# Re:  Pesticides in response to West Nile Virus

Recent research on West Nile Virus (WNV), and on the effects of pesticides on people and wildlife (mosquitoes, mosquito predators, birds and other wildlife) clearly shows the need for caution and vigilance in the use of insecticides to control WNV. Regardless of the severity of the illness, public health initiatives such as pesticide spraying must not compromise human or ecosystem health so that adverse human health effects negate the initiative, or that mosquito populations subsequently flourish because predator populations are diminished.

Public education regarding mosquito avoidance and small container breeding site cleanup are of paramount importance.  These are proven internationally to be the most successful strategies for vector-borne disease reduction.

WNV is spreading rapidly among the birds of North America, and will kill large numbers of some species. We now know that even the most effective mosquito control measures would not halt this spread, because the virus is spread amongst birds by other insects (e.g. ticks), and birds become infected by eating infected animals (bird, mammal or insect) or by exposure to virus in skin or excrement of infected birds. Fortunately, many of the birds surveyed have been shown to have developed immunity after exposure to West Nile Virus.  Based on experience elsewhere, It is hoped that WNV will fade into the background when the "viral pool" in the environment drops because immunity has developed in a large portion of wildlife, particularly in birds, the most susceptible and mobile host. (1)

Mosquito-borne diseases will become more common with global warming and international trade and travel.(2)  Insecticide resistance is increasing. (3)  Canadians' response to WNV is a rehearsal for response to other diseases on our doorstep.  The most effective, sustainable means of disease control are to dress appropriately, use non-toxic insect repellents, exclude insects from homes, minimise mosquito-specific breeding habitats, and nurture mosquito-predator populations such as amphibians, fish, birds, bats and dragonflies.  Non-specific pesticides harm people and mosquito-predator populations directly, (4) and also decrease predator populations indirectly by interrupting (temporarily) the supply of the mosquitoes they eat.  For example, eleven years of pesticide spraying to control adult mosquitoes carrying equine encephalitis in NY state led to a fifteen-fold increase in mosquitoes, as well as an increase in the proportion of the species capable of carrying encephalitis. (5)  When the pesticide effect wears off, the environment has lost its natural checks and balances.  Mosquitoes have short life spans and populations rebound in days or weeks, while mosquito predator populations rebuild more slowly, if at all.  Conversely, release of native predators such as fish and dragonflies may effectively reduce both mosquitoes and vector-borne disease. (6)
Present pesticide use practices probably put people at greater risk of WNV.  For instance, in urban areas, rain washes insecticides and fungicides used on turf into streams, at levels that could affect dragonfly, amphibian and fish populations.(7) Rather than using yet more pesticides to fight WNV, it would be more effective to nurture a diverse ecosystem which would keep mosquitoes in check.

## Comments on specific pesticides proposed for control of WNV:

### Larvicides:

*Bacillus thurigiensis* (var. *israelis*) (Bti) is a relatively specific mosquito larvicide.(8)  However, as with many pesticides, secret toxic additives (formulants) pose unknown risks.

Non-specific insect growth regulators methoprene and diflubenzuron are larvicides that may be used to treat wet areas and the catch-basins at the bottom of street drainage holes, connected to storm sewers. It is inevitable that these pesticides will be washed into streams during storm events, compromising invertebrate, amphibian and fish populations that prey on mosquitoes. (9)  During breakdown, methoprene is converted to retinoids, that are potent teratogens.(10) The diflubenzuron metabolite, 4-chloroaniline is a mutagen, is carcinogenic in rats and mice, and causes methaemoglobinaemia ("blue baby syndrome") in exposed workers and in neonates inadvertently exposed. (11) These chemicals are toxic to crustaceans such as crayfish, shrimp and lobster.

The organophosphate chlorpyrifos is registered as a larvicide.  However, it adversely affects many non-target species, including people,(12) is more persistent in the environment, and cannot be justified when other less toxic alternatives exist.

Bti may appear to be more expensive than the growth regulators because it has to be reapplied more frequently. However, when distributed in sewers, outfall concentrations of growth regulators should be monitored, and these labour and testing costs could offset up-front costs of Bti distribution.

**Adulticides:**

Killing adult mosquitoes by spraying insecticides is partially and temporarily effective at best, and poses the greatest risks to non-target species, including humans and mosquito predators. (6) Broadcasting pesticides contributes to insecticide resistance in a large number of species.

The organophosphates "malathion" and "chlorpyrifos" are adulticides approved for use in Canada. Organophosphate exposure has been a leading cause of hospitalisations for occupational pesticide poisonings in the US. (13) Organophosphates in humans can "overstimulate the nervous system causing nausea, dizziness, confusion, and, at very high exposures (e.g. accidents, major spills), respiratory paralysis and death."(14) They disturb the immune system in a number of species, (15) and in minute amounts are potent immunosuppressants in frogs. (16) Furthermore, this class of chemical has been implicated in cognitive and motor deficits in children. (17) Organophosphates are on the Quebec Pesticide Code list of pesticides banned for non-agricultural use. (18) They are very toxic to bees, other beneficial insects, snails, worms, crustaceans, fish and birds.

Canada's approval for malathion is consistent with the American registration. However, re-registration of malathion by the United States EPA was done without the safety margins for children required under Canada's new Pest Control Products Act, and despite dispute over carcinogenicity conclusions(19) and its environmental impacts(20).

Chlorpyrifos has been banned in Canada for use around homes and schools, because of acute and long-term neurotoxicity and other concerns, but incredibly is still allowed for mosquito control.(21)

## Conclusion

Wide-ranging effects of pesticides and rapidly emerging pesticide resistance are only part of what should be considered when deciding how to minimise the public health risk of WNV. Just as the medical community is belatedly emphasising common-sense behavioural disease prevention (eg avoidance and hand-washing) and reduced reliance on antibiotics, we must appreciate that chemical meddling with natural systems has a high probability of back-firing. Indeed, across the landscape, present pesticide use potentially contributes to increased risk of WNV. Healthy immune systems and diverse ecosystems are our best lines of defence against WNV.

## Recommendations

1. Public education regarding mosquito avoidance and breeding site cleanup. This is proven internationally to be the most successful strategy to deal with vector-borne disease.
2. Larvicides may temporarily reduce mosquito populations, but this is not a well-proven strategy for disease reduction, either in wildlife or people. If effective in mosquito reduction, it could well have adverse effects on predator populations. However, if a larvicide is to be used, Bti is the least toxic, most specific agent. Products registered for organic farming are free of toxic formulants. Larviciding should be targeted, and restricted to areas known to have active disease in wildlife. It would be prudent to monitor any larvicide program to examine effectiveness of mosquito control and impact on mosquito predator populations. Growth inhibiting larvicides threaten non-target species, including mosquito predators and commercial seafood. Organophosphates cannot be justified for larval control because safer alternatives are available.
3. Spraying non-specific synthetic pesticides to kill adult mosquitoes in response to WNV poses greater risks than benefits both to people and to the environment. It is not justified, even as "last resort", and even if WNV is a more virulent, serious disease than thought previously. All governments should dismiss the possibility of spraying pesticides to kill adult mosquitoes.
4. The WNV outbreak also makes urgent the need to re-examine current pesticide use practices to minimise the impact on non-target species that prey on mosquitoes and thereby reduce human risk of WNV. In light of the seriousness of WNV, it would be reasonable to impose an immediate moratorium on cosmetic pesticides. Why put citizens at increased risk of WNV for the sake of pristine lawns, especially since non-toxic alternatives are available?

**Excellent peer-reviewed summary of many relevant issues:**

Their A. Balancing the Risks: Vector Control and Pesticide Use in Response to Emerging Illness. J Urban Health 78(2):372-378, 2001

**A few interesting websites:**

From Ottawa: http://www.sankey.ws/wnv.html

The Maine perspective: http://www.meepi.org/wnv/overkill.htm

Health Canada's West Nile Virus Information http://www.hc-sc.gc.ca/pphb-dgspsp/wnv-vwn/index.html

# References


1. Smithsonian Environmental Research Center Workshop on Wildlife and WNV http://www.serc.si.edu/migratorybirds/current_events_fin.htm and Komar N, Langevin S, Hinten S, Nemeth N, Edwards E, Hettler D, Davis B, Bowen R, and Bunning M. Experimental Infection of Nowth American Birds with the New York 1999 Strain of West Nile Virus. Emerging Infectious Diseases 9(3):311-323, 2003
2. Gubler, D.J. 1998. Resurgent Vector-Borne Diseases as a Global Health Problem, Emerging Infectious Diseases. 4(3):442-450.
3. Ranson H, Claudianos C, Ortelli F, Abgrall C, Hemingway J, Sharakhova MV, Unger MF, Collins FH, Feyereisen R. Evolution of Supergene Families Associated with Insecticide Resistance. Science 298 (5591):179 2002
4. NY reports of pesticide exposure problems after spraying and Gilbertson, M.K., Haffner, G.D., Droulliard, K. Albert, A., and Dixon, B: Immunosuppression in the Northern leopard frog (Rana pipiens) induced by pesticide exposure. Environ. Tox. Chem In Press.
5. Howard J, and Oliver J. Impact of naled (Dibrom 14) on the mosquito vectors of eastern equine encephalitis virus. Journal of the Am Mosquito Control Assoc. 13(4):315-25, 1997.
6. Corbet P. Use of odonate larvae for biocontrol of insect pests. AGRION Vol. 4/2 July 2000. and "Dragonflies unleashed to fight mosquitoes". Kennebec Journal Online, Monday July 9, 2001
7. Struger J, Fletcher T, Martos P, Ripley B, Gris G. Pesticide Concentrations in the Don and Humber River Watersheds (1998-2000), 2002. http://www.ene.gov.on.ca/envision/techdocs/4335e.pdf
8. http://www.hc-sc.gc.ca/pmra-arla/english/pdf/fact/fs_bti-e.pdf
9. World Health Organisation http://www.inchem.org/pages/ehc.html
methoprene
10. Harmon, MA, Boehm MF, Heyman RA, Manglesdorf DJ. Activation of mammalian retinoid X receptors by the insect growth regulator methoprene. Proc Natl. Acad. Sci. USA 92:6157-6160, 1995
11. WHO/FAO Data Fact Sheets on Pesticides No. 77 Diflubenzuron WHO/PCS/DS/96.77 July 1996
12. Canadian Medical Association Journal editorial collection.nlc-bnc.ca/100/201/300/cdn_medical_association/
13. Blondell J. Epidemiology of Pesticide Poisonings in the United States, With Special Reference to Occupational Cases. Occupational Medicine: State of the Art Reviews. 12(2) 209-221 1997
14. Environmental Protection Agency (USA) Pesticide Summary sheets, accessed March 16, 2003 http://www.epa.gov/pesticides/op/chlorpyrifos/summary.htm
and http://www.epa.gov/pesticides/op/malathion/summary.htm
15. Barnett JB et al. Statement from the work session on chemically induced alterations in the developing immune system: the wildlife human connection, Env. Health Perspectives, 104: 807-808, 1996
16. Gilbertson MK, Haffner GD, Drouillard KG, Albert A, Dixon B. Immunosuppression in the Northern Leopard Frog (Rana pipiens) Induced by Pesticide Exposure. Environmental Toxicology and Chemistry, Vol. 22, No. 1, pp. 101-110, 2003
17. Guillette EA, Meza MM, Aquilar MG, Soto AD, Garcia IE. An anthropological approach to the evaluation of preschool children exposed to pesticides in Mexico. Environ Health Perspect Jun;106(6):347-53, 1998 and Guillette EA. A broad-based evaluation of pesticide-exposed children. Cent Eur J Public Health Jul;8 Suppl:58-9, 2000
18. http://www.menv.gouv.qc.ca/communiques_en/c20030305-pesticides.htm
19. http://www.epa.gov/pesticides/op/malathion/dementi_1100.pdf letter from Brian Dementi, Ph.D., D.A.B.T. Senior Toxicologist Toxicology Branch/HED
20. Memorandum to Betty Shackleford, Product Manager 53 and Patricia Moe, Chemical Review Manager, Insecticide Risk Branch, Special Review and Reregistration Division(7508W); from Brian Montague, Fisheries Biologist, Team Leader, Ecological Effects Assessment and Norman Birchfield, Chemist, Environmental Exposure Assessment and Richard Mahler, Hydrologist Environmental Fate Assessment http://www.epa.gov/pesticides/op/malathion/efed_cover.pdf
21. http://www.pesticide.org/chlorpyrifos1.pdf



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