in the center of their breeding ranges. Several of the 30 monitoring sites were selected in habitat types specifically to detect the presence of rare breeding species when and if they occur within GTNP. Thus the opportunities to determine which local factors correlate with GTNP breeding in these marginal species are several.

Under 40% of the breeding non-passerines can be found in Jackson Hole throughout the winter, and many of these at much reduced densities. The residents are those species that typically overwinter at high latitudes in the Holarctic region, including corvids, sittids, and fringillids. Among the several breeding species that are marginally resident, presumably in response to the severity of the winter, are Song sparrow, American robin, Red-winged blackbird and Dark-eyed junco. Note that there is no compelling reason that migrant bird populations should be expected to be more variable or less predictable on the breeding grounds than those of resident birds, or vice versa. From first principles, selection is expected to act on migration or residence strategies to maximize overwinter survival, favoring further migration if less produces lower survival and less migration if increased residence enhances survival; overall, overwinter survival should not differ greatly among the diverse strategies available to temperate breeding birds.

✦ ANALYSES

Established monitoring sites have been assessed and classified by vegetation structure. At each site a "foliage profile" has been measured, a plot of vegetation density against height above ground. A depiction of the sites in the plane of the first two principal components is shown in Fig. 2a, 2b. From the figure, it is easy to distinguish the wetland sites, grassland and grass-sage, aspen, cottonwood and conifer forests. The vegetation structure at most of the monitoring sites cannot be considered permanent and unchanging. There are many disturbance factors that change vegetation structure, conspicuous amongst which are fire and storms (e.g. blowdowns) in woodland and forest, and flood and drought in wetland sites. Successional pathways are shown in Fig. 2b. Note the expected shifts in vegetation structure on the two recently burned sites (#s 5, sagebrush; 20, lodgepole pine forest).

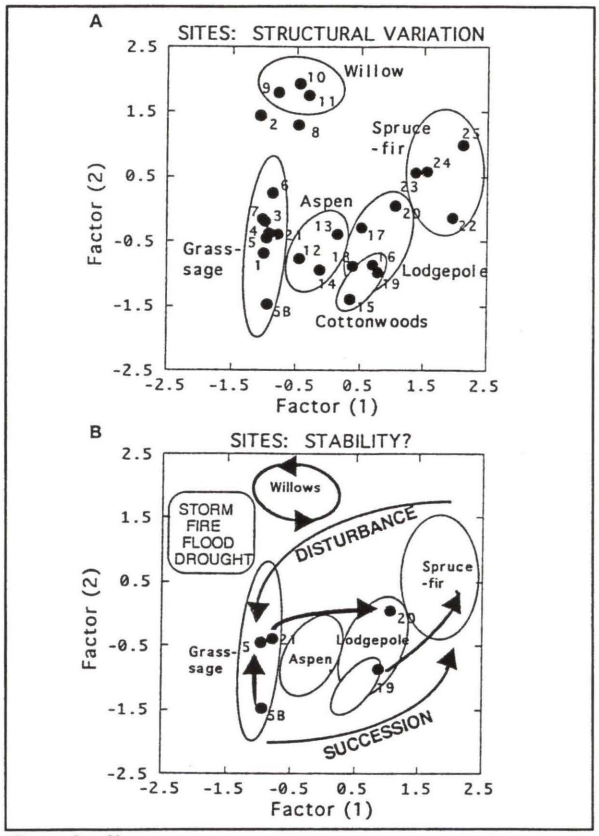

Figure 2a; 2b

Summaries of bird species censused on the GTNP monitoring sites are part of a growing data, including densities in pr/ha. Nearly 150 species are recorded on the monitoring sites in toto; most sites from willows to forest support 20-30 species, and the taller woodland and forest sites closer to 30 breeding species. Fig. 3 shows the distribution of certain species guilds over sites. Lower counts were recorded in 1995, in comparison to which species numbers were nearly uniformly higher in both 1996 and 1997. Species number appear less variable in site #'s >20, i.e. in taller conifers; the most conspicuous contributor to non-uniformity in the trend of species over sites is the smaller species numbers recorded in dry sagebrush sites, #'s 4-6.

Breeding bird densities are generally around 2-6 pr/ha in grasslands. 2-3 pr/ha in sagebrush, and 6-12 pr/ha in most other sites, with an obvious spike of high density in the Wet Willows (site #10). In general, total density parallels species numbers over sites (r = 0.76). In 1995 overall

densities were lower across sites (as were species numbers), but similar between 1996 and 1997. Both species numbers (richness) and total bird density correlate with vegetation height and foliage diversity over the profile; while significant, neither relation is compelling, as no more than 40% of the variation in either species or densities is accounted for by the vegetation structure.

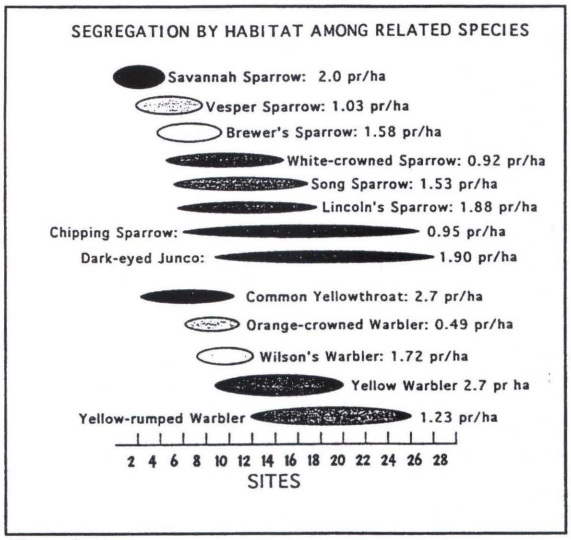

Figure 3

Each species has a characteristic distribution over GTNP habitats. The turnover in species from site to site measures a second component of diversity, b-diversity (in contrast to species richness within sites, a-diversity). Patterns of b-diversity show which sites are relatively homogeneous in the bird species they support, and between which sites the species composition changes more radically. A summary of these patterns is provided in Fig. 4. Five site clusters are defined by the criterion that species turnover among sites is <15%. These are grassland, sagebrush, willows, aspen, and lodgepole pine. When the criterion is relaxed to accommodate 30% turnover among sites, the two cottonwood sites join the aspen cluster, and the remaining conifer forests, chiefly spruce and fir, join the lodgepole cluster.

Some variation over time, i.e. between years, in census results is anticipated, but such variation itself varies among sites and among species. That is, some sites produce similar results over the years, whereas others vary considerably; and some species appear relatively constant over the years, whereas others fluctuate widely in occurrence and density. Aspen bird communities (site #s 12-14) appear to have been relatively constant for many years, since Doug Flack's 1968 censuses. In contrast, lower and more open habitats appear to be more variable in species composition over the years, e.g. at site #7 (Two Ocean Lake Meadow) where 1997 data are in strong contast to 1994 data. The suite of species Savannah/Brewer's/ Vesper sparrow dominated the earlier count, whereas White-crowned/ Lincoln's sparrow and Lazuli bunting the later count. At site #19 (AMK lodgepole forest), censused since 1992, species counts have varied 21-28, and total density 7.1-9.1 pr/ha. With a longer term data set, the possible causes of these changes can be investigated.

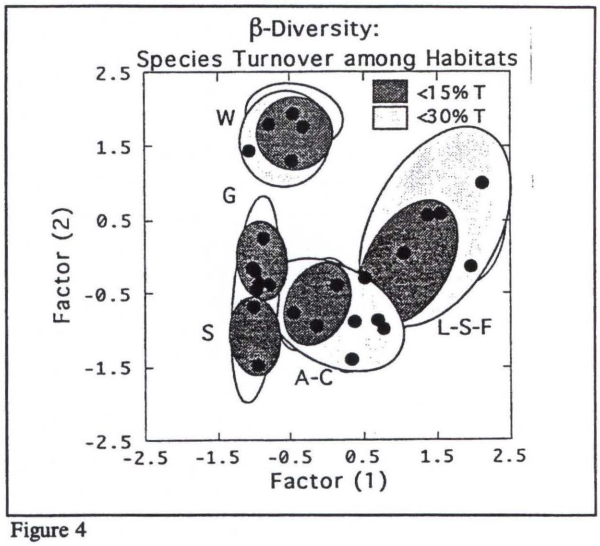

Figure 4

Between years, the densities of different species shift in different ways at different sites. In over bird densities across sites in GTNP, bird densities were very similar in 1996 and 1997. However, American robin densities were overall significantly lower in 1997 than 1996, and the reverse was true for White-crowned sparrow. Robin densities were lower in virtually all sites in 1997 except for the willows sites, and White-crowned sparrow densities were lower over virtually all sites in 1996 except for the willows sites. It seems that a) the two species responded in different ways to the changes between years (whether on- or off-site effects), but b) the wet habitats buffered the densities of each species, and in these habitats the two species were relatively constant between years. More and quantitative versions of such analyses will be possible with a longer term data set.

Willows habitats are becoming well-known as breeding bird densities are measured in

successive years, both at GTNP and elsewhere. Concommitantly, measures of insect availability have been made in each year in the willows sites (#9, 10) in GTNP, using Tanglefoot boards; notably, virtually all breeding birds in these habitats are insectivorous. But the birds and insects are only part of a larger willows ecosystem which has other conspicuous members, such as the large browsing ungulates that pre-empt much willow productivity and the beavers that not only feed on willow but alter drainage channels, and thus directly affect vegetation structure (to which the birds may respond). A diagrammatic view of the broader willows ecosystem is given in Fig. 5.

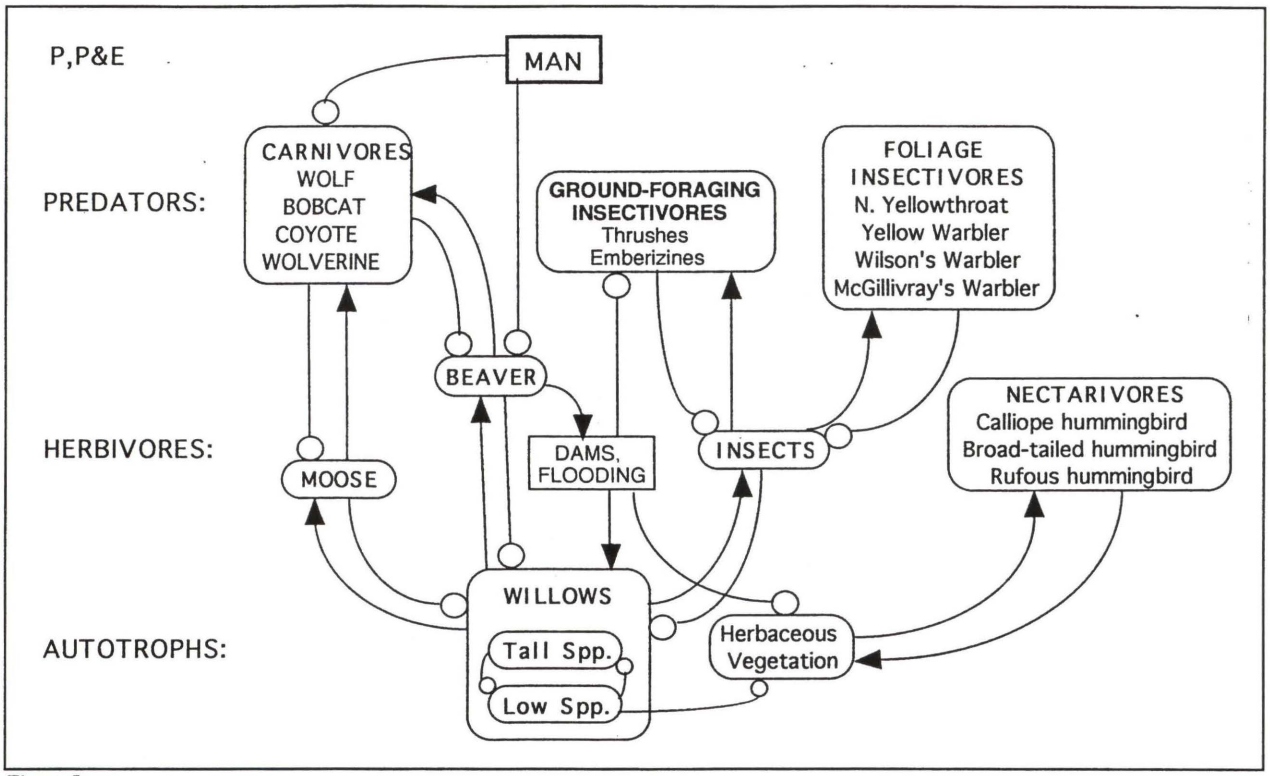

Figure 5

Two exclosures, 16' x 24' and 8'19' high, were erected at Site #9 (RKO Dry Willows); construction was completed in Sept 1996. Both exclosures are impermeable to elk, bison, moose and deer (all of which occur at the site), and one is additionally wrapped with aviary wire that excludes birds. A control site of similar size is located between the two exclosures. The exclosures allow willow herbivory only in insects and small rodents; birds may respond to insect density shifts in one exclosure but not in the other to which their access is denied. Excluding large browsers (moose et al.) is akin to elevating predation levels on the ungulates and reducing their densities. Responses to the exclosures measured yearly in three ways: a) insect Tanglefoot traps are set within exclosures and controls; b) willow shoot elongation and leaf area per shoot diameter are measured within exclosures and in the control; c) bird foraging activity is measured in the control and in the one exclosure to which birds have access. The first measurements were made in late July 1997, but so far little change of consequence has occurred. It is projected that conspicuous change should be detactable within a 5-yr period.

✦ Future Projections of the Monitoring Program

The value of a breeding bird monitoring program may be obvious, but can be restated as follows. Small birds are conspicuous, diurnal, and are easily and accurately censused on their breeding habitats; they are the chief insectivores in these

habitats; their densities respond within GTNP to habitat differences among sites, and to within-habitat changes among years; their migration strategies are diverse, and range between the extremes in-habitat residents to long-distance migrants; thus the potential impact of off-site influences can be assessed in principle. Overall, small birds are most useful bioassays of habitat health and quality, and ideal subjects for long-term monitoring studies.

While the potential advantages accruing from long-term monitoring of breeding bird populations, for assessment, management, conservation as well as purely academic (scientific, ecological) reasons are clear, they are demonstrable only with a long term data base. This is at present lacking, and it is hoped that the continuation of the GTNP monitoring program will provide a valuable basis for the evaluation of future trends and design of management policies.

✦ LITERATURE CITED

Bibby, C.J., N.D. Burgess & D.A. Hill. 1992. Bird Census Techniques. Academic Press, London, New York, Orlando. pp. 257.

Johnsgard, P.A. 1986. Birds of the Rocky Mountains. Univ. Nebraska Press, Lincoln.

Kendeigh, S.C. 1944. Measurement of bird populations. Ecol. Monogr. 14: 67-106.

McEneany, T. 1996. Field checklist of the birds of Yellowstone National Park. ABA Sales, Colo. Springs.

Raynes, B. 1995. A pocket guide to the birds of Jackson Hole. Homestead Publ., Moose, WY.

Sherry, T.W., & R. T. Holmes. 1995. Winter habitat quality, population limitation, and conservation of neotropical-nearctic migrant birds. Ecology 77(1):36-48.

Appendix.A

APPENDIX A: GTNP MONITORING SITES: SPECIES LIST 1995-97			
PELECANIDAE	White Pelican	*Pelecanus erythrorhynchus*	
ARDEIDAE	Great Blue Heron	*Ardea herodias*	
GRUIDAE	Sandhill Crane	*Grus canadensis*	
ANATIDAE	Trumpeter Swan	*Cygnus buccinator*	
	Canada Goose	*Branta canadensis*	
	Mallard	*Anas platyrhynchos*	
	Gadwall	*Anas strepera*	
	American Wigeon	*Anas americana*	
	Cinnamon Teal	*Anas cyanoptera*	
	Green-winged Teal	*Anas crecca*	
	Blue-winged Teal	*Anas discors*	
	Redhead	*Aythya americana*	
	Ring-necked Duck	*Aythya collaris*	
	Lesser Scaup	*Aythya affinis*	
	Common Merganser	*Mergus serrator*	
	Common Goldeneye	*Bucephala clangula*	
	Bufflehead	*Bucephala albeola*	
	Wood Duck	*Aix sponsa*	
RALLIDAE	Virginia Rail	*Rallus limicola*	
	Sora	*Porzana carolina*	
	American Coot	*Fulica americana*	
CHARADRIIDAE	Kildeer	*Charadrius vociferus*	
	Willet	*Catoptrophorus semipalmatus*	
SCOLOPACIDAE	Long-billed Curlew	*Numenius americanus*	
	Spotted Sandpiper	*Actitis macularia*	
	Wilson's phalarope	*Phlaropus tricolor*	
	Common Snipe	*Gallinago gallinago*	
LARIDAE	Franklin's Gull	*Larus pipixcan*	
	California Gull	*Larus californicus*	
	Ring-billed gull	*Larus delawarensis*	
CATHARTIDAE	Turkey Vulture	*Cathartes aura*	
ACCIPITRIDAE	Golden Eagle	*Aquila chrysaetos*	
	Bald Eagle	*Haliaeetus leucocephalus*	
	Northern Harrier	*Circus cyaneus*	

Appendix.A

	Red-tailed Hawk	*Buteo jamaicensis*	
	Swainson's Hawk	*Buteo swainsoni*	
	Osprey	*Pandion haliaetus*	
	Sharp-shinned Hawk	*Accipiter striatus*	
	Cooper's Hawk	*Accipiter cooperi*	
	Northern Goshawk	*Accipiter gentilis*	
FALCONIDAE	American Kestrel	*Falco tinnunculus*	
	Prairie Falcon	*Falco mexicanus*	
PHASIANIDAE	Ruffed Grouse	*Bonasa umbellus*	
	Blue Grouse	*Dendrogapus obscurus*	
	Sage Grouse	*Centrocercus urophasianus*	
COLUMBIDAE	Mourning Dove	*Zeneadura macroura*	
STRIGIDAE	Great Gray Owl	*Strix nebulosa*	
	Great Horned Owl	*Bubo virginianus*	
	Long-eared Owl	*Asio otus*	
	Northern Pygmy-Owl	*Glaucidium gnoma*	
CAPRIMULGIDAE	Common nighthawk	*Phalaenoptilus nuttalli*	
TROCHILIDAE	Calliope Hummingbird	*Stellula caliope*	
	Broad-tailed hummingbird	*Selasphorus platycercus*	
	Rufous hummingbird	*Selasphorus rufus*	
ALCENIDAE	Belted Kingfisher	*Ceryle alcyon*	
PICIDAE	Northern Flicker	*Colaptes auratus*	
	Williamson's Sapsucker	*Sphyrapicus thyroides*	
	Red-naped Sapsucker	*Sphyrapicus nuchalis*	
	Downy Woodpecker	*Picoides pubescens*	
	Hairy Woodpecker	*Picoides villosus*	
	Three-toed Woodpecker	*Picoides tridactylus*	
	Black-backed Woodpecker	*Picoides arcticus*	
TYRANNIDAE	Western Wood Pewee	*Contopus sordidulus*	
	Olive-sided Flycatcher	*Nuttallornis borealis*	
	Say's Phoebe	*Sayornis saya*	
	Dusky Flycatcher	*Empidonax oberholseri*	
	Hammond's Flycatcher	*Empidonax hammondii*	
	Least Flycatcher	*Empidonax traillii*	
	Willow flycatcher	*Empidonax difficilis*	

Appendix.A

	Cordilleran Flycatcher	*Empidonax ex. difficilis*	
HIRUNDINIDAE	Tree Swallow	*Tachycineta bicolor*	
	Violet-green swallow	*Tachycineta thalassina*	
	Rough-winged Swallow	*Stelgidopteryx serripennis*	
	Cliff Swallow	*Hirundo pyrrhonota*	
	Barn Swallow	*Hirundo rustica*	
	Bank Swallow	*Riparia riparia*	
CORVIDAE	Steller's Jay	*Cyanositta stelleri*	
	Gray Jay	*Perisoreus canadensis*	
	Clark's Nutcracker	*Nucifraga columniana*	
	Black-billed Magpie	*Pica pica*	
	American Crow	*Corvus brachyrhynchos*	
	Common Raven	*Corvus corax*	
PARIDAE	Black- capped Chickadee	*Parus atricapillus*	
	Mountain Chickadee	*Parus gambeli*	
CERTHIDAE	Brown Creeper	*Certhia americana*	
SITTIDAE	White-breasted Nuthatch	*Sitta carolinensis*	
	Red-breasted Nuthatch	*Sitta canadensis*	
TROGLODYTIDAE	Marsh Wren	*Cistothorus palustris*	
	Rock Wren	*Salpinctes obsoletus*	
	House Wren	*Troglodytes aedon*	
MUSCICAPIDAE	Golden-crowned Kinglet	*Regulus satrapa*	
Sylviinae	Ruby-crowned Kinglet	*Regulus calendula*	
	Mountain Bluebird	*Sialia currucoides*	
Turdinae	Townsend's Solitaire	*Myadestes townsendi*	
	Veery	*Catharus fuscescens*	
	Hermit Thrush	*Catharus guttatus*	
	Swainson's Thrush	*Catharus ustulatus*	
	American Robin	*Turdus migratorius*	
MIMIDAE	Gray Catbird	*Dumatella carolinensis*	
	Sage Thrasher	*Oreoscoptes montanus*	
MOTACILLIDAE	Water Pipit	*Anthus spinoletta*	
CINCLIDAE	American Dipper	*Cinclus mexicanus*	

Appendix.A

BOMBYCILLIDAE	Cedar Waxwing	*Bombycilla cedrorum*	
STURNIDAE	European Starling	*Sturnus vulgaris*	
VIREONIDAE	Solitary Vireo	*Vireo solitarius*	
	Warbling Vireo	*Vireo gilvus*	
EMBERIZIDAE	Orange-crowned Warbler	*Vermivora celata*	
Parulinae	Yellow-rumped Warbler	*Dendroica coronata*	
	Townsend's warbler	*Dendroica townsendi*	
	Yellow Warbler	*Dendroica petechia*	
	MacGillivray's Warbler	*Oporornis tolmiei*	
	Wilson's Warbler	*Wilsonia pusilla*	
	Northern Waterthrush	*Seiurus novaboracensis*	
	Common Yellowthroat	*Geothlypis trichas*	
	American Redstart	*Setophaga ruticilla*	
Emberizinae	Black-headed Grosbeak	*Pheuticus melanocephalus*	
	Lazuli Bunting	*Passerina amoena*	
	Spotted towhee	*Pipilo maculatus*	
	Green-tailed Towhee	*Pipilo chlorurus*	
	Vesper Sparrow	*Pooecetes gramineus*	
	Savannah Sparrow	*Passerculus sandwichensis*	
	Song Sparrow	*Melospiza melodia*	
	Lincoln's Sparrow	*Melospiza lincolnii*	
	Fox Sparrow	*Passerella iliacus*	
	Lark Sparrow	*Chondestes grammacus*	
	Chipping Sparrow	*Spizella paserina*	
	Clay-colored Sparrow	*Spizella pallida*	
	Brewer's Sparrow	*Spizella breweri*	
	Dark-eyed Junco	*Junco hyemalis*	
	White-crowned Sparrow	*Zonotrichia leucophrys*	
ICTERIDAE	Bobolink	*Dolichonyx oryzivorus*	
	Western Meadowlark	*Sturnella neglecta*	
	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	
	Red-winged Blackbird	*Agelaius phoeniceus*	
	Brewer' Blackbird	*Euphagus cyanocephalus*	
	Brown-headed Cowbird	*Molothru ater*	
	Common Grackle	*Quiscalus quiscula*	
THRAUPIDAE	Western Tanager	*Piranga ludoviciana*	

Appendix.A

FRINGILLIDAE	Pine siskin	*Carduelis pinus*	
	American Goldfinch	*Carduelis tristis*	
	Red Crossbill	*Loxia curvirostra*	
	White-winged crossbill	*Loxia leucoptera*	
	Pine Grosbeak	*Pinicola enucleator*	
	Rosy Finch	*Leucosticte arctoa*	
	Cassin's Finch	*Carpodacus cassinii*	
	House Finch	*Carpodacus mexicanus*	
	Evening Grosbeak	*Coccothraustes verpertinus*	
	To Date: 147 species		