# Best Management Practices for Mosquito Control

Washington State Department of Ecology
Water Quality Program

WASHINGTON STATE DEPARTMENT OF ECOLOGY

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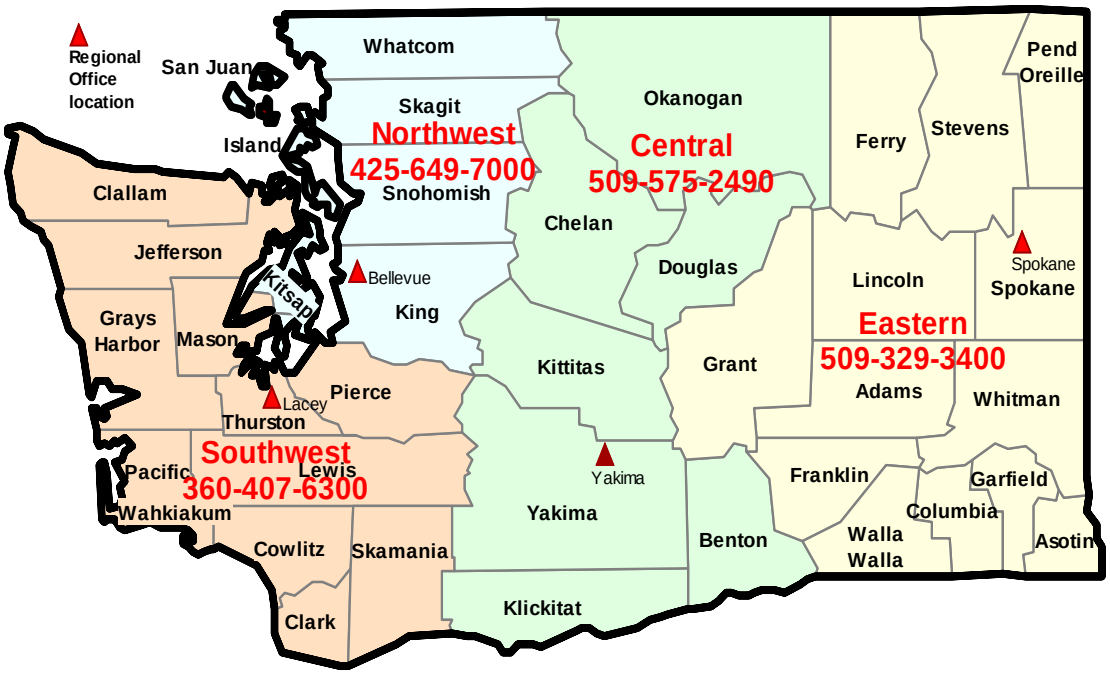


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# Introduction

On April 10, 2002, the Washington State Department of Ecology (Ecology) issued NPDES General Permit No. WAG-992000, covering mosquito control activities that discharge insecticides directly into surface waters of the state. Under the permit, the use of insecticides for mosquito control in water is allowed when the effects are temporary and confined to a specific location, though locations where insecticides are used may be widespread throughout the state. Applications of insecticides are subject to compliance with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) labels, the Washington Pesticide Control Act (15.58 RCW), the Washington Pesticide Application Act (17.21 RCW), the General Pesticide Rules (WAC 16-228), the Worker Protection Standard (WAC 16-233), a number of pesticide and/or county specific regulations, monitoring/reporting requirements, and approved best management practices (BMPs) that include integrated pest management options. When adopted by a mosquito control entity, these BMPs for Mosquito Control satisfy that NPDES Permit No. 992000, Condition S4 requirement.

These Best Management Practices for Mosquito Control were developed through a collaborative effort of representatives from Washington and Oregon based mosquito control districts, Washington State counties, Washington State University, mosquito control insecticide industry and the state departments of Health, Agriculture, Fish and Wildlife, Transportation and Ecology. Our appreciation goes out to the many mosquito control experts and others who took the time to review the draft and offer their expertise and suggestions.

Mosquito control entities in Washington State that wish to develop their own BMPS may do so, but they must be approved by Ecology. An approvable integrated pest management (IPM) program for mosquitoes must involve natural resource scientists when planning control measures that could harm delicate ecosystems and include all the features of IPM as defined in Washington State law RCW 17.15.010 (as adapted to mosquito management):

1) Minimize mosquito breeding and feeding sites.
2) Monitor mosquito populations and disease.
3) Establish the targeted densities of mosquito populations based on community factors of health, public safety, economic and aesthetic thresholds.
4) Treat mosquitoes to reduce populations below the targeted threshold using strategies that may include biological, cultural, mechanical, microbial, biochemical and chemical control methods and that consider human health, ecological impact, feasibility, and cost effectiveness.
5) Evaluate the effects and efficacy of pest treatments.

# Best Management Practices for Mosquito Control

## I. Minimize Mosquito Breeding Sites and Utilize Personal Protective Measures

**Risk Assessment:** Probability of outbreak in humans: Remote

**Action threshold**: The presence or even the suspected presence of mosquitoes (any species) in an area identified for control efforts triggers minimization efforts in the early spring and summer. The mean development time from egg hatch to pupation takes 5 to 10 days at temperatures near 25° C (77° F) (Pratt and Moore, 1993). However, "eggs of certain species can hatch in water as cold as 45° F" (Lilja, 2002, p. 24). Minimization actions are most effective in the early spring and continued through fall on an as-needed basis.

**Rationale:** Minimizing man-made breeding sites in the targeted area of control and personal protection, especially for those with compromised immune systems, are the best defenses against getting bitten by mosquitoes, giving the best protection for the least cost.

**Minimum BMP Response:**

1. Provide information to those in the area of control on eliminating artificially created mosquito breeding sites, use of biological controls (including bio-larvicides), use of repellents, and on protecting animals of concern. Local and state environmental health departments have a variety of informational brochures. See http://www.doh.wa.gov/ehp/ts/Zoo/WNV/WNV.html for links.
2. Take appropriate minimization actions.
3. If possible, obtain resources to enable effective responses.

## Minimization Actions

### Eliminate Artificial Breeding Sites around Homes and Offices

- Empty or turn over anything that holds standing water—old tires, buckets, wheelbarrows, plastic covers, and toys. Do not let water stagnate for more than seven days.
- Change water in birdbaths, fountains, wading pools, and animal troughs weekly.
- When practical, drill holes in the bottoms of containers that are left outdoors.
- Clean and chlorinate swimming pools that are not in use and be aware that mosquitoes can breed in the water that collects on swimming pool covers.
- Consider aerating ornamental pools and use landscaping to eliminate standing water; mosquitoes can potentially breed in any stagnant puddle that lasts more than four days.
- Recycle unused containers—bottles, cans, and buckets that may collect water.
- Make sure roof gutters drain properly, and clean clogged gutters in the spring and fall.
- Fix leaky outdoor faucets and sprinklers.
- Keep all ornamental shrubs and bushes trimmed and pruned to open them up to light and air flow. This will not only give mosquitoes fewer places to hide, but will promote growth and vigor in the plants.

**Use Appropriate Bio-controls**

- Stock water gardens *that have no surface inlet or outlet* with mosquito-eating fish (*i.e.,* goldfish, mud minnow, stickleback, and perch). Tadpoles, dragonfly larvae, diving beetles, back swimmers, and front swimmers also prey on mosquito larvae. For more information, see http://www.wdfw.wa.gov/factshts/westnilevirus.htm.
- Native vegetation and nest boxes can help attract mosquito-eating birds and bats. However, property owners should avoid introducing non-native fish or wildlife in an attempt to control mosquitoes. While it is permissible to release some fish commonly available in pet stores into small, contained backyard pools and ponds, non-native fish should not be released into open or partially contained waters that may occasionally flood into natural water bodies. Some non-native species, including so-called mosquito fish, *Gambusia affinis*, can be major pests when introduced outside their natural range. *Gambusia* are aggressive and have been known to feed on eggs, larvae and juvenile native fish and amphibians. Because of these negative impacts on native species, *Gambusia* is a regulated species in Washington State, and may not be introduced without a fish stocking permit issued by WDFW.
- Under WDFW policy, transfer/stocking permits may only be issued to organized mosquito control districts, the U.S. Army Corps of Engineers, and local or state health departments; permits may not be issued to private individuals. To protect the Olympic mud minnow, a state sensitive species, *Gambusia* stocking is prohibited in Clallam, Jefferson, Kitsap, Grays Harbor, Mason, Thurston, and portions of Lewis County that drain into the Chehalis river. For information on fish stocking permits contact the WDFW regional office in your area.
- Selective bio-pesticides such as *Bacillus thuringiensis israelensis* (Bti), *B. sphaericus* or methoprene are very effective preemptive controls when applied in the spring to specific sources identified by surveys. Amplifying and bridge vector species should be targeted (also see p. 11.).

**Personal Protective Measures**

- Make sure window and door screens are "bug tight." Repair or replace if needed.
- Stay indoors at dawn and dusk when mosquitoes are the most active.
- Wear a long sleeve shirt, long pants and a hat when going into mosquito-infested areas such as wetlands or woods.
- Use mosquito repellant when necessary, and carefully follow directions on the label. For extensive repellent information from the Centers for Disease Control see Appendix B: Insect Repellent Use and Safety
- Areas frequented by the public, such as parks, zoos, outdoor concert areas, and wildlife reserves should consider making repellents available.

**Protect Animals of Concern**

- To protect your horses and other equines, talk to your veterinarian about the West Nile virus vaccine. The vaccine requires two doses three to six weeks apart, and immunity may

not be achieved until up to six weeks after the second dose. An annual booster should be given a few weeks to a month prior to the start of the mosquito season in your area.

- Veterinarians should be consulted if you have concerns about your household pets or other animals. Repellents may be used in some instances.
- Thoroughly clean livestock watering troughs weekly.
- For more information see: http://www.aphis.usda.gov/lpa/issues/wnv/prv.html and/or http://www.cdc.gov/ncidod/dvbid/westnile/birds&mammals.htm

**New Construction and Storm Drains**

As new facilities are being designed, consideration should be given to reducing mosquito habitat as much as possible.

When considering a drainage or water treatment facility for mosquito control, the first consideration should be whether the problem could be reduced by physical modification or repair without compromising the facility's function. Physical modifications should be designed by an engineer and reviewed by the local government to insure they meet applicable design requirements. A possible design modification may include scarifying the pond bottom where it is no longer infiltrating as originally designed, providing slope to the bottom of the drainage facility or enhancing infiltration by some other method. Eliminating low spots that collect small amounts of standing water and altering excessive overgrown vegetation may also be options. Alterations of slopes or repairs to a facility should not involve a reduction in the water retention or carrying capacity of the facility. As an example, soil should not be added to fill low spots. Instead, low spots should be graded flat such that the carrying capacity is not reduced.

**Sprinklers and Irrigation Systems**

Over-watering and poor irrigation practices are common producers of mosquitoes around the home, in parks, in irrigated fields, and on golf courses. Report standing water to appropriate maintenance personnel.

- Irrigated lands are among the highest producers of mosquito breeding sites in Washington State. High numbers of mosquitoes can develop in standing water as a result of flood irrigation. The actions below can help eliminate mosquito breeding sites by using physical controls (Colorado, 2002; Pratt and Moore 1993).
    1) Minimize standing water in fields so that it does not lie fallow for more than four days by improving drainage channels and grading.
    2) Tail waters should not be allowed to accumulate for more than four days at the end of the field.
    3) Keep excessive overgrown vegetation out of ditches to promote more rapid drainage, but retain ground cover to prevent soil loss.

4) Have ditches repaired to reduce seepage to the extent practicable (elevated water tables can produce unintended standing water in fields). Modification or repairs to a ditch should not reduce the carrying capacity.
5) Minimize flood and rill irrigation practices to the extent practicable.
6) Avoid over-watering.

**Foster Healthy Wetlands**

Do NOT drain or fill wetlands. The chance of mosquito "outbreaks" increases in wetland and stream ecosystems that have been changed or tampered with. In disturbed systems, the predators of mosquito larvae are often excluded while the mosquitoes thrive. Thus, draining wetlands and removing greenbelts will not eliminate mosquitoes. In fact, such actions could actually increase the mosquito population if their natural predators are destroyed. The draining of wetlands will still leave behind many small puddles or wet depressions that are prime habitat for mosquitoes.

Wetlands perform at least three classes of functions: hydrologic functions (*i.e.*, flood peak reduction, shoreline stabilization, or groundwater exchange), water quality improvement (sediment accretion, filtration or nutrient uptake), and food-chain support (structural and species diversity components of habitat for plants and animals, including threatened endangered and sensitive species). Many wetlands recharge ground water critical for local drinking water supplies and prevent streams from drying up during the summer. Given the critical functions wetlands perform, Ecology does not condone draining wetlands as a method for mosquito control. Since most predation on mosquitoes occurs when they are larvae, the best mosquito control is often to target the larvae, either by fostering predators native to the area of control (amphibian larvae, aquatic salamanders, small fish) or by applying selective larvicides such as Bti. (Tom Hruby, Ecology Wetland Specialist, personal communication 2/26/03 and 1/16/04).

## II. Monitor Mosquito Populations and Disease

**Risk Assessment:** Probability of outbreak in humans: Remote to low; areas with limited or sporadic WNV epizootic activity in birds and/or mosquitoes.

**Action Threshold.** The presence of vector or nuisance mosquitoes suspected or confirmed in the area.

**Rationale.** Base-line data on mosquito populations and mosquito-borne disease will help target educational efforts and are essential to control efforts, should they become necessary.

**Minimum BMP Response.** Obtain and track avian mortality, human encephalitis/meningitis, and equine surveillance in the area of control. Further quantify epizootic activity by inventorying mosquito habitats, and trapping and testing for vector mosquitoes. Consider targeted insecticide control if surveillance indicates high potential for human risk to increase.

**<u>Monitoring Strategies for Landowners of Private Property and Contracted Licensed Applicators</u>**

- Contact your local health department for information about birds, horses, and humans found to test positive for West Nile virus or other mosquito-borne diseases in your area of control.

- Accurately map and identify rearing areas for mosquitoes, by species if possible. These are those sites for mosquito rearing that cannot be eliminated by following preventative measures such as container emptying, proper pond maintenance, and eliminating excess standing water by using appropriate irrigation BMPs. This is important because appropriate treatment measures are contingent on the habitat (species) encountered.

The following northwest mosquito habitats and control issues have been identified in the Mosquito-Borne Response Plan developed by the Department of Health (Lilja, 2002). Vectors in specific regions have not all been identified. Contact your local health department for the latest mosquito vector information.

**Floodwater.:** *Aedes vexans* and *Ochlerotatus sticticus* develop in large numbers along the borders of the Columbia and other rivers and create important mosquito problems in this region. The larvae hatch in the spring or early summer when the streams overflow areas such as willow and cottonwood swales where the eggs have been laid. The eggs of these species are dormant when temperatures remain below 45-50$^{o}$ F. Partial dormancy of the eggs may continue until sometime in June so that only some of the eggs are hatched by floods occurring in April or May. In some seasons, the larger rivers may rise, recede, and rise again to cover the same egg beds and produce an additional hatch. In other seasons, two or three successive rises may occur, each of which is higher than the last. Females that emerge in the first hatch may lay eggs that will hatch in the second or third rises of the river. Most of the eggs are laid between the 10 and 20 foot levels, and some of the eggs that are not flooded during a series of low flood crest years remain viable for as long as four years.

Large *Aedes vexans* and *Ochlerotatus sticticus* breeding areas have been managed efficiently by controlling water levels above dams such as the Bonneville Dam. Dikes have prevented flooding in other areas. Clearing of brush has been of value in some locations. However, control of the major section of these types of breeding areas must often be accomplished with insecticide applications.

**Irrigation Water:** Breeding places for several mosquito species are provided by irrigation water. *Aedes dorsalis, A. vexans, Ochlerotatus melanimon*, and *Ochlerotatus nigromaculis* are among the most important species that may develop when water is applied and stands for a week or ten days. Other species such as *Culex tarsalis, Culiseta inornata,* and *Anopheles freeborni* may also be produced. Tremendous numbers of mosquitoes breed in many areas where uncontrolled irrigation is practiced. Applications of insecticides are effective but are not substitutes for proper grading. Elimination of standing water is effective in preventing development of mosquitoes. Application of insecticides may be necessary for breeding places that cannot be drained. See Sprinklers and Irrigation Systems in Section I above.

**Tidal Waters:** *Aedes dorsalis* is the only species that can breed in large numbers in both fresh and salt water in the Northwest. The larvae develop in some coastal areas where potholes are filled by the higher tides or where water levels fluctuate in permanent or semi-permanent pools. Leveling, drainage, or similar practices are effective in preventing breeding, but such areas must be properly maintained. Insecticide control may be necessary where these methods are inadequate or ineffective. *Ochlerotatus togoi* has also been found in coastal areas including San Juan, Island,

Skagit, Kitsap, and Mason counties. Larvae of this species have been found in pools of pure seawater along rocky shorelines.

**Snow Water:** In many high mountain meadows and also at lower levels, mosquitoes breed in pools caused by snow melt. Development may require several weeks at higher elevations. *Aedes communis,A. cinereus, Ochlerotatus hexodontus, O. fitchii*, and O. *increpitus* are the most common species found in these locations. Usually there is only one generation per year, but the large numbers that may be produced are a severe annoyance to those who are working or seeking recreation in these areas. Elimination of breeding areas by drainage or maintenance of constant water levels is practical in some situations. Insecticide applications might have to be made by hand or by plane because of inaccessibility to heavy ground equipment.

**Permanent Waters, Ponds and Artificial Containers:** The mosquitoes that lay their eggs on the water are usually found where water is present continuously during the season or at least for several days. Such locations include natural permanent ponds, including still waters along the borders of lakes and rivers sheltered from wave action and currents with some degree of vegetation, log ponds, tree holes, semi-permanent ponds and wetlands of various types, and artificial containers. *Culex tarsalis, C. pipiens, C. peus, Anopheles freeborni, A. punctipennis, Culiseta incidens,* and *C. inornata* are commonly found in such places. *C. tarsalis* and *C. pipiens* develop in large numbers in log ponds. *C. pipiens* also develops in large numbers in sewer drains, catch basins, and water left in artificial containers. *Coquillettidia perturbans* are found in permanent water in wetlands, swamps, and marshes that have emergent or floating vegetation. Insecticides are often used effectively to control most of these species, except those breeding in artificial containers that can be emptied. Larvae of *C. perturbans* are difficult to control because they are attached to the roots of plants. Insecticide granules are sometimes applied, but eliminating host plants may be the most useful procedure to control this species. Consult with your local WDFW office before removing plants on WDFW-managed lands or in ecologically sensitive areas.

**Stormwater:** In response to the anticipated arrival of West Nile virus in King County, King County Water and Land Resources developed recommendations for dealing with the mosquito control at County drainage facilities. The study (Whitworth, 2002) identified the four basic habitats preferred by mosquitoes, the types of mosquitoes associated with the habitat type, and the WNV vector mosquito species that prefers each habitat type. Table 1 summarizes this information.

Table 1. Disease Vector Mosquito Species Associated With Drainage Control Facilities

| **Habitat Type** | **Facility type** | ***Vector Species*** |
|---|---|---|
| Permanent Water | Year round wet ponds<br>Larger Regional Ponds<br>Wet Bioswales | *Anopheles punctipennis* |
| | | |
| Marshes & Wetlands | Wet Bioswales<br>Some Regional Facilities | *Aedes cinereus*<br>*Coquilletidia perturbans* |
| | | |
| Temporary or Flood Water | Temporary Wet Ponds<br>Dry Bioswales<br>Retention/Detention Ponds<br>Open Ditches | *Aedes vexans*<br>*Culiseta inornata* |
| | | |
| Artificial Containers / Tree Holes | Catch Basins<br>Underground Tanks/Vaults<br>Discarded containers & Tires | *Ochlerotatus japonicus*<br>*Culex pipiens*<br>*Culex tarsalis*<br>*Culiseta inornata* |

Table 2 summarizes biological information of vector mosquitoes found in Washington State.

Table 2. Potential Disease-Carrying Mosquitoes in Washington State

| *Mosquito Species* | Day or Night Biter | Range | Generations per Year | Preferred Habitat | Breeding Comments |
|---|---|---|---|---|---|
| ***Aedes cinereus*** | Aggressive during day | Does not travel far from habitat | One-eggs hatch at different times | A woodland species: semi-permanent bogs & swamps, wetlands, wet bioswales & floodwaters | Hatches in the early spring. Larvae found among dense aquatic vegetation. |
| ***Aedes vexans*** | Day & Night | 20+ miles | Many | Any temporary water body like ditches, puddles, containers, pools & floodwater. | Eggs may lie domant 3+ yrs, hatches in ditches, still water. |
| ***Anopheles punctipennis*** | Night | Stays near habitat. | One | Springs and creeks connected to stormwater ponds, bioswales and wetlands. | Prefers algae-laden, cool pools on edges of slow flowing rivers and streams. Has entirely dark palpi. |
| ***Coquilletidia perturbans*** | Night - often comes to lights | Strong fliers, enters homes and lit areas. | One, but hatchlings do not complete development until the following spring. | Permanent marshes, wetlands, temporary wet ponds, dry bioswales & open ditches. | Needs thick growth of aquatic vegetation. Remains below the water surface attached to roots and stems. Hatchlings emerge in spring. |
| ***Culex pipiens*** | Night | Usually migrates only short distances. | Many | Found around water with high organic content, as in catch basins & sewer effuent ponds, tree holes, artificial containers & manholes. | Proliferate in in artificial containers. Lays eggs in clusters of 50 to 400. Larval and pupal stages take 8 -10 days. |
| ***Culex tarsalis*** | Night | Enters buildings after dark. | Many | Any fresh water, artificial containers, & agricultural and irrigated areas | Larvae develop from spring to fall in waters w/ high organic material. Eggs laid in rafts of 100 - 150 & hatch w/in 48 hrs. |
| ***Culiseta inornata*** | Dawn & Dusk | Stays near habitat. | Many | Cold water - associated with glacial runoff and sunlit waters, does not like hot weather. Found at all elevations. | Breeds throughout spring and summer in cold water, females may appear during warm winter breaks. Usually feeds on livestock, not people. |
| ***Ochlerotatus japonicus*** | Day & Night | Not known | Many | Artificial containers, catch basins, undergound tanks and vaults & tree holes | Larvae are found in artifical containers. |

*New information has come in on *Ochlerotatus canadensis* that adults live for several months in woodland pools by melting snow or rain. They feed on a large range of mammals, birds, and reptiles.

**Additional Monitoring for Public and Specialty Targeted Areas of Control**

- Conduct ongoing mosquito larvae surveillance, including studying habitats by air, aerial photographs and topographic maps, and evaluating larval populations.
- Monitor and track data from mosquito traps, biting counts, complaints, and reports from the public.
- Keep seasonal records concurrent with weather data to predict mosquito larval occurrence and adult flights.
- Consider using sentinel chicken flocks for surveillance (See Centers for Disease Control and Prevention, Epidemic/Epizootic West Nile Virus in the United States: Guidelines for Surveillance, Prevention and Control, page 10, http://www.cdc.gov/ncidod/dvbid/westnile/resources/wnv-guidelines-aug-2003.pdf)
- Accurately map and identify rearing areas for mosquitoes. These would be those sites that cannot be eliminated by preventative measures such as emptying containers, proper pond maintenance, and eliminating excess standing water by using appropriate irrigation BMPs. These habitats can be identified by aerial photo assessments, topographic maps, and satellite imagery where available. This is important because appropriate treatment measures are contingent on the particular species that live in specific habitats.
- Agricultural site maps should include hay, pasture, circle irrigation, orchards, and rill irrigated field crops. An important land use that has caused problems to mosquito control districts in the past is flood irrigated pastures where the water stays on more than five to seven days.

Note: Detailed information on mosquito surveillance is available from Washington State Department of Health, available online at www.doh.wa.gov/ehp/ts/Zoo/WNV/WAArboviralRespPlan.pdf and http://www.doh.wa.gov/ehp/ts/Zoo/WNV/WestNileVirusSurv.pdf

**III. Establish Targeted Densities for Mosquito Populations**

**Risk Assessment:** Probability of outbreak in humans: Remote to low; areas with confirmation of epizootic WNV in birds before August; a horse/human case, or sustained WNV activity in birds and/or mosquitoes.

**Action threshold:** The presence (positive identification) of any vector mosquitoes in the area triggers activities to reduce their presence. Since people with compromised immune systems are likely to be the most vulnerable to mosquito-borne diseases, the areas of their exposure should be a priority.

**Rationale:** Once vector mosquitoes have been positively identified in an area, control treatments are warranted, especially around high risk populations. If the cost of treatments is prohibitive, every effort should be made to educate those at risk of exposure about minimizing habitat and personal protection measures.

**BMP Minimum Response:** Analyze disease activity data, *i.e.*, avian mortality, human encephalitis/meningitis, equine encephalitis and mosquito surveillance information in the area of control. Set targeted densities with special consideration being given for segments of the

population most vulnerable to mosquito-borne diseases such as the elderly. If needed, enhance human surveillance and activities to further quantify epizootic activity, such as mosquito trapping and testing.

**Establish Targeted Mosquito Densities for All Areas of Control**

To establish the targeted density of mosquito populations review information on incidences of avian mortality, human encephalitis/meningitis, and equine encephalitis for your area (the Department of Health or your local health department can provide this information). Conduct entomologic survey (inventory habitats and map mosquito populations). Using surveillance information and input from the people in the control area, establish the targeted density of mosquito populations based on the level of control desired by those in the area of control, public safety, and funding.

- Demarcate no-spray zones on maps. This may include areas such as schools, hospitals, fish farms, wildlife refuges, ecologically sensitive areas, the homes of individuals who are on chemically sensitive registers, and crops grown under a certified organic program. Other crop sites that do not have a tolerance for the mosquito control products used should also be listed. If the control entity is not a mosquito control district organized under RCW 17.28, then individual residences where the occupants do not want to be treated should be identified as no-spray zones.
- Individual homeowners and businesses determine targeted mosquito population densities based on the level of control desired and factors of risk and cost. Mosquito control agents must consult with their sponsors to determine targeted mosquito densities.
- Once the targeted density has been established, continue larvae surveys to find density response to habitat minimization efforts and need for larvicide treatments.

## IV. Mosquito Control Treatments

**Risk Assessment:** Probability of outbreak in humans: Low to moderate

**Action Threshold:** The positive identification of vector mosquitoes in the area may trigger activities to reduce their presence. Once minimization strategies have been taken, larvae surveys (*i.e.* dipping) can indicate the effectiveness of those efforts and the need for further action. General Permit Condition S4.2.C states that the targeted density of larvae is 1 per three dips to commence larviciding unless vector mosquitoes are in the area and the probable breeding sites are inaccessible. This level is a minimum; mosquito control agents may want to set the targeted density at a higher level due to cost and risk factors.

**Rationale:** Once vector mosquitoes have been positively identified in an area, control treatments are warranted. If the cost of treatments is prohibitive, every effort should be made to educate those at risk of exposure about minimizing breeding habitat and personal protection measures.

**Minimum BMP Response:** Treat mosquitoes to reduce populations below the targeted threshold using strategies that consider biological, cultural, mechanical, and microbial, biochemical, chemical control methods. Evaluate methods for effectiveness of control, human health and ecological impacts, feasibility, and cost effectiveness.

## Use an Integrated Pest Management (IPM) Approach for All Areas of Control

Ideally, an IPM program considers all available control actions, including no action, and evaluates the interaction among various control practices, cultural practices, weather, and habitat structure. An ecologically-based IPM strategy relies heavily on natural mortality factors and seeks out control tactics that are compatible with or disrupts these factors as little as possible. When biological, biochemical or chemical treatment is needed, select treatments based on the species of mosquitoes found in larva pools, the age of larva, breeding habitat, density of larval populations and temperature.

Pesticide applications shall not commence unless surveillance of a potential application site indicates a larva/pupa count of greater than 1 per 3 dips and the need to apply insecticides to control mosquito populations, or unless dead birds, infected horses, or adult mosquito surveys indicate the presence of vector mosquitoes when larvae counts cannot be made due to their inaccessibility. In these cases beginning control methods such as larviciding may be desirable or even necessary without the larvae dips. However, just because a dead bird is found which tests positive for WNV in an area does not mean that the vector mosquitoes are breeding in the nearest storm drain. Those in the business of controlling mosquitoes will have to know the breeding sites and species of vectors in the area to perform effective mosquito control.

Natural resources biologists (e.g., WDFW) must be notified of planned control measures whenever delicate (easily impacted) ecosystems could be harmed by mosquito control practices. Other resource management agencies (e.g., National Marine Fisheries Service and U.S. Fish and Wildlife Service) should be consulted to determine when and where operations may harm ecosystems critical to threatened or endangered species, as well as appropriate treatments in these situations.

### Biological Controls

**Natural Waters:** WDFW has several concerns with stocking biological mosquito predators in natural waters. Along with the introduction of non-native fish, the transfer of fish diseases from one location to another, even among native populations, can cause disease outbreaks. That is why all movement and stocking of fish requires a permit from WDFW, whether the fish are native or not. Due to the inability to test live fish without killing them, the transportation of fish from one watershed to another requires disease testing (usually on the adults at spawning, or by sacrificing a number of young fish) and verification that the remaining fish are reared on disease-free water. In addition, any non-native fish stocking currently needs to go through SEPA review prior to approval. The laws in Washington State are designed specifically to prevent this type of "Johnny Apple-seeding" from occurring. For more information, please contact your nearest Regional Office of the Department of Fish and Wildlife.

**Ponds or Impoundments with No Inlets or Outlets:** Biological methods may include stocking species such as the Three-Spined Stickleback (*Gasterosterous aculeatus*) which is native to Washington State and known to be an effective predator of mosquitoes. Mud minnow, perch tadpoles, dragonfly larvae, diving beetles, back swimmers and front swimmers also prey on mosquito larvae. Guppies, goldfish, and other fish commonly sold in pet stores are exempt from permitting by Washington's Department of Fish and Wildlife (WDFW) and may be suitable for smaller ponds with no inlet or outlet, horse troughs, and ornamental pools. However, before

planting any of these exempt fish, consult with WDFW. Some of these fish, such as goldfish, may have severe ecological impacts on ponds and lakes.

**Mosquito Fish** (*Gambusia affinis*) have been used for mosquito control in virtually every state because of the adult's ability to consume large amounts of mosquito larvae. These warm water fish rarely exceed 2.5 inches and prefer shallow water. They tend to flourish in almost any environment, including well discharges, cisterns, water tanks, potholes, rain barrels, and open septic tanks. *Gambusia* have been known to dramatically reduce and even eliminate mosquito larvae. WDFW suggests that the use of *Gambusia* be integrated into an overall mosquito control plan rather than used as an exclusive solution to mosquito abatement. Permits must be obtained from WDFW for use of *Gambusia* as a mosquito control measure.

**Microbial, Biochemical and Conventional Chemical Controls**

Applications of insecticides to water must be made by individuals licensed by the Washington State Department of Agriculture and permitted by the Department of Ecology's Water Quality Program. Information on WSDA license requirements is online at: http://pep.wsu.edu or call WSDA toll-free at (877) 301-4555. Permitting information is available from Ecology's website at www.ecy.wa.gov/programs/wq/pesticides/index.html or call (800) 917-0043.

Select product controls by comparing the species and targeted life stage of mosquitoes, the breeding habitat, density of larval populations, and temperature with the efficacy of the products, nontarget impacts, resistance management, and costs. For example, while *Bacillus* products are effective on early instars they do not control older larva. Methoprene can be used on older larval stages (i.e., pupa), and for situations where it is too late to use either *Bacillus thuringiensis israelensis* or *Bacillus sphaericus*, a monomolecular film might be used. Some *Bacillus* products do not have residual characteristics when temperatures are high, and larval populations can grow at the rate of an instar a day. In this situation the larva may be in the late third to fourth instar stage before an application of *Bacillus* can be made. Always consult product labels for specific information on efficacy and use. Product Material Safety Data Sheets (MSDS) provide additional information such as protocols or measures to be taken for accidental releases and other pertinent product information.

The following is the approved list of larvicides that may be considered for mosquito control operations. Consult with federal, state and local agencies as needed.

1. *Bacillus thuringiensis israelensis* (Bti)
2. *Bacillus sphaericus* (H-5a5b)
3. Methoprene Granular, Liquid, Pellet, or Briquet (Restricted on state listed species sites – see Appendix A).
4. Monomolecular Surface Films (Restricted on state listed species sites – see Appendix A).
5. Paraffinic white mineral oil. Paraffinic white mineral oil is restricted on state listed species sites – see Appendix A and shall not be used in waters of the state unless:

   a. The mosquito problem is declared a public health risk; or

b. The other control agents would be or are known to be ineffective at a specific treatment site; and

c. The water body is non-fish-bearing (when uncertain, consult Washington State Fish and Wildlife concerning fish and wildlife) and has no inlet or outlet.

6. Temephos may not be used in lakes, streams, wetlands or the littoral zone of water bodies. The use of temephos shall be allowed only in highly-polluted water (i.e. tire piles) or waters with high organic content (i.e. manure holding ponds and pastures with no surface water runoff), or under either of the two following conditions:

   a. As a result of consultation between the Departments of Agriculture and of Ecology in response to the development of pesticide resistance or ineffectiveness within a population of mosquitoes. When temephos is applied to areas draining to surface waters monitoring of persistence and residues are a condition of the approval. Temephos must be rotated with one or more of the approved alternatives with a different mode of action to minimize the development of resistance.

   b. As a result of consultation between the Department of Health and Department of Ecology in response to the development of a human health emergency as determined by the Washington State Department of Health.

7. Terrestrially applied insecticides are NOT regulated under federal or state water pollution control laws and are not subject to NPDES permit conditions or requirements. A variety of adulticides are regulated for use by WSDA in Washington State. Table 4 lists some of these products. However, in Washington State all *applications of insecticides over water must be permitted under a Clean Water Act (NPDES) permit.*

Table 3. Permitted Insecticides Used For Mosquito Larvae Control

| Typical Products | Active Ingredient | Label Use Rate and 2003 cost estimates | Application Method(s) Persistence and Comments | Human Health Restrictions | Permit Restrictions on Use** | Target Pests on Label |
|---|---|---|---|---|---|---|
| Aquabac, Bactimos, Vectobac and Teknar | (Bti) *Bacillus thuringiensis israelensis* | 0.25 to 2 pints/acre or up to 10 lbs/acre @ $24/gal.<br>Granules $1.65/lb | Hand sprayer, ground sprayer or sprinkler cans.<br>Effective 1 - 30 days depending on formulation.<br>Broad spectrum, except *Coquilletidia* | Not for potable water. Minimal non-dietary and dermal risk to infants and children. | None. | Mosquito larvae |
| VectoLex WDG | *Bacillus sphaericus* (H-5a5b) | 0.5 to 1.5 lbs/acre<br>$4.65/lb | Granules are mixed with water and sprayed. Effective for 1-4 weeks, depending on the species of mosquito larvae, weather, water quality and exact form of the granules. Effective on *Culex spp*. Less effective against other species. | Not for potable water. Essentially nontoxic to humans. | None. | Larval control in water with high organic content. |
| Altosid liquid | Methoprene: Active ingredient is a growth hormone mimic that does not allow the mosquito larvae to mature. | 3-4 oz./acre<br>$226/gal | Use hand and ground sprayers.<br>Effective for a few days unless specially formulated for slow release.<br>It is not persistent because it degrades rapidly in water.<br>The briquettes are used in areas needed for longer term residual control such as ponded areas of standing water, areas where flood waters may make it impossible to use Bti.<br>Rates increase with deeper water.<br>Altosid XR-G is a sand formulation, good for pastures or marshes with thick vegetation. | Not for potable water. Does not pose risks to human health. | Restricted on state listed specie sites – see Appendix A. | mosquito larvae.*** |
| Altosid pellets | Methoprene | 2.5-10 lbs/acre<br>$24/lb | | | | |
| Altosid XR | Methoprene | 1 briquette $2.70 @100-200 sq ft. | | | | |
| Altosid briquet | Methoprene | 1 briquette / $.90 @100 sq ft. | | | | |
| Altosid XR-G | Methoprene | 5-20 lbs/ac<br>$8.48/lb | | | | |

| Typical Products | Active Ingredient | Label Use Rate and 2003 cost estimates | Application Method(s) Persistence and Comments | Human Health Restrictions | Permit Restrictions on Use** | Target Pests on Label |
|---|---|---|---|---|---|---|
| Agnique MMF<br>Arosurf MSF | Monomolecular surface film *Poly(oxy-1,2-ethanediyl)Alpha-isooctadecyl-hydroxy* | 0.2 to 1.0 gal/acre<br>@ $30/gal. | Sprayed by hand or ground equipment. Film remains active for 10-14 days on floodwaters, brackish waters and ponds. Susceptible to wind breaking surface tension. Rendered ineffective at winds above 10 mph and in very choppy water. Adult females are killed by entrapping and drowning when they contact the surface to lay their eggs. | Okay for potable water, livestock, backyard ponds, pool covers.<br>No risk to human health. | Restricted on state listed specie sites – see Appendix A. | Larval, pupal and midge control.<br>Adult female mosquitoes. |
| Golden Bear Oil<br>Bonide Oil | Petroleum distillate oils prevent the larvae from obtaining oxygen through the surface film | 3 to 5 gal/acre<br>$5 -8/gal | Liquid formulations are sprayed by hand or ground equipment. Persists for 12 – 15 hours, then evaporates.<br>Less expense--kills pupae stages | No risk to human health. | May not be applied to fish-bearing waters or on state listed specie sites – see Appendix A. | Larval and pupal control. |
| Abate | temephos | 0.5 to 1.5 oz/acre<br>$2.00/oz | Sprayed liquid. Breaks down within a few days in standing water, shallow ponds, swamps, marshes, and intertidal zones.<br>Temephos is applied most commonly by helicopter but can be applied by backpack sprayers, fixed-wing aircraft, and right-of-way sprayers in either liquid or granular form. | Not for potable water. Poses low risk to human health. High dosages, like other OPs*, can over-stimulate the nervous system, causing nausea, dizziness, & confusion. | Highly restricted use – see permit condition 1A.5. | Mosquito larvae, midge, punkie gnat, and sandfly larvae in non-potable water. |
| Malathion 8EC | malathion | 8 oz/acre, cost NA | Labeled for use in intermittent flooded areas, stagnant water and temporary rain pools. | Harmful by swallowing, inhalation or skin contact. | Can only be used under an agreement between Ecology and Health in the event of a disease outbreak. | Aphids, leafhoppers, grasshoppers, spider mites, bugs, beetles, moths, worms, flies, mosquitoes, & larvae. |

*OPs are organophosphates

** Restrictions can be waived in the event of a threat to human heath as determined by state and local health departments (see p. 16).

*** EPA's 2001 Methoprene R.E.D. Fact Sheet states that methoprene "has activity against a variety of insect species, including horn flies, mosquitoes, beetles, tobacco moths, sciarid fly, fleas (eggs and larvae), fire ants, pharaoh ants, midge flies and Indian meal moths." However, no effectiveness is claimed against these insects at the dose label rate for mosquito larvae control.

**When Adulticides Fit into a Mosquito Control Plan**

Terrestrially applied products are NOT regulated under federal or state water pollution control laws and are NOT subject to NPDES permit conditions or requirements when applied to terrestrial sites. However, adulticiding is often an integral component of an integrated pest management approach to mosquito control. In some instances, adulticiding can reduce or eliminate the need to heavily apply larvicides, can be used effectively with less environmental impact to non-targets, and can be cost-effective.

Select triggers for the use of adulticide products: Some mosquito control districts recommend using light traps to monitor for mosquitoes. For example, Adams County MD recommends that counts of 8 to 12 mosquitoes caught in 12 hours or a 3 adult mosquito landing count per minute in a residential area triggers the need to adulticide (Thomas Haworth, personal communication, November 7, 2003). Some applicators recommend adulticiding residential areas and upland areas where mosquitoes are migrating only when there is evidence of mosquito-borne epizootic activity at a level suggesting high risk of human infection. The following are examples of this type of evidence: high dead bird densities; high mosquito infection rates; multiple positive mosquito species including bridge vectors; horse or mammal cases indicating escalating epizootic transmission, including bridge vectors, horse or mammal cases, or a human case with evidence of epizootic activity.

Reducing vector densities below transmission threshold usually requires multiple ULV applications. Therefore, triggers should take into account this latency effect so that human transmission is not proceeding prior to or during operations. This presupposes identifying increasing human risk at least 2 weeks before human cases might present. Trigger design and implementation should reflect this need for preemptive adulticiding.

**BMPs for Adulticides:**

1) Meteorological conditions:
    - Record wind speed and direction before spraying and be observant of all changes in direction and speed during the application. Use appropriate wind indicators. Gauges are highly recommended for ground applications and smoke for aerial applications.
    - For aerial applications, check temperature at different elevations to decide if there is an inversion.
    - Spray only when wind is away from sensitive sites.
2) Do not spray in winds over 10 mph.
3) Follow label buffers.

The following table gives a sample of mosquito adulticides that may be used in terrestrial applications in Washington State. Labels are available from http://picol.cahe.wsu.edu/.

Table 4. Common Insecticides Used for Adult Mosquito Control

| Typical Products | Active Ingredient | Label Use Rate | Use | Cost | Residual Life | Comments |
|---|---|---|---|---|---|---|
| Biomist & Kontrol, Permanone Aqua Reslin | Permethrin | ULV 4 oz/acre | Adult Control | $.24/oz | 24 hours | Effective, 100 ft set-back from water. |
| Pyrenone 25-5 Public Health Insecticide | Pyrethrin | ULV 1-4 oz/acre | Adult Control | $1.20/oz | 1 hour | No set-backs to water. Approved for crop and pasture applications. Expensive |
| Scourge | Resmethin | ULV 4 oz/acre | Adult Control | $.58/oz | 1-4 hours | Has not performed well in some areas. No setbacks to water. |
| Fyfanon ULV | Malathion | ULV rates vary | Adult Control | $.24/oz | 24 hours | Very highly toxic to nontargets. |
| Anvil | Sumithrin | 0.0012 lb – 0.0036 lbs ai per acre | Adult Control | $.40/oz | 1-4 hours | Tested and used in the NW. No water precautions. |
| Dibrom, Trumpet | Naled | Not recommended for ground ULV use. | Adult control | | | No set-backs to water. Approved for crop and pasture applications. |

**What Constitutes an Emergency or a Health Threat?**

Health emergencies and health threats are declared by local health departments in consultation with Washington State Department of Health. A health officer should consider demographics, population densities and species of mosquitoes, proximity of positive identifications of mosquito-borne disease, and local tolerances for pesticide applications and disease outbreaks when assessing risk.

Permitted insecticides may be applied to waters as conditioned by their FIFRA labels (including methoprene in restricted areas) once an application has been submitted but before permit coverage is granted as a result of consultation between departments of Health and Ecology, in response to a human health emergency or threat as determined by the Washington State Department of Health.

If an emergency is declared or a threat is determined, and mosquito control actions haven't already been taken, the responsible officials should immediately initiate actions to minimize mosquito breeding habitat and educate at risk populations about personal protection (see p. 2); they should then begin conducting larval surveys and secure the funding, permits and licenses needed for applying insecticides. For practical purposes, once an outbreak is underway, larval surveys and

other control and habitat minimization measures will have little immediate effect. At this point, personal protective measures and large-scale adulticiding may provide the only means to reduce human/vector contact and further spread of the disease beyond those already infected.

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# Appendix A

# State Listed Species Restricted Areas

# Appendix A
# State Listed Species Restricted Areas

Basis of Restrictions

Ecology's Aquatic Mosquito Control National Pollutant Discharge Elimination System (NPDES) General Permit No. WAG-992000 Condition S4 3 states, "In developing the IPM plan, the permittee shall consult with local governments and state and federal agencies as needed."

Ecology took the lead developing an IPM plan to assist many local governments and others performing mosquito control operations who were suddenly in the business of mosquito control due to the spread of the West Nile virus. As the permit required, Ecology consulted with the Department of Fish and Wildlife (WDFW) in spring 2003 during this process. As a result, the WDFW identified wildlife species that it considered most vulnerable to certain mosquito control larvacides, identified the primary areas occupied by these species, and requested that pesticide applications be restricted in these areas.

These areas, along with areas identified as habitat for federal and state listed fish species were compiled into a document called *Insert A* and listed as areas where larvicides containing monomolecular surface films, methoprene, petroleum distillates, malathion and temephos were not allowed for use. Larvicides containing *Bacillus thuringiensis israelensis* (Bti) and *Bacillus sphaericus* (BS) were allowed for use due to their low toxicity to non-target species. Unfortunately, the recommendations for restrictions were given to Ecology after the mosquito spray season had begun and in the interest of having a permit pathway in place for applicators for the 2003 spray season Ecology listed the recommendations as *Insert A* and opened them for public review after the season was over.

The restrictions in Insert A have been considerably revised as a result of a more thorough review initiated the fall of 2003. Significantly, the restrictions on the use of methoprene in waters containing federal and state listed salmon have been lifted to allow monitoring for effects. The restrictions for state listed species that are still recommended by WDFW are listed here and a map of those areas is provided. Restrictions specific to larvicide active ingredients are also noted on *Table 3*.

Criteria Used for the Restrictions

The criteria WDFW used for denoting species as vulnerable were:

1) State species of concern (*i.e.*, listed as state endangered, threatened, sensitive, or candidate).
2) Current range and distribution of the species was highly localized.
3) The species inhabited freshwater wetlands during most of the mosquito control treatment period.

Six species initially met those criteria: northern leopard frog (*Rana pipiens*), Oregon spotted frog (*Rana pretiosa*), western toad (*Bufo boreas*), western pond turtle (*Clemmys marmorata*), American white pelican (*Pelecanus erythrorhynchos*), and one butterfly, the Yuma skipper (*Ochlodes yuma*).

WDFW identified areas occupied by the two extant populations of northern leopard frog; two extant western Washington populations of Oregon spotted frog; western toad breeding ponds (for western Washington only); the

three remaining western pond turtle populations; the single American white pelican breeding colony; and the one known Washington Yuma skipper population.

Based on the review of published literature, expert advice, and the vulnerability of these rare and endangered animals and their freshwater invertebrate food resources WDFW requested that if mosquito control is deemed necessary in the areas WDFW described in April 2003, that it be restricted to the use of *Bacillus* products.

Aerial Applications

An exception to the WDFW request regarding the use of certain larvicides was made for the single American white pelican breeding colony. The colony resides on islands and along the shores of the Columbia River, south of the confluence of the Snake River, in Walla and Benton counties. While bio-chemicals such as methoprene were not of concern for the pelican breeding colony, the method of aerial application was believed to be unacceptably disturbing for their successful breeding. It was agreed that aerial applications would not be made on the pelican breeding areas, whereas less obtrusive methods of mosquito control were acceptable near these sites.

Discussions among several WDFW biologists found that aerial applications of larvicides disturbed work being done in a few wildlife refuge areas around the state. It was therefore agreed that operators making aerial applications over wildlife refuges should notify the appropriate regional WDFW office of their scheduled aerial applications at least 24 hours prior to spraying. The notification can be made by phone or fax.

Area of Impact

Only a few populations of northern leopard frog, Oregon spotted frog, western toad, western pond turtle, and Yuma skipper remain in Washington. The total area occupied by these species in rivers, lakes, ponds, and wetlands is tiny, comprising of portions of 117 sections (<0.18% of Washington State). The areas identified for northern leopard frog (36 Sections) and western pond turtle (13 Sections) are owned or managed by WDFW. A prudent, risk-adverse approach is warranted with vulnerable threatened and endangered species.

The following areas are restricted to the use of *Bacillus thuringiensis israelensis* (Bti) and *Bacillus sphaericus* (H-5a5b) only.

**Sections added January 22, 2004 are in bold:**

1) Grant County, north of Moses Lake, within the Crab Creek watershed: T21N R27E Sections 1, 12, and 13; T21N R28E Sections 7, 17, 18, 19, 28, 29, 30, 31, 32, and 33.
2) Grant County, south and west of Moses Lake and south of Interstate-90, the northern portion of the Potholes: T19N R27E Sections 33, 34, 35, and 36; T19N R28E Sections 31 and 32, **29, 30**; T18N R27E Sections 1, 2, 3, 4, 8, 9, 10, 11, 12, 13, 14, 15, and 16, **17;** T18N R28E Sections 5, 6, **7, 8,** 17, and 18.
3) Grant County, area within and near the Sun Lakes – Dry Falls State Park wetlands: T24N R27E and 28E.
4) Kitsap County: lakes, ponds, and wetlands located in T22N R1W Sections 1, 2, 10, 11, and 12.
5) Klickitat County, west of the Klickitat River, all waters in T3N R12E Sections 28, 29, 32, and 33.
6) Mason County, on the Kitsap Peninsula: lakes, ponds, and wetlands located in T23N R2W Sections 11, 12, 13, 14, 15, 22, and 23.
7) Pierce and Kitsap counties, Carney Lake, located in T22N R1W.

8) Pierce, Thurston, and Lewis counties, within the Nisqually River watershed: Alder Lake (or Alder Lake Reservoir), located in townships: T15N R4E and 5E.

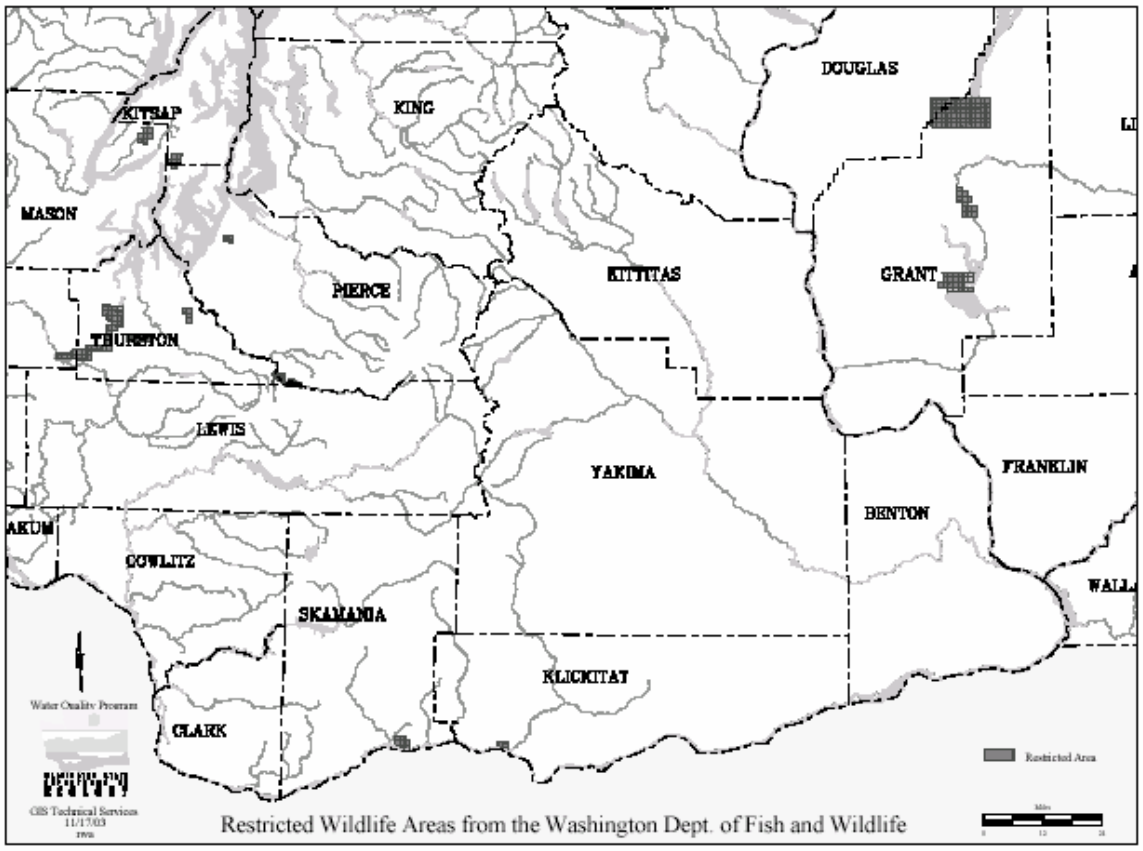
9) Pierce County, south of Tacoma, Chambers Creek and associated waters in T20N R2E Sections 26 and 27.

10) Skamania County, east of Carson, all waters in T3N R8E Sections 23, 24, 25, 26, and 36; T3N R9E Sections 30 and 31.

11) Thurston County, west of Yelm: lakes, ponds, and wetlands located in T17N R1E Sections 8, 9, 16, and 21.

12) Thurston County, south of Olympia and east of Interstate-5, within the Black River watershed, the Beaver Creek drainage, located in T16N R2W Sections 9, 10, 11, and 12; T16N R1W Section 7.

13) Thurston County, south of Olympia and west of Interstate-5, within the Black River watershed: Black River proper from south of Black Lake to the Chehalis Riverconfluence, and the following tributaries, Stony Creek, Dempsey Creek, SalmonCreek, and Blooms Ditch. Legal description as follows for these sensitive areas: T17N R3W Sections 10, 11, 12, 13, 14, 15, 23, 24, 25, 35, and 36; T17N R2W Sections 7, 18, 19, and 30; T16N R3W Sections 2, 11, 14, 19, 20, 21, 22, 23, 30, and31; T16N R4W Sections 25, 26, 27, 31, 32, 33, 34, 35, and 36.


DOUGLAS
KITSAP
KING
MASON
PIERCE
KITTITAS
GRANT
THURSTON
LEWIS
YAKIMA
FRANKLIN
BENTON
COWLITZ
SKAMANIA
KLICKITAT
CLARK
Water Quality Program
GIS Technical Services
11/17/03
Restricted Area
Restricted Wildlife Areas from the Washington Dept. of Fish and Wildlife

# Appendix B

# Insect Repellent Use and Safety

**From the Center for Disease Control**

# Appendix B

# Insect Repellent Use and Safety

### From the Center for Disease Control

**Q. Is DEET safe?**
**A**. Yes, products containing DEET are very safe when used according to the directions. Because DEET is so widely used, a great deal of testing has been done. When manufacturers seek registration with the U.S. Environmental Protection Agency (EPA) for products such as DEET, laboratory testing regarding both short-term and long-term health effects must be carried out. Over the long history of DEET use, very few confirmed incidents of toxic reactions to DEET have occurred when the product is used properly. (From the National Pesticide Information Center [NPIC], EPA re-registration eligibility decision. See npic.orst.edu/factsheets/DEETgen.pdf . )

***Insect Repellents and Sunscreen***

**Q. Can I use an insect repellent containing DEET and sunscreen at the same time?**
**A.** Yes. People can and should use both sunscreen and DEET when they are outdoors to protect their health. Follow the instructions on the package for proper application of each product. Apply sunscreen first, followed by repellant containing DEET.

To protect from sun exposure and insect bites, you can also wear long sleeves and long pants. You can also apply insect repellent containing DEET or permethrin to your clothing, rather than directly to your skin.

**Q. Has CDC changed its recommendations for use of DEET and sunscreen?**
**A.** No. Based on available research, CDC believes it is safe to use both products at the same time. Follow the instructions on the package for proper application of each product. Apply sunscreen first, then insect repellent containing DEET, to be sure that each product works as specified.

**Q. Should I use a combination sunscreen/DEET-based insect repellent?**
**A.** Because the instructions for safe use of DEET and safe use of sunscreen are different, CDC does not recommend using products that combine DEET with sunscreen.

In most situations, DEET does not need to be reapplied as frequently as sunscreen. DEET is very safe when applied correctly. The rare adverse reactions to DEET have generally occurred in situations where people do not follow the product instructions. Sunscreen often requires frequent reapplication, so using a combined product is not recommended. You do not need to reapply insect repellent every time you reapply sunscreen. Follow the instructions on the package for each product to get the best results.

**Q. I heard about a study saying that there may be some type of interaction between repellents containing DEET and sunscreen. Is this true?**
**A**. There has been attention to a study concerning the chemicals in DEET and sunscreen presented at a scientific meeting. This is an in vitro study, which means that it is a laboratory study that did not include human or animal testing. The goal of the study was to examine absorption of these chemicals, and it did not evaluate or make conclusions about health effects related to this issue. The study authors stated that further evaluation of the interaction of these chemicals should be conducted. The study has not yet been published (as of July 2003).

Evaluation by the EPA, which regulates products such as DEET, indicates that it is safe to use insect repellents containing DEET and sunscreen at the same time. CDC recommends using two separate products because sunscreen requires frequent applications while DEET should be used sparingly. Follow the directions on the package for each product, and consult your physician or pharmacist if you have questions. CDC's recommendations for the safe use of insect repellents on children and adults remain unchanged.

***Insect Repellent Use***

**Q. Why should I use insect repellent?**
**A.** Insect repellents help people reduce their exposure to mosquito bites that may carry potentially serious viruses such as West Nile virus, and allow them to continue to play and work outdoors.

**Q. When should I use mosquito repellent?**
**A.** Apply repellent when you are going to be outdoors and will be at risk for getting bitten by mosquitoes.

**Q. What time of day should I wear mosquito repellent?**
A. Many of the mosquitoes that carry the West Nile virus are especially likely to bite around dusk and dawn. If you are outdoors around these times of the day, it is important to apply repellent. In many parts of the country, there are mosquitoes that also bite during the day, and these mosquitoes have also been found to carry the West Nile virus. The safest decision is to apply repellent whenever you are outdoors.

**Q. How often should repellent be reapplied?**
**A.** Follow the directions on the product you are using in order to determine how frequently you need to reapply repellent. Sweating, perspiration or getting wet may mean that you need to re-apply repellent more frequently. If you are not being bitten, it is not necessary to re-apply repellent. Repellents containing a higher concentration of active ingredient (such as DEET) provide longer-lasting protection.

**Q. Should I wear repellent while I am indoors?**
**A.** Probably not. If mosquitoes are biting you while you are indoors, there are probably better ways to prevent these bites instead of wearing repellent all the time. Check window and door screens for holes that may be allowing mosquitoes inside. If your house or apartment does not have screens, a quick solution may be to staple or tack screening (available from a hardware

store) across the windows. In some areas community programs can help older citizens or others who need assistance.

**Q. How does mosquito repellent work?**
**A.** Female mosquitoes bite people and animals because they need the protein found in blood to help develop their eggs. Mosquitoes are attracted to people by skin odors and carbon dioxide from breath. Many repellents contain a chemical, N,N-diethyl-m-toluamide (DEET), which repels the mosquito, making the person unattractive for feeding. DEET does not kill mosquitoes; it just makes them unable to locate us. Repellents are effective only at short distances from the treated surface, so you may still see mosquitoes flying nearby. As long as you are not getting bitten, there is no reason to apply more DEET.

**Q. Which mosquito repellent works the best?**
**A.** The most effective repellents contain DEET (N,N-diethyl-m-toluamide), which is an ingredient used to repel pests like mosquitoes and ticks. DEET has been tested against a variety of biting insects and has been shown to be very effective. The more DEET a repellent contains the longer time it can protect you from mosquito bites. A higher percentage of DEET in a repellent does not mean that your protection is better—just that it will last longer. DEET concentrations higher than 50 percent do not increase the length of protection.

**Q. How does the percentage of DEET in a product relate to the amount of protection it gives?**
**A.** Based on a recent study:

- A product containing 23.8 percent DEET provided an average of five hours of protection from mosquito bites.
- A product containing 20 percent DEET provided almost four hours of protection
- A product with 6.65 percent DEET provided almost two hours of protection
- Products with 4.75 percent DEET and 2 percent soybean oil were both able to provide roughly one and a half hours of protection.

Choose a repellent that provides protection for the amount of time that you will be outdoors. A higher percentage of DEET should be used if you will be outdoors for several hours while a lower percentage of DEET can be used if time outdoors will be limited. You can also re-apply a product if you are outdoors for a longer time than expected and start to be bitten by mosquitoes. (For more information, see Table 1: Fradin and Day, 2002. See Publications page.)

**Q. Why does CDC recommend using DEET?**
**A.** DEET is the most effective and best-studied insect repellent available. (Fradin, 1998). Studies using humans and mosquitoes report that only products containing DEET offer long-lasting protection after a single application.(Fradin and Day, 2002. See Publications page.)

**Q. Are non-DEET repellents effective (e.g. Skin-So-Soft, plant-based repellents)?**
**A.** Some non-DEET repellent products which are intended to be applied directly to skin also provide some protection from mosquito bites. However, studies have suggested that other products do not offer the same level of protection, or that protection does not last as long as products containing DEET. A soybean-oil-based product has been shown to provide protection

for a period of time similar to a product with a low concentration of DEET (4.75%) (Fradin and Day, 2002. See Publications page.).

People should choose a repellent that they will be likely to use consistently and that will provide sufficient protection for the amount of time that they will be spending outdoors. Product labels often indicate the length of time that protection that can be expected from a product. Persons who are concerned about using DEET may wish to consult their health care provider for advice. The National Pesticide Information Center (NPIC) can also provide information through a toll-free number, 1-800-858-7378 or npic.orst.edu.

**Q. I'm confused. Which products contain "DEET"?**
**A.** Most insect repellents that are available in stores are labeled with the chemical name for DEET. Look for N,N-diethyl-m-toluamide or, sometimes, N,N-diethly-3-methylbenamide. Choose a repellent that offers appropriate protection for the amount of time you will be outdoors. A higher percentage of DEET should be used if you will be outdoors for several hours while a lower percentage of DEET can be used if time outdoors will be limited.

***Using Repellents Safely***

**Q. What are some general considerations to remember in order to use products containing DEET safely?**
**A.** Always follow the recommendations appearing on the product label.

- Use enough repellent to cover exposed skin or clothing. Don't apply repellent to skin that is under clothing. Heavy application is not necessary to achieve protection.
- Do not apply repellent to cuts, wounds, or irritated skin.
- After returning indoors, wash treated skin with soap and water.
- Do not spray aerosol or pump products in enclosed areas.
- Do not apply aerosol or pump products directly to your face. Spray your hands and then rub them carefully over the face, avoiding eyes and mouth.

**Q. How should products containing DEET be used on children?**
**A.** No definitive studies exist in the scientific literature about what concentration of DEET is safe for children. No serious illness has been linked to the use of DEET in children when used according the product recommendations. The American Academy of Pediatrics (AAP) Committee on Environmental Health has recently updated their recommendation for use of DEET products on children, citing: "Insect repellents containing DEET (N,N-diethyl-m-toluamide, also known as N,N-diethyl-3-methylbenzamide) with a concentration of 10 percent appear to be as safe as products with a concentration of 30 percent when used according to the directions on the product labels."

The AAP and other experts suggest that it is acceptable to apply repellent with low concentrations of DEET to infants over two months old. Other guidelines cite that it is acceptable to use repellents containing DEET on children over two years of age.

Repellent products that do not contain DEET are not likely to offer the same degree of protection from mosquito bites as products containing DEET. Non-DEET repellents have not necessarily been as thoroughly studied as DEET, and may not be safer for use on children.

Parents should choose the type and concentration of repellent to be used by taking into account the amount of time that a child will be outdoors, exposure to mosquitoes, and the risk of mosquito-transmitted disease in the area. Persons who are concerned about using DEET or other products on children may wish to consult their health care provider for advice. The National Pesticide Information Center (NPIC) can also provide information through a toll-free number, 1-800-858-7378 or npic.orst.edu.

Always follow the recommendations appearing on the product label when using repellent.

- When using repellent on a child, apply it to your own hands and then rub them on your child. Avoid children's eyes and mouth and use it sparingly around their ears.
- Do not apply repellent to children's hands. (Children may tend to put their hands in their mouths.)
- Do not allow young children to apply insect repellent to themselves; have an adult do it for them. Keep repellents out of reach of children.
- Do not apply repellent to skin under clothing. If repellent is applied to clothing, wash treated clothing before wearing again.

Using repellents on the skin is not the only way to avoid mosquito bites. Children and adults can wear clothing with long pants and long sleeves while outdoors. DEET or other repellents such as permethrin can also be applied to clothing (do not use permethrin on skin), as mosquitoes may bite through thin fabric. Mosquito netting can be used over infant carriers. Finally, it may be possible to reduce the number of mosquitoes in the area by getting rid of containers with standing water that provide breeding places for the mosquitoes.

**Q. Is DEET safe for pregnant or nursing women?**
**A.** There are no reported adverse events following use of repellents containing DEET in pregnant or breastfeeding women.

**Q. Are there any risks due to using repellents containing DEET?**
**A.** Use of these products may cause skin reactions in rare cases. If you suspect a reaction to this product, discontinue use, wash the treated skin, and call your local poison control center. There is a new national number to reach a Poison Control Center near you: 1-800-222-1222.

If you go to a doctor, take the product with you. Cases of serious reactions to products containing DEET have been related to misuse of the product, such as swallowing, using over broken skin, and using for multiple days without washing skin in between use, for example. Always follow the instructions on the product label.

*More information*

**Q. Where can I get more information about repellents?**
**A**. For more information about using repellents safely please consult the EPA Web site: http://www.epa.gov/pesticides/citizens/insectrp.htm or consult the National Pesticide Information Center (NPIC), which is cooperatively sponsored by Oregon State University and the U.S. EPA. NPIC can be reached at: npic.orst.edu or 1-800-858-7378.

# Appendix C

# Response to Public Comments

AQUATIC MOSQUITO CONTROL
GENERAL PERMIT
RESPONSE TO COMMENTS

RECEIVED DURING THE PUBLIC COMMENT PERIOD FOR
GENERAL NPDES PERMIT WAG-992000 MODIFICATION
AND
THE BEST MANAGEMNT PRACTICES FOR MOSQUITO CONTROL

This appendix contains Ecology's response to comments to the Mosquito Control General NPDES Permit WAG-992000 Modification and changes to the Best Management Practices for Mosquito Control (BMP) document received during a public review period from December 15, 2003, to March 25, 2004.

Prior to the formal public review period the Departments of Health and Fish & Wildlife, many mosquito control districts, local governments, mosquito control product manufacturers and other interested parties worked with Ecology to revise the statewide permit and BMPs to make them more pertinent and usable for those conducting mosquito control efforts in the field. Meetings were held October 14 and 15 in Moses Lake, on October 21 in Lacey, and again on March 5 in Olympia, at the Washington State Department of Agriculture. As a result, Ecology received many informal comments and suggestions that were incorporated into the proposed modifications.

Formal comments received during the public comment period pertain to wetlands, the use of methoprene and other mosquito control products, thresholds for larviciding (including preemptive methods of control), adulticiding, dipping requirements, suggestions for clarification, and other miscellaneous comments.

**Commenters**

1. Joseph M. Conlon, American Mosquito Control Association
2. Karl Malamud-Roam, Ph.D., Contra Costa Mosquito & Vector Control District, Concord, CA
3. Steve Foss and Wendy Sue Wheeler, Washington State Department of Agriculture
4. Ann Potter and Rocky Beach, Washington State Department of Fish & Wildlife
5. Tom Haworth, Adams County Mosquito Control District, WA
6. Kevin Shoemaker, Northwest Mosquito and Vector Control Association
7. Heather Hansen, Washington Friends of Farms and Forests
8. LaDell Yada, Washington State citizen
9. Lou Dooley, Environmental Health Director, Clark County Mosquito Control District
10. Doug Van Gundy, Wellmark International
11. William Meredith, Delaware Mosquito Control Section, Department of Fish and Wildlife
12. Wayne Switzer, Eden Advance Pest Technologies
13. Art G. Losey, Washington State Pest Control Association
14. William Peacock, City of Spokane
15. Jim Thompson, Grant County Mosquito District #1

**16.** Jim Tabor, WDFW
**17.** Mike Young, Snohomish Health District
**18.** Gerald Campbell, Grant County Health District
**19.** Mark Newberg, Wellmark International
**20.** Benjamin Hamilton, Washington State Department of Health
**21.** David Ensunsa, Columbia Mosquito Control District
**22.** Dan Mathias, City of Everett

Comments have been summarized and those commenting are referenced by the number given to them above. Where comments resulted in a change to either the BMP document or the permit, that change is noted.

**Wetlands**

**Comment 1.** The role of natural predation in the control of mosquitoes in the document and the webpage from which it is derived is somewhat overstated. Although there is a wealth of literature recording observations and extolling the importance of the Odonata as predators of diurnally active adult mosquitoes, this has not been supported by controlled field studies. While predation provides a worthy and welcome contribution to our integrated mosquito control efforts, it simply cannot provide the level of control needed when human lives are at stake This is certainly not meant to downplay the important part proper wetlands management plays in ecology and a fully-integrated mosquito management strategy, for the American Mosquito Control Association fully supports and endorses proper wetlands management. But I would caution against promulgating this as the sole means of mosquito control in areas where these wetlands are found. I would advise further caution against underestimating the potential magnitude of mosquito production even in natural, healthy wetlands. (1, 11, 12)

***Response to Comment 1.*** *Mosquito "outbreaks" most often occur in destabilized wetland and stream ecosystems that have been changed or tampered with so that the predators of the larvae such as invertebrates, insects, and amphibians are excluded. Ecology does not suggest that predation is the only means of mosquito control for wetlands. While draining and/or filling wetlands are not approved methods, taking an integrated approach that targets mosquito larvae control, including bio-chemical control, is recommended in the BMPs. (Tom Hruby, Ecology Wetland Specialist, Personal Communication, 1/16/04)*

**Methoprene**

**Comment 2**. This comment addresses the issue of restricting the use of methoprene in areas known to provide habitat for state threatened and endangered species during the mosquito spray season. There were divergent views on the proposed restrictions. One view suggests the restrictions are unnecessary, the other suggests precaution due to unknowns. Let it be noted that the WDFW restricted areas are the only conditions for methoprene in the Permit that are more stringent than the application conditions set by FIFRA labels.

> **View 1.** The 2001 USEPA document together with the 2003 USEPA research and the World Health Organization/FAO review state that methoprene will have minimal adverse effects on non-target species. The Fish and Wildlife letter pretty dramatically overstates the risks

associated with this product. Decisions should be made on sound science. Methoprene should be allowed in areas identified by WDFW to minimize the potential increase use of adulticides, which will likely result due to insufficient control of third and fourth instar larvae using *Bacillus* products only. (1, 2, 3, 5, 6, 7, 8, 9, 10, 12, 13, 15, 18, 19, 41)

**View 2.** We [WDFW] appreciate Mr. VanGundy's [VanGundy represents Wellmark International, a manufacturer of methoprene products] explanation regarding the contents of the EPA RED documents. We notice that EPA does denote a level of amphibian toxicity from methoprene ("minimally toxic to amphibians"). In our October 13 letter, we state that research on methoprene and frog deformities is inconclusive. There are studies that have found developmental effects to amphibians when methoprene was applied at mosquito control treatment levels, and there are studies that have not observed this. We do not think it would be productive to engage in debate/rebuttal over all research on this matter. Because the body of research on this topic is not definitive we have chosen to use the precautionary principal when conserving state and endangered species. We did not feel that there was sufficient information to recommend that methoprene products be restricted other than in very localized areas where we have identified T & E species. Given that we are making recommendations for state threatened and endangered species, in very limited areas, and that other efficacious mosquito control products (*Bacillus*) are available, we continue to support our original recommendation on methoprene restriction. (4, 16)

***Response to Comment 2.*** *Aquatic Mosquito Control Permit No. WAG – 992000, Section S4. Best Management Practices/Integrated Pest Management requires the preparation and implementation of an Integrated Pest Management Plan (IPMP) by the permittee. Among other conditions, the section states, "in developing the IPM plan, the permittee shall consult with local governments and state and federal agencies as needed." The Permit Fact Sheet provides the following rationale for this condition:*

> *…an IPM program considers all available control actions, including no action, and evaluates the interaction among various control practices, cultural practices, weather, and habitat structure. This approach thus uses a combination of resource management techniques to control mosquito populations with decisions based on surveillance. Fish and game specialists and natural resources biologists should be involved in planning control measures whenever delicate ecosystems could be impacted by mosquito control practices (p. 9).*

*Ecology took the lead developing an IPM plan to assist local governments and others performing mosquito control operations who were suddenly in the business of mosquito control due to the spread of the West Nile virus. As the permit required, Ecology consulted with the Department of Fish and Wildlife (WDFW) in spring 2003 during this process. WDFW identified wildlife species that it considered most vulnerable to certain mosquito control larvacides, identified the primary areas occupied by these species, and requested that pesticide applications be restricted in these areas. Ecology also invited representatives from the industry to comment on the basis of the WDFW recommendations. An evaluation of the issue yields the following facts:*

1. *The criteria WDFW used for denoting species as vulnerable were appropriate. Only those listed as state endangered, threatened, sensitive, or candidate species that inhabited freshwater wetlands during most of the mosquito control treatment period were considered. Five species met the criteria: northern leopard frog (Rana pipiens), Oregon spotted frog (Rana pretiosa), western toad (Bufo boreas), western pond turtle (Clemmys marmorata), and one butterfly, the Yuma skipper (Ochlodes yuma).*

2. *The total area occupied by these species in rivers, lakes, ponds, and wetlands is tiny, comprising of portions of 117 sections (<0.18% of Washington State). Many areas identified for northern leopard frog (36 Sections) and western pond turtle (13 Sections) are owned or managed by WDFW.*
3. *EPA's Methoprene Registration Eligibility Document (RED) is dated March 1991. This document has not been updated. A Fact Sheet for the RED was updated in 2001. The RED document states, "The Agency does have data, however, that show that methoprene is highly acutely toxic to estuarine invertebrates" (p. 12). The Fact Sheet for the RED document updates this assessment and describes the level of amphibian and fish toxicity from methoprene as "minimally toxic" but does not define what that means or explain if that is sufficiently protective for federally and state listed species of concern. The World Health Organization indicates methoprene is slightly toxic to fish but lists no data on amphibians.*
4. *Recent research on methoprene and frog deformities and developmental toxicity is inconclusive. For example, La Clair el al. (1998) found that methoprene breaks down quickly in sunlight and very low concentrations of the byproducts from degradation interfere with normal amphibian development. The La Clair study concluded "the addition of 1µL/L of several of S-methoprene's degradates to the environment of developing [amphibian] embryos resulted in juveniles with deformities similar to that found naturally." Ankley et al. (1998) found that UV light caused amphibian limb malformations whereas methoprene did not. The study further reported that concentrations of 500 ppb of methoprene caused mortality in amphibians. Degitz et al. (2003) was unable to reproduce the results of the La Clair study, but did determine that methoprene and its metabolites did not cause any adverse effects at rates < 1.25 ppm. These data are too disparate to be conclusive. Even though risk levels appear to be low, much uncertainty still exists with both the concentrations and the role methoprene and its metabolites play with the normal development of amphibians.*
5. *Levels of methoprene that may be found in the environment after mosquito control applications are also variable. Concentrations have ranged from 4 ppb at seven days post treatment from an Altosid 30-day briquette (Ross et al 1994) to 0.01 ppm from sustained-release formulations (Degitz et al. 2003). Henrick, et.al. (2002) found 26 ppb s-methoprene in ponds treated with Altosid Liquid Larvicide (ALL) at day one, and 1 ppb at day seven. However, one of the metabolites, 7-methoxycitronellal acid, was found at 267 ppb at day 1 and 237 ppb at day 7. Notably, these levels do not represent multiple treatments or potential accumulation or any number of other factors, such as shade, wind, water flow, temperature, pH, turbidity, etc. that may affect concentrations of applications to the natural environment.*
6. *Several studies concluded that a dose-exposure connection between frog deformities and methoprene applications for mosquito control is unlikely and that correlations between locations of methoprene applications for mosquito operations and frog deformities have not been found (Henrick, et.al. 2002, Johnson et.al. 2001, Ankley et al. 1998).*
7. *Larvicides containing Bacillus thuringiensis israelensis (Bti) and Bacillus sphaericus (BS) are allowed for use in these areas due to their extreme low toxicity to non-target species.*
8. *The restricted areas identified by WDFW may pose a threat to human health when used as breeding grounds by mosquito vectors due to the narrow window of effectiveness of Bacillus products.*

*Ecology proposes to allow the use of methoprene in more than 99% of the state as conditioned by the federal FIFRA label but will continue to restrict the areas of application for methoprene as recommended by WDFW except in the event of a human health threat from mosquito-borne disease as determined by the State and local health departments. Mono-molecular films, oils and organophosphates are also restricted in these areas, but the restriction on the use of methoprene was questioned due to its low toxicity to non-targets and high selectivity for mosquito larvae.*

*To aid future decisions regarding the use of methoprene Ecology will complete a SEPA checklist evaluation of the use of methoprene for mosquito control operations and initiate a monitoring strategy to document concentration levels of methoprene applications in relation to possible adverse effects to non-target species. Many individuals, including people*

*representing mosquito districts, local governments, Wellmark and WDFW have offered to review and/or assist with the monitoring strategy. We intend on taking advantage of these offers. The objective of the evaluation and monitoring plan will be to provide data on methoprene for decisions relevant to permit renewal by November 2006.*

**Comment 3.** Page 13 of the BMP under permitted pesticides for mosquito control: The chart should be corrected to show specifically listed pests for Altosid products. Under the heading "Target Pests on Label," the identified species in the chart for Altosid indicates a variety of pests. There are other methoprene labels that reflect these pests but for Altosid, mosquitoes are the only listed species. (10)

***Response to Comment 3**. Agreed, the chart has been edited. However, EPA's 2001 Methoprene R.E.D. Fact Sheet states that methoprene "has activity against a variety of insect species, including horn flies, mosquitoes, beetles, tobacco moths, sciarid fly, fleas (eggs and larvae), fire ants, pharaoh ants, midge flies and Indian meal moths." This information has been noted as a footnote to the chart.*

**Comment 4.** The statement in Comment 2, that "We do not think it would be productive to engage in debate/rebuttal over all research on this matter [methoprene and amphibians]," is frankly stunning. I do not believe that I have ever seen a government entity express the thought that they do not want to review the scientific facts on a controversial issue. Given that Ecology's proposed alternatives to methoprene are frequently less effective in numerous circumstances, that resistance management through pesticide rotation is a cornerstone of modern IPM, and that USEPA and numerous other independent reviewers have found "minimal toxicity" or equivalent wording, the proposed prohibition should not occur without strong scientific evidence supporting it, and this has not been provided. (2)

***Response to Comment 4.** The comment referred to in the above statement, made by WDFW, was explained in the context: "Because the body of research on this topic is not definitive we have chosen to use the precautionary principal when conserving state and endangered species. We did not feel that there was sufficient information to recommend that methoprene products be restricted other than in very localized areas where we have identified T & E species. " They did review scientific facts, it was the lack of evidence regarding methoprene's toxicity that lead them to recommend the precautionary principle.*

**Comment 5.** The WSDA would like to inform Ecology that the Centers for Disease Control and Prevention, (CDC), recommends the alternation of biorational larvicides (Bti and Bs) and insect growth regulators (methoprene) annually or at longer intervals to prevent the development of insecticide resistance in vector populations. The WSDA recommends that the restriction of the use of Bti and Bs only in certain areas identified in the BMPs be amended by allowing some use of methoprene in rotation and in combination with the approved biorational larvicides so as to prevent the development of resistance to Bti and Bs. (3)

***Response to Comment 5**. Since the restriction on the use of methoprene applies only in very select sites the rotation process recommended would not be precluded in 99% of the state.*

*Further, in discussions with mosquito control operators around the state, we found that resistance to Bacillus products has not been found.*

**Comment 6.** The language allowing local jurisdictions to declare a health threat so they have access to methoprene is very unclear. This BMP gives no guidance as to how local boards of health are to be proactive in protecting the communities or what thresholds should be used to determine the potential for human health risks. Inconsistent mosquito control thresholds could result in water quality problems and people taking illegal control measures into their own hands. (7, 16, 17)