92-20C NATURAL HISTORY
MAGAZINE
10 TI. YR. 375,000

JAN 1976

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The Bald Eagle Bicentennial Blues



by David R. Zimmerman

America's national bird is failing under the weight of poison and gunshot

Long enmeshed in allegory, the bald eagle is acquiring a doleful, new role as a symbol of Americans' destruction of their natural heritage.

As before, the great bird is shot, beaten, and driven from its range, even as it is celebrated as the expression of our national courage and resolve. Its new encumbrance is more subtle, but it may signify wider, more all-pervasive danger.

Bald eagles are among our most polluted birds. They carry larger amounts of a wider variety of chemical contaminants than virtually any other American species.

This distressing news comes from an ongoing study of bald eagles found dead or dying in the wild. The federal government asks that a state wildlife agent or a special agent of the U.S. Fish and Wildlife Service (USFWS) be notified when a dead bald eagle is discovered. It is the agent's job to retrieve, freeze, and ship the carcass to the USFWS's Patuxent Wildlife Research Center, near Laurel, Maryland, on the outskirts of Washington, D.C. The agent also is asked to provide any "history" that might indicate the cause of the eagle's demise.

At Patuxent, a research group performs gross autopsies and chemical analyses on the eagles. The autopsies are conducted by veterinarian-histopathologist Dr. Louis N. Locke. Chemical residues are measured by analytical chemist William L. Reichel, who directs Patuxent's sophisticated pesticide-monitoring laboratory. Excepting those birds that arrive too rotten for study, the Patuxent group has analyzed the remains of some 300 bald eagles in the last decade. Of this number, almost half died of gunshot wounds.

Case 982, for example, was a healthy female eagle found dead in Albany Township, Stearns County, Minnesota, in November of 1974. Locke's autopsy report says: "Death had been caused by a rifle bullet which had entered the thorax through the upper left pectoral muscles, penetrated the [breastbone], passed through the upper thorax and exited just posterior and lateral to the left [shoulder bone]."

The special agent who sent the eagle provided little data on the circumstances of its death, but Locke found a strong, if unverifiable clue: the remains of a white leghorn chicken in the eagle's mouth and stomach.

The eagle's dark, immature head

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feathers and the small size of its ovary and the egg follicles within it told Locke that this bird had never bred. Although his official report does not say so, this is more the shame, since 982 was one of the "cleanest" eagles, in terms of chemical residues, of any sent to Patuxent.

Through the years, Reichel has sharpened and refined his analytical techniques, including gas chromatography and mass spectrometry, to the point that he routinely seeks, and finds, a dozen different chemicals in the eagle brain and body tissues that he analyzes. He found absolutely none in the brain of 982. In the body he found only insignificant amounts of the DDT breakdown product DDE (0.14 parts per million) and of the chemically related industrial compounds called polychlorinated biphenyls, or PCBs (0.3 ppm). Had she not had the misfortune to run into a bullet, eagle 982 almost certainly could have bred normally—and so contributed to her species' survival.

Whether the subject on the autopsy table is a human cadaver or a bird carcass, the pathologist's success depends in part on his skill as a detective and in part on serendipity. In case 986, for example, Locke's initial diagnosis was "electrocution."

The special agent who submitted the eagle, Charles Q. Heumier, works out of the Brigham, Utah, USFWS office. He said the remains had been found "near a well-traveled roadway, about 20 yards from a 2-wire powerline on crossarms.

"The bird was frozen [when found], and appeared to have been dead for quite some time. The carcass may have been moved some by dogs. A farmhouse is nearby."

Agent Heumier added: "I was unable to find any bullet holes. Usual evidence of electrocution was not noted."

Locke, however, was able to find the presumptive evidence of electrocution that agent Heumier had missed: singed feathers high under the left wing and along the adjacent chest wall. He also found a bloody, dime-sized laceration leading past the last left rib into the lungs.

"Because of the singed feathers and the history—found near powerline—the significance of the laceration . . . was not appreciated at the time of autopsy," Locke wrote later. His initial diagnosis: "Electrocution, with laceration following the fall to the ground."

Completing his autopsy, Locke followed a standard procedure and removed the eagle's brain, kidneys, and liver for chemical assay. He removed the skin, feet, wings, and gastrointestinal tract. The feathers he put aside; when a boxful accumulated they would be sent to a USFWS special agent in the West, who gives them to Indian artisans to fashion into ceremonial headdresses.

The flesh and bones of eagle 986, the better part of its original 11.5 pounds, were then put through a food-grinding machine so that a small but representative specimen of the carcass, one-third of an ounce, could be taken for organochlorine analysis. Grinding an eagle is a routine task, but eagle 986 provided a surprise—"a .22-caliber rifle slug was found in the ground meat."

Locke thereupon abandoned his original diagnosis. "The better interpretation is [that] the eagle [first] was shot, then fell against the powerline and received the singed feathers. In all probability, the bullet slug was lodged in the blood-filled lungs."

While rarer than shooting, electrocution deaths do occur. A marine biologist in Florida wrote to explain how eagle 1011 met its end.

"On March 31, 1975, at about 6:30 P.M., my neighbors . . . observed a small bald eagle pick up the filleted carcass of a 36-inch kingfish, which had been thrown over the seawall.

"The eagle carried the fish across two wires of a high tension powerline and was electrocuted."

The loss is the greater because this eagle, a male, is believed to have been one of a breeding pair that was busy raising eaglets in a nearby eyrie.

Bald eagles that breed in Florida, and as far north as the 40th parallel—which runs through Philadelphia and Denver—are assigned to the southern subspecies *Haliaeetus leucocephalus leucocephalus*, which has been reduced to a few hundred breeding pairs and is considered highly endangered. The marginally larger northern subspecies, *H. l. alascanus*, all bald eagles that breed north of the 40th parallel, is far less threatened; the USFWS estimates there are 35,000 to 50,000 in Alaska alone.

One of the northern subspecies, eagle 857, was found frozen and dead in a fox trap near Kodiak City, Alaska, and was forwarded by Kodiak Wildlife Refuge manager Gerry Atwell, who knew enough of the circumstances to blame "an inexperienced trapper" for the bird's demise.

Pathologist Locke verified "trap injuries" on the feet, but attributed death to a skull fracture. "A hard blow . . . had been delivered . . . Skull fragments had been driven inward by the force of the blow and ruptured the large vessels of the meninges. Posterior portion of the right cerebral hemisphere reduced to pulp."

The eagle's desperate last seconds are easily visualized, but Locke passes no judgment on the humans involved. "I don't think there are many people who are going to walk up to an angry eagle and try to get him out of a trap. They either shoot him or beat him over the head with a club."

Eagles suffer other kinds of human-induced trauma. One eagle was struck by a car. Two flew into airplane motors. The most surprising case, according to Locke, involved an eagle that was seen perched on a snag over water, trying to free itself from a large fishhook caught in one nostril. The eagle reached up with one leg to kick off the hook, caught the leg on the hook, lost its balance, fell into the water—and drowned.

More insidiously, about 5 percent of the eagles sent to Patuxent died of acute poisoning by strychnine and thallium, which are predator control compounds. The great majority of the eagles autopsied at the research center thus had died from unnatural, often violent, humanly induced causes. This begs the question whether all bald eagles die of a like distribution of causes; probably not, but the answer is that nobody knows.

The dead eagles received at Patuxent are a biased sample of the bald eagle population. Like human autopsy series from medical examiners' offices, a major source of Locke's cases are lawmen—USFWS special agents. The series thus is weighted toward those deaths that lawmen learn of and follow up on.

They may be most interested in deaths where there is a suspected human perpetrator since bald eagles are protected by law, and killing one can invite a federal indictment. So, as in suspicious human deaths, the cases of violence may be a disproportionate part of the sample. On the other hand, an eagle carcass is easier to hide than a human corpse, and there is no way to know how many eagles shot in sport or in vengeance then are buried

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where the law will not discover them.

The Patuxent series is also geographically biased. From 1964 to 1972, only 5 of 190 eagles came from Alaska, although that state has more than 90 percent of this country's bald eagles. Only 2 birds came from California, another important bald eagle state, while there were 6 from Florida and 29 (representing 15 percent of the total) from Wisconsin.

Where an eagle died, however, may say little about the importance of its death for the subspecies populations. Unless it actually has been seen breeding or caring for young, there is no way to know whether an eagle that died in Florida came from the relatively threatened southern population or from the far larger—and less impacted—population of northern breeders, many of which wander south in winter.

Many eagles move north and south seasonally, but no one knows if they follow regular migratory pathways. One reason is that few eagles carry leg bands; it takes a bander with a stout heart and strong back, plus a sheaf of permits, to climb eyries to band bald eagles. And in the past the effort was of dubious value. "You couldn't band bald eagles," Reichel explains. "They chewed the bands off. That had the biologist stumped!" In the spring of 1975, however, new-type bands, which will stay on eagles, were issued and will be standard.

Few strong correlations have been found between the states of the union where the birds were found and their chemical loads. One is that dead eagles in Alaska tend to be cleaner than many of the others, although "dirty" birds are found there too. "You can have high and low values for eagles from the same state," Reichel says. "But where these eagles have been before, we don't know."

One dramatically clear correlation involves death due to lethal levels of the insecticide dieldrin. Because this chemical and the other organochlorine compounds that Reichel routinely looks for are nerve poisons, lethal levels are based on residues in the brain, not the carcass. Feeding studies with other species of birds and analyses of animals found dead in dieldrin-treated fields have convinced the Patuxent researchers that levels of 4 ppm of dieldrin in the brain are likely to be lethal. Nineteen out of 190 eagles, or 10 percent of those found dead up to 1972, had more than 4 ppm of dieldrin in their brains.

"The incidence of dieldrin poisoning is high, particularly among the specimens collected from Maryland, Virginia, South Carolina and Florida," Reichel and his colleagues recently reported. "Of the 17 eagles collected [from the southeastern seaboard], 8, or 47 percent, possibly died from dieldrin poisoning. . . . All four from Maryland and Virginia were from the Chesapeake Bay tidewater area."

Not surprisingly, breeding bald eagles have practically vanished from the Chesapeake Bay area, although dieldrin certainly is not the only factor. Also, while autopsy data are sparse, studies in the field show that bald eagle colonies near other large, tidal bodies of water, which seem to act as pesticide "sinks," have been severely threatened in recent years. Those that are far from large bodies of water have done much better.

The bald eagle's problems are aggravated because it feeds at the top of a pesticide-concentrating food chain; fish are a principal part of its diet. This has led the director of the Patuxent Center, population ecologist Dr. Lucille Stickel, to say that "Bald eagles haven't got much going for them! They choose to live in the most polluted areas in the United States. And they choose the most polluted food source."

Lethal brain loads of DDT and its metabolites and lethal levels of PCB have been found in very few eagles.

Difficulty arises in interpreting those cases in which the brain loads are just shy of known deadly levels. This difficulty is compounded when high, but sublethal, levels of two or more pollutants are present. Stickel says there is some evidence to suggest that several poisons together may lower the lethal threshold of one of them. Tests in which two or more poisons are fed to birds (not eagles) in sublethal doses are in progress at Patuxent. When combined lethal levels for DDT, dieldrin, and PCB are established, some eagles whose final diagnoses remain open may be put into the poisoned category.

Even less well understood are the effects of sublethal doses on an eagle's over-all health and ability to survive. Might half the known lethal amount of dieldrin, for example, so compromise a bird's health that stress, which it otherwise would survive, proves fatal?

Eagle 853 illustrates this problem. She was a very emaciated, immature

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female bird found in a pasture in Wildwood, Florida, in a weakened condition. She seemed alert, but refused food, had difficulty breathing, and soon died. Locke tentatively attributed death to intestinal parasites—nematodes and flukes—found in her gastrointestinal tract. In her brain, chemist Reichel found dieldrin at one-third the lethal level (1.5 ppm), DDE at one-tenth the lethal level (26 ppm), and PCB at about one-fifth the lethal level (43 ppm). Also, while Reichel excludes residues outside the brain in assessing lethality, he found strikingly high levels of DDE (110 ppm), DDD (7 ppm), dieldrin (4 ppm), and PCB (180 ppm) in the body. The eagle also carried comparatively high levels of mirex, the fire ant poison, in the brain (1.8 ppm) and body (8.3 ppm)—the significance of which is uncertain.

"The case of parasites may have made the lethal levels lower," Reichel says. "Or, look at it the other way around: Maybe these levels [in the brain] lowered its resistance and made it more subject to the parasites. I don't think we have enough to hang our hat on. But this [case] illustrates the problem."

Chemical death may be suspected long before the eagle's flesh is extracted for a trip through the gas chromatograph. A bird seen trembling and shaking convulsively is one for which Locke's index of suspicion is high.

At autopsy, there are other signs. Birds killed by pesticides tend to be very thin. Their bodies are devoid of fat, even around the coronary arteries, the most stable fatty area outside the brain. Ingested organochlorines are deposited in fat. When a bird is under stress—because it has been acutely poisoned by pesticide and is too sick to eat or is migrating or is using body resources to build eggs—body fat is mobilized into the bloodstream along with its chemical residues. The fat is burned for energy, and the pesticide tends to be reabsorbed by fat in the brain, which, unlike body fat, remains essentially stable, even in severe stress.

The organochlorine residues in body fat thus are a sword, poised to fall on a bird just when it most needs its energy reserves to meet a stressful challenge. No one knows what level of residue in the body will produce a lethal level in the brain when the bird is stressed.

Chemicals kill some bald eagles outright, but this is not their only contribution to the species' decline. Organochlorines also disrupt the female reproductive system, and as a result the breeding success of bald eagles in contaminated regions such as the coast of Maine is low.

The key question is, At what levels of these residues is reproduction impaired?

Reichel says, "That's a hard one! I don't think that anybody has enough data yet to suggest that a certain amount in the carcass will produce a certain level in the eggs, and that this will have an effect on reproduction."

Stickel concurs. "I cannot say—and I don't think anyone can say—how many of the eagles we have autopsied had, or would have had, reproductive problems. It's safe to say that some did."

Pressed to say why she and her colleagues will not be more specific, Stickel says too many conjectures are required at this point to say that a certain body burden of poisons will produce reproductive failure. "There is a relationship. We could make predictions. But it is too long a chain scientifically, and we have not chosen to make that jump."

A colleague, Dr. David Peakall, who works in the Canadian Wildlife Service laboratory in Ottawa that is Canada's equivalent to the Patuxent laboratory, agrees that the data are sparse. But he is willing to hazard an estimate, based largely on field data from peregrine falcons. The bald eagle, he says, seems to be at least as sensitive as the peregrine to reproductive loss due to DDE.

Peakall estimates that the DDE levels in eggs are 15 to 40 percent of the levels that will be found in the brains of female birds who lay them. Peregrines, he says, begin to experience reproductive difficulty at the equivalent of 1.5 to 4 ppm DDE in the brain. The average of Patuxent's median brain levels of DDE in bald eagle brains for four recent years is 2.4 ppm. This suggests that had they lived at least half the female eagles would have been subject to some degree of reproductive handicap.

The damage caused by organochlorines to bald eagles and other birds cannot yet be totaled. But since the use of these chemicals has been curtailed, it is fair to ask whether—and when—residue levels will decline and bird populations recover.

The use of DDT began to drop in the United States more than a decade ago, and a virtually complete ban was put into effect in 1972. Dieldrin was banned in 1974. The sole United States manufacturer of PCB has voluntarily restricted its sale. But continuing discoveries of large amounts of PCB being discharged into the environment by manufacturers of electrical equipment and other industrial users have convinced scientists that further limits are needed—quickly.

Mirex may again be used against the fire ant in the southern states despite the program's recent cutback. And the federal Environmental Protection Agency (EPA) is considering restrictions on chlordane, an agricultural chemical that is also used on lawns and for termite control.

According to the EPA, these restrictions have begun to reduce organochlorine residues in humans and in wildlife. One study found that the level of DDT in songbirds fell from 17 ppm to 4 ppm—a very significant reduction—in the decade from 1964 to 1973.

For reasons that are not clear the Patuxent data does not offer comparably reassuring news for the bald eagle. The median levels of DDT group residues and dieldrin were virtually the same, if not higher, in 1973/74 as they were in 1964/65. The PCB levels were roughly the same in 1973/74 as they were in 1971, the first year for which they were reported.

Bald eagles live longer and so may absorb greater amounts of chemicals than other birds. Unlike short-lived songbirds, older bald eagles may carry residues picked up years ago. The eagles may be particularly vulnerable because they take their prey from chemical sinks, such as tidal waters. Then, too, there is a hint in the data, Stickel says, that bald eagles may be less able than other birds to metabolize and excrete dieldrin.

Whatever the reason(s), for the bald eagle there seems to be no surcease, as yet, from environmental poisons. "As far as the data I have compared go," Reichel says, "I have not seen any drastic change. That stuff will be around for quite a while!"

Americans today seek ways to reanimate the national spirit for which the bald eagle was chosen as a symbol in 1782. One appropriate challenge would be to act, with alacrity, to restore the environmental health of our natural heritage—so that our national bird can survive. □

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