OTHER ISSUES AND THREATS

The Important Bird Area (IBA) Program

What is an IBA?

Important Bird Areas are sites that provide essential habitat to one or more species of birds during some portion of the year (i.e. nesting areas, crucial migration stop-over sites, or wintering grounds). IBAs may be a few or even thousands of acres, but usually are discrete sites that stand out from the surrounding landscape. IBAs may include public or private lands, or both, and they may be already protected or not.

Goals of the IBA Program

- **Identify** the most essential areas for birds.
- **Monitor** those sites for changes to birds and habitat.
- **Conserve** these areas for long-term protection of biodiversity.

A Brief History of the IBA Program

The IBA Program began as an initiative of BirdLife International. In 1989, *Important Bird Areas in Europe* was published, cataloging over 2,000 sites in 32 countries. These IBAs have become long-term conservation priorities, and steps have been taken to protect many of them.

In the U.S., the IBA Program began as a partnership of the National Audubon Society and Birdlife International. Audubon has focused on establishing state IBA Programs; the first was launched in Pennsylvania in 1995, and subsequent programs have been started in 43 states with planning in 7 others. IBA Programs are expected to be in progress for all 50 states by the year 2005.

By involving birders and other volunteers in the process of identifying IBAs, the program aims to create grassroots support for conservation initiatives. This has paid off in such victories as the passage of a state law in New York in 1997 to designate IBAs on state lands and manage those areas for birds and their habitats, potentially safeguarding nearly a million acres of state-owned lands. Specific sites have also received funding and other support thanks to their designation as Important Bird Areas. In Pennsylvania, IBAs are given priority (10 points) for open-space funding.

The Technical Review Group

The Technical Review Group has the responsibility of setting state criteria for IBA status, recommending sites that are strong candidates and matching them with potential nominators, and reviewing nomination of sites for designation as IBAs. The main purpose of the committee is to review nominations and vote on acceptance of these sites as IBAs. Nominations for a particular area will be sent to the committee member that lives in that part of the state or that has special knowledge of the nominated site.

The Conservation Committee

The conservation committee has the broad vision to serve as the technical committee of bird conservation in Wyoming. The goal of this committee will be to proactively guide Audubon's conservation and restoration efforts on the ground. The committee will be set up to advise and assist Audubon's Conservation Coordinator with focusing and prioritizing the conservation of bird species and their habitats in Wyoming. Therefore, the committee will be an assemblage of experts on bird species, Wyoming habitat types, range conditions and grazing protocol, endangered and threatened species, and plant species.

Objectives of the Conservation Committee:

- Prioritize IBA sites for conservation efforts (help with grant prioritization).
- Identify the bird species in Wyoming most in need of Audubon's conservation efforts and advice concerning restoration and conservation actions to be taken by Audubon.
- Identify the habitats in Wyoming most in need of Audubon's conservation efforts and advice concerning restoration and conservation actions to be taken by Audubon.
- Advise the Conservation Coordinator concerning avian research needs in Wyoming.
- Provide expertise on bird species and habitats when devising restoration, conservation, management and/or research plans.

Status of the Wyoming IBA Program (as of February 2003)

Accepted Sites

Beck Lake/Alkali Lake	Federal, State, and Private
Bird Island	Federal
Breteche Creek Ranch	Federal and Private
Chapman Bench	Federal
Canyon Creek	Federal, Private
Edness Kimball Wilkins State Park	State
Grand Teton National Park	Federal

Heart Mountain	Federal, State, and Private
Jackson Canyon Ranch	Federal, State, and Private
Laramie Greenbelt	City
Laramie Plains Lakes	Federal, State, and Private
Loch Katrine	Federal
Lions Park	City
Ninemile Draw	Federal, State, and Private
Pathfinder National Wildlife Refuge	Federal
Powder Rim	Federal
Red Canyon Ranch	Federal, State, and Private
Seedskadee National Wildlife Refuge	Federal
Shamrock Hills Raptor Area	Federal
Soda Lake Wildlife Habitat Mgmt. Area	State
Soda Lake, Yant's Puddle	Private
Sweetwater River Project	Federal, State, and Private
Tensleep Preserve	Federal, State, and Private
Wyecott Pinedale Ranch	Private
Wolf Creek Ranch	Private
Yellowstone National Park	Federal
Yellowtail Wildlife Habitat Mgmt. Area	State

Total Sites: 27

For more information on the Important Bird Areas program throughout the U.S., refer to the following web sites:

- Audubon's IBA home page www.audubon.org/bird/iba/index.html
- American Bird Conservancy's IBA home page http://abcbirds.org/iba/

Shade-grown Coffee

The Conservation Coffee Campaign. (Excerpted from "The Conservation Coffee Campaign Organizers Kit", available from the Rainforest Alliance, 212-677-1900.)

Introduction

Coffee is a naturally shade-loving species, and it can grow in relative harmony with natural ecosystems. Coffee originated in the rainforests of eastern Africa (modern day Ethiopia), growing under the shade of the rainforest canopy. Today, some of the highest quality coffee in the world is grown throughout the middle altitudes of northern Latin America, from Colombia to Mexico. Forests in these altitudes are home to many people who make their living in the coffee industry, and also to a diversity of wildlife, including hundreds of species of resident birds and the Neotropical migrants that spend the non-breeding season in these areas.

The shade-grown coffee available today is grown under the canopy of the forest. Shaded coffee farms range from "rustic", with coffee bushes as part of the understory, to highly managed plantations with exotic species (usually crop trees) serving as shade cover that simulates a natural forest.

The Problem

Migratory bird diversity is abundant in the tropics at elevations between 1,600 and 6,500 feet (500 and 2,000 m). These are also the elevations where coffee is grown and development occurs. Considerable changes have occurred in coffee farming over the last 25 years. In many parts of Latin America, some farmers who once grew coffee under the shade of native forests have converted to full-sun, higher yield but chemically intensive coffee varieties, which have adverse impacts on wildlife and the environment. While the higher yields tempt farmers to convert to full-sun coffee plantations, this farming method removes centuries-old forests, which destroys habitat for birds and other wildlife, reduces the land's biological diversity, and increases soil erosion. Once the forest canopy is removed, crops are more susceptible to pests and disease and, therefore, require constant doses of fertilizers and pesticides.

Coffee plantations constitute 44% of permanent cropland in northern Latin America, accounting for about 7 million acres (2.5 million ha). Unfortunately, the majority of coffee plantations in Brazil, Colombia, and Costa Rica have already been cleared of trees. For example, the central Andes of Colombia are entirely deforested within the mid-elevations, and development is spreading rapidly to eastern and western areas of the Andes. Ironically, even though full-sun coffee plantations are more expensive to maintain and cause environmental degradation, government agencies often subsidize the transition because they fail to make the "coffee connection".

The Solution

Observations from the 1930s and studies since the 1970s have shown a clear connection between coffee and songbirds. For example, in Chiapas, Mexico, biologists found that shade-grown coffee farms have considerably more birds (more than 150 species) than other agricultural systems and compare favorably with native forest habitat. Also, the Smithsonian Migratory Bird Center found 94 to 97% fewer bird species in full-sun coffee farms than on shaded coffee farms. Scientists have also surveyed other wildlife in shade-grown coffee farms and coffee farms managed other ways and concluded that traditional shade-grown coffee farms host high levels of biodiversity, while the new, full-sun coffee farms are virtual "biological deserts".

There are about 250 species of birds that breed primarily in the temperate region of North America and winter mainly in the tropics. The coffee/songbird connection is about species like warblers, orioles, tanagers, flycatchers, vireos and their forest dependant cohorts, sparrows, and thrushes. Some of these species are clearly in decline, while the status of others is being studied and debated.

Buying shade-grown coffee is perhaps one of the simplest things a North American citizen can do to protect wildlife habitat. The collective power of consumers paying slightly more for certified shade-grown coffee will help provide Latin American coffee growers incentive to maintain their traditional, more environmentally compatible coffee farming. The sample of resources listed below will help you get started.

- The Conservation Coffee Campaign-Organizers Kit (e-mail: eco-ok@ra.org)
- Café Canopy www.shade-coffee.com
- CaPulin www.capulincoffee.com
- Counter Culture Coffee www.counterculturecoffee.com
- Kalani Organica www.kalanicoffee.com
- Royal Blue Organics www.cafemam.com
- Ruta Maya Coffee Company www.rutamaya.net
- Thanksgiving Coffee Company www.thanksgivingcoffee.com
- The Green Culture www.greenculture.com/ps/pp_coffee.html
- Equal Exchange www.equalexchange.com

Pesticides

When it Comes to Pesticides, Birds are Sitting Ducks. (Fact sheet No. 8, written by Mary Deinlein, Smithsonian Migratory Bird Center, and reprinted with permission.)

The word pesticide is a catch-all term for chemicals that kill or control anything that humans have deemed to be a pest. Such chemicals can be grouped according to the kind of organism targeted, such as insecticide (insect), herbicide (weed), fungicide (fungus), or rodenticide (rodent). Most pesticide compounds in use today are synthetic; that is, they are man-made concoctions produced in a laboratory. A danger inherent to the use of synthetic poisons is that once the chemicals are released into the environment, they may harm unintended victims and have unanticipated effects.

On a global scale, over five billion pounds of conventional pesticides are used annually for agricultural purposes, forest and rangeland management, and disease control, as well as in homes, and on lawns, gardens, golf courses, and other private properties. Twenty percent of this total volume, or 1.2 billion pounds, is used in the United States alone. What does this massive chemical dousing of the earth mean for the health of the environment? Birds provide some of the answers.

Population declines and extensive mortality of birds strongly indicate that the health of the environment, and thus the health of organisms that depend on it, suffers due to the prevalence of pesticides. From songbird declines beginning in the 1940s, to population crashes of Peregrine Falcons, Ospreys, and other predatory birds first detected in the 1960s, to the more recent deaths of over 5% of the world's population of Swainson's Hawks during the winter of 1995, birds have been unwitting victims of pesticide contamination.

In 1962, Rachel Carson's eloquent and best-selling book, "Silent Spring", drew international attention to the environmental contamination wrought by pesticides, particularly the insecticide DDT. Carson cited declines in the number of songbirds due to poisoning as a key piece of evidence.

Six years later came documentation of a more insidious effect of pesticide use. Accumulations of DDE, a compound produced when DDT degrades, were causing reproductive failure in several species of predatory birds, including Peregrine Falcons, Brown Pelicans, Osprey, and Bald Eagles. Not only was DDE toxic to developing embryos, it also caused eggs to be laid with abnormally thin shells. So fragile were the shells that the eggs would easily break under the weight of the adult bird during incubation.

DDT belongs to a class of insecticides known as organochlorines, which also includes dicofol, dieldrin, endrin, heptachlor, chlordane, lindane, and methoxychlor, among others. Some of these pesticide ingredients, such as dieldrin and heptachlor, are poisonous in very small amounts. However, the most dangerous traits of the organochlorines are their persistence—that is, their tendency to remain chemically active for a long time—and their solubility in fat, which means they become stored in fatty tissues within organisms and can accumulate over time. Because of these two traits, contaminant levels become more concentrated with each step up in a food chain—a process known as biomagnification. For example, when Ospreys repeatedly feed on fish contaminated with DDT, increasing amounts of the pesticide are stored within their bodies. Biomagnification accounts for why predatory birds, being at the top of the food chain, are most severely affected by organochlorine pesticides.

Thanks partly to the fervor generated by Carson's book and partly to a study done by the National Institutes of Health which found DDT or its by-products in 100% of the human tissues it examined, DDT and most other organochlorines were banned for use in the United States in the early 1970s. Since the ban, numbers of the more severely affected bird species have slowly recovered. However, the fate of some populations of Peregrine Falcons remains uncertain because DDT, its breakdown products, and other organochlorines are still prevalent in the environment.

If DDT was banned in the United States in the early 1970s, why is there still a problem today? One reason is that the United States continues to export DDT, along with other pesticides known to be hazardous to the environment and to human health. The countries of Latin America, the wintertime destination for many of the migratory birds that breed in the United States and Canada (including many Peregrine Falcons), are also the destination for many of these exported pesticides.

Because of the ban on DDT and the tight restrictions placed on other organochlorines, a new arsenal of pesticides predominates today. Organophosphates and carbamates are now two of the most common classes of active ingredients found in pesticide products. Although organophosphate and carbamate compounds are not as persistent as the organochlorines, they are much more acutely toxic, which means that even very small amounts can cause severe poisoning.

It is estimated that of the roughly 672 million birds exposed annually to pesticides on U.S. agricultural lands, 10%—or 67 million—are killed. This staggering number is a conservative estimate that takes into account only birds that inhabit farmlands, and only birds killed outright by ingestion of pesticides. The full extent of bird fatalities due to pesticides is extremely difficult to determine because most deaths go undetected.

Nevertheless, sobering numbers of dead birds have been documented. For example, in 1995, the pesticide monocrotophos, sprayed to kill grasshoppers, was responsible for the deaths of at least 20,000 Swainson's Hawks in Argentina. Thanks to the efforts of the American Bird Conservancy and other organizations, Novartis (formerly Ciba-Geigy), a major manufacturer of monocrotophos, has recently agreed to phase out the production and sale of this pesticide.

Over 150 bird "die-offs", involving as many as 700 birds in a single incident, have been attributed to diazinon, an organophosphate insecticide commonly used for lawn care. In 1990, diazinon was classified as a restricted ingredient, and banned for use on golf courses and turf farms, marking the first time regulatory action has been taken specifically on behalf of birds. However, in most states diazinon is still available over the counter for use on home lawns and parks. So, despite the restricted-use status, as much as 10 million pounds of diazinon are still used yearly in the United States, primarily by homeowners. Continued reports of bird fatalities, and additional evidence concerning the extreme toxicity of diazinon and its metabolites to aquatic invertebrates and mammals have prompted the U.S. Fish and Wildlife Service and a consortium of environmental organizations headed by the Rachel Carson Council to petition the Environmental Protection Agency to further restrict uses of diazinon.

In 1989, the Environmental Protection Agency reported that carbofuran was estimated to kill at least 1 to 2 million birds in the United States each year. This carbamate pesticide was introduced in the mid-1960s, but it wasn't until 1994 that any regulations were imposed on the manufacturer, FMC Corporation. Granular forms are now banned for most uses because of widespread bird kills, although about 2 million pounds in liquid form are still used in the U.S. each year.

So far, about 40 active ingredients in pesticides have been found to be lethal to birds, even when used according to the instructions on the label. Only about a quarter of these ingredients have been banned in the United States, and most are still used elsewhere. The active ingredients that have proven to be deadliest to birds include diazinon, phorate, carbofuran, monocrotophos, isofenphos, chlorpyrifos, aldicarb, azinphos-methyl, and parathion.

Ingestion is probably the most common way that birds are exposed to pesticides. Birds can swallow the pesticide directly, such as when a bird mistakes a pesticide granule for a seed, or indirectly, by consuming contaminated prey. They may also ingest pesticide residues off feathers while preening, or they may drink or bathe in tainted water. Pesticides can also be absorbed through the skin, or inhaled when pesticides are applied aerially.

Whether or not a bird is harmed as a result of pesticide exposure depends on a number of factors, including the toxicity of the chemical(s), the magnitude and duration of exposure, and whether the exposure is recurrent. Potential harmful effects range from imminent death due to acute poisoning to a variety of so-called “sub-lethal” effects, including the following: eggshell thinning, deformed embryos, slower nestling growth rates, decreased parental attentiveness, reduced territorial defense, lack of appetite and weight loss, lethargic behavior (expressed in terms of less time spent foraging, flying, and singing), suppressed immune system response, greater vulnerability to predation, interference with body temperature regulation, disruption of normal hormonal functioning, and inability to orient in the proper direction for migration. Each of these sub-lethal effects can ultimately reduce populations as effectively as immediate death, since they lower birds’ chances of surviving or reproducing successfully, or both.

Pesticides can also affect birds indirectly by either reducing the amount of available food or altering habitat. Birds that eat insects are literally at a loss when insecticides cause a drop in the number of insect prey available, especially when they have young to feed. The breeding season of many birds has evolved to coincide with peaks of insect abundance. Unfortunately for them, peaks in insect abundance also mean peaks in insecticide use.

Herbicides, too, can lead to decreases in insect availability by eliminating weeds on which insects live—a chain of events responsible for sharp declines of Gray Partridges in the United Kingdom. The food supply of birds that eat the seeds of weeds can also be reduced by herbicides. In Britain, Linnets, a type of seed-eating finch, have gone from being a rather common bird on agricultural lands to an extremely rare one due to this type of indirect herbicide effect.

Another way that herbicides can harm birds is by reducing the amount of plant cover available for predator avoidance and nest concealment. For example, herbicides have been used extensively in the western United States to convert sagebrush habitat into cattle pastures. This loss of sagebrush has caused declines in Brewer’s Sparrows, which require the cover provided by the plant for nesting.

Birds that breed in the United States and Canada and winter in Latin America and the Caribbean are potentially exposed to more pesticides than are resident birds, given the great distances over which they travel. Whereas the regulatory process for protecting the environment and human health in the United States may not be exemplary, conditions are generally worse in most Latin American countries where there are few regulations banning or governing the sale and use of pesticides. Therefore, resident birds and birds that over-winter in these countries, not to mention the people who live there, have a greater likelihood of exposure to harmful pesticides.

Pesticide contamination is often cited as one of the factors responsible for declining numbers of some Neotropical migratory birds, and yet so far there is very little hard evidence to support this claim. This lack of evidence does not necessarily mean that pesticides are not contributing to the declines; more likely it is testimony to the difficulty of detecting the role of pesticides in causing death or reproductive failure.

It has been shown that exposure to acephate, an organophosphate, can interfere with an adult bird’s ability to orient itself in the proper direction for migration. Who knows how many vagrants (birds that are seen far from the range which is normal for their species) sighted off course each year have been disoriented by pesticides? Or, how many migrants don’t make it to their right destination for this same reason?

When fat reserves are rapidly used up, as can occur during migration, enough accumulated organochlorine pesticides can be “liberated” within the body to cause death. Who knows what proportion of the birds that die during migration are victims of pesticide poisoning?

The same sorts of questions can be posed regarding the numbers of young birds that do not survive each year. How many were in nests that were inadvertently sprayed with pesticides, or were fed contaminated food, or did not receive enough food because pesticides reduced the number of available insects?

It is often difficult, if not impossible, to tease apart the many factors making life more and more difficult for migratory birds and to determine the relative contribution of each factor to population declines. Accordingly, the role that pesticides play remains unexplained. It stands to reason, however, that as the amount of wildlife habitat continues to dwindle and the quality of what remains takes on an even greater significance, anything that compromises that quality could be the proverbial straw that breaks the camel’s back.

As evidence mounts regarding links between pesticide exposure and rates of sterility, cancers, hormonal disruption, and immune system disorders in humans, should we heed the warning signs provided by birds, or continue to pay the high environmental and social costs of rampant pesticide use? Here are a few thoughts and figures to consider. The benefits of pesticides are often cited in terms of their contribution to world food production, and yet it is estimated that crop losses to pests would increase only 10% if no pesticides were used. Between 1945 and 1989, pesticide use in the U.S. increased tenfold and yet crop losses doubled from 7 to 14%. Consider also that all of us, everywhere, are exposed to some pesticide residues in food, water, and the atmosphere. Residents of the United States eat an estimated 2 billion pounds of imported produce tainted with banned pesticides each year.

Scientist Paul Ehrlich has compared pesticides to heroin in that "they promise paradise and deliver addiction". Pesticide use leads to dependency by killing not only the targeted pests but also the natural predators and parasites of those pests and through the development of resistance in the pests. The destruction of natural enemies and increased resistance are countered by heavier and more frequent pesticide applications, thus maintaining the "pesticide habit" and increasing the costs of supporting it.

Honey bees and wild bees are among the victims of pesticide poisoning and their numbers are on the wane, a fact that is gaining increasing attention because of their economic, ecological, and agricultural importance as pollinators. With something as fundamental as the birds and the bees at stake, shouldn't we all be concerned?

If you want to help reduce global contamination and its costs, here are some things you can do:

- Educate yourself and others about the effects of pesticides and alternative pest control methods.
- Buy organically grown products.
- Support organizations working to reduce society's dependence on pesticides.

Here's where to go for more information:

- Northwest Coalition for Alternatives to Pesticides, P.O. Box 1393, Eugene, OR 97440; 541-344-5044; www.efn.org/~ncap.
- Pesticide Action Network, 116 New Montgomery, Suite #810, San Francisco, CA 94105; 415-541-9140; www.panna.org/panna.
- Rachel Carson Council, 8940 Jones Mill Road, Chevy Chase, MD 20815; 301-652-1877; www.members.aol.com/rccouncil/ourpage/rcc_page.htm.

Suggested reading:

- Gard, N., and M. Hooper. 1995. An assessment of potential hazards of pesticides and environmental contaminants. Pages 294-310, *in* T. Martin and D. Finch, editors. Ecology and Management of Neotropical Migratory Birds, Oxford University Press.
- Pimentel, D. et al. 1992. Environmental and economic costs of pesticide use. Bioscience Vol. 42, No. 10, November 1992.
- Stinson, E., and P. Bromely. 1991. Pesticides and Wildlife: A Guide to Reducing Impacts on Animals and Their Habitat. Virginia Department of Game and Inland Fisheries, Publication No. 420-004.
- Williams, T. 1997. Silent Scourge. Pages 28-35, Audubon, January - February 1997.

Effects of Pesticides and Contaminants on Neotropical Migrants. (Excerpted from Gard et al. 1993.)

Introduction

Substantial quantities of pesticides and industrial contaminants are released into the environment every year, both intentionally and accidentally. Migratory birds are potentially exposed to a wider range of pollutants than non-migratory species, as their annual movements can bring them into contact with pollutants in breeding and wintering regions and on migration routes. However, our understanding of the contribution of pesticides and pollutants to population declines of Neotropical migrants is hindered by a lack of knowledge on the extent to which migrants are exposed to these chemicals and the importance of pollutant-induced changes in mortality and reproductive success relative to other natural or human-caused factors which may also affect population size.

Modes of Expression of Toxic Effects

Pesticides and contaminants exert their toxic effects on birds in varying manners depending upon their chemical nature, environmental persistence, mode of action, and methods by which they are metabolized in birds. Toxic effects are either expressed acutely (brief exposure usually resulting in direct mortality), chronically (a long period of uptake of small amounts of a toxicant usually resulting in reproductive or behavioral changes, immunological impairment, carcinogenesis, and teratogenesis), directly (changes induced in a bird following exposure, such as increased mortality, decreased reproduction, increased susceptibility to predation, and behavioral impairment), or indirectly (responses to pesticide-induced changes in food resources, habitat structure, and predator or competitor abundance).

Contaminants of Concern

There are 5 major classes of environmental contaminants which may be most likely to affect Neotropical migrants: 1) Organochlorine pesticides and related industrial contaminants. These compounds typically have low acute toxicity, and the greatest risk to wildlife is due to their chemical stability, which confers prolonged environmental persistence. 2) Organophosphorus and carbamate insecticides. These compounds are widely used in North America for insect pest control in agricultural, rangeland, and forestry applications, and use in Latin American countries is increasing. These compounds generally have low environmental persistence, but their acute toxicity has resulted in numerous avian die-offs. 3) Herbicides. These are generally non-toxic to birds, but can have a severe impact on avian populations since they produce extensive habitat modification. Furthermore, it may take years for habitat alterations to have their greatest effect on bird populations. 4) Acidic precipitation. Acid-stressed ecosystems are likely to impact birds indirectly through changes in habitat structure or prey availability, and directly through the bioavailability of toxic metals such as mercury, aluminum, cadmium, and lead. 5) Metals. These have the ability to bioaccumulate through food chains, especially in aquatic systems. Of greatest concern are mercury, cadmium, aluminum, lead, and selenium. Dietary exposure can lead to reproductive dysfunction, increased susceptibility to disease, or mortality.

Monitoring Techniques

We currently lack sufficient information to satisfactorily evaluate the effects of toxicants on population dynamics of songbirds. Several non-lethal monitoring techniques can provide useful information. Blood samples can be obtained from birds captured in mist nets and analyzed for organochlorine residues. Plasma can be assayed for the presence of metals such as lead, and metal residues in feathers can also indicate contamination.

Incident monitoring involving collection of mortalities following pesticide applications or pollution events enables carcasses to be tested for the presence of pesticides or residues.

Since monitoring programs cannot be created for all songbirds, several focal species can be selected to serve as indicators of exposure to, and toxicity of, contaminants for other songbirds. A suitable focal species must be sufficiently abundant, easily manipulated, must possess ecological and behavioral characteristics similar to those of other songbirds, and must display representative sensitivity to contaminants.

Conclusion

Despite our current lack of knowledge on contaminant loads of pollutants and pesticides in songbirds, it is very likely that birds are being exposed to at least some of these chemicals, and it is reasonable to expect that some adverse effects are occurring. To improve our understanding of the effects of environmental pollutants, the following research and management needs must be addressed: 1) expansion and standardization of monitoring programs, 2) selection of appropriate Neotropical migrants as indicator species, 3) improvement of hazard identification procedures in wintering regions and on breeding habitats, 4) assessment of sublethal impacts of contaminant exposure, and 5) development of quantitative population models which incorporate appropriate ecological and toxicological data to predict the effects of environmental contaminants on population dynamics of Neotropical migratory and resident songbirds.

Predation

Human-assisted Predators

Human perception of the role of predators in the natural world has changed greatly over time. Once, all wild predators were considered evil and destructive, and were persecuted relentlessly. Today, public perceptions of predators are more diverse, and many people recognize predators as a natural part of a healthy biological community. However, even in apparently natural settings, predators can cause problems for populations of native prey species, especially bird nests, eggs, and young.

Once species become rare, even natural levels of predation may lead to endangered status, and drastic protective measures are required. Today, control of predators and nest parasites has become a necessary management tool for several rare or endangered birds like the Least Tern, Kirtland's Warbler, and Southwest Willow Flycatcher.

A more complex problem involves the adverse effects of native predators on native birds in relatively natural environments. In many cases, these habitats are not as natural as they appear. Human alterations to the landscape can affect the natural balance of predator and prey. Small mammalian predators, including the raccoon, striped skunk, red fox, and opossum, benefit from human sources of food and shelter. On the shortgrass prairie, shrub-steppe grasslands, and forested mountains and foothills of Wyoming, suitable food and shelter for these species was historically scarce in winter. The introduction of row crops, garbage cans, town dumps, road-killed carrion, and winter-killed livestock have made large portions of Wyoming habitable to these small predators. Also, shelter under houses and sheds, in junkyards, brush piles, shelterbelts, and road culverts now protect them from severe weather and natural enemies. For example, the raccoon has greatly expanded its range into the West and throughout Wyoming, increasing its population to as much as six times the levels of 60 to 70 years ago. Likewise, human development on the high plains has permitted westward range expansion of the red fox in the 20th Century.

Avian predators of adult birds and eggs also benefit from alternative food sources and shelter provided by human development. Avian predators include corvids like the American Crow, Common Raven, Black-billed Magpie, and Blue Jay; and raptors like the Great Horned Owl. Many of these species were uncommon, rare, or absent from Wyoming prior to development in the 20th Century. For example, the Blue Jay first appeared on Cheyenne Christmas Bird Counts in the 1960s.

Where they are too abundant, predators can have significant impacts on both game and nongame bird populations. Fragmented habitat can also increase the hunting efficiency of both nest predators and nest parasites, like the Brown-headed Cowbird, reducing reproductive success and leading to population declines in some songbirds.

Domestic Cat Predation on Birds and Other Wildlife. (Cats Indoors! The Campaign for Safer Birds and Cats, American Bird Conservancy.)

How many birds and other wildlife do domestic cats kill each year in the United States? No one knows, although reasonable extrapolations from scientific data can be made. Nationwide, cats are estimated to kill hundreds of millions of birds and more than a billion small mammals (such as rabbits, chipmunks, squirrels, and shrews) each year. Cats kill not only plentiful animals, but rare and endangered species for which the loss of even one animal is significant. The scientific community is increasingly concerned about cat predation.

There are over 66 million pet cats in the United States. A recent poll shows approximately 35% are kept exclusively indoors, leaving more than 40 million owned cats free to kill birds and other wildlife, all or part of the time. In addition, millions of stray and feral cats roam our cities, suburbs, farmlands, and natural areas. Abandoned by their owners or lost (stray), or descendants of strays and shunning all human contact (feral), these cats are victims of human irresponsibility through owner abandonment and the failure to spay or neuter pets. No one knows how many homeless cats there are in the U.S., but estimates range from 40 to 60 million. These creatures lead short, miserable lives.

Cats Are *Not* a Natural Part of Ecosystems

The domestic cat, *Felis catus*, is a descendant of the wild cat of Africa and extreme southwestern Asia, *Felis silvestris libyca*. Domesticated in Egypt approximately 4,000 years ago, cats were introduced to Europe around 2,000 years ago. Cats were introduced to North America when Europeans arrived on this continent, but were brought in large numbers during the latter part of the nineteenth century in an attempt to control burgeoning rodent populations associated with the spread of agriculture. Some people presume that a cat killing certain animals, such as field mice, is beneficial, but native small mammals are important to maintaining biologically diverse ecosystems. For example, mice and shrews are an important food source for birds such as the Great Horned Owl, Red-tailed Hawk, and American Kestrel.

Cats Compete with Native Predators

Owned cats have huge advantages over native predators. They may be afforded some protection from disease, predation, competition, and starvation; factors which control native predators such as owls, bobcats, and foxes. Cats with dependable food supplies are not as vulnerable to changes in prey populations. Unlike many native predators, cats are not strictly territorial, keeping members of their own species out of a given area. As a result, cats can exist at much higher densities and may out-compete native predators for food. In addition, unaltered cats are prolific breeders. A female cat can have up to three litters per year, with four to six kittens per litter.

Cats Transmit Disease to Wildlife

Unvaccinated cats can transmit rabies, and cats are the domestic animal most frequently reported rabid to the Centers for Disease Control and Prevention. Cats are also suspected of spreading feline leukemia virus to a mountain lion in California and may have infected the endangered Florida panther with feline distemper. Feline infectious peritonitis has been diagnosed in mountain lion and lynx, and feline immunodeficiency virus has been found in Florida panther and bobcat.

Studies of Cat Predation

Extensive studies of the feeding habits of domestic, free-roaming cats have been conducted over the last 50 years in Europe, North America, Australia, Africa, and on at least 22 islands. These studies show that approximately 60 to 70% of the wildlife cats kill are small mammals, 20 to 30% are birds, and up to 10% are amphibians, reptiles, and insects.

Scientists have found that the number and types of animals killed by cats vary greatly, depending on the individual cat, time of year, and availability of prey. Some free-roaming domestic cats kill more than 100 animals each year. Some cats specialize in killing birds while others take mainly small mammals. One regularly fed cat that roamed a wildlife experiment station was recorded to have killed more than 1,600 animals (mostly small mammals) over 18 months. Rural cats take more prey than suburban or urban cats. Birds that nest or feed on the ground are the most susceptible to cat predation, as are nestlings and fledglings of many other bird species. Following are summaries of specific studies:

Wisconsin Study: Researchers at the University of Wisconsin coupled their four-year cat predation study with data from other studies, and predicted a range of values for the number of birds killed each year in the state. By estimating the number of free-ranging cats in rural areas, the number of kills per cat, and the proportion of birds killed, the researchers calculated that *rural* free-roaming cats kill at least 7.8 million, and perhaps as many as 217 million, birds a year in Wisconsin. They estimated that in some parts of the state, free-roaming cat densities reach 114 cats per square mile, outnumbering all natural predators. (Coleman and Temple 1995)

Virginia Study: Virginia researchers compared free-roaming domestic pet cats in a rural setting and a more urban one. A total of 27 native species (eight bird, two amphibian, nine reptile, and eight mammal, including the star-nosed mole, a species of special state concern) were captured by a single rural cat. Four urban cats captured 21 native species (six bird, seven reptile, eight mammal). Between January and November 1990, each cat caught, on average, 26 native individuals in the urban area, and 83 in the rural area. The study did not count prey killed and completely consumed, prey killed and left elsewhere, or nonnative prey. (Mitchell and Beck 1992)

Cats at Bird Feeders Study: A continent-wide survey of 5,500 homes with bird feeders during the winter of 1989-1990 showed that the domestic cat was a significant predator of birds at feeders. Species killed by cats at bird feeders included Dark-eyed Junco, Pine Siskin, Northern Cardinal, and American Goldfinch. (Dunn and Tessaglia 1994)

Cats on Islands

Because some island bird populations evolved in the absence of mammalian predators, they have no defense mechanisms against them. When an efficient predator such as the domestic cat is introduced or abandoned on an island, elimination of entire bird populations can result. Domestic cats are considered primarily responsible for the extinction of eight island bird species and the eradication of over 40 bird species from New Zealand islands alone. Island bird species that are now extinct primarily due to cat predation include the following: Stephen’s Island Wren, South Island Thrush, Chatham Island Rail, Stewart Island Snipe, and the Auckland Island Merganser. On Marion Island in the Sub-Antarctic Island Ocean, cats were estimated to kill about 450,000 seabirds annually prior to cat eradication efforts.

Cat Predation of Wildlife in Habitat Reduced to Islands

Cats can have highly significant impacts on local wildlife populations, especially in habitat “islands” such as suburban and urban parks, wildlife refuges, and other habitats that are surrounded by human development. For birds, the loss of species from habitat islands is well documented, and nest predation is an important cause of the decline of Neotropical migrants. The Point Arena mountain beaver, Stephen’s kangaroo rat, and Pacific pocket mouse, protected under the Federal Endangered Species Act, now live on habitat islands created by destruction and fragmentation of their habitat in California. Domestic cat predation by pet and feral cats on these species is a serious threat to their future existence on the habitat that is left.

Cat Predation of Federally-Protected Wildlife

The Migratory Bird Treaty Act (MBTA) prohibits the hunting, taking, capturing, or killing of any migratory bird. However, owners of free-roaming domestic cats permit their pets to kill birds protected by the MBTA in seeming violation of this landmark law. Domestic cats are also killing birds and other wildlife protected under the Endangered Species Act.

Through the Endangered Species Act, the federal government protects and restores wildlife at risk of extinction. Habitat loss is the most significant cause of species declines, and predation, including killing by cats, ranks second. Although cats may not be responsible for the perilous status of endangered wildlife, the loss of even a single animal can be a setback to the survival of the species. It is not possible to document fully the predation of protected species by cats, but the following is a list of protected species for which there is at least one documented case of cat predation in the U.S.

Documented Cat Predation of Birds Protected by the Endangered Species Act

- Light-footed Clapper Rail, *Rallus longirostris levipes*
- California Clapper Rail, *Rallus longirostris obsoletus*
- California Least Tern, *Sterna antillarum browni*
- Western Snowy Plover, *Charadrius alexandrinus nivosus*
- California Brown Pelican, *Pelecanus occidentalis californicus*
- California Gnatcatcher, *Poliptila californica*
- Piping Plover, *Charadrius melodus*
- San Clemente Loggerhead Shrike, *Lanius ludovicianus mearnsi*

Documented Cat Predation of Mammals Protected by the Endangered Species Act

- Pacific Pocket Mouse, *Perognathus longimembris pacificus*
- Stephens' Kangaroo Rat, *Dipodomys stephensi*
- Morro Bay Kangaroo Rat, *Dipodomys heermanni morroensis*
- Point Arena Mountain Beaver, *Aplodontia rufa nigra*
- Florida Beach Mouse, *Peromyscus polionotus leucocephalus*
- Key Largo Woodrat, *Neotoma floridana smalli*
- Key Largo Cotton Mouse, *Peromyscus gossypinus allopaticola*

Documented Cat Predation of Reptiles Protected by the Endangered Species Act

- Island Night Lizard, *Xantusia riversiana*
- Alameda Whipsnake, *Masticophis lateralis euryxanthus*

Correcting Four Myths About Cat Predation of Birds and Other Wildlife

Some people mistakenly believe:

1. Well-fed cats are not a danger to wildlife.
2. Putting a bell on a cat is an effective way to deter predation.
3. Interrupting an attack by a cat allows the prey to escape and live.
4. Stray cat colonies present no danger to wildlife.

Well-Fed Cats *Do* Kill Birds: Well-fed cats kill birds and other wildlife because the hunting instinct is independent of the urge to eat. In one study, six cats were presented with a live small rat while eating their preferred food. All six cats stopped eating the food, killed the rat, and then resumed eating the food.

Cats with Bells on Their Collars *Do* Kill Birds: Studies have shown that bells on collars are not effective in preventing cats from killing birds or other wildlife. Birds do not necessarily associate the sound of a bell with danger, and cats with bells can learn to silently stalk their prey. Even if the bell on the collar rings, it may ring too late, and bells offer no protection for helpless nestlings and fledglings.

Birds that Seem to Escape *Don't* Get Away Unscathed: Contrary to popular belief that birds and other small animals can be rescued from a cat attack and get away unharmed, wildlife rehabilitation centers report that most small animals injured by cats die. Cats carry many types of bacteria and viruses in their mouths, some of which can be transmitted to their victims. Even if treatment is administered immediately, only about 20% of these patients survive the ordeal. A victim that looks perfectly healthy may die from internal hemorrhaging or injury to vital organs. Wildlife rehabilitation centers also report that a large percentage of their patients are cat attack victims and animals orphaned by cats. Victims of cat attacks may be more easily found than victims of other wildlife hazards such as cars and disease. At Wildlife Rescue, Inc. in Palo Alto, California, approximately 25% of their patients during May and June 1994 were native cat-caught birds and almost half were fledglings. Thirty percent of birds and 20% of mammals in the care of the Lindsay Wildlife Museum in California were caught by cats. Cat predation of wildlife is especially frustrating to wildlife rehabilitators. These losses are totally unnecessary because, unlike other predators, pet cats don't need these animals to survive.

Cat Colonies *Are* a Problem for Birds and Other Wildlife: Domestic cats are solitary animals, but clusters often form around an artificial feeding source, such as garbage dumps or food left out for them. These populations can grow very quickly, can have significant impacts on wildlife populations, and can cause significant health risks to other cats, wildlife, and humans. Feeding these cats does not prevent the predation of birds and other wildlife. For example, a famous heron and egret rookery of several thousand birds reportedly has been decimated, and songbird populations have plummeted, in Greynolds Park in Dade County, Florida, where the numbers of cats and raccoons fed by humans have exploded.

Conclusion

Cats are not ultimately responsible for killing our native wildlife—people are. *The only way to prevent domestic cat predation on wildlife is for owners to keep their cats indoors!*

For More Information

Contact the American Bird Conservancy; Cats Indoors! The Campaign for Safer Birds and Cats; 1250 24th Street, NW #400; Washington, D.C. 20037; phone: 202-778-9666; fax: 202-778-9778; e-mail: abc@abcbirds.org; website: www.abcbirds.org.

Nest Parasitism

Overview

Although Brown-headed Cowbirds are native to North America and traditionally followed the large buffalo herds across the plains, certain livestock grazing and management practices have enabled cowbirds to expand their range and detrimentally increase the effects of nest parasitism. Cowbirds build no nest of their own, but lay their eggs in a host species nest, often removing a host's egg in the process. Cowbird young hatch earlier than the host young and are larger and more aggressive; therefore, they receive the majority of food brought to the nest, at the expense and often demise of the host's young.

Cowbird Ecology and Management (Ortega 1998)

Cowbird Ecology

Studies from Washington, California, and Illinois have found cowbird abundance to be highest within 2 miles (3 km) of agricultural areas, but parasitism rates were not associated with cowbird abundance. The highest parasitism rates were found in riparian areas and in habitats associated with human disturbance. Parasitism rates decreased with increasingly open habitat, suggesting that cowbirds prefer forest habitat; thus, managing for large trees within riparian areas may reduce parasitism rates. Parasitism rates were lower in large native pastures than in small native pastures, but did not differ between grazed and ungrazed pastures. Conversely, in Montana, parasitism rates were greatest in disturbed and residential habitats and were lowest in mature forest. In Colorado, the most heavily parasitized species were Plumbeous and Warbling Vireos, and parasitism rates of Lazuli Buntings may reach 80 to 100%.

Cowbird-Host Interactions

Nest desertion rates are higher among old hosts (species co-evolved with cowbirds) than among new hosts (species recently exposed to cowbirds), but desertion may not be due to cowbird parasitism in all cases. Cowbird parasitism decreases the number of hosts fledged in 11 species of birds ranging in size from vireos to blackbirds. However, as host size increased, the number of host young fledged also increased, reducing the impact of parasitism. In one island study, removing cowbirds reduced nest predation rates, suggesting that cowbirds may have more of an effect on their hosts than is apparent from parasitism rates alone. Female cowbirds tend to be site faithful, and fecundity may not be as high as once thought, from 3 to 13 parasitized nests within a female's home range.

Cowbird Management

The endangered Least Bell's Vireo suffered parasitism rates of 80 to 90%, with parasitized nests averaging much lower success than unparasitized nests. After a cowbird control program was begun in 1996, parasitism rates dropped to 35%. However, even with cowbird trapping, some vireos continued to be parasitized, and removal of cowbird eggs from parasitized nests did not always prevent subsequent abandonment. In a heavily parasitized population of Lazuli Buntings, unparasitized nests only produced enough young to replace themselves and, thus, were population sinks. Point counts in areas with cowbird control programs have found higher abundance of host species than in areas without cowbird control programs. However, several studies have shown no correlation between cowbird abundance and parasitism rates. Studies have also shown that predation reduces host productivity more than parasitism and, in many parasitism studies, the effect of predation is difficult to account for. Removal of livestock from a Black-capped Vireo study area reduced cowbird parasitism rates. A study in California found parasitism to be the major source of Willow Flycatcher nest failure. A cowbird trapping program reduced cowbird abundance by 50%, parasitism rates declined, and flycatcher productivity increased. However, the flycatcher population remained unchanged, thus suggesting that factors other than parasitism are preventing population recovery.

Cowbird Control Programs

In cases where cowbird control programs have not resulted in increases in host populations, there is a danger that continued cowbird control may prevent attention from being focused on other, possibly more important, causes of host population decline. Conference participants called for standardization of cowbird control programs, methods for determining whether a control program is needed, and better methods for evaluating control program efficacy. Before a control program is established, it should be documented that host reproductive rates are less than that needed to sustain the population, that parasitism is responsible for low reproductive rates, and that predation is not responsible. It should also be recognized that cowbirds are native to western landscapes; declining habitat quality and increased predator populations are more likely responsible for host population declines than cowbird parasitism; and, because control is expensive and labor-intensive, it is best viewed as a temporary solution to localized problems. Winter trapping of cowbirds at large concentrations is viewed by many as counter-productive for a variety of reasons. First, it can detract from other, more important, factors limiting host populations. Second, cowbirds are not a problem across their entire range and winter trapping likely removes individuals from other non-target breeding populations. And finally, sacrifices of non-target species have resulted in adverse program publicity.

Colorado Cowbird Research

Dr. Ortega has studied cowbird parasitism in grazed and ungrazed Gambel oak and riparian habitats in southwestern Colorado since 1992. Her results show that parasitism increased with grazing in oak habitats, but not in riparian habitats. She also found that grazing had little effect on nest predation, which was a major cause of host reproductive failure. Chipping Sparrow parasitism rates increased and productivity decreased in association with grazing. However, Chipping Sparrows were successful in spite of parasitism. Predation had a much larger effect on the local Chipping Sparrow population than did cowbird parasitism. Dr. Ortega suggests that cowbirds may prefer riparian pastures over oak pastures and may opportunistically find host nests as they forage with cattle. Because cowbird egg-laying declines after mid-June, later nesting host species were parasitized less than earlier nesting species.

Conference Conclusions

Cowbird abundance is often not correlated with host parasitism rates. Cowbirds are not a problem throughout their range. In many habitats, predation is a far more important source of nest failure than is parasitism. Cowbird habitat preferences are variable, but disturbed habitats are preferred. Very little is known about the effects of livestock grazing on parasitism rates, and is the top research priority. The North American Breeding Bird Survey has shown an overall decline in cowbird abundance since 1966. Cowbird trapping programs can be effective in reducing parasitism in local host breeding populations. However, it is a temporary solution at best, and assessment of program efficacy should be built into project design and funding.

Cowbird Scientific Advisory Council

The American Bird Conservancy governing council approved on 14 December 1997 a proposal to create a National Cowbird Advisory Council, which grew out of the Partners In Flight Cowbird Conference in Sacramento. The Council is composed of a broad range of representatives who are resource managers, federal scientists, and academic scientists. The Council will serve as a logistic center for information on cowbird impacts on hosts and appropriate management procedures. A central database will be established at Patuxent Wildlife Research Center (U.S. Geologic Service—Biological Resources Division), Laurel, MD, where all cowbird management programs will be registered. For more information, visit the Patuxent Wildlife Research Center's home page at www.pwrc.usgs.gov.

Habitat Conversion

The landscape of North America has undergone significant changes from descriptions provided in early accounts. The impacts have been varied, with some having primarily local effects on the native avifauna and others having more universal impacts across the landscape. In this section we review three major problems of habitat conversion to the avian community: development, land use changes, and conversion of native habitat to cropland.

Habitat Fragmentation

What exactly does the phrase "habitat fragmentation" mean? Habitat fragmentation refers to the breaking-up of large, contiguous areas of similar vegetation. This occurs when a large, continuous tract of a particular vegetation type is converted to other vegetation types so that only pieces, or fragments, of the original vegetation type remain. Habitat fragmentation can be very detrimental to those species of birds and other wildlife that require these large patches to breed and forage successfully. In fact, habitat fragmentation, along with direct loss of habitat, is one of the main causes of population declines of many species of birds. Groups of species especially impacted by habitat fragmentation include those with large home ranges, very specific habitat requirements at the microhabitat level, and poor dispersal skills.

Habitat fragmentation can occur on different levels, for different lengths of time, and have varying detrimental effects. For example, converting patches of native grassland to cropland usually causes permanent and large-scale habitat fragmentation, whereas certain timber harvesting practices cause temporary fragmentation by creating patches of young forest within an overall mature forest.

Fragmenting habitats also creates an increase in the amount of edge (the junction between two different habitat types or successional stages) in relation to interior habitat. Creating more edge also leads to an increase in "edge effects"—increased rates of nest predation because predator abundance is greater along the edge than in the interior, increased rates of nest parasitism by cowbirds because this native species is also more abundant along edges, more competition between species for limited nesting and foraging sites, and diminished pairing and nesting success.

Fragmented habitats can also result in breeding areas that support "source" populations (enough young birds are produced to replace breeding adults, and perhaps enough to disperse and populate other areas) into marginal breeding habitat that supports only "sink" populations (not enough young birds are produced to compensate for adult mortality; they only exist due to continued colonization from other areas).

Landowners and land managers can use a number of tools to lessen the impacts of habitat fragmentation on birds. When planning and managing reserves and habitat restoration projects, one single large reserve is more beneficial to birds than several small reserves. This provides habitat for area-sensitive species that only breed in non-edge habitat. Reserves and habitat restoration sites should have a compact, roughly circular or square shape to maximize the size of the core area. Reserves and restoration sites should be clustered together, where possible, rather than spaced widely apart. Where fragmentation has already occurred, make sure the existing fragments retain their habitat qualities, as these sites may still be important for post-breeding dispersal habitat and as migration stopover spots for birds.

Development (Sierra Club 1998)

One of the most pressing problems facing us in the Unites States today is that of uncontrolled development, or suburban sprawl. Technically defined, sprawl is "low-density, automobile-dependent development beyond the edge of service and employment areas". The classic picture of uncontrolled sprawl is the strip malls and large-lot subdivisions spreading out over previously open or undeveloped spaces. More than just an eyesore, the consequences of decades of unplanned, rapid growth and poor land-use management are evident all across America: lost open space; destroyed wildlife habitat, farm and ranch lands, wetlands, forests, shrublands, grasslands, and riparian areas; increased dependence on fossil fuels; increased traffic congestion; longer commutes; worsening air and water pollution; increased flooding; higher taxes; increased demand and costs for public services; and dying city centers.

Land consumption is far out-pacing population growth in urban areas across the U.S. It is estimated that each person uses 4 to 5 times more land for roads, homes, and shopping now than 40 years ago. Indeed, between 1970 and 1990, more than 19 million acres of rural land were developed. Every year, 400,000 acres are being bulldozed under, and the rate of development is accelerating. The American Farmland Trust reports that an astounding 70% of prime or unique farmland is now in the path of rapid development. And residential sprawl development costs more tax money to provide for public infrastructure such as schools, roads, and sewers, than it creates in revenues.

At the same time that sprawl is making increased demands on the cleansing and restorative properties of ecosystems, it is consuming them. The forests, wetlands, and grasslands that we are losing are vital for nutrient uptake, flood control, filtering sediment, and providing wildlife habitat. In addition, sprawl is consuming our highest quality agricultural lands, especially those closest to metropolitan areas, where 79% of our fruits, 69% of our vegetables, and 52% of our milk is produced.

Smart, compact growth makes sense. Compact growth consumes 45% less land and costs 25% less for roads, 15% less for utilities, and 5% less for housing than sprawl development does. Growth management is an issue that many states are making a top priority; over 25 states now have regional or statewide growth management advocacy groups.

For more information on this topic, visit the environmental quality section of the Sierra Club's web site at www.sierraclub.org.

Land Use Changes (Askins 2000, Knopf 1994)

As human influence continues to spread, both directly and indirectly, across even the most remote natural areas, many species are unable to adapt to environmental changes we incur. For example, some birds can use young, regenerating forests, but they are intolerant of small patches of forest surrounded by open habitats that result when forests are fragmented. Similarly, many grassland specialist birds disappear from small patches of grassland that have unsuitable surroundings. Some species disappear from small areas because they have a large home range and are unable to find enough food in a small habitat patch. Some disappear because they are intolerant of the increased rates of nest predation and cowbird nest parasitism that frequently occur in small patches. Whatever the reason, small habitat size and isolation of habitat patches are more likely to affect bird populations in landscapes where 70% or more of the native habitat has been destroyed.

Conversely, some species depend on periodic destruction and simplification of the dominant vegetation. Humans have changed the landscape by interfering with natural causes of environmental disturbance, such as frequent fires, grazing by prairie dogs and bison, seasonal floods, windstorms, and beavers. When these disturbances are removed or when their frequency or intensity are reduced, then the habitat will slowly change until it is unsuitable for those species that depend on an earlier stage of plant succession. Introduced plants can also spread rapidly, and replace or eradicate the vegetation needed by habitat specialists.

Native Habitat to Cropland (Knopf 1994)

One major change across the Great Plains landscape has been extensive agricultural cultivation, where native grasses have been plowed under, mainly for cereal grain production. The eastern Great Plains have been virtually obliterated for grain (primarily corn) production, while the proportion of native grasslands on the western Great Plains in Montana, Wyoming, and Colorado that have remained in a grassland landscape is comparatively high at nearly 72%. (In 1987, native grasslands in Wyoming were comprised of 4,000 $miles^2$ in cropland, 1,200 $miles^2$ in introduced pastureland, and 42,100 $miles^2$ in native grassland.) In addition, 6,000 $miles^2$ remain in 19 National Grasslands, with 17 of those on the Great Plains, mainly in the shortgrass prairie. Compared to the eastern grassland landscape, the western is merely fragmented rather than obliterated.

Draining wetlands for cultivation purposes has also dramatically altered the local locations of plants on grasslands. Values for Montana, Wyoming, and Colorado show a 40% loss of 8,000 $miles^2$ of wetlands.

Habitat Rehabilitation and Restoration (Askins 2000)

Altered habitats can be rehabilitated and restored. Incorporating successful bird conservation depends on a thorough understanding of species' habitat requirements and how their habitats are sustained. This entails comprehension along an escalating scale, from the territory of a single breeding pair to the local and regional landscape levels, while considering how the landscape naturally shifts over time. This type of analysis is termed "landscape ecology", and is important in understanding, maintaining, and restoring natural ecosystems. Finding a balance between maintaining ecological processes and the species that depend on them across landscapes that are used by people for economic purposes is, therefore, crucial.

Part of the solution is to establish preserves that are close to other protected areas. Cluster preserves, link them with corridors, and coordinate their management. When natural areas are restricted to relatively small, scattered areas, it is important to manage different areas in different ways across the landscape. Managers of different natural areas should coordinate their efforts, with some providing habitat for species associated with mature or other relatively undisturbed habitats, while others create early successional habitats that require frequent natural or artificial disturbances.

Across North America, most of the land is privately owned, and successful conservation will depend on the efforts of landowners in partnership with land managers and nongovernmental organizations. Fortunately, most farmers, ranchers, and other landowners are interested in preserving the natural quality of their land. Although they need to derive income from the land, this is often compatible with maintaining regional biological diversity. Partners should recognize the habitat needs of different species and the economic needs of the people who own and use most of the land to earn a living.

Combine core preserves and buffer areas. When possible, manage core preserves strictly for biological diversity. Surround core preserves with buffer areas, like ranches, where some areas of natural vegetation can be sustained. Although the buffer areas are used for cattle-grazing and other land uses, they still protect large areas of habitat. The natural landscape on ranches can be protected with conservation easements. In some cases, ranchers can derive income from hunters and, increasingly, from birders and other naturalists who visit the region. Thus, many ranchers have an economic incentive (as well as a personal commitment) to saving the natural landscapes. A conservation plan for the protection of a system of preserves would protect the largest expanses of habitat while permitting development in more fragmented habitat. The emphasis is on protecting sustainable populations of all species in the region rather than attempting to protect every relict population, regardless of its long-term prospects.

Structures

Communication Towers

Migratory bird mortality from striking television and communications towers and guy wires is a serious problem. Bird kills at tall communication towers in North America were first documented during the late 1940s, when towers were being constructed to broadcast the emerging television medium. Although bird kills at lighthouses had been noted for centuries, it is unlikely that anyone anticipated the staggering number of songbirds that would be killed at tall communication towers, which were lighted at night for aviation safety. A decline in the number of towerkill studies and attention to the issue occurred during the 1980s and 1990s. Indeed, there are only a few studies on the continent that have been ongoing for more than 20 years, and there are only a handful of studies that have attempted to understand the mechanism of the towerkills. All studies indicate that sizable kills occur on a regular basis, with occurrences depending on specific weather conditions. Consequently, all show a considerable range of numbers killed from year to year; thousands may be killed in one season while only a few dozen the next. Hundreds of short-term studies have been conducted consisting of data gathered from just a single night or over several years. Due to weather variables these studies are less reliable for gauging continental mortality, although they do confirm that kills regularly occur over a wide area of North America.

The American Bird Conservancy reports that 230 species of birds have been documented as being killed at towers; this is over one quarter of all avian species found in the U.S. Night-migrating songbirds are most prone to collide with tall structures, especially warblers, vireos, thrushes, and young birds migrating in the fall for the first time. When cloudy, birds may be attracted to tower lights as an escape response. They fly toward the brightest part of the night sky, which would represent the moon under natural conditions, to get above the fog or low clouds and out of any potential problems. Unfortunately, they swarm and circle around the tower instead, crashing into each other, the guy wires, and the tower itself. Up to 10,000 birds have been killed this way on a single night.

Two aspects of tower lighting that can attract birds are the color (e.g. white, ultraviolet, or specific wavelengths) and duration (e.g. strobe, flashing, or steady). White lights seem less attractive to birds than red lights, and strobe lights are less attractive than flashing or steady lights. Also, long wavelengths of light in the red and orange part of the spectrum can disorient migratory birds by interfering with their innate magnetic compass.

There are approximately 45,000 towers tall enough to warrant warning lights nationwide, killing an estimated 4 to 5 million songbirds each year. The Federal

Aviation Administration (FAA) estimates that from the mid-1970s through the early 1990s, new tower construction (200 feet tall or higher) had been proceeding at a rate of about 1,000 per year. At least 5,000 towers measuring 200 feet or higher were planned for 2000. This number is estimated to grow at a rate of 6 to 8% a year, adding quickly to the 45,000 tall towers and over 75,000 total towers that already exist. The problem is not just the impact on the species involved, but on the ecological processes these birds are involved in—insect control, pollination, seed dispersal, etc.—that are likely being affected by declines in bird numbers.

It is widely agreed that the taller a communication tower is, the more deadly it is for night-migrating songbirds, but much seems to rely on the tower's location. Evidence suggests that a relatively short tower constructed on a hilltop may have the same impact as higher towers on flat ground. There are no long-term studies at communications towers below 500 feet high.

The data used to chart towers were derived from the FAA's Digital Obstacle File. This information lists locations and heights of communication towers and tower farms that affect aviation safety; typically when a tower stands 200 feet above average ground level. As of 2 November 1998, Wyoming's tower status includes 80 towers from 200 to 299 feet tall, 40 towers between 300 and 499 feet, three towers from 500 to 799 feet, and no towers currently over 800 feet tall; this data is outdated, however, as many new towers have been constructed over the past five years.

On 14 September 2000, the U.S. Fish and Wildlife Service developed "Interim Guidelines for Recommendations on Communications Tower Siting, Construction, Operation, and Decommissioning" to help with this problem. These guidelines are listed below.

1) Any company/applicant/licensee proposing to construct a new communications tower should be strongly encouraged to co-locate the communications equipment on an existing communication tower or other structure (e.g. billboard, water tower, or building mount). Depending on tower load factors, from 6 to 10 providers may co-locate on an existing tower.

2) If co-location is not feasible and a new tower or towers are to be constructed, communications service providers should be strongly encouraged to construct towers no more than 199 feet above ground level (AGL), using construction techniques that do not require guy wires (e.g. use a lattice structure, monopole, etc.). Such towers should be unlighted if Federal Aviation Administration (FAA) regulations permit.

3) If constructing multiple towers, providers should consider the cumulative impacts of all of those towers to migratory birds and threatened and endangered species as well as the impacts of each individual tower.

4) If at all possible, new towers should be sited within existing "antenna farms" (clusters of towers). Towers should not be sited in or near wetlands, other known bird concentration areas (e.g. state or Federal refuges, staging areas, or rookeries), in known migratory or daily movement flyways, or in habitat of threatened or endangered species. Towers should not be sited in areas with a high incidence of fog, mist, and low ceilings.

5) If taller (greater than 199 feet AGL) towers requiring lights for aviation safety must be constructed, the minimum amount of pilot warning and obstruction avoidance lighting required by the FAA should be used. Unless otherwise required by the FAA, only white (preferable) or red strobe lights should be used at night, and these should be the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes) allowable by the FAA. The use of solid red or pulsating red warning lights at night should be avoided. Current research indicates that solid or pulsating (beacon) red lights attract night-migrating birds at a much higher rate than white strobe lights. Red strobe lights have not yet been studied.

6) Tower designs using guy wires for support that are proposed to be located in known raptor or waterbird concentration areas or daily movement routes, or in major diurnal migratory bird movement routes or stopover sites, should have daytime visual markers on the wires to prevent collisions by these diurnally moving species. [For guidance on markers, see Avian Power Line Interaction Committee (APLIC) (1994), and Avian Power Line Interaction Committee (APLIC) (1996). Copies can be obtained at www.eei.org/resources/pubcat/enviro/ or by calling 1-800-334-5453.]

7) Towers and appendant facilities should be sited, designed, and constructed so as to avoid or minimize habitat loss within and adjacent to the tower "footprint". However, a larger tower footprint is preferable to the use of guy wires in construction. Road access and fencing should be minimized to reduce or prevent habitat fragmentation and disturbance, and to reduce above ground obstacles to birds in flight.

8) If significant numbers of breeding, feeding, or roosting birds are known to habitually use the proposed tower construction area, relocation to an alternate site should be recommended. If this is not an option, seasonal restrictions on construction may be advisable in order to avoid disturbance during periods of high bird activity.

9) In order to reduce the number of towers needed in the future, providers should be encouraged to design new towers structurally and electrically to accommodate the applicant/licensee's antennas and comparable antennas for at least two additional users

(minimum of three users for each tower structure), unless this design would require the addition of lights or guy wires to an otherwise unlighted and/or unguyed tower.

10) Security lighting for on-ground facilities and equipment should be down-shielded to keep light within the boundaries of the site.

11) If a tower is constructed or proposed for construction, Service personnel or researchers from the Communication Tower Working Group should be allowed access to the site to evaluate bird use, conduct dead-bird searches, to place net catchments below the towers but above the ground, and to place radar, Global Positioning System, infrared, thermal imagery, and acoustical monitoring equipment as necessary to assess and verify bird movements and to gain information on the impacts of various tower sizes, configurations, and lighting systems.

12) Towers no longer in use or determined to be obsolete should be removed within 12 months of cessation of use.

For more information on this issue, refer to the following web sites and related links:

- ABC's "Communication Towers: A Deadly Hazard to Birds" www.abcbirds.org
- Fatal Light Awareness Program, Toronto www.flap.org
- Towerkill information www.towerkill.com
- U.S. Fish and Wildlife Service sources of information http://migratorybirds.fws.gov/issues/towers/towers.htm

Windows

Window casualties can be a significant mortality factor for some species of birds because birds often do not recognize glass as a barrier. In addition, the lights in tall, lighted structures such as those in multistory buildings are known to disorient birds and cause them to collide with windows and walls. In the U.S., it has been estimated that between 100 million and 1 billion birds are killed each year by striking glass of various sizes, in all types of human-built structures, during every season. In fact, it is possible that glass panes exact the highest toll of any human-related avian mortality. Potential victims include both small and large species, and the fit and unfit of abundant as well as rare, threatened, and endangered species. The window hazard is likely to increase for resident and migrant birds as more and more undisturbed habitat is modified by human development and the construction of new buildings containing large expanses of glass.

There are varied and effective methods of preventing bird strikes. The following recommendations will not all be appropriate for every situation, but should be used as general guidelines for reducing collisions between birds and windows.

1) Minimize collisions by breaking up the reflection on the outside of the window with a non-reflective window coating, window screens, flash tape, or bird netting. Covering windows with netting is most effective when cost and appearance are acceptable. Single objects such as falcon silhouettes, owl decals, or large eye patterns may not be effective deterrents because they cover only part of the glass and are not applied in sufficient numbers to alert the birds to the glass barrier. Glass surfaces should be uniformly covered with objects or patterns to turn them into obstacles that birds can recognize and avoid. Objects or patterns may have to be separated by as little as 2 to 4 inches (5 to 10 cm) to successfully protect hummingbirds and the smallest passerines. Birds in flight are more apt to give vertical objects wider clearance than horizontal ones, so tapes or cloths should be placed vertically.

2) Bird attractants such as feeders, watering areas, and nutritious vegetation in front of windows increases the density of birds near windows and can increase the hazard. Either move attractants such as feeders a considerable distance away from windows or place them very close to the glass surface to slow birds down and lessen the effect of impact.

3) Plant trees and install window awnings to block the sun from hitting windows and eliminate some reflection.

4) Enact a building policy of minimum night lighting, especially during migration, to alleviate bird attraction and confusion around tall buildings and towers, and to reduce light pollution.

5) In new or remodeled buildings, install windows at an angle so the pane reflects the ground instead of the surrounding habitat and sky. Birds will avoid flying into a reflection of the ground, but are easily deceived by and strike reflected images of habitat and sky on windows installed in the conventional vertical position.

Power Lines

Collisions with Power Lines

For some birds, power line collisions can be a significant source of mortality. The U.S. Fish and Wildlife Service reports tens of thousands of avian fatalities per year due to collisions with power lines. Birds like ducks, geese, swans, and cranes are most susceptible to power line collisions near wetlands; in upland habitats away from wetlands, raptors and passerines are most susceptible to collision.

It is possible for birds to exist near power lines in many situations without significant risk of collisions. Problems usually occur in very specific, localized situations where certain factors exist or interact to create high collision potential. These factors include the number and species of birds present, the frequency with which birds in flight must cross a power line within their daily use area, lack of visibility of the lines, disturbances that startle birds into flight, the degree of familiarity of the birds with the area, species size and maneuverability, the height that a species usually flies, time of day and related light and visibility, adverse weather conditions, and flocking behavior. Many factors affect bird collisions with power lines, and therefore influence mitigation measures that can minimize collisions. Management decisions should therefore be based on close observation of actual conditions and development of appropriate responses.

The best method of minimizing avian collision mortality is to avoid constructing power lines in areas where birds concentrate during migration, breeding, or winter. However, if problems exist after construction, the potential for collisions can be reduced by using natural vegetation or human-made structures to shield power lines, modifying habitat near power lines to change its attractiveness to birds, and/or modifying land use to reduce disturbance (i.e. flushing birds near power lines). Some of the possibilities for line modification include enhancing the visibility of lines (e.g. flags or marker balls), burying the line, removing overhead groundwires, and removing small lightning shield wires in sensitive areas. Other possible mitigations include constructing lines parallel to prevailing wind, constructing lines lower than flight corridors, and placing lines across rivers at oblique rather than right angles.

To minimize avian mortality, power lines should be constructed to the most current standards using publications such as those from the Avian Power Line Interaction Committee (APLIC) (1994). For details on power line mitigation to benefit birds, please refer to these publications. Copies can be obtained at www.eei.org/resources/pubcat/enviro/ or by calling 1-800-334-5453.

Electrocution of Raptors

Raptors are attracted to power poles and towers as perches from which to establish territorial boundaries, hunt, rest, feed, build nests, and sun themselves. In open plains, prairies, or savannahs, power poles often provide the vertical structures necessary for nesting, roosting, and more effective foraging where natural nesting substrate and perches are limited. However, because of their large wingspans, larger birds like hawks and eagles are most likely to be electrocuted by simultaneous contact with two wires.

Much progress has been made in the effort to reduce raptor electrocution on power lines through retrofitting particularly hazardous power lines and implementing raptor-safe engineering of new lines. For example, raptor protection measures are now mandated as part of permitting and licensing requirements by most federal agencies in the U.S. and many electric utility companies have adopted or participate in raptor enhancement or protection programs. Nevertheless, raptor electrocution is still a widespread problem in North America and throughout the world. Thousands of miles of new power lines will inevitably be built in the future, and much work still remains to be completed in retrofitting existing lines.

Raptor electrocution can be addressed by a variety of mitigation measures, through design and retrofitting existing lines. Possible mitigation includes using insulating materials; gapping groundwires; adding pole-top extensions; lowering crossarms; and adding elevated perches, depending on the nature of the pole and the problem. Also, nest platforms may be installed on power line structures to enhance populations of raptors while minimizing the risk of electrocution and the risk to service. Nest platforms may be provided on the poles themselves or on "dummy" poles placed near those poles where nests have been built.

To minimize avian mortality, power lines should be constructed and retrofitted to the most current standards using publications such as those from the Avian Power Line Interaction Committee (APLIC) (1996). For details on power line mitigation to benefit birds, please refer to these publications. Copies can be obtained at www.eei.org/resources/pubcat/enviro/ or by calling 1-800-334-5453.

Wind Turbines

Although generally considered environmentally friendly because they generate electricity without emitting air pollutants or greenhouse gases, windplants, at most locations, have been associated with avian fatalities caused by collisions with turbines and other windplant structures. Early wind energy facilities in the U.S., such as those in the Altamont Pass Wind Resource Area in California, were placed without regard to level of avian use, and some of these sites are located where birds are abundant and the risk of turbine collisions is high. As a result, extensive mortality has been reported at those facilities. Studies conducted on other wind generation facilities have shown that these levels of mortality do not routinely occur and that collisions at newer generation turbines are lower than estimates from some of the older windplants. Nevertheless, wind has become the world's fastest growing power source, increasing some 30% annually since 1996, and due to declines in many species of birds, any additional mortality can be a cause for concern. Although avian collision mortality associated with windplants is currently lower than other sources of collision mortality in the U.S., if windplants became quite numerous, they would likely cause more than a few percent of all collision deaths.

Bird fatalities at wind turbines are associated with a variety of species, including raptors, passerines, waterfowl, and shorebirds. Numerous factors influence the potential for avian mortality at windplants, including avian abundance, species composition, presence of migration corridors, geographic area, topography, prey abundance, weather, turbine placement, rotor design, and rotor speed. New wind plant facilities should take all of these factors into account to limit bird fatalities.

Newer generation windplants have already incorporated many of the following mitigations, resulting in lower levels of bird mortality than some of the older windplants. However, because the cumulative impacts of all mortality factors on birds continue to increase as the human population climbs and resource demands grow, it is important to continue to be vigilant in implementing these mitigations and developing new ways to reverse avian mortality trends and minimize bird deaths.

1) Evaluate prospective windplant sites to determine how birds use the area, potential impacts on birds and other wildlife, and the best way to reduce the level of risk for birds. Because numbers of birds in an area will vary seasonally, within a season, and according to weather conditions (e.g. raptors often congregate locally during winter), monitor prospective windplant sites throughout the year.

2) Avoid situating wind projects in areas with large concentrations of birds or in known areas of high migration. For example, a dense or abundant prey base within a windplant facility may attract a greater number of raptors within the vicinity of wind turbines, and increase the potential for collision fatalities among raptors. Waterfowl and other wetland bird species may be attracted to wetlands and aquatic habitats in the vicinity of windplant facilities, increasing their potential for collision. The best way to minimize collision mortality is to situate windplants in areas with low bird use.

3) Position windplants and turbines in such a way as to reduce bird collisions. For example, space turbines more widely as seen from the direction of migration, and position them away from rim edges where raptor use can be high.

4) Mitigate bird collision mortality at windplants by limiting the height of turbines, slowing rotor speed, and creating visual clues to alert birds (e.g. paint turbine blades to provide a high level of contrast between the blades and the general background). Reduce the number of perches available to birds on turbines and towers by using tubular structures and supports. In smaller project areas, it may be practical to try to keep the birds out of the facility by employing warning techniques (e.g. broadcasts of a certain radio frequency).

5) Implement site evaluation and monitoring programs at both older windplants and newer generation facilities to continue to provide information on the impacts of windplants on birds and determine factors important for situating windplants.

Diseases

Many people perceive disease in wild populations of birds as causing the rapid death of a large proportion of the population. However, rapid and massive mortality is probably not the general rule, and diseases generally have subtler effects on animal populations. Diseases can have a wide range of effects on bird populations, from the severe mortality sometimes observed to regular fluctuations in abundance (i.e. cycles) to maintaining populations at consistent and lower numbers than would be the case had there been no disease. Subtler effects of disease may be more common than extreme cases, with changes in size of host populations leading to changes in the rate of disease transmission and thus to oscillating or smaller but stable host populations. In general, for every extremely severe epidemic, there will be other diseases with lower rates of fatality, and still other diseases that almost never cause deaths.

Although disease rarely decimates bird populations, mortality from disease is often dependent on population density. Urban populations are likely to be more susceptible to disease than populations in wildlands because artificial feeders concentrate birds and increase the ability of disease to spread among individuals. Moreover, some urban species, such as Rock Doves (pigeons) and blackbirds, may function as reservoirs for disease. For example, Rock Doves are more common in urban environments than in natural environments and are known to carry diseases such as trichomoniasis. This protozoan may be able to survive in urban settings better than rural ones because of the large Rock Dove population. When environmental conditions favor its growth, it (and other diseases such as avian pox and salmonellosis) can be quickly transmitted through urban bird populations at communal feeding sites like backyard feeders. These infectious diseases are spread by direct contact among birds at feeders as well as by fecal contamination of feed, feeder surfaces, and spillage on the ground.

Transmission of a variety of infectious agents can be enhanced by dirty bird feeders. To reduce the risk of disease transmission and the overall stress of birds using feeders: 1) Provide ample feeder space to reduce crowding. 2) Keep feeders and surroundings clean of waste feed and droppings. Regularly remove or disinfect spillage on the ground surrounding feeders. 3) Use safe feeders without sharp edges or points that may injure birds or scarify their skin. 4) Use metal, plastic, or glass feeders with non-porous surfaces that are easy to clean. Clean and disinfect feeders weekly with a 10% solution of household bleach. 5) Provide fresh feed that is free of mold and rodent droppings. Do not wait until a problem develops before implementing these precautions.

Avian cholera, like many other diseases, is often associated with stress factors such as crowding and severe weather. This disease spreads rapidly through waterfowl and other migratory bird populations, and death can result as rapidly as 6 to 12 hours after exposure. Transmission can occur by bird-to-bird contact, by ingestion of contaminated water or food, and perhaps by aerosol. Avoid feeding waterfowl during disease outbreaks to discourage waterfowl concentrations and allow waterfowl to disperse and migrate. As with most waterfowl diseases, collection and incineration of carcasses is helpful to minimize spread of the disease.

West Nile Virus (American Bird Conservancy 2000, National Audubon Society 2003)

West Nile virus belongs to the family of viruses known as flaviviruses, which also includes St. Louis encephalitis, several equine encephalitises, and the viruses that cause yellow fever and dengue fever. West Nile virus is an “arbovirus,” which means it is carried by an arthropod, usually an insect, from host to host. It is primarily an avian virus, and is usually transmitted from bird to bird by mosquitoes. Mammals can become infected if bitten by infected mosquitoes, but do not usually pass the virus on.

Scientists do not know how West Nile virus was introduced into the United States. Normal interhemispheric migration of certain bird species (e.g. Eurasian Wigeon, Ruff, Black-headed Gull) could have introduced the virus into the U.S. However, birds that would have migrated to North America would most likely harbor the West African strain of the virus, whereas the New York strain is nearly identical to a strain found in the Middle East.

In North America since 1999, West Nile virus has been found in a wide variety of wild species of birds. While most recovered dead birds have been crows, the virus does not appear to be confined within any taxonomic boundary. Birds as different as raptors, songbirds, wading birds, waterfowl, woodpeckers, doves, cormorants, grouse, and vultures have been infected. Some species are hit harder than others. For example, infected corvids appear to suffer extremely high mortality. Under laboratory conditions, more than 90% of infected American Crows died, whereas no deaths occurred in many of the other species infected. Raptors also appear to be particularly vulnerable.

Scientists from many disciplines have been taken aback by several attributes of West Nile virus. The apparent ease with which it spread west during the summer and fall of 2002 is uncharacteristic of mosquito-borne viruses; the spread of other flaviviruses introduced to new continents has been much slower. In addition, the virus’s pathogenicity in wildlife—the degree to which it causes damage, disease, and death—is highly unusual. West Nile virus is also unusual in that it has an extremely broad host range; it has infected, and killed, members of a wide variety of bird species, many mammal species, and at least one species of reptile. In addition, the large number of species of mosquitoes that West Nile virus has been able to exploit as carriers is atypical.

Thirty-six different species of mosquitoes have been documented to carry West Nile virus; this large number of vectors (organisms that carry pathogens from one host to another) is atypical for pathogenic viruses. Of the 36 species, several in the genus *Culex* have been identified as the main vectors of West Nile virus: *Culex pipiens, C. restuans, C. salinarious,* and *C. quinquefasciatus*. The females of many *Culex* species commonly lay their eggs in the stagnant water of "containers" in urban settings—birdbaths, dog dishes, old tires, rain gutters, planters, plastic bottles, and tin cans. Reduction of sources of non-ecologically important standing water can substantially reduce numbers of *Culex* species.

Several other transmission routes are known, and other possible routes have not yet been documented. Uninfected American Crows, Blue Jays, Black-billed Magpies, and an uninfected Ring-billed Gull kept together under laboratory conditions with infected birds became infected, possibly through contact with fecal or oral secretions. Also under laboratory conditions, uninfected American Crows, Common Grackles, House Finches, House Sparrows, and a Great Horned Owl became infected from eating infected prey. It is also possible, but not yet documented, that female birds might also be able to infect their offspring before they are enclosed within eggshells.

Person-to-person, or bird-to-person direct transmission is probably not possible except through blood transfusion, organ transplant, or by introducing infectious material into the blood stream. For example, a penetrating injury such as a contaminated needle-stick to a laboratory worker may transmit the virus. In 2002, the newborn baby of an infected woman was infected, and another infant possibly became infected via the breast milk of its infected mother. Although most authorities say it is unlikely for humans to become infected through handling, eating, or getting bitten by infected host animals, they also encourage taking precautions and avoiding risky behavior. Use gloves and plastic bags when handling dying or dead birds, and cook potentially contaminated meat completely. Hunters should wear gloves when handling game, and should thoroughly wash their skin with soap and water and soak their tools for 20 minutes in a 5% solution of household bleach. Most infections of West Nile virus in humans occur without symptoms, and only a very small percentage of infected people develop encephalitis. Usually, only older persons, who may be immunocompromised, develop the encephalitis form of the disease.

West Nile virus has now become established in North America; it is not going to go away. North American birds will likely forever be subject to the presence of this virus. We do not know whether West Nile virus-related mortality will result in significant declines in bird populations; it may already have. Historically, immunologically naïve birds have suffered devastating population losses due to introduced disease in many parts of the world. Mortality rates of West Nile virus vary among species, and some species will probably adapt, as resistance is passed from survivors to their offspring. Some populations will probably rebound from lowered numbers as resistance increases.

But other populations (e.g. birds like raptors with low reproductive rates) may not rebound, and some species may go extinct. Bird species and populations already in trouble because of habitat destruction and other human-related effects are particularly vulnerable. The impacts of any population declines on the ecological balance of local areas will not be known for years.

In an attempt to save endangered and threatened birds (including exotic species) being bred and maintained in captivity in the U.S., scientists have been experimenting with equine and other experimental vaccines. Apparently, the efficacy of the equine vaccine on birds varies with species. Zoo personnel are using the various vaccines on birds and other animals in their collections, including endangered California Condors, in the hope that these animals will be immune in the future when the virus arrives or returns. If captive California Condors exhibit an effective immune response, plans are to capture and vaccinate California Condors in the wild.

Since West Nile virus has now become established in North America, the time has come for the development of a standardized plan to combat the virus in the future. To protect important bird habitat, a balanced perspective on mosquito control for West Nile virus should reflect the important ecological role of non-target insects as natural mosquito predators, pollinators, and important food resources for birds.

Efforts to eliminate non-ecologically important standing water and potential mosquito breeding areas around human habitation should be intensified. *Culex* species reproduce in wet areas augmented with decaying organic matter (e.g. leaves, grass clippings, and animal wastes). There does not have to be much water and the water does not have to be standing for very long—mosquitoes can breed in any puddle that lasts more than four days. Removing potential sources of water in which mosquitoes can breed can really make a difference, so use the following recommendations:

- Get rid of unwanted containers such as old tires and tin cans.
- Empty water from flowerpots, barrels, and pet food and water dishes weekly.
- Change the water in birdbaths every few days.
- Drill drainage holes in the bottoms of containers that are left outside, such as tires, and other objects used in play areas, gardens, on farms, or at construction sites.
- Clean roof gutters regularly.
- Turn over wheelbarrows and plastic wading pools when not in use.
- Aerate ornamental pools or stock them with mosquito-eating fish.
- Keep swimming pools clean and chlorinated, and don’t let water collect on swimming pool covers.
- Use landscaping to eliminate standing water that collects on your property.
- Thoroughly clean livestock-watering troughs monthly.
- Check trees for cavities that hold water and fill them with soil or sand.
- Be sure to check for possible containers in places that may be hard to see, such as under shrubs.

- Remind or help neighbors to follow the same practices.

Larviciding is a term to describe the practice of killing mosquitoes when they are in the aquatic, larval stage. It is accomplished most commonly by using *Bacillus thuringiensis* (Bt), a naturally occurring soil bacterium. Mosquito larvae eat the product that is made up of the dormant spore form of the bacterium and the associated pure toxin. The toxin disrupts the gut in the mosquito by binding to receptor cells present in insects, but not in vertebrates. Insect growth hormone regulators, such as methoprene, have been used since 1975 for the control of mosquito larvae. Growth hormone regulators work by preventing the maturation of insect larvae. Larviciding in ditches and small ponds near human habitation is one of the most effective measures in reducing population numbers of mosquitoes that come into contact with humans. It is also the most cost-effective control measure.

Adulticiding refers to the use of a pesticide to kill adult mosquitoes. A variety of chemicals have been used to kill adult mosquitoes. Pyrethrin is a naturally occurring compound that can be extracted from plants in the Chrysanthemum family. Currently, synthetic pyrethrins, called pyrethroids, are sprayed more often in states concerned about West Nile virus than other pesticides for adult mosquito control. Pyrethroids interfere with sodium channel function in insects, and are very effective. However, mosquitoes can develop resistance to them. Also, pyrethroids are extremely toxic to fish and aquatic invertebrates and should not be sprayed near natural water sources. Pyrethroids, widely touted by government and mosquito control officials as harmless to humans and terrestrial wildlife because of their relatively low level of persistence in the environment, are suspected endocrine disruptors, and have also been shown to alter chromosomes in human white blood cells. Malathion and naled, organophosphates registered for mosquito adulticide use, have been used sparingly, if at all, to combat West Nile virus. Organophosphates are nerve toxins that affect a broad spectrum of life forms including insects, fish, mammals, and birds. In the laboratory, many of the organophosphate insecticides can cause neurological disorders, immune dysfunction in children, and cancer in laboratory animals. Naled can be highly toxic to birds when used as an adulticide. Naled is highly corrosive to metal surfaces and tends to irritate the eyes and mucous membranes of exposed humans. Malathion is the less toxic of the two, and poses less of a hazard to birds.

Organophosphates, due to their acute and sub-lethal toxic effects to birds, other wildlife, and humans, should not be used for mosquito control. Pyrethroids are highly acutely toxic to non-target and beneficial insects, and to practically all aquatic life. As pesticides are applied to kill a particular target insect, many other non-target insects are killed in the process. This can profoundly disturb the natural processes of the ecosystem. Imbalances in natural ecosystems make them susceptible to introduced plants, animals, and pathogens. In the case of West Nile virus, the indiscriminate use of pesticides, while attempting to alleviate the risk of human disease, acts to further alter the ecosystems on which native birds and wildlife depend. All pesticides used today in controlling mosquitoes kill important natural predators of mosquitoes to some extent, including frogs, fish, and dragonflies. Run-off and aerial drift of sprayed pyrethroids and organophosphates contaminate urban streams, and may persist in natural waters, thereby contaminating ecosystems far from the original site of pesticide application.

Rampant spraying of adulticides greatly reduces the numbers of insects available to resident birds as food. Adulticiding only adds to the stress placed on resident and migratory birds directly, through toxic effects on their nervous and immune systems, and indirectly, by reducing their food supply. Birds, which are already suffering losses due to the effect of West Nile, are further harmed by mosquito control efforts.

Control measures for West Nile should mirror preventive measures currently taken by public health and mosquito abatement officials for St. Louis encephalitis virus. These control measures generally do not entail the spraying of adult mosquitoes in residential or suburban areas until surveyed mosquito pools and sentinel animals are shown to carry infectious virus. Case studies in New York and in Florida have shown that after many years of spraying adult mosquitoes to control equine encephalitis, populations of the targeted disease-carrying mosquito have actually increased. Controlling mosquitoes at the larval stage using relatively non-toxic and selective microbes and insect growth hormone regulators remains the most effective and least environmentally harmful methodology available. Larviciding of mosquitoes is the primary prevention strategy recommended by the U.S. Center for Disease Control and Prevention for St. Louis encephalitis and West Nile virus. Localized use of registered larvicides should continue in an attempt to control populations of mosquitoes likely to come into contact with infected West Nile animal reservoirs and humans. Larviciding should only be undertaken in disturbed or man-made bodies of water, which are of lesser ecological importance.

Birds are important sentinels for the overall health of the environment. Birds dying from West Nile virus originally alerted public health officials in the United States to the presence of the virus. Experts agree that the practice of adulticiding for mosquito control in urban and suburban locales will not eradicate the West Nile virus from wild populations of animal reservoirs and, in the vast majority of cases where insecticides have been sprayed in the recent past, is unwarranted for the protection of humans from the virus.

Effects of Noise on Birds

Continuous noise (e.g. gas well compressors, drill rigs, highways, and construction activities) can interfere with the vocal communication of birds, particularly singing males, making it more difficult for males in noisy environments to defend territories and attract and maintain mates. Continuous noise may adversely affect territory selection, territorial defense, dispersal, foraging success, fledging success, and song learning. Noise can produce stress in individuals and stress avoidance could result in lower population density in noisy areas. Noise can also affect habitat selection if birds have greater difficulty obtaining food because aural cues are less effective. Essentially, these adverse noise effects reduce the quality of affected habitats and could result in avoidance of noisier habitats and reduced population density in those habitats relative to quieter habitats. Species differ in their tolerance of and responses to noise, and over time more tolerant species may replace less tolerant species in noisier habitats.

The effects of continuous noise on bird communities are probably strongest in areas where noise is over 50 dBA, but even moderate noise levels (40 to 50 dBA) may have some effect on bird communities. An increase of 10 dBA above background noise is probably acceptable in most situations. Assuming that background noise is approximately 39 dBA in the daytime and the evening, this is equal to the U.S. Federal Energy Regulatory Commission (FERC) level for constant noise generators (49 dBA). At nighttime it is equal to 42 dBA. To minimize the effects of continuous noise on bird populations, reduce the noise level to 49 dBA or less.

Constant noise generators should be located far enough away from sensitive habitats such as grouse leks and raptor nests that the noise that reaches those habitats is less than 49 dBA. For example, the noise impact from drill rigs is greater than 49 dBA when the rig is closer than about 800 feet (250 m) to a receptor; impact from a 26,000 horsepower compressor station is greater than 49 dBA when located closer than about 2,500 feet (750 m) to a receptor. Near roads with 10,000 cars per day the population density of birds may be reduced up to 1 mile (1.5 km) from the road, while near very busy roads (up to 60,000 cars per day) the effect may be felt up to 2 miles (2.9 km) away. Avoid placing well pads, roads, and any other facilities requiring human presence within 825 feet (250 m) of raptor nests to prevent flushing adults from the nest. This buffer zone should be expanded in areas where prey are scarce, as raptors must spend more time searching for prey and may be less tolerant of disturbances.

Where possible, avoid construction activities and other temporary disturbances during the breeding season in areas where priority bird species occur. Avoid noisy disturbances within ½ to 1 mile (0.8 to 1.6 km) of active or occupied raptor nests, depending on the species, during the period from February 1 through July 31 to prevent nest abandonment.

If necessary, implement mitigation measures to decrease continuous noise levels. For example, enclose compressor engines with buildings and install additional suppression around muffler exhausts. Noise barriers can be constructed at drilling and testing operations, and noise dampening around engines should be considered (including foam insulation around drilling rigs).

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