A Bird's Eye View of Conservation

Episode 4: Silent Spring

By John Kearney

In the autumn of 1961, I discovered birding. As happens to so many birders, it quickly became a passion. When my first birding spring arrived in 1962, I rose before dawn to bike to school, birding on the way, and to distant woodlands and wetlands on the weekends. At that time, the dawn chorus of bird song was deafening. You would have to have experienced it to realize that our present-day dawn chorus is a whisper in comparison. The variety of species, the beauty of the plumages, and the challenge of learning all the songs led me to look up the life expectancy of a man in my country to know how many of these enthralling springs I could expect to experience. It was perhaps the first time in my young life that I considered my own mortality.

Then came the shock, the bursting of the bubble of euphoria. In the autumn of 1962, I was searching for new bird books in the local bookstore when another book on the shelf in the nature section caught my eye. After quickly scanning through the book, it didn't take long to realize that the source of my passion was dying. The book was *Silent Spring* by Rachel Carson (1962).

Silent Spring documented the indiscriminate use and destructive impact of pesticides on the environment, especially DDT. The first chapter, "A Fable for Tomorrow," was a prophecy about a future where no flower blooms, fruit ripens, or birds sing. It was not the result of the actions of our enemies but something we had done to ourselves. This chapter was poetic and emotional, but the chapters that followed were a scientific exposé of the damaging effects of pesticides on the environment and human health and the intentional disinformation spread by the chemical industry.

Chapter 8, "And No Birds Sing," describes the early stages of bird population decline in North America. Carson focuses on a story about American Robins (*Turdus migratorius*) killed by eating the earthworms in an area around elm trees sprayed with DDT to kill Dutch elm disease on the campus of Michigan State University. Students on the campus witnessed robins undergoing a loss of balance, then tremors, convulsions, and death. As the robin is known by virtually everyone and is a symbol of the arrival of spring, Carson touched the hearts of her readers. The public reaction to the book was overwhelmingly positive and explosive. Despite the attempts of industry to discredit her as a communist, hysterical spinster, and incompetent scientist, Rachel Carson brought about a ban on the use of DDT and other pesticides. She inspired the emergence of the modern environmental movement and the establishment of the Environmental Protection Agency (EPA) in the United States (McLaughlin 2010).

In the final paragraphs of *Silent Spring*, Rachel Carson warns of the arrogance of a biological science that seeks to control nature for the convenience of humans rather than respecting the life forces directing ecological processes and maintaining the balance of nature. Unfortunately, that warning has gone largely unheeded and now, over sixty years later, we have lost nearly 30% of the bird population in North America (Rosenberg et al. 2019), and extinction threatens 40% of global insect populations (Sánchez-Bayo and Wyckhuys 2019). The continuing massive use of pesticides is one of the primary drivers of these declines. In this episode, we will examine how pesticide use affects the conservation of birds in general and specifically in Nova Scotia.

The pesticides used in Canada that might affect wild birds are herbicides, insecticides, and rodenticides, and the agricultural and forestry sectors are the primary settings where birds are at risk from

Rachel Carson. *Photo by Orion Pozo, Creative Commons Licence Attribution 2.0 Generic*

Rachel Carson and wildlife artist Robert Hines conductiong marine fieldwork in the 1950s. *Photo by United States Fish and Wildlife Service, public domain*

their application. Agricultural pesticides are Canada's fifth largest source of anthropogenic (human-caused) mortality, surpassed in order of magnitude by cats, power infrastructure, buildings, and transportation (Calvert et al. 2013). Environment and Climate Change Canada estimated that agricultural pesticides kill 960,000 to 4,310,000 birds yearly. While forestry operations destroyed an estimated 616,000 to 2,087,000 nests annually, that sector did not report deaths from pesticides. The effect of rodenticides on birds is a new field of research, but there may be an increasingly severe impact on raptors (Maron 2024). In the United States, pesticides kill an estimated 672 million birds annually (Erickson, Johnson, and Young 2005).

First, let us look more closely at the effect of pesticides on birds in agricultural habitats. Birds of farmlands and grasslands have experienced a dramatic decline in recent decades. Based on data from the North American Breeding Bird Survey, 74% of farmland and grassland birds (57 of 77 species) decreased from 1966 to 2013 (Stanton, Morrissey, and Clark 2018). Farm practices such as low tillage systems, heavy pesticide use, and conversion of grasslands to croplands are likely the most important reasons for this decline. Studies indicate that pesticide use is the leading cause of the decrease in the number of birds in agricultural settings (Mineau and Whiteside 2013; Stanton, Morrissey, and Clark 2018).

I will examine two of the most well-known and controversial pesticides used in agriculture: glyphosate, and a class of insecticides known as neonicotinoids or neonics. The most familiar of the neonics is imidacloprid. These two types of pesticides will also be central to our discussion of pesticides in the forestry sector.

Glyphosate-based herbicides are the most widely used pesticides to control undesirable vegetation and increase crop production worldwide. I found only one study that examined in detail the effects of glyphosate on bird health (Ruuskanen et al. 2020). This research showed that glyphosate decreased the antioxidant liver enzyme catalase in Japanese Quail (*Cotumix japonica*) but did not affect other antioxidant biomarkers or neurotransmitters. They noted suppressed beneficial microbes in the gut during the early ages of the birds and a decrease in testosterone in males at all ages. However, the researchers found no overall effect on reproduction. The significance of this study is that it shows that there likely are health effects on wild birds, especially birds smaller than a quail, which need further investigation.

A study in collaboration with a citizen science programme of the British Trust for Ornithology supports these findings. Participants in Garden Birdwatch filled out a questionnaire about the use of pesticides in gardens (Tassin de Montaigu and Goulson 2023). The most frequently used pesticides were glyphosate and metaldehyde (to control slugs and snails). The average House Sparrow (*Passer domesticus*) abundance was 24.9% lower in glyphosate-treated gardens. Additionally, the use of pesticides had a more significant negative impact on species richness in gardens surrounded by high-quality habitats compared to gardens next to low-quality habitats.

To understand the toxicity of neonics, reviewing the insecticides that preceded them is helpful (Weidensal 2022a). The first chemically synthesized class of pesticides was organochlorines, of which DDT is the most famous. These chemicals persisted in the environment and accumulated in the body fat of animals. Next came the organophosphates. These chemicals are highly toxic to insects and break down quickly in the environment. You may recognize some of their names: malathion, diazinon, and fenitrothion. However, they are highly toxic to other animals and are famous for some large bird kills. Carbonates are highly toxic to insects and birds, and their application also resulted in large-scale bird mortality incidents. An example of a carbonate is carbofuran.

Finally, there are the neonics. This class of insecticide is highly persistent in the environment and differs from its predecessors in two important ways. First, it is systemic; a plant from a seed coated or sprayed with it has the chemical everywhere: stems, leaves, flowers, fruit, and seeds. Second, it is difficult to identify its impacts. In the previous pesticides, you found a dead bird, or you could track the thinning of egg shells of top predators like Bald Eagles (*Haliaeetus leucocephalus*), Ospreys (*Pandion haliaetus*), and Peregrine Falcons (*Falco peregrinus*) through the accumulation of DDT via the food chain. With neonics, the chemical is in the soil, in the insects it kills, in the water where it kills aquatic insects, and in the emergent aquatic insects that aerial insectivores depend upon (Weidensal 2022b).

Thus, uncovering the effects of neonics has taken time, and it is not unusual for people to claim that neonics are harmless to birds, since it is hard to prove that they

are harmful. However, the evidence is now mounting. A review of 150 studies on the direct and indirect effects of neonics found significant sublethal impacts on vertebrates, including gene damage, cell damage, impaired immune function, and reduced growth and reproductive success, at chemical levels well below a lethal dose (Gibbons, Morrissey, and Mineau 2015).

Scientists attribute the 32% decline in aerial insectivores to an indirect effect of pesticides, particularly neonics, in reducing the populations of emergent aquatic insects that they eat (Weidensal 2022b).

However, other studies have documented the direct impact of imidacloprid on songbirds. In two studies of White-crowned Sparrows (*Zonotrichia leucophrys*), one in the lab and the other in the field, researchers exposed the birds to a dosage of neonic-treated seeds at field-realistic levels, equivalent to 2 to 9 treated-canola seeds during spring migration. The sparrows suffered from lethargy, impaired motor control, body mass and fat loss, and an inability to orient in the seasonally appropriate northern direction for two weeks during spring migration. They stayed 3.5 days longer at stopover sites than untreated birds. This delay could affect survival rates and reproductive success. Even before dosing, the researchers found that 80% of the White-crowned Sparrows already had neonics in their bloodstream (Eng, Stutchbury, and Morrissey 2017; Eng, Stutchbury, and Morrissey 2019; Weidensal 2022b).

In Switzerland, 100% of House Sparrows captured in one study had neonic residues on their feathers. In the Netherlands, higher concentrations of imidacloprid in surface waters corresponded with large declines in aquatic invertebrates and an annual 3.5% decline in three species of passerine insectivorous birds (Weidensal 2022b).

As another indication of the immense scale of the destructive consequences of neonic use, a recent study combining 17 years of pesticide and butterfly survey data in 81 counties in five states in the USA found that butterfly population declines were most strongly correlated with insecticides and the loss of species richness most associated with the use of neonics (Van Deynze et al. 2024).

Regulators are beginning to act. New Jersey, Maine, Vermont, and Quebec have placed some limitations on the use of neonics. In June of this year (2024), California prohibited using neonics on all Fish and Game Commission lands due to their negative impact on birds and bees (Udasin 2024). At about the same time, the State of New York passed the Birds and Bees Protection Act. This legislation bans neonic-treated seeds for agriculture and prohibits their use on outdoor ornamental plants and turf (lawns, gardens, golf courses) (Axelson 2024).

Since most pesticides used in agriculture are very similar to those in forestry, we will discuss forestry pesticides in Nova Scotia directly. The use of pesticides in Nova Scotia forests is often a hot public issue. Public protest arises annually when the forest industry receives permits to spray glyphosate on clearcuts to reduce and retard the regeneration of hardwood species on lands targeted for softwood harvesting.

This year (2024), protests erupted in several areas in the province when residents noticed signs warning them not to enter or pick berries in an area due to plans to spray it with glyphosate. Public protests and stand-ins arose in most areas marked for spraying (Don't Spray Nova Scotia Forests 2024). Local news outlets covered the story and reported on the most recent studies indicating that glyphosate has severe physiological effects on fish and may be carcinogenic to humans (Baxter 2024). For reasons that are not entirely clear, the spraying season ended early, sparing several of the protesting communities from glyphosate spray in 2024 (Starratt 2024).

Earlier in this episode, I discussed one study indicating the potential adverse effects of glyphosate on bird physiology. Another study in Nova Scotia describes the impact of glyphosate spraying on clearcuts in the province (MacKinnon and Freedman 1993). This study showed that while there was initially a suppression of bird abundance in the one to two years following spraying, bird populations were similar in treated and untreated sites by the fourth year after spraying. Nonetheless, after those four years, the spraying of clearcuts set those areas on a trajectory of forest succession that would create a habitat more favourable for coniferous bird species than those preferring deciduous habitats.

As I tell the current story of neonics in Nova Scotia forests, I realize that we have come full circle from 1962 when I picked up a copy of *Silent Spring* in my local bookstore. The arrival

Neonic spraying. *Photo by raxpixel.com, Creative Commons licence 1.0 Universal*

White-crowned Sparrow. *Photo by Don Faulkner, Creative Commons license Attribution-Sharealike 2.0 Generic*

Spraying of glyphosate on a forestry clearcut. *Photo by Francis Eatherington. Creative Commons licence Attribution-Non-commercial 2.0 Generic*

Hemlock Woolly Adelgid on Eastern Hemlock needles. *Photo by Steven Katovich, Bugwood.org. Creative Commons licence, Attribution 3.0*

of the tree-killing Hemlock Woolly Adelgid (*Adelges tsugae*) in our province in 2017 created conditions similar to those in 1962, when scientists and the pesticide industry supported using DDT to fight another tree affliction, Dutch elm disease. We are confronted again with a choice. Do we, with confidence in our knowledge and technology, decide to control nature to conquer the adelgid, or do we trust in the ecological processes that will create a new and resilient forest where the Eastern Hemlock (*Tsuga canadensis*) will play a diminished or non-existent role in the foreseeable future? The second choice is heart-wrenching, as it means the loss of a foundational species that has shaped the ecological landscape and constitutes much of the greatly diminished old-growth forest in Nova Scotia.

The federal and provincial governments and environmental organizations have made their choice. Environment and Climate Change Canada, the Nova Scotia Department of Natural Resources and Renewables, the Nova Scotia Department of Environment and Climate Change, Parks Canada, the Mi'kmaq of Nova Scotia, Nature Nova Scotia, the Nova Scotia Nature Trust, the Medway Community Forest Cooperative, and others are involved in funding, coordinating, promoting, or applying the use of neonics and other pesticides to kill the adelgid. There is virtually no public opposition.

The management plan to control the adelgid consists of two key elements. The first element is the application of pesticides through injection into the tree and by a basal bark spray. The pesticides used for injection are imidacloprid and treeazine (a botanical pesticide made from the neem tree), and imidacloprid and dinotefuran (also a neonic) for the basal bark spray. The second element is the development, environmental approval, and introduction of invasive beetles as predators of the hemlock woolly adelgid (Nova Scotia Department of Natural Resources and Renewables no date). Certain silvicultural practices have shown promise for alleviating the effects of the adelgid, which the spray proponents have not formally included in the management plan but which the Nova Scotia Hemlock Initiative mentions in their literature (Nova Scotia Hemlock Initiative no date).

The advocates of injecting and spraying

Dead Eastern Hemlocks in North Carolina. Photo by Jason Van Driesche, Bugwood.org. Creative Commons licence Attribution-Non-commercial 3.0

The Blackburnian Warbler (*Setophaga fusca*) is one of the most common birds in Eastern Hemlock forests in Nova Scotia. *Photo by Ray Hennessey via iStock*

neonics on hemlock trees claim that the substances are harmless to birds. They base this assertion on several pages of notes on the non-target effects of hemlock treatments, written by a research scientist with the Canadian Forest Service (Sweeney 2021). A summary table at the end of these notes indicates that the effect of the hemlock pesticides on birds would be "neutral" based on one study.

As I noted earlier in this episode, it is difficult and time-consuming to document the effects of neonics on the environment, due to their systemic action and long-lived persistence. To study the impact of imidacloprid on birds in hemlock stands would require studies documenting the level of neonics in their bloodstream from eating caterpillars that fed on hemlock needles, the amount of pesticides on their feet and feathers from coming in contact with the adelgid, the number of contaminated caterpillars fed to nestlings, and the amount of imidacloprid in the hemlock seeds eaten by crossbills and other finches in the winter. Once scientists can determine the exposure level in birds, they could conduct studies on the physiological effects and the long-term impact on the birds' populations. I am unaware of any such studies about birds in treated and untreated hemlock stands.

Nature Nova Scotia is a federation of environmental groups in the province, of which the Nova Scotia Bird Society is a member. Nature Nova Scotia is one of the primary advocates for treating Eastern Hemlock with pesticides. I would encourage the Nova Scotia Bird Society to challenge Nature Nova Scotia's assertion about the harmless effects of neonic injections and sprays on hemlock birds.

Harvard University has an experimental forest in Massachusetts. Ecologists have been studying the Eastern Hemlock there since the 19th century, and some current ecologists have written a book that is a eulogy for this tree (Foster 2014; Sullivan 2014). From an environmental perspective, they recommend doing nothing and letting the forest take care of itself through ecological processes. For landowners who can not afford this approach, they suggest some silvicultural practices to help their forest transition to one without the hemlock, and they urge all people to protect large areas of the remaining non-hemlock forests in ways that enhance overall resiliency and biodiversity.

Suppose we continue on the current path in Nova Scotia. In that case, we may create a double tragedy: no hemlock forest and widespread contamination of our lands and waters, continuing the decline and extinction of beneficial insects and birds. Then, my boyhood fear of a silent spring may soon be here.

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