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HISTORICAL CHANGES IN POPULATIONS AND PERCEPTIONS OF NATIVE PEST BIRD SPECIES IN THE WEST

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Abstract. A wide variety of native bird species are considered pests because they damage agriculture, present health hazards, damage structures, create a nuisance, or damage natural resources. Damage to agriculture is the most costly and most frequently reported pest problem. However, nuisance problems and damage to natural resources, especially endangered species, are becoming increasingly common. Review of the literature and analysis of BBS, BBC, and CBC survey data showed that wintering and breeding populations of most pests have increased over the last century, despite frequent eradication campaigns against them. Great-tailed Grackles have increased most rapidly and have spread throughout the west. Gulls have increased rapidly, but have shown only minor range expansions. Corvids have increased moderately, and invaded agricultural and urban habitats. Woodpecker, Golden Eagle, Red-winged and Yellow-headed Blackbird, and Northern Mockingbird populations have remained steady or increased slightly. Tri-colored Blackbirds have declined in abundance. A key to the development of pest problems is the initial removal or conversion of natural habitat to urban or agricultural sites. These changes displace native birds and provide supplemental feeding and nesting locations for those species destined to become pests. Flocking and generalized diets are important traits that may have preadapted pest species to exploit humans.

Key Words: Distribution; abundance; pest; agriculture; breeding bird survey; Christmas Bird Count.

When humans began to manage their environment to provide food and shelter the animals that successfully competed with them became known as "pests." To the student of avian populations, familiar pests are introduced exotics like the European Starling (*Sturnus vulgaris*) and House Sparrow (*Passer domesticus*; Johnston and Garrett 1994). However, native species also are serious competitors with humans, inflicting heavy monetary losses on societies in industrialized nations and threatening human survival in some underdeveloped countries (DeGrazio 1989).

Native birds are considered pests if they: 1) damage agricultural products, 2) present health hazards, 3) damage human structures, 4) create a nuisance or reduce aesthetics, or 5) damage natural resources.

Damage to agriculture is the most frequent and most costly complaint. Fifteen native birds are commonly cited as agricultural pests in the west and many others are occasionally implicated (Table 1). Most of these species eat a variety of mature crops and newly sprouted seeds. However, the larger corvids and Golden Eagles (*Aquila chrysaetos*) also prey upon poultry and livestock. A few notable examples include American Crows (*Corvus brachyrhynchos*) consuming $85,000 worth of almonds in California in 1965 (Simpson 1972), Red-winged Blackbirds (*Agelaius phoeniceus*), Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*), and Common Grackles (*Quiscalus quiscula*) damaging $7.9 million worth of sunflowers in North Dakota, South Dakota and Minnesota in 1980 (Hothem et al. 1988), House Finches (*Carpodacus mexicanus*) damaging $3 million worth of California wine grapes in 1974 (DeHaven 1974), Golden Eagles killing $48,000 worth of lambs in Montana in 1975 (O'Gara 1978), and Black-billed Magpies (*Pica pica*) destroying $10,000 worth of pollination bees in Idaho in 1989 (United States Department of Interior 1989). California leads all western States in total agricultural damage caused by birds (an estimated $12.75 million in 1976; DeGrazio 1978).

Three health hazards are created by native birds; neurosis, spread of disease, and collisions with aircraft. Aggregation of many individual birds, especially at communal

TABLE 1. NATIVE BIRD SPECIES IN THE WESTERN U.S. THAT ARE CONSIDERED IMPORTANT AGRICULTURAL PESTS

Species	Type of product damaged[a]
Primary pests	
House Finch	Grain, fruit, sunflower, grapes, sugar beets, truck crops, buds/flowers
American Crow	Grain, fruit, peanuts, tree nuts, feedlots, poultry
Black-billed Magpie	Grain, fruit, tree nuts, feedlots, potatoes, poultry, livestock, apiary
Red-winged Blackbird	Grain, sunflower, peanuts, feedlots
Brown-headed Cowbird	Grain, peanuts, feedlots
Scrub Jay	Grain, fruit, tree nuts, grapes
Common Grackle	Grain, sunflower, peanuts
Yellow-headed Blackbird	Grain, sunflower, feedlots
Brewer's Blackbird	Grain, fruit, feedlots
Common Raven	Grain, poultry, livestock
Great-tailed Grackle	Grain, fruit
Tri-colored Blackbird	Grain, feedlots
Mallard	Grain
Northern Pintail	Grain
Golden Eagle	Livestock
Secondary pests	
Western Meadowlark	Peanuts, feedlot
Franklin's Gull	Peanuts, feedlot
Blue Jay	Peanuts, feedlot, grapes
Killdeer	Feedlot
Water Pipit	Feedlot
Mourning Dove	Feedlot, grapes
Western Bluebird	Wine grapes
American Goldfinch	Sunflower, grapes, buds/flowers
American Robin	Grapes
California Quail	Grapes
White-crowned Sparrow	Grain, fruit, grapes, flowers
Horned Lark	Truck crops, buds/flowers, sugar beets
Acorn Woodpecker	Tree nuts, grapes
Lewis' Woodpecker	Tree nuts, grapes
Northern Flicker	Tree nuts, grapes
White-winged Dove	Grain
Sandhill Crane	Grain, potatoes
Northern Mockingbird	Grapes
California Thrasher	Grapes
Catbird	Grapes
Rufous-sided Towhee	Grapes
Turkey Vulture	Grapes
Western Kingbird	Grapes
Western Tanager	Grapes
Great-blue Heron	Fish
Great Egret	Fish
Double-crested Cormorant	Fish
California Gull	Fruit
Canada Goose	Grain
Snow Goose	Grain
White-fronted Goose	Grain

[a] References: Cottam 1935, Stockdale 1967, Larsen and Dietrich 1970, Palmer 1970, DeHaven 1971, 1974, Mott et al. 1972, Simpson 1972, Clark 1975, Crase and DeHaven 1976, Crase et al. 1976, Knittle and Guarino 1976, DeGrazio 1978, O'Gara 1978, Avery and DeHaven 1982, Besser and Brady 1982, Besser 1985, Hothem et al. 1988, Knittle and Porter 1988, Phillips and Blom 1988, Stickley and Andrews 1989, Pochop et al. 1990.

roosts, is a common denominator. The noises associated with large roosts of several million blackbirds have been known to drive humans crazy, and fecal deposits under roosts can act as a vector for disease transmission and promote the growth of other local pathogens, such as *Histoplasmosis capsulatum* (Garner 1978).

Bird collisions with aircraft are typically local, but deadly and expensive problems. The first human fatality occurred in San Diego, CA in 1910, but research into this problem began in earnest in 1960 when a small plane collided with a flock of starlings and killed 62 people (Pearson 1967). In 1965 the U.S. Air Force estimated that 839 collisions caused $10 million of damage to their aircraft (Pearson 1967). Large birds or flocking species that feed, or roost near airfields pose the greatest problems; these include Snow Geese (*Chen caerulescens*), Tundra Swans (*Cygnus columbianus*), Common Loons (*Gavia immer*), Red-tailed Hawks (*Buteo jamaicensis*), gulls, waterfowl and blackbirds.

Human structures, principally buildings, transmission lines, and utility poles, are damaged by several species of woodpeckers and communally roosting gulls, blackbirds, and corvids. Red-headed Woodpeckers (*Melanerpes erythrocephalus*), Northern Flickers (*Colaptes auratus*) and Pileated Woodpeckers (*Dryocopus pileatus*) damaged $250,000 worth of utility poles in Missouri from 1981–1982 (Stemmerman 1988). Acorn Woodpeckers (*Melanerpes formicivorus*) use utility poles in the southwest as graneries, causing extensive damage (Pope 1974). Lewis' Woodpeckers (*Melanerpes lewis*), Acorn Woodpeckers and Northern Flickers damage buildings, water tanks and fence posts in California (Clark 1975). Damage to house siding by woodpeckers is typically a local problem, but can cause substantial monetary loss to individual landowners ($1000 to one Idaho home in 1982). Fecal deposition by Common Ravens (*Corvus corax*) roosting above transmission line insulators enables electricity to arc between lines and cause expensive power outages (Young and Engel 1988). Feces from blackbirds, gulls, or Cliff Swallows (*Hirundo pyrrhonota*) damage houses and automobiles (e.g., Gorenzel and Salmon 1982).

Nuisance complaints against native birds are diverse. Defecation by waterfowl, notably Mallards (*Anas platyrhynchos*), Canada Geese (*Branta canadensis*), and American Coots (*Fulica americana*), on lawns, golf courses, and water treatment plants is a problem in the eastern U.S. and in parts of the west (Conover and Chasko 1985, Woronecki et al. 1990). The noise associated with urban corvids and blackbird roosts is often objectionable, as is the nocturnal singing of Northern Mockingbirds (*Mimus polyglottos*; Fitzwater 1988). Mississippi Kites (*Ictinia mississippiensis*) vigorously defend their nests and occasionally harm humans walking nearby (Peterson and Brown 1985).

Complaints of damage to natural resources have typically implicated nest predators, particularly corvids. In the late 1800s and early 1900s "jay shoots" were organized by sportsmen in California to kill the "vermin" that were believed to be lowering the productivity of California Quail (*Callipepla californica*; Erickson 1937). More recently, avian nest predators have been implicated in the decline of other native animals. For example, Pinyon Jay (*Gymnorhinus cyanocephalus*) productivity has declined in Flagstaff, AZ, partly because of increased predation by crows and ravens (Marzluff and Balda 1992). Several endangered species [Marbled Murrelet (*Brachyramphus marmoratus*), Desert Tortoise (*Xerobates agassizii*) and California Least Tern (*Sterna antillarum*)] may be suffering similar fates at the hands of corvids and other predators [e.g., American Kestrel (*Falco sparverius*) and Burrowing Owl (*Athene cunicularia*); Butchko 1990, Singer et al. 1991].

Most pests present more than one problem. Blackbirds, for example, consume agricultural crops, spread disease and disturb residents near their roosts, choke airplane engines, and damage structures with their feces. Gulls and corvids present hazards near airfields, damage structures with their feces, prey upon the eggs and nestlings of a variety of species, and consume large quantities of agricultural products.

HISTORICAL DEVELOPMENT OF PEST PROBLEMS

As soon as Europeans began to settle North America they encountered problems with some of the abundant, granivorous native birds. The first documented problem was in 1717, when blackbirds in Connecticut destroyed settlers' crops (DeHaven 1971). The problem must have been substantial because all men were required to kill 12 birds per day during the summer to curb the damage. They were fined if their quota was not met! The first settlers moving west met with similar problems (Stockdale 1967), but most problems in the western U.S. began after the transcontinental railway was completed in the 1860s and settlement of the west grew at exponential rates.

The development of early pest problems followed a consistent three phase pattern; 1) human settlement and agriculture increased, 2) native foods or nest sites were reduced, then supplemented or replaced by human agricultural crops and structures, and 3) locally abundant birds capitalized upon new feeding or nesting opportunities. The drainage of the wetlands and establishment of agribusiness in California is a classic example. Currently less than 10% of the state's historical wetlands remain (Cowan 1970).

Gone with them are traditional breeding and nesting sites for blackbirds and waterfowl. However, man has provided abundant food and habitat in the irrigated croplands of the state's interior valleys. Red-winged, Yellow-headed, and Tri-colored Blackbirds (*Agelaius tricolor*), Mallards, and Canada Geese have taken advantage of this bounty and wreaked havoc on agriculture (Knittle and Porter 1988).

A key to the development of such a pest problem is the initial removal or conversion of natural habitat. Damage rarely develops if natural resources are abundant. For example, losses of sheep to Golden Eagles and peanuts to corvids were greatly reduced in years of abundant native prey (jackrabbits and acorns, respectively; Mott et al. 1972, O'Gara 1978).

Pest problems appear to have persisted once native species began to exploit human agriculture because large populations of pests were sustained and they could quickly switch to feed on each new crop. Blackbirds surviving on cereal grains quickly became pests on sunflower crops (Hothem et al. 1988). House Finches, sustained by a variety of agricultural crops in the early 1900s, quickly adapted to blueberries in 1958, figs in 1970, wine grapes in 1973, and sunflowers in 1982 (Palmer 1970, DeHaven 1974, Avery and DeHaven 1982).

CHANGING PERCEPTIONS OF NATIVE BIRD PESTS

As human settlement of the west increased and our uses of the land multiplied, conflicts with native birds diversified (Fig. 1). From the late 1800s to approximately 1960, most concerned consumption of agricultural products. This has continued to be the major complaint, expanding greatly from 1960 to 1990 as many new crops were planted (e.g., wine grapes, sunflowers, and wild rice). However, during the last 30 years, birds have come into conflict with man increasingly for nonagricultural reasons, especially as nuisances in urban settings and as predators on threatened species (Fig. 1).

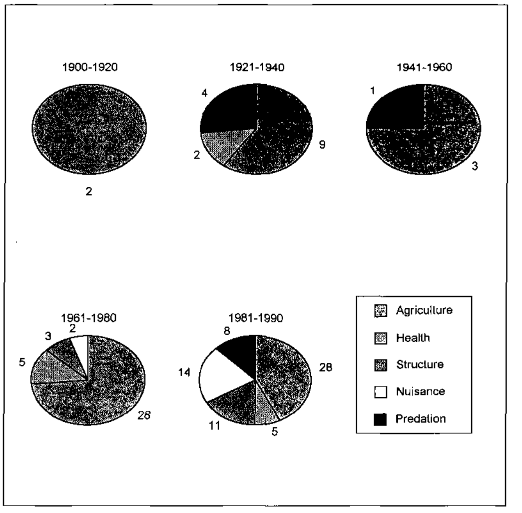

FIGURE 1. Historical changes in problems caused by native bird pests. Each pie diagram covers a specific range of dates (listed above each pie) and presents the percentage of published papers addressing the five major types of damage caused by pests (see text for definition of types and key for corresponding shading). The actual number of papers in each damage category is listed outside the pie. All issues of *The Condor* and *Proceedings of the Vertebrate Pest Conference* through 1992 were surveyed.

CHANGES IN THE ABUNDANCE AND DISTRIBUTION OF NATIVE BIRD PESTS

Methods

We searched the ornithological literature for documentation of avian populations early in the century and discussions of recent changes in populations of native bird pests. General trends in population size and distribution can be obtained from such accounts, but quantification is difficult. Therefore, we supplemented our literature review by examining annual Breeding Bird Surveys (BBS) and Christmas Bird Counts (CBC). These counts have been conducted each year and the results have been computerized for most of the past three decades (e.g., Droege 1990).

We used BBS surveys from 1966–1990. Only "type 1" surveys, those with no known problems and experienced observers, were used. We avoided biases in raw trends, caused by variable observers and missing censuses, by calculating Bailey indices. This index (Bailey 1967) only uses censuses surveyed in successive years by the same observer. Changes from year to year are therefore proportional and unbiased. We assessed the occurrence of "random walk" error in Bailey indices with a test developed by Moss (1985). Nonsignificant correlations between raw census counts and the Bailey indices indicate random walk (a rare event in our analyses; only three correlations were not significant and the maximum P-value was only 0.25). Each index was truncated to remove annual indices for years with few paired censuses (Boone 1991).

We used CBC surveys from 1961–1989. We treated census circles that overlapped in area by 50% or more as replicates of the same circle with center coordinates equal to the center of the most frequently used circle. Counts were adjusted for variable observer effort by using several modifications of the Butcher and McCulloch (1990) procedure: 1) The exponent relating survey party-hours to the number of birds counted was calculated on a state-by-state, rather than "national", scale. 2) The effect of observer effort was calculated without including counts derived from fewer than 30 party-hours. 3) Each count's contribution to the total variance between observed and predicted counts was computed. If this contribution exceeded 10%, the modified count was considered suspect and the unmodified count was used in its place.

To understand which factors influenced changes in the numbers of birds counted we used a nonparametric classification and regression tree (CART) approach (Breiman et al. 1984) to relate the natural log of the count total to the following variables: 1) Year; 2) Long-term (1966–1990) means of January temperatures, July temperatures, and precipitation; 3) Annual deviations in mean January temperatures, July temperatures, and precipitation from the long-term mean temperatures and precipitation; 4) Distance from the start of the route to the nearest coastline (±25 km); 5) Latitude and longitude for the start of the route; 6) USFWS physiographic stratum assigned to each route or circle (Robbins et al. 1986); 7) Proportion of farmland in the county containing most of the route determined by the 1987 Census of Agriculture; 8) People per square mile in the county containing most of the route determined by the 1990 population census; and 9) Total number of species observed on the route for the year surveyed.

We used breeding bird census (BBC) data to investigate changes in corvids in California. We selected surveys for single years from each of the available locations to reduce bias due to the peculiar characteristics of individual survey sites, procedures, or observers. We considered 196 survey areas covering the period from 1937 through 1990 (54 years).

For sites with breeding surveys in more than one year, we selected the one year that overlapped least with annual coverage by other surveys to minimize bias from any unusual weather conditions. Nevertheless, in 28 cases, two or more sites were surveyed by the same observers in the same year; 17 of these cases involved two sites, 11 others from three to six sites. Many of these multiple surveys were in desert habitats, where observer differences were probably less extreme than in closed vegetation types.

Ten independent variables were used in statistical analyses: 1) Year in which the survey was carried out; 2) Latitude of the survey site to the nearest 0.1 degree; 3) Direct eastward distance of the site from the Pacific Ocean; 4) Altitude of the site in meters; 5) Plot area in hectares; 6) Number of non-raptorial breeding land bird species recorded; 7) Number of pairs of non-raptorial breeding land birds per 40.5 ha; 8) Moisture/temperature Index; 9) Vegetation Structure Index; 10) Human Impact Index.

The three index variables were ratings of survey plot conditions on a 10-point scale. These ratings were assigned on the basis of information given in the description of the survey site, or determined from the geographical location of the survey plot. The moisture-temperature ranking ranged from an index of 1.0 for Sonoran Desert sites with 2–8 inches of annual precipitation and 280–345 frost-free days to 10.0 for alpine tundra sites with 25–35 inches of annual precipitation and possible freezing conditions any time. The vegetation structure ranking ranged from an index of 1.0 for low, homogeneous, herbaceous, seasonal vegetation types, such as annual grassland, to 10.0 for tall, heterogeneous, arboreal, aseasonal vegetation types, such as mixed hardwood-conifer riparian forest. The human impact ranking ranged from 1.0 for sites with negligible direct human influences, such as ecological preserves with controlled access and non-manipulative research and monitoring practices, to 10.0 for sites with intensive urban, agricultural, industrial, or vehicular use characteristics.

We used stepwise multiple regression to test whether year was correlated with bird abundance after the variability in the dependent variable due to geographical, climatic, vegetational, and human impact differences among the locations had been considered. Power, root, and logarithmic transformations were examined for certain variables. Number of species and number of breeding pairs were considered indices of general productivity or "richness" of habitat conditions. In these analyses, we set the critical F-value for inclusion or retention of an independent variable in the multiple regression analysis to 4.0. For resulting regression equations that contained year, we estimated the long-term change in numbers of pairs per 40.5 ha by examining the slope of the regression of year on the residuals of multiple regression analyses with the remaining independent variables.

RESULTS

Pest species can be characterized by the change in abundance within their historic ranges and the shifts in their distribution (Fig. 2). Most pests are increasing within their historic ranges and invading nearby

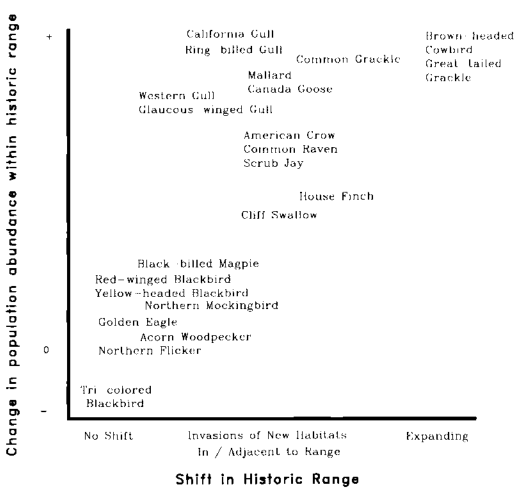

FIGURE 2. Changes in the abundance and distribution of native bird pests in the west. The position of each species is indicated by the start of its name and is plotted relative to other pests. The x-axis presents a continuum from no shift in range to large shifts in range. The y-axis presents a continuum from declines in population size (−) through stable population size (0) to progressively larger increases in population size (+).

urban or agricultural developments. However, some species are not or have declined; others have expanded their ranges significantly across the west. Several case histories illustrate this variety.

The only pest species that appears to be declining throughout its historic range is the Tri-colored Blackbird. It was extremely abundant in California and southern Oregon during the late 1800s and early 1900s, although patchily distributed because of its colonial habits (Grinnell 1915, Neff 1937). Tri-colored Blackbird populations suffered from market hunting and marsh draining in the late 1800s, but they capitalized on increased habitat and food created in the extensive rice farms of California's Central Valley beginning in 1910 (Neff 1942). They were considered a serious pest in the Sacramento Valley in the 1930s. Yet, despite poisoning campaigns (McCabe 1932), the populations flourished through the 1950s.

Colonies including 25,000 or more pairs were frequently noted early in the century, but rarely late in the century. Extensive surveys from 1969–1972 indicated that the distribution of the breeding colonies remained unchanged for 35 years, but that the population size began to decline in the 1960s, perhaps reducing the Central Valley population by as much as 50% (DeHaven et al. 1975). Populations declined to perhaps 10% of their historic levels during the 1970s and 1980s (Beedy et al. 1991), prompting the species' removal from the pest list in 1989 and addition to the California list of species of special concern and the federal endangered species candidate list. Surveys in 1992 revealed many birds in nontraditional upland habitats, suggesting that the population may not have declined as greatly as thought (R. Bowen, pers. comm.).

A group of pests including Black-billed Magpies, Red-winged and Yellow-headed Blackbirds, Northern Mockingbirds, Golden Eagles, Acorn Woodpeckers and Northern Flickers have changed only slightly in abundance and distribution (Fig. 2). Flickers, mockingbirds and Acorn Woodpeckers have maintained abundant and constant breeding populations. However, their wintering populations have all tended to increase, especially in the Rocky Mountain States (e.g., Fig. 3). Wintering populations of Golden Eagles have also increased throughout the west, possibly by as much as 29% (Phillips and Blom 1988).

Black-billed Magpies maintained high populations during the 20th century. They expanded their range east in the early 1900s into Oklahoma and Kansas (Tate 1927) and increased in abundance in western riparian locations that border agriculture (Rickard 1959). Recently, populations of breeding birds remained relatively stable (Robbins et al. 1986), but wintering populations, especially in Texas and Utah, have increased. CART analyses of BBS counts suggested that populations were declining in the Plains States, and least abundant in human dominated habitats. However, in the Coastal and Mountain States, magpies were positively correlated with human density and farmland. Winter densities were positively correlated with farmland.

Red-winged and Yellow-headed Blackbirds were noted as common by the earliest explorers of the western marshes (Grinnell 1915). They have both changed their abundance and distribution slightly by invading agriculture whenever breeding sites were close to human population centers (e.g., Howell 1922). As with all marsh dwelling birds, Red-winged and Yellow-headed Blackbird populations in the west declined periodically during the 1930s in response to urban sprawl and the draining of marshes (Davis 1935). Population growth also was checked from the 1850s–1930s by market hunters who killed hundreds of thousands of them (Neff 1942). Red-wings remained common throughout the western U.S. and Canada into the 1960s (e.g., Gullion 1951), and were first observed breeding in Alaska in the late 1950s (Shepherd 1962).

Recently, breeding populations of both species have remained stable or increased slightly throughout the western U.S. and Canada (Twedt et al. 1991, Erskine et al. 1992) while increasing significantly in the Plains States (Robbins et al. 1986). However, Red-wings in the Dakotas declined by as much as 41% from 1965–1981 due to drought and tilling of wetlands (Besser et al. 1984). Winter population trends are difficult to interpret.

Two species, Cliff Swallows and House Finches, have exhibited moderate range expansions and increases in population size. Cliff Swallows have increased throughout the west, but the major change has been in California, where increases in foraging and nesting habitat provided by irrigation and bridge building have facilitated the spread

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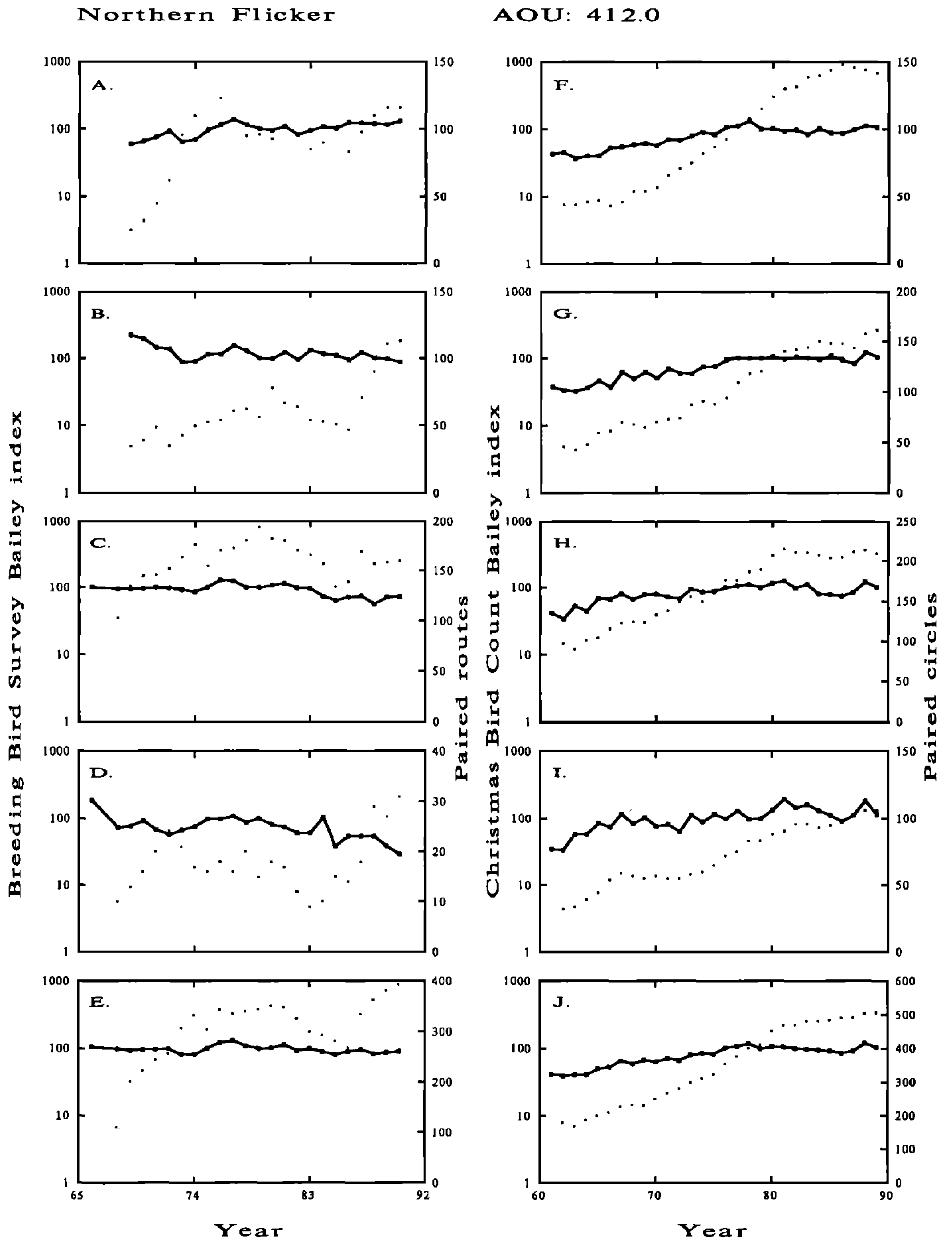
FIGURE 3. Recent trends in the population size of Northern Flickers throughout the western U.S. Counts during the breeding season (BBS) are given on the left half of the graph and counts during the winter (CBC) are



given on the right half. A solid line connects the squares representing the value of the Bailey index of population size in each year. This index is scaled to 100 in 1979 to allow relative comparisons between the years. The number of surveys (routes or circles) used to create each index is indicated by the solid circles without a line. Trends are presented separately for the Pacific Coast States (A, F), Rocky Mountain States (B, G), Plains States (C, H), Texas, Louisiana, and Utah (D, I), and all of the United States west of the Mississippi (E, J). Indices were not calculated when sample sizes of paired counts were very small, but the number of counts is still plotted.

of a large population throughout the Central Valley since the late 1950s (Gorenzel and Salmon 1982).

House Finches spread to the north from their center of abundance in California and the southeastern deserts (Edwards and Stirling 1961, Paul 1964). In 1910, they only occurred from Oregon, Idaho, and Wyoming south. By 1928 they were common in California, central Idaho and central Washington and began to spread into British Columbia in 1935, reaching 130 km north of the U.S. border by 1948. In the early 1960s, they were common throughout the lower half of British Columbia. They also spread west to coastal Oregon in 1940 and east to Montana in 1968 (Hand 1969). Recently, the numbers of breeders have remained stable for the west as a whole, but declined slightly in the Mountain West and Great Plains (Fig. 4; Robbins et al. 1986). Wintering populations have increased (Fig. 4).

The four principal species of gulls in the western U.S. have exhibited large increases in population size, with modest changes in range. Western and Glaucous-winged gulls bred on islands off the Pacific Coast early in the century (Grinnell 1915, Dickey and Van Rossem 1925). Both species are now much commoner in coastal urban areas. CBC surveys indicate that wintering populations of Western Gulls have increased approximately 10× in the last 30 years. Glaucous-winged Gulls began to increase in British Columbia in the 1930s (Woodberry and Knight 1951) and have increased by 2.6% per year from 1960–1980 (Vermeer 1982). In the last 30 years, CBC data do not suggest that winter populations of Glaucous-winged Gulls in the U.S. are increasing.

California and Ring-billed gulls increased 2.7× and 22×, respectively, from approximately 1930–1980 (Conover 1983). The expansion of California Gulls came principally from increased colony establishment in Washington, Montana and North Dakota (Conover 1983), and Canada. A similar pattern, but with greater expansion of colonies in Idaho and Oregon, was noted for Ring-billed Gulls (Conover 1983). Both species have continued to increase into the 1990s (Fig. 5; Blokpoel and Tessier 1986, Yochem et al. 1991).

Spring (BBS) and winter (CBC) surveys conducted over the last 30 years have detected sustained increases in California Gulls. Counts during the breeding season have increased more consistently in the Coastal States than in the Mountain States. Moreover, CART analyses indicated that populations in the Mountain States were more closely associated with agriculture than coastal populations. Wintering populations were greatest in areas of high human density and were less closely correlated with farmland.

CBC and BBS surveys suggest that Ring-billed Gulls have increased dramatically in the spring and winter throughout the western U.S. (Fig. 5). Counts in Plains States were strongly, positively associated with farmland and deviations from mean January temperature, and negatively correlated with the abundance of humans. Coastal counts were more strongly associated with plot species richness. Wintering populations throughout the west were positively associated with farmland and human density.

The principal waterfowl and corvid pests have sustained large increases in population size and moderate shifts in density within their historic ranges (Fig. 2). Waterfowl populations likely declined during the first third of the century in response to increased wetland drainage and severe droughts in the Prairie States (Banks and Springer 1994). Populations were lowest in the mid-1930s, but during the last 30 years, the principal pest species (Canada Geese and Mallards) increased substantially in the Plains States (Fig. 6; Conover and Chasko 1985, Robbins et al. 1986). Increases during the winter are partially due to overwintering in the breeding range by many urban and suburban populations that were once migratory.

Ravens were conspicuous but sparsely distributed permanent residents in the early

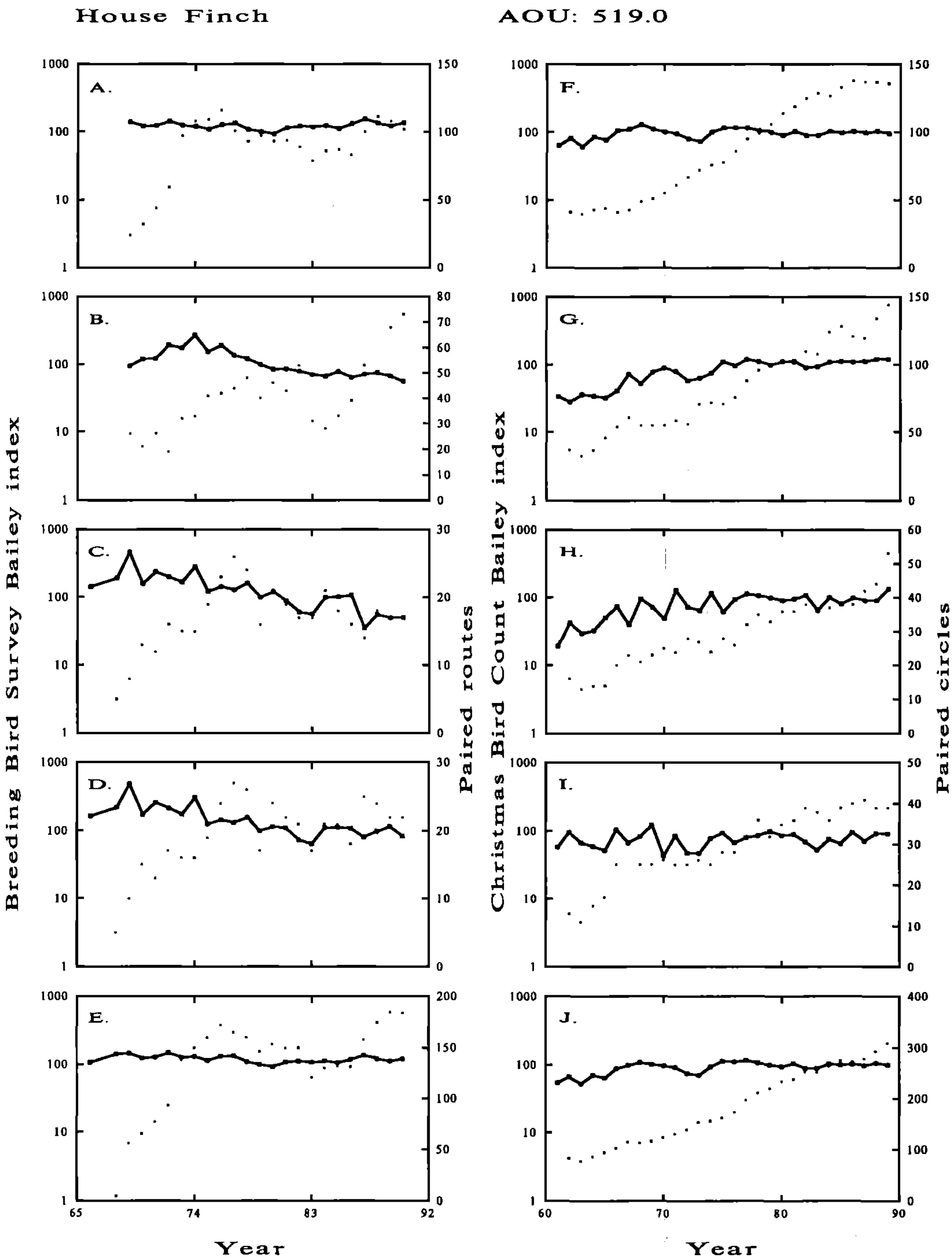


FIGURE 4. Recent trends in the populations of House Finches throughout the western U.S. See legend in Figure 3 for details.

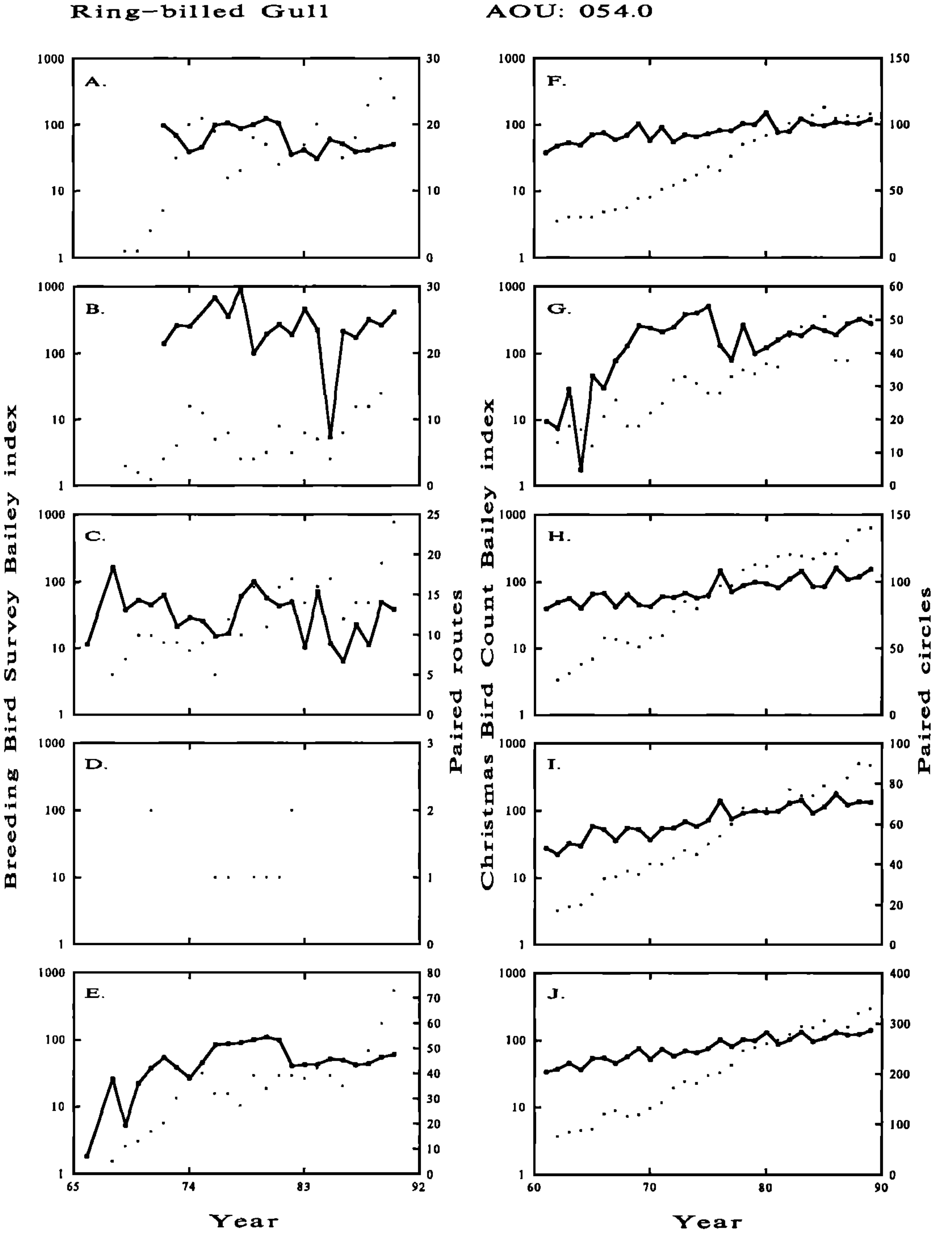


FIGURE 5. Recent trends in the populations of Ring-billed Gulls throughout the western U.S. See legend in Figure 3 for details.

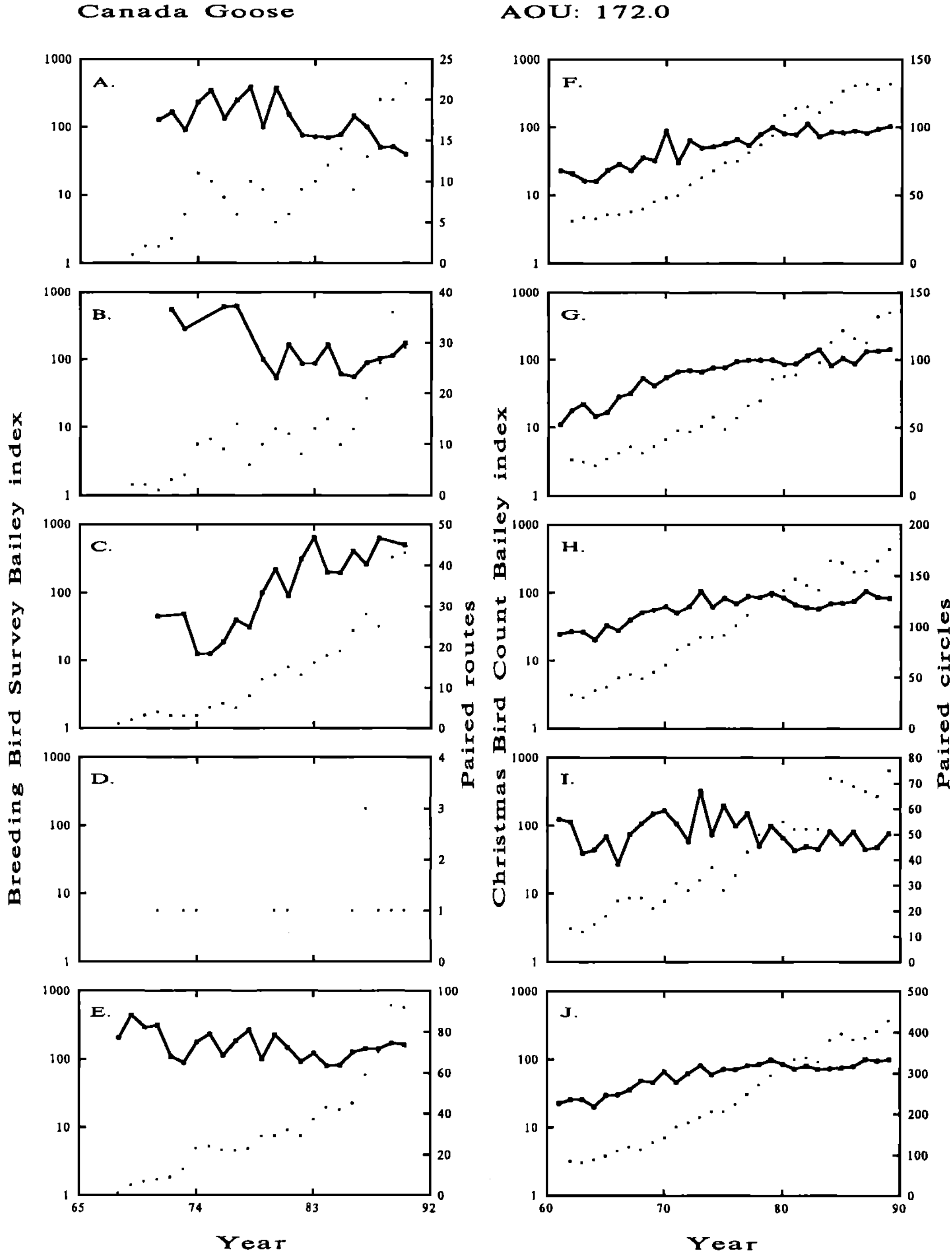


FIGURE 6. Recent trends in the populations of Canada Geese throughout the western U.S. See legend in Figure 3 for details.

1900s (Grinnell 1915). Their numbers remained fairly constant from the 1920s–1960s, except for a reduction in highly settled areas (Grinnell and Miller 1944) and local increases in response to new feeding opportunities (e.g., Santa Barbara Island in response to sheep farming; increases around garbage dumps in rural villages (Pemberton 1929, Cahn 1947).

Recently, breeding and, more notably, wintering ravens have increased in the Far Western States (Robbins et al. 1986). Ravens in southwestern deserts have increased by 5–15× in the last 20 years (Boarman in press), and moderate-sized towns in the Rocky Mountains have seen explosions in wintering populations (e.g., a 9-fold increase from the mid-1970s to the late 1980s in Flagstaff, Arizona [Marzluff 1988]). BBS counts of ravens were positively correlated with plot species richness and farmland, but negatively associated with human density. The negative influence of high human density was least important in the Coastal States and most important in the Mountain States. The positive influence of farmland was greatest in the Plains States, suggesting that the breeding populations on the edge of the range were more closely associated with agriculture than in the dense center of the range. Farmland was the most important variable used in CART analyses to explain variation in wintering populations.

American Crows were uncommon in most parts of the west through the early 1900s, except along riparian corridors (Monson 1946, Richards 1971). However, populations increased with the arrival of agriculture and irrigation in the interior of California, Oregon, and Washington. Brooks (1925) estimated a regional increase of 30× over much of the west from 1900–1920 (see also Robertson 1931). Emlen (1940) suggested that numbers in California changed little from the late 1800s to the 1930s, except along the northern coast and in the Sacramento Valley, where abundance increased substantially. Crows were uncommon throughout the Great Basin until the 1930s, after which they increased slowly with spreading agriculture (Pitelka 1942, Richards 1971). They were rare at Las Vegas Hot Springs, New Mexico in 1882, but were one of the commonest species in 1959 (Rickard 1959).

Over the last 30 years, BBS and CBC surveys indicated steady, but slight, increases in breeding and wintering populations of crows (Robbins et al. 1986). BBS counts were correlated positively with plot species richness and human density, and correlated negatively with mean January temperature and farmland. CBC surveys also were correlated positively with human density. Apparently crows are invading urban areas to a greater extent than agricultural areas. In contrast, ravens appear to be invading agricultural areas to a greater extent than urban areas (although they are common in many urban areas as well). CART analyses suggest that the importance of urban areas to crows was greatest in the Mountain and Coastal States.

During the first half of the century, Scrub Jay (*Aphelocoma coerulescens*) populations evidently remained stable throughout most of the west (Hargrave 1932, Stoner 1934), then increased slightly in lowland areas of California (Grinnell and Miller 1944), and in Arizona and Texas where overgrazing increased the spread of scrub vegetation into former grassland (Phillips et al. 1964). Breeding populations were stable from the mid-1960s to the late 1980s, increasing significantly only in Oregon and California (Robbins et al. 1986). Wintering populations have gradually increased in all areas over the last 30 years (Fig. 7). Scrub Jays appear to be invading most human dominated landscapes because BBS counts were positively correlated with human density and farmland. Colonization of farmland appears to be especially important in the Mountain States.

Results from our analysis of BBC data from California support the observations of recent increases in corvids. We found a significant increase in total corvids (per 40.5 ha) through years ($F_{1,182} = 5.24$) in combination with a significant positive relation-

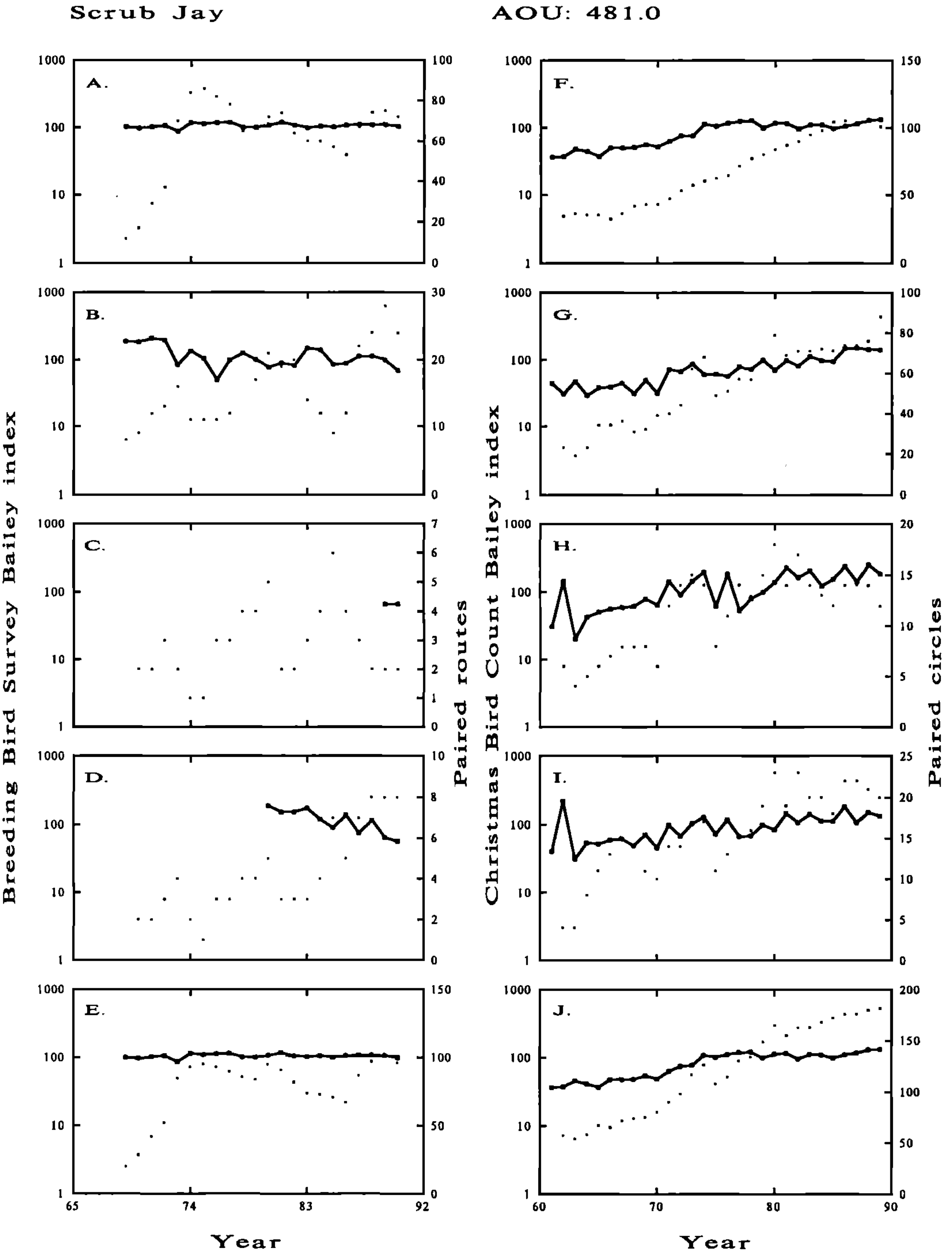


FIGURE 7. Recent trends in the populations of Scrub Jays throughout the western U.S. See legend in Figure 3 for details.

ship to number of species ($F_{1,182}$ = 11.85) and a significant negative relationship to census plot size ($F_{1,182}$ = 32.07). These relationships largely reflected population trends in jays (Scrub Jay, Steller's Jay [*Cyanocitta stelleri*], Gray Jay [*Perisoreus canadensis*]), which made up 96.5% of all corvids recorded in censuses.

The increases have occurred only in certain habitats. Of the 17 censuses with jays, showing residuals of more than +10 pairs per 40.5 ha, 12 were upland or riparian woodlands with a major component of oaks. Of the remaining five censuses, three were riparian woodlands, one a wooded urban park, and one a chaparral habitat. Of these 17 census sites, 13 were at elevations below 500 m.

Common Grackles, Great-tailed Grackles (*Quiscalus mexicanus*) and Brown-headed Cowbirds (*Molothrus ater*) have experienced the greatest rates of increase within their historic range and largest expansions of any native pest birds in the western U.S. (Fig. 2). Common Grackles were relatively rare in the west until recently. They were first observed in the 1940s in Nevada (Alcorn 1946) and the late 1950s in Utah (Talley 1957). Recently, they were mostly confined to the Great Plains, where populations increased slightly, especially in Oklahoma (Robbins et al. 1986). Although breeding populations are small in the Rocky Mountain States, they appear to be rapidly increasing. Winter population trends are erratic and difficult to interpret (Bock and Root 1981).

In the mid-1800s Great-tailed Grackles were locally abundant, but restricted to the northern Plateau of Mexico and extreme southern Texas (Selander and Giller 1961). They remained there until approximately 1913, when they began a slow northern invasion into Arizona, New Mexico, and inland Texas (Phillips 1950). Colonization proceeded north along the Rio Grande so that by the early 1940s grackles were in central and northern New Mexico, and followed the conversion of grassland to brushland north in Texas up to the panhandle (Compton 1947, Phillips 1950, Selander and Giller 1961). Grackles were resident in Arizona along the Salt and Gila Rivers north and west to Phoenix by the 1950s, and expanded west and north in the 1960s into California, all of New Mexico, and Colorado (McCaskie et al. 1966, Phillips 1968). Breeding was confirmed in Colorado in 1973 (Stepney 1975). Populations exploded in the Great Plains during the late 1960s and 1970s, especially on the Osage Plains of Kansas, Oklahoma, and southern Nebraska (Robbins et al. 1986).

Wintering and breeding populations have continued to increase, especially in the Rocky Mountain States. CART analyses of BBS counts indicated that grackles, though primarily confined to the Southwest, are increasing faster than any other pest species. Abundance was positively correlated with farmland, especially in the Plains States. Winter populations were also increasing rapidly and were associated with areas of high human density, and to a lesser extent with areas of abundant farmland.

WHY ARE MOST PESTS SUCCESSFUL?

In this era of widespread endangerment and extinction of species, most native bird pests in the west have stable or increasing populations (Fig. 2), owing to their ability to take advantage of feeding and nesting sites provided by man.

Three characteristics shared by many pests may be especially important in preadapting them to exploit humans. First, many pests forage in flocks (McAtee 1946), a common adaptation to patchily distributed, but locally abundant foods (Marzluff and Balda 1992), such as agricultural crops. Second, flocking and non-flocking pests are usually generalist foragers. This ability has likely been a key to recent increases in the abundance of many larids and corvids, which can exploit human refuse when other foods are scarce. Third, suitable breeding habitat has been expanded by human impoundment of rivers and creation of wildlife refuges (for waterfowl and larids), construction of bridges (swallows), irrigation of farmland (icterids), and creation of urban parks (corvids). Widespread geographic distribution may be of secondary importance because the one pest with a declining population, the Tricolored Blackbird, also has a very restricted range.

Our CART analyses of factors correlated with the abundance of pests indicated that large human populations were more beneficial to pest species in the winter than during the breeding season. Food provided at feeders, parks, marinas, and refuse dumps may have increased survival or changed wintering distribution of pests, or both.

Although agricultural and urban areas are important refuges for pests, increases have not been limited to sites of extensive human disturbance. For example, our results suggest that small corvids in California have increased in abundance in low- to mid-elevation woodland habitats since the early 1960s. This is most clearly shown in broadleaf woodland habitats, but is not restricted to sites internally impacted by human disturbance. Evidently, small corvids have been favored by general landscape changes such as the spread of suburban residential developments, vehicular campgrounds, and other human activities into the more accessible portions of extra-urban California. Spillover from areas of strong human impact may have increased populations of small corvids even in lightly impacted habitats.

LIMITATIONS OF RESULTS

We have relied upon the published literature and recent standardized surveys to assess changes in the population sizes of a variety of birds. A few caveats should be noted. Trends in some bird species or groups are not easily identified in BBS or CBC census data. In addition to the enormous variation in the structure of the bird communities themselves, differences among observer practices often make results difficult to compare. Data from BBC, BBS and CBC censuses may also be poor at characterizing trends in abundance of large corvids, primarily because of the small size of most census plots relative to their home ranges, and colonial larids and icterids, because census plots may only rarely fall within historically used colonies (Bock and Root 1981).

FORECAST

Native species of birds will continue to plague humans. A recent nationwide survey of Animal Damage Control needs reported that six of the top ten research needs concerned native birds (Packham and Connolly 1992). Ways to control blackbird and waterfowl populations were the top two priorities, ranking above coyote, fox and dog control. Control of wading birds, cormorants, gulls, woodpeckers, crows and ravens was considered more pressing than bear, skunk, raccoon, or rat control.

The survey results reflect current perceptions of species that will be pests in the immediate future. Many will likely continue to be problems into the indefinite future because new crops and settlements will encroach upon native habitats, forcing birds to adapt, move, or go extinct. Each new crop planted will be exploited by native birds, principally blackbirds, finches, and corvids. Indeed, any species that adapts to human encroachment is certain to be considered a pest by a portion of the human population.

Among species not considered above, cormorants and herons will be problems for western aquaculture, as is currently the case in the southeastern and southwestern U.S. Ducks and geese will gain prominence for fouling the urban environments. Problems with corvids and cowbirds (Rothstein 1994) will increase, through predation on the eggs and nestlings of endangered species, as forested areas become increasingly fractured and utilized by humans for recreation.

Safety-related problems with native birds should lessen during the next century. Relocation and closing of many landfills will reduce the concentrations of gulls, blackbirds and corvids that pose hazards to aircraft. Communal roosts, however, are likely to persist in urban areas and may increase as humans occupy more land. Disease transmission and neurosis may therefore continue to be minor problems.

At the Bicentennial meeting of the Cooper Society, participants should not be surprised to learn that the western avifauna has become dominated by generalized, flocking species.

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