FIGHT THE BITE WITH GIS

Author: Pamela Villa

ABSTRACT

Since 1989, the Vector Surveillance and Control Program (VSC) of the County of San Diego Department of Environmental Health has provided countywide mosquito surveillance and control services. Implementation of GIS in the VSC program has helped communicate and respond to the increased activity associated with the threat and imminent arrival of West Nile Virus. The VSC staff have moved from narrative descriptions and map books to an ESRI MapObjects intranet mapping application to view mosquito-breeding sources and to respond to citizen complaints. Management of staff and resources can be analyzed geographically using maps generated from ESRI ArcGIS software. Location, acreage, and cost of aerial treatment methods are determined using GIS tools. Surveillance locations to monitor disease patterns have been digitized or mapped with GPS. GIS has helped the VSC program realize management goals such as improved communication, reduction in resources and costs, and enhanced staff technical skills.

INTRODUCTION

The Vector Surveillance and Control program (VSC) of the County of San Diego Department of Environmental Health (DEH) has provided countywide vector surveillance and control measures since 1989. Housed within an environmental health department, the DEH VSC program has an emphasis on promoting healthy behavior and protecting the environment. The magnitude and seasonality of VSC program services vary, yet VSC continually focuses on mosquito control, rat control, and surveillance activities for vector-borne diseases such as plague and hantavirus. Mosquitos are a well-known vector capable of transmitting disease such as malaria and encephalitis to humans. Most recently, West Nile Virus (WNV) has been transmitted to humans from mosquitos at a rapid rate since its appearance in North America in 1999.

This paper focuses on use of GIS in DEH VSC program. Substantive information on WNV can be found on Internet sites designed to provide scientific, preventative, and medical information on WNV to the public. Nonetheless, some basic information about WNV is warranted for background to the discussion of GIS projects presented in this paper.

WNV is transmitted to humans through mosquito bites. Mosquitos become infected when they feed on infected birds that have high levels of WNV in their blood. Infected mosquitoes can then transmit WNV when they feed on humans or other animals. The bird population has acted as a host and allowed rapid spread of the virus across North America. WNV predominantly infects birds with some bird species being more susceptible than others; however, horses and humans can

become infected as well. A vaccine exists for horses but not for humans. A person infected with WNV may experience mild symptoms or in severe cases experience paralysis or death. In order to prepare and respond to the inevitable arrival of WNV to the San Diego region, several County of San Diego Departments including County Health and Human Agency (HHSA) and DEH, worked together to develop a West Nile Virus Strategic Response Plan (Plan). The Plan was designed to integrate resources to combine educational messages and mosquito control measures, and to develop a coordinated response to WNV.

USE OF GIS IN THE SURVEILLANCE & CONTROL OF MOSQUITOS

Until 2003, geographic information related to VSC program has been marked by pencils in map books or pins on poster size maps. For several years VSC supervisors, vector ecologists, and vector control technicians have recorded daily field activities in Access database(s). The ability to capture, analyze, and display this information has been made possible by working together to develop several GIS datasets. GIS has been used as a tool in preparing for WNV including mosquito control, vector surveillance, and outreach and education.

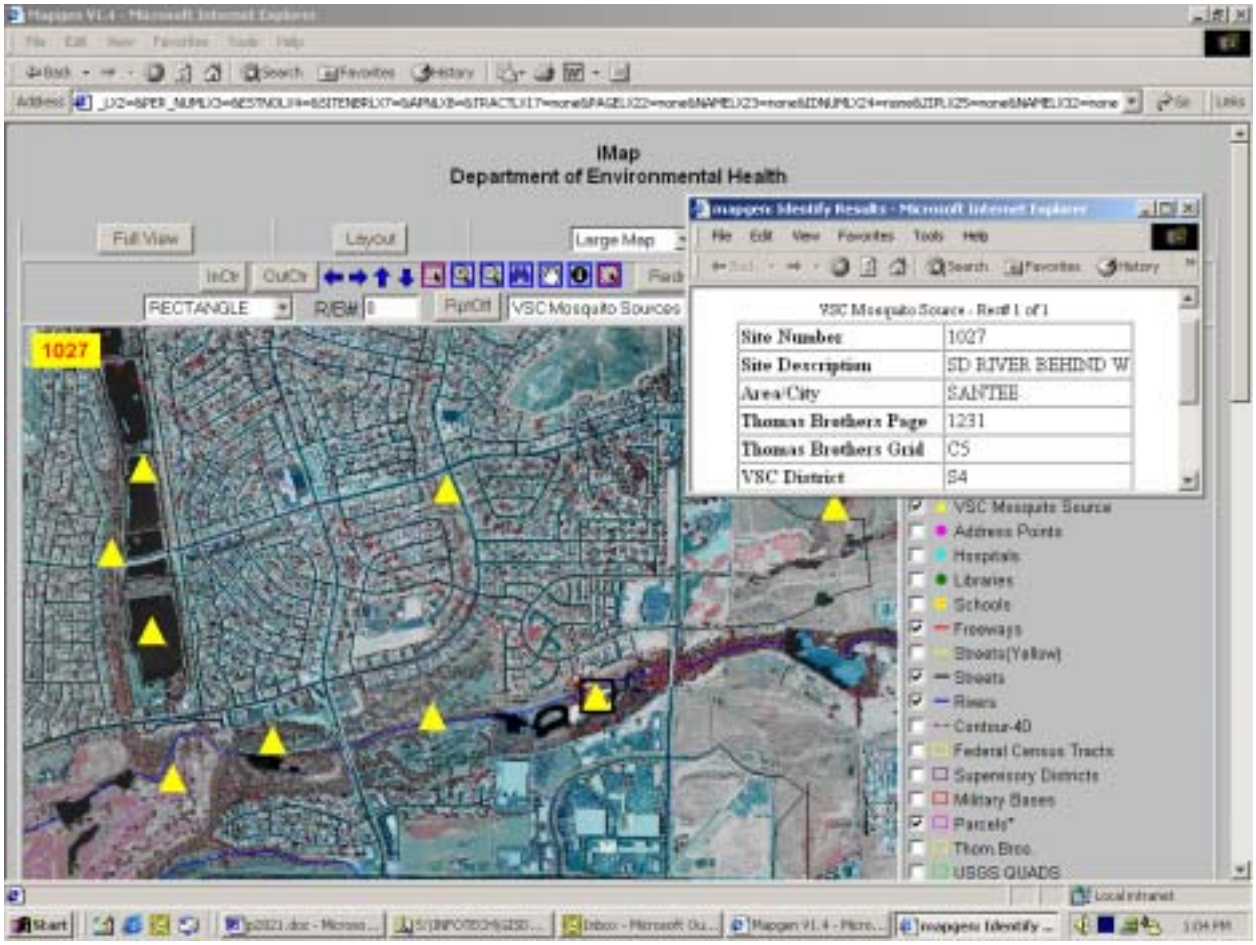
1. MOSQUITO CONTROL

a) Mosquito Breeding Source Locations

The first GIS project implemented in VSC was to map the known mosquito breeding sources. These sources are referred to as sites by the VSC staff and are recorded in an Access database using a unique site number. Each VSC field technician has an assigned route that corresponds to Thomas Brothers map book pages. Using field technician map books as a source map, a point layer was created using heads up digitizing. Hundreds of point locations were transferred from the map book into an ESRI ArcView shapefile. Brief narrative descriptions of each site was consulted and joined as an attribute text field from the Access database using the unique site number. Additional information such as amount of treatment material applied and the site visit date is associated with each site number.

Many of the mosquito sources (or sites) are large water bodies while others are smaller sources such as standing water in stormwater conveyance systems. Many of the known breeding sources are a result of citizen complaints. These breeding sources may be located on publicly owned land or easements or on private land. The accuracy of the initial source GIS layer was lacking the accuracy needed to perform a point-to-polygon geoprocessing technique to assign property ownership to each source. VSC field technicians visit these sites regularly. Thus, the personal knowledge of staff was used to create a new dataset since this was considered a more accurate means of obtaining a more precise location for known mosquito breeding sources.

In order to map the sources, VSC staff received training on a DEH GIS intranet-based mapping application developed in ESRI MapObjects. The application contains departmental GIS data and regional SanGIS data layers. The mapping application allows staff to access a low-cost, simplified GIS interface for basic query and mapping functions. VSC staff used the application to identify breeding site locations and obtain property owner information. Using the refined site location a new mosquito breeding source GIS point layer was created. The following image shows the DEH GIS mapping application interface, the mosquito breeding sources (yellow triangles), and the results of a basic report (or query) on a selected site.



Staff assignments change in order to respond to increased complaints and/or to reflect new route assignments, and the mapping application has proved helpful in allowing a newly assigned VSC field technician to locate mosquito-breeding sites throughout the County.

VSC staff also received training on Global Positioning Systems (GPS) technology. Integration of GPS with GIS allows the field technician to capture the site location in the field. GPS was used in identifying some sites and in refining the locations of other sites. Despite the training, due to a limitation in staff time and the inventory of GPS units, this technology was not relied upon given the demand to complete a map of mosquito breeding sources before the mosquito season.

b) GIS increases Knowledge and Communication

VSC management used the mosquito breeding source GIS information to communicate mosquito problems and control measures with public and private landowners, cities and public agencies in the County of San Diego. The GIS information was also used to create and mail notifications to private landowners regarding planned mosquito control measures designed to reduce the risk of WNV.

The distribution, location, and ownership of mosquito breeding sources has provided insight into program implementation and allowed evaluation by VSC management as the VSC program develops a zero-based budgeting scenario.

In addition, VSC field technician route assignments have been mapped into a GIS layer enabling staff to easily view and review routes for quick assignment and response to mosquito complaints.

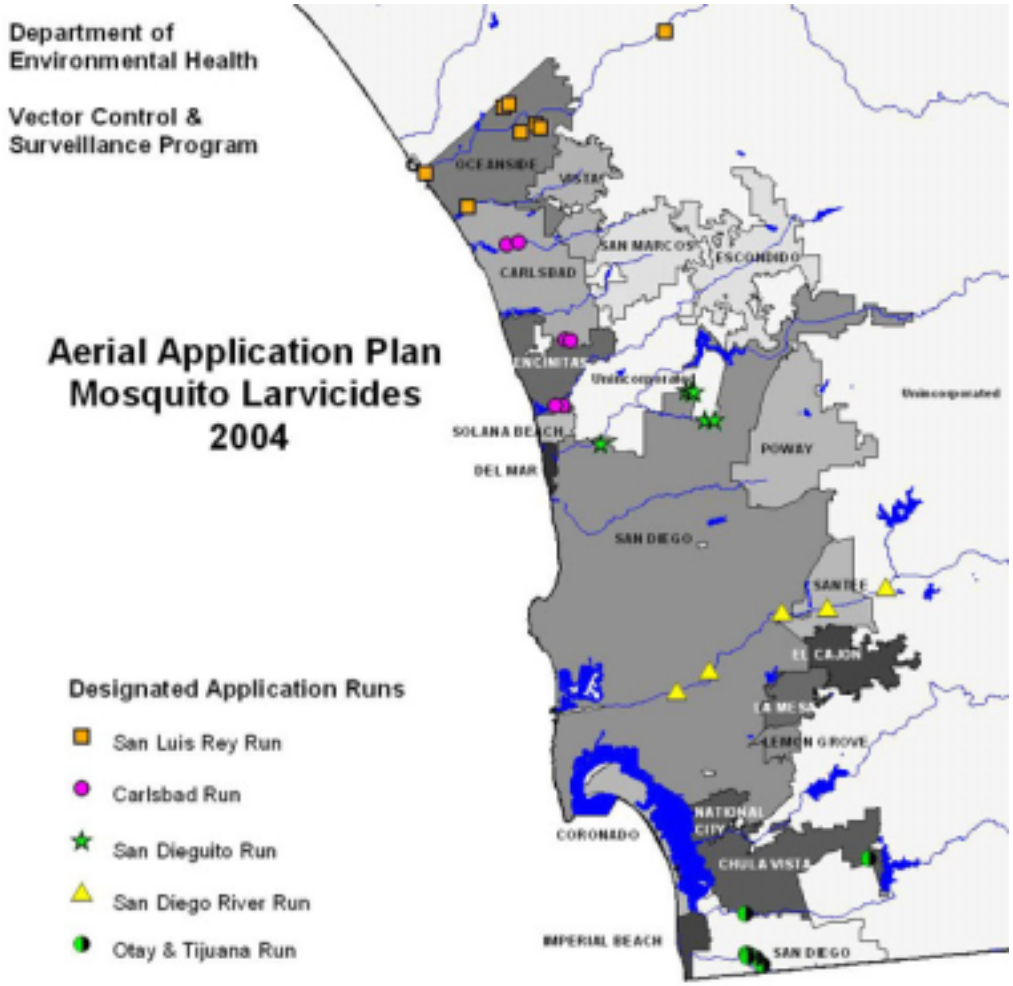
c) Mosquito Fish as a Control

Mosquito fish (Gambusia affinis) are an important part of the VSC program. These small, guppy-sized fish feed on mosquito larvae. Mosquito fish are considered a biological control as they allow for the reduction of chemical application and are considered part of an Integrated Pest Management (IPM) strategy. The fish are suitable for use in ornamental ponds and animal watering troughs. DEH VSC provides mosquito fish free to the public. Mosquito fish are reared in tanks by the VSC program. With the increase threat of WNV, VSC has increased the distribution location from one location to eleven locations throughout the County. These locations have been mapped and posted as a map for public access via the Internet.

d) Aerial Applications of Larvicide as a Control

GIS techniques were used to determine exact location, area, and amount of larvicide for treatment, and in turn, allowed for better contract specifications and communication among VSC staff, contractors, helicopter pilots, administrators, other agencies and the public.

For the 2004 mosquito season VSC is conducting monthly aerial mosquito larvicide applications near high-risk urban areas and in sensitive or difficult-to-access habitats. These larvicides reduce mosquito population by targeting the larvae in water; the larvicide acts specifically on mosquito larvae and will not harm other wildlife. As part of the planning phase, GIS was used to create polygons to mark the location of the proposed application. The polygons were merged into groups based on watershed and project logistics. The following map illustrates the aerial mosquito larvicide applications.



This mosquito control effort involves the use of a helicopter to apply or drop larvicide into water bodies near urban areas. For this purpose detailed maps were created for the use in staging the activities and in communicating target mosquito sources with the helicopter pilot.

Area was calculated and reported in square acres using GIS tools. The square acreage is used to calculate the amount of mosquito larvicide necessary to treat a given volume of water. Thus, GIS provided refined project costs and provided better contract specifications.

2. VECTOR SURVEILLANCE

Location is critical to designing surveillance or monitoring plans and to understanding the resultant data or observations. GIS software was used to create shapefiles and to map various types of surveillance data.

Surveillance mosquito trap locations have been mapped using heads up digitizing and GPS technology. The traps are located throughout the County. A long history of stored information is maintained in an Access database. Adult mosquito population counts by trap per event or by season can be mapped to illustrate trends. Test results can be assigned as a feature attribute for each trap. In addition, trap locations can be reviewed and identified for best locations to monitor efficacy of aerial larvicide applications and/ or to deploy field staff into areas where traditional control measures can be employed.

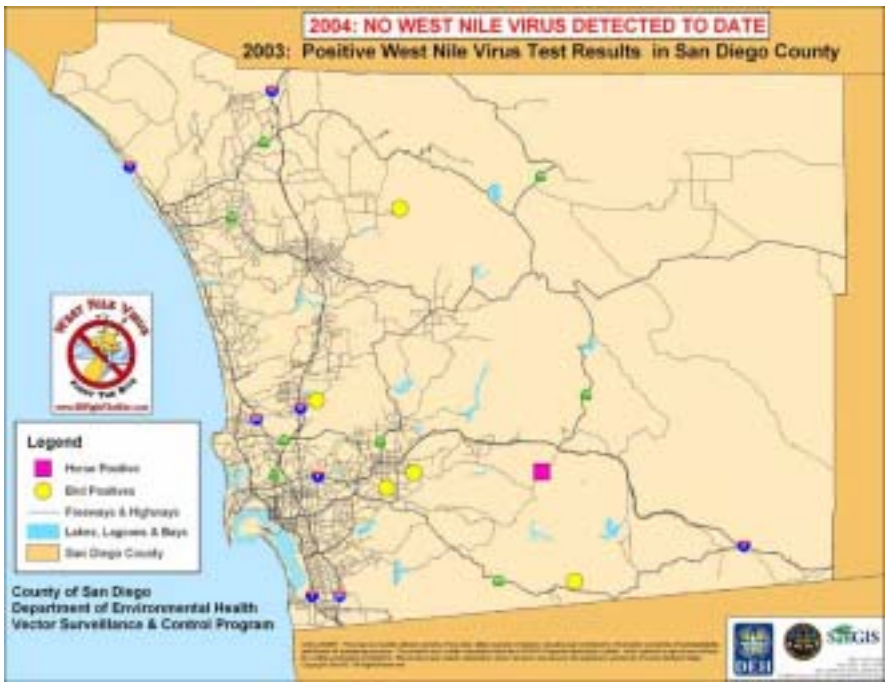
Sentinel chicken flocks are located at three sites in the County. These sites have been mapped as GIS layer. Blood samples are collected every two weeks and are tested as part of the disease surveillance program.

As part of the WNV surveillance activities, if a dead bird meets certain requirements, then it is picked up and shipped to a state laboratory for testing. The pickup locations of the dead birds have been mapped using the X, Y coordinate tool feature of the DEH GIS mapping application.

Additional surveillance activities and sample results can be mapped and analyzed at the request of VSC Vector Ecologists. Special GIS projects have included mapping data associated with vector-borne disease such as plague and hantavirus. Fly complaints and fly population counts associated with residential development in traditional agricultural land use areas have also been mapped. In order to communicate information and resolve issues, these maps were exported as JPEG images and incorporated in a Microsoft PowerPoint presentation with attribute data tables illustrating fly population counts.

3. OUTREACH AND EDUCATION

DEH is recognized as a leader in educating the regulated community and the public on environmental health issues. As WNV threatens public health, DEH has strived to remain highly visible in the services that VSC provides to the citizens of the County and to continuously provide WNV educational resources and informational updates. The DEH VSC has developed a website, SDFightthebite.com, that is regularly updated by VSC staff and public information officers. The map (below) resides on the website and informs the public of WNV test results in San Diego County.



Additional educational resources that utilize GIS map products include a speaker bureau consisting of VSC staff that may be scheduled to present WNV information to special interest groups or to school groups, or to the general public. Also, VSC joins other DEH programs in promoting environmental health via an educational display or booth at fairs and other public events. The outreach and education resources have been developed as part of, and in implementation of, the WNV Strategic Response Plan. Pamphlets and brochures include precautions, resources, and information on WNV in English and Spanish.

The aerial mosquito larvicide application is a highly visible control method. VSC prepared press releases and media events in order to notify the public of the aerial application of larvicide to waterbodies using a helicopter. During pilot testing, a GIS buffer technique was used to identify and notify schools near the area of aerial application. Maps were created in ESRI ArcGIS software and exported as Adobe PDF documents for posting to the website and for dissemination in press release packets. These aerial application activities and associated press conferences provided an opportunity to educate a large sector of the public on WNV.

CONCLUSION

The WNV Strategic Response Plan (Plan) has been recognized with a 2004 National Association of Counties (NACO) Achievement Award. Implementation of the Plan includes much of the control, surveillance, and outreach components discussed in this paper. While perhaps still underutilized, it may be concluded that GIS has played an instrumental role in the success of the Plan.

Overall, the use of GIS technology has improved the VSC program by providing problem-solving and decision-making tools, by allowing a mechanism for improving communication, and by increasing the type of outreach media available to the public, and by inspiring the innovation of a growing GIS savvy work force.

Future plans for the VSC program includes migrating the existing DEH GIS intranet mapping application from ESRI MapObjects to an ESRI ArcIMS application. This is planned for August 2004.

ACKNOWLEDGEMENTS

Information on vector control and surveillance including the WNV information has been obtained by working daily with VSC staff, who I must acknowledge for the breadth of their combined knowledge, and who I must thank for allowing me to learn beside them and to bring GIS into their program where together we can Fight the Bite with GIS. The regional GIS data such as roads, property ownership, city boundaries, Thomas Brother Page boundaries, and aerial photo images are from SanGIS (San Diego Geographic Information Source) and SANDAG (San Diego Association of Governments). These agencies create and provide regional GIS datasets in a shared environment to the San Diego region and thus have allowed

DEH to develop an interactive mapping application and in-house GIS layers using consistent and reliable data sources. All information and maps presented in this paper have been presented publicly to groups via educational outreach and media events, speakers bureaus, as well as posted on the DEH managed website, SDFighttheBite.com.

Pamela Villa
Environmental Health Specialist/GIS Specialist
County of San Diego
Department of Environmental Health
9325 Hazard Way, San Diego, CA 92123
858-694-3583
pam.villa@sdcounty.ca.gov