Pest Management for Prevention and Control of Mosquitoes with Special Attention to West Nile Virus

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Mosquitoes, like many other biting flies, are important pests. They annoy and bite humans and animals. Also, they may transmit disease-causing organisms such as malaria and encephalitis. While human malaria does not occur in Washington, outbreaks of encephalitis and mosquito transmission thereof do occur from time to time. In 2002, a type of encephalitis caused by the "West Nile Virus" was found in Washington State. West Nile Virus is a mosquito-transmitted encephalitis that can impact the health of humans, many bird species, horses, and a variety of other animals. West Nile Virus is primarily a virus of birds and is transmitted from infected birds to other birds by mosquitoes; other animals and people are incidental hosts and obtain the virus from infected mosquitoes. As of 2006, there have been 3 cases of West Nile Virus found in humans, 6 cases in horses, and 13 cases in birds in Washington State. Visit the Center for Disease Control (www.cdc.gov) or Washington State Department of Health (www.doh.wa.gov) for the most recent information on West Nile Virus in North America.

Life Cycle

The adult stages (Fig. 1) of many mosquito species are feeders of blood, which has given some disease-causing organisms a reliable mode of transmission to animal hosts. The feeding times and behaviors can differ between mosquito species; some species will feed in daylight while some feed at dusk and dawn (Bohart & Washino, 1978). The egg (Fig. 2), larval (Fig. 3) and pupal (Fig. 4) stages of mosquitoes are generally associated with bodies of water. Some mosquito species are specific to tidal flood lands while others are specific to shallow, warm, stagnant water (Laird, 1988). Mosquitoes are always located near water since water is essential for growth of the immature stages, thus the presence of water is crucial in focusing control programs. The advice provided here concerns mosquito control on private property –city governments or county mosquito abatement districts handle extensive areas of control.

Fig. 1. An adult mosquito taking a blood meal.

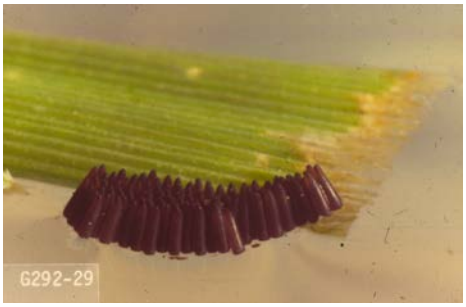

Fig. 2. An egg raft of Culex sp. mosquito.

Fig. 3. A mosquito larva (wiggler).

Control

Fig. 4. A mosquito pupa (tumbler).

Prevent mosquitoes from reproducing by altering their natural habitat. Habitat alteration is a long-term solution to mosquito problems and is the best means of control. In situations where habitat alteration will have undesirable consequences, such as draining wetlands, use other approaches to augment or support natural predators such as native fish and frogs to assist in pest reduction. Information on mosquito eating fish is available from WDFW at 360-902-2667. This is the logical first step in integrated pest management, which by definition utilizes all reasonable methods to achieve pest reduction in a way that has the least negative impact on the environment. The following guidelines will assist you in identifying potential habitats that harbor mosquitoes. Special attention is paid to objects and structures that retain water.

To eliminate breeding places:

1. Remove standing water caused by construction puddles, seepage pools, lawn, or landscaping depressions by drainage or filling with earth.
2. Check irrigation and drainage ditches for leaks or seepage and maintain free flow of water.
3. Grade newly developed land to prevent standing water.
4. Provide drainage away from premises for excess irrigation water, or collect in storage sump and reuse on land.
5. Manage weeds in areas where adult mosquitoes congregate (such as small man-made bodies of water, ornamental pools (Fig. 5), water retention ponds (Fig. 6), lagoons or water reservoirs.)
6. Regularly remove floating debris from ponds to reduce egg-laying sites.
7. Construct drainage holes on structures and containers that may trap water such as barrels.
8. Promote drainage of old tires (Fig. 7) by drilling holes.

Fig. 5. Ornamental pool-a potential breeding site

Fig. 6. Water retention pond in a housing development- a potential breeding site. **Application of larvacides to retention ponds requires a NPDES permit and a valid pesticide applicator license.**

9. Recycle, destroy, flatten or dispose of tin cans or any other artificial water containers.
10. Drain gutters and water from under homes.
11. Change water in birdbaths, pet watering dishes and livestock watering troughs once or twice a week. Stock ornamental pools with predacious fish.
12. Fill tree holes with sand or mortar, or develop drainholes so water cannot accumulate.
13. Pay particular attention to such gardening aids as sheets of discarded, crumpled polyethylene film (often used as plastic mulch). Since these catch water easily, they provide an excellent almost permanent breeding site. They shield against evaporation, even help moisture condense.
14. Check and regularly drain pool tarps and Jacuzzi covers for collected rainwater.

Fig. 7. Old tires- another potential breeding site for mosquitoes.

Pesticides Registered for Mosquito Control

If the problem cannot be solved with cultural methods such as habitat alteration, then judicious use of pesticides may be the final alternative.

Commercial Applicators

Pesticides used in mosquito control are designed basically as “Adulticides” and “Larvacides.”

Adulticides are available as “Liquid Concentrations” primarily designed for use in “Ultra-low Volume” sprayers, either by aerial applications or by ground-based equipment; and “Emulsifiable Concentrations” primarily designed to be suspended in water and used relatively coarse sprays. Both forms of concentrations can be diluted with oil and used in thermal fog generators.

Lavacides are available as “Liquid Concentrations,” “Emulsifiable Concentrations,” are described in the preceding paragraph, and as “Granules.” Granules are prepared from clay with the pesticide mixed into them or as sand granules coated with the pesticide and can be distributed by aerial application or ground-based equipment. They are best used in aquatic areas with heavy vegetation canopies and as prehatch applications in floodwater situations. There are also light paraffinic-based oils for use as larvacides as well as some specialty items, which release chemicals slowly into the water.

Due to constant changes in registrations of commercial pesticides we will not list specific ones but rather refer the reader to the PNW Insect Control Handbook, which is annually revised. A copy of this handbook resides in virtually all Cooperative Extension offices.

Aquatic applications, with the exception of specific products listed in the paragraph below and used according to label instructions, require the user to possess a valid pesticide applicator license with the appropriate category as well as an NPDES permit. A list of license categories can be obtained at http://agr.wa.gov/PestFert/docs/PesticideLicensingMosquitocontrol.pdf. NPDES permit applications can be found at www.ecy.wa.gov/programs/wq/pesticides/index.html.

Homeowner Products

Homeowners are allowed to apply certain mosquito larvacides to water on their own property. Do **not** apply pesticides to moving water such as streams and do not apply them in such a way that the chemical drifts or moves off your property. Products labeled only for home and garden mosquito larval control may be used. At the time this bulletin was revised these include three Bti (*Bacillus thuringiensis israelensis*) labels, the trade names of which are **Mosquito Bits Kills Mosquitos**™, **Bayer Advanced Garden Mosquito Preventer R-T-U Granules**, and **No-squito! Granules**. There is also one growth regulator label (S-methoprene) available called **Pre-Strike Kills Mosquitoes**.

If you have questions about mosquito control on adjacent properties, housing development retention ponds, etc. contact your local city or county authority.

Protection from Biting Mosquitoes

To reduce the risk of mosquito-borne diseases and annoyances caused by biting mosquitoes, it is important to protect ones self. Limit outdoor activities when mosquitoes are active, such as at dusk. Keep windows and doorways tightly sealed and install window and door screens to prevent mosquitoes from entering the house. When working outside during mosquito season, wear protective clothing such as long-sleeved shirts and pants. Mosquito netting can also be used to protect one's face and neck or used on infant carriages and strollers.

Repellents are commonly used to prevent mosquito bites during outdoor activities, such as hunting and gardening. Choose a repellent that best fits your outdoor activity. Apply repellents to areas that are exposed. Wash off repellents when retuning inside and reduce the amount of time of unnecessary exposure. Repellents, especially those containing diethyltoluamide (commonly known as DEET), prevent mosquito bites for at least several hours up to a full day. DEET can be applied to both skin and clothing. For most conditions, products with 10-40% DEET are sufficient for repelling mosquitoes on adult persons (Lilja 2002; Peterson & Marfin, 2002). Higher concentrations do not offer much benefit for

longer protection (Fradin, 1998). Few people experience adverse reactions from DEET and other repellents (Fradin, 1998). Be sure to read and follow the directions on the container. Consult your physician or local health department for inquiries about use on infants and children.

Citronella is a commonly used repellent that is applied topically or volatilized in citronella candles. Protection of topically applied citronella is short lasting and multiple applications may need to be made for long-lasting protection. Citronella candles, and other candles, can offer some reduction of mosquito bites but there is no evidence attributing repellency to citronella (Fradin, 1998).

Permethrin has both insecticidal and repellency characteristics. Products containing permethrin, labeled for mosquito repellency can be used on clothing and other fabrics, such as tents, but should not be applied directly to skin (Fradin, 1998). Read the label and follow directions carefully when using these mosquito repellents and insecticides.

Some bath oils, such as Avon Skin-So-Soft, do offer some protection from mosquito bites and contain repellents recognized by the Environmental Protection Agency. These products last only a short amount of time. Multiple applications may be needed to offer mosquito repellency (Fradin, 1998).

Using mosquito-repelling plants, such as the citrosa plant, and electronic bug zappers are not known to significantly reduce mosquito numbers. Repellents containing plant-derived chemicals, such as soybean oil, may have some repellent properties but durations of repellency are not as long lasting as products containing DEET (Fradin & Day, 2002).

Regarding Horses and West Nile Virus.

While certain birds are the primary host, there are mammals that are dead end hosts, some of which are harmed more by the disease than others. Horses are particularly susceptible. From information garnered from Department of Ecology and Department of Health, it is anticipated that 30-40% of infected horses showing symptoms will die or be permanently disabled. Thus it is imperative that horse owners have their horses vaccinated before the next mosquito (the vector) season begins (April.) Why the urgency? It is because **2 doses, 3-6 weeks apart are required, and immunity is not achieved until 5 or 6 weeks after the second dose.** This also requires an annual booster. Only a veterinarian can perform the vaccination.

Mosquito Control by Municipal Corporations

Frequently mosquito control by an individual or a small group of individuals is impractical because the problem is too extensive.

Under these conditions, a more extensive control program may be organized by the formation of a vector control district or a mosquito abatement district, or by having a program instituted through the local health department. Whether the county administration institutes such a program or a formal district is formed will depend upon the wishes of the taxpayers and voters of the area involved. Moreover, it is important to report mosquito problems to your local government to aid in their assessment and monitoring of mosquito problems.

The first step in organizing a formal program of mosquito control is a survey to establish the severity of the problem, the major mosquito producing sources, and the area involved. Assistance from the local health department or appropriate office of the responsible state health department is available. The information acquired from this survey should be correlated with a feasibility study. This study should report on the need for a program, methods of organizing a formal control program, specific recommendations on methods of control, and economic ramifications result from control activities.

If the report recommends a control program administered by county authorities (usually local health department), concerned citizens should then petition the governing body of the county to institute such a program, with financing to be provided through the appropriate county budget.

Conversely, if the report recommends a control program conducted by a formally organized district, then appropriate action as prescribed by the applicable state law or laws must be taken. This usually involves preparation of a petition, hearings, and an election. For this type of action, legal counsel should be obtained.

Technical consultation and advice on mosquito prevention and control may be obtained from the appropriate state health departments or from Extension offices.

References:

Bohart M. R., Washino R.K. Mosquitoes of California. Berkeley. University of California-Division of Agricultural Services. Number 4084. 1978.

Fradin M.S., Day J.F. Comparative efficacy of insect repellents against mosquito bites. N Engl J Med. 2002; 347(1):13-8.

Fradin M.S. Mosquitoes and Mosquito Repellents: A clinician's guide. Annals of Internal Medicine 1998; 128:931-940.

Laird, M. Introduction. Integrated Mosquito Control Methodologies. Vol. 1 Experience and components from conventional chemical control. Ed. M. Laird & J.W. Miles. New York. Academic Press. 1-14. 1983.

Laird, M. The Natural History of Larval Mosquito Habitats. New York. Academic Press. 1988.

Lilja, J. Mosquito-borne Disease Response Plan. Washington State Department of Health. 2002 Edition.

Petersen L.R., Marfin A. A. West Nile Virus: A Primer for the Clinician [Review] Annals of Internal Medicine 2002; 137:173-179.

Service, M.W. Mosquito Ecology: Field Sampling Methods. London. Applied Science Publishers Ltd., 1976.