

The Current Status of North American Vultures

Lloyd F. Kiff

ABSTRACT

Population trends of three species of North American cathartid vultures, the Turkey Vulture *Cathartes aura*, Black Vulture *Coragyps atratus*, and California Condor *Gymnogyps californianus*, are reviewed here. Both of the smaller species have undergone dramatic northward range extensions since the 1920s. A temporary decline in numbers occurred in many areas from the 1950s to the early 1970s, coinciding with the period of DDT use in North America, and widespread eggshell thinning was documented in California, Texas, and Florida during that period. Soon after the domestic use of DDT was banned in the United States and Canada in the early 1970s, vulture populations began to increase. Based on distributional data from diverse sources, numbers of both species are presently stable or increasing throughout their North American ranges. The ongoing northward range expansion has been enhanced by several factors, including increases in the deer population, increased availability of other road-killed animals, reduced pesticide use, reduced human persecution, the increased number of landfills, and a general warming trend. Given the long-term nature of the northward expansion, its continental dimensions, and parallel expansions of other, ecologically unrelated species, it seems likely that climatic changes may be the most important. The California Condor, a rare species throughout its recorded history, has shown an encouraging increase in numbers during the past decade as a result of a vigorous captive breeding and release programme. Although it is still one of the most endangered species in the world, there is increasing hope that its once all-but-inevitable extinction can be prevented.

INTRODUCTION

Three species of cathartid vultures, the Black Vulture *Coragyps atratus*, Turkey Vulture *Cathartes aura*, and the California Condor *Gymnogyps californianus*, occur in the portion of North America north of the United States-Mexico border. A status review indicates that the fortunes of all three species have improved markedly in recent years, although on different scales.

Because their recent status, distributional trends, and ecological requirements are similar in general details, the two small North American cathartids are discussed together here. In preparing this update, I have relied heavily on the valuable reviews by Pattee and Wilbur (1989), Coleman and Fraser (1989, 1990), Kirk and Hyslop (1998), Kirk and Mossman (1998), and Mossman (1991).

To prevent the impending extinction of the California Condor, an aggressive management programme, involving captive breeding and reintroduction, was initiated in 1980 and has continued

to the present time. Fuller details of that programme are described elsewhere in this volume; hence, the discussion here is limited mostly to details on condor numbers and range.

TURKEY AND BLACK VULTURES

General Notes

The Turkey Vulture is the most widespread and differentiated cathartid species, occurring from southern Canada to Tierra del Fuego and the Falkland Islands, ranging from sea level to 4,300 m (Brown & Amadon 1968, Houston 1995). Four subspecies were recognized by Brown and Amadon (*op. cit.*) and Houston (*op. cit.*), but additional valid undescribed races may exist while molecular techniques may reveal that some groups are actually full species.

The northernmost temperate breeding populations are migratory. The eastern populations of North America winter mostly in the southern United States, whereas the western United States populations migrate south through Central America south to Paraguay (Brown & Amadon *op. cit.*). More than one million individuals pass each fall over Veracruz, Mexico migration hawk watch stations (E. Ruelas pers. comm.), and hundreds of thousands have been recorded in a single fall migration season over Panama (Smith 1980).

On a hemispheric basis, the monotypic Black Vulture is the most common cathartid; indeed, Brown and Amadon regarded it as the most common bird of prey in the Western Hemisphere. The species occurs from the southeastern United States and extreme southern Arizona and Texas south to Argentina and Chile (AOU 1998). Despite the abundance of the species, its migratory status is still unclear. It appears to be resident throughout most of its range, but possible migratory movements have been detected in Central America (Eisenmann 1963, Skutch 1969). Black Vultures do not occur as far south in South America as Turkey Vultures, nor as far north or west in the United States. Interestingly, in California, where the Black Vulture is presently absent, the Pleistocene equivalent, *Coragyps occidentalis*, was the most common small cathartid as recently as 10,000 years ago, judging from fossil remains from Rancho La Brea (Howard 1930).

Turkey Vultures have the most catholic habitat preferences of any member of the Cathartidae, perhaps owing in part to their ability to use olfactory clues in locating carcasses. This adaptation, shared by all *Cathartes* species, including the Neotropical Lesser Yellow-headed Vulture *C. burrovianus* and Greater Yellow-headed Vulture *C. melambrotus*, allows them to penetrate denser forests than other avian scavengers, all of which rely solely on visual cues (Houston 1986, 1988). In eastern North America, Turkey Vultures prefer a mosaic of open and forested habitats to accommodate their nesting, feeding, and roosting requirements. Although they often roost in large congregations, Turkey Vultures are usually solitary or occur as loosely associated pairs when foraging. They are usually the first species to find carcasses, but, depending on the region, they are displaced by the later-arriving Black Vultures, King Vultures *Sarcorhamphus papa*, California Condors, and Andean Condors *Vultur gryphus* (Koford 1953, Wallace & Temple 1987, Houston 1988).

Black Vultures tend to occur in larger groups at carcasses than the Turkey Vulture, and they are associated with human settlements and activities throughout their range. They seldom penetrate actual unbroken primary forest, although birds may occasionally feed just within forest edges on carcasses found first by Turkey Vultures. Probably as a consequence of its foraging strategy and its capacity to feed on smaller food items, the Turkey Vulture is more widely distributed ecologically and geographically, even though the Black Vulture is more abundant in most areas of sympatry.

Population Trends

In compiling this summary I have drawn upon data provided by the Breeding Bird Survey, Christmas Bird Counts, migration counts from hawkwatches, state breeding bird atlases, National Wildlife Federation regional raptor symposia, and the field notes sections of *American Birds*. Enumerating the various biases and sampling weaknesses of certain of these approaches has become a discrete scientific discipline in itself by now, but, in aggregate, the surveys are adequate for detecting broad population trends and changes in continental range patterns of easily detected species like vultures.

Breeding Bird Survey

The Breeding Bird Survey (BBS) is an ongoing cooperative programme initiated in 1965 and sponsored jointly by the U.S. Fish and Wildlife Service and the Canadian Wildlife Service. It was designed to estimate population trends of migratory bird species nesting in North America north of Mexico. Pairs of observers conduct surveys along highways, making 50 3-min stops 0.8 km apart during a single morning each year at the height of the breeding season. All bird species seen or heard in the vicinity of each stop are recorded. The strength of the BBS lies both in the scope of its coverage (>3,700 routes) and in the repetition of the same survey routes in successive years (> 2,900 annually) (Sauer *et al.* 1997).

In the first summary of long-term BBS results, Robbins *et al.* (1986) analysed population trends that emerged from the first 15 years (1965-79) of the survey. These data indicated that populations of both Black and Turkey Vultures were stable, and no significant changes were detected in any major region of the country. A modest population increase was detected in the Great Lakes Region for the Turkey Vulture, and a significant decrease was found in Florida.

These findings agree with later analyses, using more sophisticated statistical techniques (Sauer *et al.* 1997). An increase, albeit not statistically significant, in Turkey Vulture populations was apparent only in Canada during the early period (1966-1979), and populations elsewhere showed little or no change (Table 1). In contrast, BBS survey data from 1980-1996 revealed highly significant population increases for Turkey Vultures in all areas, particularly Canada, except for a slight, non-significant decline in the Central Region (Table 2). Black Vultures also increased in all areas in both periods, although the changes were not highly significant (Tables 3, 4).

As noted by Kirk and Mossman (1998), cathartid vultures are probably underrepresented by BBS techniques, since the surveys are conducted in the early morning before thermals develop and the birds have become active. The effects of such a bias should not have varied over the history of the BBS project, however, so overall population trends indicated by these data are probably valid.

Christmas Bird Count (CBC)

The National Audubon Society Christmas Bird Count is an early-winter survey of birds conducted annually within two weeks of 25 December by an army of observers throughout North America. Total numbers of species and individual birds are recorded within 15-mi (24 km) diam circles, and many of the same localities have been censused for decades; 1,692 counts were made by over 45,000 participants during the 1995-96 season (Sauer *et al.* (1996).

Brown (1976) analysed North American vulture population trends from CBC data between 1950 and 1973 and found that populations of both species declined steadily during that 24-year study period. Turkey Vulture populations held fairly steady through the 1950s, then dropped off more steeply after 1959. Black Vulture sighting frequencies dropped by almost 50% from the beginning to the end of the study period. Brown's study period coincided closely with the period (1946-1972) of legal DDT use in the United States and Canada.

Based on CBC data, Sauer *et al.* (1996) estimated North American bird population trends for the period 1959-88 (data for subsequent years have not yet been analysed). Based on this technique, the Black Vulture showed minor trend declines in several southern states, including Alabama (-2.5), Georgia (-3.4), Kentucky (-0.1), and South Carolina (-4.2). Only the latter was highly statistically significant ($P < 0.01$). Highly significant positive trends were found in Tennessee (7.3) and Maryland (4.3), and a significant ($P < 0.05$) positive trend was found in Pennsylvania (5.2). Despite the apparent declines in the southern states, the relative abundance of the species was still much higher in that region, being highest in Georgia, where 21.35 birds were counted per 100 party hours. Because this span of years overlaps between the period of greatest DDT use and 16 years following the ban on the pesticide, any population trends that might be related to that contaminant would be masked. However, a rough analysis of survey-wide data for this period show a decline in numbers between 1959 to about 1971, then a steady increase through 1988 (Sauer *et al. op. cit.*).

The equivalent data for the Turkey Vulture indicate a more or less stable North American population from 1959 to 1971, followed by a steady upward trend in numbers through 1988. Highly

significant percentage increases in Turkey Vulture survey counts were found in Alabama (5.3), California (2.0), Florida (4.0), Pennsylvania (7.2), and throughout the entire survey area (2.6); none of the few reported declines in trends were significant.

In the following tables Trend = % change/yr, P = statistical significance, N = number of count circles on which trends were estimated. (Data from Sauer *et al.* 1996).

Table 1. Turkey Vulture population trends based on BBS data, 1966-79.

	<i>Trend</i>	<i>P</i>	<i>N</i>
United States	+1.2	0.30	816
Eastern Region	+1.2	0.38	447
Central Region	+2.1	0.19	208
Western Region	-2.3	0.24	169
Canada	+8.1	0.43	8

Table 2. Turkey Vulture population trends based on BBS data, 1980-96.

	<i>Trend</i>	<i>P</i>	<i>N</i>
United States	+1.6	0.00	1522
Eastern Region	+3.2	0.00	890
Central Region	-0.2	0.83	353
Western Region	+3.8	0.00	328
Canada	+17.3	0.00	49

Table 3. Black Vulture population trends based on BBS data, 1966-79.

	<i>Trend</i>	<i>P</i>	<i>N</i>
United States	+1.8	0.31	220
Eastern region	+1.4	0.53	149
Central region	+2.6	0.39	70

Table 4. Black Vulture populations trends based on BBS data, 1980-96.

	<i>Trend</i>	<i>P</i>	<i>N</i>
United States	+2.3	0.09	415
Eastern region	+2.1	0.24	284
Central region	+3.0	0.15	130

Migration hawk watches

These stations record actual observations of birds passing by established lookout points. All North American hawk watches have recorded increasing numbers of both vulture species in recent years, apparently reflecting the growth of summering populations ever farther to the north. Representative findings from some of the best known observation stations are as follows:

Cape May, New Jersey: The count of fall migrating Turkey Vultures continues to increase steadily. In 1993, the first season that the count exceeded 1,000, 1,540 individuals were recorded. Subsequent counts were 2,260 in 1994, 3,242 in 1995, and 5,425 in 1996 (Greenstone 1997). Black Vulture numbers also have continued to increase at this site, where the species was virtually unknown only a few decades ago (Greenstone *op cit.*).

Hawk Mountain, Pennsylvania: The first Black Vulture was sighted in fall migration at Hawk Mountain in 1979 (in the 35th year of observations), and the species has been detected annually since 1985. The average number sighted in fall during the last five years is 50 (L. Goodrich *in litt.*).

Over the years at Hawk Mountain, Turkey Vulture observations have been recorded only intermittently, and interpretation of sightings is complicated by the presence of a resident population. However, the number of birds recorded during the past 10 years is believed to be stable or possibly increasing (L. Goodrich *in litt.*).

Niagara Peninsula Hawkwatch, Grimsby, Ontario: Hussell and Brown (1992) reported an increase in annual indices of abundance of 8.0% in Turkey Vulture numbers in fall migration between 1975-1990 at this site, based on logistical multiple regression procedures, which permitted corrections for date and weather effects.

Hawk Ridge, Duluth, Minnesota: Based on logistical multiple regressions, Hussell and Brown (1992) found an increase of 3.6% in annual indices abundance of Turkey Vulture numbers between 1974-1989, the highest rate of change for any of the species detected at this site during the same period.

HawkWatch International: Based on their analysis of hawk watch data from four western sites (Wellsville Mountains, Utah; Goshute Mountains, Nevada; Manzano Mountains, New Mexico; Sandia Mountains, New Mexico), Hoffman *et al.* (1992, unpubl. data) concluded that the number of Turkey Vulture detections in fall migration has increased steadily (as much as 15% annually) during the past two decades along at least two distinct migration flyways in the Interior West.

Golden Gate Raptor Observatory, Marin Headlands, California: As in the case of Hawk Mountain, interpretation of Turkey Vulture observations at this site is complicated by the presence of a resident population and the apparent tendency of some migrants to remain in the area for several days. Nevertheless, the fall population has been stable, or possibly increasing, over the past five years (A. Fish pers. comm.). This coincides with the conclusions of the California Department of Fish and Game for the state in general (K. Hunting pers. comm.).

Veracruz, Mexico: The population of migrant Turkey Vultures in fall appears to be stable, and fall counts at two major observation sites averaged 1,205,707 individuals during the five-year period of 1992-1996 (E. Ruelas pers. comm.).

Breeding bird atlases and state bird books

I reviewed the status summaries for Black and Turkey Vultures in recent bird atlases and/or state bird books for most North American states and provinces and found that all reported stable or increasing resident and migrant vulture populations since the late 1970s and 1980s.

National Wildlife Federation reviews

The National Wildlife Federation organized five regional symposia between 1985-1988 on the status of United States raptors. Except for the one held in the Southwest, each proceedings volume contained a chapter on vultures, and these are still relatively up-to-date assessments of vulture status in North America. The conclusions of the respective authors were as follows:

Southeast: Turkey Vulture populations stable over the region as a whole; range expansion and increase in numbers of the Black Vulture northward (Coleman & Fraser 1990).

Northeast: Increased numbers and northward range expansion of both species (Coleman & Fraser 1989).

Midwest: Turkey Vulture populations stable or increasing overall; Black Vultures possibly declining (Mossman 1991).

Western: Turkey Vulture populations appeared stable with no evidence of recent significant changes in distribution... "the long-term outlook for the species in the West is good." (Pattee & Wilbur 1989).

American Birds

Another rich source of information on the current status of North American birds is the field notes columns of the journal *American Birds* (formerly *Audubon Field Notes*; now titled "*Field Notes*"), which were initiated in 1947, the year when DDT was first widely used in North America. Whereas there has been a strong preoccupation with vagrants in these columns over the years, they

also contain frequent comments on apparent range extensions or unusual increases in abundance of more common species. The *American Birds* field notes sections represent the most comprehensive source of up-to-date, albeit subjective, information on the recent and present status of bird populations in North America.

In general, the regional reports documented declining populations of cathartid vultures in most parts of North America in the 1960s. Increasing populations were reported in most regions in the mid- to late-1970s and throughout the 1980s. During the 1990s, there has been unanimous agreement that the ranges of both species of small cathartids are continuing to expand northward, more individuals are attempting to overwinter ever farther north, and birds are arriving earlier in spring and staying later in fall than was previously the norm. For example, both species, especially the Turkey Vulture, now occur with regularity in southern Quebec, northern Ontario, and the Maritime Provinces, where they were virtually unrecorded formerly, and some birds are now overwintering successfully. There is even a recent record for the Turkey Vulture in Yukon Territory, Canada (Bowling 1996) and multiple records for southeastern Alaska (Tobish 1997)! In view of the continuing lack of documented nestings in most of this region, it is probable that many of these pioneering individuals may be non-breeders, or post-breeding wanderers, as suggested by Cadman *et al.* (1988) and others.

Limiting factors

The historical causes of mortality and/or population limitation of North American vultures include shooting, trapping, primary and secondary poisoning, eggshell thinning, human-related accidents, the lack of suitable food, and the loss of foraging habitat and nesting sites. Only the latter two factors are likely to still be of any significance.

Human persecution

Direct human persecution of these vulture species has taken the usual forms, including shooting, trapping, and deliberate poisoning. Throughout the first half of the present century, many ranchers and farmers associated Turkey and Black Vultures with the spread of livestock diseases, especially anthrax, and therefore often sought to eliminate them, usually by trapping (Parmalee 1954). In addition, there were also more valid concerns about Black Vulture depredations on calves and other newborn livestock. In some regions there were large-scale government-sponsored and private programmes to eliminate problem vultures (Howell 1928). According to Snyder and Rea (1998), literally hundreds of thousands of Black and Turkey Vultures were eliminated by trapping in Florida and Texas during the 1940s and 1950s. There are still some locally based government-sanctioned removal episodes, usually in response to Black Vulture livestock depredations. Otherwise, there appears to be little direct persecution of either species, and both are now protected by the Migratory Bird Treaty Act, a treaty between the United States, Canada, and Mexico.

Where they are sympatric, both species may roost together in large aggregations with little, if any, interspecific conflict. In some populated areas, these roosts are regarded as a public nuisance, and occasional government permits are issued to disperse the birds, generally by non-lethal means. By and large, however, shooting and directed poisoning episodes are increasingly rare throughout most of the ranges of these species and will probably continue to decline as a result of changing American attitudes toward wildlife and an increasing trend toward corporate agriculture in the United States and Canada. There is a low cost:benefit ratio for large corporations in shooting or poisoning vultures in this era of heightened environmental awareness in North America. Most find it more acceptable to endure occasional minor losses or inconveniences from the vultures than to generate disproportionate negative publicity and public outcry by shooting them.

Secondary poisoning

According to Snyder and Snyder (1991), Turkey Vultures are relatively insensitive to natural pathogens and some rodenticides, including the compound 1080, but quite sensitive to other poisons, including cyanide and strychnine, which were formerly used widely to poison coyotes and other perceived threats to cattle and sheep. These two vulture species like California Condors, may also be

unusually sensitive to lead poisoning, which they can obtain in the form of bullet fragments in shot mammals carcasses and gutpiles. Little is known of the effects of range poisons on North American vulture populations, but it could have been considerable during former eras, when setting out poisoned carcasses for vermin was a widespread practice, and hunting was more pervasive.

One of the most widespread and dramatic forms of indirect poisoning of these species has been DDE-induced eggshell thinning. Wilbur (1978) first reported declines of 11%, 12%, and 18% in eggshell thickness indices of post-1947 (post-DDT) Turkey Vulture eggshells from California, Florida, and Texas, respectively. Drawing on larger samples, Kiff *et al.* (1983) confirmed these trends in eggshell thickness indices from post-1947 samples from the same three states, finding declines of 9.7%, 15.9%, and 10.1%, respectively, and they were associated with high levels of DDE residues extracted from the eggshell membranes. Elsewhere, Coleman and Fraser (1989) reported eggshell thinning of 8% and 14% in small Turkey Vulture eggshell samples collected between 1947-1964 in southeastern and mid-Atlantic states, respectively.

Kiff *et al.* (1983) also found even greater declines in thickness indices of post-1947 Black Vulture eggshells from Florida (16%) and Texas (17%), and there was a significant negative correlation with DDE residue levels of 6 ppm wet wt in the latter sample. These levels of eggshell thinning are very close to those associated with population declines in other species (Peakall & Kiff 1988) and probably led to breakage in some eggs.

Food limitation

In most other regions, the availability of eligible carcasses has probably increased greatly as a result of human activities. As soon as automobiles became part of the American scene in the early part of this century, vultures began to profit from the new availability of road-killed creatures, despite occasionally becoming road kills themselves (Sutton 1928). Sutton (1928 *op. cit.*) may have been the first to advance the notion that a tremendous resurgence of the White-tailed Deer *Odocoileus virginianus* population and their subsequent starvation led to a marked increase in the Turkey Vulture population in Pennsylvania in the 1920s. This factor has subsequently been mentioned by various authors. e.g., Wilbur (1983) and Kirk and Hyslop (1998), as an important reason for the notable increase in the range of both vulture species in northeastern North America in recent decades.

Throughout the western portion of the United States range of Turkey and Black Vultures, cattle have become a modern staple of their diet, but changes in ranching practices, including the increased use of feedlots and the tendency of some ranchers to promptly remove cow carcasses from the open range, have led to a decline in the availability of this food source. This may have contributed to a lower density of these species in some western states, as suggested for Texas by Porter and White (1977), for Utah by Taylor (1986), and for Arizona by Rea (1998b), but it has no doubt been partially compensated by the increase in landfills and roadkills.

Habitat changes

Widespread habitat changes have probably favoured both vulture species in the eastern United States and Canada. After well over two centuries of settlement by Europeans and subsequent retreats and advances of the forests, the prevailing habitat is a mosaic of forest patches and open areas well suited to the cathartid species. However, increasing urbanization of coastal southern California, once a stronghold of Turkey Vulture populations, has probably contributed to a decline in numbers there (Garrett & Dunn 1981, Unitt 1984). Another negative anthropogenic effect on vulture habitat has been a decline in the Southeast in the availability of suitable nesting sites, principally large hollow trees, for Black Vultures as a result of modern timbering practices (Jackson 1983, Robbins & Easterla 1992).

DISCUSSION

Bagg and Parker (1951, 1953) provided detailed summaries of the spread of the Turkey Vulture into New England and eastern Canada, beginning in the second quarter of this century. Since their analysis, the limits of the range of both vulture species in North America have continued to undergo

a steady expansion northward. This trend, which also occurred in northern and western New York (Allen *in* Bagg & Parker 1951) and the Midwest (Van Tyne *in* Bagg & Parker 1951), has continued into Quebec, Ontario, the Maritime Provinces, and even along the Pacific Coast, as shown in the preceding section. Based on all available evidence, it appears to be a long-term, unidirectional phenomenon that is unprecedented in the recorded history of these two species.

Wilbur (1983) and Pattee and Wilbur (1989) suggested that the United States range of the Turkey Vulture has both expanded and contracted over time regionally, citing as an example the temporary abundance of this species in Montana in the 1880s during the massive slaughter of the great bison *Bison bison* herds and their subsequent retraction to the south when this temporary food supply subsided (Cameron 1907). Other authors also noted declines of Turkey Vultures in South Dakota (Grinnell 1875) and Minnesota (Roberts 1932) which may have been related to the disappearance of the bison. This, and Webster's (1978) report of a striking increase in Texas Turkey Vulture populations in response to an increase in rat populations, shows that the species is capable of major changes in distribution and abundance. However, aside from the earlier (temporary) retreat from the northern Great Plains and upper midwestern states, the entire recent history of the Turkey Vulture appears to be characterized by a continual northward expansion.

Nevertheless, Coleman and Fraser (1989, 1990) stated that Turkey Vultures occurred in New England in the early 1800s, but were rare there by the last part of the century, implying that they began returning in the 1920s in response to a recovery of the deer population. They apparently based this on Merriam's (1877) mention that Linsley (1843) found the species "not uncommon" in southern Connecticut in the early 1800s, although Merriam himself characterized the species as "a rare visitor from the South" by mid-century, an assessment echoed by Sage and Bishop (1913). Linsley, a clergyman, also described in detail a purported incident of a Turkey Vulture attempting to carry off a chicken in its feet, which calls his reliability as an observer into question. The assertion of the Turkey Vulture's former abundance was dismissed by Bagg and Parker (1951), and there is little else in the older literature to support the notion that the species was ever numerous in New England until recent times. Indisputably, probably on the basis of hearsay, Wilson (1808-14) stated that "this species inhabits a vast range of territory, being common, it is said, from Nova Scotia to Tierra del Fuego." However, in his later revision of Wilson's great work, Bonaparte (1825-33) injected the qualifying comment with this account that "In the northern States of our Union, the turkey buzzard is only occasionally seen. It is considered a rare bird by the inhabitants."

Giraud (1844) reported that the Turkey Vulture was "of rare occurrence in the vicinity of New York (City)", although he noted that it was more common in New Jersey and nested there. He stated that he was unaware that this species ever reached New England, and he suggested that Long Island was the northern terminus of its range. Giraud's work was based on several decades of study, so he should have been aware of any profound declines in the numbers of Turkey Vultures. Similarly, De Kay's contemporaneous work (1844) on the birds of the whole State of New York, also showed this bird to be rare. Finally, in the most comprehensive 19th century work on North American land birds, Ridgway (*in* Baird *et al.* 1874) also stated that the species was not common north of central New Jersey, and mentioned only that "occasionally individuals have been seen as far north as New Brunswick and Nova Scotia". If the species had formerly been common in the New England area, this surely would have been noted.

The Black Vulture has also undergone a conspicuous range expansion since the 1920s. It was unknown in the Northeast, or even as far north as Virginia, until well into the 20th century. Bonaparte (1825-33) and Ridgway (*in* Baird *et al.* 1874) gave North Carolina as its northern limit, and the latter authority stated specifically that the species did not occur then as far north as (Norfolk) Virginia. Subsequently, Black Vultures have moved farther north, and the species now breeds regularly as far north as Pennsylvania and Ohio, and individual birds are routinely found much farther north, even in winter.

Farther west, Parmalee (1954) showed that the Black Vulture increased greatly in numbers in Texas in the 1920s, attributing this to changing livestock practices. The intrusion of this species into Arizona also evidently occurred at about the same time, judging from the assessment of Phillips (1934), who noted that "The Black Vulture was apparently merely casual in Arizona up to a few

years ago. Now it is rather regular but still very rare in the region south of Tucson and Ajo, near the border. It probably occurs in summer, but observation here is chiefly limited to the winter months.”. Subsequently, the species has increased greatly in numbers, if not in range, and it breeds regularly in the southern portions of the state (Rea 1998a).

Bagg and Parker (1951) listed several factors that, acting in combination, might have been responsible for the northward expansion of cathartid vultures, including (1) the great increase in deer populations in the Northeast, particularly since 1920, as suggested earlier by Sutton (1928) and Peterson (1948), (2) an increase in the number of road-killed animals, as automobile traffic burgeoned, (3) the deterioration of vulture habitat farther to the south, owing to the spread of civilization, and (4) the warming of the climate in the Northeast.

It is tempting to speculate that the range of the Turkey Vulture, at least, has ebbed and flowed northward and southward in eastern North America over the past two centuries as a result of the changing fortunes of the deer population, yet the historical data do not support the notion that vulture distributional changes in the Northeast, where the most conspicuous expansion has occurred, have involved anything more than a steady expansion northward. There is no evidence that vulture movements represent a cyclic response correlated with the rise and fall of deer populations, although the presence of large numbers of deer no doubt makes it easier for these scavengers to survive. By now, the expanding vulture populations have moved well beyond the portions of the continent where the deer populations have increased the most, and it is of interest that none of the birds reported from the northern extremes of the range have been feeding on deer carcasses. A more general explanation seems to be in order.

The somewhat incidental suggestion of Bagg and Parker (1951) that Turkey Vultures may have moved northward as a result of a decline in habitat quality in the South seems quite unlikely, since there has not been a long-term population decline there concomitant with the northerly range expansion, despite intense persecution in some areas. However, Mossman (1991) agreed that this might have been an important factor in the northward expansion of Turkey Vultures in the Midwest. Unquestionably, there have been deleterious widespread habitat changes for vultures in portions of both the South and the Midwest, primarily as the result of widespread conversion of formerly forested areas to agricultural uses and housing tracts.

Evidence from the CBC, *American Birds* regional reports, and various other sources, including Porter and White (1977), indicate that most North American populations of Black and Turkey Vultures were in decline from the 1950s to the early 1970s and that a recovery subsequently occurred. The timing of the decline coincided closely with the period (1946-1970) of the greatest use of DDT and other persistent organochlorine pesticides in North America. The documentation of widespread eggshell changes, presumably DDE-induced, in both species (Wilbur 1978, Kiff *et al.* 1983), and the subsequent increase in vulture numbers, which began shortly after the domestic use of DDT was banned in 1972, strongly suggest that these population effects were the result of DDE contamination. It is doubtful that eggshell thinning is still a problem for North American Turkey and Black Vultures, based on measurements of several recent samples obtained opportunistically. For example, by 1983 and 1984, Pennsylvania Turkey Vulture eggshells exhibited near historical shell thicknesses (L. Kiff & J. Coleman, unpubl. data).

Although vulture populations in some parts of the country were probably suppressed during the period of greatest DDT use, there is no evidence that the broader northward expansion was appreciably slowed. Whereas it is likely that the pattern of organochlorine pesticide use accounts for most of the trends observed in Black and Turkey Vulture numbers throughout the North American range of both species, the ongoing northward expansion was a separate matter related to other factors. It would be useful to compare BBS data for the periods 1966-1972, when DDT was still in use, and 1973-1979, the period when a rebound from the pesticide era may have occurred, but such figures are presently unavailable.

Rea (1998b) suggested that Turkey Vultures (and presumably also Black Vultures) in Latin America might still be suffering from eggshell thinning, since heavy DDT use continued in Mexico and more southern countries well after the compound was banned in Canada and the United States. In fact, Albert *et al.* (1989) reported high DDE levels and declines in eggshell thickness indices in

Black Vulture eggs from the State of Veracruz, Mexico. Presumably, Turkey Vultures migrating through the Neotropics from more northern breeding grounds would also be affected. However, DDT use in Mexico and most other Latin American countries has greatly declined during the last decade (Pesticide Action Network *in litt.*), so affected populations may now be recovering from years of DDE contamination.

The range expansion of the vultures is occurring over such a broad front that it requires a generalized explanation. Of the hypotheses suggested by Bagg and Parker (1951), the idea that northward changes in the ranges of both of these cathartids is related to a long-term warming trend is a tantalizing one that deserves further examination. Certainly, a similar northward range expansion in eastern North America over the past few decades by several weather-sensitive passerine species, e.g., Northern Cardinal *Cardinalis cardinalis*, Northern Mockingbird *Mimus polyglottos*, and Carolina Wren *Thryothorus ludovicianus*, seems to be related to an overall warming trend (Root 1988). Various *American Birds* regional editors have commented upon the apparent tendency of Black and Turkey Vultures to overwinter or to appear earlier in spring in northern areas in milder winters, and short-term movements of these species are probably greatly influenced by extreme weather conditions.

It is possible that the limits of the winter ranges of both vulture species may be imposed by minimum temperatures. From her analysis of Christmas Count data, Root (1988) concluded that, with the exception of portions of the Mississippi Valley, most of the areas in the United States where Black Vultures occur have an average minimum January temperature of above 30°F (-1°C). Cannings *et al.* (1987) and Rea (1998 a,b) suggested that the availability of unfrozen carcasses may be a important factor in limiting the winter range of both species. Obviously, an overall warming trend would push the limits of inhabitable territory farther northward. Many of the extralimital birds reported from New England and eastern Canada have been found at landfills. Naturally, such individuals are probably easier to detect than birds in more remote areas, but the increasing number and size of these facilities may provide a source of relatively unfrozen food that was previously unavailable to the vultures.

Of the two species, the Turkey Vulture is probably less vulnerable to future changes that may occur as human populations continue to increase. As a consequence of its adaptability to a wide range of habitats, perhaps related to its specialized foraging strategy, a capacity to feed on a wide range of food items, and its less restricted choice of nest sites, including even abandoned buildings (Valentine 1973), the Turkey Vulture is more widely distributed over the landscape, even though the Black Vulture is more abundant in most areas of sympatry. Within historical times, Turkey Vultures have traditionally occurred farther north and in more diverse habitats than the Black Vulture.

In the short term, there is probably little cause for concern about either of the small cathartid vulture species in the North American portion of their range, except possibly on a local basis where isolated poisoning or shooting episodes might occur. In the not-too-distant future, however, the increasingly antiseptic ranching practices of corporate agriculture and the relentless conversion of formerly open lands to housing developments will probably result in gradual declines of some local vulture populations unless these species again become fixtures in urban and suburban areas, as was the case in the early days of American history.

CALIFORNIA CONDOR

The California Condor has traditionally been the posterchild for rare and endangered bird species in North America and even globally. Warnings about its alarming decline were sounded as early as 1890 (Cooper 1890), and the inevitability of its extinction was the common refrain of most writings on the species throughout the present century. In an effort to prevent the condor's extinction, an aggressive management programme, involving captive breeding and reintroduction, was initiated in 1980. Fuller details of that programme are described elsewhere in this volume; hence, this discussion is limited to details on changes in condor numbers and range.

Range

The California Condor occurred widely in North America as recently as the late Pleistocene, and fossil remains have been found in New York, Florida, northern Mexico, Texas, New Mexico, Arizona,

and California (Emslie 1990). The species became extinct throughout most of its range around the end of the Pleistocene (about 10,000 yr B.P.). Most ornithologists, including Grinnell and Miller (1944), Koford (1953), Wilbur (1978), and AOU (1998), have concluded that the range of the California Condor was limited to the Pacific Coast region, from British Columbia, Canada to Baja California Norte, Mexico, during the last two centuries.

Snyder and Rea (1998) argued otherwise, however, listing several reported condor sightings from Arizona and Utah between the 1860s and 1924. Taken singly, none of these records, which include several secondhand accounts (e.g., Brown 1899, Harris 1941), is particularly satisfactory by modern standards, and they do not differ greatly in character from other long discarded or dubious reports of condors in Alberta (Fannin 1897), Idaho (Wilcox 1917) Nevada (Dillon 1966, Ryser 1985), and Colorado and Wyoming (Harris 1941). In lieu of specimens or more detailed accounts, the matter of whether or not the species has occurred east of the California Sierra Nevada in historical times is a subjective judgement. At most, condors could only have been exceedingly rare outside of the Pacific Coast region within the past century.

Numbers

Despite its low numbers throughout its history, efforts to determine the actual size of the condor population met with little success until recently. “Best-guess” estimates between 1923 and 1943 ranged widely, but most estimators put the number of living condors at 100 or less (Table 5). Following his landmark study of the species between 1939 and the late 1940s, Koford (1953) was challenged to produce an estimate of the condor population, based for the first time on actual research throughout the range of the species. He settled on the figure of 60 birds, while admitting that this was a somewhat arbitrary figure and that the number could actually be as high as 100 (Ed Harrison pers. comm., Snyder & Johnson 1985). A National Audubon Society-sponsored survey of the status of the condor population was conducted in the early 1960s by two rancher conservationists, Ian and Eben McMillan, and together with their collaborator, Alden Miller, they concluded that there had been a decline to only 40 birds (Miller *et al.* 1965).

Table 5. Historical estimates of the total California Condor population.

<i>Estimate</i>	<i>Year</i>	<i>Authority</i>
<100	1923	Dawson (1923)
“a few dozen”	1925	Finley & Finley (1926)
150	1926	J. Grinnell (<i>fide</i> Phillips) (1926)
12	1933	Wetmore (1933)
< 50	1933	Willett (1933)
60+	1934	Robinson (1934)
< 50	1939	American Ornithologists’ Union (1940)
100	1943	Grinnell & Miller (1944)
60-100	1951	Koford (<i>in litt.</i>)
60	1953	Koford (1953)
40	1964	Miller <i>et al.</i> (1964)
50-60	1966-71	Wilbur <i>et al.</i> (1972)
<50	1975	Wilbur (1976)
40-<50	1976	Wilbur (1978)
25-35	1978	Wilbur (1980)
21-22	1982-83	Snyder & Johnson (1985)
27	1987	Snyder & Snyder (1989)
147	1998	R. Mesta (pers. comm.)

Following formal involvement of the U.S. Fish and Wildlife Service in condor conservation, an annual survey was conducted each October between 1966 and 1980 in an attempt to monitor numbers

of the species. The survey results were somewhat ambiguous, owing to the strong influence of weather conditions on the reported totals and the impossibility of detecting all extant condors in the still-vast range of the species in a two-day effort (Wilbur 1980). However, it was apparent that the condor population probably included as many as 50-60 individuals between 1966-71 (Wilbur *et al.* 1972) and that ever fewer birds were detected in succeeding years (Wilbur 1978, 1980).

Snyder and Johnson (1985) devised an ingenious method of censusing condors by photographing them in flight and separating them by their individual peculiarities in feather patterns. By compiling a comprehensive photographic record of condors in all parts of the known range, they concluded that the number of wild condors was reduced to 20-21 birds by late 1982. At that time there was only a single individual in captivity, and the estimate of 21-22 total condors represented the probable lowest point in the history of the species. Snyder and Johnson (1985) also re-analysed earlier estimates of condor numbers, and they concluded that both Koford and the McMillans had greatly underestimated the size of the populations during their respective eras. According to their extrapolations, there could have been as many as 180 condors during the early 1950s and 120 during the 1960s.

Management programme

Despite the imprecision of the survey results, it was generally agreed that the condor population was continuing to decline at a precipitous rate. In response, the U.S. Fish and Wildlife Service and the National Audubon Society initiated a vigorous condor management programme in 1980. One thrust of this was to radio-tag several condors to determine causes of mortality, to track movements of individuals, and to identify critical habitat. Another major component of the programme was a detailed study of the nesting habits of wild condors. This eventually came to include removal of eggs from wild condor nests for hatching in captivity and capturing several adult and juvenile birds for captive breeding purposes. Between 1984 and 1987 these manipulations resulted in a slight increase in the total population of the species, the first documented reversal in the decline of condor numbers in the recorded history of the species.

Although overall numbers were increasing, the wild flock continued to decline for unknown reasons, most likely from shooting and/or poisoning incidents. When the last wild bird was taken into captivity in 1987 for its own security and for use in the captive breeding programme, there were only 27 condors in existence (Snyder & Snyder 1989). The efficacy of the photographic censusing method was confirmed by the fact that no condors undetected by Snyder and Johnson (*op. cit.*) turned up after the presumed last free-flying individual was captured. Sadly, the photographic census had accounted for them all.

Successful captive breeding of California Condors began with the production of a single chick (Molloko) at the San Diego Wild Animal Park in 1988 (Kiff 1990). Two more were produced in 1989, four in 1990, and ever increasing numbers annually through the 1998 breeding season, when 20 birds were produced at three captive breeding facilities (Los Angeles Zoo, San Diego Wild Animal Park, and the World Center for Birds of Prey, Boise, Idaho). Since a majority of the birds presently in captivity have not attained the usual breeding age (five-six years), captive production of young may soon show a more logarithmic rate of increase.

The first release of captive-produced condors to the wild was conducted in January 1992, when two chicks hatched in 1991 were released with two similar-aged Andean Condor chicks in the Sespe Condor Sanctuary, Ventura County, California. Subsequently, 14 groups of 2-6 young condors have been released at four sites in California and one in Arizona. Survival of the released birds has been 56% (Kiff, this volume), among the highest rates enjoyed by any similar vertebrate reintroduction programme. The oldest individuals in the wild have been observed engaging in courtship display and are probably forming breeding pairs. By the end of 1998, there were 42 condors alive in the wild, and 105 were housed in the three captive breeding facilities (R. Mesta pers. comm.).

The short-term objectives of the condor programme, which would lead to the consideration of downlisting the species to threatened status, are to establish 150 pairs in at least three self-sustaining populations, being the captive flocks (in aggregate) and two disjunct wild populations, with at least

15 breeding pairs in each of the three groups (USFWS 1996). This goal has nearly been reached with the captive flock, and it is hoped these numbers can also be achieved in the wild over the next decade.

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Lloyd F. Kiff
The Peregrine Fund
566 West Flying Hawk Lane
Boise
Idaho 83709
USA

