Journal of the American Mosquito Control Association, 10(2):233–235, 1994

EFFECTS OF A NATURAL MARSH FIRE ON LARVAL POPULATIONS OF *CULEX SALINARIUS* IN EAST TEXAS[1]

T. E. JANOUSEK[2] AND J. K. OLSON[3]

ABSTRACT. A natural marsh fire caused by lightning suppressed *Culex salinarius* larval populations for 2 months following the fire. Removal of emergent vegetation and higher water temperatures rendered burned-area pools unsuitable either for larval development or deposition of eggs or both. With a drop in seasonal ambient temperature and a regrowth of emergent vegetation, the burned areas returned to being suitable larval development sites for *Culex salinarius.* No differences in water salinity or pH were observed between burned and unburned locations.

In certain instances, fire, through controlled burns, has been used as a tactic to improve wildlife habitats and rangeland for livestock (Kayll 1974, Chabreck 1988, Stutzenbaker and Weller 1989). Similarly, fire can be used to regulate diseases and insect pests (Ahlgren 1974). In this regard, certain populations of floodwater mosquitoes have been suppressed by burning habitats where their eggs were located (Ward et al. 1969, Wallace et al. 1990, Whittle et al. 1993). However, little information is available about the potential use of fire to control populations of standing water-breeding mosquitoes such as *Culex salinarius* Coq., which occur along coastal plains of Texas. In this particular case, a lightning-caused fire swept through a 809-ha area of intermediate to brackish marsh zone on the Anahuac National Wildlife Refuge in Chambers County, TX, during July 28–31, 1988. The burned area was identical in vegetative composition and topographical features to nearby *Cx. salinarius* larval habitats being used for an extensive study of the bionomics of this species (Janousek and Olson, unpublished data). An opportunity was thus provided to investigate effects of the fire on larval activity of *Cx. salinarius* populations.

Immediately after the fire (August 1, 1988), 4 larval sampling sites were established, 2 in burned areas and 2 in adjacent unburned sites for controls. Species composition and condition of the plant communities occurring at each site were determined, and pools of standing water at each site were sampled for mosquito larvae using the 1-pint (350-ml) dipper sampling technique. At least 25 dips were made at each site, with numbers of larval instars present in each dip recorded. Water temperatures in the pools were measured with a standard Celsius-scaled bulb thermometer. The water pH of each site was determined using litmus paper. Salinity was determined using a silver nitrate titration test with potassium chromate as the indicator solution. Salinity was calculated in mg of NaCl per liter of water (i.e., ppm).

We attempted to evaluate each site on a weekly basis over a 12-wk postfire period, which extended to November 12, 1988. On each sampling date, larval samples, pH readings, and salinity estimates were taken in the same manner as done on the first day postfire. During the latter half of the study period heights of 20 randomly selected blades of grass were measured at each of the 4 locations.

The dominant species of emergent vegetation present in the region of the fire were marsh hay cordgrass (*Spartina patens*) and saltgrass (*Distichlis spicata*) interspersed with patches of 3-cornered sedges (*Scirpus olneyi* and *S. robustus*). The postfire emergent plant communities and land topography in burned sites were identical to those at unburned sites.

On the first day postfire (August 1, 1988), emergent vegetation in burned sites was burned to soil or water level, exposing the underlying pools of water to direct sunlight. In contrast, most pools in unburned sites continued to be shaded by a thick overstory of emergent vegetation. Correspondingly, water temperatures in pools sampled in burned sites on August 1 (mean 34.0°C) were significantly higher ($P < 0.001$, *t*-test; CoStat 1990) than those in pools sampled in unburned sites (mean 27.1°C, Table 1). The pH readings at burned and unburned sites were similar (6.4 and 6.5, respectively); and water salinities in the 2 areas (4,899 ppm and 3,768 ppm, respectively) were not significantly different ($P = 0.65$, *t*-test) throughout the study.

Dipper samples of *Cx. salinarius* larvae collected from both burned and unburned sites on

---

[1] This study was conducted in cooperation with the U.S. Department of Agriculture, Agricultural Research Service, as a part of USDA, CSRS Southern Regional Project S-230 involving State Agricultural personnel located in Arkansas, California, Louisiana, Mississippi, and Texas and is approved for publication as TA31436 by the Director of the Texas Agricultural Experiment Station.

[2] Jefferson County Mosquito Control, 2748 Viterbo Road, Box 8, Beaumont, TX 77705.

[3] Department of Entomology, Texas A&M University, College Station, TX 77843.

Table 1. Average emergent vegetation height and water temperatures at *Culex salinarius* larval collection sites in burned and unburned areas of an intermediate brackish marsh on the Anahuac National Wildlife Refuge, TX, from August 1 to October 23, 1988.

Date	Vegetation height (cm)[1,2,3] Burned areas	Vegetation height (cm)[1,2,3] Unburned areas	Temperatures (°C)[3,4] Burned areas	Temperatures (°C)[3,4] Unburned areas
Aug. 1			34.0	27.1
Aug. 5			34.5	29.3
Aug. 22			31.2	27.8
Aug. 26			35.0	28.6
Sep. 10			30.3	25.3
Sep. 14	37.3	90.4		
Sep. 24	37.8	78.5	35.5	30.4
Sep. 30	46.0	73.4		
Oct. 8	53.3	80.0	28.5	22.2
Oct. 16	52.6	83.8	28.9	23.5
Oct. 23[5]	56.6	81.0	26.6	25.9[6]

[1] Average of 20–40 measurements.
[2] Height of emergent vegetation in burned areas was noted to be reduced to ground or water level on August 1, 1988.
[3] Burned and unburned values are significantly different ($P < 0.001$, *t*-test; CoStat 1990), unless otherwise noted.
[4] Average of 5–10 measurements.
[5] *Culex salinarius* larvae were collected in burned areas at this time.
[6] Burned and unburned values are not significantly different ($P > 0.05$, *t*-test).

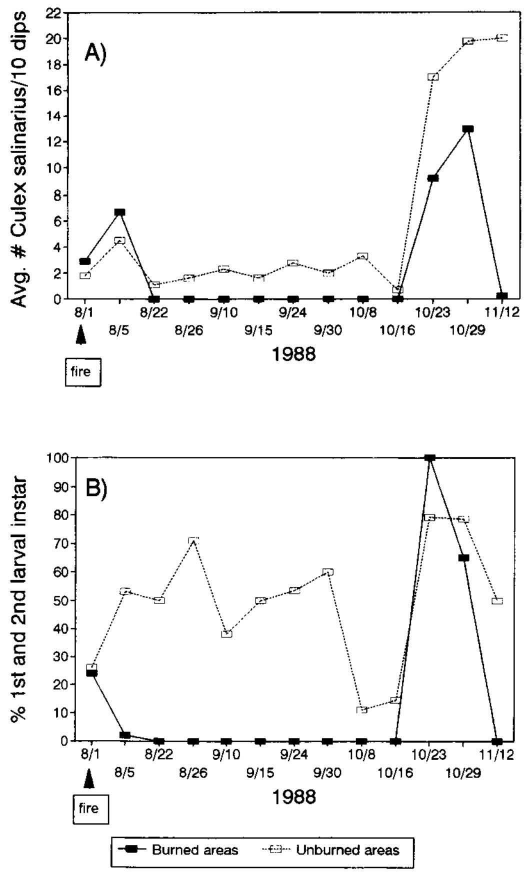

Fig. 1. Average numbers of *Culex salinarius* larvae collected at sites in burned and unburned areas of a marsh on the Anahuac National Wildlife Refuge, TX, from August 1 to November 12, 1988. A. Average number of larvae in all stages of development. B. Percent of larvae collected that were in the 1st or 2nd instar of development.

August 1, 1988, revealed little apparent effect of the fire upon the underlying larval population (Fig. 1A). Although slightly more larvae were collected in burned areas than in unburned areas (Fig. 1A), the percentages of 1st- and 2nd-instar larvae present in the areas were almost the same (24 and 26%, respectively, Fig. 1B).

On the 5th day postfire (August 5, Figs. 1A, 1B), a noticeable difference appeared between larval populations in burned and unburned sites. The total number of larvae per dip was still higher at burned sites, but the percentage of 1st- and 2nd-instar larvae present in burned sites (2% of 110 larvae collected) was much lower than that recorded in unburned sites (53% of 68 larvae collected). Beginning with the next sampling trip on August 22 (22 days postfire) and for *ca.* 2 months thereafter, no *Cx. salinarius* larvae were detected at burned sites, whereas various larval instars of this species continued to occur in unburned sites. On October 23, 1988 (84 days postfire), *Cx. salinarius* larvae reappeared in burned areas, at which time 100% of collected larvae were either 1st or 2nd instar (Figs. 1A, 1B).

One possible reason for the 2-month absence of *Cx. salinarius* larvae in burned sites might be that females seeking oviposition sites avoided pools of water left exposed by the fire. These pools no longer had a canopy of vegetation to protect the larvae from direct sunlight, wind, and detection by predators. The sudden decrease of 1st- and 2nd-instar larvae in these particular pools within 4 days postfire provides some evidence of ceased oviposition.

Another explanation for this extended absence of larvae or oviposition might be the higher water temperatures observed in burned sites. The elimination or reduction of overstory emergent vegetation by the fire exposed pools of water to the heating effects of direct sunlight. From August 1 to October 16, 1988, water temperatures in burned site pools ranged from 3.4 to 6.9°C higher than those in pools in unburned sites and the differences between the 2 sites were significant ($P < 0.001$, *t*-test). The high temperatures in the exposed burned site pools may have exceeded the tolerance level for early instar *Cx. salinarius* larvae or caused gravid females to seek sites having cooler water temperatures. When larvae reappeared in burned sites (October 23, 1988, Fig. 1A), emergent vegetation in these sites had regrown to 70% of that in unburned sites and water temperatures were no longer significantly different. The pools were no longer exposed to heating effects of direct sunlight.

In conclusion, fire might be an effective control tactic to use against marshland populations of standing-water mosquito species such as *Cx. salinarius* in certain instances. In such cases, controlled burning should be used during the dry summer months when combustibility of the emergent vegetation is highest and larvae of this species are confined to marshland areas (Janousek and Olson, unpublished data). Use of this control tactic must be contingent upon its integration into the overall land and habitat management schemes used in the area. Vogl (1973) stated that fire is variable and its effects upon diverse habitats, each with a variety of microhabitats and organisms, produces a diverse range of results. Thus, as suggested by Kantrud (1985) and Weller (1990), more research is needed to determine specific effects of controlled burning upon plants and wildlife in marsh areas where *Cx. salinarius* occurs so as to insure that this control tactic does not cause irreparable damage.

We thank the staff of the Chambers County Mosquito Control District, personnel at the Anahuac National Wildlife Refuge, and others at the Texas A&M University Mosquito Laboratory for their assistance in this project. Special appreciation is also extended to Tracy Dickerson and Cliff Thornton for their help in the field. We thank Milton W. Weller and Charles Stutzenbaker for their critical reviews of the manuscript.

REFERENCES CITED

Ahlgren, I. F. 1974. The effect of fire on soil organisms, pp. 64–66. *In:* T. T. Kozlowski and C. E. Ahlgren (eds.). Fire and ecosystems. Academic Press, New York.

Chabreck, R. H. 1988. Coastal marshes: ecology and wildlife management. Univ. of Minnesota Press, Minneapolis.

CoStat. 1990. CoHort Software, Berkeley, CA.

Kantrud, H. A. 1985. Effects of vegetation manipulation on breeding waterfowl in prairie wetlands: a literature review. U.S. Fish & Wildl. Serv. Rep. 3.

Kayll, A. J. 1974. Use of fire in land management, p. 488. *In:* T. T. Kozlowski and C. E. Ahlgren (eds.). Fire and ecosystems. Academic Press, New York.

Stutzenbaker, C. D. and M. W. Weller. 1989. The Texas Coast, pp. 385–405. *In:* L. W. Smith, R. L. Pederson and R. M. Kaminski (eds.). Habitat management for migrating and wintering waterfowl in North America. Texas Tech Univ. Press, Lubbock, TX.

Vogl, R. J. 1973. Effects of fire on the plants and animals of a Florida wetland. Am. Midl. Nat. 89: 334–347.

Wallace, F. L., M. A. Tidwell, D. C. Williams and K. A. Jackson. 1990. Effects of controlled burning on *Aedes taeniorhychus* eggs in an abandoned rice impoundment in South Carolina. J. Am. Mosq. Control Assoc. 6:525–529.

Ward, C. R., J. C. Owens, E. W. Huddleston and D. Ashdown. 1969. Project completion report: alternate methods of mosquito control to reduce chemical pollution of waters for recharge of the Ogallala Formation. WRC-69-/Apr. 1969. Water Resources Center, Texas Tech Univ., Lubbock, TX.

Weller, M. W. 1990. Waterfowl management techniques for wetland enhancement, restoration and creation useful in mitigation procedures, pp. 517–528. *In:* J. A. Kusler and M. E. Kentula (eds.). Wetland creation and restoration. Island Press, Washington, DC.

Whittle, R. K., K. J. Linthicum, P. C. Thande, J. N. Wagati, C. M. Kamau and C. R. Roberts. 1993. Effect of controlled burning on survival of floodwater *Aedes* eggs in Kenya. J. Am. Mosq. Control Assoc. 9:72–77.