HUMAN RELATED MORTALITY OF BIRDS IN THE UNITED STATES

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Abstract

Modern man serves as both a direct and an indirect cause of the death of birds. In the early 1970's, human activity was responsible for the death of approximately 196 million birds per year, or about 1.9% of the wild birds of the continental United States that died each year.

Hunting was the largest direct mortality factor and accounted for about 61% of human related bird deaths. Control or prevention of avian depredations took about 1% of the total, and all research and propagation about 0.5%. Collision with man-made objects was the greatest indirect human cause of avian deaths, accounting for about 32% of the human related deaths. Pollution and poisoning caused the death of about 2% of the total.

A relatively few species account for most of this mortality but continue to maintain large, harvestable populations, suggesting that the numbers of most bird species are essentially unaffected by the human activities discussed. Other activities of man that do not necessarily result in the death of birds but rather reduce reproductive potential are more likely to have long-term effects on avian populations.

The causes of avian mortality are numerous. Such natural factors as predation by other wild animals, disease, severe weather, accident, and even old age, served for eons as agents controlling the size of bird populations. Mortality caused by these factors, although difficult to assess, is considered by ecologists and biologists interested in life history studies and population dynamics.

A report by the American Ornithologists' Union (1975) presents figures leading to estimates of a total breeding season bird population in the United States (exclusive of Alaska and Hawaii) of nearly 10 billion, which is probably doubled to 20 billion with the addition of young in the autumn. If the total breeding population remains stable from year to year, it follows that some 10 billion birds must succumb to one or another mortality factor each year. In most bird species, the highest mortality takes place in the first few months of life; seldom do more than one-third of the passerine birds hatched in a given year become part of a later breeding population (Lack 1954:85). Annual adult mortality may be as great as 60% (Lack 1954:106).

Civilized man, at least in recent years, has taken a place as an agent in avian mortality. Despite the opportunity for philosophical harangue as to the "naturalness" of man as a predator, for the purposes of this paper I consider modern civilized man as a non-natural source of avian mortality. Modern man serves as both a direct and an indirect source of mortality. Directly, he kills wild birds for food, sport, protection of crops and health, and a variety of other reasons. Indirectly, he places deadly obstacles in flight paths, spreads oil on waters, and disseminates poisons or agents of disease. Figures provided in this paper suggest that approximately 1.9% of the normal avian mortality results directly or indirectly from human activities. The various activities of man that result in a lack of productivity of birds, such as destruction of habitat and pollution of the environment, are not considered here as mortality factors.

Contrary to the situation in natural mortality, man's conscience makes it possible to assess, if only in general terms, the extent of direct human related avian mortality. Efforts to protect and manage birds have resulted in a system of allotting permits and licenses

for their controlled killing. Reports required under the permit and license system provide a reasonably accurate estimate of the number of birds killed. Observers of catastrophic events leading to mass deaths have provided a much less accurate measure of indirect mortality.

Even the best data available are not in most instances sufficiently specific to permit an assessment of mortality among individual species of birds. Figures on human related mortality have relatively little meaning without data on total population size and on other mortality factors. The effect of human induced mortality on a population, whether of a species or a class, cannot be evaluated properly without considering the extent to which other human factors have resulted in a perhaps artificial increase in the population, either facilitating, permitting, or necessitating a subsequent reduction of the population (see Murton 1972). Nor can one evaluate human related mortality without knowing the extent to which it replaces or adds to other mortality.

This paper draws together mortality data from various sources so that human related factors can be placed in perspective with one another (cf. Lincoln 1931) and perhaps, eventually, with other mortality factors.

Essentially, the present paper presents the picture as it was in the early 1970's. Work on this project was initiated in 1971, but the report was not put into final form until 1975. In the final editorial process, excellent suggestions were made about new data that could be used to update certain portions of the report. I have refrained from acting on these suggestions because not all parts of the discussion could be updated equally. For example, I am aware that data exist on waterfowl harvest for years beyond 1971, but to my knowledge none exists on the harvest of galliform birds later than those cited here. Reports on birds taken in depredation control and by special permits were not compiled or are not available beyond the years given, and no basis exists for modifying some estimates that are little more than calculated guesses in the first place. I fear that a distorted picture might appear if all data were not based on essentially the same time span. Despite the somewhat dated nature of the paper, it should have some value as a first approximation of its stated purpose.

Direct Mortality

In this category I include factors that result in the death of birds by the deliberate action of man. There are few such factors and most are under some degree of legal control, that is, a permit system. An illegal portion of the direct mortality factors lacks a firm basis for estimation, as does mortality of birds not legally protected and therefore not subject to report.

Hunting

Hunting, without question, causes the most direct human related mortality of birds. During much of man's history, hunting might have been classified with other predatory activity directed toward birds, but now it certainly deserves standing as a mortality factor in its own right. Although the impact on total bird populations may be much greater now than in the time of lower populations of more primitive man, the number of species affected has probably decreased. In the United States, legal hunting is restricted now to birds in five orders (Anseriformes, Charadriiformes, Gruiformes, Columbiformes, and Galliformes) and one additional family (Corvidae). In 1970 there were 14.3 million hunters in the United States (U. S. Bureau of Sport Fisheries and Wildlife [1972]).

Anseriformes

The hunting of ducks and geese in the United States is subject to both Federal and State regulation. Limits are imposed on the regional and total harvest, based on surveys of wintering and breeding populations. Estimates of the harvest of ducks and geese are obtained from hunter surveys, and species composition (as well as age and sex data for each species) is determined from examination of wings and tails sent by hunters to the Fish and Wildlife Service. Data on individual species may be found in the annual waterfowl status reports cited in Table 1. During 1966-71 the average annual harvest including crippling losses in the United States was 15,271,800 ducks and 1,581,800 geese.

Species composition of the waterfowl harvest varies somewhat throughout the years, although the mallard (*Anas platyrhynchos*) is most commonly taken. It is estimated that more than 5 million mallards were harvested in both 1970 and 1971 (Chamberlain et al. 1972). Other ducks for which the estimate exceeds 1 million in either of those years are the American wigeon (*Anas americana*), American green-winged teal (*Anas crecca*), northern pintail (*Anas acuta*), and wood duck (*Aix sponsa*). The Canada goose (*Branta canadensis*) is the most frequently harvested goose, followed by the snow goose (*Chen caerulescens*).

The whistling swan (*Olor columbianus*) was legally hunted in Utah from 1962 to 1970, in part of Nevada in 1969 and 1970, and in part of Montana in 1970. The number of permits issued each year was 1,000 from 1962 to 1968, but increased to 2,500 in 1969 and 3,500

Table 1. *Retrieved and unretrieved harvest of ducks, geese, and coots in the United States, 1966–71.*

Year	Ducks	Geese	American coot	Reference
1966	14,334,500	1,627,100	1,278,100	Martinson et al. 1968
1967	15,077,600	1,315,400	1,041,900	Martinson et al. 1968
1968	9,959,000	1,084,700	594,700	Martinson et al. 1969
1969	15,904,800	1,654,900	1,174,800	Chamberlain et al. 1971
1970	19,215,900	2,101,800	1,603,600	Chamberlain et al. 1972
1971	17,108,800	1,707,100	1,119,000	Chamberlain et al. 1972
Average	15,271,800	1,581,800	1,135,400	

in 1970. According to data compiled by Martin (1971), the average annual harvest in Utah in 1962-68, including crippling loss, was 452 birds. In 1969 and 1970 the average increased to 1,274. Adding estimates for Nevada and Montana for the latter years, the average harvest was increased to 1,650 birds. More recent figures (U. S. Fish and Wildlife Service 1975) show an average harvest in the three States in 1970-73 of 1,130 birds, about one for every three permits issued.

Galliformes

Johnsgard (1973:147) presented estimates of the annual harvest of grouse and quails in the United States exclusive of Hawaii. His total estimate was 47,301,000 birds. The bobwhite (*Colinus virginianus*) led the list with an estimated kill of 35 million birds a year, giving it the second place among game birds in the country. Other important birds in this group are scaled quail (*Callipepla squamata*), ruffed grouse (*Bonasa umbellus*), California quail (*Lophortyx californica*), and Gambel's quail (*Lophortyx gambelii*), each with more than a million individuals harvested annually.

The introduced ring-necked pheasant (*Phasianus colchicus*) is a widespread game bird in the United States, but harvest estimates are difficult to obtain. Estimates from various States compiled by the National Rifle Association of America (Hobart 1972) suggest that the annual national harvest is at least 11 million.

Although the turkey (*Meleagris gallopavo*) was extirpated from much of its original range in the United States, it has been reintroduced in many areas and has once again become an important game bird. Mosby (1967:115) graphed reported harvests of turkeys from 1952 through 1964, and showed an increase from about 46,000 to 90,000 birds. Data compiled by the U. S. Fish and Wildlife Service (1966-71) for years since those reported by Mosby are: 1965, 94,316; 1966, 94,461; 1967, 118,844; 1968, 128,167; 1969, 94,778; 1970, 137,533. The average figure for the last 5 years is about 115,000 which may be used as an approximation of the annual harvest.

Gruiformes

Data for the harvest of American coots (*Fulica americana*) are tabulated by the U. S. Fish and Wildlife Service along with figures for ducks and geese (Table 1). In 1966-71 an average of 1,135,400 coots were taken by waterfowl hunters in the United States.

Information on the harvest of other game species of gruiform birds is not tabulated with the same precision or regularity as data on more important migratory game birds. Questions relating to rails and gallinules (as well as to hunted charadriiform and columbiform species) were included in questionnaire surveys of waterfowl hunters for the hunting seasons of 1964-65 through 1968-69. The resulting data, limitations of which have been thoroughly discussed by MacDonald and Martin (1971), provide the basis for estimates of the harvest of these species in those years. A severe limitation is that the survey covered only hunters who had purchased migratory bird hunting stamps ("duck stamps"), and one must estimate the proportions of the harvest taken by those waterfowl hunters and by other hunters. Consultation with Duncan MacDonald of the U.S. Fish and Wildlife Service led to estimates that 50% of the sora rails (*Porzana carolina*), 60% of the other rails, and 75% of the gallinules were taken by waterfowl hunters. Thus, total harvest figures given in Table 2 for these species have been adjusted from those estimates provided by MacDonald and Martin (1971). Those authors reported that interest in hunting migratory species other than waterfowl was increasing several years ago, and it is unfortunate that more recent data, compiled in a more accurate way, are not available.

Estimates of the harvest of sandhill cranes (*Grus canadensis*) in New Mexico and Texas for 1961-70 have been compiled by Miller et al. (1972), who also provide an estimate for the harvest in other States in 1970. The average annual harvest, including a suggested 30% crippling factor, is about 4,000 birds. More comprehensive data (U. S. Fish and Wildlife Service 1975) that include the Alaska harvest and all years from 1960 through 1972 indicate a harvest, incorporating the crippling factor used above, of about 6,500 birds a year.

Charadriiformes

Figures representing the annual harvest of the common snipe (*Capella gallinago*) and American woodcock (*Philohela minor*), the only legally hunted birds of this order, are, like those for most gruiform species, not as accurate as data for waterfowl. Estimates are based on responses to questionnaires submitted to waterfowl hunters. In estimating the snipe harvest (Table 2), I have assumed that waterfowl hunters account for 75% of the total, and have modified estimates provided by MacDonald and Martin (1971) accordingly.

Table 2. *Estimated harvest of rails, gallinules, and snipes in the United States, 1964-69; data modified from MacDonald and Martin (1971).*

Hunting season	Sora	Other rails	Gallinules	Common snipe
1964-65	81,800	73,870	31,120	512,000
1965-66	62,400	48,140	27,130	350,980
1966-67	75,000	87,480	23,270	377,180
1967-68	59,000	164,000	30,500	521,750
1968-69	30,000	119,850	13,830	454,060
Average	61,850	98,660	25,170	443,190

Using figures apparently based on actual kill reports for several years, Sheldon (1967:122) estimated that more than 500,000 woodcock were shot each year. Goudy (1967:17) extrapolated figures from waterfowl hunter surveys and estimated that 900,000 of this species were taken in the 1965 season. Using similar techniques and assuming that waterfowl hunters account for half the woodcock harvest, Clark (1970), estimated the harvest in the 1968-69 season to be about 1 million. Noting that both the woodcock harvest and the number of woodcock hunters seem to have increased substantially since 1964, Clark (1972, 1973) estimated the United States harvest in the 1970-71 season was 1,375,000.

Columbiformes

It is surprising to many to learn that the mourning dove (*Zenaida macroura*) is the "Number 1" game bird in the United States. Even so, reliable estimates of the annual mourning dove harvest are not readily available. Ruos and Tomlinson (1968:29) cite early estimates ranging from 11 million birds in 1942 to 42.6 million in 1963 and 1964. Using several sources of data, and aware of the limitations of each, Ruos and Tomlinson (1968) suggested that 40.8 million mourning doves were harvested in the United States in 1965.

Cottam and Trefethen (1968) gave figures for estimates of the hunting harvest of white-winged doves (*Zenaida asiatica*) in Arizona for 1961-65, and in the Lower Rio Grande Valley of Texas for 1947-67. Estimates for Arizona ranged from 400,000 to 575,000 birds annually, and averaged 459,000. In Texas the harvest varied between 21,000 and 282,000, and averaged 127,552 for the 17 years in which the season was open. Although the trend in both areas was toward a higher kill in the last years for which data were given, there is no particular reason to believe that the average figures would not apply equally well to more recent years, and for the purposes of the present paper they are considered to be valid estimates.

The white-winged dove is a less important game species in New Mexico and in parts of California and Nevada than in Arizona and Texas. Figures are not available on the harvest in those States. Considering information on the length of the hunting season, bag limit, and geographic restrictions, as supplied by Cottam and Trefethen (1968), I conservatively estimate that the kill in these three States combined might average 25,000 birds per year.

The figures above are based on the results of a variety of mail questionnaires and field checks of hunters, and their accuracy is open to some doubt. They account for the number of birds legally killed, but make no provision for illegal harvest or crippling. Cottam and Trefethen (1968:251) believed that "in Texas, a conservative estimate of the total kill, including unreported, illegal, and over-the-limit birds and those downed and lost by hunters, is at least 50 per cent greater than the number legally and successfully bagged." If that factor applied also to other areas in which this species is hunted, the adjusted overall hunting mortality estimate is about 900,000 birds.

The band-tailed pigeon (*Columba fasciata*) is hunted in several western States. Representatives of these States, along with a representative from the western region of the U. S. Fish and Wildlife Service, form the Western Migratory Upland Game Bird Committee. An unpublished report of this Committee for 1974 gives estimates on the bandtail harvest from most of the pertinent States for the past several years. From 1968 through 1973, including a 10% factor for unretrieved birds, the average annual harvest has been about 423,000 birds.

More recent estimates (U. S. Fish and Wildlife Service 1975) place the total columbid harvest in the United States in 1972 at more than 50 million birds, which is not adjusted for unretrieved kill but includes species and geographic areas outside the limits of this report.

Other Hunting

Crows (*Corvus brachyrhynchos*) may be hunted le-

gally in accordance with regulations of several States. I have no figures on the harvest of this species, which must be insignificant compared with the harvest of the more typical game birds reported above.

Control of Avian Depredation

Birds protected by Federal law may be killed, under permit, for the protection of life, crops, or property. The greatest utilization of depredation permits is in the western States, but a substantial number of permits are also issued in the northeastern States. In 1969-72, an average of 70,469 protected birds were taken under authority of these permits (Table 3).

Only a few groups of birds are involved under control procedures covered by Federal depredation permits; Table 4 lists those reported as taken in greatest numbers. The American coots were taken in the northwestern States, mainly Washington, as were most of the mergansers (both American, *Mergus merganser*, and red-breasted, *M. serrator*). Approximately one-third of the gulls were identified as herring gulls (*Larus argentatus*), the rest being unidentified but probably mainly that species or great black-backed gulls, *Larus marinus*. About 60% of the herons were reported as great blue heron (*Ardea herodias*); the rest were black-crowned night herons (*Nycticorax nycticorax*) and green herons (*Butorides striatus*). A number of egrets were also killed, but these are not tabulated with herons in the reports available to me. It is likely that not all herons were properly identified. Mourning doves are killed to protect aircraft from collision, mainly in the Southwest.

Federal regulations provide that the Commissioner of Agriculture of the State of California may issue permits for the killing of certain migratory birds when necessary to protect agricultural or horticultural crops from depredation. Figures for 8 years are available that indicate the extent of this authorized control work in California (Table 5). These figures are separate from any control activity conducted under the Federal permits discussed above. From 1965 through 1972, an annual average of 1,206,055 birds have been killed under California permits. Three species, the house finch (*Carpodacus mexicanus*), the white-crowned sparrow (*Zonotrichia leucophrys*), and the horned lark (*Eremophila alpestris*) make up all but a small proportion of the birds killed. House sparrows (*Passer domesticus*) may not have been reported in early compilations because they are not protected by Federal law, but were commonly killed in the last 3 report years.

Permits may be issued in California only for the control of certain species, and in general only those species are killed or reported. The accuracy of both the total number and the species composition of the kill is subject to some doubt because of difficulties of identification, and perhaps because of reluctance to report the death of species not covered by the permits. Most control is by placement of poisoned bait, and exact counts of dead birds are not made. The numbers are estimated based on a formula that stipulates 300 birds killed per pound of bait sold; bait is available only through the State. This estimate is predicated on the basis of field observations, autopsy information, and feeding trials conducted with the various species. The figure may be high, but when recommended baiting procedures are followed closely it is achievable and valid (T. K. Palmer, personal communication). As for selectivity, the habitat involved is a monoculture which is attractive to only certain species, and flocks large enough to be a threat to agriculture tend to be homogeneous in species composition. The type of bait used and the manner of its exposure also tend to exclude nontarget species (T. K. Palmer, personal communication).

No permit is required for the killing of blackbirds, crows, and magpies when they are found committing or about to commit serious depredation. Figures are

Table 3. *Federal depredation permits issued and number of birds killed, 1969–72; data from permittees' reports compiled by U. S. Fish and Wildlife Service.*

Permits to protect:	1969	1970	1971	1972	Average
Agricultural crops	260	383	351	399	348
Life and property	143	151	109	84	122
Fish and hatcheries	238	276	281	257	263
Airports	9	13	39	56	29
Other	68	57	66	109	75
Total permits	718	880	846	905	837
Total birds killed	41,420	74,244	77,005	89,209	70,469

Table 4. *Selected species of birds reported killed under Federal depredation permit, 1969–72; data from permittees' reports compiled by U. S. Fish and Wildlife Service.*

Species	1969	1970	1971	1972
American coot	14,992	51,488	43,646	66,526
Mergansers	1,367	1,229	1,097	973
Herons	1,652	909	1,731	1,344
Gulls	6,333	7,222	7,498	4,304
Woodpeckers	115	155	169	35
Mourning dove	—	2,842	3,556	3,246

Table 5. *Birds killed under depredation permits issued by California, 1965-72; data from reports submitted to U.S. Fish and Wildlife Service.*

Year	No. of permits	House finch	Crowned sparrows[a]	Horned lark	Other species[b]	Total
1965	1,421	1,195,185	249,800	286,947	1,810	1,733,742
1966	698	730,593	219,700	199,231	1,400	1,150,924
1967	698	475,195	364,155	205,700	400	1,045,450
1968	830	1,061,455	247,867	522,240	33	1,831,595
1969	711	764,983	270,820	453,500	850	1,490,153
1970	481	708,663	81,975	326,410	49,560	1,166,608
1971	506	216,441	70,107	127,901	112,310[c]	526,759
1972	425	460,803	73,760	79,004	80,244[d]	703,211
Total		5,613,318	1,578,184	2,200,933	246,607	9,648,442
Average		701,664	197,273	275,116	30,825	1,206,055
Percent of total		58.18	16.36	22.81	2.55	

[a]Probably mainly white-crowned sparrows, *Zonotrichia leucophrys,* but not always so specified.

[b]Includes 10 flickers (*Colaptes auratus*) in 1965; 2,900 purple finches (*Carpodacus purpureus*) in 1965 and 1966; 633 western meadowlarks (*Sturnella neglecta*) in 1965-68; 950 goldfinches (*Spinus* sp.) in 1967 and 1969; 1,750 brown-headed cowbirds (*Molothrus ater*) in 1970; and 47,800 blackbirds and 10 woodpeckers, not further identified, in 1970.

[c]Includes 112,225 house sparrows (*Passer domesticus*) and 85 meadowlarks.

[d]Includes 80,065 house sparrows. House sparrows may not have been included in compilations for earlier years because they are not protected by Federal law.

not available on the number of individuals of blackbird species, or of nonprotected species such as the starling (*Sturnus vulgaris*), killed for protection of crops or property each year. The term "blackbirds," as used in Federal regulations, is essentially equivalent to the avian family Icteridae of the Check-list of the American Ornithologists' Union (1957) minus the genera *Icterus, Sturnella,* and *Dolichonyx* and the species *Euphagus carolinus.*

Even excluding blackbirds, it is apparent from the figures reported under Federal permits for 1969-72, and under California permits for 1965-72, that the number of birds killed each year in the United States for the protection of life, crops, and other property is in excess of 1.2 million. With the inclusion of blackbirds the figure would undoubtedly approach 2.0 million.

These figures do not include mortality resulting from control efforts directed toward large mixed flocks of starlings and blackbirds, such as those made in the late winter of 1975 while this paper was in preparation. According to the Smithsonian Institution's Center for Short-Lived Phenomena, more than 2.3 million birds were killed in Kentucky and Tennessee in late February 1975. Such control efforts are now made on an annual basis, and the figure of 2.0 million birds killed annually to prevent depredation or other damage should be doubled, if all data could be updated.

Research and Propagation

The U. S. Fish and Wildlife Service and individual States issue permits for the taking of otherwise protected migratory birds for scientific purposes and for other purposes specified in legislation or regulations. Among the "other" purposes for which permits may be issued are the salvage of birds found dead, taking of birds for aviculture and propagation, and for research on control measures. Holders of permits must annually report any activity carried out under the permit. Compilations of the reports submitted by permittees have been prepared for 1969-72. In those years, an average of 2,746 holders of permits (excluding depredation control permits, discussed above) reported an annual average of about 130,000 birds (Table 6). The figures available are not separated by type of permit, but a partial breakdown is possible by analysis of the lists of species most frequently reported.

Of the 36 species of birds reported in numbers that totaled 800 or more individuals in the 4-year period (Table 7), or an average rate of 200 or more individuals per year, 5 are "blackbirds" and 2 are gulls, on which groups depredation control research was being conducted. These seven species account for more than 76% of all birds taken under permit. Four species of waterfowl (mallard, Canada goose, wood duck, and black duck, *Anas rubripes*), most probably taken for propagation purposes, make up 1.4% of the total, and many other waterfowl species were taken in smaller numbers, probably for the same purpose. Another 1.3% of the total is accounted for by four game species (mourning dove, American woodcock, American coot, and oldsquaw, *Clangula hyemalis*). The oldsquaws were salvaged birds utilized for research.

The remaining birds in Table 7 are mainly small passerine species. There is an amazing similarity between

Table 6. *Analysis of scientific and special purpose permits issued by U.S. Fish and Wildlife Service, 1969–72.*

Year	Permits outstanding	Negative report or no report	Active permittees	No. birds reported	No. birds per active permittee[a]	No. birds per permittee
1969	2,504	1,552	952	119,329	21.6	8.6
1970	2,512	1,465	1,047	132,784	21.6	8.6
1971	3,121	1,605	1,516	196,761	16.7	8.1
1972	2,849	1,752	1,097	71,531	27.3	10.5
Average	2,746	1,593	1,153	130,101	21.8	9.0

[a]Excluding birds taken for depredation control research and those reported in large numbers that are believed to represent salvage. 1969 and 1970 are calculated together because these exclusions are not separable by year.

the passerine species listed in Table 7 and the species that frequently hit TV towers (Table 8), suggesting strongly that birds salvaged from tower kills make up a substantial proportion of those reported under permit requirements. Many of these are reported by holders of scientific collecting permits, others by holders of salvage permits. W. K. Taylor (personal communication) has reported, under his collecting permit, birds salvaged during his study of tower kills in southern Florida. Indeed, the 12 species marked in Table 7 and found also on Table 8 account for 4% of the total birds reported under permit. If other common tower casualties reported in smaller numbers by permit holders are considered, the proportion increases to about 6%, or 7,800 birds per year.

These calculations leave about 15% of the birds reported as taken under permit in 1969-72, or about 19,500 individuals per year unaccounted for. The activities of persons collecting for scientific purposes probably account for most (estimate 15,000) of these, and other permitted activities for the rest.

It should be kept in mind that these figures concern only birds protected by Federal law under terms of the Migratory Bird Treaty Act. In 1972, amendment of the bird protection treaty between Mexico and the United States brought a large number of species under Federal protection that had not previously been covered. Thus, numbers of birds reported as taken under permit after 1972 might reasonably be expected to be higher than those before and including 1972, merely because more species must be reported.

The reports on birds taken under permit do not include all birds killed by the Fish and Wildlife Service in the course of research on methods of control of depredating species, particularly starlings and blackbirds. Experiments with surfactant solutions in Georgia and Ohio on mixed blackbird flocks resulted in the deaths of over 1 million birds in 1969 and 1970; the highest proportion of the birds killed were common grackles (*Quiscalus quiscula*) and starlings (U. S. Bureau of Sport Fisheries and Wildlife 1970, 1971). Other research on control methods performed in western States resulted in an average of 244,900 bird deaths a year in the 5-year period 1966-70, more than 93% of which were starlings (W. C. Royall, Jr., personal communication). Thus, in the most active phase of this depredation control research, about 772,000 birds were killed annually.

Thus, estimates of annual mortality under special permits, including both protected and unprotected (starling) species, can be summarized as follows: research on control of depredating species, 871,000; removal from wild for propagation, 1,820; and scientific collecting (including research on game birds) and other permit purposes, 21,190. The estimated 7,800 salvaged birds reported under permit are in reality part of the estimated mortality related to collisions, discussed later, and are excluded here.

Other Direct Mortality

No information is available on the number of raptors removed from the wild for use in falconry and on other consumptive utilization of birds not (for the time mainly covered by this report) protected by Federal law. Similarly, no data are available relating to the number of birds illegally shot by hunters or others, or the number of birds killed by vandalism (Lincoln 1931) or by the attempted "rescue" of "abandoned" baby birds.

The overall incidence of mortality related to factors not otherwise estimable may be placed arbitrarily at one bird per square mile per year. According to the 1973 edition of the Rand McNally Cosmopolitan World Atlas, there are 3,540,938 square miles of land (exclusive of inland waters and Great Lakes) in the United States, and the estimate of mortality may conveniently be rounded to 3.5 million.

Indirect Mortality

As ways in which man contributes indirectly to

Table 7. *Birds most commonly reported as taken under Federal scientific and special purpose permits,*[a] *1969–72.*

Species	Number of birds reported taken			
	1969–70	1971	1972	Total
Red-winged blackbird, *Agelaius phoeniceus*	139,615	148,602	14,677	302,894
Brown-headed cowbird, *Molothrus ater*	57,218	10,826	11,511	79,555
White-crowned sparrow, *Zonotrichia leucophrys*	3,833	1,986	1,727	7,546
Common grackle, *Quiscalus quiscula*	2,098	2,029	2,690	6,817
White-throated sparrow, *Zonotrichia albicollis*	1,619	581	1,811	4,011
Mourning dove, *Zenaida macroura*	1,952	742	1,173	3,867
*Ovenbird, *Seiurus aurocapillus*	1,144	1,011	1,607	3,762
Horned lark, *Eremophila alpestris*	2,440	607	401	3,448
Mallard, *Anas platyrhynchos*	1,385	1,191	589	3,165
*Yellowthroat, *Geothlypis trichas*	642	1,251	805	2,698
Canada goose, *Branta canadensis*	1,336	712	526	2,574
Rusty blackbird, *Euphagus carolinus*	1,870	520	77	2,467
Herring gull, *Larus argentatus*	1,661	190	316	2,167
*Red-eyed vireo, *Vireo olivaceus*	1,009	523	605	2,137
House finch, *Carpodacus mexicanus*	246	1,078	777	2,101
American robin, *Turdus migratorius*	628	456	986	2,070
Boat-tailed grackle, *Quiscalus major*[b]	261	1,003	752	2,016
Dark-eyed junco, *Junco hyemalis* (includes *J. oreganus*)	595	468	587	1,650
Oldsquaw, *Clangula hyemalis*	531	841	254	1,626
*Blackpoll warbler, *Dendroica striata*	382	719	470	1,571
American woodcock, *Philohela minor*	418	379	708	1,505
*Tennessee warbler, *Vermivora peregrina*	182	165	1,073	1,420
*American redstart, *Setophaga ruticilla*	230	404	784	1,418
Cardinal, *Cardinalis cardinalis*	384	182	649	1,215
*Swainson's thrush, *Catharus ustulatus*	407	416	348	1,171
*Magnolia warbler, *Dendroica magnolia*	338	176	648	1,162
Eastern meadowlark, *Sturnella magna*	316	440	294	1,050
*Black-throated blue warbler, *Dendroica caerulescens*	286	331	394	1,011
Common flicker, *Colaptes auratus* (includes *C. cafer*)	392	328	345	1,065
*Gray catbird, *Dumetella carolinensis*	309	215	481	1,005
*Black-and-white warbler, *Mniotilta varia*	306	301	391	998
Wood duck, *Aix sponsa*	419	230	328	977
American coot, *Fulica americana*	329	234	371	934
Cattle egret, *Bubulcus ibis*	571	76	271	918
Black duck, *Anas rubripes*	106	64	641	811
Ring-billed gull, *Larus delawarensis*	111	375	324	810

[a]*cf. Table 8.
[b]Includes great-tailed grackle, *Q. mexicanus.*

avian mortality, I include a variety of accidental factors related to human activity. In those instances, the death of the birds is not deliberate but is a by-product of some other action. Because of the nature of these deaths, the figures relating to them are estimates with much less reliability than those concerning direct mortality. I have, of course, attempted to make the figures realistic, but I would not be surprised if the error in some instances exceeded 50%.

Collision

Mortality on Roads

Many variables affect the rate at which birds are struck by motor vehicles on roadways. The number of lanes and the nature of the road surface (McClure 1951) are in a general way correlated with traffic density and traffic speed (Murton 1972). The nature of the habitat through which a road runs, and particularly the structure of the adjacent vegetation, plays an important role in determining what birds are near the road and where they may attempt to cross. Finnis (1960) and Hodson (1962) noted that mortality in Britain is high in certain "black spots" where open gates, breaks in hedges or walls, or the proximity of feeding and resting sites, made natural crossing areas. Weather factors may determine day-to-day variation (Scott 1938). Even the time of day at which traffic is heavy may be an important factor; Flickinger and King (1972) found that 33% of avian deaths on a Texas road occurred between daybreak and 0800 hours.

Seasons when bird populations are high or when birds tend to congregate along roads because of the availability of food or grit are particularly important. In Wiltshire, England, Dunforth and Errington (1964) found that 85% of roadside casualties occurred between 1 April and 30 September, and that 38% of these were juveniles. Sargeant and Forbes (1973), Vestjens (1973), McClure (1951), and others who have made long-term studies also report an increased rate of highway mortality during summer months when bird populations are at high levels because of the large number of young. Buss and Swanson (1950) noted that combining in Washington wheat fields forced pheasants to seek other cover during harvest time, and many were attracted to roadsides where grit and spilled grain were plentiful. Mortality was high, but juveniles were not more vulnerable to automobiles than were adults. Dunforth and Errington (1964) banded young birds from nests near roads and found that 7.5% of them were killed by traffic. The mortality rate from this cause varied greatly between species, ranging from 3 to 12% of the banded young where samples were of meaningful size.

Table 8. *Birds most frequently reported as casualties at autumn TV tower kills.*[a] *Position in table determined by relative frequency of casualties and number of stations reporting species.*

Species	Number of stations reporting
Red-eyed vireo *Vireo olivaceus*	9
Ovenbird *Seiurus aurocapillus*	9
Yellowthroat *Geothlypis trichas*	8
Palm warbler *Dendroica palmarum*	7
Magnolia warbler *Dendroica magnolia*	5
American redstart *Setophaga ruticilla*	6
Yellow-rumped warbler *Dendroica coronata*[b]	5
Chestnut-sided warbler *Dendroica pensylvanica*	5
Gray catbird *Dumetella carolinensis*	5
Swainson's thrush *Catharus ustulatus*	4
Bay-breasted warbler *Dendroica castanea*	5
Nashville warbler *Vermivora ruficapila*	4
Blackpoll warbler *Dendroica striata*	4
Black-and-white warbler *Mniotilta varia*	4
Gray-cheeked thrush *Catharus minimus*	4
Northern waterthrush *Seiurus noveboracensis*	4

[a]Data from Taylor and Anderson 1973; Elder and Hansen 1967; Brewer and Ellis 1958; Johnston and Haines 1957; Stoddard and Norris 1967; Tordoff and Mengel 1956; Bureau Sport Fisheries and Wildlife 1971–74; Caldwell and Cuthbert 1963; and Kemper 1959.

[b]Figures are for myrtle warbler only.

Highway mortality may be significant for certain species whose habitat is concentrated near roadways. Road deaths may account for one-eighth of the annual mortality of adult house sparrows in Britain (Hodson and Snow 1965), where a million adult sparrows a year are estimated to be killed in this way. Sutton (1927) investigated the causes of deaths of 113 screech owls (*Otus asio*) to which the public drew his attention in Pennsylvania in a period of about 3 years. Of this total, 82 birds (73%) had been killed by autos. This sample of birds that were relatively easy to discover

Table 9. *Rates of avian road deaths calculated from various studies.*

Study location	Miles of road studied	Birds/mile per year	Reference
Great Britain	349.0	15.1	Hodson and Snow 1965
Wiltshire, England	7.0	60.9	Dunforth and Errington 1964
Northamptonshire, England	2.0	144.0	Hodson 1960
Texas, U.S.A.	4.0	96.25	Flickinger and King 1972
New South Wales, Australia	187.0[a]	87.0[a]	Vestjens 1973
Minnesota, U.S.A.	17.0	6.1	Sargeant and Forbes 1973
New York, U.S.A.	2.1	3.3	Anon. 1973*b*
Maryland, U.S.A.	1.5	5.4	Evenden 1971
Washington, U.S.A.	22.0	2.7	Channing 1958

[a]Distance originally given in km.

and recover is probably not representative of screech owl mortality in general, but it suggests that the automobile may take a fairly high toll of this species in some areas. Scott (1938) also noted high screech owl mortality. Glue et al. (1971) reported that high percentages of band returns of some British species were from birds recovered dead on roads or railways; they listed nine species (including three owls) in which such recoveries made up 12 to 33% of returns. House sparrows, ring-necked pheasants, American robins (*Turdus migratorius*), and song sparrows (*Melospiza melodia*) are often listed as the birds most frequently found in studies of road kills in the United States (Sargeant and Forbes 1973; Evenden 1971; McClure 1951; Channing 1958; Zimmerman 1954; Scott 1938). The same pheasant, the song thrush (*Turdus philomelas*), blackbird (*Turdus merula*), and house sparrow lead the lists in Britain (Hodson 1962; Dunforth and Errington 1964; Hodson and Snow 1965).

If one knows the number of miles of road in an area, and the average annual avian mortality per mile, he can easily calculate the annual toll of birds in any given area. Because of the many variables involved, determination of the annual rate per mile is difficult. A survey in Britain covering 349 miles yielded rates ranging from 0.6 to 177 birds per mile depending on the nature and location of the roads; Hodson and Snow (1965) calculated an average rate of 15.1, which was extrapolated to a national annual total of 2.5 million birds. Studies of shorter stretches of road, which may tend to be concentrated in particularly hazardous areas or on especially dangerous types of road, suggest higher rates (Table 9). Studies that suggest lower rates may merely have been carried out less intensely than those that show high rates. A number of writers have given the number of dead birds found per mile of road traveled, a measure that may or may not be comparable to rates per mile of "stationary" road. Various studies from which rates can be determined in a uniform way, give rates in two different orders of magnitude (Table 9), one ranging from 2.7 to 6.1 and another ranging from 60 to 144 birds per mile per year.

In 1972, there were 3,786,713 miles of road in the United States (Federal Highway Administration 1973). Use of minimum (2.7) and maximum (96.25) annual avian deaths per mile in U.S. studies (Table 9) yields a range of from 10.2 to 374.5 million birds killed per year on our roads. The variables related to kinds of habitat, and other factors are too complex for analysis with the meager information on hand. For the sake of uniformity and comparability, I will use the figure of 15.1 deaths per mile per year used by Hodson and Snow (1965) for Britain (which, incidentally, is considerably lower than the average of five U.S. studies in Table 9) and settle for an estimated annual mortality of birds on U.S. roads of 57.2 million.

Television Towers, Ceilometers, and Other Obstructions

Sporadic mass avian mortality at towers, tall buildings, and airport ceilometers has been reported frequently; a list of 51 such reports was compiled by Velie (1963), most of the events occurring within the previous decade. A number of reports of such mortality are discussed by Orr (1970:244). Johnston and Haines (1957) reported on 25 instances of mass avian mortality occurring between 5 and 8 October 1954 when 106,804 dead birds were recorded in eastern and southern United States. A major cause of that spectacular mortality was a particular weather pattern that affected the entire area in a fairly short period of time.

Most reports of avian mortality at TV towers and similar obstacles are based on single incidents of mass death or, at best, recoveries of dead birds over a short period of time, and they are of little value in establishing an estimate of the number of birds that may be killed on an annual basis under "normal" conditions. That a single instance of spectacular mass mortality may far exceed the normal annual mortality was demonstrated by Overing (1938), who reported the death of 576 birds at the Washington Monument in Washington, D.C., in a single night in 1937 although

the average annual mortality for the preceding 6 years had been 328 birds. Only three studies have come to my attention that have been sufficiently methodical and long-term to provide useful estimates of mortality at tall TV transmission and similar towers. Stoddard and Norris (1967) counted 15,200 dead birds (and estimated 17,000) under a single low television tower in northern Florida in a period of 5¾ years, an average of 2,643 per year. The tower was then replaced by a taller one, and the study continued to a total of 11 years, during which time 29,451 birds were found, an average of 2,677 per year. Taylor and Anderson (1973) studied mortality at a tower in central Florida for three autumn seasons, and found an average of 2,600 birds per year. Biologists of the Bureau of Sport Fisheries and Wildlife studied year-round mortality in 1972-73 at a tall navigational aid tower in North Dakota and estimated mortality at 2,121 in 1972 and 2,177 in 1973, or 2,150 per year. The similarity of these three independently achieved figures is striking, and suggests that the rounded average of 2,500 birds per tower per year is a usable estimate.

According to the Federal Communications Commission (personal communication) there were 1,010 television transmitting stations in the United States on 1 February 1975; no statistical breakdown on height, location, power, and other possibly pertinent factors is available. I have no information on the number of airport ceilometers, radio transmitting towers, obelisks, and other similar obstacles that exist. Interestingly, the many reports of mass mortality that I have scanned or studied are all for incidents in the central or eastern United States; I know of no such reports for phenomena in or west of the Rocky Mountains. Still, if only half the television transmitting towers in the country are so situated that a hazard is presented to migrating birds, annual mortality resulting from birds flying into such obstacles at the rate of 2,500 per year may reasonably be estimated at 1,250,000.

Mortality resulting from flying into obstacles such as those discussed here is concentrated mainly on nocturnal migrants. Analysis of a series of reports that covered long periods of time and large numbers of birds shows that the families Vireonidae, Parulidae, and Fringillidae are most frequently affected (Table 8). Of the 39 species included in the lists of 10 most frequently killed birds in 9 separate studies, only 6 species were in families other than those mentioned.

Picture Windows

Anyone whose interest in birds is known to neighbors sooner or later becomes the recipient of birds that have flown into windows of homes or that have otherwise been found dead in residential areas. Many birds that die in this manner are certainly removed by cats, dogs, or other scavengers. The use of reflective glass, particularly in buildings situated in wooded areas, can result in considerable mortality of birds at certain seasons of the year (Banks 1976).

I am unaware of any information on which an estimate of annual mortality resulting from flying into windows can be based. If we assume the low incidence of one bird per square mile per year, the figure would be 3.5 million.

Other collisions

Birds occasionally fly into fences (e.g., McCarthy 1973; Edeburn 1973), electrical transmission wires, aircraft (Solman 1974), and almost anything else that man places in the air. A newspaper article (Washington Star-News, 26 July 1973) told of a sparrow killed by a tennis ball during tournament play. Bands have been returned from birds hit by golf balls (Lincoln 1931). Annual mortality from all these factors must be rather low.

Pollution and Poisoning

Lead Poisoning

Waterfowl hunters scatter tons of lead shot over wetlands each year. Some of this is ingested by waterfowl, and undoubtedly by other organisms, with lead poisoning an often fatal result. Bellrose (1959) estimated that nearly 25% of the North American mallard population ingests some lead shot, and that 4% of the mallard population in the Mississippi Flyway annually dies from lead poisoning. Bellrose (1959:286) estimated that lead poisoning annually kills between 2 and 3% of the North American waterfowl population. The post-hunting season waterfowl population can be placed at about 80 million birds. A mortality of 2.5% would provide an estimate of 2 million lead poisoning deaths.

I have no information to indicate the number of birds that may succumb to other mortality factors because they are weakened by nonfatal lead poisoning, but it seems likely that such deaths must occur. Bellrose (1959) noted that weakness and fatigue in poisoned mallards reduced their ability to migrate, and that afflicted ducks were more likely to be bagged by hunters than were healthy birds.

Lewis and Legler (1968) noted that 1% of a sample of mourning doves taken in Tennessee had ingested lead shot. These birds had been harvested on fields managed for public hunting. Soil samples revealed the presence of more than 43,500 lead shot per acre in the

upper 3/8 inch of soil; an additional 52,000 shot per acre were found in the next 3 inches of soil. Susceptibility of doves to lead poisoning is not known; this amount of lead in the soil may pose a hazard to all ground-feeding birds. Individual cases of lead poisoning have been reported in a number of species of game birds, and may be a much more important mortality factor than is presently suspected.

Oil Spills

Oil spills are most often considered marine or coastal events, resulting from accidental or deliberate discharge of oil from ships, or occasionally, from offshore production facilities. Similar results can occur on inland waters or on land, however, when tank trains or trucks overturn and when pipelines rupture or are vandalized. Depending on location, time, weather, and type of oil product spilled, avian mortality may range from none or only a few birds to many thousands. Actual mortality on water is seldom determined because of the difficulty of recovering dead birds, which may drift away. If oiling is light, some birds may fly a considerable distance before death occurs.

The Smithsonian Institution's Center for Short-Lived Phenomena recorded 9 oil spill events in the United States in 1970, 9 in 1971, 11 in 1972, 14 in 1973, and 29 in 1974. Estimates of avian mortality, when available, ranged from none to 30,000-50,000 for individual events. The latter estimate was for bird deaths caused by an oil spill off the Alaska Peninsula in April 1970. Other large estimates were 10,000 birds killed near Kodiak Island, Alaska, in February 1970, and 5,000-10,000 birds at Soda Lake, Wyoming, in April 1973, the result of a pipeline rupture. An oil spill in San Francisco Bay, California, caused the death of an estimated 20,000 birds in January 1971 (Smail et al. 1972).

Large oil spills that kill large numbers of birds can have drastic effects on local populations, but most spills produce relatively low levels of mortality that is often spread among many species. The fortunate fact that large spills, until now, have been infrequent in our waters makes an estimate of annual mortality rather tenuous. If small spills take a total of 5,000 birds per year and large spills occur about every 2nd year, an annual average figure of 15,000 deaths is probably reasonable.

Oil Sumps

An oil sump is a pit or excavation in which fluids produced attendant to oil or gas field operations are collected or stored. Sumps vary in surface area from a few square feet to several acres. Typically they are filled with waste water covered with a layer of oil, from a thin skim to several inches in depth. Such sumps occur in oil fields throughout the country. Because they have the general appearance of ponds, these sumps are particularly attractive to water birds (and also to other wildlife), many of which become fatally oiled or entrapped.

Wildlife losses have undoubtedly occurred in oil sumps since oil fields came into existence. The extent of the problem first became apparent in California shortly after World War II, but it was not until the mid-1960's that significant corrective action was taken (unpublished reports, California Department of Fish and Game). By the mid-1970's, legal and legislative action at both State and Federal levels had some effect in reducing the number of sumps and their attractiveness to wildlife, and thus reduced the mortality resulting from them.

Avian mortality in oil sumps in the San Joaquin Valley of California has been estimated at 150,000 birds per year (Anon. 1973*a*). Data or estimates for other areas are not available, but similar sumps occur in many other States. Somewhat similar hazards may occur as a result of certain methods of coke production, as well. The extent of the overall mortality has not, to my knowledge, been documented, but certainly it is greater nationwide by a factor of 10 than that estimated for the San Joaquin Valley. Thus for present purposes the figure of 1.5 million may be used as a low, and probably very conservative, estimate.

Other Poisoning and Contamination

The use of pesticides and herbicides has had drastic effects on certain local bird populations in the past 2 decades, and has been linked to reproductive failures that further reduce populations (Hickey 1966; Stickel 1968). I am unaware of data that can be used for extrapolation to an annual mortality of birds directly related to pesticides and similar materials. Birds occasionally are attracted to poisoned baits placed for control of mammalian predators. Avian predators and scavengers may occasionally die as a result of feeding on the carcasses of poisoned mammals.

Banding Casualties

About 1 million birds are banded each year. Officials of the Bird Banding Laboratory of the U. S. Fish and Wildlife Service (personal communication) estimate that there is about 1% mortality among birds captured for banding, or approximately 10,000 birds.

Other Indirect Mortality

One can easily think of a number of ways in which man or his activities causes the death of birds. Electrocution by power transmission lines results in the death of large birds of prey in western States (Laycock 1973), and an amazingly large number of birds may be killed by electric fences (Stewart 1973). Birds may become entangled in commercial fishing nets (Tull et al. 1972) or sport fishing lines (Tarshis 1971) or may be trapped in buildings. Domestic pets probably take large numbers of birds, especially of ground-nesting species; George (1974) documented that domestic cats may be effective competitors of rodent-eating hawks, and suggested that they may remove 2.5 billion non-mammalian vertebrates from U. S. populations each year. Undoubtedly nests and their contents, and some sitting birds, are destroyed during haying and logging operations. Small mammal traps set by mammalogists (personal observation) and steel traps set by professional fur trappers (Laycock 1973) occasionally catch birds. Lincoln (1931) discussed several of these factors.

If one assumes again an average annual incidence of one bird death per square mile for all these miscellaneous factors combined, the estimate is 3.5 million in the United States.

Discussion and Summary

Estimates of avian mortality resulting from various human activities discussed above are summarized in Table 10 and Fig. 1, from which the relative importance of the factors can be determined. Hunting, for which the data are most nearly accurate, is the primary human related mortality factor for birds (although the completeness of hunting data may result in overemphasis of this factor). Collision with man-made objects, for which fairly firm bases of estimation exist, is second in importance. These two factors account for about 90% of the avian mortality documented here.

It is evident from Table 10 and figures given earlier that human related bird mortality is unevenly distributed among the species of birds in the United States. Hunting is concentrated on members of three orders and a few species in three other orders, but accounts for about 60% of the total mortality. Even among the hunted birds, four species—mourning dove, bobwhite, ring-necked pheasant, and mallard—account for about 40% of the total mortality and 75% of the hunting mortality. Further, these and other hunted species are also affected by the other mortality factors listed. The nongame bird most subject to human related mortality is probably the starling, taken in depredation control and control research; the red-winged blackbird is a close second.

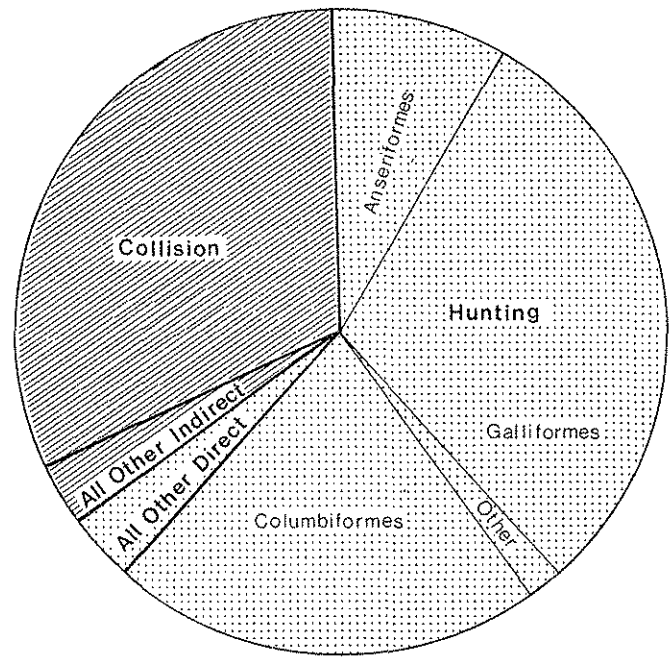

Fig. 1. Diagrammatic representation of relative importance of human activities to bird mortality. Individual factors grouped as "all other direct" and "all other indirect" project wedges too small for separate plotting.

The least important human related mortality factors are removal from the wild for propagation purposes (which obviously is mortality only relative to the wild population), accidental death related to banding activities, spillage of oil, and the taking of birds for scientific research and other permitted purposes which cannot be separated at present.

The fact that just a few species account for most of this mortality and yet continue to maintain large, harvestable populations suggests that populations of most bird species are essentially unaffected by the human activities discussed. Other activities of man that do not necessarily result in the death of birds but rather reduce reproductive potential, such as habitat alteration and environmental contamination, are much more likely to have long-term effects on avian populations.

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Table 10. *Summary of estimates of annual avian mortality related to human activity.*

Mortality factor	Number of birds and % of total deaths	Number and % (in parentheses) of total deaths[a]
Hunting		
Anseriformes	16,854,730 (8.60)	
Galliformes	58,416,000 (29.81)	
Gruiformes	1,327,580 (0.67)	
Charadriiformes	1,818,190 (0.92)	
Columbiformes	42,123,000 (21.49)	
Subtotal		120,539,500 (61.50)
Depredation control		2,000,000 (1.02)
Research and propagation		
Depredation control research	871,000 (0.44)	
Propagation	1,820 (0.00)	
Scientific research and other permit purposes	21,190 (0.01)	
Subtotal		894,010 (0.46)
Other direct mortality		3,500,000 (1.79)
Pollution and poisoning		
Lead poisoning	2,000,000 (1.02)	
Oil spills	15,000 (0.00)	
Oil sumps	1,500,000 (0.77)	
Subtotal		3,515,000 (1.79)
Collision		
Roads	57,179,300 (29.18)	
TV towers, etc.	1,250,000 (0.64)	
Picture windows	3,500,000 (1.79)	
Subtotal		61,929,300 (31.60)
Banding casualties		10,000 (0.00)
Other indirect mortality		3,500,000 (1.79)
Total		196,887,810 (100)

[a]Percentages do not total exactly because of rounding.

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