

In Reply Refer To:
FWS/ANRS-NR-WR/020301

Memorandum

To: Regional Directors, Regions 1-7
Manager, California/Nevada Operations Office

From: Director

Subject: Interim Guidance for Mosquito Management on National Wildlife Refuges

A draft policy on mosquito management for the National Wildlife Refuge System is expected to be released for public comment within the next few months. In the interim, and while the draft policy is undergoing public review, the attached document has been prepared to provide refuges with a Systemwide, consistent process for addressing mosquito management issues.

Because refuges with existing mosquito management programs have already begun the process for the current season, there will be a 6-month transition period during which these refuges should review their existing programs to ensure consistency with this guidance. Refuges with no current mosquito management program should follow the attached guidance when health threats from refuge-based mosquitoes are identified.

Mosquito management on national wildlife refuges can be a very controversial issue. The Service is committed to protecting the health of humans, wildlife, and domestic animals while maintaining our statutory and policy obligations for wildlife conservation.

For additional information, please contact Michael Higgins at (410) 573-4520.

Attachment

Cc: 3238-MIB-FWS/Directorate File
3238-MIB-FWS/CCU
3251-MIB-FWS/ANRS
670-ARLSQ-FWS/ANRS-DNRS
670-ARLSQ-FWS/ANRS-CPP
570-ARLSQ-FWS/ANRS-NR
570-ARLSQ-FWS/ANRS-NR-WR File
570-ARLSQ-FWS/ANRS-NR-WR Staff (Higgins)

FWS/ANRS-NR-WR:MHiggins:kem:2/22/05:703-358-2043
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**NATIONAL WILDLIFE REFUGE SYSTEM
MOSQUITO MANAGEMENT GUIDELINES FOR 2005**

With the spread of West Nile virus across the country, national wildlife refuges (NWRs) may come under increasing pressure to manage refuge-based mosquitoes (mosquito populations that are bred or harbored within refuge boundaries). In addition to West Nile virus, there may be other human or wildlife health concerns from refuge-based mosquitoes. The following document provides refuges with guidance in addressing mosquito-associated health threats in a consistent manner. Generally, refuges will not conduct mosquito monitoring or control, but these activities may be allowed under special use permits. When necessary to protect the health of a human, wildlife, or domestic animal population, we will allow management of mosquito populations on National Wildlife Refuge System (Refuge System) lands using effective means that pose the lowest risk to wildlife and habitats. In summary, the guidance provides for the following:

- Mosquito management can occur only when local and current monitoring data indicate that refuge-based mosquitoes are contributing to a human, wildlife, or domestic animal health threat.
- Refuges may use compatible nonpesticide options to manage mosquito populations that represent persistent threats to health.
- Refuges will collaborate with Federal, State, or local public health authorities and vector control agencies to identify refuge-specific health threat categories. These categories will represent increasing levels of health risks, and will be based on monitoring data.
- Management decisions for mosquito control will be based on meeting or exceeding predetermined mosquito abundance or disease threshold levels that delimit threat categories.
- In the case of officially determined mosquito-borne disease emergencies, we will follow the guidelines described in this document. Monitoring data are still required to ensure that intervention measures are necessary.
- All pesticide treatments will follow Service and Department of the Interior pest management and pesticide policies. In an emergency, the pesticide approval process can be expedited.
- Refuges must comply with Federal statutes and Service policies by completing the appropriate documentation prior to mosquito management activities taking place.

MOSQUITO MANAGEMENT GUIDANCE FOR 2005

Although the National Wildlife Refuge System (Refuge System) does not engage in mosquito control activities directly, under certain circumstances we will allow State or local vector control agencies to conduct mosquito control on refuge lands when it is necessary to protect the health and safety of humans, wildlife, or domestic animals.

In the management of the Refuge System, we will allow populations of native mosquito species to function unimpeded unless they cause a wildlife and/or human health threat. This interim guidance recognizes that mosquitoes are a natural component of most wetland ecosystems, but may also represent a threat to human, wildlife, or domestic animal health. When necessary to protect the health and safety of the public or a wildlife or domestic animal population, we will allow management of mosquito populations on Refuge System lands using effective means that pose the lowest risk to wildlife and habitats. Except in cases of officially determined health emergencies, any method we use to manage mosquito populations within the Refuge System must be compatible with the purpose(s) of an individual refuge and the Refuge System mission, and must comply with applicable Federal laws such as the Endangered Species Act. Compatible habitat management and pesticide uses for mosquito control must give full consideration to the integrity of nontarget populations and communities. They must also be consistent with integrated pest management strategies and with existing pest management policies of the Department of the Interior (Department) and the Service. We will allow pesticide treatments for mosquito population control on Refuge System lands only when local, current mosquito population monitoring data are collected and the data indicate that refuge-based mosquito populations are contributing to a human, wildlife, or domestic animal health threat.

Mosquito-Associated Health Threats on National Wildlife Refuges

A mosquito-associated health threat is defined as an adverse impact to the health of human, wildlife, or domestic animal populations from mosquitoes. A health threat determination will be made by the appropriate Federal, State, or local public health authority that has the expertise and the official capacity to identify human, wildlife, or domestic animal health threats.

Documentation of a specific health threat on a refuge by a Federal, State, or local public health agency must be based on local and current mosquito population and/or mosquito-borne disease monitoring data.

A health emergency indicates an imminent risk of serious human disease or death, or an imminent risk to populations of wildlife or domestic animals. A health emergency represents the highest level of mosquito-associated health threats. Health emergencies will be determined by Federal, State, or local public health authorities and documented with local and current mosquito population and disease monitoring data.

Addressing Health Threats from Refuge-Based Mosquitoes

Prior planning to address mosquito-associated health threats and emergencies is strongly encouraged. Refuges where health threats have been documented (see below) are encouraged to

work collaboratively with Federal, State, or local public health authorities and vector control agencies to develop integrated pest management (IPM) plans for monitoring and potentially managing refuge mosquito populations. Development of such plans (Exhibit 1) is particularly important for refuges currently lacking a mosquito monitoring/management program, but where a potential health threat has been identified by public health authorities. These refuge-specific IPM plans will outline the conditions under which monitoring and mosquito population management would occur (exhibit 1). Development of a mosquito management IPM plan during a health emergency is not appropriate; refer to the section below that addresses emergency procedures.

Nonpesticide Options and Best Management Practices for Mosquito Control

When necessary to protect human, wildlife, or domestic animal health, we will reduce mosquito-associated health threats using an integrated pest management (IPM) approach, including, when practical, compatible, nonpesticide actions that reduce mosquito production. The procedures described in this section may be considered long-term options to reduce persistent mosquito-associated health threats. Except in officially determined health emergencies, any procedure we use to reduce mosquito production must meet compatibility requirements as found in 603 FW 2 and must give full consideration to the safety and integrity of nontarget organisms and communities, including federally listed threatened and endangered species.

- For native or nonnative species of mosquitoes, we will remove or otherwise manage artificial breeding sites such as tires, tanks, or other similar debris/containers, where possible, to eliminate conditions that favor mosquito breeding regardless of health threat conditions.
- When enhancing, restoring, or managing habitat for wildlife, we will consider using specific actions that do not interfere with refuge purposes or wildlife management objectives to reduce mosquito populations. Examples include water-level manipulation that disrupts mosquito life cycles, including timing and rate of flood-up and drawdown of managed wetlands, and/or vegetation management to discourage egg laying by mosquitoes. Except when determined appropriate during human or wildlife health emergencies, we prohibit habitat manipulations for mosquito management that conflict with wildlife management objectives, such as draining or maintaining high water levels inappropriate for other wildlife.
- We will consider the introduction of predators for mosquito management only if we can contain such introductions. Such introductions must have demonstrated efficacy, have been evaluated by the refuge with respect to potential adverse impacts to nontarget organisms and communities, not interfere with the purpose(s) of the refuge or other refuge management objectives, and not adversely affect federally listed species. We must have appropriate procedures in place for all species introductions to ensure that we do not release other species with the desired introductions. Any introduction of a nonnative predator requires a compatibility determination, a written plan for containment of the introduced species to the desired location(s) and, if applicable, an Endangered Species Act (ESA), section 7(a)(2), consultation examining the evaluation of potential effects of

the introduced predator on federally listed threatened or endangered species. In compliance with Executive Order 13112, we will not authorize any activities likely to cause or promote the introduction or spread of invasive species (see 601 FW 3).

Monitoring Mosquito Populations

We recognize the importance of monitoring mosquito populations to document species composition and estimate their size and distribution because this information is used to make integrated pest management decisions. We will allow compatible monitoring of mosquito populations on Refuge System lands by State/local public health authorities or vector control agencies.

The goal of mosquito monitoring is to detect relative changes in population sizes that can indicate an increased risk to human, wildlife, or domestic animal health (see section on action thresholds below). In addition, adult mosquitoes collected with certain traps can be tested for the presence of pathogens. Mosquito abundance data is recorded by the manner in which the mosquitoes are collected. The standard tool for monitoring larval and pupal mosquito populations is a long-handled 500 ml “dipper”. The tool is dipped at several locations within a mosquito breeding habitat and the number of larvae and pupae recovered is recorded. The density of mosquitoes within a specific habitat is recorded as the average number per dip. Adult mosquitoes are collected with a number of different portable or semi-permanent traps, and abundance is usually recorded, by species, as number of individuals per trapping period. Although some vector control agencies use the number of biting mosquitoes landing on a human subject per minute to assess mosquito abundance, this technique is not recommended on refuges due to the increased risk of the subject acquiring a mosquito-borne pathogen.

We will allow compatible monitoring of larval and adult mosquito populations on refuges under special use permits (SUPs) issued by individual refuges. To avoid harm to wildlife or habitats, access to traps and sampling stations must meet the compatibility requirements found in 603 FW 2 and may be subject to refuge-specific restrictions. Where federally listed species are present, monitoring methods must undergo an ESA, section 7(a)(2), consultation in order to determine whether or not such monitoring programs will adversely affect the listed species.

Mosquito-Borne Disease Monitoring

The purpose of mosquito-borne disease monitoring is to detect the presence of mosquito-borne pathogens and estimate the relative intensity of disease transmission over time. The data collected in such monitoring is used to estimate health risks to humans, wildlife, or domestic animals, and to make mosquito management decisions based on the level of risk. The ultimate goal in mosquito-borne disease monitoring is to detect disease activity prior to any human infection. Early detection of pathogenic activity, combined with up-to-date mosquito population monitoring, can allow for timely intervention measures to occur and thus potentially lessen the impact of disease on humans, wildlife, and domestic animals.

Federal and/or State/local public health and wildlife management authorities can use documentation of previous or current mosquito-borne disease activity near the refuge to identify

a potential health threat. We will obtain mosquito-borne disease activity information from State/local public health authorities.

Refuge personnel will note dead or sick wildlife during their routine outdoor activities. In most cases, this will only involve passive surveillance for affected wildlife. Refuges will identify a facility that will test dead or sick wildlife for mosquito-borne pathogens. This may be a State or local laboratory or the National Wildlife Health Center. Refuge personnel will receive instruction on proper procedures for safely collecting, handling, shipping, or disposing of potentially infected wildlife (refer to guidelines developed by the National Wildlife Health Center: http://www.nwhc.usgs.gov/research/west_nile/wnv_guidelines.html). If wildlife specimens from a refuge test positive for mosquito-borne disease, we will provide these results to the State/local public health authorities, State fish and wildlife agencies, and the refuge supervisor immediately.

State/local public health authorities or vector control districts will generally be responsible for other disease surveillance methods, such as monitoring disease activity in reservoir hosts for pathogens or antibodies, and collecting adult mosquito samples using live traps and testing them in same-species pools for virus. These activities must meet the compatibility requirements of 603 FW 2, and we must authorize the activities. We discourage using caged sentinel chickens on refuges for reservoir host surveillance due to the risk of spreading disease to wild birds.

Individual refuges may allow compatible disease surveillance activities under SUPs or other agreements. To avoid harm to wildlife or habitats, access to traps and sampling stations must meet the compatibility requirements found in 603 FW 2 and may be subject to refuge-specific restrictions. Where federally listed species are present, monitoring methods must undergo an ESA, section 7(a)(2), consultation in order to determine whether or not such monitoring programs will adversely affect the listed species.

Risk Assessment

The first step in addressing mosquito management on a refuge is notification by the appropriate Federal, State, or local public health authority of a potential mosquito-associated health threat. Federal and/or State/local public health authorities with expertise in mosquitoes and mosquito-borne disease will identify and document a potential mosquito-associated human health threat and notify the refuge manager. Appropriate documentation may include species-specific larval or adult mosquito monitoring data from the refuge or areas adjacent to the refuge that indicate an abundance of species known to vector one or more endemic/enzootic diseases or otherwise adversely impact human health. For refuges with current mosquito monitoring programs, such documentation should already be in place. For refuges without an ongoing mosquito or disease monitoring program, documented mosquito-borne disease activity near the refuge would also identify a health threat (refer to section below on emergencies, if applicable). The identification and documentation of a potential mosquito-associated health threat does not necessarily imply a need to manage mosquito populations, but may indicate the need to initiate on-refuge monitoring (if not already underway) and contingency planning should mosquito management become necessary.

Health threat determinations will be made at the local level, based on the historical incidence of mosquito-borne health threats and current, local monitoring of mosquito populations and disease activity. When a potential health threat has been documented, we will work with local, State, or Federal public health authorities with expertise in mosquito-borne disease epidemiology to identify refuge-specific categories of mosquito-associated human health threats based on monitoring data. Where local or State public health expertise in mosquito-borne disease epidemiology is lacking, we will consult with the Department of Health and Human Service's Centers for Disease Control and Prevention (CDC) to develop these categories. Health threats lie along a continuum in potential severity from secondary infection of mosquito bites to lethal infection by a mosquito-borne pathogen. Health threat categories will reflect increasing severity and risks to health (table 1).

Federal and/or State/local public health authorities with jurisdiction inclusive of refuge boundaries will make actual mosquito-associated human health threat level determinations using current local monitoring data and take the appropriate response(s) developed for that threat category (table 1). We will also respond appropriately to determinations made by neighboring State/local public health authorities. Mosquito-associated wildlife health threat determinations will be made by wildlife health experts from Federal or State wildlife agencies.

Action Thresholds

We expect mosquito-associated health threat levels to vary over time and space. In general, the health threat levels can be expected to be relatively static, changing only when monitoring data indicate significant changes in mosquito populations and/or disease activity. When monitoring data indicate an increasing risk to human and/or wildlife health, health threat levels may be increased (table 1). Action thresholds are mosquito population levels and/or levels of disease activity that, once reached, indicate an increased health risk and trigger additional response. We will establish numerical action thresholds in collaboration with Federal and/or State/local public health authorities and vector control agencies.

Mosquito abundance action thresholds represent mosquito population levels that may require intervention measures or more intense surveillance. It is important to consider the limitations of such numerical action thresholds, especially in the context of minimizing disease transmission. Thresholds are developed considering many factors which include, but are not limited to, those listed in table 2. Unfortunately, very few scientifically-determined estimates of mosquito abundance have been defined as threshold values for any mosquito species in the context of limiting disease transmission. Vector control agencies usually develop threshold values for their own immediate use based on years of experience. However useful such values are for limiting human annoyance from biting mosquitoes, these values often cannot be practically validated with respect to being accurate thresholds of disease transmission. Thus, in the absence of scientifically-determined threshold data, there will necessarily be some subjectivity in establishing numeric thresholds for mosquito abundance.

The factors identified in table 2 can be used as a guide in establishing numeric thresholds collaboratively with public health authorities and vector control agencies. When establishing mosquito abundance thresholds in the context of mosquito-borne disease, it is appropriate to

consider the current and historical incidence of disease and the vector potential of the species. Also note that numerical thresholds can be raised or lowered depending upon current conditions (e.g., environmental conditions, abundance of mosquito predators, presence of pathogens; see table 2).

Thresholds will be species specific (or species-group specific) for larval, pupal, and adult mosquito vectors and reflect the potential significance of a particular species or group of species in to a particular health threat. For example, mosquito vector species known to be important in the transmission cycle of a disease may have a lower action threshold than species with lesser transmission roles. We will implement intervention measures only when current mosquito population estimates, as determined by current mosquito monitoring data, meet or exceed action thresholds.

Treatment Options

Mosquito population management will be based on the level of health threat identified. The appropriate response to a health threat will be based on the level of severity and risk associated with that particular threat (table 1).

We will choose treatment based on our pest management policy (30 AM 12). We will base the choice on, in order of preference: human safety and environmental integrity, effectiveness, and cost. We will use human, wildlife, and/or domestic animal mosquito-associated health threat determinations combined with refuge mosquito population estimates to determine the appropriate refuge mosquito management response (table 1). Where federally listed threatened or endangered species are present, we will use ESA, section 7(a)(2), consultation information to assist in the decision-making process.

We will consider allowing pesticide treatments to control mosquitoes on Refuge System lands after we evaluate all other reasonable IPM actions (see above). We will determine the most appropriate pesticide treatment options based on monitoring data for the relevant mosquito life stage. We will use current monitoring data for larval, pupal, and adult mosquitoes to determine the need for larvicides, pupacides, and adulticides, respectively. We will allow the use of adulticides only when there are no practical and efficacious alternatives to reduce a health threat. We will not allow pesticide treatments for mosquito control on Refuge System lands without current mosquito population data indicating that such actions are warranted. We require an approved pesticide use proposal (PUP) prior to application of a pesticide to Refuge System lands.

Emergency Procedures

Federal, State, or local public health authorities may officially identify a mosquito-borne disease human health emergency based on documented disease activity in humans, wildlife, or domestic animals. A human health emergency indicates an imminent risk of serious human disease or death. Public health authorities may request pesticide treatments to Refuge System lands to decrease mosquito vector populations and lower the health risk to humans. Refuges with ongoing mosquito monitoring programs should have addressed potential emergency situations

and appropriate responses within those documents. Refuges without an ongoing monitoring program should immediately contact their refuge supervisor and Regional IPM coordinator in the event of an emergency and review the steps listed below. Even in emergency situations, we will only allow pesticide treatments for mosquito population control on Refuge System lands when local and current mosquito population monitoring data are available and the data indicate that refuge-based mosquito populations are contributing to a human and/or wildlife health threat. In the context of a mosquito-borne disease emergency, appropriate documentation would include identification of infected mosquitoes or abundant populations of vector species within refuge boundaries. In mosquito-borne disease emergency situations, we will undertake the following:

- If no mosquito population data are available for the refuge, we will request (or undertake, if applicable) short-term (24 hours or less) monitoring of adult and/or larval mosquito populations on the refuge to ensure that intervention is necessary.
- We will complete and submit a pesticide use permit (PUP) to the Regional IPM coordinator and Washington Office IPM coordinator, if applicable, for emergency review. Actual use of any pesticide will be contingent on current mosquito population monitoring data indicating intervention with pesticides is warranted. However, in an emergency we will not wait for monitoring results to initiate the PUP process, and we will expedite the review of PUPs.
- If there is no site-specific National Environmental Policy Act (NEPA) documentation for the proposed emergency intervention measure(s), contact the Regional NEPA coordinator for guidance (see below).
- If federally listed species are present and an ESA, section 7(a)(2) consultation has not been completed for the potential intervention measures, we will contact the local Ecological Services (ES) office for recommendations (see below).
- We will notify refuge employees and visitors of the increased human health risk and provide information for personal protection against mosquito-borne disease. Where appropriate, we will consider restricting or closing all or part of the refuge to visitors and restricting outdoor activities of employees.
- If monitoring data indicate that intervention with pesticides is warranted, we will prepare an SUP for pesticide application(s), in which we may identify pertinent conditions and restrictions on pesticide application activities to ensure compatibility.
- Following pesticide applications, we will require (or undertake, if applicable) additional mosquito population monitoring to assess the efficacy of the pesticide treatment(s).

Communication and Conflict Resolution

It is important to develop a communication plan with public health and vector control agencies, particularly in regard to addressing emergencies. Timely communication at the outset of an emergency will speed any necessary response. Contact information should be shared among

agencies, and refuges should have the necessary contact information of appropriate Service personnel to expedite any needed compliance documentation (see below).

Mosquito management on NWRs can be a very controversial issue, especially with regard to applying pesticides to control mosquito populations. Developing health threat categories and establishing action thresholds in collaboration with public health and vector control agencies can be a difficult process. This may be especially true in establishing mutually-agreed upon action thresholds, where the science is often lacking and the numbers become somewhat subjective. In cases where agreements cannot be reached, we will work with the public health and vector control agencies to identify third-party agencies or individuals with appropriate expertise in mosquito biology and vector-borne disease ecology for further guidance.

Compliance Documentation

The following statutes and policies may be relevant to mosquito management activities on refuges. In most cases, proper documentation must be in place prior to any mosquito management occurring.

A. National Environmental Policy Act (NEPA) (42 U.S.C. 4321-4347).

(1) Categorical Exclusions. Under most circumstances, we can categorically exclude monitoring and surveillance activities under existing Department NEPA procedures for data collection and inventory (516 DM 2, appendix 1.6; and 516 DM 8.5B(1), see 516 DM 2, appendix 2, for exceptions to categorical exclusions). In addition, some habitat management actions as described above may be categorically excluded. If a proposed refuge mosquito management activity qualifies as a categorical exclusion, refuges should document that determination by preparing an environmental action statement (EAS). We generally cannot categorically exclude intervention measures such as pesticide applications for mosquito-borne health threats.

(2) Environmental Assessments. Refuges that have completed the NEPA process for mosquito management should ensure that they addressed the environmental consequences of potential intervention measures for mosquito-associated health threats. Refuges that have not completed the NEPA process for mosquito management should prepare an environmental assessment (EA) if they can reasonably expect to need intervention measures (e.g., pesticide applications). You may reasonably expect intervention measures if the State/local public health agency has documented a potential health threat from refuge-based mosquitoes. In a nonemergency situation, when a State/local public health agency documents a potential threat, you must complete an EA with the appropriate finding (such as a finding of no significant impact (FONSI)) prior to any substantial intervention activities. You must consider local conditions in an EA. When assessing the potential environmental effects of pesticide applications, consider such factors as the spatial and temporal extent of the treatment, the toxicity and specificity of the proposed pesticide(s) to fish and wildlife populations, the persistence of the proposed pesticide(s), and the alternatives to the proposed action (e.g., different pesticides, using larvicides versus adulticides, compatible habitat management). To minimize potential impacts, identify and document restricted areas and activities in an EA.

(3) Emergencies. In a health emergency, you may need to take immediate intervention measures without completing a NEPA review. If such measures cannot be categorically excluded, contact the Regional NEPA coordinator who will consult with the Council on Environmental Quality (CEQ) for guidance. The CEQ may require follow-up documentation once the emergency has passed. Once an emergency has passed, you must complete proper NEPA documentation that addresses future mosquito management activities on the refuge.

B. Endangered Species Act (16 U.S.C. 1531-1544). Comply with ESA, section 7(a)(2), for listed species. You should complete this prior to an emergency. In order to complete consultation in a timely manner, please submit consultation documents at least 135 days prior to proposed mosquito management activities. Note that the Department pesticide use policy (517 DM 1) and the Department/Service pest management policy (30 AM 12) do not allow for adverse impacts to listed species from pesticides. Should a health emergency occur prior to the completion of an ESA, section 7(a)(2), consultation, contact the local ES office for recommendations. An “after-the-fact” consultation may be required once the emergency has passed.

C. Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 136 *et seq.*). On Service lands, we may only use pesticides that are registered with the Environmental Protection Agency. We must apply them according to the pesticide label directions.

D. Compatibility Determination (50 CFR 26.41 and 603 FW 2). We must complete a compatibility determination before allowing surveillance and intervention activities to be undertaken by an outside agency. However, we may waive this requirement in a health emergency involving humans, wildlife, and/or domestic animals. In health emergencies involving wildlife, we will consult with the State fish and wildlife agency. In health emergencies involving domestic animals, we will consult with the State Agricultural Department.

E. Pest Management and Pesticide Use Policies (516 DM 1 and 30 AM 12). Follow all Department and Service pest management and pesticide use policies. Before applying any pesticide to Refuge System lands, you must have a PUP reviewed and approved by the appropriate Regional or National IPM coordinator. The National IPM coordinator must approve the use of all adulticides. We can expedite PUP approvals in a health emergency. If an outside agency conducts pesticide applications, as will usually be the case, we require an SUP, memorandum of understanding, or other agreement. The agreement will detail the justification for pesticide applications, identify the specific areas to be treated, and list any restrictions or conditions that must be followed before, during, or after treatment.

Table 1. Example of Mosquito-Borne Disease Health Threat and Response Matrix

Current Conditions		Threat Level	Refuge Response
Health Threat Category ¹	Refuge Mosquito Populations ²		
No documented existing or historical health threat/emergency	No action threshold	1	Remove/manage artificial mosquito breeding sites such as tires, tanks, or similar debris/containers. Allow compatible monitoring.
Documented historical health threat/emergency	Below action threshold	2	Response as in threat level 1, plus: evaluate compatible nonpesticide management options to reduce mosquito production.
	Above action threshold	3	Response as in threat level 2, plus: allow compatible site-specific larviciding of infested areas as determined by monitoring.
Documented existing health threat (specify multiple levels, if necessary; e.g., disease found in wildlife, disease found in mosquitoes, etc.)	Below action threshold	4	Response as in threat level 2, plus: increase monitoring and disease surveillance.
	Above action threshold	5	Response as in threat levels 3 and 4, plus: allow compatible site-specific larviciding, pupaciding, or adultciding of infested areas as determined by monitoring data.
Officially determined existing health emergency	Below action threshold	6	Maximize monitoring and disease surveillance.
	Above action threshold	7	Response as in threat level 6, plus: allow site-specific larviciding, pupaciding, and adultciding of infested areas as determined by monitoring.

¹ Health threat/emergency as determined by Federal and/or State/local public health or wildlife management authorities with jurisdiction inclusive of refuge boundaries and/or neighboring public health authorities.

² Action thresholds represent mosquito population levels that may require intervention measures. Thresholds will be developed in collaboration with Federal and/or State/local public health or wildlife management authorities and vector control districts. They must be species and life stage specific (see text).

Table 2. Factors to be considered in establishing thresholds for use of larvicides/pupacides/adulticides to control mosquitoes to address human health threats.

Factor	Description	Consideration
Mosquito species	Mosquito species vary in the following: their ability to carry and transmit disease; flight distances; feeding preference (birds, mammals, humans); seasonality; and type of breeding habitat	These factors should be considered when establishing adult and larval thresholds. Often the species and biology of the mosquito will be more important in developing thresholds than the relative abundance.
Proximity to human populations	The distance from potential mosquito habitat on NWRs to population centers (numbers and density).	The potential to produce large numbers of mosquitoes in close proximity to population centers may result in less tolerance or lower thresholds for implementation of mosquito control on NWRs.
Weather patterns	Prevailing wind patterns, precipitation, and temperatures.	Prevailing wind patterns that carry mosquitoes from refuge habitats to population centers may require lower thresholds. Inclement weather conditions may prevent mosquitoes from moving off-refuge resulting in higher thresholds.
Cultural mosquito tolerance	The tolerance of different populations may vary by region of the Country and associated culture and tradition.	In many parts of the Country, mosquitoes are accepted as a way of life, resulting in higher mosquito management thresholds. NWRs in highly populated areas may require lower thresholds because of the intolerance of urban dwellers to mosquitoes.
Adults harbored, but not produced, on-refuge	Refuge provides resting areas for adult mosquitoes produced in the surrounding landscape.	Threshold for mosquito management on the refuge should be high with an emphasis for treatment of mosquito breeding habitat off refuge.
Spatial extent of mosquito breeding habitat	The relative availability of mosquito habitat within the landscape that includes the refuge.	If the refuge is a primary breeding area for mosquitoes that likely affect human health, threshold may be lower. If refuge mosquito habitats are insignificant in the context of the landscape, thresholds may be higher.

Factor	Description	Consideration
Natural predator populations	Balanced predator-prey populations may limit mosquito production.	If refuge vertebrate and invertebrate prey populations are adequate to control mosquitoes, threshold for treatment should be high.
Type of mosquito habitat	Preferred breeding habitat for mosquitoes is species- specific.	Because breeding habitat is species-specific, thresholds for each species to initiate control should be correlated with appropriate habitat types.
Water quality	Water quality influences mosquito productivity.	High organic content in water may increase mosquito productivity, lower natural predator abundance, and may require lower thresholds.
Opportunities for water and vegetation management	Management of water levels and vegetation may reduce mosquito productivity.	Thresholds for treatment should be higher where mosquitoes can be controlled through habitat management.
Presence/absence of vector control agency	Many areas do not have adequate human populations to support vector control. In addition, resources available for mosquito management vary among districts.	Thresholds for management may be much higher or non-existent in areas without vector control.
Accessibility for monitoring/control	Refuges may not have adequate access to monitor or implement mosquito management.	Thresholds will probably be higher for refuges with limited access that will require cost- prohibitive monitoring and treatment strategies.
History of mosquito borne diseases in area	Past monitoring of wildlife, mosquito pools, horses, sentinel chickens, and humans have documented mosquito-borne diseases.	Thresholds in areas with a history of mosquito-borne disease(s) will likely be lower.

EXHIBIT 1**Outline: Integrated Pest Management Plan for Mosquito Associated Threats on Refuges****I. Health Threat Determination.**

A. Describe the communication process and identify points of contact and their contact information for Federal and/or State/local public health authorities, vector control districts, and recognized experts in vector ecology, epidemiology, public health, and wildlife health. Identify agency with public human health authority and personnel with medical training regarding the epidemiology of mosquito-borne diseases that has the official capacity to make a human health determination.

B. Elaborate on regional/local history of mosquito associated health threat(s). Identify endemic and enzootic mosquito-borne diseases.

C. Determine health threat using criteria in table 1 based on documentation from Federal or State fish and wildlife agency health experts, Federal and/or State/local public health authorities, and/or public health veterinarians employed by the appropriate public health authorities that refuge-based mosquitoes threaten human, wildlife, or domestic animal health.

1. Off-refuge (or on-refuge, if available) mosquito surveillance summary data (species and abundance).

2. List of mosquito species present, enzootic/endemic diseases they may vector, and any other potential adverse impacts to health they may have.

II. Monitoring Mosquito Populations (developed in cooperation with Federal/State/local public health authorities, vector control agencies, and State fish and wildlife agencies).

A. Identify the purpose and goals of monitoring on the refuge.

B. Identify who will be conducting the monitoring on the refuge and their contact information.

C. Identify when monitoring will be conducted.

1. Routine, seasonal; or

2. Monitoring only when threat level is elevated (identify triggers for monitoring).

D. Description of monitoring protocols.

1. Larval and pupal mosquito monitoring and breeding habitat inventory and mapping.

(a) Objective(s)

(b) Method(s).

- (c) Sampling locations and numbers of samples/location.
- (d) Frequency of sampling.
- (e) Processing/identification of samples (species, larval stage).

2. Adult mosquito monitoring.

- (a) Method(s) of sampling (e.g., traps, landing counts).
- (b) Sampling locations and frequency of sampling.
- (c) Processing/identification of samples.

3. Post-treatment monitoring: Monitoring should continue after any treatment to determine efficacy.

E. Reporting.

- 1. Refuge receives copies of all monitoring data concerning refuge.
- 2. Refuge shares annual habitat management plans, if applicable, with public health or vector control agency.

F. Restrictions/Stipulations: Identify any restrictions/stipulations on monitoring activities (e.g., access, vehicle use, sensitive species or habitats, time of day, etc.) to ensure compatibility.

III. Surveillance of Mosquito-Borne Disease (developed in cooperation with Federal/State/local public health authorities, vector control agencies, and State fish and wildlife agencies).

A. Identify the purpose and goals of surveillance.

B. Identify who will be conducting surveillance on or near the refuge and their contact information.

C. Identify when surveillance will be conducted.

- 1. Routine, seasonal surveillance; or
- 2. Surveillance only when threat level is elevated (identify triggers for surveillance).

D. Description of surveillance protocols.

1. Disease monitoring.

- (a) Objective(s).
- (b) Method(s).
- (c) Monitoring locations.
- (d) Wildlife testing facility (for dead or sick wildlife found on the refuge).

2. Disease activity notification procedures between public health agency, State fish and wildlife agency, and refuge (these procedures are developed cooperatively).

3. Post-treatment monitoring: Surveillance should continue after any treatment to determine efficacy.

E. Restrictions/Stipulations: Identify any restrictions/stipulations on surveillance activities (e.g., access, vehicle use, sensitive species or habitats, time of day, etc.).

IV. Treatment Options (developed in cooperation with Federal/State/local public health authorities, and vector control agencies, and State fish and wildlife agencies using stepwise approach, table 1).

A. Identify and categorize refuge-based mosquito species or species groups based on role in transmission cycle(s) of enzootic/endemic diseases and other impacts to human, wildlife, or domestic animal health.

B. Identify species-specific larval, pupal, and adult mosquito vector action threshold levels that reflect the importance of vector species in identified health threats (see table 2).

C. Identify health threat levels and describe potential intervention measures for each level (table 1). Include non-pesticide and pesticide intervention options.

D. Complete NEPA process, as necessary, to examine potential environmental effects of potential intervention measures. In an emergency, contact the Regional NEPA coordinator for guidance.

E. Complete ESA, section 7, consultation for potential impacts to endangered species from intervention measures.

F. Identify specific pesticides or other management actions to use at specific threat levels based on NEPA and ESA, section 7, analyses.

G. Unless it is an emergency, complete a compatibility determination for intervention measures.

H. Follow Service pesticide use and permitting procedures, and attach approved pesticide use proposal (PUP) and special use permits (SUP).

1. Complete PUP.

2. Submit PUP to Regional IPM coordinator. In an emergency, contact Regional pest management coordinator (and national IPM coordinator, if applicable) to expedite PUP approval.

- 3.** Prepare SUP or other agreement for agency conducting intervention measures, outlining specific actions to be taken (when, where, how) and describing any restrictions, stipulations, or other conditions on such actions.