Teton County Mosquito Abatement West Nile Virus Response Plan

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INTRODUCTION

West Nile virus (WNV) was first isolated from a febrile adult woman in the West Nile District of Uganda in 1937. The ecology was characterized in Egypt in the 1950s. The virus became recognized as a cause of severe human meningitis or encephalitis (inflammation of the spinal cord and brain) in elderly patients during an outbreak in Israel in 1957. WNV first appeared in North America in late summer 1999, when the first domestically acquired human cases of West Nile encephalitis were documented in New York City. Since that initial epicenter the virus has spread across the U.S. Unlike WNV within its historical geographic range, or St. Louis encephalitis (SLE) virus in the Western Hemisphere, mortality in a wide variety of bird species has been a hallmark of WNV activity in the U.S.

Previous early season field studies have determined that areas with bird mortality due to WNV infection were experiencing ongoing enzootic transmission. However, most birds survive WNV infection as indicated by the high seroprevalence in numerous species of resident birds within the regions of most intensive virus transmission. The contribution of migrating birds to natural transmission cycles and dispersal of both WN and SLE viruses is poorly understood. WNV has been transmitted principally by *Culex* species mosquitoes, the usual vectors of SLE virus. However, sixty species of mosquitoes have been shown to be infected with WNV. This wide variety of WNV-infected mosquito species has broadened this virus' host-range. In the U.S. 27 mammalian species have been shown to be susceptible to WNV infection and disease has been reported in 20 of these (including humans and horses).

In 2003, there were 30 human cases and 81 horse cases of West Nile encephalitis in counties adjacent to Teton County. In 2004, Teton County hired a new supervisor of the mosquito abatement program and a West Nile virus response plan was developed. The following plan is a metered response to a West Nile outbreak, as well as a mosquito control plan that reduces mosquito populations and thereby the possibility of the establishment of an arboviral transmission cycle. Although this plan is focused on West Nile Virus, with minor modifications, it could serve as a template for any arboviral threat.

I. SURVEILLANCE

Teton County Mosquito Abatement (TCMA) will conduct surveillance for both mosquito populations and West Nile Virus.

A. Ecological Surveillance

Detection of WNV in bird and mosquito populations helps predict and prevent human and domestic animal infections. Surveillance to detect WNV should focus on the avian and mosquito components of the enzootic transmission cycle. Nonhuman mammals, particularly equines, may also serve as effective sentinels because a high intensity of mosquito exposure makes them more likely to be infected than people. Descriptions of the avian- and mosquito-based surveillance strategies follow.

1. Avian

All avian collections are made through the Teton County Health Department and the Wyoming Department of Game and Fish. If either agency feels they have a possible positive WNV infected bird TCMA will test the bird with the RAMP system prior to shipping the bird for further testing.

2. Mosquito

While dead-bird-based surveillance has proven to be a sensitive method of detecting WNV presence in an area, mosquito-based surveillance remains the primary tool for quantifying the intensity of virus transmission in an area, and should be a mainstay in most surveillance programs for WNV and other arboviruses.

Goals of mosquito-based surveillance: 1) use data on mosquito populations and virus infection rates to assess the threat of human disease; 2) identify geographic areas of high risk; 3) assess the need for and timing of interventions; 4) identify larval habitats for targeted control; 5) monitor the effectiveness of this type of surveillance and improve prevention and control measures; and 6) develop a better understanding of transmission cycles and potential vector species.

a) Protocols

1) Adult mosquitoes are collected using a variety of trapping techniques and are used to identify the mosquito species and primary vector species present in an area as well as the relative density of those species. When coupled with virus detection protocols, mosquito collections can be screened for the presence of virus and provide a quantifiable index of WNV activity. Adequate sampling requires trapping regularly at representative sites throughout a community, and rapid testing of collections of sufficient size to detect low infection rates in the vector population.

2) Larval mosquitoes are collected by taking dip samples from a variety of habitats to identify species present in the area and to identify mosquito sources. Thorough mapping of larval habitats will facilitate larval control or source reduction activities. In addition, where larval management is not feasible, quantitative estimates of larval densities will permit anticipation of new adult emergences. At a minimum, field staff record data on the number of larvae collected per dip and the sample location to provide a basis for tracking larval production and associating larval density with resulting adult mosquito population density.

b) Advantages of mosquito-based surveillance include the following:

1) It may provide the earliest evidence of transmission in an area.
2) It helps establish information on potential mosquito vector species.
3) It provides an estimate of vector species abundance.
4) It gives quantifiable information on virus infection rates in different mosquito species.
5) It provides quantifiable information on potential risk to humans and animals.
6) It provides baseline data that can be used to guide emergency control operations.
7) It allows evaluation of control methods.

c) Disadvantages of mosquito-based surveillance include the following:

1) It is labor-intensive and expensive.
2) Substantial expertise is required for collecting, handling, sorting, species identification, processing, and testing.
3) Collectors may be at risk from mosquito bites and infection from arboviruses, especially if day biting species are important bridge vectors, and should wear topical repellents and/or repellent-treated clothing when working in areas where a risk of WNV transmission exists.

II. PREVENTION AND CONTROL

Prevention and control of arboviral diseases is accomplished most effectively through a comprehensive, integrated mosquito management program using sound integrated pest management (IPM) principles. IPM is based on an understanding of the underlying biology of the transmission system, and utilizes regular monitoring to determine if and when interventions are needed to keep pest numbers below intolerable levels of damage, annoyance, or disease. IPM-based systems employ a variety of physical, mechanical, cultural, biological and educational measures, singly or in appropriate combination, to attain the desired pest population control.

A. Surveillance

Effective mosquito control begins with a sustained, consistent surveillance program that targets pest and vector species, identifies and maps their immature habitats by season, and documents the need for control. Records should be kept on the species composition of mosquito populations prior to enacting control of any kind and to allow programs to determine the effectiveness of control operations. All components of the integrated management program must be monitored for efficacy using best practices and standard indices of effectiveness. The following is a list of surveillance methodologies used by Teton County Mosquito Abatement.

1. Larval Mosquito Surveillance

Larval surveillance involves sampling a wide range of aquatic habitats for the presence of pest and vector species during their developmental stages. TCMA will collect larval specimens on a regular basis from known larval habitats, and will perform systematic surveillance for new sources. A mosquito identification specialist will identify the larvae to species and separately note nuisance and vector mosquito species.

2. Adult Mosquito Surveillance

Adult mosquito surveillance is used to monitor species presence and relative abundance of adult mosquitoes in an area. Information derived from adult mosquito surveillance programs using standardized and consistent surveillance efforts provide information essential to monitoring potential vector activity, setting action thresholds, and evaluating control efforts. Various methods are available for this purpose and have been demonstrated to be effective in collecting a variety of mosquito species. The New Jersey light trap, Centers for Disease Control (CDC) miniature light trap, and Mosquito Magnets with carbon dioxide bait, have been used extensively for collecting host-seeking adult mosquitoes. Gravid traps are frequently are used to monitor the ovipositing segment of *Culex* species populations. These species have been incriminated as the primary enzootic vectors of WNV. Host-seeking individuals of *Cx. tarsalis*, a species that has been strongly associated with WNV transmission in Wyoming, are also readily collected in CO2-baited CDC miniature light traps.

3. Virus Surveillance

The purpose of this component of the vector management program is to determine the prevalence of WNV in the mosquito population. This is often expressed simply as the number of WNV-positive mosquito samples (pools) of a given adult species collected at a defined location and time period. Specimens collected in the routine adult mosquito surveillance program supplemented by special collections from key areas identified by other surveillance indicators can be used for this purpose. Mosquito collections made at permanent study sites in a sustained program provide important baseline data to which new surveillance data are compared and decisions about human risk and need for emergency interventions are made. The methods of virus detection include the rapid analyte measurement platform (RAMP) system, which incorporates immunochromatographic test strips, and reverse transcriptase polymerase chain reaction (RT-PCR), which amplifies genetic material for easy detection.

B. Source Reduction

Source reduction is the alteration or elimination of mosquito larval production habitat. This remains the most effective and economical method of providing long-term mosquito control in many habitats. Source reduction spans activities as simple as the proper disposal of used tires and the cleaning of rain gutters, bird baths and unused swimming pools by individual property owners, to water management projects conducted on private, state or federal lands. All of these activities eliminate or substantially reduce mosquito breeding habitats and the need for repeated applications of insecticides in the affected habitat. Source reduction activities can be separated into the following two general categories:

1. Sanitation

The by-products of human activities have been a major contributor to the creation of mosquito breeding habitats. An item as small as a bottle cap or as large as the foundation of a demolished building can serve as a mosquito breeding area. Sanitation, such as tire removal, catch-basin cleaning and container removal, is a major part of all integrated vector management programs. The sanitation problems most often resolved by agency inspectors are problems of neglect, oversight, or lack of information on the part of property owners. Educational information about the importance of sanitation in the form of videos, slide shows**,** and fact sheets distributed at press briefings, fairs, schools and other public areas is effective.

2. Water Management

Water management for mosquito control is a form of source reduction that is conducted in freshwater mosquito production habitats. The main goals of the program focus on reducing standing water (while retaining hydric soils and hydrophytic vegetation) and/or increasing access for predators. Water management programs for vector control generally take two forms as described below; however, with the prevalence of flood irrigation in Teton County, another avenue for water management is available.

a) Open Marsh Water Management (OMWM)
OMWM is a technique whereby mosquito producing locations on the floodplain surface are connected to deep-water habitat (e.g., rivers, deep ditches) with shallow ditches. Mosquito broods are controlled without pesticide use by allowing larvivorous fish access to mosquito-producing depressions. Conversely, the removal of standing water at these locations occurs before adult mosquitoes can emerge. The use of shallow ditching (ditches approximately 3 feet or less in depth) is considered more environmentally acceptable because fewer unnatural hydrological impacts occur to the marsh.

b) Management in stormwater retention structures
Source reduction and water management practices may also be applied to stormwater retention structures designed to hold runoff before it is discharged into groundwater or surface water. Mosquito control should be considered in the design, construction, and maintenance of these structures, as appropriate. Stormwater retention structures should be designed in consultation with experts in mosquito biology and control to prevent as much mosquito production as possible and to facilitate proper functioning and maintenance in the future. Regulations associated with stormwater retention and flood control structures
should incorporate appropriate operations and maintenance provisions including considerations for routine monitoring and control of mosquito populations.

c) Management in flood irrigation
Flood irrigation of hayfields is still practiced extensively in Teton County and offers a prime focus for water management. The manipulation of flooding cycles and creation of deep water fish habitat could be implemented to reduce mosquito populations.

C. Chemical Control

Insecticides can be directed against either the immature or adult stage of the mosquito life cycle when source reduction and water management are not feasible or have failed because of unavoidable or unanticipated problems, or when surveillance indicates the presence of infected adult mosquitoes that pose a health risk. Chemicals used by TCMA comply with all state and federal requirements and all applicators are licensed by the Wyoming Department of Agriculture.

1. Larviciding

Larviciding, the application of chemicals to kill mosquito larvae or pupae by ground or aerial treatments, is typically more effective and target-specific than adulticiding, but less permanent than source reduction. An effective larviciding program is an important part of an integrated mosquito control operation. The objective of larviciding is to control the immature stages at the breeding habitat before adult populations have had a chance to disperse. This facilitates maintaining populations at levels at which the risk of arbovirus transmission is minimal.

Larvicides can be applied from the ground or by aerial application if large or inaccessible areas must be treated. Several materials in various formulations are labeled for mosquito larviciding including the organophosphate temephos (Abate); bacterial larvicides such as *Bacillus thuringiensis israelensis* (*B.t.i.*), *Bacillus sphaericus* (*B.s.)*; methoprene, an insect growth regulator (*e.g.*, Altosid); larvicidal oils (*e.g.*, petroleum based Golden Bear and mineral based Bonide) and monomolecular surface films (*e.g.*, Agnique, Aerosurf); and in some limited habitats, diflubenzuron (*e.g.*, Dimilin, a chitin synthesis inhibitor).

Applications of larvicides often encompass fewer acres than adulticides because treatments are made to relatively small areas where larvae are concentrated, as opposed to larger regions where adults have dispersed. When applying larvicides, it is important that the material be specific for mosquitoes, minimize impacts on non-target organisms, and**,** where appropriate, be capable of penetrating dense vegetation canopies. Larvicide formulations (*i.e.*, liquid, granular, sand) must be accurately applied and appropriate to the habitat being treated. Accuracy of application is important because missing even a relatively small area can cause the emergence of a large mosquito brood resulting in the need for broad-scale adulticiding.

2. Adulticiding

Adulticiding is the application of pesticides to kill adult mosquitoes. The ability to control adult mosquitoes is an important component of any integrated mosquito management program and like the other components of the program, its use should be based on surveillance data. Mosquito adulticiding may be the only practical control technique available in situations where surveillance data indicate that it is necessary to reduce the density of adult mosquito populations quickly to lower the risk of WNV transmission to humans. In some situations, source reduction and larvicide applications are not practical, and adulticide application is the only available control strategy.

Mosquito adulticiding differs fundamentally from techniques used to control many other adult insects. Mosquito adulticides are applied as an ultra low volume (ULV) spray where small amounts of insecticide are dispersed either by truck-mounted equipment or from fixed-wing or rotary aircraft. For adult mosquito control, insecticide must drift through the habitat in which mosquitoes are flying in order to provide optimal control benefits. Barrier treatments are another approach and are typically applied as high volume liquids with hand-held spray equipment using compounds with residual characteristics. This technique is especially attractive to individual homeowners living near mosquito-producing habitats where residual chemicals applied along property boundaries can provide some control benefits.

The Environmental Protection Agency has determined that the insecticides labeled nationally for this type of application do not pose unreasonable health risks to humans, wildlife, or the environment when used according to the label. Adulticides labeled for mosquito control include several organophosphates such as malathion and naled. Some natural pyrethrins and synthetic pyrethroids (permethrin, resmethrin and sumithrin) also hold adulticide labels. Insecticide selection and timing of application should be based on the distribution and behavior of the target mosquito species. Application of adulticides should be timed to coincide with the activity period of the target mosquito species. This should be taken into consideration when planning adulticide applications. Control of adult day-active species poses additional problems because ULV adulticide effectiveness is greatly reduced during daylight hours.

D. Resistance Management

In order to delay or prevent the development of insecticide resistance in vector populations, integrated vector management programs should include a resistance management component (modified from Florida Coordinating Council on Mosquito Control, 1998).

1. Resistance monitoring

Resistance in target populations should be monitored annually to provide baseline data for program planning and pesticide selection before the start of control operations. Annual monitoring facilitates detection of resistance at an early stage so that timely management can be implemented. Even detection of resistance at a late stage can be important in elucidating why disease control may fail. In such cases though, management options other than replacement of the pesticide may not be possible. Continuously monitoring the efficacy of control strategies is a primary step in detecting resistance.

2. Resistance management

a) Management by moderation: preventing onset of resistance by

1) Using dosages no lower than the lowest label rate to avoid genetic selection.
2) Using less frequent applications.
3) Using chemicals of short environmental persistence.
4) Avoiding slow-release formulations.
5) Avoiding the use of the same class of insecticide to control both adult and immature stages.
6) Treating only hot spots. Area-wide treatments are used only during public health alerts or outbreaks.
7) Leaving certain generations, population segments**,** or areas untreated.
8) Establishing high pest mosquito densities or action thresholds prior to insecticide application.
9) Alternation of biorational larvicides and insect growth regulators annually or at longer intervals.

b) Management by continued suppression

This is a strategy used in areas of high-value (*e.g.*, heavily touristed areas) or where arthropod vectors of disease must be kept at very low densities. This does not mean saturation of the environment by pesticides, but rather the saturation of the defense mechanisms of the insect by insecticide dosages that can overcome resistance. This is achieved by the application of dosages within label rates but sufficiently high to be lethal to susceptible as well as to heterozygous-resistant individuals. If the heterozygous individuals are killed, resistance (which is often a homozygous trait) will be slow to emerge. This method should not be used if any significant portion of the population in question is resistant. Another approach more commonly used is the addition of synergists that inhibit existing detoxification enzymes and thus eliminate the competitive advantage of these individuals. Commonly, the synergist of choice in mosquito control is piperonyl butoxide (PBO).

c) Management by multiple attack

This strategy involves the use of insecticides with different modes of action in mixtures or in rotations. There are economic problems (*e.g.*, costs of switching chemicals or having storage space for them) associated with this approach, and critical variables in addition to mode of action must be taken into consideration (*i.e.*, mode of resistance inheritance, frequency of mutations, population dynamics of the target species, availability of refuges, and migration). General recommendations are to evaluate resistance patterns at least annually and the need for rotating insecticides at annual or longer intervals.

E. Biological Control

Biological control is the use of biological organisms, or their by-products, to control pests. Biocontrol is popular in theory, because of its potential to be host-specific and virtually without non-target effects. Overall, larvivorous fish are the most extensively used biocontrol agent for mosquitoes. Predaceous fish, which occur naturally in many aquatic habitats, can be placed in permanent or semi-permanent water bodies where mosquito larvae occur, providing some measure of control. Other biocontrol agents that have been tested for mosquito control, but that to date generally are not widely used include; the predaceous mosquito *Toxorhynchites*, predacious copepods, the parasitic nematode *Romanomermis,* and the fungus *Lagenidium giganteum*. Biocontrol certainly holds the possibility of becoming a more important tool and playing a larger role in mosquito control in the future, but will likely be effective only as part of an integrated approach.

F. Continuing Education of Mosquito Control Workers

Continuing education is directed toward operational workers to instill or refresh knowledge related to practical mosquito control. This takes the form of scientific publication and trade journal subscriptions as well as attendance at local, regional and national meetings and conferences. Training is primarily in safety, applied technology, and requirements for the regulated certification program mandated by the Wyoming Department of Agriculture.

G. Vector Management in Public Health Emergencies

A surveillance program adequate to monitor WNV activity levels associated with human risk must be in place. Detection of epizootic transmission of enzootic arboviruses typically precedes detection of human cases by several days to two weeks or longer (*e.g.*, as found in SLE epidemics). If adequate surveillance is in place, the lead time between detecting significant levels of epizootic transmission and occurrence of human cases can be increased, which will allow for more effective intervention practices. Early-season detection of enzootic or epizootic WNV activity appears to be correlated with increased risk of human cases later in the season. Control activity should be intensified in response to evidence of virus transmission. TCMA will incorporate public education emphasizing: personal protection and residential source reduction; larval control to prevent repopulation of the area with competent vectors; adult mosquito control to decrease the density of infected, adult mosquitoes in the area; and continued surveillance to monitor virus activity and efficacy of control measures. As evidence of sustained or intensified virus transmission in an area increases, emergency response should be implemented. This is particularly important in areas where vector surveillance indicates that infection rates in *Culex* mosquitoes are increasing, or that potential accessory vectors (*e.g.*, mammalophilic species) are infected with WNV. Delaying adulticide applications in such areas until human cases occur is illogical and negates the value and purpose of the surveillance system.

H. Evaluation of Adult Mosquito Control

The following parameters should be monitored during control operations:

1. Minimum requirements:

a) Pre- and post spray vector mosquito densities inside and outside control area using CO2-baited traps and gravid traps;

b) Vector mosquito infection rates pre- and post-spray inside and outside the control area; and

c) Weather conditions during application (temperature, wind speed, direction).

3. Desirable additions if capacity exists: population age structure of key mosquito species.

4. In addition, both droplet size and flow rate should be documented for each piece of ULV application equipment.

5. During aerial application, GPS monitoring of spray track should be conducted if equipment is available on aircraft.

I. Public Information and Human Behavior Change

The goals of health education, public information, and behavior change programs are to inform the public about WNV, promote the adoption of preventive behaviors that reduce disease risk, and gain public support for control measures. Health education/public information includes use of print materials (posters, brochures, fact sheets), electronic information (websites), presentations (health experts or peers speaking to community groups), and the media. Information alone is seldom sufficient to encourage people to adopt new behaviors or to change old practices. Programs should include strategies to facilitate protective actions and to address barriers that hinder preventative actions. The following section covers key prevention messages and selected best practices for promotion of personal and community measures to decrease risk of WNV infection. Public education and risk communication activities must be increased to respond to the degree of WNV risk in a community, as noted in Table 1.

1. Key WNV Prevention Messages

a) Address the multiple levels at which prevention can occur: personal protection(use of repellent on skin and clothing, use of protective clothing, awareness of prime mosquito-biting hours); household protection (eliminating mosquito breeding sites, repairing/installing screens); and community protection (reporting dead birds, advocating for organized mosquito abatement, participating in community mobilization).

b) Use of DEET-based repellents on skin and clothing is the backbone of personal protection. Permethrin-based repellents should be promoted for use on clothing.

c) Emphasize the feasibility of actions that can lower an individual’s WNV risk through personal protection measures. Messages should acknowledge the seriousness of the disease but should not be fear-driven. Fear-driven messages may heighten the powerlessness many people express in dealing with emerging diseases.

d) Recommendations to avoid being outdoors from dusk to dawn may conflict with Teton County’s social patterns or with other health programs seeking to increase physical activity. An alternative is to emphasize that the hours from dusk until dawn are prime mosquito-biting hours, and that protecting oneself through repellent use during these hours is critical, with the option of remaining indoors.

e) Communication about adulticiding: public acceptance of emergency adult mosquito control is critical to its success, especially where mosquito control is unpopular. Questions about the products being used, their safety, and their effects on the environment are common. Improved communication about surveillance and how decisions to adulticide are made may help residents weigh the risks and benefits of control. When possible, provide detailed information regarding the schedule for adulticiding through newspapers, radio, internet or a recorded phone message.

f) Keep messages clear and consistent with the recommendations of Teton County Health Department. Use plain language whenever possible, and adapt materials for non-English speaking audiences.

2. Selected Best Practices

a) Targeted prevention: audience members have different disease-related concerns and motivations for action. Proper message targeting permits better use of limited communication and prevention resources. The following are some audience groups that require specific targeting:

1) *Persons over age 50*: While persons of any age can be infected with WNV, US surveillance data indicate that persons over age 50 are at higher risk for severe disease and death due to WNV infection. Collaborate with organizations that have an established relationship with mature adults, such as the senior centers, or programs for adult learners. Include images of older adults in your promotional material. Identify activities in your area where older adults may be exposed to mosquito bites (e.g. jogging, golf, gardening).

2) *Persons with outdoor exposure:* While conclusive data are lacking, it is reasonable to infer that persons engaged in extensive outdoor work or recreational activities are at greater risk of being bitten by WNV-infected mosquitoes. Develop opportunities to inform people engaged in outdoor activities about WNV. Encourage use of repellent and protective clothing, particularly if outdoors during evening, night, or early morning hours.

J. Guidelines for a Phased Response to WNV Surveillance Data

The principal goal is to minimize the health impact of WNV in humans, as well as in domestic animals. Given the limited understanding of the ecology and epidemiology of WNV in the U.S., the low incidence of arboviral encephalitis, and the limitations of prevention methods, prevention and control measures, regardless of intensity, may not prevent all WNV infections in humans. The recommended response levels for the prevention and control of WNV should augment, but not replace, long-standing mosquito control efforts. These programs often have two objectives: to control nuisance mosquitoes, and to control vector mosquitoes that can transmit pathogens. Nuisance mosquito control often has different objectives than vector control and the target mosquito species may also differ.

1. Measures of the intensity of WNV epizootic in an area should be considered when determining the level of the mosquito control response. Accumulating data analyses indicate that intensity of epizootic WNV activity as measured by avian mortality and mosquito infection rates are good indicators of subsequently increased human infection risk. Analysis of 2001 and 2002 surveillance data indicate that counties reporting WNV-infected dead birds early in the transmission season are more likely to report subsequent WNV disease cases in humans than are counties that do not report early WNV-infected dead birds. These observations should be interpreted as a guide rather than an absolute. Levels of epizootic activity that correlate with increased human risk will vary.

2. Flexibility is required when implementing the guidelines. Knowledge gained from ongoing surveillance and research could change the phased response plan. Specific and detailed recommendations that will fit all possible scenarios are not possible. Therefore, TCMA control action should depend on interpreting the best available surveillance data in an area, in light of these general guidelines. In addition, the following factors should be considered when translating these guidelines into a plan of action:

a) Current weather and predicted climate anomalies,

b) Quality, availability, and timeliness of surveillance data,

c) Feasibility of the planned prevention and control activities, given existing budgets and infrastructure,

d) Public acceptance of the planned prevention and control strategies,

e) Expected future duration of WNV transmission (surveillance events earlier in the transmission season will generally have greater significance) and

f) Other ongoing mosquito control activities, such as nuisance mosquito control or other mosquito borne disease control.

The recommended phased response to WNV surveillance data is shown in Table 1.

Table 1.

Risk Category	Probability of human outbreak	Definition	Recommended response*
0	None	Off-season; adult vectors inactive; climate unsuitable.	Develop WNV response plan. Secure surveillance and Control resources necessary to enable emergency response. Initiate community outreach and public education programs. Contact community partners.
1	Remote	Spring, summer, or fall; areas anticipating WNV epizootic based on previous WNV activity in the region; no current surveillance findings indicating WNV epizootic activity in the area.	Response as in category 0, plus: conduct entomologic survey (inventory and map mosquito populations, monitor larval and adult mosquito density), Initiate source reduction; use larvicides at specific sources identified by entomologic survey and targeted at likely amplifying and bridge vector species; maintain vector and virus surveillance; expand community outreach and public education programs focused on risk potential and personal protection, and emphasizing residential source reduction; maintain surveillance.
2	Low	Summer, or fall; areas with limited or sporadic WNV epizootic activity in birds and/or mosquitoes. No positives prior to August.	Response as in category 1, plus: notify County Commissioners and Department of Public Health, increase larval control, source reduction, and public education emphasizing personal protection measures, particularly among the elderly. Implement adulticide applications if vector populations exceed locally established threshold levels, emphasizing areas where surveillance indicates potential for human risk to increase.
3	Moderate	Spring, summer, or fall; areas with initial confirmation of epizootic WNV in birds before August; a horse and/or a human case, or sustained WNV activity in birds and/or mosquitoes.	Response as in category 2, plus: intensify adult mosquito control in areas where surveillance indicates human risk, Initiate adult mosquito control if not already in progress, Initiate visible activities in community to increase attention to WNV transmission risk.
4	High	Spring, summer, or fall; quantitative measures indicating WNV epizootic activity at a level suggesting high risk of human infection (*e.g.*, high dead bird densities In early summer, sustained high mosquito infection rates, multiple positive mosquito species, horse or mammal cases indicating escalating epizootic high levels of epizootic activity). Areas with early season positive surveillance indicators where WN epidemic activity has occurred in the past.	Response as in category 3, plus: expand public information program to include TV, radio, and newspapers (use of repellents, personal protection, continued source reduction, risk communication about adult mosquito control), Increase visibility of public messages, engage key local partners (e.g., government officials, religious leaders) to speak about WNV ; intensify adult mosquito control program, repeating applications in areas of high risk or human cases.
5	Outbreak in progress	Multiple confirmed cases in humans; Conditions favoring continued transmission to humans (*e.g.*, persistent high infection rate in mosquitoes, continued avian mortality due to WNV)	Response as in category 4, plus: intensify emergency adult mosquito control program repeating applications as necessary to achieve adequate control. Enhance risk communication about adult mosquito control. Monitor efficacy of spraying on target mosquito populations. If outbreak is widespread and covers multiple jurisdictions, consider a coordinated widespread aerial adulticide application; emphasize urgency of personal protection through community leaders and media, and emphasize use of repellent at visible public events.