# 4.12 Vector Control

## 4.12.1 Introduction

Mosquitoes are referred to as vectors because they can transmit diseases between birds, mammals, and humans. There are 51 species of mosquitoes known in the Tennessee Valley.

**Resource Issues**

- Population abundance of permanent pool and floodwater species, which is related to the potential transmission of vector-borne diseases

All species of mosquitoes require standing water to complete their life cycle. The cycle from egg to adult typically takes from 7 to 12 days, depending on water temperature. With such a short reproductive cycle, a large number of generations can be produced over a single breeding season (March through October), leading to large and persistent populations of mosquitoes.

Mosquito breeding success is directly related to the extent and duration of shallow standing water, their breeding habitat. The degree to which a policy alternative would increase or decrease standing water throughout the Tennessee River watershed would directly affect the availability of breeding habitat, and indirectly affect the density and persistence of mosquito populations and the related potential transmission of disease.

Mosquitoes can be grouped ecologically, by breeding habitat, into three categories: permanent pool, floodwater (temporary pool), and container breeders ("containers" such as old tires, house gutters, and tree holes) (Breeland et al. 1961). Twelve species are considered to be major pests; most of these species are classified in the permanent pool and floodwater ecological categories. Since the container breeders are not likely to be largely affected by changes in reservoir operations, they are not included in the analyses of impacts associated with alternatives.

Based on the discussion above, the primary issue for vector control is population abundance of permanent pool and floodwater species, which is related to the potential transmission of vector-borne diseases. The Tennessee River watershed was the study area for this analysis.

### Permanent Pool Species

The 17 mosquito species in the permanent pool category develop in standing water that is present for 3 weeks or longer along the margins of reservoirs, ponds, swamps, sewage lagoons, and other depressions and drainages. These species produce 10 or more generations per year. Factors conducive to the continued breeding of permanent pool populations include water level stability, lack of wave action, nutrient levels, and presence of cover (such as vegetation or floating debris) to protect larvae from wave action and predation. Water level conditions that are favorable to increases in aquatic plant acreage, such as the submersed plant Eurasian watermilfoil (see Section 5.9, Aquatic Plants), provide important breeding habitat and would likely result in increased reproductive success for a number of species, including *Anopheles*

*quadrimaculatus* (the major malaria vector in the eastern United States) (Gartrell et al. 1981). Permanent pool species typically overwinter as adults, but two species overwinter as larvae and one as eggs.

#### Floodwater (Temporary Pool) Species

This group of 22 species includes some of the more aggressive pest species of mosquitoes. They develop in areas prone to intermittent flooding, such as floodplains and temporarily inundated areas. Eggs must go through a conditioning process (drying) before they hatch and can remain in this condition for up to 3 years or more and still be viable upon flooding. During hot summer months, a generation can develop as quickly as within 5 or 6 days. Rapid development is necessary for survival due to the temporary nature of the larval habitat. Development time is prolonged during spring and fall when temperatures are cooler. Adults emerge nearly simultaneously, seemingly producing a large population overnight. Floodwater mosquitoes overwinter in the egg stage.

#### Mosquito-Borne Diseases

Presently, four major viruses can be transmitted by mosquitoes bred in the Tennessee Valley: Eastern equine encephalitis, St. Louis encephalitis, LaCrosse encephalitis, and West Nile virus. These four viruses naturally infect birds and are incidentally passed to other vertebrates, such as horses and humans, by mosquitoes. Only certain species of mosquitoes have tested positive for the different viruses; however, not all species that have tested positive for a particular virus are competent vectors for that virus (Beaty and Marquardt 1996).

Malaria, a parasite of red blood cells, is not carried by birds. Since 1949, no cases of malaria of local origin have been reported, nor has there been an indigenous case traced to the TVA reservoirs (TVA 1974). But if an infected individual came to the Valley and was bitten by *Anopheles quadrimaculatus* (a permanent pool mosquito and a competent vector of malaria), malaria could be reintroduced to the Valley.

### 4.12.2 Regulatory Programs and TVA Management Activities

TVA actively manipulates reservoir levels on four reservoirs to limit mosquito breeding habitat. TVA monitors populations of all mosquito species by light trapping during the mosquito season. County and municipal governments are responsible for all other mosquito control activities, such as pesticide application and drainage improvement of non-TVA land.

#### Permanent Pool Species

To reduce populations of permanent pool mosquitoes, TVA manages the water level from late May to August on Chickamauga and Pickwick Reservoirs, and from late May to September on Guntersville and Wheeler Reservoirs. Each week, water levels are lowered 1 foot and are then returned to the normal summer pool levels. Weekly water level fluctuations of 1 foot during the mosquito season break the generation cycle because mosquito eggs and larvae are stranded

on the banks, exposing them to drying and predators. This method of water fluctuation was developed early in TVA's history to reduce and control malaria in the Valley.

Other water management strategies that reduce populations of permanent pool mosquitoes include the following:

- Low winter reservoir water levels (January to mid-March), primarily in place for flood control, reduce the growth of submersed aquatic plants and provide drainage of low-lying areas.

- Higher reservoir water levels in early spring (mid-March to mid-April) retard emergent plant growth and leave driftwood and other floating material that is washed into the reservoir stranded on the shoreline when water recedes during the lower summer pool levels.

- Fluctuation and recession to winter reservoir water levels destroy eggs and larvae, reduce breeding area, and provide clean shorelines.

#### Floodwater Species

TVA shortens the amount of time for floodwater mosquitoes to develop by removing water from the floodplains and returning reservoirs to their normal level as soon as possible after a rain event, usually within 7 to 10 days. Removing water from the floodplain effectively reduces floodwater mosquito breeding habitat. Leaving water in the floodplains longer than 7 to 10 days can increase floodwater mosquito populations. If a reservoir could be maintained to never crest above maximum elevation levels, the problems of floodwater mosquitoes could be reduced, but not eliminated.

### 4.12.3 Population Abundance of Permanent Pool Species

#### Existing Conditions

Permanent pool mosquitoes occur on mainstem and tributary reservoirs with stable water levels, no wave action, and the presence of cover. On mainstem reservoirs, these conditions occur primarily from Chickamauga to Kentucky Reservoirs. Consequently, weekly 1-foot water level fluctuations to reduce mosquito populations are implemented at these reservoirs, excluding Wilson and Kentucky Reservoirs. Studies have confirmed that water level fluctuations will suppress permanent pool mosquito populations (Breeland et al. 1961, Gartrell et al. 1981). During wet years, higher populations of adult permanent pool mosquitoes will overwinter due to the extended high water levels. This could result in more females laying eggs in spring and population increases in early generations, which could increase the disease transmission potential because vector populations would be higher when migratory birds arrive—both in spring and fall. If water levels are high when fall migration begins (a time when virus-infected birds can move south), the potential exists to extend the mosquito-borne encephalitis season. Migration of birds through, or from, an area of high virus activity with coinciding high mosquito

populations would increase mosquito–bird contact above typical levels, thus increasing the disease transmission potential.

Mosquitoes are not as widespread on tributary reservoirs as they are on mainstem reservoirs, and they tend to occur in pockets. The existing operation of drawdowns on tributary reservoirs in mid-July to August helps to reduce overwintering populations of mosquitoes.

#### Future Trends

No change in existing trends is anticipated without a change in existing operations.

### 4.12.4 Population Abundance of Floodwater Species

#### Existing Conditions

Floodwater mosquitoes develop in pools of water left on the floodplain after a breach of maximum water level elevation. This can occur on any of the mainstem or tributary reservoirs. In recent history, Kentucky Reservoir has experienced the largest concentration of floodwater mosquitoes. The existing early drawdown helps to reduce overwintering populations of floodwater mosquitoes and the associated risk of disease.

#### Future Trends

No change in existing trends is anticipated without a change in existing operations.