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BREEDING BIRDS AT THE IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY, 1985–1991

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ABSTRACT.—During the summers of 1985–1991, bird censuses were conducted along 13 permanent routes located at the 2315-km^2 Idaho National Engineering and Environmental Laboratory (INEEL, formerly INEL) in southeastern Idaho. The objectives of the surveys were to (1) compare avifauna in and near facility complex sites with remote, relatively undisturbed habitats, (2) identify trends in populations of sagebrush-obligate species and other common shrubsteppe species, and (3) determine the presence, abundance, and population status of species of special concern. Five routes were official U.S. Geological Survey, Biological Resources Division 40.0-km Breeding Bird Survey (BBS) routes (formerly administered by the U.S. Fish and Wildlife Service) located in relatively remote portions of the INEEL where access by humans was controlled and limited. Eight shorter routes (5.8–19.2 km in length) were near INEEL facility complexes, which more regularly experienced disturbance by humans. The surveys recorded 25,597 individuals representing 90 species. Western Meadowlarks (*Sturnella neglecta*), Brewer's Sparrows (*Spizella breweri*), Sage Sparrows (*Amphispiza belli*), Horned Larks (*Eremophila alpestris*), and Sage Thrashers (*Oreoscoptes montanus*) comprised 72% of all individuals. Almost half of all species were represented by fewer than 10 individuals. Bird density was significantly greater along facility complex routes. Moreover, because of human-constructed wetlands and structures of various types, facility complex routes had significantly more bird species per unit area, including more species of waterfowl and human-associated species. Some year-to-year variation in bird density was related to weather. More individuals were recorded in cooler, wetter years, although such increases were reflected more along facility complex routes. Among sagebrush-obligate species, trend analysis suggests that both Brewer's Sparrows and Sage Sparrows increased significantly in abundance, which may be in contrast to regional trends for these species. Of 5 species of special concern observed, trend analysis could be performed for only 2: Ferruginous Hawks (*Buteo regalis*) and Loggerhead Shrikes (*Lanius ludovicianus*). Both species had more routes with negative regression coefficients and negative trend means, indicating that declines may have occurred, although the goodness-of-fit test for neither species was significant. These data from the INEEL should be useful for comparison with future studies at the site and other studies from throughout the Great Basin region.

Key words: Idaho National Engineering and Environmental Laboratory (INEEL), avifauna, sagebrush shrubsteppe, sagebrush obligates.

Although a number of recent reports document population changes in the avifauna of the eastern or midwestern U.S. (e.g., Askins et al. 1990, Sauer and Droege 1990, 1992, Hagan and Johnston 1992, Finch and Stangel 1993, Hagan 1993, Peterjohn and Sauer 1994, Hekert 1995), patterns of population change in western bird species have remained largely understudied. Dobkin (1994) noted that fewer studies in the West may be a result of fewer Breeding Bird Survey routes and proportionately greater non-urban/suburban habitat compared to the eastern U.S. Additionally, insufficient route coverage over much of the western U.S. has limited attempts to compare trends between periods in BBS data for populations of many western species (e.g., see Sauer and Droege 1992). Despite such limitations, Paige (1990) indicated there are key species in every major habitat in the West that warrant either concern or immediate action. Of particular interest in her analysis were shrubsteppe and grassland habitats, which apparently experienced widespread declines in avifauna between 1966 and 1985 (Paige 1990). Additional and more recent information concerning avian populations in shrubsteppe and grassland habitats would be useful to determine whether such declines have continued or have been exacerbated.

The Idaho National Engineering and Environmental Laboratory (INEEL), located in southeastern Idaho, is a federal facility containing large expanses of shrubsteppe habitat within its boundaries. In contrast to many other sites in southern Idaho and elsewhere where this habitat type has been converted for crop

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and hay production, or severely altered by invasion of exotic species of annuals, shrubsteppe habitat at the INEEL remains relatively undisturbed because there are few roads, access by humans to much of the area is controlled and limited, and there is no crop or hay production. Instead, this area was designated as a National Environmental Research Park in 1975 and serves as an outdoor laboratory to assess impacts of energy development technologies on the environment. Although the vertebrate fauna on the area have been described (Reynolds et al. 1986), little information exists concerning how the avifauna changes with time, or how changing land-use patterns and other activities affect the structure or abundance of avian populations. Therefore, because of the paucity of information on population status of breeding birds in the western U.S., and because the INEEL provides an ideal study site for conducting longer-term studies within shrubsteppe habitat, we examined the avifauna by censusing permanent survey routes for birds each summer.

Specifically, our objectives in the present study were to (1) identify bird species present at the INEEL during the summer breeding season; (2) assess the effects of INEEL activities by comparing the abundance and composition of avifauna occupying facility complex sites and more remote habitats; (3) identify trends in abundance of sagebrush-obligate species (i.e., species characteristic of the shrubsteppe habitat that require large areas of unfragmented sagebrush habitat) and other common shrubsteppe species; (4) determine the presence, abundance, and population status of species of special concern in Idaho; and finally (5) generate baseline information concerning populations of breeding birds at the INEEL, which hopefully will be useful for comparisons with ongoing and future studies both at the site and in shrubsteppe habitat throughout the western U.S.

STUDY AREA

The 2315-km^2 INEEL is located approximately 48 km west of Idaho Falls, on the upper Snake River Plain in portions of Bonneville, Butte, Bingham, Jefferson, and Clark counties, Idaho. The area is dominated by semiarid, cold desert shrubland with an average elevation of approximately 1500 m above sea level. The climate, geology, and vegetation of this high desert area are described in detail by Anderson and Holte (1981) and Anderson et al. (1996). Briefly, vegetation at the site is characteristic of shrubsteppe habitat and dominated by woody, mid-height shrubs and perennial bunchgrasses. Common plant species include sagebrush (*Artemisia* spp.), rabbitbrush (*Chrysothamnus viscidiflorus*), shadscale (*Atriplex confertifolia*), winterfat (*Krascheninnikovia lanata*), squirreltail (*Elymus elymoides*), thickspike wheatgrass (*Elymus lanceolatus*), needle and thread grass (*Hesperostipa comata*), and ricegrass (*Achnatherum hymenoides*). In general, the topography is flat to gently rolling, with lava outcroppings characteristic of the Columbia Plateau Province. The area experiences hot summers, cold winters, frequent wind, and low soil stability (Short 1986). Annual precipitation, averaging approximately 20 cm/ yr, is produced mainly during spring rain and snow events. Surface water is limited to residual flows of the Big Lost Rivers and Birch Creek, each of which is diverted upstream for agriculture and flood prevention, and several (0.3–15.8 ha in size) human-constructed ponds near research facilities. Grazing by sheep and cattle occurs but is seasonal and concentrated on the periphery of INEEL where the site borders Bureau of Land Management (BLM) and private holdings. Stocking densities in areas grazed at INEEL are lower (10 ac/AUM) than those on neighboring BLM lands (6 ac/AUM).

METHODS

Survey Routes and Procedures

Thirteen permanent avian census routes were established within the study area (Fig. 1). These include 40.0-km routes (n = 5 standard Breeding Bird Survey [BBS] routes administered by U.S. Geological Survey, Biological Resources Division) that traverse the major habitat types within more remote regions of the site (Table 1, Fig. 1). For brevity, hereafter we refer to these as *remote routes*, and the areas in which they are located as *remote areas*. Eight shorter routes, averaging 8.5 km in length, are around major INEEL facility complexes (Table 1), where effects of site activities on the abundance and composition of avifauna are assessed in comparison to remote areas. We refer to these routes as *facility complex routes*. The 13 routes were surveyed for

TABLE 1. Summary of length of route, number of stops, and area surveyed along permanent bird survey routes (n = 5 remote routes, n = 8 facility complex routes) at the Idaho National Environmental and Engineering Laboratory in southeastern Idaho. Major habitat associations along each route and mean ($\pm s$) number of species and individuals (number/km^2) observed along each route, 1985–1991, also are summarized.

Route	Length (km)	No. stops	Area (km^2)	No. species	No. individuals	Major habitat types[a] (percentage of route)
REMOTE ROUTES						
Twin Buttes (TB)	40.0	50	25.1	17.3 ± 1.9	12.9 ± 3.4	1 (16), 2 (31), 8 (16), 9 (12), 11 (17), 13 (4), 15 (4)
Lost River (LR)	40.0	50	25.1	15.8 ± 1.3	12.3 ± 3.4	1 (76), 3 (12), 12 (12)
Kyle Canyon (KC)	40.0	50	25.1	22.8 ± 3.9	11.7 ± 2.7	3 (20), 4 (20), 6 (10), 7 (12), 11 (16), 12 (14), 14 (8)
Circular Butte (CB)	40.0	50	25.1	13.0 ± 1.5	13.0 ± 5.5	2 (4), 3 (6), 5 (60), 10 (20), 12 (10)
Tractor Flats (TF)	40.0	50	25.1	17.3 ± 2.3	18.9 ± 6.1	1 (8), 2 (23), 8 (7), 10 (40), 13 (22)
FACILITY COMPLEX ROUTES						
Idaho Chemical Processing Plant (ICPP)	8.0	25	2.01	13.4 ± 1.8	88.0 ± 30.6	3 (100)
Test Reactor Area (TRA)	10.2	32	2.57	13.4 ± 3.6	102.2 ± 60.1	3 (100)
Central Facilities Area (CFA)	9.6	42[b]	3.38	18.6 ± 1.5	88.3 ± 19.4	2 (75), 3 (25)
Naval Reactors Facility (NRF)	6.4	20	1.61	22.4 ± 5.4	168.7 ± 57.4	2 (100)
Test Area North (TAN)	19.2	60	4.82	18.1 ± 4.0	92.2 ± 40.6	4 (40), 10 (15), 14 (45)
Power Burst Facility (PBF)	9.0	28[c]	2.25	12.1 ± 1.9	81.1 ± 28.3	2 (80), 13 (20)
Radioactive Waste Management Complex (RWMC)	5.8	18	1.45	12.7 ± 2.4	72.3 ± 11.1	1 (100)
Argonne National Laboratory–West (ANL-W)	5.8	18	1.45	20.1 ± 3.5	136.9 ± 27.8	2 (80), 15 (20)

[a]Habitat types: (1) *Artemisia tridentata–Pseudoroegneria spicata–Chrysothamnus viscidiflorus*, (2) *Artemisia tridentata–Chrysothamnus viscidiflorus–Elymus elymoides*, (3) *Artemisia tridentata–Elymus lanceolatus–Hesperostipa comata*, (4) *Artemisia tridentata–Krascheninnikovia lanata–Chrysothamnus viscidiflorus*, (5) *Artemisia tridentata–Achnatherum hymenoides–Hesperostipa comata*, (6) *Artemisia tridentata–Krascheninnikovia lanata–Atriplex confertifolia*, (7) *Artemisia arbuscula–Artemisia tridentata–Atriplex confertifolia*, (8) *Agropyron cristatum* (seeded), (9) *Pseudoroegneria spicata–Artemisia tripartita–Chrysothamnus viscidiflorus*, (10) *Achnatherum hymenoides–Chrysothamnus viscidiflorus–Opuntia polyacantha*, (11) *Juniperus osteosperma–Artemisia tridentata–Pseudoroegneria spicata*, (12) *Tetradymia canescens–Chrysothamnus viscidiflorus–Artemisia tridentata*, (13) *Chrysothamnus viscidiflorus–Artemisia tridentata*, (14) *Atriplex nuttalii–Krascheninnikovia lanata–Achnatherum hymenoides*, (15) *Leymus cinereus–Chrysothamnus viscidiflorus–Pseudoroegneria spicata*.

[b]Only 30 stops were included in 1985.

[c]Thirty stops made in 1986.

birds in June of each year between 1985 and 1991, with the exception of 4 individual route surveys (3 in 1985, 1 in 1990), which were performed in early July because of delays caused by unsuitable weather. Beginning 0.5 h before sunrise, we recorded the number of individuals of each bird species seen or heard during 3-min observation sessions at each stop along the route. For remote routes, we located stops every 0.8 km and counted birds if they occurred within 0.4 km of the stop. Surveys along the shorter facility complex routes were performed in a similar fashion, except that stops were 0.32 km apart and birds were recorded only if they were within 0.16 km (i.e., half the distance between stops) of the observer. Stops were visited in the same order each year, but surveys were conducted only when weather conditions were considered satisfactory according to BBS guidelines.

Finally, 4 different observers performed the surveys. Because 3 observers each performed the surveys for 2 consecutive years (1985–86, 1987–88, 1990–91), and the 4th conducted surveys in only 1 yr (1989), the possibility of interobserver (Sauer et al. 1994) and 1st-time observer (Kendall et al. 1996) effects in the data set cannot be ruled out. For example, Kendall et al. (1996) noted that trend estimates for many species based on formal breeding bird survey route data decreased by an average of 1.8% per year when data from an observer's 1st yr were excluded, and the authors suggested the difference was most likely a result of observers' improvements in counting birds in subsequent years. Kendall et al. (1996) suggested that to reduce 1st-time observer effects, 1st-yr data could be eliminated from analyses, or the effects might be reduced by improved training of observers prior to their 1st survey. Because our study was of relatively short duration in comparison to the Breeding Bird Survey, which has been underway since the mid-1960s (Robbins et al. 1986, 1989), we are unable to eliminate

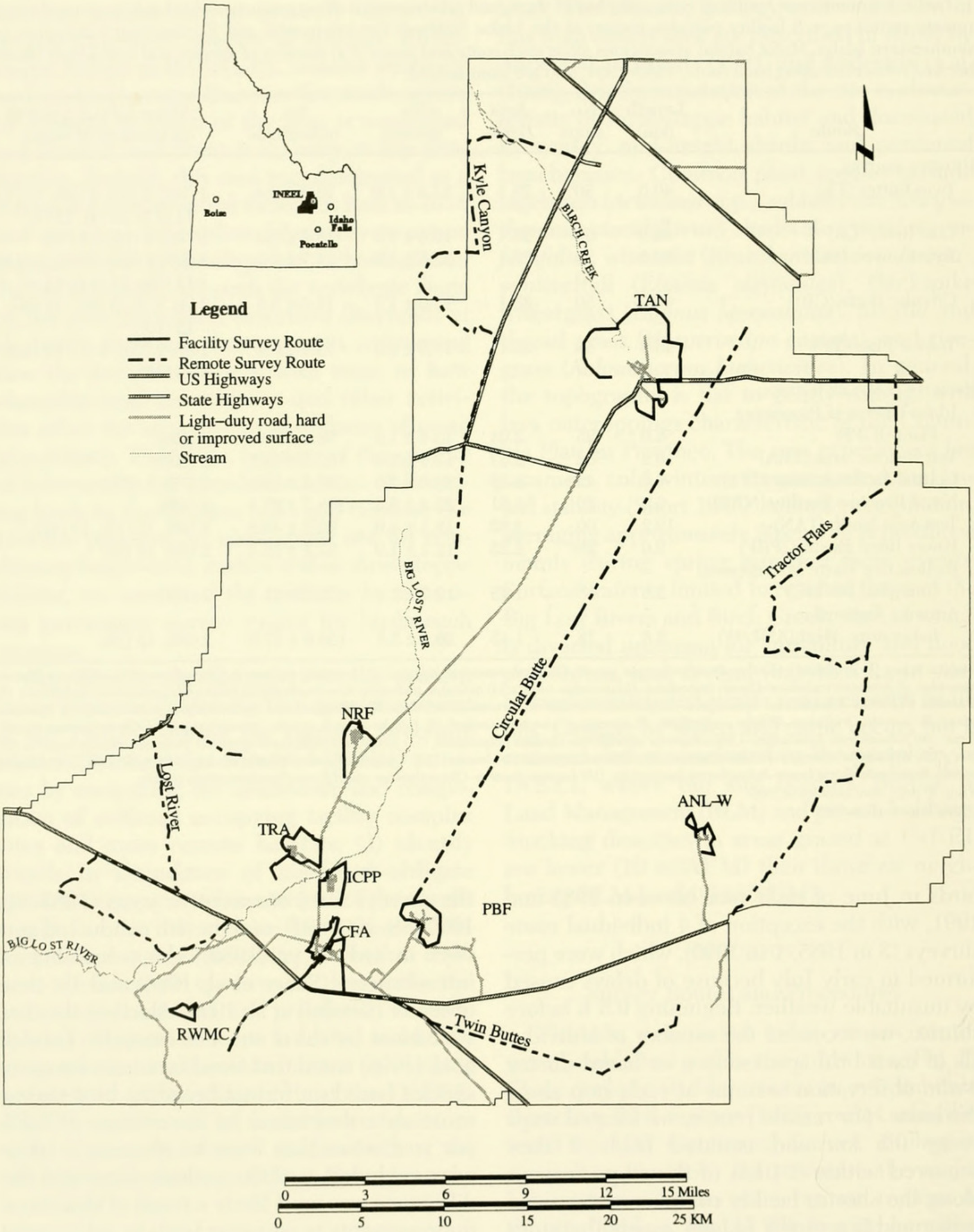

Fig. 1. Relative locations of remote routes and facility complex routes for breeding bird census at the INEEL, 1985–1991. Route designators relate to those in Table 1.

the 4 yr of data in which 1st-time observers performed the surveys; instead, we made every effort to reduce potential interobserver and 1st-time observer effects using the latter recommendation of Kendall et al. (1996). In our study all survey personnel were skilled with bird identification in the habitats of interest, they typically had experience in performing standardized surveys for birds, and they were routinely trained in the point-count method prior to beginning the surveys.

Data Analyses

Each year, and for each route, we recorded number of birds observed and number of species detected (species richness). Because the radius of surveys around stops was not equal between types of routes, we also transformed bird abundance and species data to per-unit-area (km^2) measures to allow more appropriate comparisons between types of routes. Then, to assess differences in bird abundance and species richness between types of routes and among years, we performed 2-factor, repeated-measures ANOVAs (Winer et al. 1991) using the Statistical Analysis System (SAS®, Version 6.1, SAS Institute, Cary, NC), with type of route as the between-group factor and year of survey (1985–1991) as the within-subjects or repeated factor. We examined assumptions (e.g., sphericity) for repeated-measures analyses using the REPEATED statement in SAS prior to analysis and used Fisher's protected least significant difference for means comparisons at a rejection level (i.e., α) of 0.05.

We also examined relationships between weather and climate variables and bird abundance and species richness using the nonparametric Spearman's correlation analysis (Sokal and Rohlf 1995, conducted using SAS's CORR procedure). Weather data were from the National Oceanic and Atmospheric Administration monitoring station operated at the Central Facilities Complex, which is located in the southern portion of the study area but relatively centrally among the facility complexes. Although some variation in weather is likely between the survey routes and this station, and among survey routes, these data should provide a general indication of weather conditions at the site during each survey year. For June 1985–1991, which is the month during which most individual surveys were performed, we calculated mean daily maximum temperature (all temperatures are reported as °C), mean daily minimum temperature, mean daily temperature (i.e., daily maximum minus daily minimum and averaged across days of month), maximum monthly temperature, minimum monthly temperature, and total monthly precipitation (cm).

Finally, to examine trends in populations of sagebrush-obligate species, common shrub-steppe species, and species of special concern, using the REG procedure in SAS we regressed against year (1) the total number of individuals per route, and (2) number of individuals per km^2 surveyed for each of the 13 routes (see Atkinson 1995). We included only those routes for which the species of interest was detected in ≥5 yr. We subsequently (1) averaged regression coefficients to calculate trend means and (2) determined the number of routes for which regression coefficients were positive and tested the observed distribution against a null random distribution (e.g., that half of the coefficients should be positive) using a χ^2 goodness-of-fit test (including Yates correction for continuity, Zar 1996). We used this approach rather than the route regression approach used in more expanded studies of standardized Breeding Bird Survey data because the majority of routes in our study were not standard BBS routes and the 7 yr of data from our study would result in degrees of freedom below those recommended for the latter (see Geissler and Sauer 1990).

RESULTS

From 1985 through 1991, we recorded 25,597 individuals representing 90 species along 13 survey routes (Tables 1, 2). Western Meadowlarks (*Sturnella neglecta*) were most abundant; this species occurred along all 13 routes and at approximately 62% of the 4991 stops. Other common species were Brewer's Sparrows (*Spizella breweri*), Sage Sparrows (*Amphispiza belli*), Horned Larks (*Eremophila alpestris*), and Sage Thrashers (*Oreoscoptes montanus*), each of which occurred at more than 1100 stops and along all 13 routes (Table 2). These 5 species accounted for approximately 72% of all individuals over the study period. Mourning Doves (*Zenaida macroura*), Brown-headed Cowbirds (*Molothrus ater*), and Common Nighthawks (*Chordeiles minor*) also occurred along each of the 13 routes but in smaller numbers than the preceding species. None of the other 82 species were recorded along all 13 survey routes (Table 2). Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*) and Franklin's Gulls (*Larus pipixcan*) also were relatively abundant, but these 2 species were present along fewer routes and

TABLE 2. Species and number of birds observed along bird survey routes (n = 13) at the Idaho National Engineering and Environmental Laboratory, 1985–1991.

Common name	Scientific name	Overall No.	Overall %	Overall Routes[b]	Overall Stops[c]	Overall %	Annual values No. ($\bar{x} \pm s$)	Annual values Stops ($\bar{x} \pm s$)
Western Meadowlark	*Sturnella neglecta*	4497	17.6	5,8	2129	61.9	642 ± 275.6	304 ± 84.4
Brewer's Sparrow	*Spizella breweri*	4297	16.8	5,8	1711	49.7	614 ± 430.3	244 ± 114.9
Sage Sparrow	*Amphispiza belli*	3731	14.6	5,8	1830	53.2	533 ± 297.2	261 ±89.4
Horned Lark	*Eremophila alpestris*	3348	13.1	5,8	1195	34.7	478 ± 123.6	171 ± 36.9
Sage Thrasher	*Oreoscoptes montanus*	2441	9.5	5,8	1670	48.5	349 ± 91.8	239 ± 61.8
Mourning Dove	*Zenaida macroura*	996	3.9	5,8	600	17.4	142 ± 64.4	86 ± 33.0
Brown-headed Cowbird	*Molothrus ater*	875	3.4	5,8	427	12.4	125 ± 59.4	61 ± 20.0
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	610	2.4	2,4	70	2.0	87 ± 67.5	10 ± 6.0
Franklin's Gull	*Larus pipixcan*	495	1.9	1,4	16	0.5	71 ± 178.4	2 ± 4.4
Common Nighthawk[a]	*Chordeiles minor*	495	1.9	5,8	288	8.4	71 ± 30.6	41 ± 16.2
Brewer's Blackbird	*Euphagus cyanocephalus*	375	1.5	4,8	143	4.2	54 ± 22.9	20 ± 6.9
Killdeer	*Charadrius vociferus*	353	1.4	3,8	173	5.0	50 ± 16.5	25 ± 8.0
Vesper Sparrow	*Pooecetes gramineus*	308	1.2	5,7	151	4.4	44 ± 63.8	22 ± 28.5
Loggerhead Shrike	*Lanius ludovicianus*	280	1.1	5,7	210	6.1	40 ± 18.7	30 ± 10.9
European Starling	*Sturnus vulgaris*	186	0.7	1,8	57	1.7	27 ± 20.0	8 ± 6.6
Wilson's Phalarope	*Steganopus tricolor*	166	0.6	1,2	10	0.3	24 ± 35.4	1 ± 0.5
Black-billed Magpie	*Pica pica*	164	0.6	4,5	110	3.2	23 ± 12.6	16 ± 7.2
Sage Grouse	*Centrocercus urophasianus*	163	0.6	5,5	34	1.0	23 ± 32.0	5 ± 4.6
Barn Swallow[a]	*Hirundo rustica*	152	0.6	2,8	70	2.0	22 ± 8.7	10 ± 3.9
Short-eared Owl	*Asio flammeus*	144	0.6	5,7	91	2.6	21 ± 37.5	13 ± 21.3
Ferruginous Hawk	*Buteo regalis*	95	0.4	5,5	73	2.1	14 ± 3.3	10 ± 2.6
Bank Swallow[a]	*Riparia riparia*	95	0.4	2,2	25	0.7	14 ± 10.8	4 ± 1.3
American Robin	*Turdus migratorius*	84	0.3	4,4	42	1.2	12 ± 6.8	6 ± 3.3
Canada Goose	*Branta canadensis*	82	0.3	1,1	2	0.1	12 ± 26.8	<1
House Sparrow	*Passer domesticus*	79	0.3	0,1	10	0.3	11 ± 16.2	1 ± 0.8
American Kestrel	*Falco sparverius*	72	0.3	4,6	53	1.5	10 ± 5.5	8 ± 4.4
Red-tailed Hawk	*Buteo jamaicensis*	67	0.3	4,7	63	1.8	10 ± 11.3	9 ± 10.2
House Finch	*Carpodacus mexicanus*	67	0.3	0,6	20	0.6	10 ± 9.6	3 ± 1.9
Northern Harrier	*Circus cyaneus*	60	0.2	5,5	54	1.6	9 ± 4.0	8 ± 4.0
Common Raven	*Corvus corax*	57	0.2	5,3	45	1.3	8 ± 5.5	6 ± 3.3
Lark Bunting	*Calamospiza melanocorys*	49	0.2	1,2	17	0.5	7 ± 16.8	2 ± 5.6
Northern Shoveler	*Anas clypeata*	48	0.2	0,2	15	0.4	7 ± 7.0	2 ± 1.4
Lark Sparrow	*Chondestes grammacus*	42	0.2	3,1	23	0.7	6 ± 6.1	3 ± 2.9
Common Flicker	*Colaptes auratus*	40	0.2	3,0	33	1.0	6 ± 3.8	5 ± 2.9
Mallard	*Anas platyrhynchos*	36	0.1	0,2	6	0.2	5 ± 8.4	1 ± 0.9
Ruddy Duck	*Oxyura jamaicensis*	36	0.1	0,2	10	0.3	5 ± 1.8	1 ± 0.5
Cinnamon Teal	*Anas cyanoptera*	33	0.1	0,2	8	0.2	5 ± 6.8	1 ± 1.1
Chipping Sparrow	*Spizella passerina*	33	0.1	1,0	13	0.4	5 ± 4.6	2 ± 2.0
Rock Wren	*Salpinctes obsoletus*	33	0.1	4,5	21	0.6	5 ± 6.7	3 ± 3.6
American Avocet	*Recurvirostra americana*	30	0.1	0,1	4	0.1	4 ± 6.4	1 ± 0.5
N. Rough-winged Swallow	*Stelgidopteryx serripennis*	30	0.1	1,5	16	0.5	4 ± 4.5	2 ± 1.8
Gadwall	*Anas strepera*	28	0.1	0,3	7	0.2	4 ± 6.2	1 ± 1.5
Blue-winged Teal	*Anas discors*	26	0.1	0,2	6	0.2	4 ± 5.4	1 ± 1.5
Swainson's Hawk[a]	*Buteo swainsoni*	23	0.1	5,2	22	0.6	3 ± 1.4	3 ± 1.4
Lazuli Bunting	*Passerina amoena*	23	0.1	1,0	15	0.4	3 ± 5.2	2 ± 3.4
Redhead	*Aythya collaris*	21	0.1	0,2	4	0.1	3 ± 3.2	1 ± 0.5
Rock Dove	*Columba livia*	17	0.1	0,1	5	0.1	2 ± 3.3	1 ± 1.2
American Coot	*Fulica americana*	16	0.1	0,2	9	0.3	2 ± 2.1	1 ± 1.0
Say's Phoebe	*Sayornis saya*	16	0.1	1,6	14	0.4	2 ± 3.0	2 ± 2.9
Gray Flycatcher	*Empidonax wrightii*	14	0.1	2,1	10	0.3	2 ± 2.9	1 ± 2.2
Burrowing Owl	*Athene cunicularia*	13	0.1	4,3	12	0.3	2 ± 3.1	2 ± 3.0
Northern Pintail	*Anas acuta*	9	<0.1	0,1	2	0.1	1 ± 3.0	<1
Prairie Falcon	*Falco mexicanus*	9	<0.1	2,1	8	0.2	1 ± 1.4	1 ± 1.4
Cliff Swallow[a]	*Petrochelidon pyrrhonota*	9	<0.1	1,1	2	0.1	1 ± 2.6	<1
Lesser Scaup	*Aythya affinis*	8	<0.1	0,2	3	0.1	1 ± 1.7	<1
Eastern Kingbird[a]	*Tyrannus tyrannus*	8	<0.1	2,2	5	0.1	1 ± 1.9	1 ± 1.1
Clark's Nutcracker	*Nucifraga columbiana*	8	<0.1	1,0	1	0.0	1 ± 3.0	<1
Red-winged Blackbird	*Agelaius phoeniceus*	7	<0.1	1,2	4	0.1	1 ± 1.5	1 ± 0.8

TABLE 2. Continued.

		Overall					Annual values	
Common name	Scientific name	No.	%	Routes[b]	Stops[c]	%	No. ($\bar{x} \pm s$)	Stops ($\bar{x} \pm s$)
Violet-green Swallow	*Tachycineta thalassina*	7	<0.1	2,2	5	0.1	1 ± 1.8	1 ± 1.1
Ring-billed Gull	*Larus delawarensis*	6	<0.1	2,2	4	0.1	1 ± 0.9	1 ± 0.8
Common Goldeneye	*Bucephala clangula*	6	<0.1	1,1	2	0.1	1 ± 1.9	<1
Great Horned Owl	*Bubo virginianus*	6	<0.1	1,2	3	0.1	1 ± 1.5	<1
Western Kingbird[a]	*Tyrannus verticalis*	6	<0.1	2,1	5	0.1	1 ± 0.9	1 ± 0.8
Ring-necked Pheasant	*Phasianus colchicus*	6	<0.1	0,3	5	0.1	1 ± 1.5	1 ± 1.1
Willet	*Catoptrophorus semipalmatus*	5	<0.1	1,1	5	0.1	1 ± 0.8	1 ± 0.8
Common Poor-will	*Phalaenoptilus nuttalii*	5	<0.1	1,0	4	0.1	1 ± 1.9	1 ± 1.5
Spotted Sandpiper	*Actitis macularia*	4	<0.1	0,2	3	0.1	1 ± 0.8	<1
Mountain Bluebird	*Sialia currucoides*	4	<0.1	1,0	3	0.1	1 ± 1.0	<1
Gray Partridge	*Perdix perdix*	4	<0.1	3,0	3	0.1	1 ± 1.1	<1
California Gull	*Larus californicus*	3	<0.1	2,0	3	0.1	<1	<1
Caspian Tern	*Sterna caspia*	3	<0.1	1,0	1	<0.1	<1	<1
Forster's Tern	*Sterna forsteri*	3	<0.1	1,0	1	<0.1	<1	<1
Long-billed Curlew	*Numenius americanus*	3	<0.1	1,0	2	0.1	<1	<1
Golden Eagle	*Aquila chrysaetos*	3	<0.1	1,1	3	0.1	<1	<1
Blue Gray Gnatcatcher	*Polioptila caerulea*	3	<0.1	1,0	2	0.1	<1	<1
Green-winged teal	*Anas crecca*	2	<0.1	0,1	1	<0.1	<1	<1
Wood Duck	*Aix sponsa*	2	<0.1	0,1	1	<0.1	<1	<1
White-faced Ibis	*Plegadis chihi*	2	<0.1	1,0	1	<0.1	<1	<1
Cooper's Hawk	*Accipiter cooperii*	2	<0.1	1,0	2	0.1	<1	<1
Savannah Sparrow	*Passerculus sandwichensis*	2	<0.1	0,1	2	0.1	<1	<1
Green-tailed Towhee	*Pipilo chlorurus*	2	<0.1	1,0	2	0.1	<1	<1
Eared Grebe	*Podiceps nigricollis*	1	<0.1	1,0	1	<0.1	<1	<1
Sora	*Porzana carolina*	1	<0.1	0,1	1	<0.1	<1	<1
Greater Yellowlegs	*Tringa melanoleuca*	1	<0.1	0,1	1	<0.1	<1	<1
Merlin	*Falco columbarius*	1	<0.1	1,0	1	<0.1	<1	<1
Willow Flycatcher[a]	*Empidonax traillii*	1	<0.1	0,1	1	<0.1	<1	<1
American Crow	*Corvus brachyrhynchos*	1	<0.1	1,0	1	<0.1	<1	<1
Orchard Oriole[a]	*Icterus spurius*	1	<0.1	1,0	1	<0.1	<1	<1
Song Sparrow	*Melospiza melodia*	1	<0.1	1,0	1	<0.1	<1	<1
Mountain Chickadee	*Poecile gambeli*	1	<0.1	1,0	1	<0.1	<1	<1
TOTAL		25,597	100.0					

[a]Winters exclusively south of the U.S. (after Dobkin 1994).
[b]Number of remote routes along which species occurred, number of facility complex routes along which species occurred.
[c]Number of stops at which species was detected; total stops surveyed = 4991.

occurred at very few stops along those routes (Table 2). Many species observed within the study area were neither widespread nor abundant. For example, 28 species (31.1%) occurred along only 1 of the 13 routes, and 39 species (43.3%) were represented by fewer than 10 individuals (Table 2).

Comparisons Between Types of Routes

There were no significant differences between remote routes and facility complex routes for the absolute number of individuals or species (richness) observed (Table 3). However, both average number of birds per km^2 surveyed and average number of species per km^2 were significantly greater for facility complex routes (Table 3). Thus, despite the fact that these routes were shorter in length than remote routes and that a smaller diameter around each stop was censused, there were more individuals and more species per unit area along facility complex routes.

Species Assemblages

In addition to differences in density of individuals and the number of species per km^2, the composition of species also differed between remote routes and facility complex routes.

WATERFOWL.—Of the 14 species of waterfowl (order Anseriformes, family Anatidae) detected along the survey routes (Table 2), only 2 species (14%) were recorded along remote

TABLE 3. Comparison of bird survey results between routes located near INEEL facility complex sites ($n = 8$) and those in remote areas ($n = 5$). Means ($\pm s_{\bar{x}}$) of dependent variables and results of 2-factor repeated-measures ANOVA are presented. Note: Year was a repeated factor in the analysis.

Variable	Facility complex routes ($\bar{x} \pm s_{\bar{x}}$)	Remote routes ($\bar{x} \pm s_{\bar{x}}$)	$F_{1,11}$	P
Birds recorded	240.6 ± 32.8	346.3 ± 41.4	4.0	0.071
Avg. number of birds/km^2[a]	103.7 ± 9.2	13.8 ± 11.7	47.1	<0.001
Species richness	16.4 ± 1.3	17.3 ± 1.7	0.2	0.692
Avg. number of species/km^2	7.9 ± 1.1	0.7 ± 1.4	16.2	0.002

[a]Significant interaction between type of route and year for this variable; see Figure 3.

routes: Canada Goose (*Branta canadensis*) and Common Goldeneye (*Bucephala clangula*).

SHOREBIRDS, GULLS, AND WADERS.—Thirteen species of shorebirds/wading birds/gulls and terns were observed (Table 2). Of these, 5 were observed along remote routes only, 3 species were observed along facility complex routes only, and the remaining 5 occurred along both types of route. The most abundant species among these was Franklin's Gull, which was observed along 4 of 8 facility complex routes but only 1 remote route (Table 2).

RAPTORS.—Twelve species of raptors, including eagles, falcons, hawks, and owls, were observed along the survey routes. Although most species of raptors were detected equally along both types of routes, Swainson's Hawks (*Buteo swainsoni*) and Burrowing Owls (*Athene cunicularia*) occurred along 80–100% of the remote routes but only 25–38% of the facility complex routes, respectively. Additionally, Cooper's Hawks (*Accipiter cooperii*) and Merlins (*Falco columbarius*), both of which were very rare, occurred along remote routes only (Table 2).

NEOTROPICAL MIGRANTS.—The study recorded relatively few species of Neotropical migrants ($n = 9$) that winter exclusively south of the U.S. (e.g., wintering areas 1–3 in Dobkin 1994; Table 2). Most of these were detected in equal proportion along both remote and facility complex routes. The exceptions included Swainson's Hawks, which occurred along more remote routes; Orchard Orioles (*Icterus spurius*), which occupied remote routes only; and Willow Flycatchers (*Empidonax traillii*), which occurred along facility complex routes only. The latter 2 species, however, each were represented by a single individual throughout the study period, and thus were very rare.

EXOTIC AND URBANIZED SPECIES.—Finally, species associated with human introductions, human-altered landscapes, or other human activities typically occupied facility complex routes rather than remote routes. European Starlings (*Sturnus vulgaris*), Barn Swallows (*Hirundo rustica*), House Sparrows (*Passer domesticus*), House Finches (*Carpodacus mexicanus*), Rock Doves (*Columba livia*), and Ring-necked Pheasants (*Phasianus colchicus*) either were not observed along remote routes or occupied fewer remote routes than facility complex routes (Table 2). However, a single introduced species, Gray Partridge (*Perdix perdix*), was observed along 3 remote routes only.

Effects of Year

Mean number of birds per route differed significantly among years ($F_{6,66} = 16.35$, $P < 0.001$); the greatest numbers of birds were tallied during 1990 and 1989, respectively, and the fewest birds occurred during 1988 (Fig. 2a). Average number of birds per km^2 also differed significantly among years ($F_{6,66} = 5.88$, $P < 0.001$), peaking in 1989 (Fig. 2b), although for this dependent variable year interacted with type of route (see below). Average number of species per km^2 of survey area ($F_{6,66} = 2.02$, $P = 0.075$, Fig. 2c) and species richness ($F_{6,66} = 2.13$, $P = 0.062$, Fig. 2d) did not differ significantly among years. Finally, the significant interaction between type of route and year for birds per km^2 ($F_{6,66} = 3.34$, $P = 0.006$) is apparently explained by relatively larger increases in this variable along facility complex routes in the latter years of the study (Fig. 3), which generally corresponded with cooler and wetter weather (see below).

Relationship to Weather

Some variation in bird abundance and diversity appeared to be related to weather (Table 4). The first 4 yr of the study (1985–1988)

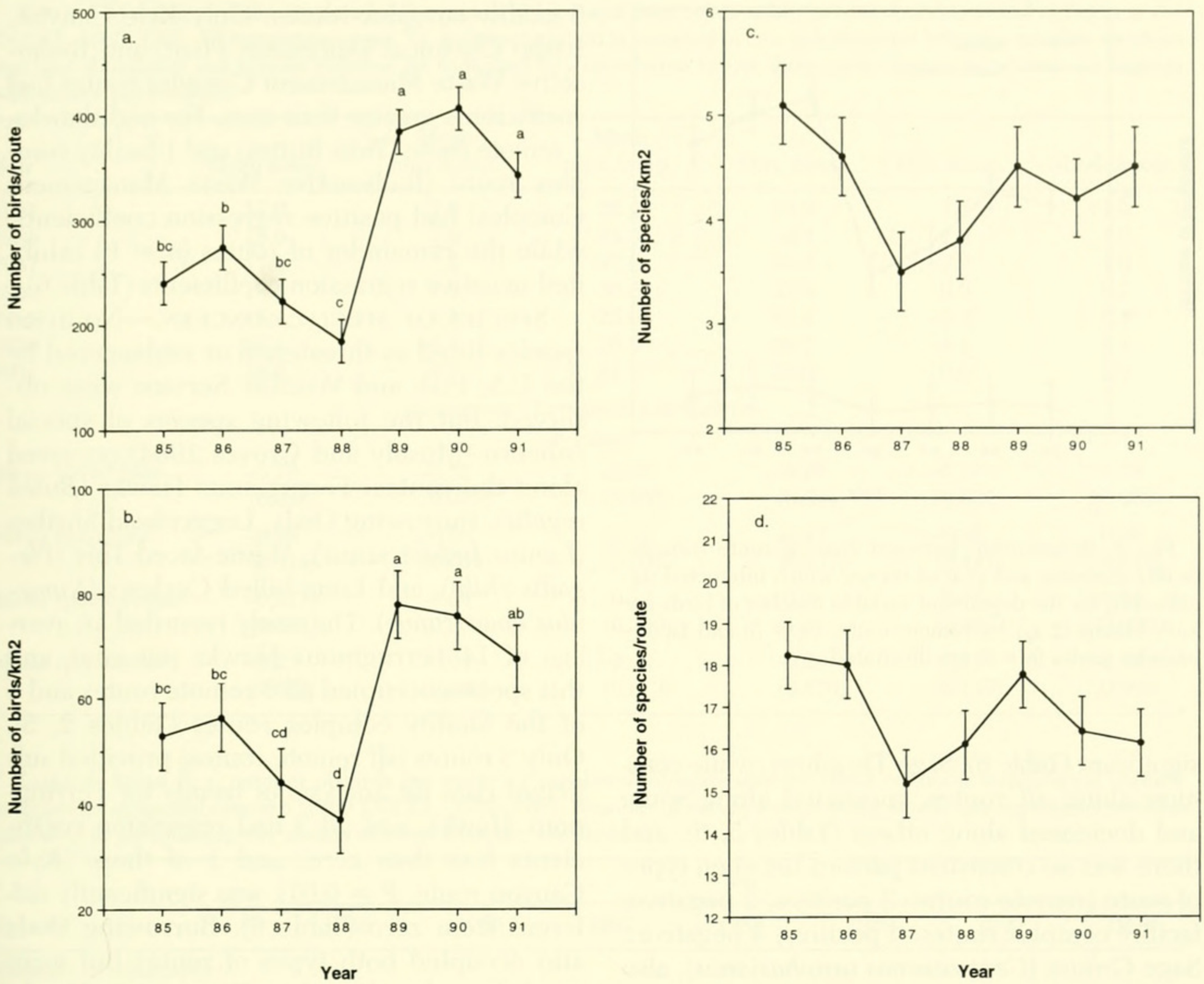

Fig. 2. (a) Number of breeding birds per route, 1985–1991, (b) number of birds per km^2 of survey area, (c) number of species observed per km^2 of survey area, and (d) number of species observed (species richness) per route. All values are $\bar{x} \pm s_{\bar{x}}$ and n = 13. Means that differ significantly have different letters. Note: No means comparisons were performed for number of species per km^2 or species richness because the ANOVA was not significant at the 0.05 level.

tended to be warmer and drier, while the summers of 1989–1991 were cooler and wetter. Bird abundance (mean birds/route and mean birds/km^2) was significantly correlated with average temperature, average minimum temperature, average maximum temperature, and total precipitation; that is, more birds were recorded when temperatures were lower and when precipitation was greater (Table 4). There was no relationship between bird abundance and absolute minimum and maximum temperatures for June during the study period (Table 4). Moreover, there were no relationships detected between average species richness or species per km^2 and any weather variables measured (Table 4).

Population Status and Trends for Selected Species

SAGEBRUSH OBLIGATES.—Of sagebrush-obligate species, both Brewer's Sparrows and Sage Sparrows exhibited significant positive trends in abundance (Tables 5, 6). Brewer's Sparrows exhibited positive regression coefficients across all 13 routes (5 of the individual regression analyses were significant at the 0.05 level or less), suggesting that this species increased along both remote and facility complex routes. Similarly, Sage Sparrows had positive regression coefficients for all but 1 route (a facility complex route: Radioactive Waste Management Complex), but fewer individual regressions were

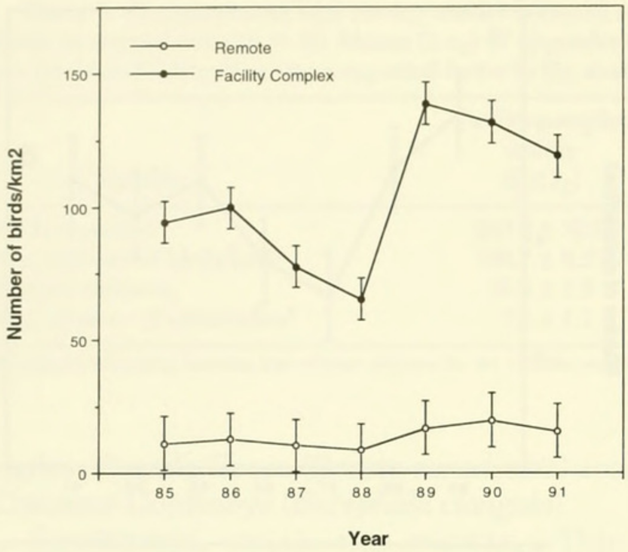

Fig. 3. Relationship between type of route (remote, facility complex) and year of survey, which interacted significantly, for the dependent variable number of birds per km^2. Means ($\pm s_{\bar{x}}$) for remote routes (n = 5) and facility complex routes (n = 8) are illustrated.

significant (Table 6). Sage Thrashers, while common along all routes, increased along some and decreased along others (Tables 5, 6), and there was no consistent pattern between types of route (remote routes: 3 positive, 2 negative; facility complex routes: 4 positive, 4 negative). Sage Grouse (*Centrocercus urophasianus*), also sagebrush obligates, were relatively common within the study area (Table 5); however, no trend mean could be calculated because Sage Grouse were not detected in ≥5 yr along any single route.

OTHER SHRUBSTEPPE/GRASSLAND SPECIES.—Among other common shrubsteppe species (Table 5), Western Meadowlarks, Horned Larks, Mourning Doves, and Vesper Sparrows (*Pooecetes gramineus*) had more routes with positive than negative regression coefficients and positive trend means, indicating that these species tended to increase in abundance rather than decline (Table 6). However, for none of these species was the goodness-of-fit test significant, but expected cell frequencies were low in at least some cases (e.g., for Vesper Sparrows that produced only 3 regression coefficients). Brown-headed Cowbirds and Common Nighthawks had more routes with negative regression coefficients and negative trend means, indicating that these species tended to decline in abundance over the study period (Tables 5, 6). Of the 10 routes for which cowbirds had negative coefficients, 4 were remote routes and 6 facility complex routes. Only Kyle Canyon, Idaho Chemical Processing Plant, and Radioactive Waste Management Complex routes had coefficients greater than zero. For nighthawks, 1 remote route (Twin Buttes) and 1 facility complex route (Radioactive Waste Management Complex) had positive regression coefficients, while the remainder of routes (n = 6) exhibited negative regression coefficients (Table 6).

SPECIES OF SPECIAL CONCERN.—No avian species listed as threatened or endangered by the U.S. Fish and Wildlife Service were observed, but the following species of special concern (Mosely and Groves 1994) occurred along the routes: Ferruginous Hawks (*Buteo regalis*), Burrowing Owls, Loggerhead Shrikes (*Lanius ludovicianus*), White-faced Ibis (*Plegadis chihi*), and Long-billed Curlews (*Numenius americanus*). The study recorded an average of 14 Ferruginous Hawks per year, and this species occupied all 5 remote routes and 5 of the facility complex routes (Tables 2, 5). Only 3 routes (all remote routes) provided sufficient data for analysis of trends for Ferruginous Hawks, and all 3 had regression coefficients less than zero, and 1 of these (Kyle Canyon route, P = 0.01), was significantly different from zero (Table 6). Burrowing Owls also occupied both types of routes but were much less abundant than Ferruginous Hawks (Table 5). A trend analysis could not be performed for Burrowing Owls because they were not detected along any single route for ≥5 yr. Although Loggerhead Shrikes occupied 12 of 13 routes (Tables 2, 5), only 7 routes provided sufficient data for trend analysis (Table 6). Of these routes, 3 had positive and 4 had negative coefficients, and the trend mean for Loggerhead Shrikes was negative (Table 6). Finally, White-faced Ibis (n = 1) and Long-billed Curlews (n = 3) were rare and occurred along remote routes only (Table 2), but no trend analysis could be performed for either species.

DISCUSSION

With respect to avifauna, low species richness is typical of arid and semiarid shrubsteppe and grassland habitats throughout the western United States (e.g., Wiens and Rotenberry 1981, Wiens 1985, Dobkin 1994). Moreover, these habitats support relatively few Neotropical migrants when compared to riparian or forested habitats in the same regions.

TABLE 4. Weather and climate data for the month of June and their relationship to bird abundance and richness at the INEEL, 1985–1991. All temperatures are °C, and precipitation is reported in cm. Relationships between weather variables and bird abundance and species richness are indicated by a correlation matrix showing Spearman correlation coefficients with associated P-values.

Year	Mean temp.	Mean min. temp.	Mean max. temp.	Max. temp.	Min. temp.	Total precip.
1985	17.0	7.6	26.4	33.9	1.7	1.0
1986	18.0	7.8	28.3	34.4	2.2	1.6
1987	17.1	7.2	27.0	33.3	–2.2	1.9
1988	19.6	8.8	30.2	37.8	0.0	0.3
1989	15.1	5.3	25.0	32.2	–3.3	3.1
1990	16.2	6.4	26.0	36.7	–1.1	2.2
1991	15.6	6.7	24.6	30.0	0.0	2.9
			Spearman Correlation Coefficients (P-value)			
Mean birds/route	–0.79 (0.036)	–0.82 (0.023)	–0.75 (0.052)	–0.28 (0.534)	–0.29 (0.531)	0.78 (0.036)
Mean birds/km^2	–0.86 (0.014)	–0.86 (0.014)	–0.78 (0.036)	–0.43 (0.337)	–0.36 (0.427)	0.86 (0.014)
Mean species/route	–0.21 (0.644)	–0.04 (0.939)	–0.14 (0.760)	0.0 (1.0)	0.49 (0.268)	–0.04 (0.939)
Mean species/km^2	–0.23 (0.613)	0.04 (0.939)	–0.23 (0.613)	–0.20 (0.670)	0.61 (0.147)	–0.02 (0.969)

TABLE 5. Mean ($\pm s$) number of birds per route for sagebrush-obligate species, other common shrubsteppe species, and species of special concern at the INEEL, 1985–1991. Number of survey routes along which species was recorded is indicated in parentheses. For results of trend analyses, see Table 6.

	Year						
Species	1985	1986	1987	1988	1989	1990	1991
SAGEBRUSH OBLIGATES							
Brewer's Sparrow	9.6 ± 7.7 (13)	45.0 ± 20.1 (13)	27.2 ± 12.2 (13)	15.4 ± 14.3 (12)	74.7 ± 32.2 (13)	99.5 ± 66.9 (13)	60.3 ± 37.0 (13)
Sage Sparrow	44.6 ± 20.3 (13)	19.5 ± 12.8 (13)	18.5 ± 13.0 (13)	35.5 ± 20.1 (13)	25.5 ± 18.0 (13)	72.2 ± 39.4 (13)	71.2 ± 38.6 (13)
Sage Thrasher	26.9 ± 15.3 (13)	35.8 ± 17.6 (13)	22.5 ± 9.5 (13)	15.8 ± 6.3 (13)	22.7 ± 14.7 (13)	34.2 ± 23.0 (13)	29.8 ± 16.6 (13)
Sage Grouse	1.6 ± 1.1 (3)	5.0 ± 1.4 (2)	8.0 ± 9.0 (4)	12.8 ± 26.6 (7)	0 (0)	5.2 ± 3.4 (5)	0 (0)
OTHER COMMON SHRUBSTEPPE SPECIES							
Western Meadowlark	41.1 ± 23.2 (13)	52.5 ± 20.9 (13)	30.8 ± 16.8 (13)	21.5 ± 12.0 (13)	85.6 ± 37.8 (13)	62.6 ± 35.4 (13)	51.8 ± 24.4 (13)
Horned Lark	30.1 ± 32.2 (13)	32.4 ± 43.6 (12)	45.4 ± 42.9 (13)	25.0 ± 27.0 (13)	38.6 ± 44.4 (13)	39.5 ± 48.7 (12)	52.1 ± 61.6 (13)
Mourning Dove	8.1 ± 6.0 (12)	8.6 ± 8.2 (12)	14.5 ± 15.0 (11)	7.5 ± 5.7 (10)	16.5 ± 15.7 (13)	18.6 ± 19.6 (13)	9.5 ± 7.4 (11)
Brown-headed Cowbird	19.8 ± 24.3 (11)	10.6 ± 7.7 (13)	13.9 ± 11.1 (13)	6.4 ± 7.8 (11)	9.7 ± 5.8 (13)	7.0 ± 6.7 (12)	4.8 ± 2.5 (12)
Common Nighthawk	10.4 ± 8.3 (8)	6.0 ± 5.9 (11)	5.7 ± 2.4 (9)	11.8 ± 8.2 (11)	4.8 ± 5.6 (9)	9.8 ± 11.2 (8)	4.9 ± 3.6 (9)
Vesper Sparrow	1.8 ± 1.8 (5)	2.0 ± 1.0 (3)	4.5 ± 4.9 (2)	7.0 ± 7.1 (2)	8.3 ± 7.9 (11)	4.0 ± 1.4 (4)	24.4 ± 25.4 (7)
SPECIES OF SPECIAL CONCERN							
Ferruginous Hawk	2.8 ± 3.0 (5)	3.2 ± 3.3 (5)	3.6 ± 2.6 (5)	3.5 ± 2.1 (4)	2.8 ± 1.5 (5)	2.8 ± 1.7 (4)	2.0 ± 2.0 (4)
Loggerhead Shrike	5.9 ± 3.0 (11)	5.3 ± 4.0 (9)	5.9 ± 5.4 (9)	2.6 ± 2.6 (5)	2.4 ± 1.5 (8)	5.2 ± 5.5 (9)	3.5 ± 1.9 (10)
Burrowing Owl	1.3 ± 0.5 (6)	4.0 (1)	0 (0)	0 (0)	1.0 (1)	0 (0)	0 (0)

TABLE 6. Results of trend analyses (regression coefficients) for selected species at INEEL, 1985–1991. For each species, the 1st line summarizes analyses of total birds per route, and the 2nd line summarizes analyses of birds per km^2. *P*-values for individual regression analyses are in parentheses. Also summarized are the number of positive and negative regression coefficients for each species and results of χ^2 goodness-of-fit tests using the Yates correction for continuity. Columns with no data represent routes where the species of interest was not detected in at least 5 survey years.

	Remote routes[a]					Facility complex routes										
Species	TB	LR	KC	CB	TF	ICPP	TRA	CFA	NRF	TAN	PBF	RWMC	ANL-W	Trend mean	No. pos./ no. neg.[b]	χ^2
SAGEBRUSH OBLIGATES																
Brewer's Sparrow	5.5	11.2	5.1	16.9	24.1	11.9	26.9	7.0	6.4	13.2	9.9	2.2	2.9	11.02	13/0	11.08***
	0.2	0.4	0.2	0.7	1.0	5.9	10.4	2.0	4.0	2.7	4.4	1.5	2.0	2.74		
	(.36)	(.26)	(.41)	(.05)	(.02)	(.05)	(.08)	(.10)	(.03)	(.12)	(.03)	(.17)	(.34)			
Sage Sparrow	8.6	14.2	7.2	10.6	8.5	2.0	12.5	7.9	0.1	9.7	7.0	–0.7	1.7	6.86	12/1	7.69**
	0.3	0.6	0.2	0.4	0.3	1.0	4.8	1.9	0.1	2.0	3.1	–0.5	0.3	1.20		
	(.15)	(.10)	(.25)	(.06)	(.22)	(.39)	(.09)	(.13)	(.97)	(.14)	(.07)	(.67)	(.33)			
Sage Thrasher	–1.8	4.5	–5.3	0.9	6.4	0.8	–0.1	1.0	–1.4	–2.1	1.9	0.0	–2.2	0.20	7/6	0.31
	–0.1	0.2	–0.2	0.0	0.2	0.4	–0.1	0.1	–0.8	–0.4	0.8	0.0	–1.5	–0.09[c]		
	(.52)	(.16)	(.11)	(.77)	(.22)	(.68)	(.94)	(.69)	(.08)	(.53)	(.19)	(.96)	(.16)			
OTHER COMMON SHRUBSTEPPE SPECIES																
Western Meadowlark	–0.9	–1.8	0.5	7.4	6.4	1.9	12.6	1.7	7.2	–2.3	8.0	3.2	6.0	3.83	10/3	2.77
	–0.1	–0.1	0.0	0.3	0.3	0.9	4.9	0.2	4.5	–0.5	3.5	2.2	4.2	1.57		
	(.90)	(.65)	(.95)	(.30)	(.46)	(.48)	(.05)	(.66)	(.16)	(.66)	(.11)	(.26)	(.14)			
Horned Lark	2.8	0.2	–2.1	5.4	11.7	2.0	5.1	3.0	1.2	7.4	–0.9	–0.3	–1.9	2.58	9/4	1.23
	0.1	0.0	–0.1	0.2	0.5	1.0	1.7	0.5	0.8	1.5	–0.4	–0.2	–1.0	0.35		
	(.63)	(.72)	(.56)	(.26)	(.03)	(.34)	(.36)	(.26)	(.58)	(.40)	(.61)	(.84)	(.59)			
Mourning Dove	2.3	2.5	2.6	3.1	1.8	—	0.4	0.4	–0.1	–0.1	0.1	0.2	–0.3	1.07	9/3	2.08
	0.1	0.1	0.1	0.1	0.1	—	0.3	0.0	–0.2	–0.1	0.0	0.1	–0.2	0.04		
	(.50)	(.12)	(.38)	(.07)	(.64)	(—)	(.35)	(.58)	(.66)	(.88)	(.91)	(.68)	(.67)			
Brown-headed Cowbird	–1.9	–2.0	0.1	–1.9	–2.4	0.5	–0.1	–4.5	–0.7	–0.3	–1.4	0.3	–8.4	–1.74	3/10	2.77
	–0.1	–0.1	0.0	–0.1	–0.1	0.3	–0.1	–2.1	–0.4	–0.1	–0.6	0.2	–5.8	–0.69		
	(.10)	(.25)	(.90)	(.38)	(.36)	(.48)	(.98)	(.31)	(.35)	(.59)	(.17)	(.69)	(.09)			

TABLE 6. Continued.

Species	TB	LR	KC	CB	TF	ICPP	TRA	CFA	NRF	TAN	PBF	RWMC	ANL-W	Trend mean	No. pos./ no. neg.[b]	χ^2
	Remote routes[a]					Facility complex routes										
OTHER COMMON SHRUBSTEPPE SPECIES																
Common Nighthawk	0.0	–2.1	–0.4	–0.6	–0.4	—	—	—	–0.9	—	—	1.1	–1.5	–0.62	2/6	1.12
	0.0	–0.1	–0.1	–0.1	–0.1	—	—	—	–0.5	—	—	0.8	–1.0	–0.12		
	(.99)	(.10)	(.08)	(.68)	(.67)	(—)	(—)	(—)	(.44)	(—)	(—)	(.30)	(.53)			
Vesper Sparrow	—	—	11.2	—	4.5	—	—	—	—	5.9	—	—	—	7.21	3/0	1.30
	—	—	0.4	—	0.2	—	—	—	—	1.2	—	—	—	0.61		
	(—)	(—)	(.01)	(—)	(.04)	(—)	(—)	(—)	(—)	(.27)	(—)	(—)	(—)			
SPECIES OF SPECIAL CONCERN																
Ferruginous Hawk	–0.3	—	–0.7	–0.3	—	—	—	—	—	—	—	—	—	–0.43	0/3	1.30
	–0.1	—	–0.1	–0.1	—	—	—	—	—	—	—	—	—	–0.02		
	(.16)	(—)	(.01)	(.49)	(—)	(—)	(—)	(—)	(—)	(—)	(—)	(—)	(—)			
Loggerhead Shrike	–1.0	—	1.1	0.4	—	—	—	0.2	—	–0.3	–1.2	–0.9	—	–0.23	3/4	0.00
	–0.1	—	0.1	0.1	—	—	—	0.1	—	–0.1	–0.5	–0.6	—	–0.16		
	(.36)	(—)	(.31)	(.18)	(—)	(—)	(—)	(.72)	(—)	(.37)	(.08)	(.19)	(—)			

** = $P < 0.01$; *** = $P < 0.001$. Critical value $\chi^2_{0.05}$ with 1 df = 3.841.
[a]Correspond to routes listed in Table 1.
[b]Number of routes with positive regression coefficients/number of routes with negative regression coefficients.
[c]Difference in sign results from rounding.

For example, although more than 50 species of Neotropical migrants may breed in various parts of the Intermountain West shrubsteppe, the typical community has 2–7 regular breeders, with 100–600 birds/km^2, and over half of all individuals belong to the most common species (Bock et al. 1993). Results from our study indicate that richness and density of birds at the INEEL are relatively low as well, as each route supported an average of 13–22 species and 11–169 individuals/km^2 for the 7 yr of the study. Although 90 different species were recorded, the 5 most abundant species accounted for 72% of all individuals, and over 40% of all species were represented by fewer than 10 individuals. Despite the low number of species, the INEEL does provide important habitat for several species that depend largely on sagebrush communities (e.g., Brewer's Sparrows, Sage Sparrows, Sage Thrashers, Sage Grouse), some of which have experienced declines in many portions of their range (Dobkin 1994).

Ideally, to assess the significance of trends in population numbers, one should have data from many years, over which biases related to effects of short-term variation can be minimized or eliminated. Because the current study was of relatively short duration, the trends in abundance we calculated for each species could be adversely affected by such variation. With this caveat in mind, it appears that none of the common species we examined declined significantly in abundance during the study period. In contrast, Brewer's Sparrows and Sage Sparrows apparently increased significantly in abundance during the years of the study. These increases for Brewer's and Sage Sparrows are in contrast to statewide and regional trends. Based on regional analyses of BBS data and other published information, Dobkin (1994) concluded that Sage Sparrow numbers declined in Idaho (but sample sizes were very small) and that Brewer's Sparrow numbers have declined steeply and significantly in Idaho. Declines in sagebrush-obligate species are likely related to widespread loss or fragmentation of sagebrush habitat that has occurred throughout much of the West. This habitat is being converted to grasslands via fire followed by invasion of nonnative, annual grass species (Billings 1994, Peters and Bunting 1994), or it is being converted to agriculture. Knick and Rotenberry (1995) determined that site occupancy by shrubsteppe species (e.g., Sage and Brewer's Sparrows, and Sage Thrashers) in southwestern Idaho was more probable with larger shrub habitat patches and greater total shrub cover, and by decreasing disturbance. Sagebrush-obligate species may be faring better on the INEEL because large expanses of relatively undisturbed sagebrush habitat remain.

There were significantly more species of birds and individuals per unit area along the facility complex routes. This likely reflects the different types of human activities along these routes. For example, in addition to native shrub habitat, some facility complex sites have man-made ponds while others support a variety of man-made structures, roads, and parking lots. These different land-use patterns appear to attract more species in greater density than habitats along remote routes. Remote routes traverse large expanses of mostly undisturbed habitat located in remote regions of the site. Moreover, the collection of remote routes is more homogeneous than facility complex routes (i.e., remote routes lack human structures and there is little wetland habitat along each), and this is reflected by the fact that bird abundance and species measures varied less for remote routes. In addition to increased variation in bird abundance along facility complex routes, species composition differed between remote routes and facility complex routes in several important respects. Facility complex routes supported more species of waterfowl and a larger number of "human-associated" species, while several species of raptors (Ferruginous Hawk, Burrowing Owl, Cooper's Hawk, Merlin, and Swainson's Hawk) occurred more commonly along remote routes. Such data make it clear that human activity associated with construction and operation of major facility complexes (buildings, roads, parking lots, sewage ponds, etc.) on the INEEL site affects the composition of avifauna in comparison to remote sites, although facility complex areas appear to support greater numbers of individuals.

Shrubsteppe bird populations can fluctuate independently of one another and of variation in habitat structure (Wiens et al. 1986, Bock et al. 1993), but there appears to be some association between bird abundance and plant species, their seed crops, and perhaps insect fauna (Goebel and Berry 1976, Wiens and Rotenberry 1981). However, Bock et al. (1993)

conclude that extreme and irregular fluctuation in precipitation and ecosystem productivity may be the primary factor influencing shrubsteppe avifauna. While some short-term, random fluctuations in abundance and variety of avifauna certainly are expected, results of correlation analyses suggest that some variation observed in the present study was related to weather conditions. For example, in warmer and drier years (1985–1988), fewer individuals of each species were detected, although there was no such relationship for species richness. One possible explanation for this pattern is that detectability of birds changed with weather conditions. Birds may have limited their singing or other activities during hot, dry periods, making them more difficult to census accurately using the protocol employed. However, the present study avoided at least some difficulties along these lines by performing surveys early in the day, when temperatures were more moderate. Conversely, fewer birds may have inhabited the study area or attempted reproduction during hotter, drier years. If shrubsteppe species are as highly opportunistic and ecologically adaptable as Bock et al. (1993) suggest, then more individuals would appear and attempt breeding during cooler years when precipitation is high, and when summer conditions are more favorable for reproduction (e.g., more plant cover and food, summer temperatures are less extreme). Interestingly, the significant interaction between type of route and year of study for individuals per unit area suggests that larger increases in bird density in cooler, moister years were observed along facility routes. While an explanation of this relationship is not obvious, fluctuations in avifauna were more pronounced in habitats that experienced more disturbance (i.e., along facility complex routes). Finally, because there was no relationship between species richness and weather, it appears that most of the weather-related variation among years was reflected in changes in numbers of individuals rather than in numbers of species.

Five species of special concern (Mosely and Groves 1994) were detected along the survey routes. Of these, Loggerhead Shrikes and Ferruginous Hawks were relatively common, while Burrowing Owls, White-faced Ibis, and Long-billed Curlews were rare. Previously published studies indicate that Ferruginous Hawks have declined somewhat in Idaho but increased in nearby Montana, Loggerhead Shrikes have maintained somewhat stable populations despite large annual variation, Burrowing Owls have declined steadily throughout their range, and Long-billed Curlew populations have remained stable or undergone slight declines (Dobkin 1994). Finally, White-faced Ibis populations appear to be increasing in abundance throughout many portions of their range (Sauer et al. 1997, internet access at http://www.im.nbs.gov/bbs). The 2 species for which we had adequate data, Ferruginous Hawks and Loggerhead Shrikes, had negative trend means, although the trends were not statistically significant. Nonetheless, negative trend means indicate possible declines, and more specific studies directed at these species and the land-management practices that affect them within the INEEL boundaries and elsewhere may be warranted.

In summary, the present study has provided bird population data from shrubsteppe habitats located at the Idaho National Engineering and Environmental Laboratory which will be useful for comparison with other studies in the region and future studies at the site. Analyses indicated that there are differences in avifauna between remote areas and those located near research facilities resulting from human-constructed ponds and structures and a variety of human activities. Two common shrubsteppe species (Brewer's Sparrows and Sage Sparrows) appear to have increased in abundance at the INEEL during the study period despite statewide and regional declines purportedly from destruction of sagebrush habitat. In addition to providing important large patches of habitat for a number of sagebrush-obligate species, the INEEL supported at least 5 avian species of special concern, 2 of which had negative trend means and declined in abundance along some routes.

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