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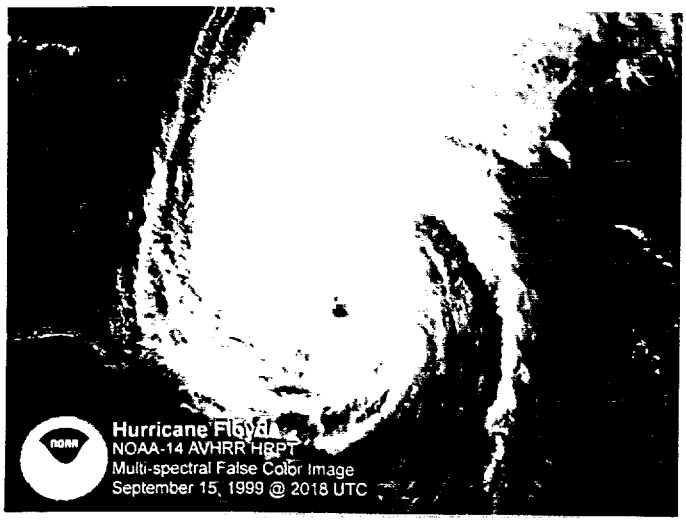
Feature

Emergency Aerial Spraying in North Carolina after Hurricane Floyd, 1999

by *Alice L. Anderson, Barry Engber, Bruce Harrison, Jeff Brown, Joe Andrews, L. M. Rueda, Parker Whitt, and Nolan Newton*

Hurricane Floyd made landfall as a category II storm on the morning of September 16, 1999. Floyd arrived in a rain-soaked landscape where persistent Hurricane Dennis, the week before, had already left up to 20 inches of rain. As the floodwaters began to recede from these two storms, another hurricane, Irene, arrived and remained offshore, but brought an additional three to six inches of rain. This renewed the threat of river flooding. The Federal Emergency Management Agency (FEMA) and the North Carolina Division of Emergency Management (NCDEM) assessments indicated that of the 66 counties designated for Federal assistance, 44 were listed with damages ranging from moderate to severe. The most severely affected counties according to FEMA and NCDEM were: Pitt, Edgecombe, New Hanover, Wayne, Lenoir, Columbus, Nash, Pender, Brunswick, Robeson, Beaufort, Duplin, Bladen, and Wilson.



In the Northern section of coastal North Carolina, sparsely populated counties suffered extensive damage, not accounted for in the population-based damage assessments, and also faced severe mosquito outbreaks like the more populated coastal counties. Population-based accounting of impact did not always reflect the total stress on a given county.

In early 1999, a North Carolina toxicological report ranked available mosquito aerial spray adulticides in this order: Sumithrin, Permethrin, Malathion, and Naled. All four chemicals were used in 35 sprayed counties after Hurricane Floyd. Coordinating emergency spray was more difficult with four products, but it gave us an opportunity to observe the effectiveness of the four chemicals.

Landing counts were essential to determine the initial extent of the mosquito problem in early September, and these counts were required by the Centers for Disease Control (CDC) and FEMA for funding. All 35 counties surveyed in September and October exceeded the 25+ per minute level for FEMA emergency spray funding. Landing counts were done according to standard procedures by NC Public Health Pest Management field staff.

Approximately 10-20 days following Hurricane Floyd, mosquito landing counts in the 35 counties exceeded 25 per minute. Many of the individual adult counts reached 150 to 200 per minute. Extremely high numbers of *Aedes atlanticus/tormentor, Ae. canadensis, Ae. sollicitans, Ae. taeniorhynchus, Ae. vexans, Psorophora ciliata, Ps. columbiae, and Ps. ferox* were encountered in many counties. These day-biting species severely hampered outdoor activities, including recovery efforts. Aerial spray was

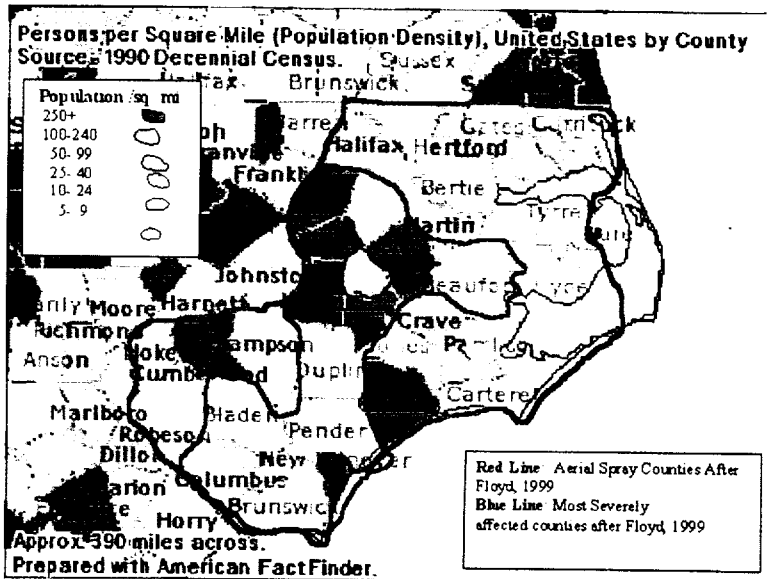


Figure 1 Total county population densities in Eastern North Carolina with post-Floyd aerial spray counties outlined in red, and most severely affected counties outlined in blue.

done from dawn until 10:00 AM and again from 3:00 PM until sunset.

As in 1996 (after Hurricane Fran), aerial treatments following hurricanes Dennis and Floyd were contracted to five companies based on past performance and current capability: K&K Flying Service, Lee County Mosquito Control District, Steed's Flying Service, and Donald's Flying Service. In 1999, the U. S. Air Force Reserve 910 TAG Unit, and a local company, Whitfield Flying Service, were added to the contractors.

The total number of acres aerially sprayed after Hurricane Floyd was 3,953,558. Because of the expansive area involved, only those parts of a county with population densities of 151people/sq. mi. or greater were sprayed. Aerial spray began on September 27 and continued until October 25. Twenty counties were sprayed with Sumithrin, seven were sprayed with Malathion, four were sprayed with Resmethrin, two with Sumithrin and Resmethrin, and one with Naled (by a county mosquito control program). In addition to aerial spray, at least three counties initiated new mosquito control programs, and most ground ULV machines were used daily.

In order to evaluate relative effectiveness of aerial spray with the four chemicals in use, landing counts were conducted by 6 field staff just prior to spray dates in as many counties as possible. Landing counts were then conducted again after spraying where possible. Where possible, counts were an average of 3 one-minute intervals at the same sites as the pre-spray counts. Spray effectiveness observations for a county were included in this analysis only if the county had more than 3 locations for counts, and if the counts were made within 2-3 days of the spray.

Figure 2. **Hurricane Floyd Spray Chemicals: Percent Change measured by Landing Counts for 14 Counties with Four Chemicals**

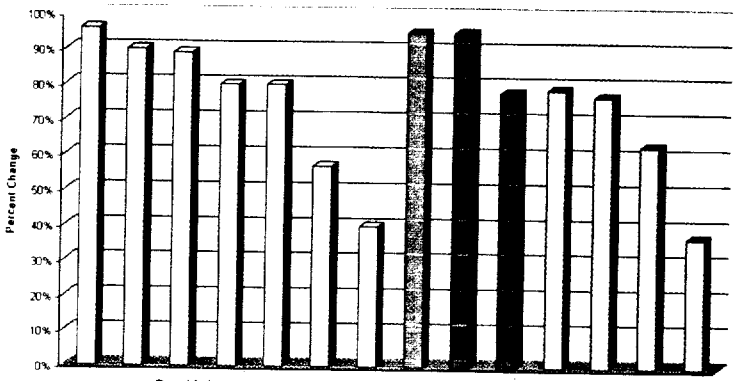


Table 1 is a summary of the counties that met the above criteria for inclusion.

The last column shows the percent reduction based on averaged before and after landing counts. The bar graph (Figure 2) shows the variability in results measured for Resmethrin and Sumithrin and includes two counties sprayed with Malathion and one with Naled. There were more counties using Resmethrin and Sumithrin that had complete landing counts. There were also more counties using Sumithrin than any other chemical.

In general, we found that all chemicals performed well in some situations. Weather conditions in the fall in North Carolina are extremely unpredictable, leaving only very small windows of suitable weather available to cover large areas. Large aircraft seemed much more effective in these situations because more territory could be covered in a short time. However, despite aircraft size, adequate control was difficult to achieve in counties with large salt marsh acreage. Two counties with salt marsh acreage and major flooding had counts averaging over 25 throughout the spray operation, before and after spray. Counts continued to be high in these counties until cold weather arrived.

In counties with low human population densities, limited total spray acreage affected overall control. Total spray acreage was determined mainly by population density (151people/sq. mi.). Large-scale control was difficult with restricted acreage, especially when the county had extensive salt marsh and forest coverage.

Table 1. **Landing Counts, NC Emergency Aerial Spray Following Floyd**

County	Acres Sprayed	Date of Spray	Chemical Used	Applicator	Pre count	Post count	Percent Change
Robeson	378,694	7-10-Oct	Sumithrin	K&K	32	1.3	96%
Columbus	224,052	5-8-Oct	Sumithrin	K&K	30.7	3.2	90%
Bertie	100,500	18-19-Oct	Sumithrin	USAF	14.8	1.7	89%
Nash	258,625	8-16-Oct	Sumithrin	USAF	19.4	3.8	80%
Sampson	126,998	8-11-Oct	Sumithrin	K&K	32	6.6	80%
Brunswick	296,178	5-11-Oct	Sumithrin	K&K	38.7	16.5	57%
Washington	35,500	19-22-Oct	Sumithrin	Donald's	4.6	2.8	40%
Carteret	168,960	27-Sept-2-Oct	Naled	Steed's	20	1	95%
Pitt	101,887	7-10-Oct	Malathion	Lee Co.	28	1.5	95%
Lenoir	67,875	16-Oct	Malathion	Lee Co.	17.6	3.8	78%
Onslow	139,420	12-15-Oct	Resmethrin	Steed's	36.3	7.6	79%
Beaufort	143,550	23-24-Oct	Resmethrin	K&K	25.7	6	77%
Hyde	22,600	25-Oct	Resmethrin	K&K	24.4	9.2	63%
Pender	208,080	9-11-Oct	Resmethrin	Steed's	16	10	37%
Total	2,326,789						
Total Spray	3,953,558						

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inspecting the site will eliminate the problem of unnecessary treatments.

Question 4 allows a site holding water to be inspected again after 7 days. The 7 days is based upon the desire to inspect sites holding water on a weekly basis.

Question 5 prevents inspection of a site that was dry until there has been at least 0.75 inches of rainfall in the area within the last 7days. Sites that are dry should not be inspected again until there has been enough rainfall to cause the site to hold water. In our area we have found that it takes at least 0.75 inches of rainfall before most dry sites will hold water long enough to produce mosquitoes.

The second component of the ground larviciding system is the computer-mapping system. Computer based mapping allows us to select the map coordinates associated with each site directly from the computer screen. These coordinates represent actual points on the ground are used as the unique identifier or name for that site

The third component of the ground larviciding system is the GPS receiver. GPS receivers rely on a group of satellites to pinpoint your location on the ground. Thanks to the recent removal of the "Selective Availability" feature of these satellites, the margin of error is usually less than 30 feet. Instead of using paper maps, we have found that using handheld GPS units to be a much simpler and more accurate method for locating sites. The map coordinates are loaded into the handheld GPS units and the units are then used to locate the sites in the field. New employees usually learn to operate the unit after only a few hours and are then able to locate the sites in the field. This has proven to be a very efficient method when dealing with hundreds of sites.

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From North Carolina's two experiences (1996 and 1999), it appears that large-scale aerial spray is most effective when aircraft can be used to treat large spray blocks and quickly deliver chemicals that are the most reliable over a wide range of conditions.

Constraints in North Carolina imposed by choice of chemicals, weather conditions, geography, environmental concerns, aircraft types, and timing produced highly variable results in pesticide effectiveness in most counties sprayed in 1999. With imperfect conditions for the application of chemicals, and with limited staff to carry out precise data collection, our results indicate a range of effectiveness which could be expected in an emergency situation of this magnitude.

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