THE NEED FOR WILDLIFE - PESTICIDE RESEARCH IN SASKATCHEWAN*

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Do Pesticides Harm Wildlife?

Earlier research into the effects of pesticides on wildlife attempted to document direct mortality in the area of application, at the time of application. Often such mortality could not be demonstrated (e.g. Folker, 1960). Gradually, much evidence has been accumulated to show that low residue levels of the persistent organochlorine insecticides are concentrated by relatively resistant organisms, and are magnified at each step (trophic level) of various food chains in various habitats (Rudd, 1964). Carnivorous and piscivorous species at the top of complex food chains thus accumulate very high residue levels, even in a relatively uncontaminated environment.

Still more recently it has been shown that these insidious, sub-lethal side-effects can have far-reaching consequences for wild populations. In fact, recent discoveries in this area rank among the most profound and startling ever made in environmental biology. In both Great Britain (Ratcliffe, 1963; 1965) and North America (Hickey, 1968) it was the decline of the Peregrine Falcon which initiated concern about the extent of harmful effects of environmental contamination. The population changes are **without parallel in the recent history of bird populations** (Hickey *op. cit.*). They include the pending extirpation of the Peregrine in northwestern Europe, the complete extirpation of the nesting population of this species in the eastern half of the United States, and simultaneous declines among other bird-and-fish-eating raptors, on both sides of the Atlantic. More recently it has been shown that, on both continents, the Peregrine populations which showed declines were characterized by egg-eating and by the production of eggs which showed reduced shell weight and thickness (Hickey and Anderson, 1968; Ratcliffe, 1967). A similar reduction in shell thickness has been shown in eggs of Herring Gulls (Hickey and Anderson, *op. cit.*), White Pelicans and Double-crested Cormorants (Anderson *et al*, 1969), and Prairie Falcons (Fyfe *et al*, 1969). Similar phenomena have been produced experimentally using Japanese quail (Bitman *et al*, 1969) and Mallards (Heath *et al*, 1969). Experimental studies have very recently elucidated the mechanism whereby organochlorine compounds interfere with reproduction. A wide variety of those insecticides or their metabolites, including DDE, will induce increased production of hepatic microsomal enzymes in both mammals and birds. These enzymes in turn break down (by hydroxilation) the steroid hormones which play a major role in regulating calcium metabolism and eggshell thickness during egg production (Peakall, 1967; Risebrough *et al*, 1968).

Effects on mammals have been less thoroughly studied, although similar food chain relationships have been found. Sherburne and Dimond (1969) found levels of DDT and its metabolites to be from 10 to 90 times as high in mink (up to 12 ppm) as in hares collected in the same habitat in Maine. Gilbert (1969) fed wild-caught fish containing low levels of DDT metabolites to ranch mink and found significantly decreased blood counts and increased embryonic loss. These studies suggest that **present environmental organochlorine levels have a potential for initiating population losses in carnivorous mammals.**

The recent research results which conclusively show that spectacular and widespread avian population declines are a direct result of impaired reproduction induced by organochlorine pesticide residues do not appear

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*Opinions expressed in this article are those of the author and not necessarily those of the Saskatchewan Department of Natural Resources.

to have been forcefully brought to the attention of those people manufacturing, distributing and using persistent biocides. Professional entomologists are still stating that they "are unconvinced that DDT has any widespread harmful effects." Such ignorance of ecological fact must be corrected. Likewise, it does not appear to be appreciated that most of the insidious reproductive effects are not due to DDT itself, but to its metabolite, DDE, a compound of demonstrably lower acute toxicity than its parent. However, 80 to 90 per cent of the residues normally found in biological material are DDE, and it is now clear that **DDE itself is a thoroughly capable steroid degrader.**

Is There a Potential Problem in Saskatchewan?

It has been stated by many people, including scientists and laymen, that pesticides are little used in Saskatchewan relative to many other areas in North America, and therefore it is inferred that research into wildlife-pesticide relationships is not an urgent matter here. Indeed, extensive pesticide spraying such as that employed in the orchards of southern Ontario, spruce forests of New Brunswick, and vegetable farms in California has not been used here and is not presently being carried out. As a result, organochlorine pesticide residues in Saskatchewan soils are apparently low compared with a few other Canadian localities where analyses have been conducted.

Saha *et al* (1968) found all dieldrin levels in 20 soil samples from the northeastern agricultural area of Saskatchewan to be below 0.30 p.p.m. (85% had 0.10 p.p.m. or less), and found *no* evidence of DDT. In contrast, Duffy and Wong (1967) found dieldrin levels of 0.75 to 4.0 p.p.m. in soil from the Maritime Provinces, and 45% of their samples contained residues of DDT and its metabolites between 1 and 9 p.p.m. In 31 soil samples from southern Ontario, Harris *et al* (1966) found DDT and its metabolites in excess of 0.1 p.p.m. in 24 samples, and an average of 61.8 p.p.m. in orchard soils. They found dieldrin and/or aldrin in excess of 0.1 p.p.m. in 16 of the 31 samples. Thus it appears that average residue levels in **some** Saskatchewan soils are relatively insignificant as a source of wildlife contamination.

However, it would be unwise to be complacent about possible harmful contamination of Saskatchewan wildlife for several reasons:

1. There is now world-wide contamination by organochlorine and other pesticides, particularly DDT and its breakdown products. During application, in particular by aerial means, much of the spray never reaches the ground, but goes into the global air circulation and falls as rain or snow (Risebrough *et al*, 1968a, 1968b). This explains DDT in Antarctic penquins and Arctic polar bears in more than trace amounts. Virtually all living organisms, including Saskatchewan's wildlife, contain residues.

2. Even in areas of low environmental residue levels, *certain* species, i.e., those at the top of food chains, may suffer due to trophic level magnification of residues. The bird-eating and fish-eating birds are particularly vulnerable. Saskatchewan has several good examples of such contamination, documented by Fyfe *et al* (1969), Vermeer (1969) and Anderson *et al* (1969).

Fyfe *et al* (*op. cit.*) have found a 34% decline in breeding populations of Prairie Falcons in six study localities in southern Alberta and Saskatchewan during the past 10 years. The decline has been concentrated in four of the six areas, and characterized by high organochlorine levels (1-22 p.p.m. in eggs), thin eggshells, and poor nestling production. In the two Saskatchewan areas studied, The Big Muddy and South Saskatchewan River valleys, the former has maintained its falcon population levels while the latter has suffered an almost complete decline. Regional differences appear to be related to food habits, those individual Falcons that feed mainly on birds (e.g., Horned Larks) being more heavily contaminated than those primarily eating ground squirrels (R. Fyfe, personal comm.). Vermeer *(op. cit.)* collected eggs of 21 species of aquatic birds, including gulls, terns, cormorants, pelicans, herons, grebes, avocet, coot, Canada goose, and ducks from 22 localities in western Canada, including 10 in Saskatchewan. Analysis for organochlorine residues showed that the eggs of gulls (except Franklin's), and of fish-eating birds such as cormorants, pelicans, herons and grebes, contained highest residues (up to 26 p.p.m.), while those of ducks and geese were much lower (up to 1 p.p.m.). Anderson *et al* (*op. cit.*) reported on organochlorine levels in pelican and cormorant eggs in Minnesota, North Dakota, Manitoba and Saskatchewan (Suggi Lake). While they found no levels above 0.1 p.p.m. in fish eaten by those birds, they found egg residues as high as 45 p.p.m. DDE and 28 p.p.m. PCB's (polychlorinated biphenyls) in cormorants, and 4.8 p.p.m. DDE and 1.2 p.p.m. PCB's in pelican eggs. This indicates a magnification of 50 to 500 times in one trophic level.

3. Migratory species may pick up residues in southern wintering areas, then return to nest in Saskatchewan. Since these are part of our breeding bird fauna we should be concerned if they are contaminated, regardless of the source. In addition, contaminated migratory songbirds contribute to food chain contamination as described above. Peregrine Falcons have been found to be highly contaminated in such remote areas as interior Alaska (Cade *et al*, 1968) and the Northwest Territories (Enderson *et al*, 1968) from feeding on migratory insectivorous birds which winter in southern agricultural areas but nest in the boreal forest.

4. There may be, and probably are, local areas in the Province where high levels of pesticides enter the environment. This may be a result of local treatments for grasshoppers or wireworms, or from pesticide abuses such as dumping of excess treated seed grain, or drainage of unusued gallonage from sprayer tanks. Abuses resulting in severe contamination of livestock or poultry frequently come to the attention of veterinarians; thus there is no reason to expect that wild species are not similarly affected on occasion. Very strong concentrations of aldrin, heptachlor and lindane are still used to dress seed grain for wireworm control. Wireworm outbreaks are most serious in the western two-thirds of the province and Burrage (1963) states that " . . . in spite of the widespread use of chemical seed treatments, the potential wireworm hazard has not diminished." Extensive collections of upland birds in Alberta for mercury analysis have revealed several "hot spots" where it was later determined that abuses had occurred. Although mercury levels in Saskatchewan upland birds are quite low, it is apparent that a few birds acquire higher than background levels, probably from seed grain. The origin of such contamination needs to be traced to its source.

Whose Responsibility is Wildlife-pesticide Research in Saskatchewan?

Pesticides pose a threat in two general areas—wildlife conservation and public health. The threat to human health through ingestion of residue-laden wildlife is essentially a Public Health problem, yet public health agencies have been little concerned with it. The Federal Food and Drug Act makes provision for residue testing in food products sold commercially, but this does not include wildlife products. Both Federal and Provincial Departments of Agriculture test for residues in forages and feeds, and in agricultural products such as milk and meat. **There is no similar program to protect the consumer of the wildlife resource.**

It might be argued that since Wildlife agencies get revenue from the game consumer in the form of license fees, and since they actively promote their product and are essentially marketing it, that they are responsible for some degree of quality control. Acceptance of such a premise would put additional onus on wildlife agencies for residue monitoring. Be that as it may, the responsibility of wildlife agencies for conservation of species under the respective jurisdictions cannot be disputed.

The Canadian Wildlife Service has taken an active stand on pesticide-wildlife research in Canada, and its responsibility in the area of migratory birds—including fish-eating species such as pelicans, herons, and cormorants—is well founded. They are also heavily involved with certain species of raptors (which come under provincial jurisdiction) particularly Prairie and Peregrine falcons, because of the world-wide plight of those species. The Federal Government should be encouraged to continue these studies and to initiate new ones. However, at present, the C.W.S. Pesticides Section is only equipped to conduct fairly broad studies, and it is obvious that because of manpower and financial limitations, the Provincial wildlife agencies will have to be responsible for local and short-term studies, particularly where detailed ancillary information on local pesticides use is required.

What are our Immediate and Long-term Research Needs?

1. Immediate

a). A review of past and present use of organochlorine pesticides in Saskatchewan including types of chemicals, distribution of use, amounts used (per year and since use began), and reason for use. A map could then be compiled showing the degree of exposure of various parts of the Province to chemicals applied within the Province. This would greatly help in the interpretation of residue level results in wildlife.

b). A comparative survey of pesticide levels in the eggs of raptorial birds. Eggs are relatively easy to collect and form an excellent standard of comparison. In addition, there is good evidence that residues in eggs provide a reliable index to fat-stored contamination in the female, especially in birds with small clutches (Stickel, 1968). A small number of nestlings and/or adults of the more abundant species could also be collected for analysis. This would provide needed information on: 1) comparative levels in species of varying food habits, 2) relationship of levels in eggs, nestlings and adults, and 3) regional variations in contamination of resident species.

c). A survey of organochlorine and mercury levels in tissues of game birds. Specimens could readily be collected by various field staff already in the Province. Very detailed data concerning locality (down to quarter section) and pesticide use in the area must be collected with each specimen. These data are needed 1) to assess any possible public health hazard, and 2) to try to pinpoint "hot spots" of pesticide abuses.

2. Long-term

2). Studies of trophic level pesticide relationships on study areas in Prairie, Parkland and Forest ecosystems. Residue levels in soils and vegetation would have to be determined as well as in avian and mammalian herbivores, carnivores and insectivores. Detailed knowledge of food habits would also have to be obtained. Such studies would provide a valuable insight into ecological magnification of pesticides in various food chains in three habitat types, under Saskatchewan conditions. Active participation of the universities, as well as government agencies, would be prerequisite for such studies.

b). Experimental studies to determine residue levels which will induce eggshell thinning and reproductive failure in Saskatchewan's native raptorial birds. Such studies would again have to be conducted largely under the auspices of the Universities. This would involve captive rearing of certain species such as Short-eared Owls and Marsh Hawks.

c). Studies of variations in carcass deposition of pesticides in game birds eaten by man. The relative amounts of residue deposited in pectoral muscle, viscera and visceral fat should be determined, and the effect of fat mobilization and seasonal changes in physical condition on pesticide levels and their intra-carcass distribution.

d). Additional data are needed on

home range and migratory movements of all species likely to carry significant residue loads. These data are required to relate residue levels in wildlife to those in the environment.

Who Should Finance Pesticide-Wildlife Research

An expanded program of research into biocide side-effects is obviously necessary in Saskatchewan, as well as elsewhere, and will require considerable money. In addition, the virtually complete contamination of even remote areas now dictates that assays for DDE be made before the results of many other studies, particularly of reproductive success and behaviour, are taken seriously. This adds an additional financial burden to many studies.

Since it is primarily studies of wildlife-pesticide relationships, conducted by wildlife ecologists, which have pointed out possible horrendous implications for mankind, there would appear to be an obligation on behalf of the general public to support such research. It is unrealistic to expect the existing budgets of Provincial Wildlife agencies to accommodate such research. Increased funding should come from the following sources:

1. Increased allotments of Provincial Government funds to the Wildlife Branch for staff and equipment for pesticides research.
2. Federal government cost-sharing of such research.
3. The large corporations which produce pesticides should feel an obligation, if for no other reason than public relations, to support directly such research, and should be approached for funds.
4. The sportsmen and naturalists of the province should also contribute directly, since they stand to gain (or lose) more than other segments of the public.

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