I am Dr. Margaret Reda, a retired Emergency room physician who worked first at the Seven Oaks and then at the Concordia Hospital Emergency Department for over 25 years.

I want to make a summary of my submission by stating that I want the Cosmetic Pesticide Ban to remain in effect for these reasons

Dandelions and other plants that grow on disturbed ground are indicator plants of deficient soils, nutrient deficiency, imbalance of microorganisms and/or soil compaction. They are symptoms of underlying issues, that once addressed, will result in a reduction or elimination of dandelions. Herbicides and pesticides are one of the causes of poor soil conditions and poor soil conditions create conditions where problematic plants proliferate.

As well, dandelions are nontoxic, could be used as a very nutritious food source and and provide valuable services to the ecosystem. Dandelions help sustain populations of bees and beneficial insects by producing pollen and nectar in early spring for bees when little else is available

The herbicides used to control dandelions contain toxins like dioxins, that are proven to have many adverse health effects

The toxic effects of herbicides and the reduced number of flowers producing nectar and pollen are believed to be contributing causes of the alarming declines in pollinator populations. We are loosing bees and this is of major importance for fruit and seed production. Many foods that we depend on need pollination from bees

I want to address the soil microbiology of healthy grasslands. One teaspoon of soil contains 1 billion microorganisms Herbicides deaden these and create unhealthy soil organism balances that may take years or decades to recover. We started the ban in 2014.
We need at least a decade or more to give the soil a chance to recover. Please keep the ban and revisit it in 2025.

There are other factors besides avoiding the use of herbicides, that we need to make the public aware of to create healthy grasslands For example, hardy grasses like native varieties are better suited to our climate and can withstand competition. Using legume plants,(like white clover, or better yet, native clover and vetches) to fix nitrogen instead of artificial nitrogen fertilizer helps restore equilibrium to soil microbiology and promote strength. Grasslands, to remain healthy, need a variety of flowering plants to maintain their vigor to withstand invasive plants

I am now open to questions

Manitoba Syrphid Fly
An important Pollinator



June 10, 2019

Executive Policy Committee

His Worship Mayor Brian Bowman
Councillor Allard
Councillor Gilroy
Councillor Orlikow
Councillor Gillingham
Councillor Mayes
Councillor Rollins

A Poitras
M Ruta
K Boryskavich

Dear Members of the Executive Policy Committee

Thankyou for allowing me the opportunity to speak today regarding the 2016 Cosmetic Ban Review Findings. I understand that Transcona is finding the the challenges of weed management are significant and extremely visible

The recommendation to request Government of Manitoba to release the findings from their 2016 Cosmetic Ban review alarmed me because of the implication that the the findings of this review may result in our cosmetic ban to become weakened or abolished

I do question how relevant the review would be, since the ban would actually be in its first year if the grace period were taken into account. It means that this study is being performed on the very first summer of full implementation So I do think that should be considered

The cosmetic ban had been championed by a group called the Cosmetic Pesticide Ban Manitoba

Members of the working group represent Campaign for Pesticide Reduction, Chemical Sensitivities Manitoba, Coalition of Concerned Mothers of Manitoba, Environmental Health Association of Manitoba, Green Action Centre, Manitoba Eco-Network, and the Social Planning Council of Winnipeg. The Canadian Association of Physicians for the Environment provides health and policy input. Ecojustice provides legal and regulatory advice.

Members of the working group represent Campaign for Pesticide Reduction, Chemical Sensitivities Manitoba, Coalition of Concerned Mothers of Manitoba, Environmental Health Association of Manitoba, Green Action Centre, Manitoba Eco-Network, and the Social

Planning Council of Winnipeg. The Canadian Association of Physicians for the Environment provides health and policy input. Ecojustice provides legal and regulatory advice.

These national organizations support a ban on cosmetic uses of pesticides: Canadian Cancer Society, Canadian Environmental Law Association, Canadian Nurses for Health and Environment, David Suzuki Foundation, Prevent Cancer Now, and the Sierra Club of Canada.

So there have been many groups supporting the ban. The very limited time frame to make this presentation didn't allow me time to contact these group to accompany me So I wanted to review with the Executive Committee what is at stake if this legislation is weakened or abandoned

We have to remember that pesticides are poisons. They kill not only flowering plants and broadleaved plants, but also soil microorganisms. Their effects on the soil fertility can last for years if not decades or longer. There is drift from herbicides that affect untargeted plants resulting in reduced seed production or poor health. Toxic pesticides, the breakdown products and their adjuvants end up in our streams, rivers, lakes and marshlands adversely affecting aquatic life. These many effects, the reduction of flowering and broad leaved plants and seeds have wide ranging implication for the insects, birds and other living creatures that depend on those plants and seeds for their survival. Especially alarming is the effects on keystone species of beneficial insects such as pollinators

I have included several references that document wild bees visiting flowering plants on turf lawn(15),(19)

One study from Kentucky found 50 different species of insect pollinators visiting dandelion and white clover. There were 6 species of bumblebees including 2 that were considered uncommon and in decline The conclusion of this article was that "Fostering a public awareness of the diversity of bees and other pollinators that visit flowering lawn weeds might help nurture a sociocultural shift towards more pollinator friendly lawn care practices

In another 2014 study of 17 surburban yards in Springfeild, MA where they did not apply pesticides or herbicides, 5331 individual bees representing 111 species were collected Of these, 94.6 per percent were native species of bees. The most abundant species were of flowering lawn plants were dandelion and white clover. There were 63 plant species growing in lawns, and nearly 30 percent were native to North America. The conclusion of this study was that spontaneous lawn flowers could be viewed as supplemental floral resources and support pollinators , thereby enhancing urban green space

Pollinators are known to be in decline where studied. Bees are of considerable importance since without them we would not be able to grow fruits like apples, berries, tomatoes, zucchini and sunflower seeds in our gardens

The health risks of herbicides are well documented and include increased cancer risks, and birth defects. Neurological and neurobehavioural problems, are especially featured with children being especially vulnerable

What is at stake?

Pollinators
Soil microorganisms and soil fertility
Aquatic life
Our health, especially children and pets
Increased cancer risks
Increased risks of birth defects
Neurological and neurobehavioural health

I want to share a bit about why I am especially sensitive to this issue. I am trained as a physician and am retired for 3 years now. My undergraduate degree was Science and I was working towards a Degree in Microbiology and took second year microbiology course. As a physician, we are trained about the microbial causes of disease. But I do have extra training in my undergraduate year about microorganisms. A few years ago I took an Online university course called The world beneath your feet. It was about soil, its importance and fragility, how vulnerable it is and how it should be considered a nonrenewable resource since it takes many centuries to form a very thin layer.

There are 100,000 to one billion microorganisms per teaspoon of soil.(25) There are very complex interactions between plants and soil microorganisms responsible for nutrient cycling and plant health. And we are just starting to learn about these intricacies. It is complicated and fascinating. But we should know that herbicides change the ratios and composition of soil microbes and can create unfavorable and disturbed soil conditions for plants, with some plants being more sensitive than others.

During my medical training years, I also did a research project (B.Sc. Med)in the Department of Pharmacology in the University of Manitoba under Dr F LaBella There were two research assistants working there on his projects Some of his work was with dioxins Dioxins are a toxic molecule that is byproduct in the production of herbicides as well as many other industrial processes The percentage of dioxins in herbicides can vary from very tiny amounts to very significant depending on the quality of the production process

They two researchers both had small children with birth defects. And they did believe that the chemicals they worked with may have been the cause. They were very protective of me while I was working there, advising me to stay clear of their work areas when they were working with dioxins and advising me that even one molecule of dioxin could alter DNA within me permanently

Dioxins are just one of the many toxins associated with herbicide pesticides

We are storytellers and we have often believed things that are false. And these stories have led to many atrocities and calamities through out history and in our world. And now we are concocting a story that a beautiful lawn should be free of flowering plants, especially dandelions. This story threatens the fertility of our soil, the populations of bees, pollinators and other beneficial insects, and our health and wellbeing. For the longterm interests of our ecosystem, our planet and our wellbeing, we need to believe in a different story. A story that recognizes the important beneficial roles that dandelions and other flowering plants play in our lawns. A story that respects and fears the many problems created by poisonous chemicals

When we recognize dandelions as the symptom and not the disease, then we can start to ask the right questions and obtain the right answers. What constitutes healthy grassland? How do we restore a healthy community of soil microbes for optimal soil fertility? If we were to achieve the plant communities of the native prairie grasslands, there would be no dandelions and we would have a vibrant community of grasses and flowering plants all contributing to vibrant soil health

But in the meantime, while our soil recovers from the assaults that have been inflicted, let us have the humility and the wisdom to allow natural processes, that have sustained life on our planet for 3.5 billion years, to restore its balance. You hold the power to create a better world for our soil, our pollinators, our health and our children's health. The cosmetic ban on pesticides is a small step in the right direction. I ask that you continue to support it.

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(2) https://winnipeg.ca/publicworks/insectControl/mosquitoes/pdfs/Pyrate-480EC-Label.pdf

(3) https://www.amazon.ca/ORTHO-KILLEX-Lawn-Killer-Concentrate/dp/B00LM9AWU6/ref=sr_1_fkmr0_2?creativeASIN=B004Q0BQ6C&imprToken=sliM5nIRhN.1myJSXikc-g&keywords=BAYER+NATRIA+LAWN+WEED+KILLER+2+PACK+CONC.+10oz+%28Two+5oz+Bottles%29&linkCode=g13&qid=1560188633&s=lawn-garden&sr=1-2-fkmr0

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(5) https://en.wikipedia.org/wiki/Dicamba

(6) https://en.wikipedia.org/wiki/Herbicide

(7) https://necsi.edu/a-possible-link-between-pyriproxyfen-and-microcephaly-preliminary-version

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(23) https://www.biologicaldiversity.org/campaigns/native_pollinators/pdfs/Pollinators_in_Peril.pdf

(24)
https://www.biologicaldiversity.org/campaigns/native_pollinators/pdfs/native_bees_index.pdf

(25)Teaming with Microbes Revised edition. Jeff Lowenfels & Wayne Lewis 2010 page 112

Dioxins

What are they?

Where are Dioxins found?

How can I be exposed to Dioxins?

What happens when I am exposed to Dioxins?

Who is at risk for exposure to Dioxins?

Reduce your risk

External links

What are they?

Dioxins are a group of chemicals that are highly toxic and persistent in the environment. Dioxin is also the common name for the chemical TCDD, the most toxic of this family. These chemicals are persistent organic pollutants (POPs) and endocrine disruptors.

Most dioxins are byproducts of industrial activities, including making pesticides and herbicides. They are also emitted from cigarette smoke, vehicle exhaust, and oil furnaces. They are produced from waste incineration, trash burning and fuels, forest fires, and volcanoes. Polychlorinated biphenyls (PCBs) are dioxins.

TCDD dioxin was a byproduct of the herbicide Agent Orange, which was used as a defoliant by the U.S. military during the Vietnam War.

See also: Trash Factories Food and Cooking Brownfield Air Pollution Learning and Developmental Disabilities Reproductive Health Cancer

Where are Dioxins found?

- Consumer products - cigarettes, pesticides, and herbicides
- Food – meat, dairy products, fish, and shellfish
- Air - forest fires, volcanoes, cigarette smoke, secondhand smoke, and industrial activities

How can I be exposed to Dioxins?

Dioxins commonly enter(s) the body through:



Ingestion (swallowing)

- Eating contaminated food



Inhalation (breathing)

- Breathing contaminated air, cigarette smoke, secondhand smoke, fuel emissions, and vehicle exhaust

---

What happens when I am exposed to Dioxins?

Short-term:

Exposure to dioxins can cause:

- Skin disease and discoloring
- Liver damage

Long-term:

Long-term exposure to TCDD dioxin can cause:

- Cancer

Long-term exposure to all dioxins can cause:

- Reproductive and infertility problems
- Miscarriage
- Developmental problems in children
- Interference with the body's natural hormones
- Damage to the immune system
- Liver damage

Who is at risk for exposure to Dioxins?

- Consumers
  - Cigarettes and vehicles emit dioxins.
- Farmers
  - Some pesticides and herbicides contain dioxins.
- Vietnam veterans
  - The herbicide Agent Orange produced TCDD dioxin as a byproduct.
- Women of child-bearing age
  - Exposure to dioxin can cause miscarriage and reproductive and infertility problems.

Reduce your risk

If you think your health has been affected by exposure to dioxins, contact your health care professional.

Always wash your hands thoroughly after handling chemicals. For poisoning emergencies or questions about possible poisons, please contact your local poison control center at 1-800-222-1222.

Evaluate

Avoid and Address

Protect Children

External links

National Library of Medicine Resources and Databases

- 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD). Hazardous Substances Data Bank
  Search results on 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) from a toxicology database that focuses on the toxicology of potentially hazardous chemicals.

Additional Resources

- Dioxins and Their Effects on Human Health (World Health Organization)
  Factsheet on dioxins and how exposure affects human health, including background information, sources and incidents of dioxin contamination, populations at risk for adverse health effects, and activities for identifying, measuring, preventing, and controlling exposure.

- Dioxins (National Institute of Environmental Health Sciences)
  Information on dioxins, including potential adverse health effects due to exposure, their chemical make up, and links to relevant news, factsheets, and additional resources from a federal institute that investigates the interplay between environmental exposures, human biology, genetics, and common diseases to help prevent disease and improve human health.

- Chlorinated Dibenzo-p-dioxins (CDDs). ToxFAQs (Agency for Toxic Substances and Disease Registry)
  Factsheet with answers to most frequently asked questions about chlorinated dibenzo-p-dioxins (CDDs) exposure and its effect on human health, developed by a federal public health agency that protects communities from harmful health effects related to exposure to natural and man-made hazardous substances.

- What is Dioxin? (Navy and Marine Corps Public Health Center)
  Resource on dioxin that includes information about its properties and sources, as well as its effects on the health of the environment, humans, and laboratory animals.

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Published May 31, 2017

World Health Organization

PREVENTING DISEASE THROUGH HEALTHY ENVIRONMENTS

EXPOSURE TO DIOXINS AND DIOXIN-LIKE SUBSTANCES: A MAJOR PUBLIC HEALTH CONCERN

Human exposure to dioxins and dioxin-like substances has been associated with a range of toxic effects, including immunotoxicity, developmental and neurodevelopmental effects, and changes in thyroid and steroid hormones and reproductive function. Developmental effects are the most sensitive health end-point, making children, particularly breastfed infants, the population most at risk.[1,2] Dioxins and dioxin-like substances are persistent organic pollutants (POPs) covered by the Stockholm Convention on Persistent Organic Pollutants; they can travel long distances from the emission source and can bioaccumulate in food-chains.[3] Human exposure occurs mainly through consumption of contaminated food.[1,4] Public health and regulatory actions are needed to reduce emissions of these substances, as required by the Stockholm Convention, and to reduce human exposure, particularly for children.

What are dioxins and dioxin-like substances?

The term "dioxins and dioxin-like substances" commonly refers to polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs). They are two- or three-ring structures that can be chlorinated to varying degrees. PCBs can have up to 10 chlorine atoms substituting for hydrogen atoms, and PCDDs and PCDFs can have up to 8. The compounds often have similar toxicity profiles and common mechanisms of action and are generally considered together as a group to set guidelines.[1,4]

Sources of exposure to dioxins and dioxin-like substances[1,4,5]

PCDDs and PCDFs are widely present in the environment, occurring naturally and as by-products of combustion and of various industrial processes. PCDFs were major contaminants of PCBs, but neither PCDDs nor PCDFs have ever been manufactured deliberately. They have no known uses.

PCBs are not natural substances but were globally manufactured and used in the past. Although PCB manufacture is prohibited under the Stockholm Convention on Persistent Organic Pollutants, their release into the environment still occurs from the disposal of large-scale electrical equipment and waste.

Mixtures of the substances with different numbers and positions of chlorine substitution are found in the environment. The degree of chlorination of dioxin mixtures released to the environment through incineration is determined by the source material and the amount of chlorine available.

Remedial actions have led to reductions in exposure in the developed world, with a fall to around 10% of levels seen in the 1970s. Countries with rapidly expanding development are experiencing increasing exposure, particularly to PCDDs and PCDFs, but levels are still below those developed countries in the 1970s.

Industrial processes and natural events

PCDDs and PCDFs are by-products of industrial processes, including the manufacture of chlorophenols and phenoxy herbicides, chlorine bleaching of paper pulp and smelting. They can also be generated by natural events, such as volcanic eruptions and forest fires. PCBs were previously manufactured for use as dielectric fluids (with low electrical conductivity) in larger-scale electrical products such as transformers and capacitors, in heat transfer and hydraulic systems and in industrial oils and lubricants. PCDFs were common contaminants of commercial PCB mixtures.

Food, water and air

Generally, levels of PCBs, PCDDs and PCDFs in air are very low, except in the vicinity of inefficient incinerators. Concentrations of these compounds in drinking-water and surface water are also very low, because they are poorly soluble in water. Releases to air from inadequate incineration and releases from waste sites contaminate soil and aquatic sediments, leading to bioaccumulation and bioconcentration through food-chains. The higher chlorinated components and components with specific positions of chlorination persist longer in the environment and show greater bioaccumulation. The substances have high fat solubility, which may lead to higher concentrations in fatty foods, such as dairy products, some fish, meat and shellfish. Most human exposure is through ingestion of contaminated food. These compounds persist in fatty tissue, with typical half-lives in humans in excess of 7 years.

Waste disposal

Any source of organic materials in the presence of chlorine or other halogens will generate dioxins and furans during combustion. PCDDs and PCDFs are generated through the incineration of waste (domestic, industrial and hospital) at low to moderate temperatures; guidance has been developed to identify and quantify releases from various incineration processes. The use of modern incineration technology destroys dioxins and furans, whereas inadequate incineration creates them.[6]

Disposal of electrical equipment may release PCBs (and PCDF contaminants); guidance is available on equipment likely to contain PCBs.[7,8] Stockpiles of old industrial lubricants containing PCBs are also a potential source of emissions.

Derivation of toxic equivalency factors (TEFs)

Some individual compounds with particular levels of chlorination and/or positions of the chlorine substitutions are much more toxic than others. Toxic equivalency factors (TEFs) have been established to compare the toxicities of individual PCDDs, PCDFs and PCBs relative to the most toxic of these compounds: 2,3,7,8-tetrachlorodibenzodioxin (TCDD), which is used as a reference and given a TEF of 1.[9,10] The common mechanism of action for these substances means that their effects are additive, and TEFs for individual compounds can be summed to establish a TEF for mixtures. This approach has proved robust as a method for establishing the relative toxicities of these compounds.

Countries should develop local inventories based on guidance for the identification and quantification of dioxin and furan releases.[6]

- Reduce emissions of dioxins and dioxin-like substances as required under the Stockholm Convention on Persistent Organic Pollutants.[3]

- Incineration at high temperatures with long residence times and adequate mixing is required to reduce emissions of dioxins and dioxin-like substances. An inventory of suitable incineration facilities globally has been prepared.[16]

Disposal

- Follow global guidelines for the identification of PCBs in materials and equipment to inform local actions.[7,8]
- Clean up and safely dispose of industrial waste containing PCBs and PCDFs (or likely to generate PCDDs). Routine rehabilitation of contaminated sediments is not recommended. The necessity for environmental cleanup should be decided through risk assessment on a case-by-case basis.
- Guidance is available on the disposal of health-care waste.[17]
- Further develop international programmes for disposal to aid countries without suitable waste management facilities.

Reduce contamination in food

- Apply strategies developed by WHO/FAO to reduce contamination in food and feed. Countries should develop and implement local strategies.[2]

Monitoring

- Monitor PCDDs, PCDFs and PCBs in food items and human milk. WHO has been involved in such monitoring since 1976, and this is properly done at the international level.[18] More cost-effective bioassays should precede costly chemical analysis in individual developing countries.

References

1. WHO (2002). Polychlorinated dibenzodioxins, polychlorinated dibenzofurans, and coplanar polychlorinated biphenyls. In: *Safety evaluation of certain food additives and contaminants*. Geneva, World Health Organization (WHO Food Additives Series, No. 48; http://www.inchem.org/documents/jecfa/jecmono/v48je20.htm).
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World Health Organization

World Health Organization (WHO) dioxin guidelines

Provisional tolerable monthly intake

In 2002, the Joint Food and Agriculture Organization of the United Nations (FAO)/WHO Expert Committee on Food Additives (JECFA) established a provisional tolerable intake of 70 pg/kg body weight per month for PCDDs, PCDFs and coplanar PCBs expressed as TEFs, based on reproductive end-points.[1] The value is expressed "per month" to reflect that exposure is cumulative and chronic rather than acute.

Drinking-water

No water quality guidelines have been set for these substances because of their low water solubility.

Air

An air quality guideline for PCBs was not established, because direct inhalation exposures constitute only a small proportion of the total exposure, in the order of 1–2% of the daily intake from food. Although this air concentration is only a minor contributor to direct human exposure, it is a major contributor to contamination of the food-chain.[11]

Health effects

- Short-term exposure to high levels of dioxins and dioxin-like substances in occupational settings or following industrial accidents may cause skin lesions known as chloracne, which is persistent.[1]

- Longer-term environmental exposure causes a range of toxicity, including immunotoxicity, developmental and neurodevelopmental effects, and effects on thyroid and steroid hormones and reproductive function. The most sensitive life stage is considered to be the fetus or neonate. Guidance values have been based on reproductive and developmental effects.[1,4,5]

- Experimental animal studies indicate carcinogenicity in a range of species with multiple sites of tumours. Epidemiological studies in occupational settings also indicate human carcinogenicity at multiple sites. The International Agency for Research on Cancer (IARC) classified TCDD in Group 1 (*carcinogenic to humans*) and some other dioxins in Group 3 (*not classifiable as to their carcinogenicity to humans*).[12,13] PCBs as a group are classified in Group 2A (*probably carcinogenic to humans*).[14] In addition, IARC recently classified 2,3,4,7,8-pentachlorodibenzofuran and 3,3′,4,4′,5-pentachlorobiphenyl in Group 1.[13]

- These substances are not genotoxic carcinogens. It is considered that the mechanism of carcinogenesis, involving the aryl hydrocarbon receptor, means that there is a threshold for carcinogenicity. Tolerable intake guidance based on non-cancer end-points is considered protective for carcinogenicity.[1]

Risk mitigation recommendations

Inventory and reduce emissions

- Inventory emissions of dioxins and dioxin-like substances, guidance on inventory development and analysis of current inventories regionally and globally is available.[15]

ScienceDaily®
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More than dozen wild bee species declining in Northeastern U.S.

Date: April 9, 2019

Source: University of New Hampshire

Summary: Researchers have found a dramatic decline of 14 wild bee species that are, among other things, important across the Northeast for the pollination of major local crops like apples, blueberries and cranberries.

FULL STORY

Researchers at the University of New Hampshire have found a dramatic decline of 14 wild bee species that are, among other things, important across the Northeast for the pollination of major local crops like apples, blueberries and cranberries.

"We know that wild bees are greatly at risk and not doing well worldwide," said Sandra Rehan, assistant professor of biological sciences. "This status assessment of wild bees shines a light on the exact species in decline, beside the well-documented bumble bees. Because these species are major players in crop pollination, it raises concerns about compromising the production of key crops and the food supply in general."

In the study, which was recently published in the journal *Insect and Conservation Diversity*, researchers used local museum records to compare changes in the wild bee community in New Hampshire over the span of 125 years (1891-2016). They looked at characteristics such as habitat preferences, range, elevation, and latitude as well as social behavior. Researchers say all 14 of the species found to be in decline are native to New England but are widespread and important across the Northeast and North America. Out of those declining species, 13 are ground nesters and one is a cavity nester. Researchers also found that most of the declining species experienced significant shifts in both elevation and latitude.

"We found that wild bee species that once greatly populated more southern areas near sea level are now in decline," said Rehan. "While up north in more mountainous areas, like the White Mountains, those same species persist which is an indicator of how climate change is affecting certain populations, especially in the Seacoast area."

Of the bee species found to be in decline, 50% showed a shift of being more abundant in northern areas and in higher elevations. However, one third of the eight wild bee species that seemed to be on the increase also showed a northward migration over the 125-year period. Researchers say that with the predictions for climate change to continue, monitoring the habitat shifts in these wild bees will be important to help with appropriate landscape management, crop production and conservation policies.

Story Source:

Materials provided by **University of New Hampshire**. *Note: Content may be edited for style and length.*

Journal Reference:

1. Minna E. Mathiasson, Sandra M. Rehan. **Status changes in the wild bees of north-eastern North America over 125 years revealed through museum specimens**. *Insect Conservation and Diversity*, 2019; DOI: 10.1111/icad.12347

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Data from: Patterns of Widespread Decline in North American Bumble Bees

Bumble bees (*Bombus*) are vitally important pollinators of wild plants and agricultural crops worldwide. Fragmentary observations, however, have suggested population declines in several North American species. Despite rising concern over these observations in the United States, highlighted in a recent National Academy of Sciences report, a national assessment of the geographic scope and possible causal factors of bumble bee decline is lacking. Here, we report results of a 3-y interdisciplinary study of changing distributions, population genetic structure, and levels of pathogen infection in bumble bee populations across the United States. We compare current and historical distributions of eight species, compiling a database of >73,000 museum records for comparison with data from intensive nationwide surveys of >16,000 specimens. We show that the relative abundances of four species have declined by up to 96% and that their surveyed geographic ranges have contracted by 23–87%, some within the last 20 y. We also show that declining populations have significantly higher infection levels of the microsporidian pathogen *Nosema bombi* and lower genetic diversity compared with co-occurring populations of the stable (nondeclining) species. Higher pathogen prevalence and reduced genetic diversity are, thus, realistic predictors of these alarming patterns of decline in North America, although cause and effect remain uncertain.

Bumble bees (*Bombus*) are integral wild pollinators within native plant communities throughout temperate ecosystems, and recent domestication has boosted their economic importance in crop pollination to a level surpassed only by the honey bee. Their robust size, long tongues, and buzz-pollination behavior (high-frequency buzzing to release pollen from flowers) significantly increase the efficiency of pollen transfer in multibillion dollar crops such as tomatoes and berries. Disturbing reports of bumble bee population declines in Europe have recently spilled over into North America, fueling environmental and economic concerns of global decline. However, the evidence for large-scale range reductions across North America is lacking. Many reports of decline are unpublished, and the few published studies are limited to independent local surveys in northern California/southern Oregon, Ontario, Canada, and Illinois.

Furthermore, causal factors leading to the alleged decline of bumble bee populations in North America remain speculative. One compelling but untested hypothesis for the cause of decline in the United States entails the spread of a putatively introduced pathogen, *Nosema bombi*, which is an obligate intracellular microsporidian parasite found commonly in bumble bees throughout Europe but largely unstudied in North America. Pathogenic effects of *N. bombi* may vary depending on the host species and reproductive caste and include reductions in colony growth and individual life span and fitness. Population genetic factors could also play a role in *Bombus* population decline. For instance, small effective population sizes and reduced gene flow among fragmented habitats can result in losses of genetic diversity with negative consequences, and the detrimental impacts of these genetic factors can be especially intensified in bees. Population genetic studies of *Bombus* are rare worldwide. A single study in the United States identified lower genetic diversity and elevated genetic differentiation (FST) among Illinois populations of the putatively declining *B. pensylvanicus* relative to those of a codistributed

stable species. Similar patterns have been observed in comparative studies of some European species, but most investigations have been geographically restricted and based on limited sampling within and among populations.

Although the investigations to date have provided important information on the increasing rarity of some bumble bee species in local populations, the different survey protocols and limited geographic scope of these studies cannot fully capture the general patterns necessary to evaluate the underlying processes or overall gravity of declines. Furthermore, valid tests of the *N. bombi* hypothesis and its risk to populations across North America call for data on its geographic distribution and infection prevalence among species. Likewise, testing the general importance of population genetic factors in bumble bee decline requires genetic comparisons derived from sampling of multiple stable and declining populations on a large geographic scale. From such range-wide comparisons, we provide incontrovertible evidence that multiple *Bombus* species have experienced sharp population declines at the national level. We also show that declining populations are associated with both high *N. bombi* infection levels and low genetic diversity.

This data was used in the paper "Patterns of widespread decline in North American bumble bees" published in the Proceedings of the National Academy of United States of America.



Data from: Patterns of Widespread Decline in North American Bumble Bees (Data Dictionary) (/dataset/data-patterns-widespread-decline-north-american-bumble-bees/resource/c647727a-ae32-4332-bb79-637d6c1feb94)

Dataset data dictionary

This is an XML data dictionary for Data from: Patterns of Widespread Decline...

Patterns of Widespread Decline in North American Bumble Bees (DWC Archive) (/dataset/data-

ZIP **patterns-widespread-decline-north-american-bumble-bees/resource/fd32c51d-4532-41a5-bc25-d32dc0ad7b57)**
Data from: Patterns of Widespread Decline in North American Bumble Bees --...

CSV **Patterns of Widespread Decline in North American Bumble Bees (DWC Archive) (/dataset/data-patterns-widespread-decline-north-american-bumble-bees/resource/7893e707-a1f4-47c1-bf01-98221b0725c3)**
File modified to remove fields with no recorded values.

HTML **Nosema bombi isolate Bom.pen.Ark1 18S ribosomal RNA gene (/dataset/data-patterns-widespread-decline-north-american-bumble-bees/resource/1fb2b96a-5993-4707-af24-77d8d495c22d)**
Nosema bombi isolate Bom.pen.Ark1 18S ribosomal RNA gene, partial sequence;...

HTML **Nosema bombi isolate 1 small subunit ribosomal RNA gene (/dataset/data-patterns-widespread-decline-north-american-bumble-bees/resource/7c963643-3696-4ec3-a6e3-3430cd174c4e)**
Nosema bombi isolate 1 small subunit ribosomal RNA gene, partial sequence;...

Dataset Info

Field	Value
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bees, Bombus, Bombus occidentalis, Hymenoptera, pollinators, pathogens, population dynamics, genetic variation, genetic factors, geographic distribution, Microsporidia, Nosema, crops, decline, pollen, plants (botany), plant communities, population structure, wild plants, domestication, indigenous species, ecosystems, flowers, tomatoes, small fruits, honey bees, hosts, gene flow, gravity, risk, longevity