DRAFT ENVIRONMENTAL ASSESSMENT

for the

MOSQUITO MANAGEMENT PLAN

Lower Florida Keys Wildlife Refuge Complex

April 10, 2014
*Comment Due Date*
*All comments must be received by the contact person below on or before this date.*

Submitted: March 10, 2014

U.S. Fish and Wildlife Service
28950 Watson Blvd.
Big Pine Key, FL 33043

In Cooperation with

Florida Keys Mosquito Control District

# LOWER FLORIDA KEYS REFUGES

**National Key Deer Refuge**
**Key West National Wildlife Refuge**
**Great White Heron National Wildlife Refuge**
*Monroe County, Florida*

**U.S. Department of the Interior**
**Fish and Wildlife Service**
*Southeast Region*
**Atlanta, Georgia**

# *Executive Summary*

**Mosquito Management Plan**
**Florida Keys National Wildlife Refuges Complex**

This Environmental Assessment (EA) addresses the proposal by the U.S. Fish and Wildlife Service (Service) to update, develop and implement a Mosquito Management Plan (Plan) for The Lower Keys National Wildlife Refuge Complex (Refuge). The Plan addresses mosquito management operations for the entire Refuge and encompasses a five year program period of those operations.

Four alternatives are analyzed in this document. Alternative A is the No Action Alternative, representing *status quo* mosquito control operations; Alternative B is the Proposed Alternative – Phased Mosquito Management Plan Alternative; Alternative C is a larvicide only Alternative; and Alternative D is a no treatment alternative.

Alternative A, No Action Alternative (*status quo* mosquito control operations) - The No Action alternative is presented as a requirement of the National Environmental Policy Act (NEPA), and is the baseline condition with which proposed activities are compared. This alternative represents a continuation of current management actions as last conducted in 2012; it does not mean an absence of active management of mosquitos. Under the no-action alternative, mosquito control and management would consist of Larvicide distribution in aquatic larval development areas, truck based fogging of pyrethroids, and aerial applications of naled products. Treatments would occur when the District deemed appropriate under certain environmental constraints such as wind and other constraints such as "no spray" zones determined by the Refuge and regulated by an annual Special Use Permit. Under alternative A, 2,956 acres of habitat and 28.7 miles of road adjacent to the Refuge would be considered "no spray" in order to protect sensitive species and habitats.

Alternative B, Implement Phased Mosquito Management Plan Alternative - *(Preferred Alternative)* - Under Alternative B, an integrated approach would balance the missions of both the FKMCD and the Service by allowing for a level of flexibility in mosquito control operations with site specific requirements based on natural resources concerns and environmental conditions. No spray zones designated under Alternative A would be expanded to include proposed critical habitat for the Bartram's hairstreak and Florida leafwing butterflies. In addition, no spray zones would include buffer zones to account for expected distances of pesticide drift from treatments to adjacent private properties. Mosquito control operations would only occur if designated thresholds are met or if there is a real threat of or actual human health or safety risks to the community associated with mosquitoes at the Refuge.

Alternative C, Larvicide Application Only Alternative – This alternative would only utilize larvicidal treatments to manage mosquito populations except under emergency human health conditions. During public health emergency conditions, no restrictions would be made on treatment type or specific restrictions to treatment locations assuming the emergency was declared by a public health agency or their designated representative and mosquitoes at the Refuge were considered a vector of human disease/threat. However, activities would be subject to emergency consultation with the Service for endangered species issues.

Alternative D, No Mosquito Control Alternative - No actions would be undertaken to manage mosquito populations except under emergency conditions. During public health emergency conditions, no restrictions would be made on type of treatment used or specific restriction on treatment locations assuming the emergency was declared by a public health agency or their designated representative and mosquitoes at the Refuge were considered a vector of human disease/threat. However, activities would be subject to emergency consultation with the Service for endangered species issues.

Alternatives were evaluated based on impacts to natural resources; aesthetic resources and visitor experience; public use and surroundings; and health and safety. The preferred alternative (Alternative B) was selected based on its balance of impacts indicating less negative impacts associated with natural resources than Alternative A (*status quo*), while still providing for beneficial impacts to aesthetics, visitor experience, public use and surroundings. Alternative A may provide additional beneficial impacts associated with these latter impact topics but was found to result in greater negative impacts to natural resources. Alternative C (larvicide only) was found to be the environmentally preferred alternative given the lesser use of chemical treatments and its commensurate protections to natural resources, while still providing some protection to visitors and the surrounding community. Alternative D was considered to be protective of natural resources but provided no real protections to the aesthetics, comfort, or health and safety of the community and the visiting public.

**Public Comment**

If you wish to comment on the environmental assessment (EA), you may mail comments to the name and address below. This environmental assessment will be on public review for 30 days. The EA has been posted and is available for public review on the Refuges web site at http://www.fws.gov/nationalkeydeer/ and click on the "*Mosquito Management Plan EA*" link. Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment – including your personal identifying information – may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

COMMENTS MUST BE RECEIVED BY April 10, 2014. Written comments may be received later if postmarked by April 10, 2014. Please address written comments to:

Refuge Manager
Florida Keys National Wildlife Refuge Complex
28950 Watson Blvd
Big Pine Key, Florida 33043

Comments may also be submitted to the Refuges email address at keydeer@fws.gov

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## *1.0 Introduction*

Mosquito management occurs throughout the Florida Keys, where there is a long history of mosquito control activities and documented mosquito-borne disease transmission to humans and wildlife.  The Florida Keys National Wildlife Refuges Complex (Refuge) lies within the jurisdiction of the Florida Keys Mosquito Control District (District or FKMCD), which is responsible for mosquito abatement and control throughout the Keys from Key Largo to Key West, Florida.  The Florida Keys National Wildlife Refuges Complex (Figure 1) is composed of four individual National Wildlife Refuges (NWR) that include;  Crocodile Lake National Wildlife Refuge, which is located at the northern end of the Florida Keys near Key Largo, Florida: and the Lower Florida Keys Refuges which include;  National Key Deer Refuge, Key West National Wildlife Refuge , and Great White Heron National Wildlife Refuge, which are situated between the city of Marathon and the Marquesas Keys (west of Key West, Florida).

Mosquito management in the community has been a topic of discussion for many years. In response to requests by local residents and/or political officials, the Florida Keys Mosquito Control District (District) has routinely requested permission to access to Refuge lands to control mosquitoes. Requests for mosquito control solely to address nuisance mosquitoes raise a myriad of concerns. The Refuge is concerned about introducing mosquito control abatement materials onto refuges, including direct effects of mosquito management techniques on non-target invertebrates and other species and indirect effects associated with reductions in mosquito populations and other non-target species that have essential functions in the natural environment.

### 1.1 Purpose of and Need for Action

The Refuge proposes to implement a mosquito management plan (plan) that consists of a phased approach to mosquito management and is consistent with the principles of integrated pest management. The plan includes ongoing coordination with the District and incorporates the draft policy issued by the U.S. Fish and Wildlife Service (USFWS or Service) for mosquito-borne disease management pursuant to the NWRS (Federal Register, Vol.72, No. 198, 10/15/07) and also incorporates compliance with the Service policies described in Section 1.5 below. The policies provide a standard process for Refuges to follow and criteria to consider when making decisions regarding management of mosquitoes and mosquito-borne disease. Mosquito control management plans and documentation of management actions on refuges are necessary to protect both threatened and endangered plants, fish, and wildlife and to ensure the health and safety of surrounding human populations.

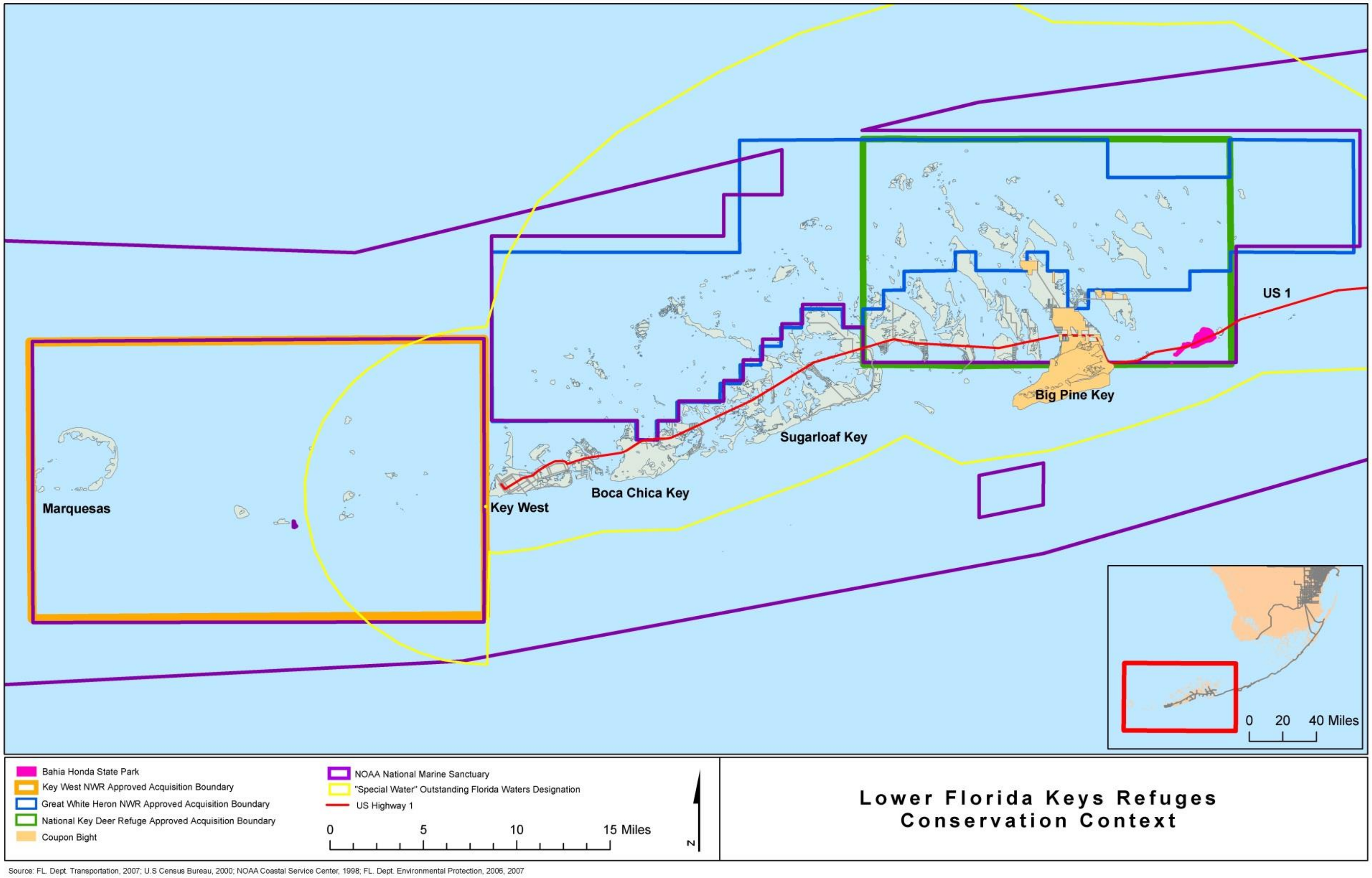


**Figure 1. Area addressed within this Environmental Assessment.**

This mosquito management plan and Environmental Assessment (EA) addresses mosquito control operations in the Lower Florida Keys Refuges, and primarily those that affect National Key Deer and the adjacent community. The scope of this plan and Environmental Assessment only covers the area described as the Lower Florida Keys Refuges and is not intended for application beyond that action area. It should be noted that we will interchangeably use the term “plan” and “EA” throughout the document. The mosquito management “plan” is assessed within the “EA” and after public input is received, a plan would be completed. Thus the component details of the “plan” are contained within this EA.

### 1.2 Purpose of Action

The purpose of the Proposed Action is to ensure that activities to survey and control mosquito populations on the Refuge are compatible with the establishing purposes of the Refuge. It should be noted that mosquito control is only permitted on Refuge lands in association with a human health and safety threat. With the potential for spread of mosquito-borne disease, there is increasing pressure to manage mosquito populations that occur on lands of the National Wildlife Refuge System (NWRS), especially in populated areas such as the Florida Keys. The Refuge considers some mosquitoes a natural component of tidal wetlands but also recognizes that mosquitoes may pose a threat to human and/or wildlife health. Thus the purpose of this action is to develop a long-term Mosquito Management Plan consistent with Service regulation and policies that will reduce or eliminate impacts of the mosquito adulticides and mosquito control activities to non-target species on and adjacent to refuge lands, while still helping to ensure public health and safety concerns are addressed.

### 1.3 Need(s) for Action

Mosquito management and control is an ongoing occurrence in the Florida Keys. Refuges are to identify mosquito management activities through development of a mosquito management plan or through the refuge’s Comprehensive Conservation Planning Policy and Step-Down Management Planning or through the Service’s Step-Down Management Planning Policy 602 FW 4 which allows for Step-Down Management Plans, such as Integrated Pest Management Plans and/or Mosquito Management Plans (Federal Register, Vol.72, No. 198, 10/15/07). The 2007 policy provides a standard process for refuges to follow and criteria to consider when making decisions regarding management of mosquitoes and mosquito-borne disease.

The refuge’s Comprehensive Conservation Plan (CCP, USFWS 2009)) was developed in 2009 to guide the management of the national wildlife refuges in the Florida Keys, as mandated by the National Wildlife Refuge System Improvement Act of 1997. The CCP outlines management strategies and corresponding resource needs for the next 15 years to protect, enhance, and restore the natural diversity and integrity of the ecological landscapes of the Lower Florida Keys Refuges, and provides unique opportunities for research and compatible wildlife-dependent recreational uses in cooperation with our partners. The CCP called for the development of 11 step-down management plans in specific program areas, including one for mosquito management.

The CCP (USFWS 2009) calls for action to achieve several key goals and objectives that have direct or indirect linkages to the development of a mosquito management plan. For example, under: FISH AND WILDLIFE POPULATION MANAGEMENT (Page 63 and 68), Objective 1 states that we will implement necessary measures to ensure the viability of all imperiled species and their habitats. The follow-up strategy stipulates that the refuge will adopt a step-down Mosquito Management Plan according to Service policy that will reduce or eliminate impacts of the Florida Keys Mosquito Control District's operations to non-target species on and adjacent to refuge lands. More specifically, Objective 11 (Lepidopterans) states that the refuge will maintain or restore refuge populations of Lepidopterans of special conservation concern, particularly Bartram's hairstreak, Florida leafwing and Miami blue butterflies. The CCP (USFWS 2009) states that Objective 11 will be achieved by the development of a step-down Mosquito Management Plan in cooperation with the Mosquito Control District, state public health officials and entomologists to balance the conservation of native insect species on refuge lands with public health concerns with nuisance and disease-carrying mosquitoes. The CCP also stipulated that the refuge will continue cooperative efforts in developing improved methods of mosquito control, which reduce the use of broad-spectrum adulticides and minimizes impacts to natural resources and maintain and expand the "no spray" zones in pine rockland, hardwood hammock and other sensitive habitat. The development of this plan is discussed in several other locations within the CCP but those presented above highlight the need for this action. Therefore, this plan and EA are needed to develop these strategies for implementation of improved methods as a tool to communicate to the community the guidelines for implementation; and to provide certainty in business practice for the District and the Refuge in their operations.

The timing and initiation of this action are accentuated by a settlement agreement that was filed in response to a court action (Multi-District Litigation (MDL), Center for Biological Diversity and WildEarth Guardians v. Salazar, see http://www.fws.gov/ENDANGERED/esa-library/index.html#listing) where the Service committed to publishing certain Endangered Species Act (ESA) listing actions – petition findings, listing determinations, critical habitat designations – in Fiscal Years 2013-2018. As a result of the settlement, a work plan was developed to, over a period of 6 years, systematically review and address the needs of more than 250 species listed within the 2010 Candidate Notice of Review, including the Florida leafwing and Bartram's scrub-hairstreak, to determine if these species should be added to the Federal Lists of Endangered and Threatened Wildlife and Plants. This work plan enabled the Service to again prioritize its workload based on the needs of candidate species, while also providing State wildlife agencies, stakeholders, and other partners clarity and certainty about when listing determinations will be made. On July 12, 2011, the Service reached an agreement with the plaintiff group and further strengthened the work plan, which will allow the agency to focus its resources on the species most in need of protection under the ESA. These agreements were approved on September 9, 2011. The timing of this proposed listing for butterflies is, in part, therefore, an outcome of the work plan.

The commitment with the MDL included the development of a listing package and critical habitat designation for two butterfly species in the lower keys, namely the Florida leafwing butterfly (*Anaea troglodyta floridalis*) and the Bartram's scrub-hairstreak butterfly (*Strymon acis bartrami*) as endangered species (see http://www.regulations.gov/#!documentDetail;D=FWS-R4-ES-2013-0031-0001). Both butterflies are candidate species for which there is sufficient information on biological vulnerability and threats to support preparation of a listing proposal, but for which development of a listing regulation has until now been precluded by other higher priority listing activities. The settlement resulted in a need to reassesses all available information regarding status of and threats to both butterfly subspecies.

Under the ESA, the Service can determine that a species is an endangered or threatened species based on any of five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. The Service has determined the threats to both subspecies fall under all five factors, and include of a lack of adequate fire management, small population size, isolation from habitat loss and fragmentation, loss of genetic diversity, inadequate regulatory mechanisms, pesticide applications, poaching, hurricanes and storm surge, and sea level rise. Given these species could be potentially impacted by mosquito control activities and its associated pesticide use, a mosquito management plan and EA is necessary to evaluate risk to these sensitive species.

It also should be understood that mosquitoes are a part of the ecosystem and serve as a food resource for other organisms. In general, unless mosquito populations interfere with site management goals and objectives, or jeopardize human health or safety, the Department and Service IPM policies authorize Refuge managers to allow mosquito populations to exist unimpeded. When human health or safety is jeopardized due to mosquitoes, Refuge managers are authorized to allow management of mosquitoes on the refuge. Mosquitoes are unique in their role as vectors of disease organisms to humans and animals. Even “nuisance” species can have an effect on nearby human populations. For this reason, the approach needed to manage mosquitoes must be balanced and thoughtful of the needs of the community while still being protective of natural resources.

**1.4 Decision(s) to be Made**

The Service must decide whether implementing the Proposed Action would have a significant impact to the human environment. If we conclude that the Proposed Action does not have a significant impact to the human environment then we will sign a finding of no significant impact (FONSI) and begin implementation immediately. Should we determine that the Proposed Action does have a significant impact to the human environment, we would proceed with preparing an Environmental Impact Statement (EIS).

## 1.5 Relevant Laws, Policies, and Planning Documents

There are many laws, regulations and policies that direct the Service and its activities. The following sections provide a brief overview of these documents and their meaning and each is considered in developing this plan.

### *1.5.1 Service and Refuge Missions and Policies:*

***The mission of the U.S. Fish and Wildlife Service is:*** "...to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people." (1 RM 4.3)

***The mission of the National Wildlife Refuge System is:*** "To preserve a national network of lands and waters for the conservation and management of the fish, wildlife and plants of the United States for the benefit of present and future generations."(EO 12996)

***The goals of the National Wildlife Refuge system are:***

- To preserve, restore and enhance in their natural ecosystems (when practicable) all species of animals and plants that are endangered or threatened with becoming endangered. (2 RM 1)
- To perpetuate the migratory bird resource.
- To preserve a natural diversity and abundance of fauna and flora on refuge lands.
- To provide an understanding and appreciation of fish and wildlife ecology and man's role in his environment, and to provide refuge visitors with high quality, safe, wholesome, and enjoyable recreational experiences oriented toward wildlife to the extent these activities are compatible with the purposes for which the refuge was established.

**The goals of National Key Deer Refuge are:** The purposes of the Refuge come from the executive orders and subsequent laws Congress passed as it established each refuge. There are also specific purposes Congress designated for managing the Refuge System as a whole. While the Lower Keys Refuge Complex has several specific purposes outlined for each individual refuge unit, National Key Deer Refuge exemplifies the general purpose and goals and is used to illustrate themes that are paralleled in the other units in the Complex. The purpose of the Refuge is as follows:

- "... to protect and preserve in the national interest the Key deer and other wildlife resources in the Florida Keys." 71 Stat. 412, dated Aug. 22, 1957
- "... to conserve (A) fish or wildlife which are listed as endangered species or threatened species .... or (B) plants...." 16 U.S.C. 1534 (Endangered Species Act of 1973)

- "... suitable for–(1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species...." 16 U.S.C. 460k-1 "... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors...." 16 U.S.C. 460k-2 [Refuge Recreation Act (16 U.S.C. 460k- 460k-4), as amended]

- "... for the development, advancement, management, conservation, and protection of fish and wildlife resources ...." 16 U.S.C. 742f(a)(4) "... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude...." 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956)

- "... conservation, management, and … restoration of the fish, wildlife, and plant resources and their habitats … for the benefit of present and future generations of Americans...." 16 U.S.C. 668dd(a)(2) (National Wildlife Refuge System Administration Act)

- "…so as to provide protection of these areas…and to ensure…the preservation of their wilderness character.…" (Wilderness Act of 1964, Public Law 88-577)

These purposes and the mission of the Refuge System are fundamental to determining the compatibility of proposed uses of the refuge, including public recreation and in this case the action of mosquito control activities.

*1.5.2 Summary of the Laws, Regulations and Policies Governing the Proposed Action*

**Endangered Species Act (ESA) of 1973 as amended**. The Endangered Species Act (ESA – 16 U.S.C.1531-1544) provides for the identification, protection, and recovery of species approaching extinction. One of the means used to protect such species is found in section 7 of the Act. This section requires Federal agencies to consult with the Fish and Wildlife Service's Ecological Services (ES) Program or the U.S. Department of Commerce's National Marine Fisheries Service (NMFS) whenever an action is proposed which may affect a threatened or endangered species or its critical habitat. Consultation is with NMFS for marine species, including anadromous fish, most marine mammals, and sea turtles. All mosquito management activities conducted on the Refuge will be in compliance with the ESA. The Refuge will determine whether section 7 consultation is required for the plan.

**National Wildlife Refuge System Administration Act of 1966**, as amended. The most important Federal statute guiding management of the NWRS and its units is the National Wildlife Refuge System Administration Act of 1966, as amended (Refuge Administration Act - 16 U.S.C. 668dd-668ee). This law was significantly amended in 1997 with passage of the National Wildlife Refuge System Improvement Act of 1997 (Refuge Improvement

Act). This amendment provides the NWRS with the following statutory mission statement: "The mission of the System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans." The law makes clear that the NWRS is to be managed first and foremost for wildlife conservation. It also requires that six wildlife-dependent public uses be given priority consideration in refuge planning and management over all other general public uses. In essence, the law establishes a management hierarchy by declaring that refuges are to be managed first for wildlife, second for priority public uses, and last for other general public uses (which would include mosquito control). Several substantive and procedural requirements associated with compatibility determinations form a major feature of the law. This is because all public uses must first be determined compatible with the purpose(s) of the refuge and the NWRS mission before they are allowed on a refuge. The law also requires monitoring of the status and trends of refuge fish, wildlife, and plants; as well as maintenance of the NWRS' biological integrity, diversity, and environmental health.

**Wilderness Act**: Congress designated wilderness areas in the Lower Florida Keys Refuges on January 3, 1975 (Public Law 93-632) to be managed under the Wilderness Act of 1964 (78 Stat. 890.892: 16 U.S.C.1132). The wilderness areas include 1,990 acres in Great White Heron NWR, 2,019 acres in Key West NWR, and 2,278 acres in National Key Deer Refuge.

Under the Wilderness Act, wilderness areas "…shall be administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness."

Sixteen principles of wilderness stewardship are derived from the Wilderness Act of 1964. They are:

- Manage wilderness as a distinct resource with inseparable parts;
- Manage the use of other resources and activities within wilderness in a manner compatible with the wilderness resource;
- Allow natural processes to operate freely within wilderness;
- Attain the highest level of primeval wilderness character within legal constraints;
- Preserve wilderness air and water quality;
- Produce human values and benefits while preserving wilderness;
- Preserve outstanding opportunities for solitude or a primitive and unconfined recreation experience in each wilderness;
- Control and reduce the adverse physical and social impacts of human use in wilderness through education or minimum regulation;
- Favor wilderness-dependent activities when managing wilderness use;
- Exclude the sight, sound, and other tangible evidence of motorized or mechanical transport wherever possible within wilderness;

- Remove existing structures and terminate uses and activities not essential to wilderness management or not provided for by law;
- Accomplish necessary wilderness management work with the minimum tool;
- Establish specific management direction with public involvement in a management plan for each wilderness;
- Harmonize wilderness and adjacent land management activities;
- Manage wilderness with interdisciplinary scientific skills; and
- Manage special provisions provided for by wilderness legislation with minimum impact on the wilderness resource.

Activities of the Service are governed by Acts of Congress. The proposed action must comply with the legislative acts, executive orders, laws, policies and regulations.

**Biological Integrity, Diversity, and Environmental Health Policy**. National policy has been developed to implement some of the key provisions of the 1997 amendments to the Refuge Administration Act. This includes the Biological Integrity, Diversity, and Environmental Health policy (601 FW 3). Consistent with the Refuge purpose(s), this policy provides for maintenance and restoration of healthy, functioning biological communities composed of native species and habitats comparable with historic conditions. The policy favors refuge management which restores or mimics natural ecosystem processes or functions. The policy generally discourages use of chemical pesticides and removal of native species, although it acknowledges that these actions may at times be necessary and appropriate. A key to proper implementation of this policy is evaluating how proposed actions would affect achievement of the Refuge purpose(s).

**Appropriate Refuge Uses (603 FW 1) policy.** The Service's Appropriate Refuge Uses (603 FW 1) policy provides evaluation procedures (603 FW 1.11A (3)) for refuge managers to ensure that a new or existing management actions or methods are appropriate refuge uses. There are five types of refuge uses, mosquito management to protect human health and safety would be covered under 603 FW 1.10 D Specialized Uses.

**Compatible Use Policy**. Compatible Use policy (603 FW 2). If the District is proposing to conduct mosquito management activities on a refuge in support of the refuge purpose(s) and in the role of a Service-authorized agent, then that use qualifies as a "refuge management activity" and compatibility does not apply. Otherwise, mosquito control or other mosquito management activities proposed the District would qualify as a "refuge use" and the compatibility regulations and policy would require that a compatibility determination be developed. This determination would be for the purpose of determining whether, based on the Refuge Manager's sound professional judgment, the proposed mosquito management activities would materially interfere with or detract from the Refuge purpose(s) or the NWRS mission. The determination would need to be made in writing and would have to allow an opportunity for public comment.

The Compatibility policy also states that a use must be determined not compatible if we have insufficient information to determine it compatible. If we have insufficient management resources (e.g., funds, staff, facilities, and equipment) to ensure that a use would occur in a compatible manner, then the use is determined not compatible. Finally, the Compatible Use policy states that a use would not be compatible if it would conflict with maintenance of refuge biological integrity, diversity, and environmental health. A refuge mosquito management program needs to be carefully planned and implemented to ensure that this last policy requirement is not violated. Appendix A includes a copy of the compatibility determination for mosquito management operations at the Refuge. It was prepared as part of the CCP (USFWS 2009). This compatibility determination was provided to the public with a 30 day comment period as part of the environmental impact statement that was prepared for the CCP.

**National Environmental Policy Act.** The National Environmental Policy Act of 1969, as amended (NEPA - 42 U.S.C. 4321-4347) is another important Federal statute that would be triggered by a proposed refuge mosquito management program. NEPA's requirements are primarily procedural in nature. Among other things, NEPA requires that Federal agencies, "Utilize a systematic, interdisciplinary approach…in planning and decision-making…" and "...insure that presently unquantified environmental amenities and values... [are]...given appropriate consideration in decision making along with economic and technical considerations...." Prior to making a decision to undertake a proposed action, agencies are to consider a range of reasonable alternatives and the effects of their implementation. We have prepared this draft environmental assessment in compliance with NEPA. Following public review of the environmental assessment, we will make a decision whether or not to sign a finding of no significant impact.

**National Historic Preservation Act of 1966**, as amended. Section 106 of the National Historic Preservation Act requires Federal agencies to consider how their actions could affect historic properties.

**Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA**), as amended. This law regulates all activities related to pesticides, including development, registration and classification, production, storage and transport and applications. Section 18, as amended, provides for exemption of State or Federal agencies from all requirements in cases where the Governor or head of that agency requests and secures such an exemption. This constitutes declaration of official emergency conditions (such as an imminent human health hazard).

**Pesticide Use Proposals.** Both the Department of the Interior and Service has Integrated Pest Management (IPM) policies which address management of pests and application of pesticides on national wildlife refuges. These policies can be found at 517 DM 1, and 569 FW 1. The policies are based on integrated pest management (IPM) principles and allow use of pesticides only after evaluation of a range of alternatives (including physical and cultural methods, biological controls, and no action) and full consideration of safety, environmental effects, efficacy, specificity, and costs. In order to provide assistance with refuge proposed pesticide applications, policy requires Refuge Managers to develop and submit Pesticide Use Proposals (PUPs) for review and approval/disapproval. This requirement includes pesticides that the District proposes for use as part of a refuge mosquito management program. Depending on the pesticide proposed for use and the proposed application method(s), approval of PUPs may reside with the Refuge Manager, Regional Office, or Headquarters Office. Appendix B is an example of the information contained in a PUP. A PUP would be prepared each year that pesticides are proposed for use on the Refuge.

**Special Use Permits**. Long-standing NWRS policy addressing Administration of Specialized Uses (5 RM 17) guides issuance of special use permits for economic uses, special events, access to closed areas, and other privileged uses. If the District is conducting mosquito management on a refuge in support of the refuge purpose(s) and in the role of a Service authorized agent, then an agreement or contract is an appropriate instrument to guide their activities. Otherwise, conduct of mosquito management on a refuge by the District is a specialized use and requires issuance of a special use permit. Requests by the District to control mosquitoes on a refuge trigger requirements to comply with several, potentially all, of the laws and policies briefly discussed above. According to the Refuge Administration Act, such a request for mosquito control would be considered a general public use, which is the lowest of the three tiers in the NWRS management hierarchy. Implementation of the Proposed Action includes developing an SUP. In addition, prior to issuing the SUP, we will review the Section 7 consultation, cultural resource compliance, and this Environmental Assessment to determine if any additional documentation will be necessary.

**Department of Interior Policy for use of Pesticides (517 DM Section 1.2.A)**

"To use pesticides only after full consideration of alternatives - based on competent analysis of environmental effects, safety, specificity, effectiveness, and costs. The full range of alternatives including chemical, biological, and physical methods, and no action will be considered. When it is determined that a pesticide must be used in order to meet important management goals, the least hazardous material that will meet such goals will be chosen."

**Integrated Pest Management policy, 569 FW 1**. The Service's Integrated Pest Management policy, 569 FW 1, allows for management of pests, defined as any living organism that may interfere with the site-specific purposes, operations, or management objectives or that jeopardizes human health and safety. Under 569 FW 1.3 and 1.6 we manage pests that interfere with site management goals and objectives, when human health or safety is jeopardized, when there is a threat to wildlife health; and when action thresholds for the pest are exceeded. Unless mosquitoes interfere with site management goals and objectives, or jeopardize human health or safety, the Service policy authorize Refuge managers to allow native mosquito populations to exist unimpeded. When human health or safety is jeopardized or when there is a threat to wildlife health from mosquitoes, Refuge managers are authorized to allow management of mosquitoes on the Refuge.

**Service's Draft Mosquito Management Policy**

A draft mosquito management policy was published in the *Federal Register* on October 15, 2007 (Vol. 72, No. 198) with the intent of providing Managers a decision-making process for mosquito management. The Service received comments on that draft policy from mosquito control agencies and organizations, State and local governments, and private citizens. This draft policy officially rescinds the Director's Memorandum dated April 8, 2005, *Interim Guidance for Mosquito Management on National Wildlife Refuges*; and sets forth the Service's interpretation of the existing laws, regulations, and policies of the National Wildlife Refuge System that authorize us to manage mosquitoes, when necessary, on Refuges. The policy also establishes that a technical handbook which is in preparation to guide Service employees in interpreting existing NWRS regulations and policies as they pertain to mosquito management activities and understanding mosquitoes and management alternatives for refuges.

## 1.6 Scoping Process

Scoping is an early and open process for determining the scope of the issues to be addressed and for identifying major issues related to a proposed action. It is the process by which lead agencies solicit input from the public, tribes, and other agencies on the nature and extent of issues, and alternatives and impacts to be addressed.

Scoping meetings were held on December 9, 2013 at 2:00 pm and 6:30 pm at the Lower Keys Property Owners Association Building at 1668 Bogie Rd, Big Pine Key, FL 33043. Comments and input through scoping were accepted until close of business January 9, 2014.

### *1.6.1 Consultation and Coordination*

The Refuge has coordinated closely with the District in the development of this document. In April of 2013, the Refuge met with the District informing them the ongoing practice of issuing annual Special Use Permits without NEPA review was not appropriate given the long-term nature of the activity and that National Environmental Policy Act considerations would need to be included in future mosquito control planning. During the ensuing months, the Service's Ecological Services Office (South Florida Ecological Service Office, Vero Beach, FL) and the District have had an ongoing dialog on methods and measures to minimize harm to trust species and their habitats. In September and October of 2013, the Refuge met with members from the Florida Keys Mosquito Control Board to discuss the need to proceed with this planning process and subsequently received concurrence with this approach.

The Refuge has also had ongoing correspondence with the North American Butterfly Association, who has expressed concerns associated with mosquito control operations and their potential for impacts to sensitive and listed butterfly species.

Local representatives have also been contacted relative to this issue. Scoping meetings were held on December 9, 2013 (2:00 pm and 6:30 pm) at the Lower Keys Home Owners Association building on Big Pine Key and information was posted in local newspapers, as well as through other media including radio. Input from scoping was open from December 9, 2013 to January 9, 2014. No comments were received during the scoping period other than those provided during the December 9, 2013 meetings.

### *1.6.2 Issues and Concerns*

Scoping meetings generally focused on the communication of the methods and approaches used in mosquito control in the lower Keys. Comments were provided that suggested alternatives and also in suggesting additional study that should be done to assist in understanding more on the biology and impacts of adulticide on the sensitive species.

Alternatives proposed during scoping included the concept of evaluating larvicide use only (no adulticide). Comments included the development of an alternative or alternatives that evaluated efficiencies in reducing adulticide applications by altering spatial and temporal application rates, as well as evaluating whether concentrations used are appropriate for the target species of mosquito (to reduce non-target impacts). Discussions also resulted in some dialog on developing trigger points for mosquito adulticide application rationalizing that there are differing sensitivities with individuals requesting adulticide service in the area.

Comments indicated interest in refining the effectiveness of larvicide application so as reduce adulticide use and need. Increased understanding of adulticide application and drift impacts outside the target area was desired, as well as additional information on the effectiveness of adulticide in controlling mosquitos. Additional thoughts were provided relative to developing improvements to timing of adulticide application and the concentrations used.

Other comments surrounded efforts the refuge could take to improve sensitive species success by making improvements to habitat, mitigation and in evaluating other threats to these species outside the scope of mosquito control operations.

## *2.0 Alternatives*

Alternatives were developed to meet the purpose and need, using guidance from several pertinent information sources. These include relevant scientific literature, the Service's 2007 Draft Mosquito and Mosquito-Borne Disease Management Policy and the Service IPM policy. A significant amount of information was provided by the District and included mosquito ecology, history of mosquito populations and their management on the Refuge, cultural tolerances for mosquitoes, past and current historical human health threats, monitoring techniques, treatment thresholds and disease surveillance. Substantial information was obtained on sensitive species life history information from the South Florida Ecological Services Office of the USFWS in the development of the alternatives.

## 2.1 Factors Common to all Alternatives

Actions that are generally common to all alternatives are described below and are not repeated in each alternative description.

### *2.1.1 General Permits*

The Refuge, in cooperation with the District, must obtain all permits required for state and federal endangered species compliance before allowing mosquito management activities in endangered species habitat on the Refuge. Other general permits may also be required, such as an NPDES permit, depending on the scope of the action proposed each year.

### *2.1.2 Special Use Permits*

The issuance of this plan and associated documentation will serve as the Special Use Permit. The plan will be reviewed annually in conjunction with the District to determine if any significant deviations are anticipated. Should any deviations be deemed significant or additional species warrant additional protections, additional NEPA compliance and review will be completed prior to initiating any mosquito control efforts outside the parameters stipulated in this plan. To ensure that mosquito management activities are compatible with the Refuge purposes, permitted activities must meet the stipulations listed in the Compatibility Determination (Appendix A).

### *2.1.3 Pesticide Approval Process*

As a result of its statute authority under the Migratory Bird Treaty Act, the Endangered Species Act and Service policy, the Service is required to consider whether use of specific pesticides would harm trust species. The Service would also provide guidance on avoidance of “take” under various laws. The Service evaluates approval of specific pesticide use based on its history of adverse effects on non-target species and persistence in the environment.

The Refuge would prepare Pesticide Use Proposals (PUPs) on an annual basis (in coordination with the District) for Service review and approval/disapproval. The PUP’s include pesticides that are proposed for use as part of the NEPA complaint refuge mosquito management plan. Pesticide Usage Reports (PUR) would be prepared by the Refuge in coordination with the District on an annual basis following application of pesticides to control mosquitoes on the Refuge. To assist the Refuge in tracking mosquito management activities, the District would prepare an annual quantitative summary of refuge mosquito monitoring and surveillance results, control activities on the Refuge (e.g., pesticides applied, amount of pesticides applied, locations of application, method of application), and regional disease surveillance.

The report will be accompanied by maps showing specific areas where management activities occurred. All surveillance and control activities would be spatially referenced as technologies develop at the District (e.g., use of GPS, GIS). Comparisons of mosquito management within and among years will be presented to permit analysis of patterns that may indicate success of habitat management efforts or suggest the need for a new management approach.

*2.1.4 Education and Outreach*

Where appropriate, the Refuge and the District will collaborate with Federal, State, and/or local wildlife agencies, public health authorities, and District to conduct education and outreach activities aimed at protecting human and wildlife health from threats associated with mosquitoes. Where appropriate, the Refuge will provide access to information materials about mosquito-associated threats to our visitors and employees (e.g., refuge office, internet sites, and signage). The Refuge will prepare an instructional package for employees on personal protection measures to minimize their exposure to mosquito-borne diseases. The Refuge and the District would make this plan and related information available on their respective website.

*2.1.5 Monitoring and Surveillance*

Monitoring of both larval and adult mosquitos is a baseline activity of mosquito management on the Refuge. Monitoring is required to determine mosquito population estimates and locations of infestations. The District would have the lead for monitoring mosquito populations. Communication and cooperation between the District and the Refuge must be maintained so as to convey information and determine appropriate management actions or level(s). All decisions to conduct mosquito management would be made in consultation with the Refuge and as appropriate any health department using mosquito and mosquito borne disease monitoring data collected on and within the vicinity of the Refuge.

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 as stipulated herein or under a separate addendum to this document. Mosquito population monitoring involves activities associated with collecting quantitative data to determine mosquito species composition and to estimate relative changes in mosquito populations over time. The objectives of mosquito monitoring are to:

- Establish baseline data on species and abundance;
- Map larval development and/or adult harboring habitats;
- Estimate relative changes in population sizes for making IPM decisions to reduce mosquito populations when necessary;
- Assess effectiveness of no spray/buffer zones; and
- Evaluate impacts to natural resources and the human environment.

The purpose of mosquito-borne disease surveillance on or near the Refuge is to inform decisions regarding threats to human health and safety from mosquitoes. Activities associated with detecting pathogens causing mosquito-borne diseases include testing adult mosquitoes for pathogens or testing reservoir hosts for pathogens or antibodies.

Monitoring of immature mosquitoes on the Refuge would be conducted by the District. District technicians will sample during predominant periods of mosquito production. The timing and frequency of monitoring is based on a number of factors including history of mosquito production, tidal cycles, precipitation levels, and available resources. Mosquitoes are sampled using established protocols. Samples are examined in the field or laboratory by the District to determine the abundance, species, and life-stage of mosquitoes. This information is compared to historical records and established thresholds (Appendix D) and would be used as a tool for treatment decisions.

#### *2.1.6 Access*

Access for the purposes of mosquito management (e.g., monitoring, surveillance, control) would be limited in Wilderness Areas in the backcountry and within sensitive habitats (i.e., critical habitat for listed species) in the front country areas. These access restrictions would limit direct and indirect (e.g., habitat) negative effects on sensitive species. Access restrictions include no motorized access in front country areas within the Refuge specifically in areas identified as critical habitat for listed species; boat access to backcountry islands with limited personnel so as to avoid disturbance to roosting, nesting or loafing birds; and no use of fire roads or trails by any method other than by foot.

### 2.2 Mosquito Control Products

Mosquito control products can be categorized into three groups: larvicides, pupicides, and adulticides. There are relatively few products available within each of these categories, and all differ with regard to efficacy and effects on non-target organisms. The active ingredients vary from conventional chemicals, naturally occurring bacteria, analogs of insect molting hormones, surfactants, monomolecular oils and predaceous fish. Formulations commonly used by the District are presented in Table 1. Additional information on those pesticides can be found in Appendix E.

**Table 1. Mosquito Control Products.**

| Adulticide | Pupicide | Larvicide |
|---|---|---|
| naled | oils | *B. thuringiensis israeliensis* |
| permethrin | surfactants | *B. sphaearicus* |
| malathion | | Methoprene |
| bifenthrin | | spinosad |
| Duet (prallethrin +, δ-phenothrin) | | surfactants |
| | | *Gambusia affinis* |

The use of larvicides and pupicides would be subject to review by the Regional Office Integrated Pest Management Coordinator acting under the U.S. Fish & Wildlife Service, Headquarters. Data from various sources (e.g., scientific literature) are used to identify whether new abatement materials exist, as they become available. Oil-based pupicides are currently used by the District off Refuge lands, only.

Before applying pesticides to Refuge lands in a non-emergency situation the Refuge in coordination with the District must:

- Use current monitoring data for larval, pupal, and adult mosquitoes, which documents the need for mosquito management.
- Determine the most appropriate pesticide treatment options based on monitoring data for the relevant mosquito life stage.
- Consider whether use of pesticide would harm trust species
- Have an approved pesticide use proposal (PUP) in place.

<u>Larvicides</u>. Larvicides are materials that affect the four larval stages of mosquitoes known as instars. They can be applied through a wide variety of methods including hand application and backpack sprayers, amphibious tracked vehicle, truck-mounted equipment and aerial sprayers. Mosquito larvicides relevant to this EA include Bti (*Bacillus thuringiensis* var.*israelensis) and Bacillus sphaericus* (Bsp). Larvicides may be reviewed and approved/disapproved through a PUP by the Project Leader of the Florida Keys NWR Complex. Bti (*Bacillus thuringiensis* var. *israelensis*) is a very common larvicide. Refer to Appendix F for a more detailed account of non-target effects of this larvicide in mosquito control.

*Bacillus thuringiensis* (Bt) is a natural soil bacterium that acts as a larval stomach poison. Bt must be ingested by the larval form of the insect in order to be effective. Bt contains crystalline structures containing protein endotoxins that are activated in the alkaline conditions of an insect’s gut. These toxins attach to specific receptor sites on the gut wall and, when activated, destroy the lining of the gut and eventually kill the insect. The toxicity of Bt to an insect is directly related to the specificity of the toxin and the receptor sites. Without the proper receptor sites, the Bt will simply pass harmlessly through the insect’s gut. Several varieties of Bt have been discovered and identified by the specificity of the endotoxins to certain insect orders. *Bacillus thuringiensis* var. *kurstaki*, for example, contains toxins that are specific to Lepidoptera (butterflies and moths), while Bti (var. is specific only to certain primitive dipterans (flies), particularly mosquitoes, black flies, and some chironomid midges. Bti is the form used on the Refuge. Bti is not known to be directly toxic to non-dipteran insects.

Because Bti must be ingested to kill mosquitoes, it is most effective on first-, second-, and early third-instar larvae than on late third and fourth instars since the earlier instars feed at a faster rate (fourth instar larvae feed very little) and require ingestion of fewer crystals to induce mortality. The pesticide is ineffective on pupae because they do not feed at all. Formulated products may be granular or liquid, and potency is expressed in

International Toxicity Units (ITU), usually ranging from 200-1200 ITU. The concentrations of Bti in water necessary to kill mosquito larvae vary with environmental conditions, but are generally 0.05-0.10 ppm. Higher concentrations (0.1->0.5 ppm) of Bti are necessary when there is a high amount of organic material in the water, late-third and early fourth instar larvae predominate, larval mosquito density is high, or water temperature is low (Nayar et al. 1999). Operationally, Bti is applied within a range of volume or weight of formulated product per acre as recommended on the pesticide label, with the goal to achieve an effective concentration. The label recommended range of application rates under most conditions varies by a factor of 4 for most formulations (e.g., for granular formulations, 2.72-11.12 kg/ha (2.5-10 lb./acre)). For later instar larvae and water with a high organic content, higher application rates are recommended that may reach 8 times the lowest rate (e.g., for granular formulations, the higher rate is 11.1-22.5 kg/ha (10-20 lb./acre)). Mosquito control agencies use the recommended label rates, along with previous experience, to administer an effective dose.

Bti has practically no acute or chronic toxicity to mammals, birds, fish, or vascular plants (U.S. EPA, 1998). Extensive acute toxicity studies indicated that Bti is virtually innocuous to mammals (Siegel and Shadduck 1992). These studies exposed a variety of mammalian species to Bti at moderate to high doses and no pathological symptoms, disease, or mortality were observed. Laboratory acute toxicity studies indicated that the active ingredient of Bti formulated products is not acutely toxic to fish, amphibians or crustaceans (Brown et al. 2002, Brown et al. 2000, Garcia et al. 1980, Lee and Scott 1989, and Wipfli et al. 1994). However, other ingredients in some formulated Bti products are potentially toxic. The acute toxicity response of fish exposed to the formulated Bti product Teknar® HPD was attributed to xylene (Fortin et al. 1986, Wipfli et al. 1994). Teknar® HPD is not a standard product of the District, nor is planned to be in the future. Field studies indicated no acute toxicity to several fish species exposed to Bti (Merritt et al. 1989, Jackson et al. 2002); no detectable adverse effects to breeding red-winged blackbirds using and nesting in Bti treated areas (Niemi et al. 1999, Hanowski 1997); and no detectable adverse effects to tadpole shrimp 48 hours post Bti treatment (Dritz et al. 2001).

In addition to mosquitoes (Family Culicidae), Bti affects some other members of the suborder Nematocera within the order Diptera. Also affected are members of the Family Simuliidae (black flies) and some chironomids midge larvae (Boisvert and Boisvert 2000, Garcia et al. 1980). The most commonly observed Bti effects to non-target organisms were to larvae of some chironomids in laboratory settings when exposed to relatively high doses (Boisvert and Boisvert 2000, Lacey and Mulla 1990, Miura et al. 1980). In field studies, effects to target and susceptible non-target invertebrates have been variable and difficult to interpret. Field study results are apparently dependent on the number, frequency, rate and aerial extent of Bti applications; the Bti formulation used; the sample type (e.g. benthic, water column or drift); the sampling interval (e.g. from 48 hrs to one or more years after treatment); the habitat type (e.g. lentic or lotic); the biotic (e.g. aquatic communities), and abiotic factors (e.g. suspended organic matter or other suspended substrates, temperature, water depth); the mode of feeding (e.g. filter feeder, predator, scraper or gatherer); the larval development stage and larval density (Ali 1981, Boisvert and Boisvert 2000, Lacey and Mulla,1990). Bti activity against target and susceptible non-target invertebrates is also related to Bti persistence and environmental fate, which are in turn affected by the factors associated with field study results (Dupont and Boisvert 1986, Mulla 1992). Simulated field studies resulted in the suppression of two unicellular algae species, *Closterium* sp. and *Chlorella* sp. resulting in secondary effects to turbidity and dissolved oxygen of aquatic habitats, with potential trophic effects (Su and Mulla 1999). For these reasons, Bti effects to target and susceptible non-target organisms, and potential indirect trophic impacts in the field are difficult to predict. *Bti* does not persist in the environment after application and studies of activity after application indicate a decline in efficacy within days and little residual activity after several weeks (Glare and O' Callaghan, 1998).

*Bacillus sphaericus* (Bsp)

Bsp has slight to practically no acute mammalian toxicity, practically no acute avian toxicity, slight to practically no acute fish toxicity, and slight aquatic invertebrate toxicity (USFWS 1984, and FCCMC 1998). Insecticidal activity may persist longer than 20 days because Bsp can reproduce and sporulate in larval cadavers (Becker et al, 1995) and can retain its larvicidal properties after passing through the gut of a mosquito. Bsp is insoluble in water. Spores and toxin become suspended in the water column and retain insecticidal activity in water with high organic matter content and suspended solids. Because Bsp is a more recently developed larvicide than Bti, there are fewer studies that have examined the non-target effects of this pesticide. The data available; however, indicate a high degree of specificity of Bsp for mosquitoes, with no demonstrated toxicity to chironomid larvae at any mosquito control application rate (Mulla, 1984, Ali, 1986, Lacey, 1990, and Rodcharoen, 1991). Therefore risks to sensitive wildlife resources resulting from direct exposure to a single Bsp application and indirect food chain effects are expected to be negligible. However, the ability for a population to re-colonize a wetland following multiple larvicide treatments would depend on the intensity and frequency of applications at different spatial scales.

<u>Pupicides</u> *(Surface Oils and Films):* . Surface oils and films are applied to mosquito breeding sites to kill mosquito larvae and pupae. The products create a barrier to the air-water interface and suffocate insects, which require at least periodic contact with the water surface in order to obtain oxygen. The oils are mineral oil based and are effective for 3-5 days. Surface films are alcohol based and produce a monomolecular film over the water surface. Both oils and the films are potentially lethal to any aquatic insect that lives on the water surface or requires periodic contact with the air-water interface to obtain oxygen. Studies have demonstrated significant negative effects on water surface-dwelling insects from applications of oils (Mulla and Darwazeh 1981; Lawler et al. 1998). Surface oils may also adversely affect wildlife by wetting the feathers of young waterfowl. This may be of particular concern at low temperatures when the oil could affect thermoregulation (Lawler et al. 1998).

*Golden Bear 1111*. Golden bear 1111 is a petroleum product registered for larval mosquito control. It is considered an effective control agent that acts on the pupal stage of mosquitoes to prevent adult mosquito emergence. This surface oil is effective against all immature stages through suffocation. It disrupts the surface tension of water by preventing female mosquitoes from landing to lay eggs. In some cases control with this material has been demonstrated for up to two weeks (Mulla and Darwazeh 1981). The use of petroleum distillate products is prohibited on the Refuge although it is a pesticide that is used within the local area. Oil-based pupicides are currently used by the District off Refuge lands, only.

*CocoBear.* CocoBear is a mineral oil product registered for larval and pupal mosquito control. It is considered an effective control agent that acts on the pupal stage of mosquitoes to prevent adult mosquito emergence. Cocobear contains petroleum distillates. Compared to older generations of larvicidal oils, CocoBear contains only 10% petroleum distillates as opposed to the more than 98% found in older formulations. This surface oil is effective against all immature stages through suffocation. It disrupts the surface tension of water by preventing female mosquitoes from landing to lay eggs. The use of petroleum distillate products is prohibited on the Refuge although it is a pesticide that is used within the local area. Oil-based pupicides are currently used by the District off Refuge lands, only.

*Agnique Monomolecular Film (MMF)* is a non-ionic surfactant that has an alcohol base. The film produced by MMF reduces the surface tension of the water making it difficult for mosquito larvae and pupae to attach and causes them to drown. Emerging adult mosquitoes or midges are unable to fully emerge and will drown. The film produced by Agnique is not visible on the water surface and should not be used in areas that are subject to unidirectional winds greater than 10 mph or where surface water overflow or runoff is an issue.

<u>Adulticides</u>. Adulticides are pesticides used to kill adult mosquitoes. All pesticides used to kill adult mosquitoes are broad-spectrum insecticides. The only selective aspect of these pesticides is in the manner in which they are applied. Most adulticides under use in the Florida are applied as ultra-low volume (ULV) sprays and they are sprayed as very fine droplets (aerial 30-50 microns; ground 8-30 microns). Small droplet size allows the spray to drift for a relatively longer period of time compared to larger droplets, and the small size delivers an appropriate dose of the pesticide to kill an adult mosquito.

Drift is a necessary component of adulticiding because these sprays are most effective on flying insects. For this reason, adulticide applications generally would occur in the evening or early morning hours when the majority of mosquito species are most active. Adulticides would be applied by truck-mounted sprayers or applied aerially by helicopter or fixed-wing aircraft although only truck-mounted or backpack sprayers would be allowed for adulticiding on the Refuge unless specific triggers require consideration of aerial application.

There are three general classes of adulticides: organophosphates, pyrethroids and pyrethrins/pyrethroids. These pesticides work on the nervous system although they have different modes of action. Organophosphates are cholinesterase inhibitors while pyrethroids and pyrethrins are sodium channel blockers. Organophosphates are not used by the District for mosquito control except in aerial applications. Pyrethrins are naturally occurring compounds extracted from chrysanthemum plants and have been used to make pesticides (McLaughlin 1973, Klassen et al. 1996, Todd et al. 2003). Pyrethroids are synthetic products that have the same basic chemical make-up as pyrethrins but are not naturally occurring.

The most common pyrethroids are the synthetic pyrethroids, permethrin, resmethrin, and sumethrin. Both pyrethroids and pyrethrins are usually combined with the synergist piperonyl butoxide, which interferes with an insect's detoxifying mechanisms (Tomlin 1994). Non-target toxicity from pyrethroids may occur in either terrestrial or aquatic habitats as a result of deposition, runoff, inhalation, or ingestion (Appendix G). In general, pyrethroids have lower toxicity to terrestrial vertebrates than the organophosphates. Pyrethroids, although less toxic to birds and mammals, are toxic to fish and aquatic invertebrates (Anderson 1989, Siegfried 1993, Tomlin 1994, Milam et al. 2000). The actual toxicity of pyrethroids in aquatic habitats; however, is less than may be anticipated because of the propensity of these pesticides to adsorb to organic particles in the water (Hill et al. 1994). There are also data that indicate synthetic pyrethroid degradates have endocrine disrupting properties (Tyler et al. 2000).

Barrier treatments would be conducted through the application of the pyrethroid insecticide bifenthrin. Barrier treatments for mosquito control are useful when applied as part of an integrated mosquito control program (Cilek 2008). They can outperform truck sprays and can give significant cost savings (Qualls et al. 2012). Barrier treatments are differentially effective due to sex, parity status, blood-fed status, and time after application (Doyle et al. 2009). Not all mosquito species are impacted equally by the barrier treatment (Hurst et al. 2012). Exposure to rain and sunlight also affect bifenthrin barrier sprays, with residual effects most pronounced in shady areas protected from rainfall (Allen et al. 2009). Avoidance of damage to bees can be attempted by making barrier applications late in the day, as the active ingredient would have time to break down overnight (Qualls et al. 2010). Hoffman et al. (2009) tested 5 sprayers for droplet size, deposition on both surfaces of the leaf (top and bottom) and depth of penetration into the canopy. Larger droplet size was better for barrier treatments, and sprayers with higher wind velocity at nozzle discharge performed better than did those with lower wind velocity. All sprayers tested gave maximum deposition of bifenthrin at 1 meter into the treated vegetation.

Barrier treatments are applied at a distance of 5 feet from the vegetation canopy with a sprayer angle of 60 degrees. Target height of spray is 6 to 9 feet high, and the concentration of droplets in this target area is 30 to 180 droplets / $cm^2$. Droplet size in this scenario is 300 – 350 μm.

Naled is a non-systemic, broad-spectrum organophosphate insecticide, which affects the nervous system of adult mosquitoes and other insects by cholinesterase inhibition. Naled is a fast acting, non-systemic contact and stomach organophosphate insecticide used to control aphids, mites, flies, and mosquitoes. Naled is highly to moderately toxic via the oral route. It is moderately toxic through skin exposure, may cause skin rashes and skin sensitization and may be corrosive to the skin and eyes. Naled is highly to moderately toxic to birds. The reported acute oral LD50 (lethal dose 50, the dose of a substance, which is fatal to 50% of the test animals) for naled is 52 mg/kg in mallard ducks, 65 mg/kg in sharp-tailed grouse, 36-50 mg/kg in Canadian geese, 120 mg/kg in ring-neck pheasants. Naled is highly to moderately toxic to fish and may be very highly toxic to aquatic invertebrate species (ETN 1996). However, naled is practically non-persistent in the environment, with reported field half-lives of less than 1 day. It is not strongly bound to soils and is rapidly broken down if wet. Soil microorganisms break down most of the naled in the soil. It, therefore, should not present a hazard to groundwater (ETN 1996).

### 2.3 Alternative A – No Action Alternative--*Status Quo Approach*

The No Action Alternative consists of activities undertaken by the District under the 2012 Special Use Permit issued by the Refuge. These activities include the use of larvicides and chemical mosquito controls to manage mosquito populations on the Refuge.

Larvicide (*Bacillus thuringiensis israelensis* (Bti) or *Bacillus sphaericus* (Bsp)) will be applied to areas accessed by primary and secondary roads in addition to back country islands (Annette Key, Mayo Key, Porpoise Key, Johnson Keys, Horseshoe Key, Howe Key, Raccoon Key, Pumpkin Key, Johnston Key, Water Keys, Little Knockemdown Key, Top Tree Hammock Key, and Little Pine Key) when larval mosquitoes are verified by on the ground technicians.

Pyrethroids are used for ground adulticidal treatments on inhabited islands. Truck-mounted ultra-low volume fogging machines are employed to spray pyrethroid fog from roads (Figure 2). Applications will be conducted when mosquitoes are concentrated in small areas. Ground treatments will be applied at a rate of 0.0064 lbs. of active ingredient per acre. Volume mean diameter will be between 8 and 30 microns. Missions will be conducted in the evenings during peak mosquito activity and with acceptable environmental factors. Applications will be made to private lands and the machines will be turned to the off position when drift directly onto Refuge property is imminent, because of adjacency, due to wind direction.

Areas authorized for naled application under this alternative consist of certain Refuge lands on Big Pine, No Name, Middle Torch, Big Torch, and Little Torch Keys. Application of naled is prohibited on Refuge properties on Cudjoe Key, Sugarloaf Key, Saddlebunch Keys, Boca Chica Key, and all backcountry islands. Application of naled is prohibited in designated no-spray zones on Big Pine Key, and the entire area south of Watson Boulevard on No Name Key (Figure 3). On Big Pine Key, these include the Watson Hammock, Cactus Hammock, and BPK Pine Rockland no-spray zones. The latter includes the area surrounding Watson Hammock (2007-2010 trial Watson Hammock Expanded No Spray Zone) plus additional pine rocklands delineated in 2011. Applications of naled will be spaced at least five days apart with a maximum of nine applications each year on any given area of the Refuge. Naled will be aerially applied at

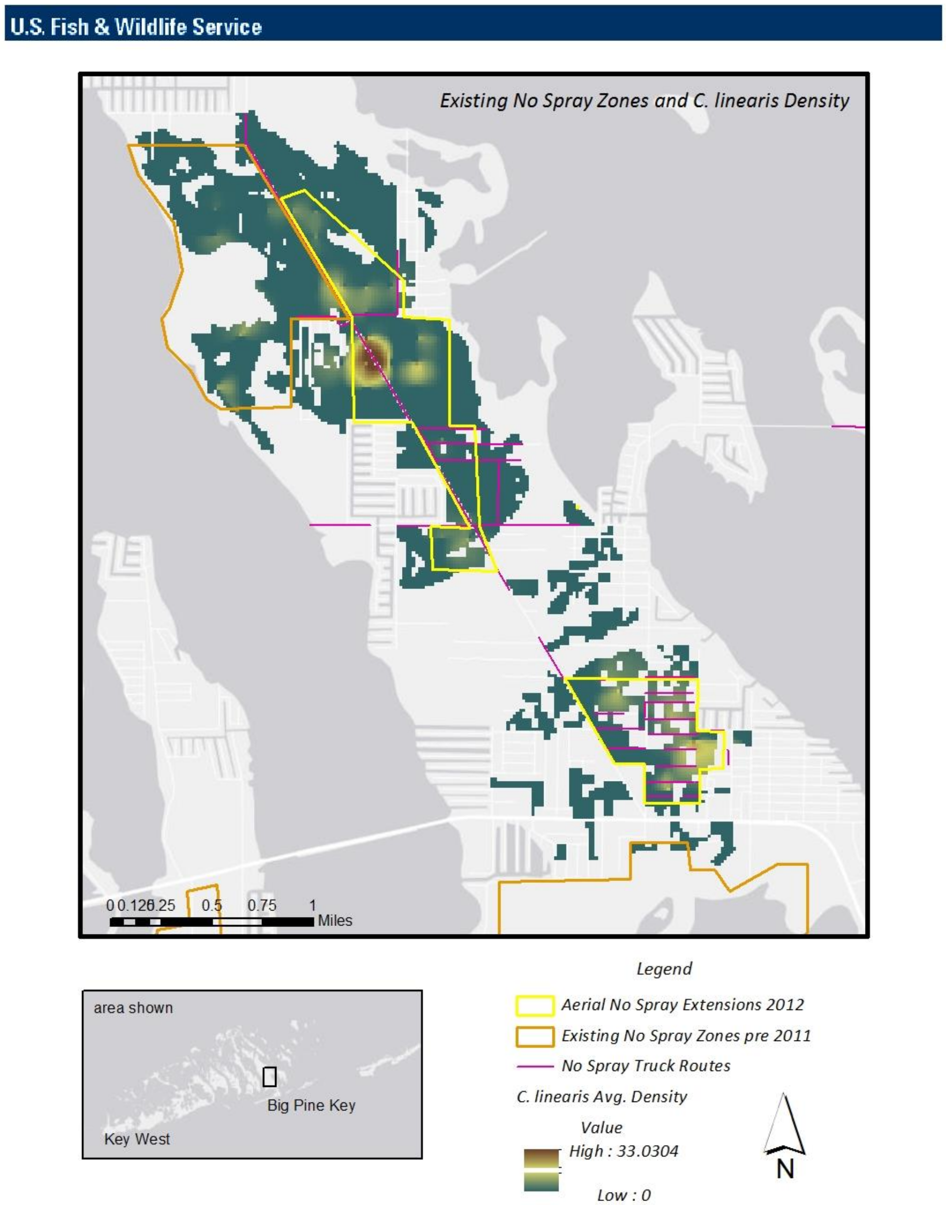


**Figure 2. No-Spray areas delineated under Alternative A – No Action, *Status Quo.* Figure also illustrates the distribution of *Croton linearis* in Refuge managed pineland (green, yellow, and red). *C. linearis* is the sole host plant for the Florida leafwing and Bartram's hairstreak butterflies. Average densities of Croton as measured per plot (Bradley and Saha 2009) are shown here as an interpolated surface map achieved using Arc GIS© 10.0. Red represents high, yellow equals medium, and green equals low densities of *C. linearis*. Interpolated surfaces infer density between known values and may not represent actual densities.**

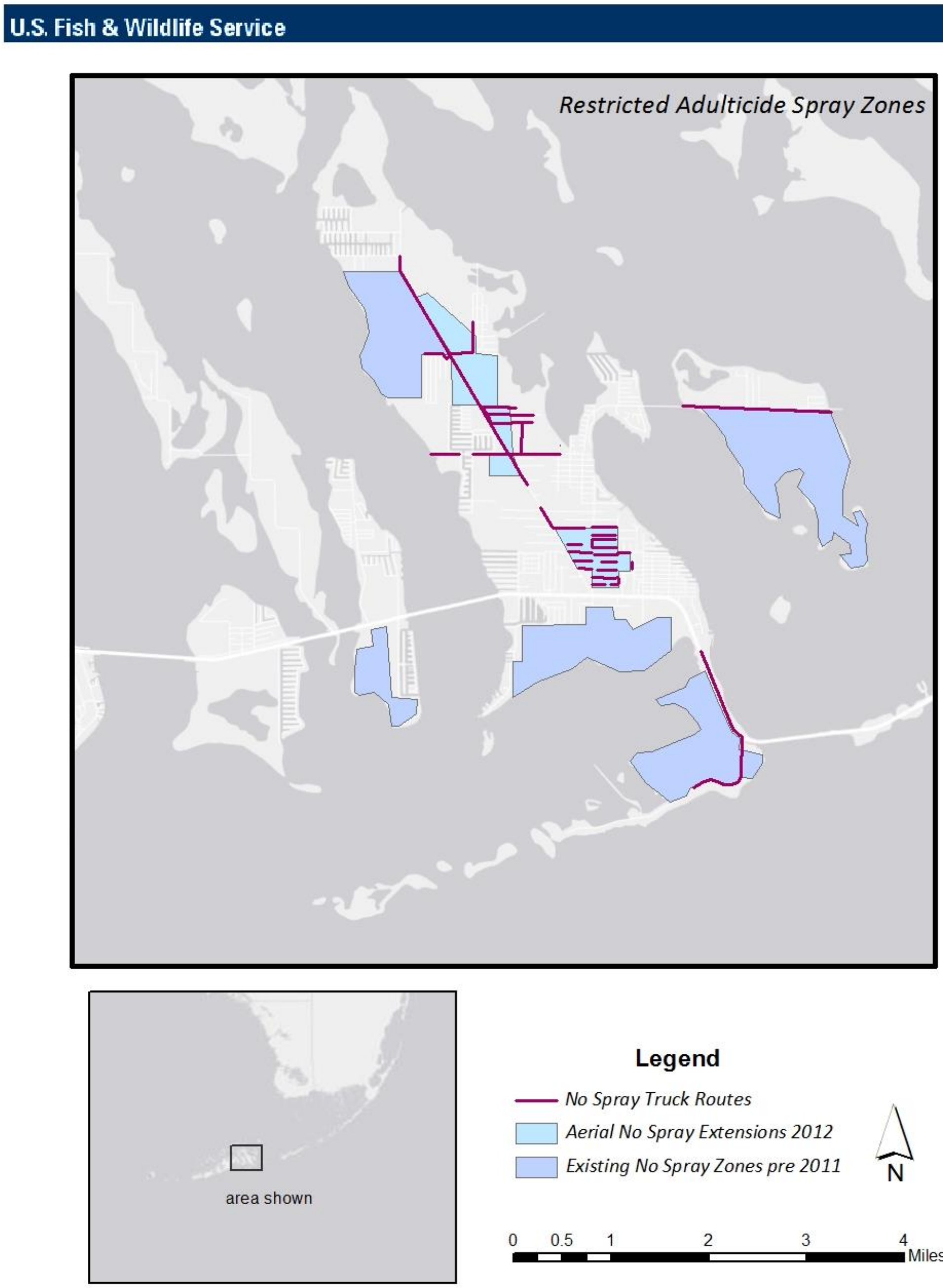


**Figure 3. Alternative A – No Action: Big Pine and No Name Keys conservation areas where aerial spraying for mosquitoes with naled is prohibited (shades of blue). The darker shade of blue denotes all no-spray zones existing before 2011. The lighter blue polygon delineates the no aerial spray zone expansion of 2012. Pink lines are road segments where truck-based Permethrin spraying is not allowed.**

rates of 0.0785 lbs active ingredient/acre or less, at the optimal droplet size of 22-29 microns using ULV spray equipment. Specific attention will be paid to applying naled during temperatures when mosquitoes are actively flying (70-85 degrees Fahrenheit). To reduce drift to non-target areas, Naled will be applied at an altitude of 100-150 ft with winds ≤10 mph at land surface. In addition, naled applications on No Name Key will occur only when the wind is from the south, southeast or southwest to reduce drift into the no-spray zone south of Watson Boulevard.

Appropriate monitoring and detection elements will be deployed to detect drift (e.g. yarn) and deposition (e.g., pads) in no-spray zones. These will be distributed among different no-spray zones as per discussion and concurrence with the Refuge to ensure compliance with drift requirements.

### 2.4 Alternative B – Proposed Action – Phased Approach to Mosquito Management

The Proposed Action is to develop and implement a mosquito management plan (plan) that would allow the Refuge to respond to public health issues due to mosquitoes on the Refuge as identified by a current monitoring data by a public health agency or their designated authorized representative. The mosquito management plan would consist of a phased approach to mosquito management and is consistent with the principles of integrated pest management. The Proposed Action emphasizes design, and management of Refuge lands in a manner beneficial to wildlife consistent with the mission of the Refuge and so as to minimize mosquito production and specifically the public health threat due to Refuge mosquitoes. Monitoring and surveillance will be the first front to identify mosquito source areas and status. A summary of the Proposed Alternative is provided at the end of this section (Table 3).

District activities should be focused on identifying changes in hydrology, weather and vegetation that form mosquito habitat and develop improvements in monitoring and use advances in pesticide methods to reduce the potential for exposure to non-target species. The methods employed should minimize chemical control measures and to decrease mosquito production, seeking the least invasive approach given the current environmental conditions. This alternative is consistent with an integrated pest management (IPM) approach. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. When practical, the approach may include compatible actions that reduce mosquito production and do not involve pesticides. We consider the procedures described below as long-term practices to reduce persistent potential mosquito-associated health threats that Federal, State, and/or local public health authorities have identified.

While the emphasis of this alternative is to minimize chemical control measures and protect non-target resources, it also includes monitoring, surveillance and the potential application of pesticides. Application of pesticides would be approved based on the phased (threshold based) approach outlined below. The principle goal of a phased approach to mosquito management is to minimize effects on refuge resources to fulfill the Refuge mission while addressing legitimate human health concerns and complying with Service regulations and policy. The implementation of a phased-response program represents a standardized approach that would result in a consistent mosquito management program that adheres to Service and District guidelines. Because occurrences of human health issues resulting from mosquitoes are sporadic, phases of mosquito management implemented on the Refuge would vary through time.

The Refuge and the District would work jointly in the implementation of a mosquito management program. The District would have the lead for monitoring, disease surveillance, and pesticide applications; however, the evaluation of monitoring data and approval for the management actions proposed would be the responsibility of the Refuge. While this would require additional staff time, it is necessary to ensure that the conditions for compatibility are met and the program is implemented so as to avoid or minimize effects on Refuge resources.

**Mosquito Threshold Treatment Levels.** Human and wildlife treatment threshold levels (e.g., numbers per sample) are determined by considering several factors unique to an area. Factors for the Florida Keys are presented in Table 2. These factors, in conjunction with sheer abundance of biting mosquitoes, including allergic response, potential magnification of disease in mosquito and host populations, and potential passage of disease even if mosquitoes have not yet been determined to contain a pathogen are considered.

Although treatment thresholds vary according to several factors, most districts across the country have an established baseline threshold treatment level for larval and adult forms. Threshold treatment levels for larva and adult mosquitoes developed for the purposes of this plan/EA are presented in Appendix D.

**Table 2. Factors that may affect thresholds for application of chemical pesticides.**

| Factor | Description | Consideration |
|---|---|---|
| Proximity to human populations | The distance from potential mosquito habitat on the refuge 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 the Refuge. |
| Seasonality and weather patterns | Seasonal changes in prevailing wind patterns, precipitation, and temperatures. | Prevailing wind patterns that carry mosquitoes from Refuge environments 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 within proximity of the Refuge varies. | The Refuge lies within a highly populated area that exhibits lower thresholds (relative to other areas of the country) and a general intolerance to mosquitoes. Number of mosquito complaints is a factor. |

| | | |
|---|---|---|
| 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 larval development habitat off Refuge |
| Spatial extent of mosquito larval development habitat on and off the refuge | The relative availability of mosquito habitat within the landscape that includes the Refuge. | If the Refuge is a primary larval development area for mosquitoes that likely affect human health, thresholds may be lower. If refuge mosquito habitats are insignificant in the context of the landscape, thresholds may be higher. |
| Tidal cycles | The tides rise and fall twice daily in areas within the tidal zone. Spring tides bring higher than normal tide levels and result in flooding of the marsh plain. | Much of the land base of the Refuge lies within the tidal zone where spring tides can flood the marsh plain. Where lower elevation swales exist, water ponds and creates mosquito habitat |
| 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. |
| 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. |
| 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) are lower. |

Alternative B will include monitoring driven, site specific management of treatment units based on thresholds and resource risk. Treatments will be done in the temporally and spatially strategic fashion to maximize reductions of mosquito populations and reduce damage to natural resources. The intent of this alternative will be to integrate the buffer zone from critical habitat of the Bartram’s hairstreak and Florida leafwing butterflies and require site specific adaptive management based on phased approach (Figure 4) for control applications given a demonstrated necessity for treatments based on thresholds. Additional buffers (250 meters) will be designated around occupied Bartram’s hairstreak or Florida leafwing areas as determined by regular monitoring of all currently known and newly discovered sites (Figure 5) and are layered over the existing “no spray zones” designated under Alternative A (protecting hammock and other sensitive areas). The thresholds, or trigger points, will relate to densities of mosquitoes that pose a threat to human health. Depending on the magnitude of the health threat associated trigger points this alternative would allow for different treatment application methods and products. Refuge Islands will be divided into treatment areas, such as neighborhoods or Keys (in the case of the Back Country Islands). The types of mosquito control products, treatment methods, and environmental conditions permitted will be based on site specific issues such as natural resource concerns and Wilderness status.

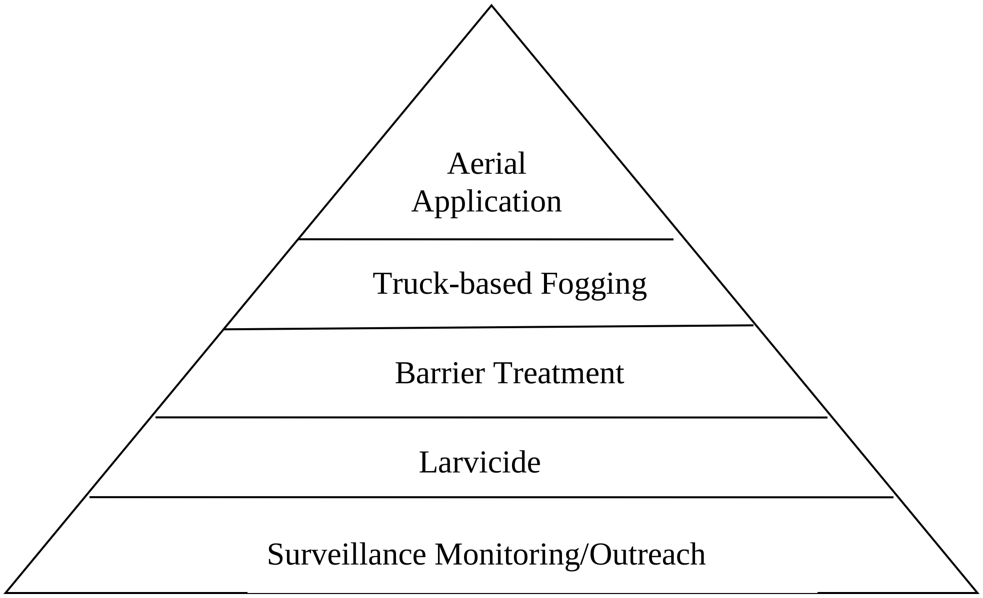


**Figure 4. Illustration of Phased Approach to Mosquito Control indicating that higher risk approaches will represent the least utilized methods.**

*Level 1*

In Level 1, a health threat has not been identified and mosquito management issues have not been recorded by District Monitoring, reported, or identified by the appropriate public health authority. To avoid any possible mosquito management issues, artificial mosquito larval development habitat throughout the Refuge, such as tires, open containers, and other equipment or objects that pool water where mosquitoes may breed, should be eliminated. To aid in this effort, outreach efforts shall be conducted to homes inside the acquisition boundaries of the Refuge by both the District and the Refuge. Mosquito larvae are not detected in larval development sites.  Community education will be a key component to ensure understanding the balance of use of mosquito intervention methods vs. preventative measures.  In addition, under this phase, innocuous control measures including use of native *Gambusia* (mosquito fish) for control of larval mosquitos would be continued.

*Level 2*

Larvicide will be the primary tool for reducing mosquito populations using the methods described in Alternative C.  Larvicide operations will be triggered by the presence of larval instars at larval development sites as observed in field monitoring, as well as historical presence of larvae should the District perform a pre-treatment application. Larvicides used will be Bti or Bsp.  Larvicide is applied at the earliest period provided so as to reduce the quantity of larvicide deployed to minimize cost and improve effectiveness (as early instars are more vulnerable to the action of the larvicide than later instars). Larvicide applications are made to eliminate potential emergence of adult mosquitoes. Applications will be made as described in Alternative A; however, additional areas may be identified as larval development locations and may be added as appropriate, based on monitoring. Additional larvicide treatments are preferable to initiating adulticide operations.

*Level 3*

Ground application of pyrethroid products at maximum label concentrations as a "barrier treatment" may be used when adult mosquito thresholds exceed 3.0 mosquitoes/minute for two consecutive days on private property or in public areas (i.e. park, school) but not on Refuge managed areas. Positive samples collected during surveillance monitoring for invasive mosquito species can also trigger this method of application. Applications will be done using either a backpack or trailer-mounted mist blower, depending upon the area (Barrier treatments typically consist of applying the product at approximately 300-350 um to non-flowering vegetation in a vertical band of 3-6 feet; effectiveness lasts approximately 1 week in the Keys ecosystem) (FKMCD, unpublished data). Barrier treatment will be applied to suitable vegetation and extreme care will be used to avoid direct treatment to refuge lands. "Extreme care" is defined as stopping the barrier application at least 15 feet from non-target areas (e.g., buffer areas in the refuge).

Barrier treatments will be done by the application of the pyrethroid insecticide bifenthrin. Barrier treatments for mosquito control are useful when applied as part of an integrated mosquito control program (Cilek 2008). They can outperform truck sprays and can give significant cost savings (Qualls et al. 2012). Barrier treatments are differentially effective due to sex, parity status, blood-fed status, and time after application (Doyle et al. 2009). Not all mosquito species are impacted equally by the barrier treatment (Hurst et al. 2012). Exposure to rain and sunlight also affect bifenthrin barrier sprays, with residual effects most pronounced in shady areas protected from rainfall (Allen et al. 2009). Avoidance of damage to bees can be attempted by making barrier applications late in the day, as the active ingredient would have time to break down overnight (Qualls et al. 2010). Hoffman et al. (2009) tested 5 sprayers for droplet size, deposition on both surfaces of the leaf (top and bottom) and depth of penetration into the canopy. Larger droplet size was better for barrier treatments, and sprayers with higher wind velocity at nozzle discharge performed better than did those with lower wind velocity. All sprayers tested gave maximum deposition of bifenthrin at 1 meter into the treated vegetation.

Barrier treatments will be applied at a distance of 5 feet from the vegetation canopy with a sprayer angle of 60 degrees. Target height of spray is 6 to 9 feet high, and the concentration of droplets in this target area is 30 to 180 droplets / cm2. Droplet size in this scenario is 300 – 350 μm.

*Level 4*

When monitoring results indicate one or more neighborhood(s) adjacent to Refuge are displaying adult mosquito numbers that exceed the threshold of 3.0 mosquitoes/minute average, Pyrethroid application could be initiated outside of excluded areas and buffer zones. Positive samples collected during surveillance monitoring for invasive mosquito species can also trigger this method of application. Two separate options would be available. Both options are intended to minimize exposure of this pesticide to non-target species including listed butterflies. In addition, residents experiencing a high level of mosquito activity in a limited and localized area (i.e., within their property limits) could request application of Pyrethroid via handheld applications by trained District staff, as appropriate. Monitoring would need to confirm this localized effect and all efforts will be made by District staff to limit applications near Refuge boundaries so as to avoid any localized drift (Given the localized control of the handheld application method, 50 ft buffer is recommended based on expected drift distances from application techniques used and no application direct to refuge lands permitted. This would be restricted to low wind periods as described below).

*Option A*: Truck based fogging of Pyrethroid products will be applied in neighborhood(s) adjacent to Refuge. Applications will not occur within the proposed Critical Habitat or designated Critical Habitat (50 meters) or occupied Bartram's hairstreak butterfly and Florida Leafwings buffers (250 meters) (see Figure 5). Buffer zones are based on expected drift distances to protect sensitive habitats. Drift at a level of concern has been measured under 250 m from truck routes (Pierce 2010, Rand and Hoang 2010). Therefore, no permethrin applications shall occur within 250 m of known occupied Florida leafwing or Bartram's hairstreak proposed critical habitat (Figure 5). Buffer areas may be refined with additional study, in an iterative process as needed, and with the approval of the Service. These applications will not reoccur unless the thresholds are met following a monitoring period and no more than 96 hours following a previous treatment to prevent accumulation of product. Treatments will otherwise follow the methods outlines in Alternative A. Permethrin applications shall not occur when sustained winds exceed 10 mph, or gusts exceeding 15 mph during the entire operational period. Wind direction shall be considered in all application scenarios where excluded areas or buffer zones are not established, but Refuge is present.

*Option B:* Truck based fogging of Pyrethroid products will be applied to neighborhood(s) adjacent to Refuge. Applications may occur within the proposed Critical Habitat (50 meters) but never within the occupied Bartram's hairstreak butterfly and Florida Leafwings buffers (250 meters) (see Figure 5). This would be a one-time application based on an isolated mosquito occurrence rate that exceeds 10.0 mosquitoes/minute average threshold. Only one neighborhood that is within the critical habitat area designation could be fogged in this manner at any one time so as to provide refuge for animals within other areas. Applications will not reoccur unless the thresholds are met following a monitoring period and no more than 1 month following a previous treatment. Treatments will otherwise follow the methods outlines in Alternative A. Pyrethroid applications shall not occur when sustained winds are forecasted to exceed 10 mph, or gusts exceeding 15 mph. Wind direction shall be considered in all application scenarios to ensure that drift does not penetrate critical or occupied habitat for the listed species. Buffer zones are in place to ensure that added protective buffer to those sensitive habitats.

*Level 5*

Aerial application of naled products will be broadcast when mosquito levels reach 10.0 mosquitoes/minute average on any given treatment area on Big Pine Key, or mosquito levels reach 40 mosquitoes/minute average on any given treatment area on No Name Key. Positive samples collected during surveillance monitoring for invasive mosquito species can also trigger this method of application. These applications shall follow the methods outlined in Alternative A. Every effort will be made to avoid occupied butterfly habitat within the Refuge. Aerial application will not be permitted when sustained winds are forecasted to exceed 10 mph, or gusts exceed 15 mph.

### 2.5 Alternative C – Larvicide Only (No Chemical Mosquito Management)

Under this Alternative no chemical mosquito control agents would be used. Larvicide (Bti) will be applied in appropriate areas adjacent to the populated zones near primary and secondary roads in addition to back country islands (Annette Key, Mayo Key, Porpoise Key, Johnson Keys, Horseshoe Key, Howe Key, Raccoon Key, Pumpkin Key, Johnston Key, Water Keys, Little Knockemdown Key, Top Tree Hammock Key, and Little Pine Key). Application of larvicide will be triggered by confirmation of larval mosquitos by field technicians or historical larval presence for pretreatment larvicide applications.

**Table 3. Summary of Alternative B methods**

| Control Measure | Description | Applicability | Active Ingredients | Formulation | Surveillance Method | Threshold | Application Method | Rate Determination |
|---|---|---|---|---|---|---|---|---|
| **Source Reduction** | Container control program | Used in urban areas | N/A | | Property checks, public education | Presence of container breeders | N/A | N/A |
| **Larviciding** | Use of Gambusia spp. | Used in storm water retentions, abandoned swimming pools, ornamental ponds, rain barrels | N/A | | *Larval dipping, inspector observations of conducive conditions* | *Presence of target species* | *Hand placement* | 1 fish per 6 square feet |
| **Larviciding** | Use of approved larvicides | Containers, sewage treatment plants, ponds, rain barrels, tires, other domestic sites | Bacillus thuringiensis; Bacillus sphaericus; Temephos; Methoprene; Spinosad<br>Oil | *Bti: granular, wettable powder*<br>*Bs: granular*<br>*Temephos: granular*<br>*Methoprene: pellets, briquette*<br>*Spinosad: tablet*<br>*Oil: dispersible oil* | *Larval dipping* | *Presence of live larvae of target species; presence of conditions historically conducive to larval development* | *Hand applications (all methods); Aerial application (Bti wettable powder)* | Bti: granular (10lbs/acre), wettable powder (0.5lbs/acre)<br>Bs: 10lbs/acre<br>Temephos: 10lbs/acre<br>Methoprene: 5lbs/acre<br>Spinosad: small tablet:1/up to 55 gallons; large tablet: 1/100 sq. ft<br>Oil: 0.5floz/100 sq. ft |
| **Larviciding** | Use of approved larvicides | Roadside ditches, storm water retention ponds, solution holes, salt marshes | Bacillus thuringiensis<br>Spinosad<br>Methoprene | Bti: granular<br>Spinosad: Tablet<br>Methoprene: briquette, granular | Larval dipping | Presence of live larvae of target species; presence of conditions historically conducive to larval development | Ground application for small, accessible sites<br>Aerial application for large inaccessible sites | Bti:10lbs/acre<br>Spinosad: small tablet:1/up to 55 gallons; large tablet: 1/100 sq. ft<br>Methoprene: 5lbs/acre (briquette); 3.5lbs/acre (granular) |
| **Adulticiding** | Barrier application to vegetation | Used in urban areas | Bifentrhin<br>Deltamethrin | Liquid mixed with water | Landing rate counts | 3 adults per minute for 2 consecutive days | Trailer mounted ULV sprayer; Back pack sprayers | Bifenthrin: 0.1gal/acre<br>Deltamethrin: 0.13gal/acre |
| **Adulticiding** | Ground application | Used in urban areas | Permethrin;<br>Malathion;<br>Prallethrin/ Sumithrin;<br>Chlorpyrifos | Concentrate or mixed with mineral oil | CDC lighted and baited traps; landing rate counts | 25 adults per trap per night; 3 adults per minute; 3-fold increase in base population | Ground application: truck mounted ULV equipment, ATV ULV equipment, handheld ULV equipment | Permethrin: 0.36-0.08floz/acre<br>Malathion: 0.75floz/acre<br>Prallethrin/Sumithrin: 0.41-1.23floz/acre<br>Chlorpyrifos: up to 0.33fl oz/acre |
| **Adulticiding** | Aerial application | Used in all areas of the District | Naled | Concentrate | CDC lighted and baited traps; landing rate counts | 25 adults per trap per night; 10 mosquitoes/minute landing count; 3-fold increase in base population | Aerial application using helicopter and fixed wing aircraft | 0.5-0.75oz/acre |

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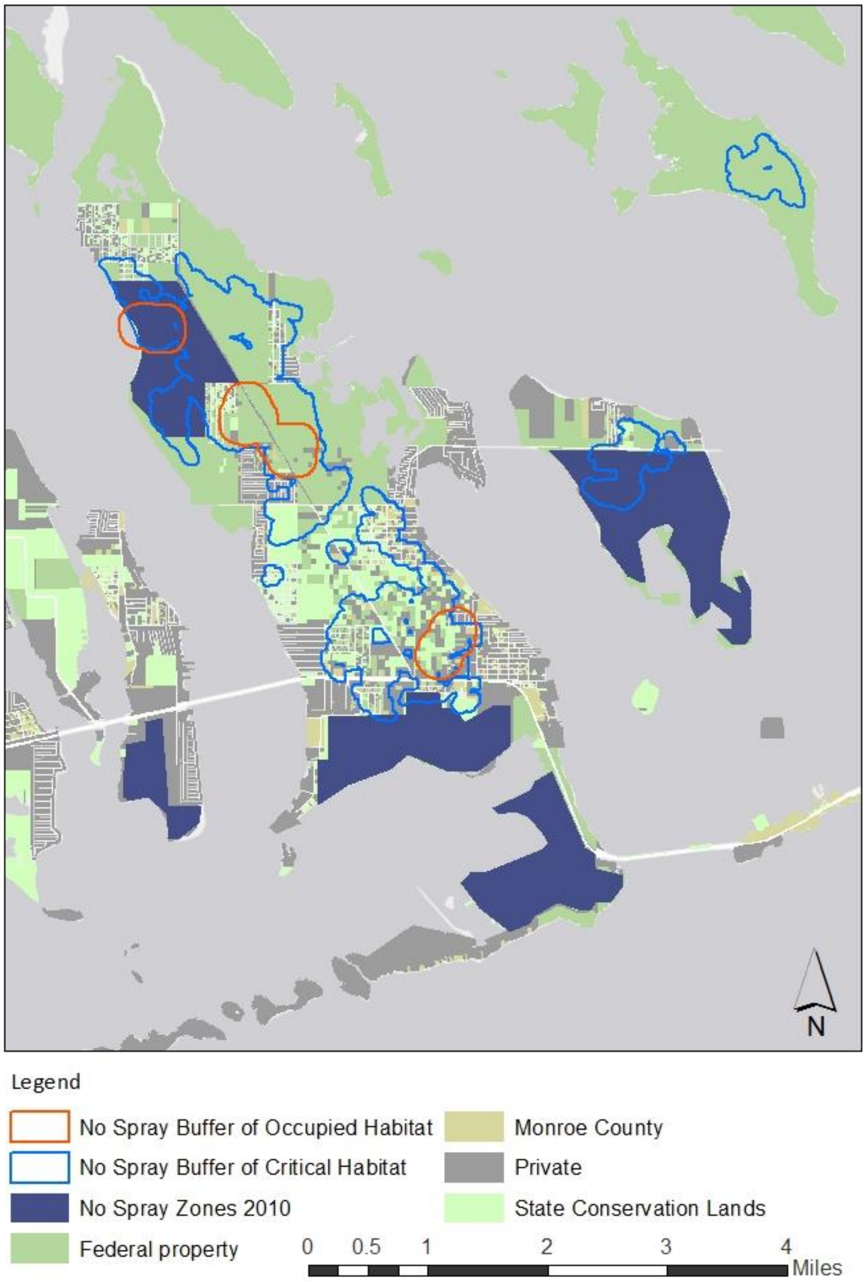


**Figure 5. Depicts alternative B with 50 meter buffers around proposed critical habitat for the Bartram's hairstreak and Florida Leafwing butterflies and 250 meter buffer to protect occupied Bartram's hairstreak areas.**

## 2.6 Alternative D – No Mosquito Management

Under this alternative native mosquito populations would persist unabated within the Refuge. Mosquito control operations would continue to occur outside of the Refuge. Mosquito control within the Refuge could take place only when human health or safety is jeopardized.

## 2.7 Comparison of the Alternatives

**Table 4. Matrix illustrating general features of the four alternatives.**

| Alternative | Product Type Used | Buffers applied | Estimated Refuge Acres Potentially Available for Treatment | Estimated Private Acres located within designated No Spray or Buffered Areas |
|---|---|---|---|---|
| **Alternative A – No Action** | Larvicide<br>Adulticide<br>With no spray zones | No | Larvicide: 18,695<br>Adulticide: 3,059 | 368 |
| **Alternative B - Proposed Action: Phased Approach to Mosquito Management** | Larvicide, Adulticide Based on Triggers and buffers around sensitive habitat | Yes | Larvicide: 18,695<br>Adulticide: 2,658 | 825 |
| **Alternative C – Larvicide Only** | Larvicide | No | Larvicide: 18,695 | Not Applicable |
| **Alternative D- No Mosquito Management** | None | Not Applicable | None | Not Applicable |

## 2.8 Alternatives Considered But Dismissed From Further Consideration

A number of additional alternatives were discussed and evaluated. Those include using other biological controls, such as dragonflies, birds or bats in the control of mosquitos. These techniques have not been found to be effective in other areas; current information for the Florida Keys indicates they would not be effective, locally. There is no good evidence that encouraging birds, in particular Purple martins, to live around homes will reduce mosquito numbers (Kale 1968). Bats consume larger prey items such as beetles; this has been verified via stomach content and fecal analyses (Easterla and Whitaker 1972, Vestjens and Hall 1977, Sparks and Valdez 2003, Whitaker and Frank 2012). Adults of most dragonfly species are not active during the hours that mosquitoes are flying (Pritchard 1964, Walton 2003). Moreover, collecting sufficient dragonflies to start a self-sustaining captive colony would necessitate depopulating the local fauna or introducing non-native species into the ecosystem. The flight space requirements of reproductively active dragonflies, coupled with their territoriality and cannibalistic larvae, would make captive breeding for inundative release prohibitively expensive. The use of carbon dioxide traps (mosquito magnets) for greater control was assessed. While these units are somewhat effective in trapping experimentally for mosquitos, they have not been effective in control efforts and the magnitude of the trapping effort would be cost prohibitive.

A number of other chemical treatments are available, but the compounds provided above are considered the most appropriate given the need to reduce or eliminate non-target organism impacts.   Thus, current knowledge indicates other pesticides may represent a greater impact to the populations at risk.

The concept of the use of automatic misting systems by the general public was evaluated. These systems are simple but can result in misuse and added exposure to both the user and to the environment.  In addition, there is some concern that continued use my result in promoting resistance to the chemical agent in the localized area making control more difficult in the long run.

For the reasons stipulated above, the alternatives discussed were considered but are dismissed from additional consideration and will not be carried through the remaining portion of the analysis of alternatives.

## *3.0 Affected Environment*

### 3.1 Physical Environment

*CLIMATE*

The climate of the Lower Florida Keys is tropical (Jordan l99l) with a mean annual temperature of about 77 degrees Fahrenheit (F). The coldest average monthly temperature, 70 degrees F, occurs during January. The warmest mean monthly temperature is 84 degrees F and occurs in August (Thomas 1974). Temperatures below 39 degrees F are unusual due to the moderating effects of the warm marine waters and the coastal Gulf Stream. Freezing temperatures and frost have never been recorded. The mean annual rainfall is 39 inches, of which 80 percent falls from May through October (Hanson 1980). Compared to other seasons, winters are usually dryer with most rainfall occurring during passing cold fronts. Prevailing wind direction is east to southeast with an annual average of about 11 knots. Winds are strongest during the winter months (December through March) when cold fronts from the north move through the area. The mean annual sunshine is 3,300 hours, 10 percent more than the Florida Peninsula to the north.

*GEOLOGY*

The geology of the Lower Florida Keys (Big Pine Key west to Key West) has been described in detail by Hoffmeister (l974). Marine carbonate sediments nearly 20,000 feet in depth underlie the Keys. Along this submerged platform, coral reefs developed in a band from present day Miami to the Dry Tortugas. Two limestone formations of marine origin are found in the Lower Florida Keys. Miami oolite, a medium-to-hard limestone, overlies the Key Largo limestone formation. In the Lower Keys, Key Largo limestone is exposed only in a narrow band on the extreme southeast end of Big Pine Key. Elsewhere in the Lower Keys, it is overlain by Miami oolite, formed during the Pleistocene era in a high-energy, shallow-water environment containing an abundance of calcium carbonate.

The configuration of limestone strata in the Lower Keys allows for the development of the freshwater lenses found there.

*SOILS*

Physical and chemical properties of soils in Monroe County have been described by the U.S. Department of Agriculture (1989). Saddlebunch marl is the dominant soil in tropical hardwood hammocks. In some hardwood hammock areas, humus may be present to a depth greater than 3 feet. Key Vaca, a very gravelly loam, is the dominant soil in the pine rocklands. Soil types in the freshwater wetlands are of the Rock-Outcrop-Cudjoe Complex, consisting of 55 percent rock outcrop and 45 percent Cudjoe marl. Soils within the fire-dependent pine rocklands are very thin; burning removes vegetative litter and exposes the bare oolitic caprock. Cracks and crevices in the exposed limestone cap rock form pockets of soil. The relationship between soil productivity and different forest cover types in the Florida Keys was studied by Ross et al. (2003).

*PHYSIOGRAPHY*

While refuge islands range in size from less than 1/4-acre (e.g., Hurricane Key) to nearly 6,300 acres (Big Pine Key), the majority of islands are less than 100 acres. Elevation ranges from sea level on inundated mangrove islands (e.g., Little Crane Key) to approximately 9 feet above sea level (Big Pine Key) according to LiDAR-derived digital terrain maps (Keqi Zhang, Florida International University, personal communication, 2008). A complex network of narrow tidal creeks dissects small mangrove islands in some areas (e.g., between Snipe Point and Outer Narrows).

*HYDROLOGY AND FRESHWATER RESOURCES*

Except for limited shallow pooling following a rainstorm, freshwater is absent from Key West NWR and from nearly all backcountry islands (i.e., islands not linked by U.S. Highway 1) in the other refuges. A notable exception is Little Pine Key, which is underlain by a freshwater lens. The distribution of surface freshwater on refuge islands was mapped and described in detail by Folk et al. (1991). Refuge lands on Cudjoe, No Name, Upper Sugarloaf, Big Torch, Little Pine, Howe, and Big Pine Keys contain freshwater wetlands year-round. Freshwater wetlands reach their greatest extent and distribution on Big Pine Key. Rainwater collects and is held chiefly in shallow, impermeable limestone basins and solution holes distributed throughout the island's hardwood hammocks and pine rocklands. At slightly lower elevations amidst these habitats are freshwater wetland communities. Big Pine Key is underlain by two distinct subterranean freshwater lenses. The largest one is north of Watson Boulevard; the other is south of this road (Hanson 1980). In both lenses, freshwater floats on the underlying saltwater with changes occurring seasonally due to tidal influences and rainfall dependent freshwater recharge. During the highest spring tides, freshwater may be discharged above ground level (Folk et al. 1991). Extensive canals dug to create waterfront property accelerated the natural discharge from freshwater lenses, decreasing the size of the lens by 20 percent (Langevin et al. 1998). The freshwater layers are narrow for both lenses (20 to 23 feet), with only a 5- to 10-foot transition zone between freshwater and saltwater (Wightman 1990). Additionally, there are more than 60 miles of ditches on Big Pine Key alone that were dug in the 1960s to drain freshwater wetlands for mosquito control. These ditches criss-cross nearly every inhabited island along the Overseas Highway, and they have likely had a substantial impact on the natural hydrology and flow patterns across the island landscape.

*WATER QUALITY AND QUANTITY*

Studies of surface and nearshore water quality have been performed in the Florida Keys (Florida Department of Environmental Regulation 1985; 1987; Kruczynski 1999; Lapointe and Clark 1990). Florida International University's Southeast Environmental Research Center maintains a long-term water quality monitoring network for the marine waters of the Florida Keys National Marine Sanctuary, including several sampling points within the backcountry waters of the refuges. For more information, see: http://serc.fiu.edu/wqmnetwork. The Florida Department of Environmental Protection also conducts semi-annual monitoring of water quality in several wells in the Florida Keys. For more information, see: http://www.dep.state.fl.us/water/monitoring/index.htm. Both the surface and subterranean freshwater resources of refuge lands on Big Pine Key are vulnerable to contamination because of sea level rise, runoff of fertilizers, herbicides and pesticides from lawns, and the outflow from septic tanks (Wightman 1990). The latter are a constant source of pollution (Paul et al. 1995) because of the geological characteristics of the Lower Florida Keys (Lapointe and Clark 1992). Septic tank densities in subdivisions adjacent to refuge lands greatly exceed the normally accepted national benchmark of 40 tanks per-square-mile. This benchmark was set for areas unlike Big Pine Key where suitable soils are present (Saarinen 1989). Storm surges, such as that experienced in Hurricane Wilma in 2005, cause a short-term spike in salinity levels of freshwater solution holes, but normal levels are recovered over time.

*AIR QUALITY*

Air quality is a global concern. The U.S. Environmental Protection Agency (EPA) has lead responsibility for the quality of air. Through the 1990 Clean Air Act, EPA set limits on the amount of pollutants that can be legally discharged into the air. Nationally, more than 170 million tons of pollution is emitted into the air annually within U.S. borders, through either stationary sources (e.g., industrial and power plants) or mobile sources (e.g., automobiles, planes, trucks, buses, and trains). There are also natural sources of air pollution, such as fires, dust storms, volcanic activity, and other natural processes. The EPA has identified six principal pollutants that are the focus of its national regulatory program: lead, carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, and particulate matter. Air pollution causes damage to the environment and property and affects human health. Both federal and state governments track air quality and visibility impairment, through a system of 5,200 monitors at 3,000 locations across the United States. Florida has 227 monitors at 141 sites. Carbon monoxide is from combustion or fire sources and is a problem mainly in cold weather climates. Lead has not been detected above standard levels, except in places that have a smelter source. Nitrogen dioxide is only monitored in large metropolitan areas, but Florida has never approached the standard. Sulfur dioxide is emitted from power plants and paper mills. None of these four principal pollutants are monitored near the refuges, since they are not considered problem pollutants in this area. The Clean Air Act provides for the protection of visibility in national parks and wilderness areas, also known as Class 1 areas; however, there are no monitoring stations within the refuges.

## 3.2 Biological Environment

### *FLORA – PLANT COMMUNITIES AND COVER TYPES*

The refuges harbor a very diverse assemblage of plants, with 423 native and 88 non-native species recorded (from Gann et al. 2007a, b, c). Upland vegetation is primarily of West Indian origin (Dickson 1955, Weiner 1979). Native plant diversity is greatest in National Key Deer Refuge (410 species), followed by Key West NWR (182 species), and Great White Heron NWR (128 species) (Gann et al. 2007a, b, c). Federally listed species include the Key tree cactus (endangered) and Garber's spurge (threatened), with six candidate species under consideration for listing. On-line floristic databases maintained by the Atlas of Florida Vascular Plants (http:// www.plantatlas.usf.edu) and Institute for Regional Conservation (http://www.regionalconservation.org/) provide additional information on plant communities and species.

The Florida Keys are a disturbance-based ecosystem, affected periodically by wind and flooding events associated with hurricanes, drought, and fire. Due to the small size of the islands, flat topography, low elevation, depth to groundwater, close proximity to the sea, and geological substrate, very slight differences in elevation yield marked differences in plant communities (Ross et al. 1992). Major cover types described below include pine rockland, tropical hardwood hammock, freshwater wetlands, salt marsh transition, mangrove forest, inland salt ponds, beach ridge hammock, beach and dune, and marine. Each of these major cover types includes multiple plant communities, providing for a diverse mosaic of habitats across the island landscapes.

#### Pine Rockland

Pine rockland is a globally endangered plant community found only in the Lower Florida Keys, Everglades National Park, and in scattered parcels in Miami-Dade County, representing less than 3 percent of its original extent due to conversion to other land uses, significant ecological degradation, and outright destruction (Noss et al. 1995). Pine rocklands consist of an open canopy of slash pines with patchy understory and groundcover layers. The south Florida slash pine (*Pinus ellioti* var. *densa*) and palms (*Coccothrinax argentata, Thrinax morrisii, Thrinax radiata,* and *Serenoa repens*) are fire-adapted and dependent on periodic fires for their long-term persistence (Snyder et al. 1990).

Sub-canopy layers include a diverse assemblage of tropical and temperate shrubs, palms, grasses, and herbs (Folk 1991). Pine rocklands occur at an elevation 3 to 8 feet above mean sea level and are usually underlain by a freshwater lens. Pine rocklands have the highest plant diversity of all plant communities in the Florida Keys. A total of 250 species of plants has been identified in the pine rocklands of south Florida and the Lower Keys. This community contains 14 herbs endemic to south Florida, 5 of which occur only in these Lower Keys settings (Avery and Loope 1980). Common plants associated with pinelands include long-stalked stopper, blackbead, Keys thatch palm, silver palm, locustberry, and poisonwood. Pine rocklands contain significant freshwater resources, including widespread freshwater solution holes and marshes that are important to Key deer.

Pine rocklands are dependent on fire to maintain the diverse assemblage of plants. Radiocarbon dating on soil samples taken from two water holes on Big Pine Key reveal repeated, local fires during the past ca. 450–500 years, documenting the long importance of fire in the Florida Keys' pine rocklands (Horn 2008). Pine rocklands typically burn once or twice every decade (Hofstetter 1974). Fire frequency has been shown to be an important parameter affecting the abundance and diversity of endemic herbs and the vegetation structure of pine rocklands (Lui et al. 2005, Bradley and Saha 2009, others). In the absence of fire, pine rocklands will succeed to hardwood hammock approximately within a 50-year-timeframe (Dickson 1955).

Pine rocklands are intolerant of saltwater. Of all refuge plant communities, flooding events from hurricanes and sea-level rise pose the greatest risks for the pine rocklands (Klimstra 1986). Flooding by sea water occurs only periodically due to storm surges associated with strong tropical storms. In the wakes of hurricanes in 1998 (Georges) and 2005 (Wilma), many slash pines were killed by this form of saltwater intrusion. Ross et al. (1994) reported that a 1/2-foot rise in sea level over a 70-year period reduced the size of the pine rocklands on Upper Sugarloaf Key by 66 percent.

Tropical Hardwood Hammock

Tropical hardwood hammocks are the climax terrestrial plant community in the Florida Keys. Occurring on uplands 2 to 8 feet above sea level, hammocks are hardwood forests consisting of a wide diversity of evergreen and semi-deciduous trees and shrubs, many of West Indian origin. These include paradise tree, gumbo limbo, Jamaican dogwood, pigeon plum, blolly, and wild dilly. Except during extreme storm events, these areas are not inundated by sea water. Although tropical hardwood hammocks are not fire-maintained communities, fire may periodically enter hammocks from a nearby pineland wildfire, especially during extreme drought conditions (Klimstra 1986). Tropical hardwood hammocks serve as important stopover areas for Neotropical migratory birds, particularly during inclement weather. Human development has severely reduced and fragmented this habitat in the Florida Keys, deleteriously affecting forest nesting birds and fruit foragers, such as the state-listed white-crowned pigeon (Bancroft and Bowman 1994, Bancroft et al. 1995).

Freshwater Wetlands

Freshwater wetlands are primarily isolated features in the Lower Keys, occurring in shallow basins or lowlands either surrounded by higher upland forests or between upland areas and transition zones. Within this category, there are natural mosaics of subtypes related to depressions, elevations, bedrock surface exposure, soil types, and fire regimes. They have standing freshwater levels that persist for extended periods. The average marsh elevation is 3 to 6.5 feet above mean sea level, with size varying up to 247 acres (Folk 1991). Wetland plant species include sawgrass (*Cladium* sp.), buttonwood, white-top sedge, and leather fern. These wetlands are important to amphibians, reptiles, insects, mammals, birds, and crustaceans. Freshwater wetlands reach their greatest extent and distribution on Big Pine Key, but refuge lands on Cudjoe, No Name, Upper Sugarloaf, Big Torch, Little Pine, and Howe Keys also contain freshwater wetlands year-round. Freshwater wetlands are absent in Key West NWR; however, ephemeral puddling occurs on a very small scale where limestone caprock is exposed on Boca Grande Key.

Salt Marsh Transition

This cover type includes salt marsh and transitional communities including buttonwood transition zones. Salt marsh communities consist of halophytic (salt tolerant) species that have developed biological and physiological mechanisms to adjust to a range in environmental conditions. In the Lower Keys, salt marsh transition communities occur primarily in the elevational transition zone between coastal mangrove forests and upland hardwood hammocks and pine rockland forests.

Common plants include cordgrass, sea oxeye, saltgrass, saltwort, glasswort, buttonwood, joewood, saffron plum, key grass, Christmas berry, and sea purslane. The predominant characteristics of salt marsh transition vary among a broad range of subtypes that are distributed along even finer elevation gradients within this zone, depending on their tolerance and adaptability to salinity changes and periodic inundation. The range of subtypes includes open scrub salt marsh, buttonwood-dominated scrub salt marsh, and cordgrass (*Spartina* sp.) salt marsh. The salt marsh transition communities are used by a variety of resident and transient taxa. It is important habitat for the endangered Lower Keys marsh rabbit.

Mangrove Forest

Mangrove communities range from tall, coastal forest to low, dense scrub communities, each variety providing different physical habitats, topology, niches, microclimates, and food sources for a diverse assemblage of animals. This community type is dominated by black mangrove, white mangrove, or red mangrove. Elevation ranges from shallow submerged land to about 4 inches above sea level. The roots of these trees are usually either constantly submerged or inundated daily by the tides. Mangrove communities are among the most biologically productive ecosystems in the world (Lugo and Snedaker 1974). These forests are a vital component of the estuarine and marine environment, providing a major detrital base and essential nutrients to organic food chains; important habitat for arboreal, intertidal, and subtidal organisms; brooding areas for juvenile fish and crustaceans; nesting sites; cover and foraging sites for birds; and habitat for some reptiles and mammals, notably the silver rice rat. Mangrove wetlands are excellent filters of runoff, and provide a protective barrier that diminishes the intensity of storm surges on interior upland habitats.

Inland Salt Pond

Salt ponds are high-salinity, non-vegetated, shallow-water areas of at least an acre in size that occur landward of mangroves. Large salt ponds (greater than 3 acres) are found on Big Pine, Barracouta, Cudjoe, and Boca Grande Keys. High numbers of wading birds may gather in such areas, depending on water depths and fish density. Of special note is the salt pond on Boca Grande Key, which is used year-round by wading birds. Seasonally, it is used by piping plovers; white pelicans; blacknecked stilts; and least, royal, and sandwich terns. This island and Barracouta Key harbor the largest known mangrove terrapin populations in Key West NWR.

Beach Ridge Hammocks

These hardwood hammocks occur on high sand berms, within a few feet above sea level, created by storm surge and wind events. Although many of the plants found there are also found in tropical hardwood hammocks, this habitat is sufficiently different to warrant a separate classification (Folk et al. 1991). Trees in this habitat type grow on a sand or calcareous gravel substrate with low freshwater retention and are usually long, narrow linear features immediately adjacent to beaches.

Beach ridge hammocks normally have relatively low plant diversity with a sparse understory, which may contain limber caper, Bahama nightshade, and blackbead. However, the latter may serve as the dominant species over a large area in some beach ridge hammocks. A nearly pure, 4-acre stand on Boca Grande Key provides an example. Of all berm hammocks in Key West NWR, elevation is highest (6.5 to 10 feet) and size greatest on the northwest side of the Marquesas Keys. Within this hammock is the only viable population of yellow heart trees in the United States.

Beach and Dune

The beach and dune communities are closest to the high-energy shoreline. Within this high-energy zone, there are a number of naturally reoccurring events, such as wave action, tidal fluctuations, sand burial, and salt spray. Beaches and associated dunes are rare in the Lower Florida Keys Refuges. Except for a narrow beach on the extreme southeast side of Big Pine Key and on Ohio Key, this habitat is absent in National Key Deer Refuge. Short, narrow beaches are found on east Sawyer Key and Snipe Point in Great White Heron NWR. Beach and associated dunes are a prominent part of the Key West NWR, occurring on Man, Woman, Marquesas (7 separate beaches) and Boca Grande Keys. Beach length varies from 164 to 8,530 feet. All refuge beaches are narrow and coarse grained, formed primarily of calcareous remains from various shallow water marine organisms.

Green and loggerhead sea turtles nest on refuge beaches; hawksbill turtles nest occasionally on Key West NWR. The beaches also afford important nesting, foraging, and loafing habitat for a variety of shorebirds, including the threatened roseate tern and piping plover.

Dunes occur landward of the beaches and reach their greatest size and have the highest plant diversity on refuge islands in Key West NWR. Small patches of coastal prairie communities also occur among beach and dune systems in Key West NWR. The beach-dune interface is an important ecological front that produces sustained levels of biological activity. The beach and dune may function in a state of equilibrium with the nearshore system such that alteration of one of these elements may affect the others (Carter et al. 1990). Narrow dunes are the most vulnerable to overwash. On Boca Grande Key, for example, a small portion (about 165 feet) of the narrow dune on the extreme northwest side of the island is inundated during exceptional spring high tides. Dunes are a fragile habitat easily damaged by humans, the extent of which depends on dune size and profile, quantity and type of flora, beach characteristics, and surrounding water depth (Liddle and Greig- Smith 1975, McDonnel 1981, Nickerson and Thibodeau 1983).

Marine

The marine zone extends out from the shoreline's high water mark to the open gulf and ocean. Marine habitats include tidal flats, seagrass meadows, patch corals, and the coral reef tract. Bank reefs are considered unique due to the presence of elkhorn coral (*Acropora palmata*), coral zonation by depth, and seaward-oriented spur-and-groove formations. Soft corals are the predominant organisms on the Florida Keys reefs. The sea whips and sea fans are a unique Caribbean feature. Coral reef systems serve as barriers, protecting many coastal populations and developments from storm damage; they support commercial fisheries; they serve as major tourist attractions; and they hold the possibility of unimagined medicinal compounds in the diverse life forms within them. A portion of the main reef tract is located near Sand Key in the southeastern corner of Key West NWR.

The backcountry of the Lower Florida Keys Refuges is predominantly shallow water habitat with seagrass beds, scattered coral heads, and small patch reefs. There are several types of seagrasses in the Keys, with turtle, manatee, and shoal grass being most common. The depths at which seagrasses grow are limited by water clarity, which determines the amount of light reaching the plant. The seagrass beds provide important foraging habitat for sea turtles. Tidal flats provide essential foraging habitat for wading birds that hunt small fish and crustaceans during low tide cycles.

*FAUNA – FISH AND WILDLIFE*

A complete listing of the wildlife known to occur in the Lower Florida Keys Refuges can be found in the Comprehensive Conservation Plan for the Refuge Complex (USFWS 2009) or see http://www.fws.gov/southeast/planning/CCP/LowerFLkeysFinalPg.html

Fish

Although marine reef fishes in the Florida Keys have been studied extensively (Bohnsack et al. 1998), those inhabiting freshwater and brackish wetlands on refuge lands have received little attention. There is no freshwater in Key West NWR. Freshwater is absent on nearly all islands in Great White Heron NWR and occurs sparingly (excepting Little Pine Key) on a few islands which are located within the overlapping boundaries of the National Key Deer Refuge. Thus, the following discussion pertains only to National Key Deer Refuge. Freshwater resident fish are largely limited to small freshwater holes (also known as solution holes), freshwater wetland ponds and man-made mosquito ditches. The few published works have been species-specific and narrowly focused (Travis et al. 1990, Turner 1992). The Florida Audubon's Tavernier Science Center, on behalf of the Keys Environmental Trust Fund, conducted a baseline inventory of non-tidal fish habitats on Big Pine Key and surrounding islands and sampled fish assemblages in 16 mosquito ditches. A total of 13 fish species were identified, including 2 species listed as Species of Special Concern by the State of Florida, the mangrove Gambusia (*Gambusia rhizophorae*) and mangrove rivulus (*Rivulus marmoratus*) (Faunce et al. 2001, Hobbs 2003).

Birds

More than 250 bird species have been observed in the refuges. Avian species that are listed under the provisions of the Endangered Species Act and documented in the refuges include the roseate tern and piping plover. The red knot is a candidate species. State-listed species include the aforementioned species, as well as the least tern, peregrine falcon, snowy plover, bald eagle, and white-crowned pigeon.

The refuges provide important breeding, wintering, and stopover habitat for Neotropical migratory birds, including songbirds, shorebirds, and raptors. Through the Partners in Flight Initiative, federal, state, and private agencies are developing and implementing a comprehensive approach for managing selected species of migratory nongame birds. In an attempt to prevent the listing of most of these birds as threatened or endangered species, these trust species are given high priority in management decisions. Nesting bald eagles, wading birds, white-crowned pigeons, and some terns are also surveyed annually.

Shorebirds, Waterbirds, and Marshbirds

The Lower Florida Keys Refuges contain extensive mangrove and shallow-water habitats that are important loafing and foraging sites for local wading birds and migratory shorebirds. With the exception of the wood stork, the refuges harbor all species of Florida wading birds as either nesters or vagrants. Known nesters include all Florida herons and egrets, as well as the white ibis. The refuges are particularly important to nesting great white herons. A peak of 336 nests was documented in 1998, but thereafter nesting declined yearly to less than 100 (Wilmers 2003; 2008).

Other birds that nest in the refuges include the brown pelican and double-crested cormorant. Brown pelican nesting has declined markedly in Key West NWR since 1987. The historic (1986-2005) nesting colony in the Marquesas Keys was abandoned in 2005, with no sign of nesting activity in 2006-2008. In 2008, only one rookery near Key West was active and no young were produced. Non-nesting, fish-eating birds include various tern and gull species. Descriptions of piping plover, roseate tern, and red knot can be found under the section on Endangered, Threatened, and Candidate Species.

Raptors (Hawks and Allies)

The Lower Florida Keys Refuges are situated along a major migratory pathway for raptors. Sixteen migratory species have been observed in the refuges. Migration begins in late August with the passage of American swallow-tailed kites and ends in November with Swainson’s hawks. Broad-winged and sharp-skinned hawks and American kestrels are the most abundant migratory birds. More peregrine falcons pass over the Keys than any other hawk observation sites in North America (Lott 2006). While most of the migratory raptors use the refuges as a resting and feeding stopover en route to the tropics, significant numbers of certain species overwinter, such as the broad-winged and short-tailed hawks. Bald eagle nesting has been monitored annually since 1985 with four to six active nests sighted yearly. Some islands were used for nesting for over 20 years and others for only a few years, with pairs moving elsewhere. Osprey and red-shouldered hawks are also nesters in the refuges.

Waterfowl

Waterfowl do not nest in the Lower Florida Keys Refuges. Apart from small numbers of overwintering red-breasted mergansers and blue-winged teal seen annually, other migratory waterfowl are rarely observed.

Resident Landbirds

Red-bellied woodpeckers, red-winged blackbirds, gray kingbird, black-whiskered vireo, white-crowned pigeon, and mangrove clapper rail are among the more common resident breeding birds. The only warbler species known to breed in the Lower Florida Keys Refuges are Cuban yellow and prairie warblers. Both are common breeders in the backcountry islands. The mangrove cuckoo is a species of concern, but data are lacking on its status and ecology in the Florida Keys.

## Neotropical Migratory Birds

Neotropical migratory birds are species that breed in North America and winter in Mexico, Central America, the Caribbean, and South America. These species are of keen interest to birdwatchers and conservationists because they migrate remarkable distances in all weather conditions, and they provide a diversity of viewing opportunities during the spring and fall migration, more than doubling the number of species seen in the Florida Keys compared to the nesting season. Many are experiencing range-wide declines due to the destruction and fragmentation of breeding and wintering habitat, poisoning by pesticides, collisions with towers and large buildings, and feral cat predation.

## Mammals

As with many island chains, few land-dwelling species occur in the Florida Keys. Most of the native mammals represent sub-species of those found on mainland Florida, but they have become genetically distinct due to thousands of years of geographic isolation. Key deer and raccoons are the most commonly seen native mammals in the Lower Florida Keys Refuges. Marsh rabbits and silver rice rats occur in low numbers and due to their behavioral habits, are rarely seen. Native mammals are absent from Key West NWR. Bottlenose dolphins are the most common sea-dwelling mammal within the refuges' boundaries. The Florida manatee is a rare, transient visitor. Descriptions of Key deer, Lower Keys marsh rabbit, and silver rice rat can be found under the section on Endangered, Threatened, and Candidate Species.

## Amphibians

Amphibians require freshwater and therefore are absent in Key West NWR and most of the back country islands in the Great White Heron NWR. They occur on National Key Deer Refuge, most notably in freshwater solution holes, wetland ponds and man-made mosquito ditches on Big Pine Key. At least seven native amphibians occur on this refuge. The most common is the southern leopard frog. Inventories are needed to establish baseline data on the status and distribution of amphibians.

## Reptiles

A comprehensive survey of reptilian species in the Lower Florida Keys Refuges is lacking and a precise number of species is not known. Eleven species of lizards, nine species of snakes, and eleven species of turtles have been documented; however, many are non-native. The American alligator, American crocodile, Big Pine ring neck snake, eastern diamondback rattlesnake, and eastern indigo snake (likely extirpated) are among the noteworthy native species. The green, loggerhead, and hawksbill sea turtles are nesting species, while Kemp's ridley forages in waters surrounding the refuges. Box turtles inhabit upland areas of National Key Deer Refuge (Verdon 2004). Inventories are needed to establish baseline data on the status and distribution of reptiles as only sea turtles have been the subject of long-term monitoring. Descriptions of marine turtles and eastern indigo snake can be found under the section on Endangered, Threatened, and Candidate Species.

Invertebrates

No attempt has been made by the Service to catalogue the entire suite of invertebrate species on the Lower Florida Keys Refuges, although other researchers have studied certain species or groups of tree snails, dragonflies, and butterflies. There are a variety of *Liguus* tree snails that inhabit similar hammock communities that merit attention and conservation. Currently, there is little substantively known about the numbers of the *Liguus* snails on Big Pine Key, which are likely phenotypes of the Florida tree snail (*Liguus fasciatus*) (Close 2000, Hillis et al. 1991). Butterfly assemblages have been studied (Minno and Emmel 1993, Minno et al. 2005). At least eight resident butterflies have disappeared from the Keys since the late 1970s, and another eight species of butterflies found in the lower Keys are highly imperiled (M. Minno pers. comm. 2008). The causes of this widespread decline are likely due to many factors, especially habitat destruction and fragmentation, as well as mosquito control spraying, exotic predatory ants, hurricanes, and poaching. The application of insecticides to control adult mosquitoes is known to deleteriously impact butterfly populations (Emmel 1991, Salvato 2002). Three federal candidate butterflies that occur in the refuges (Bartram's hairstreak, Florida leafwing, and Miami blue) are described in more detail in the section under Endangered, Threatened, and Candidate Species below.

*ENDANGERED, THREATENED, AND CANDIDATE SPECIES*

"Endangered" means a species is in danger of extinction throughout all or a significant portion of its range. "Threatened" means a species is likely to become endangered within the foreseeable future. "Candidate" species are those for which the Service has enough information to warrant proposing them for listing but is precluded from doing so by higher listing priorities; however, the Service carries out priority conservation actions for these species to prevent further decline and possibly preclude the need to list. Most of these species are declining or experiencing severe population losses due to alteration and/or degradation of their habitats.

By perpetuating intact natural communities, restoring degraded natural communities and processes, and eliminating adverse human impacts, the refuges can contribute to species recovery goals and benefit other plants and animals dependent on the unique and imperiled ecosystems in the Florida Keys. Monitoring efforts of sufficient intensity and duration to determine refuge-specific status and trends of federally listed species are needed.

*Endangered Species*

**Key deer.** The Key deer is the smallest subspecies of the North American white-tailed deer. It historically ranged from Key Vaca to Key West, but the current range includes approximately 26 islands from Big Pine Key to Sugarloaf Key, with the center of its population on Big Pine and No- Name Keys. Most lands within its current range, including privately owned lands, lie within the administrative boundaries of National Key Deer Refuge. Key deer use all cover types, including those normally above tidal influence (pine rockland, hardwood hammock, freshwater wetlands), as well as tidally influenced types (mangrove, salt marsh transition). They also use residential areas extensively where they feed on ornamental plants and grasses and seek freshwater. The Key deer remains listed as endangered due to its restricted range, sea level rise, habitat fragmentation, and high human-related mortalities and disturbances.

The Key deer population increased markedly during the 1990s and now likely exceeds habitat carrying capacity in areas of high animal densities on No Name Key and parts of Big Pine Key. The result has been degradation of native plant communities and loss of habitat diversity, with probable but as yet unstudied impacts on other wildlife species. Several once-common plant species that are highly palatable to deer, such as black torch, have disappeared or been greatly reduced over large areas of Big Pine and No Name Keys. Deer at high densities may exist at a lowered nutritional plane and are more susceptible to epizootic diseases.

For many years, Key deer aggregations have been particularly high near subdivisions, such as Port Pine Heights and Koehn. Their burgeoning numbers are due to the reproductive output of a large number of resident does, the availability of ornamental plants for feeding, and feeding by tourists and residents. Deer road kill numbers have increased steadily with deer population growth, with annual mortality sometimes exceeding 100 animals. Despite this elevated mortality, deer numbers have remained high and are offset by annual population recruitment.

Although deer numbers have increased on Big Pine and No Name Keys, there was a reduction or extirpation in other parts of the deer's range, including Johnson, Cudjoe, and Sugarloaf Keys. More than 30 deer were translocated to suitable habitat on Cudjoe and Sugarloaf Keys in recent years.  The fate of these herds must be monitored over time to assess the efficacy of translocation as an effective management strategy to ensure the long-term viability of the species. Deer on backcountry islands also need to be monitored. To date, detailed demographic studies have only been conducted on the core population on Big Pine and No Name Keys.

**Lower Keys marsh rabbit.**

The Lower Keys marsh rabbit is a subspecies of the marsh rabbit, which is more widely distributed in the southeastern United States. This subspecies originally ranged throughout the Lower Florida Keys, including Key West. The current range appears to consist of three separate metapopulations: the Boca Chica area (Boca Chica, Geiger, East Rockland and Saddlehill Keys), the Sugarloaf area (Sugarloaf and Saddlebunch Keys), and the Big Pine area (Big Pine, Annette, East Water, Howe, Johnson, Little Pine, Mayo, Newfound Harbor, Porpoise, and No Name Keys) (Forys and Humphrey 1999a). Lower Keys marsh rabbits are predominantly found in salt marsh transition communities that have dense ground cover created by a clump grass, cordgrass (*Spartina spartinae*).

Rabbits are also widely distributed among freshwater wetlands and they travel through all cover types, including pine rockland. Habitat for rabbits provides for forage, nest cover, and predator avoidance. The amount of thick ground cover within a patch of habitat was the single most important variable in predicting whether a patch would be consistently occupied by marsh rabbits (Forys and Humphrey 1999b). Although habitat loss from human development is responsible for the original decline of the Lower Keys marsh rabbit, current threats include predation by cats, encroachment of woody overstory into grassy habitats, and road mortalities caused by vehicles (USFWS 2007).

**Silver rice rat.**

The silver rice rat is a primarily nocturnal, semi-aquatic, wetland rodent that forages in intertidal zones, feeding on fish, crabs, grasses and forbs (Perry et al. 2005). Compared to other small mammals, silver rice rats inhabit large home range areas. Its habitat includes areas of contiguous mangrove swamps and salt marsh transition. Populations are found at extremely low densities on at least 13 islands, ranging from Big Pine Key to Lower Sugarloaf Key. Silver rice rats were listed as endangered due to habitat destruction from human development. Loss of mangrove habitats was greatly curtailed after the passage of the Clean Water Act of 1974 that restricted development in wetlands; however, threats due to sea level rise are an emerging concern for silver rice rat conservation.

**Florida manatee.**

Manatees are rare in the Lower Florida Keys Refuges, partly because freshwater outflows into the nearshore marine waters are lacking. The Service staff provide logistical assistance to local and state wildlife agencies, as needed, if sick, injured, or dead animals are found.

**Kemp's ridley sea turtle.**

This is a small-to-medium-sized turtle with a nearly circular shell. Primarily a Gulf of Mexico species, it inhabits marine coastal waters with sand or mud bottoms. Juveniles frequent bays. Nesting occurs on Gulf beaches in south Texas and northern Mexico, although a few nests have been confirmed in Florida. Data is lacking on this species, but it likely occurs at least sporadically in the waters within the boundaries of the Lower Florida Keys Refuges.

**Green sea turtle.**

This large sea turtle inhabits marine coastal and oceanic waters and occurs in Florida year-round. Nesting occurs on four beaches in the Key West NWR: Boca Grande Key, Sawyer Key, and two beaches in the Marquesas Keys. The number of nests in the Marquesas Keys has doubled since 1998, with as many as 20 nests recorded in a single year. Since 1990, nest numbers have remained stable on Boca Grande and Sawyer Keys thus far, despite progressive degradation of nesting habitat from wave action caused by storm events and boat traffic. Climate change effects, such as sea level rise and more frequent storms could have a substantial impact on nesting habitat for sea turtles.

**Hawksbill sea turtle.**

This is a small-to-medium-sized sea turtle that is found throughout Key West NWR in hard-bottom and reef habitats containing sponges. Nesting is rare and has only been documented once on Boca Grande Key and several times in the Marquesas Keys. On the latter island, nesting has been restricted to the fall and winter months.

**Key tree cactus.**

The Key tree cactus is endemic to the Florida Keys, and grows in hardwood hammocks. It was listed as endangered due to severe population declines caused by destruction of upland areas. Historically distributed from Key Largo to Key West, the species presently occurs only on Big Pine Key in the National Key Deer Refuge, Long Key State Park, Dagney Johnson Key Largo Hammock State Botanical Park, and private lands on Upper and Lower Matecumbe Keys. The Key tree cactus population continues to decline even on public conservation lands, attributed to saltwater intrusion from recent hurricanes and maturing hammocks that may be shading out seedlings and young plants. Its ability to persist in light of climate change may be tenuous without direct intervention, such as assisted migration to suitable habitat at higher elevations or captive propagation.

**Miami blue butterfly.**

The Miami blue is a small, brightly colored butterfly approximately 0.8 to 1.1 inches (1.9 to 2.9 centimeters) in length with a forewing length of 0.3 to 0.5 inches (8.0 to 12.5 millimeters) (Minno and Emmel 1993). Wings of males are blue above (dorsally), with a narrow black outer border and white fringes; females are bright blue dorsally, with black borders and a red and black eyespot near the anal angle of the hindwing. There are two distinct wild metapopulations, with one in Bahia Honda State Park and the other on several islands within the Key West NWR (Cannon et al. 2009). The Miami blue is a coastal butterfly reported to occur in and around the edges of hardwood hammocks near the coast, including landscapes prone to frequent natural disturbances immediately adjacent to the coast (e.g., coastal berm hammocks, dunes, and scrub), but also tropical pinelands and along trails, using open sunny areas. In the Keys, it was most abundant near disturbed hammocks where weedy flowers provided nectar (Minno and Emmel 1993, 1994).

**Cape Sable thoroughwort.**

Bradley and Gann (2004) found Cape Sable thoroughwort on five islands in the Keys (Upper Matecumbe Key, Lignumvitae Key, Big Munson Island, Boca Grande, Long Key) and one small area in Everglades National Park. The only large population is on Big Munson Island, a privately owned island adjacent to Big Pine Key (Bradley and Gann 2004). It occurs in Key West NWR on Boca Grande Key. This herb has been observed most commonly in open sun to partial shade at the edges of rockland hammock and in coastal rock barren. It was historically known from coastal berm along the northern edges of Florida Bay. Periodic storm events may be responsible for maintaining the community (Bradley and Gann 1999).

**Florida semaphore cactus.**

The Florida semaphore cactus is an erect, trunk-forming cactus endemic to the Florida Keys. The branches may grow in one or multiple planes from the trunk. The spines are not barbed. There is only one naturally occurring population in the Lower Keys, on The Nature Conservancy's Torchwood Hammock Preserve on Little Torch Key. There are outplanted populations on north Key Largo, Big Pine Key, and at the Key West Tropical Forest and Botanical Garden. This cactus grows close to saltwater on bare rock with a minimum of humus-soil cover in hammocks near sea level (Small 1933, Benson 1982). It occurs in buttonwood-dominated scrub salt marsh areas between rockland hammocks and mangrove swamps and possibly other habitat such as openings in rockland hammocks (Gann et al. 2002). Like the Key tree cactus and other cactus species in the Lower Keys, its ability to persist in light of climate change may be tenuous without direct intervention.

*Threatened Species*

**Piping plover.**

The piping plover is found on open, sandy beaches and on tidal mudflats and sand flats, and winters along both coasts of Florida. Piping plovers have been observed on four refuge islands – Boca Grande, Woman, and the Marquesas Keys in Key West NWR, and Ohio Key in National Key Deer Refuge. A peak of 29 piping plovers was observed on Woman Key in February 1998.

**Roseate tern.**

Roseate tern nesting is rare in the United States. The location of roseate tern breeding sites is dependent on the distribution and abundance of islands with open sandy or broken coral substrates. Other important factors include the absence of predators and minimal amounts of human disturbance. One of the most crucial and recurring mortality factors is human interference during nesting, which may cause birds to abandon their nests and young. Fewer than 100 pairs of roseate terns nest in the entire Florida Keys, including the Dry Tortugas, in 2007. Nesting occurred annually outside refuge boundaries on Pelican Shoal, but that island was obliterated by hurricanes in 2004 and 2005. For the first time on record in 2006 and again in 2007, roseate terns nested within the Key West NWR on Wilma Key, a small sand island that was created by Hurricane Wilma; however, this island is eroding and may prove to be ephemeral. In 2005, Hurricane Wilma also created a large expanse of sand on the interior of Boca Grande Key that may be marginally suitable for roseate tern nesting. In July 2007, 82 non-nesting roseate terns were observed in this area.

**Loggerhead sea turtle.**

This large sea turtle inhabits marine coastal and oceanic waters and is present in Florida year-round. Nesting has been monitored annually since 1990 and occurs yearly in Key West NWR on Woman, Boca Grande, and the Marquesas Keys and on Sawyer Key in Great White Heron NWR. A peak of 70 nests was found in Key West NWR in 1995, but has declined sharply since then to less than 30 nests (Wilmers pers. comm.).

**Eastern indigo snake.**

This large, stout-bodied, shiny black snake can grow up to 8 feet long. It is docile, non-poisonous, and occurs throughout Florida, but is rare in the Lower Keys. It is a habitat generalist inhabiting the pine rocklands, tropical hardwood hammocks and buttonwood-dominated scrub salt marsh. There have been no confirmed sightings within the Keys in more than a decade. So, although its status has not been assessed, it is thought to be extirpated from the Florida Keys.

**Stock Island tree snail.**

The Stock Island tree snail is found in hardwood hammocks in the Florida Keys. The snail historically occurred on Stock Island and Key West where it is virtually extirpated. Habitat loss and a major decline in the original Stock Island population led snail collectors to move snails to other hammocks throughout the Keys. The translocation of snails successfully prevented extinction of the species, but several of the few remaining populations are at risk due to continuing habitat loss to development. The National Key Deer Refuge contains one of the last established populations of this snail. Strategies for protecting hardwood hammocks will benefit the Stock Island tree snail.

**Garber's spurge.**

Populations of Garber's spurge in the Florida Keys historically occurred on beach dunes, coastal rock barrens, hammock edges and canopy gaps, and to a lesser extent pine rockland. Populations on dunes have the potential to be threatened by trampling from beach goers. Small isolated populations could become extirpated due to a number of factors, including natural events, such as hurricanes and tidal surges, or manmade factors, such as mowing or herbicide application. It probably occurs on less than half of the islands where it once occurred in the Florida Keys.

*Candidate Species*

**Bartram's hairstreak (proposed for listing).**

The Bartram's hairstreak is a small butterfly approximately 1 inch (in) (25 millimeters [mm]) in length with a forewing length of 0.4 to 0.5 in (10 to 12.5 mm) and has an appearance (i.e., color, size, body shape) characteristic of the hairstreak genus (Minno and Emmel 1993). The Bartram's hairstreak requires pine rockland that retain its host plant, pineland croton. The mainland population is within Long Pine Key in Everglades National Park, with sporadic and localized occurrences within pine rockland fragments on lands owned by Miami-Dade County. In the Florida Keys, the butterfly occurs only on Big Pine Key within National Key Deer Refuge, private, state, and other lands (Salvato and Hennessey 2003; M. Salvato, Service, pers. comm. 2008).

**Florida leafwing (proposed for listing).**

The Florida leafwing butterfly is a medium-sized butterfly approximately 2.75 to 3 inches (in) (76 to 78 millimeters [mm]) in length with a forewing length of 1.3 to 1.5 in (34 to 38 mm) and has an appearance characteristic of its genus (Minno and Emmel 1993). The upper wing (or open wing) surface color is red to red-brown, the underside (closed wings) is gray to tan, with a tapered outline, cryptically looking like a dead leaf when the butterfly is at rest. As with the Bartram's hairstreak, the Florida leafwing occurs only within pine rocklands that retain its host plant, pineland croton. The Florida leafwing has not been seen on Big Pine Key since 2006 (M. Salvato, Service, pers. comm. 2008).

**Blodgett's silverbush.**

On the mainland, Blodgett's silverbush grows in pine rockland and edges of rockland hammock (Bradley and Gann 1999). In the Keys, this species grows in pine rockland, rockland hammock, coastal berm, and on roadsides, sometimes disturbed areas in close proximity to a natural area, especially in sunny gaps or edges (Bradley and Gann 1999). The pine rockland habitat where it occurs in Miami-Dade County and the Florida Keys requires periodic fires to maintain an open sunny understory with limited hardwoods. Occupied sites within the National Key Deer Refuge currently include Cactus hammock, Long Beach coastal berm, Koehn's subdivision, and Watson's hammock.

**Big Pine partridge pea.**

The Big Pine partridge pea is a small prostrate to ascending herbaceous shrub with yellow flowers and pinnately compound leaves. Big Pine partridge pea occurs mostly in pine rockland on Big Pine Key and Cudjoe Key, where it is widely but unevenly distributed (Bradley 2006). Plants also occur on conservation lands owned by the State of Florida, Monroe County, and The Nature Conservancy. Additional sites occur on county and state road rights-of-way and private properties. Big Pine partridge pea is fire-adapted, and fire history and time since fire are important parameters that affect the abundance of this species (Lui et al. 2005a). While the storm surge from Hurricane Wilma in 2005 resulted in significant population declines in all areas, post-hurricane recovery has been greater in burned plots, suggesting that fire may have a positive impact on the recovery of candidate species and species richness (Bradley and Saha 2009).

**Wedge spurge.**

Wedge spurge is a small prostrate perennial herb. The stems are slender and numerous, radiating out from the tap root. Wedge spurge is known only from pine rockland vegetation on Big Pine Key (Small 1933, Long and Lakela 1971, Wunderlin 1998, Ross and Ruiz 1996). Most of the range is encompassed within the National Key Deer Refuge. The remainder occurs on State of Florida, Monroe County, and private lands, including the Terrestris Preserve owned by The Nature Conservancy. A similar relationship between fire and hurricanes exists for wedge spurge as was discussed above for the Big Pine partridge pea (Bradley and Saha 2009).

**Sand flax.**

Sand flax is a wiry, yellow-flowered herb found in pine rockland, disturbed pine rockland, marl prairie, roadsides on rocky soils, and disturbed areas (Bradley and Gann 1999; Hodges and Bradley 2006). There are 11 extant occurrences in the Florida Keys and extreme south Florida, with only 3 of these sites located on public conservation lands. The largest population in Monroe County is located on Big Pine Key within National Key Deer Refuge and surrounding lands (Gann et al. 2002; Bradley 2006; Hodges and Bradley 2006).

## 3.3 Cultural Resources

At the end of the late Pleistocene, Florida’s shoreline extended 100 to 125 miles seaward of its current location. Pollen profiles from south Florida indicate that the area supported an arid scrub/shrub habitat between 14,000 to 10,000 years before present (B.P.). Evidence of Florida’s earliest inhabitants is very limited. Less than 100 Paleoindian sites are known statewide; none of these are located in the Keys. The Cutler-Fossil Site in Miami-Dade County yielded bones of humans and late Pleistocene fauna, a possible hearth, and stone and bone tools. The hearth yielded a radiocarbon date of about 9,670 B.P. The site is situated on the Atlantic Coastal Ridge and overlooked forested and open savannahs, open marshes, and wetlands. Like for the region’s later occupants, potable water was a limiting factor for settlement and population size (Borremans 1990).

By 4000 years ago, sea level had risen and formed the modern shorelines, and the Florida Keys were established as a chain of islands off the southern tip of Florida. The establishment and spread of shellfish species, such as conch, whelk, oyster, and clam, began in this period. The Archaic Period (10000-3000 B.P.) is denoted by the presence of large coastal shell middens, often containing fiber and sand-tempered pottery, and interior black earth middens situated on hardwood hammocks or along natural drainages. To date, no archaeological sites dating to the Archaic Period have been identified on uplands in the Keys. The now-submerged landscape holds a higher probability for sites dating to the Paleoindian and Archaic Periods (Borremans 1990; Mathewson 1992). The best-documented precolumbian site in the Keys is the Upper Matecumbe Key Site (Goggin 1944). Decorated pottery recovered from the site shows its occupation during the latter part of the Glades II Period (750 – 1200 A.D.) and the Glades III Period (1200 – 1500 A.D.). The Archaeological and Historical Conservancy, Inc., has conducted large-scale archaeological and historical reconnaissance of the Keys, documenting a number of historic properties or verifying the locations of previously identified sites (Carr, Allerton, and Rodriguez 1987; Carr and Fay 1990; Carr and Rodriguez 1988).

Ethnohistoric accounts dating to the 16th century indicate the Keys were occupied by groups either affiliated with the Tequesta or the Calusa. The Tequesta primarily occupied the area around Biscayne Bay, but they were also present throughout most, if not all, of southeastern Florida (Wheeler 2004). The Calusa was a maritime-based chiefdom centered in the Charlotte Harbor region, but whose reach extended well into the Ten Thousand Islands area. These chiefdoms relied heavily on the rich estuarine and maritime resources of south Florida (Marquardt 1992; Widmer 1988). Fontaneda, a Spanish sailor shipwrecked on the Florida coast in the mid-16th century, listed the caciques or political leaders, as well as the provinces and towns that they controlled. Three caciques listed as being in the "land of the Martines" are Guarungunve, Cuchiyaga, and Matecumbe (Worth 1995). In 1675, Bishop Calderon visited the Viscaynos, the Matacumbeses, the Bayahondos, and the Cuchiagaros. The Viscaynos are thought to have occupied the area around Biscayne Bay; the Matacumbeses occupied either Upper or Lower Matacumbe Key; the Bayahondos occupied Bahia Honda Key or Key Vaca; and the Cuchiagaros occupied Big Pine Key (Griffin, Fryman, and Miller 1979). By the late 18th century, the Keys and much of south Florida appeared to have been abandoned by the Calusa, the Tequesta, and other Indian groups. The Miccosukees, Seminoles, and their Oconee and Creek ancestors began to move into Florida from Georgia and Alabama during the mid-1700s. It does not appear that either tribe ever occupied the Keys, though the Seminole established the town of Ochupocrassa near Biscayne Bay about 1820 (Leynes and Cullison 1998).

Prior to the Spanish cession of Florida to the United States in 1821, the Keys had no permanent settlements. The Straits of Florida were an important, but treacherous, passage from the Gulf of Mexico to the North Atlantic and Europe. Native American, Spanish, Bahamian, and American "wreckers" established temporary camps to salvage cargo from ships that had run aground and would occasionally refloat seaworthy vessels. The construction of the Florida Reef lighthouses between 1852 and 1878 lead to the industry's decline. Havana, Cuba, was the center of the salvage industry during the period of Spanish dominance in the Caribbean and Florida. By the 17th century, the industry's efforts shifted to New Providence and Nassau in the Bahamas. Until the late 1870s, the Keys' economy continued to focus on the sea, although hunting, charcoal production, and small-scale agricultural operations were becoming more important. The Watson Homestead, located on Big Pine Key and within the present National Key Deer Refuge, provides a glimpse into this period. Robert B. Watson and his family, who owned a 107-acre tract from 1905 to 1924, grew limes, plantains, guavas, tomatoes, and onions. Bee-keeping and operating a small grocery store augmented their income (Carr and Fay 1990).

The earliest "plantations" produced fruits and vegetables for the market in Key West. Shortly after 1900, pineapples became a lucrative crop, leading to the deforestation of scrubby woods and mature hardwood hammocks for fields. Aiding the commercial success of pineapple and lime plantations was the extension of Florida East Coast Railway from Miami to Key West. Railroad construction began in 1900 and was completed by 1912. Pineapple production was in decline by 1906. Clearing of the pine rockland and hammocks for fields led to erosion that left "old stony fields." Limes were introduced by Dr. Henry Perrine from the Yucatan in 1838; the first trees were planted on Indian Key and possibly nearby keys. The Conchs used the limes for seasoning and medicinal purposes. Although wild limes sold for very high prices, the lime industry only took off following the demise of the pineapple plantations, reaching peak production in 1923. A hurricane in 1926 devastated most of the Keys' lime groves. Competition from West Indies and Mexican growers slowed recovery.

Production in 1935 was only a quarter of 1923 yield (Griffin, Fryman, and Miller 1979; Leynes and Cullison 1998; Windhorn and Langley 1974). The Hurricane of 1935 destroyed the Florida East Coast Railway, but not access to the Keys. Construction of the Overseas Highway began in the early 1920s. By 1928, the highway ran from Miami to within 40 miles of Key West, with the remainder connected by ferry runs between islands. Following the 1935 hurricane, the former railway bridges and landfill islands supported the remaining stretch of the Overseas Highway to Key West. The Highway opened up the Keys to the emerging saltwater fishing, recreational, and tourist markets (Griffin, Fryman, and Miller 1979; Windhorn and Langley, 1973 and 1974). Residential and commercial development expanded quickly after World War I.

Congress passed legislation in 1825 that required any wreck salvaged in American waters be brought to an American port for adjudication. A number of Bahamians moved to the Keys following the establishment of a U.S. Navy base and federal court on Key West (Leynes and Cullison 1998). These early immigrants became known as "Conchs" and made their living primarily by exploiting maritime resources, such as fish, sponges, turtles, and ship wrecks (Griffin, Fryman, and Miller 1979).

### 3.4 Public Use and Surrounding Community

This section provides information on (1) the current social and economic status of Monroe County and its residents; (2) the economic value of wildlife-dependent recreation; and (3) the Service's recreation opportunities and environmental education programs in the Lower Florida Keys Refuges.

Monroe County includes the Florida Keys and a section of the southwest tip of the Everglades. This report is only concerned with the socioeconomics of the Florida Keys. The Florida Keys are sparsely populated compared to Florida as a whole. Many of the islands are semi-rural though there are several large, densely developed island communities--Islamorada, Marathon, and Key West. According to the U.S. Census Bureau, for the year 2000, compared to the state as a whole, the county represents only a half percent of the state population and about 0.7 percent of the state's housing. The Keys represent only 5.6 percent of Monroe County's total area, 1.8 percent of the state's land area, and 23 percent of the state's waters.

There is still much undeveloped land that is in private ownership. The county and state have limited the rate of development to prevent the human population from exceeding the carrying capacity of the water, electric, sewage, and road services. The latter pertains to concerns about hurricane evacuation times of the current resident and tourist populations with the present road and bridge infrastructure. With many private lands in the Lower Florida Keys containing habitat for threatened or endangered species, habitat loss or degradation from development remains a concern.

The economy of the Keys is supported primarily by tourism. There is extensive service support for the tourist industry and local resident needs. Almost every island accessible by U.S. Highway 1 has one or more residential subdivisions, trailer parks, recreational vehicle parks and/or campgrounds, and associated commercial services. Water-based sports (e.g., sport fishing, diving, and kayaking) and the night life of Key West have become major draws to the area, with associated economic gains. Also important to the economy of the Keys is real estate—the renting, selling, and buying of homes, many of them to seasonal residents.

**Regional Demographics and Economy**

Information for 2000 is available for Monroe County from the following websites:

http://www.census.gov/main/www/cen2000.html
http://www.census.gov/census2000/states/fl.html

The population density of the Keys is approximately one-quarter of the rest of Florida, and the housing unit density is approximately one-third of the rest of Florida.

The average age of residents over 65 living in the Florida Keys is higher than the U.S. average; there has been a decline in population of residents between the ages of 18 to 65. The Florida Keys are experiencing a decline of local residents who grew-up with the knowledge of the intrinsic and economic value of the Keys' natural resources. This is pertinent to the refuges in terms of the continuing effort needed to educate new residents about natural resources and the needs of endangered and imperiled species, especially with a large, seasonal influx of visitors.

**Economic Contribution of Recreating Visitors to the Florida Keys/Key West**

The tourist-industry activities of boating, fishing, scuba diving/snorkeling, and sightseeing generate $147 million per year. All of these activities occur on the three refuges. The Monroe County Tourist Development Council conducted a survey of over 3,000 visitors from March 2005 – February 2006.Visitors were asked to choose among 10 categories of activities as reasons for their visit to the Keys. Thirty-six percent of respondents identified diving, snorkeling, wildlife viewing, and boating as their primary visitor activities.

**Recreation Use and Visitor Services**

The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation has been conducted about every 5 years since 1955. It provides information on the number of participants in fishing, hunting, and wildlife watching (observing or photographing wildlife, and bird feeding), and the amount of time and money spent on these activities. Over 87 million U.S. residents, aged 16 years old or older, fished, hunted, or watched wildlife in 2006 (USFWS and U.S. Census Bureau 2007). Nearly 34 million people fished or hunted and more than 71 million participated in at least one type of wildlife watching activity. Wildlife recreators' enthusiasm was reflected in their spending, which totaled $122 billion in 2006, and amounted to 1.1 percent of the gross domestic product. Wildlife watchers spent more than $45 billion on trips, equipment, and other related items.

The Service's *Banking on Nature 2007: Economics Benefits to Local Communities of National Wildlife Refuge Visitation* report states, "Recreational visits to national wildlife refuges generate substantial economic activity. In Fiscal Year 2006, more than 34.8 million people visited refuges in the lower 48 states for recreation. Their spending generated more than $1.7 billion of sales in regional economies.

As this spending flowed through the economy, nearly 27,000 people were employed and $542.8 million in employment income were generated. About 82 percent of total expenditures were by nonconsumptive activities on the refuges" (Carver and Caudill 2007). According to the Monroe County Tourist Development Council, the Florida Keys receive approximately 1.9 to 2 million visits by car annually (Leeworthy and Wiley 1997). An important part of the revenue income in the Lower Florida Keys is related to the three refuges, which collectively receive about 861,750 visits annually: National Key Deer Refuge--139,000 visits; Key West NWR-- 436,500 visits; and Great White Heron NWR--146,125 visits. About 10,000 visitors come into the Refuge Visitor Center in the Big Pine Key Plaza annually, and approximately 80,000 visitors have been recorded annually at the Blue Hole interpretive site on Big Pine Key. The estimates for Key West and Great White Heron NWRs are estimated from recent observations from staff of customers to the diving, snorkeling, fishing, and kayaking industries.

The National Wildlife Refuge System Improvement Act of 1997 established six priority wildlife dependent public uses on national wildlife refuges, assuming that they are compatible with the purpose of each refuge: hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation. Hunting is prohibited on all complex refuge lands and throughout the Florida Keys. Collectively, the three refuges provide opportunities for the other five priority wildlife-dependent activities. Some non-priority recreation uses have been allowed on the refuges, for example, horseback riding occurs on certain trails in the National Key Deer Refuge and picnicking occurs on refuge beaches that are open to public access. Refuge lands with public access are free of charge and open 7 days a week. Hours are from 1/2-hour before sunrise to 1/2-hour after sunset. Some refuge lands are closed to public access to protect environmentally sensitive wildlife or habitats.

Most of the refuge-owned lands within the National Key Deer Refuge are located on the mainline keys (islands that are accessible by vehicles) and open to public access via fire roads and other trails. Many visitors come to the National Key Deer Refuge to observe and photograph the unique, tiny Key deer; most of the deer population is found on Big Pine and No Name Keys. Other popular wildlife viewing areas on Big Pine Key include Long Beach Road and at the north end of Key Deer Boulevard. The Service provides extensive interpretive information at the Refuge Visitor Center on Big Pine Key, the Blue Hole interpretive site, and the 2/3-mile Watson and the 1/8-mile Mannillo nature trails, the latter of which is accessible for persons using wheel chairs. The Blue Hole is an old quarry with an observation deck and a partial trail that provides for viewing of a variety of turtles, fish, green herons and other birds, and the occasional alligator, Key deer, and raccoon.

There are many other undeveloped trails open to wildlife-dependent recreational activities on Big Pine, No Name, Cudjoe, and Lower and Upper Sugarloaf Keys. Ohio Key also has beach access. The backcountry islands that have Key deer are designated as Wilderness and are only open to public access on a case-by-case basis with a special use permit.

Fishing on any of the three refuges is not specifically listed as a refuge-regulated activity in the Code of Federal Regulations. Saltwater fishing along the refuges' shorelines and in state-owned marine waters adjacent to the refuges' lands is regulated by the State of Florida and occurs primarily on Ohio Key. Saltwater fishing activities in the backcountry areas include hook and line for finfish, baitfish netting, crabbing, and lobstering. There is no freshwater fishing allowed on any Keys refuge lands.

Key West and Great White Heron NWRs contain over 300,000 acres of marine waters, dozens of mangrove islands, and several islands with pristine undeveloped beaches that are designated as Wilderness. The marine waters are some of the best waters for saltwater sport fishing in North America. Visitors come from all over the world to fish these waters and numerous tournaments are held to catch and release fish. The dozens of mangrove islands and shallow waters are home for nesting, feeding, and resting birds, such as pelicans, cormorants, herons, egrets, plovers, and frigate birds, to name a few. Due to an abundance of birds, the refuges are havens for birders. Boaters travel to the pristine beaches of Woman and Boca Grande Keys to enjoy a leisurely day in a secluded beach setting.

Management of the marine waters is limited as they are state-owned waters. This limited authority is granted by the State of Florida via the Management Agreement with the State of Florida for Submerged Lands within the Boundaries of the Key West and Great White Heron National Wildlife Refuges, authorizing certain measures to be implemented within the state-owned waters to minimize wildlife disturbance and habitat destruction from non-wildlife dependent recreational activities. The Management Agreement specifically allows the Service to regulate access within 300 feet of certain islands, to enforce boating speed zones and no-entry areas, and to prohibit the use of personal water craft (e.g., jet skis), aircraft landings, hovercraft, airboats, and waterskiing within the administrative boundaries of the two refuges. All other marine activities (e.g., fishing) within the refuges' administrative boundaries are regulated by the State of Florida and Florida Keys National Marine Sanctuary.

The visitor services' park ranger operates a Visitor Center and oversees management of various sites on National Key Deer Refuge. The Service is actively involved in several environmental educational and interpretive organizations and events including, but not limited to, the Monroe County Environmental Education Advisory Council, the Florida Keys Birding and Wildlife Festival, the Florida Keys Scenic Highway Initiative, the Florida Keys Overseas Heritage Trail, and the interagency Florida Keys Eco-Discovery Center. Environmental education opportunities are provided on National Key Deer Refuge for local students from schools on Big Pine and Sugarloaf Keys, though teachers can bring students from elsewhere to the refuge.

Volunteers continue to be a major contributor to the success of the Refuge System. In 2005, nearly 38,000 volunteers contributed 1.4 million hours on refuges nationwide, a service valued at more than $25 million. The Lower Florida Keys Refuges depend on a volunteer base of about 50 individuals. Inerrant workers, such as college students doing alternative spring breaks, and other organized programs, such as Student Conservation Association and AmericCorps, also assist. Combined, these volunteers contributed almost 5,000 volunteer hours in 2008.

## *4.0 Environmental Consequences*

NEPA requires that a range of reasonable alternatives and the unavoidable environmental consequences associated with implementation of the alternatives be revealed prior to undertaking proposed federal actions. This chapter provides a summary of the analysis of the environmental consequences associated with implementation of the proposed alternatives.

The goals of Service management for all resources are achieved through consideration of the potential resource impacts associated with each alternative and identification of an alternative that balances unavoidable impacts with the goals and objectives of the plan. Resource impacts associated with each alternative differ greatly in their context, intensity and duration and this balanced approach considers the merit of all resources equally.

Impact topics are the resources of concern that could be affected by the range of alternatives. Specific impact topics were developed to ensure that alternatives were compared on the basis of the most relevant topics. The following impact topics were evaluated: natural resources, cultural resources; aesthetics and visitor experience; and public use and experience. Other impacts categories were dismissed due to the nature of the plan and the lack of direct relevance to the planning process.

**Table 5. Comparison of potential Environmental Impacts associated with each alternative.**

| | Bartram's Hairstreak * | Vegetation | Other Wildlife | Surrounding community | Visitor Use |
|---|---|---|---|---|---|
| **Alternative A – No Action** | Species would likely decline or persist at current levels however population may be limited in dispersal and edge of habitat. | Vegetation may be affected by loss of pollinators | No changes from status quo are associated with this alternative. | Increased potential for ESA listing of new species may pose economic threat; continued general satisfaction with mosquito control operations. Low health risk | No effect is likely |
| **Alternative B - Proposed Action** | Population would be buffered from drift into occupied and potential habitat. Species would persist at current levels or increase in abundance. | Vegetation may be affected by loss of pollinators, but less so than alternative A. Mitigation measures would benefit rare species. | Invertebrate species would benefit directly. Others may benefit indirectly more so than A. Species associated with protected sites and/or vegetation would benefit. | Reduced likelihood of ESA listing and increased stability of local economy; continued general satisfaction with mosquito control operations. Low health risk. | No effect is likely |
| **Alternative C** | Species would persist at current levels or increase in abundance. Chance of adverse impacts from incidental drift would be eliminated. | Vegetation would benefit from protection of pollinators. Rare plant species would likely benefit. | Invertebrate species would benefit directly. Others may benefit indirectly more so than A or B. Species associated with protected sites and/or vegetation would benefit. | Decreased potential for ESA listing resulting in economic stability. Negative satisfaction from neighboring community about operations more likely. Possible decrease of tourism, ability to conduct business during peak season. Low to moderate health risk | No effect is likely |
| **Alternative D** | Species would persist at current levels or increase in abundance. Chance of adverse impacts from incidental drift would be eliminated. | Vegetation would benefit from protection of pollinators. Rare plant species would likely benefit. | Invertebrate species would benefit directly. Others may benefit indirectly more so than A or B. Species associated with protected sites and/or vegetation would benefit. | Decreased potential for ESA listing resulting in economic stability. Likely adverse impacts to social and economic conditions with no mosquito control. Moderate health risk | Moderate to major effect is likely due to elevated levels of mosquitos during summer months |

*Note: Species abundance and viability is dependent on a wide array of environmental variables. Pesticide use or none use alone does not fully determine the fate of sensitive species and these points are generalizations.

## 4. 1 Impact Topics Considered, But Dismissed From Further Analysis

NEPA and CEQ regulations direct agencies to “avoid useless bulk…and concentrate effort and attention on important issues” (40 CFR 1502.15). Certain impact topics that are sometimes addressed in NEPA documents for other kinds of proposed actions or projects have been judged not to be substantively affected by any of the Mosquito Management Plan alternatives considered in this EA.

The following is a discussion of several impact topics that have been analyzed and considered with regard to potential effects resulting from the alternative actions. The relationships of these topics to mosquito management are summarized as part of the impacts analysis based on a factual, objective review of potential effects that alternatives might have, or the lack thereof. The impact topics are discussed below, but will not be carried forward into the detailed analysis in this Draft EA. There will not be any changes to these effect topics resulting from the proposed Plan activities.

These topics are listed below and a rationale is provided for dismissing specific topics from further consideration.

- ***Geology*** **–** The Refuge is host to a variety of outstanding geological features with unusual intrinsic value. Many of these geological features are regularly viewed and studied by a wide range of visitors, educators, and scientists and are considered a valuable natural resource. The proposed management options will not alter geologic features and resources at the refuge. Therefore, geological resources will not be carried forward into the detailed analysis portion of this EA.

- ***Floodplains -*** Floodplain or flood-prone areas include those low-lying areas that are flooded during 100 year storm events. These areas are generally mapped by the Federal Emergency Management Agency and those maps are made available to the general public. Local and some state governments implement the federal floodplain protection regulations, which at a minimum regulate construction of dwellings and other structures in the floodplain. While floodplains do play a role as mosquito habitat, the alternatives would not involve the filling or alterations of floodplain areas, and would not require the construction of any structures. Earthwork and construction activities that could adversely affect flood-prone areas are not part of the proposed alternatives. Given that the alternatives proposed will not affect floodplain values, this topic will not be carried forward into the detailed analysis.

- ***Wild and Scenic Rivers -*** Wild and scenic rivers are designated by the federal mandate and are provided with advance protection at the federal, state, and local levels. Wild and scenic rivers have not been designated within the refuge boundaries; therefore, this topic will not be carried forward into the detailed analysis.

- ***Transportation*** **–** The Refuge does not have a public transportation system that operates and the proposed alternatives would not require or include any transportation services. The proposed alternatives will not affect transportation, and as such transportation will not be carried forward into the detailed analysis.

- ***Indian Trust Resources -*** Indian trust resources include those resources not on Native American owned property, but rather on DOI administered lands that are held in trust on behalf of Native American tribes. Secretarial Order 3175 requires that any anticipated impacts to Native American trust resources from a proposed project or action by DOI agencies be explicitly addressed in environmental documents. The federal Indian Trust responsibility is a legally enforceable fiduciary obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights, and it represents a duty to carry out the mandates of federal law with respect to Native American and Alaska Native tribes. The Refuge as a public holding is not considered a Native American trust resource and there are not any such designated resources at the refuge. The proposed alternatives do not conflict with any American Indian interests. Therefore, this topic will not be carried forward into the detailed analysis.

- ***Prime or Unique Farmland -*** The Natural Resource Conservation Service (CFR Title 6, PART 657 - PRIME AND UNIQUE FARMLANDS) defines prime farmland as soil that produces general crops such as common foods, forage, fiber, and oil seed. Unique farmland is defined as soil that produces specialty crops such as fruits, vegetables, and nuts. The soil types in the refuge area provide limited support for prime farmland and unique farmland based on these definitions. Areas of agricultural use on the Refuge do not exist and as such the proposed alternatives do not involve alterations to any land-use or soil that involve farmlands. Therefore, prime or unique farmland will not be carried forward as an impact topic.

- ***Lightscape -*** The Service strives to preserve natural ambient lightscapes, which are resources and values that exist in the absence of human caused light. The proposed alternatives would not be expected to result in any changes to the existing lightscape conditions. Therefore, this topic will not be carried forward into the detailed analysis.

- ***Soundscape Management -*** Preservation of natural soundscapes associated with natural areas is important. Natural soundscapes exist in the absence of human-caused sound. The natural ambient soundscape is the aggregate of all the natural sounds that occur in Refuge units, together with the physical capacity for transmitting natural sounds. The frequencies, magnitudes, and durations of human-caused sound considered acceptable varies among Refuge units, as well as potentially throughout each Refuge unit, are generally greater in developed areas and less in undeveloped areas. The proposed alternatives would not create additional noise other than short-term use of some equipment (i.e., fogging truck or periodic helicopter/plane use). Therefore, this topic will not be carried forward into the detailed analysis.

- ***Environmental Justice –*** According to the United States Environmental Protection Agency (USEPA), environmental justice is the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group, should bear a disproportionate share of the adverse environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies. Presidential Executive Order 12898, "General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing the disproportionately high and/or adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. Any actions related to the proposed alternatives would not be expected to have health or environmental effects on minorities or low-income populations or communities as defined in the USEPA Environmental Justice Guidance (USEPA 1998). Therefore, this topic will not be carried forward into the detailed analysis.

- ***Cultural Resources -*** Impacts to cultural resources are in context to regulations of the Council on Environmental Quality (1978) that implement the National Environmental Policy Act and Section 106 of the National Historic Preservation Act (NHPA). In accordance with the Advisory Council on Historic Preservation's regulations implementing Section 106 of the National Historic Preservation Act (36 *Code of Federal Regulations* Part 800, Protection of Historic Properties), impacts on cultural resources are to be identified and evaluated by determining the area of potential effects; identifying cultural resources present in the area of potential effects that are either listed in or eligible to be listed in the National Register of Historic Places; applying the criteria of adverse effect to affected cultural resources either listed in or eligible to be listed in the National Register; and considering ways to avoid, minimize, or mitigate adverse effects. Under the Advisory Council's regulations, a determination of either adverse effect or no adverse effect must also be made for affected cultural resources. An adverse effect occurs whenever an impact alters, directly or indirectly, any characteristic of a cultural resource that qualifies it for inclusion in the National Register. For example, this could include diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association. Adverse effects also include reasonably foreseeable effects caused by the alternative that would occur later in time, be farther removed in distance, or be cumulative (36 *Code of Federal Regulations* Part 800.5, Assessment of Adverse Effects). No historic places or properties will be impacted by the proposed alternatives; therefore, this topic will not be carried forward into the detailed analysis. It is acknowledged that mitigations (see mitigation section) associated with croton planting may involve minor surficial ground disturbance; however, that compliance would be completed when a croton mitigation plan was developed given acreages and locations are not know that is time.

### 4.2 Environmental Impact Definitions

***Type of Impact*:** Impacts are categorized in two different and contrasting types: adverse and beneficial. Adverse impacts are considered contrary to the goals, objectives, management policies, and practices of the Refuge and the public interest or welfare. These impacts are of a kind likely to be damaging, harmful, or unfavorable to one or more of the various impact topics. Beneficial impacts are believed to promote favorable conditions for the impact topics.

***Levels of Intensity:*** Levels of intensity refers to severity of the impact, whether it is negligible or major, or somewhere in between. The gradient of this grading system can be general or very detailed, but ultimately the assumptions and subjectivity of the system affect its sensitivity. A simple and subjective rating system is used in this Draft EA, which includes a rating scale of "no effect, negligible, minor, moderate, and major effects." The authors of this Draft EA based the rating system score on studies completed, data and information obtained from scientific and administrative sources, discussions with relevant individuals, public comments, common sense, and professional opinion. For example, consideration was given as to whether or not an action affects any natural resource parameters. The definition of "no effect" would be the same for each of the general impact topics, natural resources, cultural resources etc. No effect would mean that no measurable effects could be recorded or surmised. Each of these gradient levels are further defined below.

- For natural resource impacts including wildlife and vegetation:
  - *Negligible:* Impacts would be barely detectable, measurable, or observable.
  - *Minor:* Adverse Impacts would be detectable, but not expected to have an overall effect on the natural community. Impacts generally affect less than one-half acre vegetation or would not be expected to influence the population of any wildlife species, or may influence a small number of individuals of a species. Beneficial impacts would enhance the ecology for a small number of individuals.
  - *Moderate:* Impacts would be clearly detectable, but could have short-term appreciable effects on the local ecology. Impacts may affect up to one-acre of vegetation, but would not threaten the continued existence of any natural community. Impacts would have short-term effects. Beneficial impacts would enhance the population of any species at the refuge.
  - *Major:* Long-term or permanent, highly noticeable effects on the population of a species, natural community, community ecology, or natural processes. Impacts may affect over one-acre of vegetation or may affect the continued existence of any natural community or species. Beneficial impacts would enhance the population of more than one species over the long-term.

- For aesthetic resources and visitor experience:
  - *Negligible:* Impact to aesthetic resources and visitor experience would be barely perceptible and, hence visitors would not be aware of any changes to

aesthetic resources. There would be no noticeable change in the visitor experience or any indicators of changes in visitor satisfaction.

- *Minor:* For adverse impacts, visitors would be aware of effects, but this would not appreciably limit critical characteristics of the major of visitors. For beneficial impacts, public satisfaction would be enhanced for a small number of visitors.
- *Moderate:* Adverse impacts would result in a change of a few critical characteristics of the desired public experience and/or the number of visitor complaints would increase. Public satisfaction would begin to either decline as a result of the effect. Beneficial impacts would improve a few critical characteristics of the public experience and/or the number of positive visitor comments would increase.
- *Major:* Multiple critical characteristics of the desired public experience would change and/or the number of visitor/resident complaints would greatly increase. The public would be aware of the effects associated with implementing the alternative and public satisfaction would markedly decline or increase. Beneficial impacts would improve multiple characteristics of the public experience and/or the number of positive visitor comments would increase, substantially.

- <u>For public use and surrounding community impact:</u>
  - *Negligible:* Impacts would be barely detectable, hence visitors/residents would not be aware of any effects or changes to the management practice. There would be no noticeable change in public use and experience or in any indicators of visitor/resident satisfaction or behavior.
  - *Minor:* For adverse impacts, visitors would be aware of effects, but this would not appreciably limit critical characteristics of a majority of the visitors/residents. For beneficial impacts, public satisfaction would be enhanced for a small number of visitors/residents.
  - *Moderate:* Adverse impacts would result in a change of a few critical characteristics of the desired public experience and/or the number of participants engaging in an activity would decrease. Public satisfaction would begin to decline as a result of the effect. Beneficial impacts would improve a few critical characteristics of the public experience and/or the number of visitors would increase.
  - *Major:* Multiple critical characteristics of the desired public experience would change and/or the number of participants engaging in an activity would be greatly reduced or increased. The public would be aware of the effects associated with implementing the alternative and public satisfaction would markedly decline or increase. Beneficial impacts would improve multiple characteristics of the public experience and/or the number of visitors would increase, substantially.

- <u>For health and safety impact</u>:
  - *Negligible:* Impacts would be barely detectable; hence visitors/residents would not be aware of any effects or changes to the health and safety

practices. There would be no noticeable change in disease or discomfort and visitor/resident satisfaction or behavior would not be altered.

- *Minor:* For adverse impacts, visitors/residents would be aware of potential health and safety concerns, but this would not appreciably limit critical characteristics of a majority of the visitors/residents. For beneficial impacts, public safety and health would be enhanced for a small number of visitors/residents.
- *Moderate:* Adverse impacts would result in a change in the status of the potential for disease with mosquito levels potentially at or above levels were disease could be observed but no disease is detected. Public satisfaction would begin to decline as a result of the effect. Beneficial impacts would improve the status of the potential for disease risk and the public satisfaction would improve relative to the efforts in place to address health and safety.
- *Major:* Multiple critical characteristics of health and safety would change and/or the number of individual impacted would greatly be reduced or increased. The public would be aware of the effects associated with implementing the alternative and public satisfaction would markedly decline or increase. Beneficial impacts would improve multiple characteristics of the health and safety, substantially.

***Duration:*** Duration describes how long an impact would be expected to last. In this EA, impacts are described as either being short-term or long-term. Short-term is an impact that would last no more than two years. Long-term would be an impact that would last for more than two years.

***Context:*** Context is the setting within which an impact is analyzed, such as the affected region or locality and the affected interests. In this EA, the intensity of impacts is evaluated within a local context, primarily considering effects on the Big Pine Key area itself. The intensity of effects on cumulative impacts is evaluated in a regional context, and considers effects further in time and effects from other projects.

***Direct and Indirect Impacts:*** Direct impacts include effects on the resource actually caused by the proposed action, generally at the immediate site of the action and at the time of the action. Direct impacts can extend into the future and are often permanent, but can be temporary. A direct effect is an effect that is caused by an action and occurs at the same time and place. An example of a direct impact would be the filling of a portion of a stream, which immediately causes habitat loss at that location.

Indirect impacts generally occur as a result of a "side-effect" of a direct impact, but occur later in time or further in distance than the action. For example, an indirect impact could result from silt flowing downstream, creating turbid conditions, and adversely affecting water quality.

***Cumulative Impacts:*** The CEQ regulations, which implement the NEPA (42 USC 4321 *et seq*.), require assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are considered for all alternatives and focus on a regional area well beyond the Refuge boundary.

Cumulative impacts were determined by combining the impacts of each alternative with other past, present, and reasonably foreseeable future actions within the Refuge and the vicinity. These impacts are assessed on a regional basis. These projects include development within the region, long-term population trends, cultural and social changes.

## 4.3 Alternative A (Status Quo, No Action Alternative)

### *4.3.1 Natural Resources*

*Impact Analysis*: Alternative A, in employing a mosquito management response to unwanted mosquito populations, does represent a gross overall approach to mosquito control without added safe guards to sensitive resources. While existing no-spray zones (refuge lands) are identified, the approach does not account for drift of chemical controls (pyrethroids and naled) using their existing delivery methods (Figure 6). Previous studies have indicated that chemical control pesticides have been detected on Refuge lands (Pierce 2009, Bargar 2013 (interim report only) despite no-spray zones (Bargar 2013). These chemicals are known to cause toxicity to non-target species. Specifically, in a study on butterflies, Pierce (2009) monitored naled and permethrin deposition following application in and around the Refuge from 2007 to 2009. Permethrin, applied by truck, was found to drift considerable distances from target areas with residues that persisted for weeks (Pierce 2009). Naled, applied by plane, was also found to drift into non-target areas but was much less persistent, exhibiting a half-life of approximately 6 hours. To expand this work, Pierce (2011) conducted an additional deposition study in 2010 focusing on permethrin drift from truck spraying and again documented measurable amounts of permethrin in non-target areas. In 2009, Bargar (2013) conducted two field trials on the Refuge that detected significant naled residues at locations within non-target areas on the Refuge that were up to 440 yards (402 meters) from the edge of zones targeted for aerial applications.

In addition to mosquito control chemicals entering non-target areas, the toxic effects of mosquito control chemicals to non-target organisms have also been documented. Lethal effects on non-target Lepidoptera have been attributed to fenthion and naled in both south Florida and the Keys (Emmel 1991; Eliazar and Emmel 1991; Eliazar 1992). In the lower Keys, Salvato (2001) suggested that declines in populations of the Florida leafwing were also partly attributable to mosquito control chemical applications. Salvato (2001 and 2002) found populations of the Florida leafwing (on Big Pine Key within the Refuge) to increase during drier years when adulticide applications over the pinelands decreased, although Bartram's hairstreak did not follow this pattern; because a range of variables could also influence leafwing trends further study would be needed to infer a stronger correlation. It is important to note that vulnerability to chemical exposure may vary widely between species, and current application regimes do not appear to affect some species as strongly as others (Calhoun et al. 2002; Breidenbaugh and De Szalay 2010; Rand and Hoang 2010; Hoang et al. 2011).

Dose-dependent decreases in brain cholinesterase activity in great southern white butterflies (*Ascia monuste*) exposed to naled have been measured in the laboratory (T. Bargar, pers. comm. 2011). An inhibition of cholinesterase, which is the primary mode of action of naled, prevents an important neurotransmitter, acetylcholine, from being metabolized, causing uncontrolled nerve impulses that may result in erratic behavior and, if severe enough, mortality. From these data, it was determined that significant mortality was associated with cholinesterase activity depression of at least 27 percent (T. Bargar, pers. comm. 2011). In a subsequent field study on the Refuge, adult great southern white and Gulf fritillary (*Agraulis vanillae*) butterflies were placed in field enclosures at both target and non-target areas during aerial naled application. The critical level of cholinesterase inhibition (27 percent) was exceeded in the majority of butterflies from the target areas, as well as in a large proportion of butterflies from the non-target areas (T. Bargar, pers. comm. 2011). During the same field experiment, great southern white and Gulf fritillary larvae were also exposed in the field during aerial naled application and exhibited mortality at both target and non-target sites (T. Bargar, pers. comm. 2011).

In a laboratory study, Rand and Hoang (2010) and Hoang et al. (2011) examined the effects of exposure to naled, permethrin, and dichlorvos (a breakdown product of naled) on both adults and larvae of five Florida native butterfly species: common buckeye (*Junonia coenia*), painted lady (*Vanessa cardui*), zebra longwing (*Heliconius charitonius*), atala hairstreak (*Eumaeus atala*), and white peacock (*Anartia jatrophae*). The results of this study indicated that, in general, larvae were slightly more sensitive to each chemical than adults, but the differences were not significant. Permethrin was generally the most toxic chemical to both larvae and adults, although the sensitivity between species varied.

The laboratory toxicity data generated by this study were used to calculate hazard quotients (concentrations in the environment/concentrations causing an adverse effect) to assess the risk that concentrations of naled and permethrin found in the field pose to butterflies. A hazard quotient that exceeds one indicates that the environmental concentration is greater than the concentration known to cause an adverse effect (mortality in this case), thus indicating risk to the organism. Environmental exposures for naled and permethrin were taken from Zhong et al. (2010) and Pierce (2009), respectively, and represent the highest concentrations of each chemical that were quantified during field studies in the Keys. When using the lowest median lethal concentrations from the laboratory study, the hazard quotients for permethrin were greater than one for each adult butterfly, indicating a significant risk of toxicity to each species. In the case of naled, significant risk to the zebra long wing was predicted based on its hazard quotient exceeding one (indicting risk).

In a recent study, Bargar (2012) conducted a probabilistic risk assessment for adult butterflies using published acute toxicity data in combination with deposition values for naled that were quantified at eight locations within the Refuge. The published toxicity data were used in conjunction with morphometric data (total surface area and weight) for 22 butterfly species and the Refuge naled deposition values to estimate the probability that field exposure to naled will exceed butterfly effect estimates (quantity of naled per unit body weight associated with mortality in adult butterflies). From the field deposition measurements, the probability that the effect estimate for 50 percent of the examined butterfly species will be exceeded ranged from 70 (lowest butterfly surface area to weight ratio) to 95 percent (highest surface area to weight ratio) based on filter paper deposition results and 33 to 87 percent based on yarn sampler results. As the surface area to weight ratio increases, the probability that a greater quantity of naled per unit body weight will be delivered increases. These results suggest that major short-term impacts on butterfly survival may result from aerial naled application.

Indirect impacts associated with pesticide use under this Alternative can be best described relative to plant species in the Refuge, as well as marine species adjacent to the Refuge. Specific concerns are associated with pollination and residuals effects from drift and overspray.

Garber's Spurge

Historically, Garber's spurge occupied pine rocklands and hammock edge from south Florida through the Florida Keys. Although surveys in 2005 and 2006 indicated that certain Garber's spurge populations were extirpated on Big Pine Key (Green et al. 2006), some extant populations were found on southern Big Pine Key more recently (Green et al. 2008). Garber's spurge is believed to be wind pollinated (Keith Bradley, The Institute for Regional Conservation [IRC] pers. comm. 2007). The lack of phytotoxicity of naled and lack of reliance on insect pollination for reproduction indicates that the application of naled in the Florida Keys would have negligible short-term direct and indirect effect to the Garber's spurge.

Key Tree-Cactus

The Key tree-cactus is present in Cactus Hammock on Big Pine Key. Populations formerly located in Key West and Boca Chica Key have been extirpated. The closest population to the Big Pine Key population is located on Long Key (Service 1999). Although Cactus Hammock is a no-spray zone, this species could be adversely affected by mosquito spraying through a reduction in the population of potential pollinators, thus producing a reduction in the reproductive potential of this endangered plant species. The likely pollinator of the Key tree-cactus is moths and or bats.

While flowering occurs year round, the peak reproductive months for the Key tree-cactus are July through September, which coincides with the peak period for mosquito spraying in the Florida Keys (Adams and Lima 1994). A study on the reproductive biology of this species revealed that bagged and non-bagged blooms of the Key tree-cactus in naled application areas set fruit and produced viable seed (Hennessey and Habeck 1994). This indicates that the Key tree-cactus employs self-pollination in reproduction at least to some extent. While this does not entirely eliminate the potential adverse effects to the species, it does minimize them to the extent they are considered negligible.

Candidate Plants

Big Pine partridge pea, wedge spurge, and sand flax are three candidate plants that occur within pine rocklands in the Keys and have a large proportion of their habitat within the NKDR. Most of the range of the Big Pine partridge pea is within the Refuge. Ross and Ruiz (1996) estimated that about 90 percent of the plants on Big Pine Key are within the Refuge. Wedge spurge is known only from Big Pine Key in the Keys, and most of its range is encompassed within the Refuge. Sand flax has a larger range, but the largest population in Monroe County is located on Big Pine Key within the Refuge. The status of sand flax in the Keys is of particular concern. Updated monitoring information from TNCs Terrestris Preserve on Big Pine Key indicates that no sand flax was found on transects in any of the management units in 2006 (Slapcinsky and Gordon 2007; D. Gordon, TNC, pers. comm. 2008). Slapcinsky and Gordon (2007) generally found density of sand flax declined to zero in all three burn units (burns were conducted from 1994 – 2003) in 2006, although Gordon (pers. comm. 2008) attributed the response to the damaging effects of Hurricane Wilma in 2005.

Pollinator limitation is identified as a threat for the Big Pine partridge pea within wildland-urban interface areas on Big Pine Key where fewer seeds per fruit were produced than those well within solid blocks of preserved pine rockland (Liu and Koptur 2003). Buzz-pollinating bees (*Xylocopa micans* and *Melissodes* spp.) were the only functional group observed to be effective in pollinating partridge pea. The species composition of visits to partridge pea by those bees was altered in urban edge (fewer visits by *Melissodes* spp.) as compared to visits in the more pristine pine rockland areas, and overall visits were reduced on the urban interface. Liu and Koptur (2003) suggested that aerial mosquito spraying may exacerbate the existing pollinator limitation suffered by Big Pine partridge pea by reducing the number of visits by the buzz-pollinating bees.

Bradley (2006) indicated that pesticide spraying is common on Big Pine Key and its suppression of pollinator populations may also have a long term impact on reproduction rates of sand flax and wedge spurge. However, the lack of pollinator information makes assessing the effects of mosquito spraying in the Keys on sand flax and wedge spurge difficult if not impossible (Hodges and Bradley 2006).

Water resources in the area including the near shore are also receiving drift from aerial application of naled. Mosquito control reports have indicated drift of pesticides in near shore waters of the Florida Keys (Hennessy et al. 1992, Rumbold and Snedaker 1999, Pierce 2005). Previous studies of thermal fog applications showed drift of naled into non-targeted (no-spray) terrestrial habitats in the Florida Keys. Pesticide residues collected on cellulose pads exhibited up to 90 µg/m2 naled at 15 m inside a pineland no-spray zone, with naled drift detected up to 750 m into the no-spray zone (Hennessey et al.1992). At 6 hours after application, naled concentrations on the pads diminished to about 50% that observed at 1.5 hours (Hennessey et al.1992). These results show the potential for non-target marine organisms exposure to drift from mosquito adulticide applications.

Concentrations of permethrin and naled in the estuarine/marine environment have not been studied thoroughly. Pierce et al. (2005) conducted a field study in 1998 on Key Largo that examined the occurrence of naled, dichlorvos, and permethrin at 18 sampling sites in nearshore waters during three separate pesticide applications. Samples were taken on filter pads elevated above the water surface, in a surface water micro layer, and at subsurface depths. In general, permethrin deposition was detected on filter pads at most sites downwind of each application. Naled and dichlorvos were periodically detected on filter pads at downwind sites, but many downwind sites showed no detectable the compounds. Naled was not detected in any surface water microlayer samples and was detected in only one subsurface sample at a concentration of 0.19 µg/L. Dichlorvos was detected in multiple subsurface samples with concentrations ranging from 0.05 to 0.56 ug/L and in one surface water microlayer sample at a concentration of 1.3 µg/L. Permethrin was only detected in one subsurface sample at a concentration of 0.07 µg/L. During the third field trial, surface water samples were taken from the opening of a residential canal system. Permethrin concentrations in these samples ranged from 5.1 to 9.4 µg/L. Given short residence time and half-life of these compounds and the study information, the effects of drift in the marine environment would be considered a moderate short-term adverse impact.

A study of both permethrin and naled/dichlorvos was conducted in a mangrove community and residential water collection systems on Grand Cayman Island showed persistence of permethrin in mangrove tree leaves and in association with suspended sediment in the water cisterns, but none was detected in saltmarsh water pools (Pierce and Henry 1988). Although no naled or dichlorvos was detected in the mangrove community following application, residues of both were recovered from cistern water up to 16 hours after application, but no pesticide residues were detected in drinking water as it came out of the tap (Pierce and Henry 1988).

Although naled and permethrin are considered to be relatively non-persistent in an aquatic environment, even short exposure periods to pesticides can have adverse impacts on susceptible life stages of aquatic invertebrates.

Sea Turtles

There is a paucity of data linking pesticide application to sea turtle response *in situ*. The ecotoxicology of these species and reptiles in general, remains poorly understood. In one study, green sea turtle tissues and shells were analyzed, but no detectable levels of organophosphates were found (Aguirre et al. 1994). In general, the enzyme and hormone disrupting capabilities of pesticides, such as naled, are suspected as possible contributing factors for a global decline in amphibians, reptiles, and fish (Khan 2005). However, skin permeability of sea turtle species is relatively low and exposure amounts from run-off or over spray associated with mosquito control activates on land would likely result in a minimal potential for exposure and therefore is unlikely to be adversely impacted.

Acropora Corals

Pesticides are listed as one of many threats to Acropora corals (Boulon et al. 2005). However, few studies specifically examine naled or permethrin. Morgan and Snell (2002) examined the influence of dibrom (naled) on stress gene expression in the reef-building coral *Acropora cervicornis*; in lab studies the authors concluded that stress-induced genes specific to exposure to dibrom could be isolated. In addition, *A. cervicornis* subjected to dibrom could experience reduced fitness which could have significant impacts during their reproductive period (August) which coincides with heavy mosquito control activity periods (Morgan and Snell 2002, FKMCD annual report 2012). Samples taken from *A.corvicornis* in the Florida Keys exhibited the dibrom induced stress gene demonstrated in the lab, which would suggest that corals are exposed to some naled based pesticides under real world conditions (Morgan and Snell 2002).

More recently, Markey et al. (2007) examined the effects of permethrin on the coral species *Acropora millepora*. Larval metamorphosis was reduced in nominal permethrin concentrations of 1.0 ug/L. The next lowest treatment concentration was 0.3 ug/L, therefore the effective concentration that inhibited metamorphosis fell somewhere in the range of 0.3 to 1.0 ug/L. Fertilization of *A. millepora* eggs was not inhibited by permethrin at 30 ug/L, which was the highest concentration tested. Bleaching of adult branches of *A. millepora* was observed at 10 ug/L. As a conservative guideline, the low end of the concentration range (0.3 ug/L) that showed effects on the most sensitive endpoint (larval metamorphosis) could be used as a screening level concentration when assessing potential impacts of permethrin on coral species. It should be noted that nominal permethrin concentrations were reported in Markey et al. (2007), but measured concentrations in the treatment solutions were not provided. The actual exposure concentrations may have varied from the expected nominal concentrations.

Markey et al. (2007) found high levels of bleaching and lowered metamorphic success of *Acropora millepora* coral larva to permethrin below concentrations found in previous field measurements in the Florida Keys of 5.1 to 9.4 µg/l (Pierce 1998).

Because naled and permethrin are short lived in the terrestrial environment, actual site exposures via direct applications to Acropora corals and their critical habitat via storm water run-off may be minimal. However, accidental over spray of permethrin onto marine environments is very likely to occur and has been documented in the past (Pierce 2005). Significant drift from targeted areas onto no spray zones has been more extensively documented within the Refuge from both permethrin and naled (Hennessy 1991, Pierce 2011, Barger 2012). Because of the likelihood of drift and overspray that will likely result in exposure to significant quantities of naled and permethrin, staghorn coral (*Acropora cervicornis*), elkhorn coral (*Acropora palmate*) are likely to display a moderate short-term adverse impact.

Smalltoothed Sawfish

Harvest from bycatch, habitat loss and degradation, entanglement, saw removal and are listed as reasons for the decline of small toothed sawfish (recovery plan 2009). Small toothed sawfish (STSF) critical habitat does not include the waters adjacent to the Refuge. However, the species is included on the Refuge species list and could potentially occupy the action area. The STSF is known to occupy habitats including shallow bays, estuaries, river mouths, and deep water offshore areas up to 122 feet deep. Assumedly, juvenile and adult fish would be most vulnerable in near shore habitats where mosquito over-spray and runoff are likely to occur. Permethrin, and naled, are considered to be moderate to highly toxic to fish in lab studies (USEPA 2002, USEPA 2009). There is limited information however on the aforementioned pesticides and elasmobranchs. However the STSF is known to be long-lived, which would make them vulnerable to bioconcentration. Bioconcentration has been documented with pyrethroids in fish (Wei 1995). In addition, prey items of the STSW could be impacted in estuarine environments. In the past, an Opinion issued by the USFWS has determined a 40 yard buffer from the edge of the water to be sufficient to protect salmonids from incidental take of endangered and threatened species from naled (Stavola 2004). The recovery plan for the STSF states that all point source solution combined has an unknown impact (NOAA 2009). Under a realistic scenario field exposure to the STSF via run-off or overspray is unlikely to be toxic. While impacts to prey abundance or bioconcentration are more likely, too little evidence supports these possibilities. For these reasons, we estimate that the small toothed sawfish may be moderately adversely affected with a potential for long-term issues in association with the possible bioaccumulative component.

Other Wildlife Species

An Ecological Risk Assessment was completed in 2004 by the Service's South Florida Ecological Services Office to assess the impacts of naled and permethrin on listed species, specifically the Key deer, Lower Keys marsh rabbit, rice rat, and indigo snake. The assessment and exposure model, prepared by URS Corporation (2004), was used to determine total applications and application intervals to wildlife species, excepting the Lepidopterans and plants.

*Key Deer*

The Key deer is present in all areas proposed for application of naled and potential permethrin drift. It frequents most vegetative community types found in the Lower Keys, including hardwood hammock, pine rocklands, mangrove forest, freshwater marsh, and saltmarsh. Its habits are crepuscular, placing it actively feeding during ideal periods for naled and permethrin application. The exposure pathways for this mammal for naled or permethrin would be through dermal, oral, and inhalation exposure (URS CORP. 2004).

Data on toxicity of naled to deer species are sparse. The only $LD_{50}$ available for an oral dose is for the mule deer (*Odocoileus hemionus*) and was approximately 200 mg/kg-BW (Hudson et al. 1984). No chronic, subchronic, or reproductive toxicity values are available for deer. Therefore, all HQs are based on TRVs derived from common laboratory species. Key deer would be exposed to naled through direct application, contact with contaminated vegetation or soil, ingestion of the product on vegetation, and inhalation.

The interval between applications as well as the total number of applications changes the HQ. The model results indicate that no application frequency yielded an HQ for the LOAEL of greater than 1.0. However, applications of naled at an average frequency of 7 days or less resulted in HQs for the chronic NOAEL above 1.0. Application intervals of 8 days or greater (i.e., 23 applications per year or less) resulted in HQs of less than 1.0 for both the LOAEL and NOAEL. Based on these results, the proposed application rate would be unlikely to adversely affect the Key deer.

Permethrin generally exhibits low mammalian and avian toxicity (Ware 1994).

*Rice Rat*

The rice rat is an omnivorous mammal that prefers salt marsh habitat in the Lower Keys. Critical habitat has been designated for this species. The rice rat is predominantly nocturnal, which may reduce the likelihood of exposure to the highest concentrations of naled, and potentially permethrin drift, which will occur during the early morning hours.

Naled and permethrin is a specific neurotoxin and as such poses no known threat to plant physiology. This lack of measurable effects to plants indicates that critical habitat is unlikely to be affected by application of naled. In addition, pesticide application will not result in soil disturbance or other impacts to critical habitat.

Rats are commonly used in laboratory assays, meaning that data on the effects of naled and permethrin on a related species are relatively abundant compared to the other species addressed in this document. Rice rats would be exposed to naled or permethrin through inhalation, oral exposure, and dermal exposure. The oral exposure for the rice rat is different than that of the Key deer or Lower Keys marsh rabbit, since the rice rat is an omnivore. Rice rats may ingest dead or dying invertebrates following naled and permethrin applications, a compounding factor that may or may not increase the level of exposure.

For permethrin, acute oral toxicity in rats was found at 2280 mg/kg for females and 3580 mg/kg in males (USEPA 2009). An apparent data gap exists for acute inhalation. Acute neurotoxicity in rats found a LOAEL=75 mg/kg based on observations of clinical signs such as abnormal or decreased movement (USEPA 2009).

As noted for the Key deer, the URS Corp. 2004 HQ for the LOAEL (both chronic and subchronic) for the rice rat did not exceed 1.0 for any of the application intervals modeled. The HQ for the chronic NOAEL; however, exceeded 1.0 at application intervals of 4, 5, and 8 days. Chronic HQs for the rice rat did not drop below 1.0 until the average application interval was at least 14 days (13 applications per year).

Subchronic, dermal exposures may present a risk to the rice rat with short application intervals. Application frequencies of every two to four days resulted in HQs greater than 1.0 even for short term (subchronic) exposure; the HQs dropped to 1.0 or less at exposure intervals of five or more days (URS 2004). These results indicate that the proposed application rate of nine applications per year spaced at least five days apart would be unlikely to adversely affect the rice rat

*Lower Keys Marsh Rabbit*

The Lower Keys marsh rabbit is a small, herbivorous rabbit found only in the Lower Florida Keys. This species prefers herbaceous cover and inhabits transition zone habitats with sawgrass (*Cladium jamaicensis*), cordgrass (*Spartina spartinae*) and sea oxeye daisy (*Borrichia frutescens*). It is crepuscular and nocturnal in nature and will be foraging at optimal naled and permethrin application times. Life history information for this species indicates it will be exposed to naled through dermal, oral, and inhalation exposure pathways.

Permethrin was found to be virtually non-toxic after 21 days of oral dosage from 0.1 to 1 g/kg of weight showed no signs of toxicity but some skin irritation (WHO 1994). Permethrin is considered to be low toxicity for dermal exposure also (LD50 >2000 mg/g) (USEPA 2009).

The Lower Keys marsh rabbit appears to be the most sensitive of all species examined to potential adverse effects from naled application. The chronic LOAEL HQ did not exceed 1.0 for any of the application intervals modeled. However, the chronic NOAEL HQ exceeded 1.0 for 4, 5, 8, and 14 day intervals. An application interval of 21 days or greater (nine applications per year) was required to reduce the HQ to less than 1.0.

In addition to being the species most sensitive to chronic naled exposure, the Lower Keys marsh rabbit may be affected by shorter term (subchronic) exposures. The subchronic NOAEL HQ for combined dose from all exposure routes exceeded 1.0 at an application interval of four days or less. The HQ dropped below 1.0 at five day intervals. Therefore, the results of the model indicate that the proposed application rate of nine applications per year no more frequently than every five days is unlikely to adversely affect the Lower Keys marsh rabbit.

*Eastern Indigo Snake*

The eastern indigo snake is a large, heavy-bodied snake found in nearly all the upland and wetland plant communities in Florida. Historically, the eastern indigo snake ranged throughout the upland habitats of the Lower Keys; however, its present distribution is uncertain. Indigo snakes have not been documented in the mainline Florida Keys connected to U.S.1 since 1991 and road mortalities have not been recorded. It is diurnal in nature and commonly uses burrows or tree root holes as refugia during dry conditions. This species has a large home range, making censusing difficult. The indigo snake is not a constrictor, but ambushes prey items. Prey items include small mammals and birds as well as reptiles and amphibians. Exposure routes for this species would primarily be through inhalation and ingestion. It is believed that the scales on the snake’s skin would impede absorption of naled through the dermis.

The lowest TRV values for both the LOAEL and NOAELs presented for any of the species studied were used. These values are 2.0 and 0.2 for the oral LOAEL and NOAEL, respectively (URS CORP. 2004). Since the only other complete exposure pathway for this species is inhalation, the lowest TRV LOAEL and NOAEL of 0.17 and 0.033 were used as were applied to all species. Concentrations on the animal post-application were modeled based on data available for racers.

Model results indicate that risks to the indigo snake are insignificant and discountable at all the application rates modeled. These results indicate that the proposed application rate would be unlikely to adversely affect this species.

Much paucity exists in the data regarding snakes and Permethrin toxicity. One study, Brooks et al. (1998), suggests that pyrethroids produced mortality at doses of 40 mg/kg.

Neither naled nor permethrin will be applied on any island known or suspected to be occupied by indigo snake. Currently, indigo snakes are only known to occur outside the action area for this plan. Thus, there is no exposure to this species and therefore no risk.

*Stock Island Tree Snail*

The Stock Island tree snail (*Orthalicus reses,* not including *nesodryas*) eats algae and lichens found on hardwood hammock flora. During the dry season, the snail aestivates by sealing its outside shell to the tree trunk or branch. This strategy prevents dessication. Within the area to be treated, the Stock Island tree snail only occurs on No Name Key.

Studies have shown that naled and permethrin is highly toxic to freshwater and estuarine/marine invertebrates; acute $LC_{50}$ values were 0.79, 8.8, 0.79, and 0.019 ppb, respectively (USEPA 1999, USEPA 2006). For the purposes of this analysis, we assume that naled is equally toxic to the Stock Island tree snail. Stock Island tree snails may be especially susceptible to aerial naled application due to their location in the tree canopy and their exposed mucosa, which provide little barrier to the absorption of chemicals. Three small populations on No Name Key could be adversely affected by the application of naled for the control of mosquitoes.

Given the potential exposure to naled and the high level of toxicity to invertebrates, a risk assessment model was not necessary to analyze the potential effects of the proposed action on this species. Any direct application of naled could result in mortality of individual Stock Island tree snails. To avoid adverse impacts to Stock Island tree snails, all occupied habitat of this species are designated as a no spray zone for naled and permethrin.

***Cumulative Impacts:*** Cumulative exposure to mosquito control chemicals would likely have few compounding impacts with other current actions proposed by the Refuge to natural resources resulting in negligible to minor impacts that would be species specific. Decreases in effectiveness of current restorations efforts (using exotic plant control and prescribed fire) may result due to reductions in beneficial pollinator in association with Alternative A impacts. Restoration efforts in the refuge are generally small scale thus the cumulative impact is minimized and disturbance associated with restoration is usually short-term in nature. In addition, it is estimated that Alternative A would limit the perceived need for insecticide use by private landowners by providing additional coverage to the community. Preventing private use of permethrin products (i.e., mishandling, improper use), which are widely available may prevent over use and benefit natural resources. There are no other current ongoing activities that could cumulatively impact the resources discussed.

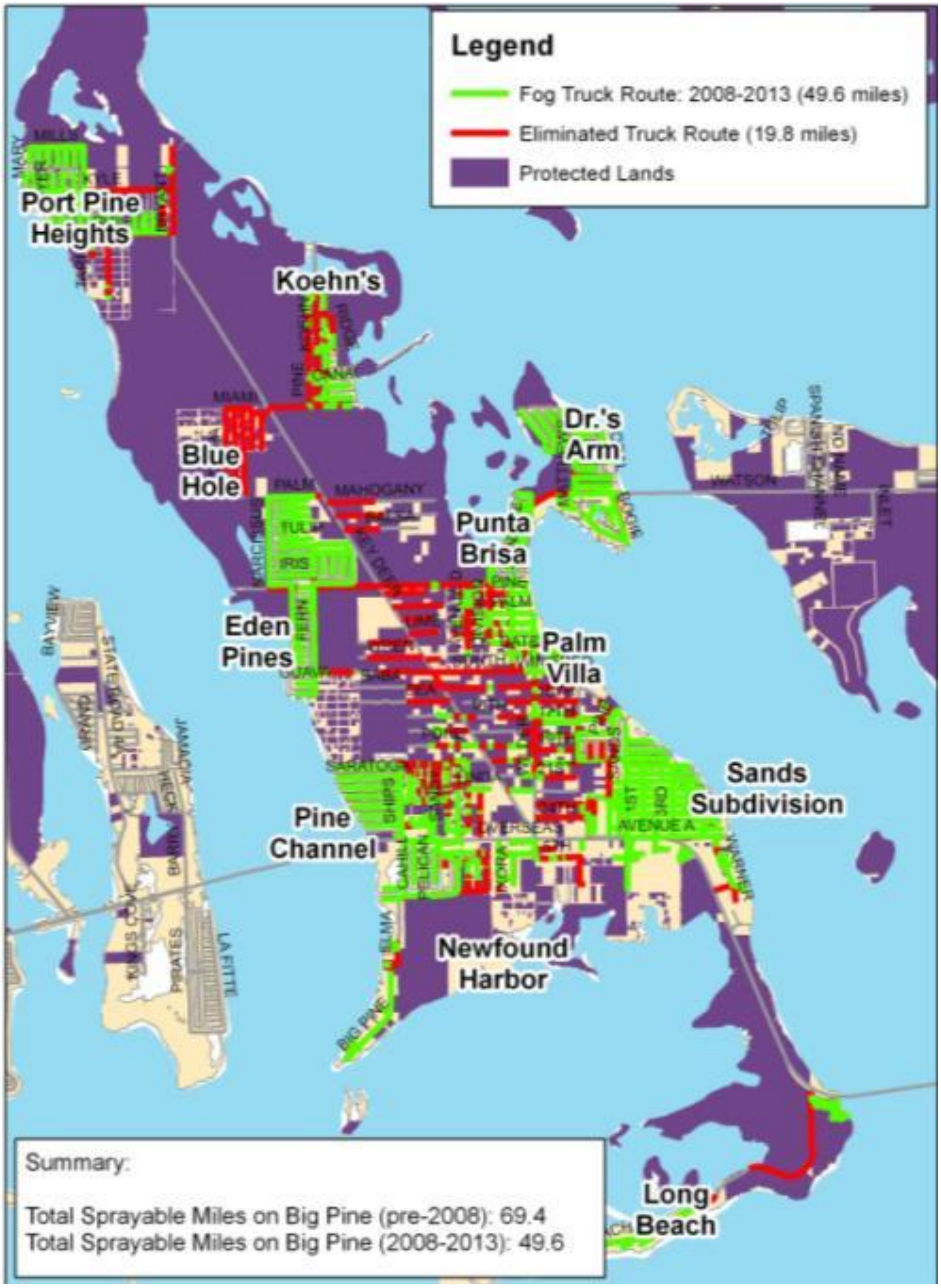


**Figure 6. Change in mosquito control adulticide fogging routes over time.**

***Natural Resources Conclusion:*** Short-term, long-term, and cumulative impacts to natural resources would widely vary depending on a given species individual species specific tolerance for, or a populations resiliency to, the direct and indirect effects of mosquito control chemicals. Overall, it is estimated that the net impact would be a moderate to major adverse short-term, moderate to major species specific long-term, and negligible to minor cumulative.

*4.3.2 Aesthetic Resources and Visitor Experience*

***Impact Analysis***: The bulk of mosquito control activities would be conducted during periods of lower visitation (majority in summer) or in areas of restricted public access (backcountry) and managed to create little visual impact or change when visiting the Refuge. Visitor access to the Refuge would not be curtailed during any operation; consequently there would be no direct adverse impacts to visitors. Indirect adverse effects would include the sound of fogging trucks or aircraft associated with pesticide application for very short periods of time. Therefore, the adverse direct impacts of this alternative on visitor experiences would be short-term, localized, and minor. Longer-term indirect impacts would include a reduced potential for large mosquito hatches due to preventative larvicide/adulticide applications and subsequent reduced potential for substantive modifications of access to trails and other outdoor area; these indirect impacts would be negligible and beneficial.

Direct adverse impacts may include minor displacement of some visitor activities during mosquito management operations, but that would be limited to a few hours over the course of a year in total. Other direct adverse impacts of mosquito management on visitor experiences and aesthetic resources would include fog in scenic views, odors, and temporary restrictions in access to some areas. The potential direct adverse impact to visitor experiences and aesthetic resources is localized, short-term, and negligible to minor.

Some of the visitors' diminished experience would probably be offset as they realize the beneficial aspects of the mosquito management and control through educational programs or direct observation. Some visitors may believe that control is not environmentally acceptable, but the bulk of visitors do not appear to convey any opinion on this issue given the short duration of their visit. So while that may have that value in general it is not carried forward during a short visit for the most part.

Because of the relatively small area where mosquito management is conducted within this alternative and the overall acreage of the Refuge as a whole, the vast majority of visitors to the Refuge on any given day would not be aware of mosquito management practices.

***Cumulative Impacts:*** The direct and indirect adverse can be estimated based on the varied beneficial impacts of this alternative would be offsetting and likely negligible. Other activities that contribute to cumulative impacts on visitor experiences and refuge use include recreational uses, residential development, wildland fire, and other land management activities (restoration, fire management). The adverse impact of these activities is considered negligible to minor since most would be distant from visitor use activities. The paved Refuge roads and facilities intrude on the visual scene, though they are situated so as to minimize the intrusion. No other projects are currently proposed within the Refuge that would contribute to cumulative impacts on visitor experience or aesthetic value.

***Aesthetic Resource and Visitor Experience Conclusion:*** Alternative A would have localized, short-term, negligible to minor direct adverse impacts on visitor use and aesthetics. Long-term effects would be negligible beneficial. The indirect adverse impacts would be localized, short-term, and minor. Only negligible cumulative impacts could be identified.

*4.3.3 Public Use and Surrounding Community*

***Impact Analysis***: Alternative A would have negligible short-term adverse impacts since there would be limited disruption of surrounding community area given the approach is status quo and what residents generally expect for mosquito control operations. There would be limited consistency in approach as the decision to apply adulticides would be based on a more localized and individual neighborhood area needs dependent on field conditions. Under this alternative, it is expected that there would still be only occasional, temporary surge of mosquito activity based on environmental conditions in the area but adulticide application may be more frequent. Larvicide operations would largely take place in unpopulated areas (backcountry) but some developed areas will experience short-term moderate adverse effects associated with the noise of low flying aircraft. Similarly, short-term minor adverse impacts would be noted in association with truck fogging operations with adulticides while short-term moderate adverse effects would be noted with aerial application of adulticides. Little short-term adverse or positive impacts would be impacted for public use of the Refuge.

Mosquitoes are a part of the ecosystem and serve as a food resource for other organisms. However, it is important to also recognize that mosquitoes are unique in their role as vectors of disease organisms to humans and animals. Even “nuisance” species can have an economic effect on nearby human populations, For example, during the 1990 Saint Louis Encephalitis outbreak (223 confirmed cases, 11 deaths), Florida saw a 15% decrease in tourism-related revenues in the last quarter of 1990 (Mulrennan 1991). Mosquitoes collected in Monroe County were found infected with West Nile Virus (Hribar et al. 2003, 2004). The 2002 West Nile outbreak cost about 20 million dollars in Louisiana alone (Zohrabian et al. 2004). Worker productivity can fall to near zero when high numbers of mosquitoes are present (Williams 1986). Livestock lose weight and produce less milk when subjected to high numbers of mosquito bites (Steelman 1976). The Association of State and Territorial Health Officers states that mosquito control is an important and basic public health service (ASTHO 2003). Thus, mosquito control operations have a long-term reoccurring major impact (this impact can be negative or positive based on the effectiveness of mosquito control operations in a given event or season) on the local community given the dominant tourist based economy. Secondarily, the success of mosquito control operations also has a short-term ongoing impact on disease occurrence that is further discussed in the health and safety section below.

***Cumulative Impacts:*** It is estimated that alternative A would curtail insecticide use by private landowners by providing adequate service to customers. Preventing private use of permethrin products which are widely available may prevent over use. This impact could be characterized as negligible.

***Public Use and Access Conclusion:*** Alternative A would have negligible short-term adverse, negligible long-term benefit, and no cumulative impact. The indirect adverse impacts would be localized, short-term, and minor. However, the effects on the public use and of the community could be highly variable depending on the effectiveness of the control in a given year. This is highly dependent on environmental and weather conditions and the operation controls used by the District in any season.

*4.3.4 Health and Safety*

***Impact Analysis***: The direct adverse effect of the no-action alternative is exposure to adulticide pesticides in the environment. The chemicals used have low mammalian toxicity and low persistence in the environment; however, there is a potential for exposure during fogging operations. That exposure risk is moderate to negligible and short-term, depending on whether an individual is in direct contact with fogging trucks or exposed during the immediate application of pesticides from aerial sources. Indirect short-term negligible exposure could occur to the human population through interaction with vegetation or the natural environment shortly after application or through inhalation. Chronic exposure could result in adverse health effects. Exposure to direct and indirect effects of mosquito control pesticides would be greatest with this alternative since this alternative has the greatest potential for application of pesticides (both frequency of application and area of application).

Moderate short-term beneficial impacts are associated with this alternative in that adulticide use is more freely applied in response to reports from the community members and thus there is likely a slight improvement in localized control. Thus, residents in neighborhoods might experience more mosquito control during isolated events and not be subject to exposure to bites.

Mosquitos can cause immunologically mediated reactions. While these mosquito allergies can be small to large and localized, others can be systemic. The reaction is sometimes called “skeeter syndrome;” however there is no specific threshold for number of bites that cause this effect rather it is related to the specific health status of the individual. The immune reaction is largely in response to proteins that exist within the mosquito saliva. Some 30 different proteins are present in the saliva and they include antiplatelet, anticoagulant, and vasodilator to facilitate feeding and sugar digestive and bacteriolytic enzymes (Crisp and Johnson 2013). Most of the population will exhibit some level of reaction but large localized reactions were reported in only 2.5% of the population in one study and individuals at greatest risk are those with greatest potential exposure (outdoor workers and those with lacking acquired immunity (Crisp and Johnson 2013). It has been shown that most people that experience immediate and delayed local reactions to mosquito bites that are immunologically mediated will see a decrease over time (Crisp and Johnson 2013; Peng and Simons 2007).

With any break in the skin, there is the potential for secondary (indirect) bacterial infection resulting from mosquito bites. These issues are generally minor and short-term and resolve without medical intervention. Some can result in cellulitis (inflammation of dermal and subcutaneous layers of the skin) with the potential to become more serious (Nasci 2013); however, these circumstances are less common.

Mosquitoes are unique in their role as vectors of disease to humans and animals. Even “nuisance” species can have an economic effect on nearby human populations. The Association of State and Territorial Health Officers states that mosquito control is an important and basic public health service (ASTHO 2003). ). Worker productivity can fall to near zero when high numbers of mosquitoes are present (Williams 1986). Livestock lose weight and produce less milk when subjected to high numbers of mosquito bites (Steelman 1976). Prolonged exposure to large numbers of biting *Aedes taeniorhynchus* has caused mortality in Florida cattle (Addison and Ritchie 1993). One source estimated a loss of $61 million in the southeastern United States due to mosquitoes (Hamer 1985, cited in Frank et al. 1977). Interestingly, a fatal West Nile virus was reported from Georgia in 2005 (Miller et al. 2005). Davis et al. (2007) provided a review and risk analysis of six mosquito adulticides: δ-phenothrin (sumethrin), permethrin, resmethrin, pyrethrins, malathion, and naled, and the synergist piperonyl butoxide, and determined that all risk quotients were low, indicating small ecological impacts.

***Cumulative Impacts:*** Cumulative impacts with other proposed actions are likely to be negligible adverse from the potential for health and safety issues as a result from the exposure of the general public to potentially harm chemicals used in mosquito control and combination with the potential for inhalation of noxious weed control chemicals and potentially smoke from prescribed fire operations. However, the probability of any one person receiving a harmful exposure to all actions is exceedingly rare, and therefore negligible. In addition, it is estimated that alternative A would curtail insecticide use by private landowners by the District continuing to provide the same level of service to customers. Preventing private use of permethrin products which are widely available may prevent over use and benefit health and safety.

***Health and Safety Conclusion:*** Under Alternative A, short term minor to major beneficial impacts would be experienced along with negligible adverse impacts associated with the low probability of chemical exposure and major benefits associated with reduced disease spread from mosquito vectors. Cumulative impacts would be negligible adverse. A greater relative benefit to health and safety may be experienced under alternative A resulting from a potential for lowered probability for secondary infections or disease as a likely overall increased capability to control mosquitos.

## 4.4 Alternative B (Preferred Alternative) - Phased Levels Approach to Mosquito Management

### *4.4.1 Natural Resources*

***Impact Analysis***: Alternative B employs a mosquito management response based upon targeted thresholds and carefully measured outcomes, which represents a more integrated and adaptive approach to mosquito control with added safe guards to sensitive resources. Existing no-spray zones (refuge lands) account for drift of chemical controls (permethrin and naled) using their existing delivery methods. Previous study has indicated that chemical control pesticides have been detected on Refuge lands (Pierce 2009, Bargar 2013) despite no-spray zones (Bargar 2013) (which may be attributed to home use or other sources in the case of permethrin). Because mosquito chemicals are known to cause toxicity to non-target species, alternative B accounts for expected drift zones in proposed critical habitat and adds additional protections in sensitive areas occupied by species that may be directly affected. Due to this, Alternative B may be generally similar to alternative A for most natural resources. However, operations would be more targeted in public areas on an as needed basis and a greater protection for critical habitats would be included resulting in diminished adverse temporal and spatial impacts to those species most likely to impacted.

Buffer zones would account for the majority of the change over the status quo as explained in impacts to natural resources under alternative A. It’s estimated that permethrin can drift anywhere from 50 (M. Hudon, pers. comm. 2013) to over 650 m (Pierce 2009) from designated truck routes. The extent of permethrin drift is dependent on several factors, including wind speed, wind direction, and vegetation density. Pierce (2009) detected drift of permethrin at concentrations lethal to three surrogate butterfly species from a laboratory exposure study by Rand and Hoang (2010) at approximately 250 m away from targeted truck routes (Figure 7). The direct effects of permethrin drift could include acute exposure to larval or adult butterflies that results in reduced fitness or death. Butterflies within the 50 to 250 m range have the potential of coming into direct contact with permethrin that would result in dermal or inhalation exposure. Because permethrin is not phytotoxic to plants, there is no direct effect to butterfly proposed critical habitat or candidate plant species by the proposed spraying.

Do to their tenuous population size within the action area, it is unknown exactly how many Bartram’s hairstreak butterflies could be directly exposed to permethrin drift. Within NKDR, there are approximately 1,211.46 acres of potentially suitable Bartram’s hairstreak butterfly habitat; however, only 35.83 acres of this habitat are currently occupied by the Bartram’s hairstreak. Estimating 50 to 250 m of pesticide drift, butterflies residing in 2.39 percent (0.86 acres) to 20.43 percent (7.32 acres) of NKDR occupied Bartram’s hairstreak habitat could potentially be directly exposed to permethrin (Table 1). When considering all potentially suitable Bartram’s hairstreak habitat (1,211.46 acres) within NKDR, anywhere from 11.65 percent (141.18 acres) to 47.27 percent (572.69 acres) could potentially receive lethal concentrations of permethrin drift that would directly affect the Bartram’s hairstreak. However, the likelihood of exposure would be greatly reduced under alternative B due to 250 meter buffer zones in occupied areas.

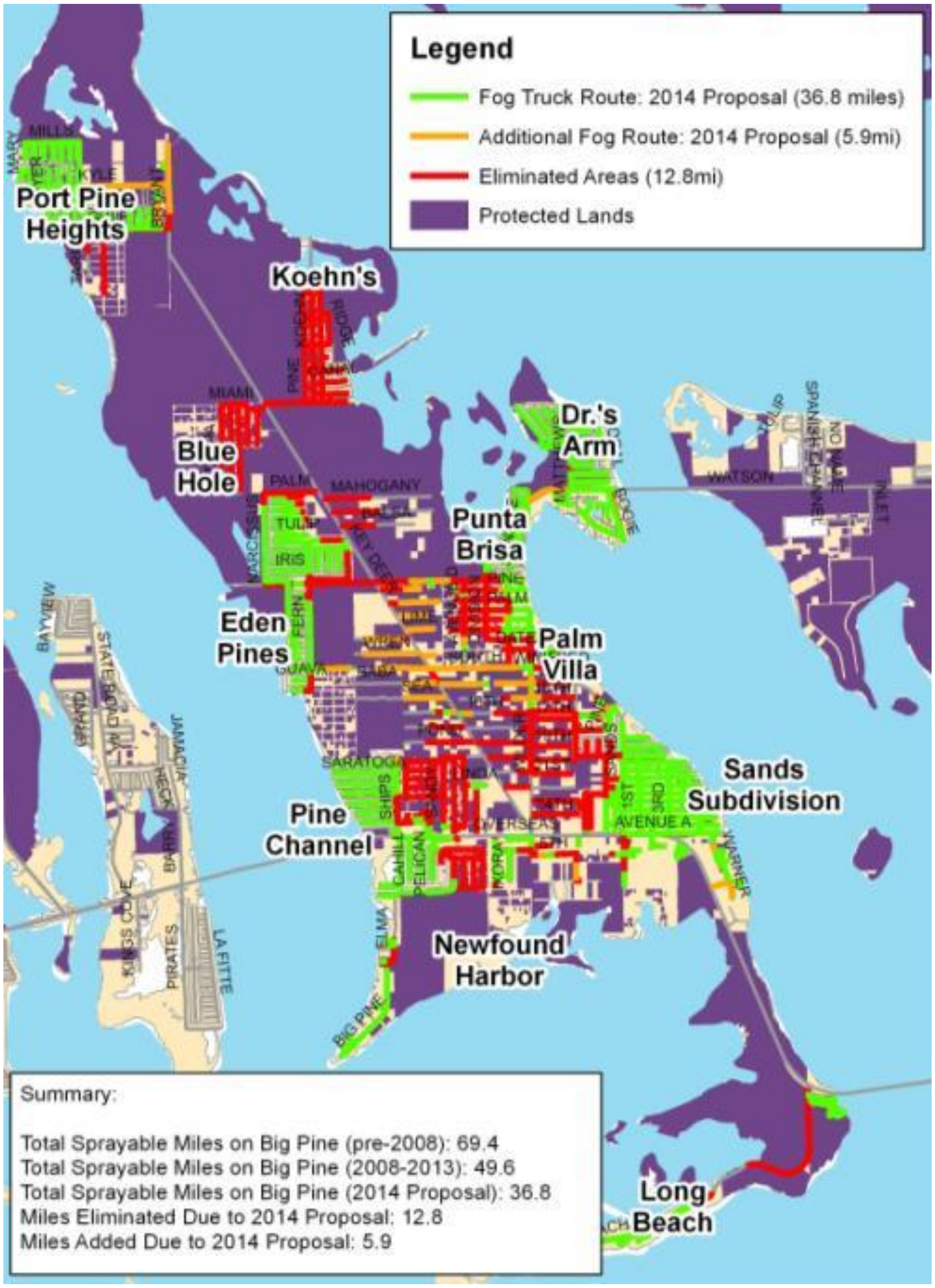


**Figure 7. Adulticide Fogging Routes and change in area treated under alternative B.**

There are an estimated 1,115.14 acres of potential Florida leafwing suitable habitat within NKDR. Based on this, Florida leafwing living within roughly 12.57 percent (140.20 acres) to 48.13 percent (536.70 acres) of the potentially suitable habitat could be directly exposed to lethal concentrations of permethrin (Pierce 2009, Rand and Hoang 2010). However, the Florida leafwing butterfly has not been observed on Big Pine Key since

2006 (Salvato and Salvato 2010b) and is considered to be extirpated from its former range within the action area. Without reintroduction efforts, it is unlikely that the Florida leafwing would be directly exposed to permethrin drift within the action area.

Barrier treatments, if imposed under alternative B, would result in high dosage permethrin treatments to adjacent private lands in an effort to reduce adult mosquito populations in neighborhoods areas while greatly reducing, or eliminating risk of drift on to Refuge managed areas. This method would be strategically implemented in areas where it would be most effective, such as city parks or areas where truck fogging may be unsuccessful. For this reason, the impact to natural resources from drift into natural areas within the Refuge would likely be reduced to some degree. However, species which encounter a toxic dosage of permethrin in the areas where barrier treatments occur will be adversely impacted.

Big Pine partridge pea, wedge spurge, and sand flax all occur within the action area. The potential incidental drift of permethrin within the 250 m range could result in impacts to insect pollinators for the Big Pine partridge pea, wedge spurge, and sand flax, ultimately indirectly affecting the reproductive potential of candidate plant species. The exposure could be acutely toxic to pollinators, resulting in death, or more chronic in nature, resulting from residual deposits on food sources and repeated spraying events throughout the mosquito spraying season.

Bargar (2012) conducted a prospective risk assessment for adult butterflies exposed to naled, which would be applied aerially under alternative B. Adult butterfly exposure was estimated based on the product of naled residues on samplers placed in the National Key Deer Refuge and an exposure metric that normalized total surface area to weight ratios. The probability that the 10th percentile effect estimate for adult butterflies exposed to naled would be exceeded following applications was 67 to 80%. The greatest risk would be for butterflies in the family Lycaenidae, of which the Bartram’s Hairstreak belongs. Based on fields measured values, the probability of a toxic exposure would be very likely, both in and outside of no spray areas. However, due to the low toxicity of naled to mammals and bird species, and the short environmental residence time impacts to other v species would be unlikely.

Direct and indirect impacts to resources associated with pesticide use would be similar to alternative A. However, the impacts would be reduced and more site treatments of mosquito control chemicals based on quantitative need and use of buffer zones, which could be adjusted based on research to mitigate risk, would minimize or eliminate spray into the Refuge that may impact resources, Alternative B would have short-term and long-term moderate benefits to natural resources compared to the baseline of *status quo*. This benefit would impact multiple species, and have secondary beneficial impacts to additional species based on a reduction in the negative impacts demonstrated in alternative A.

***Cumulative Impacts:*** Alternative B would likely have negligible to minor cumulative beneficial impacts to multiple resources, such as invertebrates whose populations may be reduced directly by mosquito control and therefore would not benefit to the same degree from other ongoing restoration actions.

***Natural Resource Conclusion:*** Minor to moderate short-term adverse impacts in alternative B for natural resources. Long-term would likely be minor to major adverse impacts to natural resources under alternative B. Cumulative impacts with other proposed actions would be negligible to minor beneficial.

*4.4.2 Aesthetic resources and visitor experience*

***Impact Analysis***: The bulk of mosquito control activities would be conducted during periods of lower visitation (majority in summer) or in areas of restricted public access (backcountry) and managed to create little visual impact or change when visiting the Refuge in the short-term. Visitor experience would have the short-term and long-term benefit of increased efficacy of mosquito control. Visitor access to the Refuge would not be curtailed during any operation; consequently there would be no direct adverse impacts to visitors. Indirect adverse effects would include the sound of fogging trucks or aircraft associated with pesticide application for very short periods of time. This alternative would have slightly less fogging truck activity in neighborhoods and within the refuge because of the application of buffer zones around critical and occupied habitat compared to Alternative A. Option 1 and 2 would slightly differ in that zonation but both would be considered minor localized and short-term in nature. Therefore, the adverse direct impacts of this alternative on visitor experiences would be short-term, localized, and minor. Longer-term indirect impacts would include a reduced potential for large mosquito hatches due to preventative larvicide and adulticide applications and subsequent reduced potential for substantive modifications of access to trails and other outdoor area; these indirect impacts would be minor and beneficial. In the long-term visitor experiences and aesthetic resources may increase if natural resources benefit from alternative B as predicted. Alternatively, the percentage of visitors that seek rare butterfly or plant encounters or value their inherent aesthetic value could benefit in their experience if populations increase.

***Cumulative Impacts:*** Cumulative impacts to aesthetic resources and visitor experience may have negligible to minor benefit overtime as mosquito populations will be managed under alternative B along with other restoration projects and the likelihood sightings of rare species may incrementally increase. In addition, it is estimated that alternative B would limit insecticide use by private landowners through providing some level of service to customers similar to that in Alternative A. Preventing private use of permethrin products, which are widely available may prevent over use and benefit natural resources. A benefit to natural resources may improve visitor experience by providing a wider variety of wildlife viewing opportunities. These benefits would be negligible.

***Aesthetic Resources and Visitor Experience Conclusion:*** Public use and aesthetic resources will be minor, localized, adverse impacts in the short-term, with a negligible beneficial and adverse impact in the long-term. Cumulatively impacts would be negligibly beneficial.

*4.4.3 Public Use and Surrounding Community*

***Impact Analysis***: Alternative B would have negligible short-term adverse impacts on since there would be limited disruption of surrounding community area given the approach is similar to status quo and would allow the adaptive ability to treat mosquitos when needed. There would be consistency in approach as the decision to apply adulticides would be based on a more localized and individual neighborhood area needs dependent on field conditions. Under this alternative, it is expected that there would still be only occasional, temporary surge of mosquito activity based on environmental conditions in the area but adulticide application may be used when elevated mosquito populations are detected and pose an actual health threat. Larvicide operations would largely take place in unpopulated areas (backcountry) but some developed areas will experience short-term moderate adverse effects associated with the noise of low flying aircraft. Similarly, short-term minor adverse impacts would be noted in association with truck fogging operations with adulticides while short-term moderate adverse effects would be noted with aerial application of adulticides. Few short-term adverse or positive impacts would be impacted for public use of the Refuge or the surrounding community. Long-term impacts would be largely driven by a reduction in mosquito populations overtime because of enhanced efficiencies and a wide variety of operational tools to reduce mosquito populations. However, these improvements may go unnoticed by a large segment of the surrounding community for a majority of the year.

***Cumulative Impacts:*** In addition, it is estimated that alternative B would reduce insecticide use by private landowners by the District providing additional service to customers. Preventing private use of permethrin products, which are widely available may prevent over use and benefit the surrounding community of the general public. These benefits are considered negligible beneficial.

***Public Use and Access Conclusion:*** Negligible to minor adverse short-term, and long-term negligible beneficial impacts are likely. Cumulative impacts are only found to be linked with other pesticide use and are considered negligible beneficial under this alternative.

*4.4.4 Health and Safety*

***Impact Analysis***: Similar to alternative A. However, chemical control is lessened and thus exposure to pesticide products is minimized while attempting to optimize some level of mosquito control within the sensitive habitats. The difference in control of mosquitoes and impact on health and safety would minor to major beneficial considering the options that the District has to optimize control.

***Cumulative Impacts:*** Similar to alternative A**.**

***Health and Safety Conclusion:*** Similar to alternative A.

## 4.5 Alternative C – Larvicide Only. Environmentally Preferred Alternative No Chemical Control

### *4.5.1 Natural Resources*

***Impact Analysis***: Larvicides in the form of Bti are known to exhibit low toxicity to other macroinvertebrates and vertebrates and studies indicate negligible short-term localized impacts to non-target species in salt marsh systems (Lawler *et al*., 2000; Back *et al*. 1985; Federici 1995). Other studies have found that that applications of Bti and *s*-methoprene (not suggested for use here) do not impact the abundance and composition of non-target arthropod assemblages in subtropical saltmarshes, although more work on potential sub-lethal effects of the insecticides is needed (Russell et.al., 2009).

No direct toxic effects have been observed to any other vertebrate taxa in association with exposure to Bti (USEPA 1998). As *Bti* must be ingested and activated to have a toxic effect, there is no clear *Bti* exposure pathway for plants. In its Reregistration Eligibility Decision for *Bacillus thuringiensis*, USEPA was unable to find any reports of adverse effects to plants despite its extensive use on vegetation (USEPA 1998).

One study has shown that Bti and Bsp yielded good control of immature mosquito populations but also had a secondary effect of suppressing the growth of algal species, namely *Closterium* sp. and *Chlorella* sp (Su and Mulla 1999). This resulted in reduced algal productivity and photosynthesis and thus lower water turbidity and oxygen concentrations in the treatments than in the controls, especially during the hot season (Su and Mulla 1999). While this might represent a short-term localized effect the study indicated that water in treatments areas were discernibly clearer than in the controls. While not a primary objective of the mosquito control operations, this may represent an indirect minor beneficial effect associated with this method.

The effects of Bti and Bsp are short-term with compounds displaying short residence times.

Natural resources and sensitive species may be impacted negatively by emergency measures should a disease event occur and pesticide applications be deemed necessary. This approach would potentially result in minor to major short-term impacts during the disease event given broader spectrum application and use of chemicals may take place. However, emergency events would be unlikely as they are generally very rare and local. Overall, it is likely that a wide variety of natural resources would experience a major benefit from an elimination of pesticide products due to the sensitivity of some species as discussed in alternative A. Additionally, these benefits would compound overtime as species rebounded and secondary impacts accumulated throughout the ecosystem. However, it is estimated that alternative C would increase insecticide use by private landowners because of a perception of localized increases in adult mosquitoes in localized areas. Increasing private use of permethrin products, which are widely available may cause over use and adversely affect natural resources.

***Cumulative Impacts:*** Alternative C will provide negligible to minor cumulative beneficial impacts to natural resources. However, Alternative C will likely have beneficial direct and secondary cumulative impacts to resources with the elimination of use of chemical insecticides. As insecticides are known to have impacts to some species (see Alternative A), the elimination of these chemicals would prevent lethal or sub-lethal exposures, which would over time have cumulative major long-term beneficial impacts to ecosystem in combination with other restoration activities. No other cumulative impacts to natural resources are identified with the exception of fire suppression and restorations as stated in Alternative B.

***Natural Resources Conclusion:*** Alternative C would have major beneficial short and long term impacts. Cumulative impacts to natural resources similar to those described under alternative B.

*4.5.2 Aesthetic resources and visitor experience*

***Impact Analysis***: There would be a reduced ability to control mosquito numbers over time with this alternative. The direct and indirect adverse impacts to the visitor experience of this alternative would be localized, short-term, and minor. Mosquito populations could increase to pre 2003 densities at which minor adverse impacts could occur, but may be considered negligible to minor since a large portion of visitor use of trails occurs outside of mosquito season. Aesthetic resources and visitor experience value could be increased if populations of rare plants or butterflies are increased directly as a result of the reduction of insecticides. Secondary beneficial impacts could also result if bird or other species of aesthetic value are benefitted by alternative C.

***Cumulative Impacts:*** No other projects are ongoing are currently proposed within the Refuge that would contribute to cumulative impacts on visitor experience or aesthetic value associated with Alternative C.

***Aesthetic Resources and Visitor Experience Conclusion:*** Minor adverse and minor beneficial short-term, and long-term are likely. Cumulative impacts are expected to be minor and beneficial.

*4.5.3 Public Use and Surrounding Community*

***Impact Analysis***: Alternative C would have negligible to minor short-term adverse impacts in sporadic events on since there would be limited disruption of surrounding community area given the approach would reduce mosquito numbers by about 80%. Under this alternative, it is expected that there would still be only occasional, temporary surge(s) of mosquito activity based on environmental conditions and no other tools would be available to reduce numbers of nuisance mosquitos once emerged. Larvicide operations would largely take place in unpopulated areas (backcountry) but some developed areas will experience short-term moderate adverse effects associated with the noise of low flying aircraft. As a result, the surrounding community and public use may experience minor to moderate adverse impacts. The effectiveness of this strategy in controlling mosquitos is further illustrated by Figure 8.

***Cumulative Impacts*****:** It is estimated that alternative C could increase insecticide use by private landowners, as localized adult mosquitoes emergence would be possible and private landowners adjacent to the refuge would not have the same level of service from the District. Increasing private use of permethrin products, which are widely available, may cause minor adverse effects to surrounding community.

***Public Use and Surrounding Community Conclusion:*** Minor to moderate adverse short-term and long-term, impacts are likely. Minor adverse cumulative impacts are anticipated.

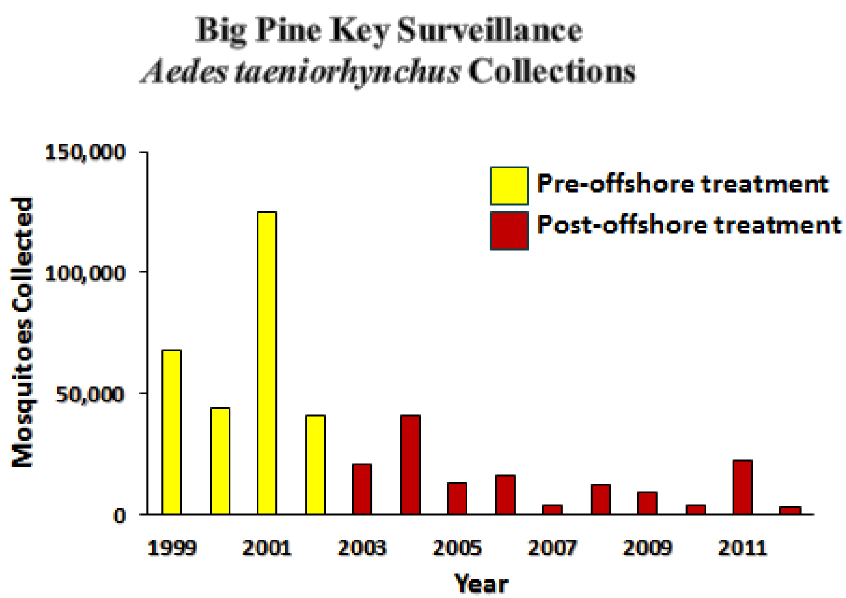


**Figure 8. Effectiveness of larvicide in reducing mosquito populations. Graphic evaluates the impacts of treating offshore areas and its contribution to reducing the overall mosquito numbers in the community. (Source: Florida Keys Mosquito Control District).**

*4.5.4 Health and Safety*

***Impact Analysis***: *Bti and Bsp* pose negligible risk to mammalian and human safety. *Per os* inoculations of Bti in animals and humans have shown no clinical symptoms (Glare and O'Callaghan 1998). Concerns have been raised concerning the solubilized δ-endotoxin of *Bti* that was activated in a laboratory setting, which was found to be toxic to mice when injected and cytolytic to human erythrocytes but this solubilization only occurs at high pH (such as in insect guts) and does not occur in mammalian guts (Glare and O'Callaghan 1998). The mosquito control operations that apply larvicide are conducted via on the ground operations (which are likely to have no effect in the short or long-term) and via helicopter operations which may have a minor to negligible adverse impact based on the risk posed from highly technical flight operations in close proximity to structures. Mosquito populations may increase from current averages without the use of adulticides which may increase the number of mosquitos and in turn the potential for a health and safety risk from infection or disease. However, this increase is expected to negligible to minor as larvicide has been demonstrated to reduce mosquito populations effectively and risk from infectious disease as a result of mosquitos is low. Should disease become a problem, the use of emergency measures to control a disease event is permitted under this alternative to avoid a human health emergency. Thus the impacts should be minor in both the short and long term in reference to disease. In terms of exposure, minor benefits could come from the elimination of mosquito control chemicals as the possibility of a toxic exposure by the general public or wildlife would be eliminated.

***Cumulative Impacts:*** It is estimated that alternative C could increase insecticide use by private landowners, as localized adult mosquitoes emergence would be possible and private landowners adjacent to the refuge would not have the same level of service from the District. Increasing private use of permethrin products, which are widely available, may cause minor adverse effects to health and safety.

***Health and Safety Conclusion:*** Short-term and long-term minor to moderate adverse and major beneficial impacts may be experienced under alternative C. Minor adverse cumulative impacts are anticipated.

## 4.6 Alternative D – No Mosquito Management

### *4.6.1 Natural Resources*

***Impact Analysis***: Alternative D would have the highest probability to benefit natural resources in both the short and long term due to the removal of all chemical and non-chemical insecticides from the Refuge's ecosystem. The result may likely be a negligible to minor short term gain as species (although species success or failure is clearly dependent on a number of variables, not just chemical exposure) that are indirectly and directly impacted. Although there can be negative impacts to wildlife from foreign diseases spread from mosquitos. West Nile virus has been isolated from Double-Crested Cormorants (Phalacrocorax auritus) in the Florida Keys (Allison et al. 2005). Mosquitoes collected in Monroe County were found infected with West Nile Virus (Hribar et al. 2003, 2004. One study of blood meal sources for Aedes taeniorhynchus found that about 80% of this species' blood meals are taken from the endangered Key deer (O'Meara and Edman 1975); however this is likely the result of relative prey abundance and reflects a natural process. The long-term gain would likely be more substantive with an estimated effect of a larger scale moderate benefit over time. However, emergency mosquito control operations could occur as a result of increased mosquito populations would likely have major short-term negative impacts to sensitive natural resources. It is estimated that alternative D would increase insecticide use, in the short and long-term, by private landowners in response to episodic adult mosquito emergences as District treatments in neighborhoods adjacent to the Refuge would be limited. Increasing private use of permethrin products, which are widely available may result in over use (beyond label instructions) and adversely affect natural resources.

***Cumulative Impacts:*** As insect populations are directly impacted by insecticides used in mosquito control, there would likely be a moderate and landscape-scale benefit from elimination of all mosquito control activities (basically, ecosystem wide decrease in chemical loading to the natural system would be deemed positive and would have synergistic effects with other restoration act ivies). In addition, secondary wide-scale major beneficial effects would likely occur as many invertebrate species serve beneficial roles in the ecosystem such as pollination of species, recycling of nutrients, and as prey species for larger organisms. As stated above, alternative D would increase insecticide use by private landowners and cumulatively could cause negligible to major adverse impacts.

***Natural Resources Conclusion:*** Large-scale long-term major benefits would likely be experienced with the elimination of all mosquito control for natural resources. Negative short term impacts may be experience in the event of an emergency spray. Cumulative impacts would be negligible to major depending on community interests.

*4.6.2 Aesthetic Resources and Visitor experience*

***Impact Analysis***: Alternative D would have minor short-term adverse impacts to aesthetics and visitor experience due to the fact that there may be off setting effects. While visitor experience may be moderately negatively impacted in short-term events such as peak mosquito flight seasons, there may be minor positive benefits in both the short and long-term through the result in potential for viewing of rare species given these species recover and populations increase as expected in the absence of insecticides. Under this alternative, it is expected that there would regular, temporary surge(s) of mosquito activity based on environmental conditions and no tools would be available to reduce numbers of nuisance mosquitos once emerged.

***Cumulative Impacts:*** Cumulative effects may increase the magnitude of the offsetting impacts described in the impact analysis above in combination with other restorations; this would likely result in a cumulative negligible to minor beneficial impact to aesthetic resources and visitor experience in terms of wildlife viewing

***Aesthetic Resource and Visitor Experience Conclusion:*** Given the conflicting outcomes described in impact analysis above; the alternative would likely result in a short-term and long-term major beneficial and adverse impacts to aesthetic resources and visitor experience. Cumulative impacts would likely be minor beneficial.

*4.6.3 Public Use and Surroundings*

***Impact Analysis***: Alternative D would have minor to moderate short-term adverse impacts to public use and the surroundings due to elevated mosquito levels. Public use experience may be moderately negatively impacted in short-term events such as peak mosquito flight seasons, there may be moderate to major adverse impacts in both the short and long-term to the surrounding areas as mosquito populations recover and populations increase as expected in the absence of insecticides. This might impact tourism and the local economics. Under this alternative, it is expected that there would be regular, temporary surges (seasonal) of mosquito activity based on environmental conditions and no tools would be available to reduce numbers of nuisance mosquitos through prevention of emergence or once emerged.

***Cumulative Impacts:*** As discussed above under natural resources, alternative D could increase insecticide use by private landowners because limitations of District treatment adjacent to Refuge lands. Increasing private use of permethrin products may result in over use and would cause negligible cumulative impacts.

***Public Use and Access Conclusion:*** Adverse impacts would likely result in a minor to moderate short-term adverse impact and a major long-term impact to public use and surroundings. Negligible adverse cumulative impacts were identified.

*4.6.4 Health and Safety*

***Impact Analysis***: Minor to moderate short-term and long-term adverse impacts are associated with this alternative in that adulticide or larvicide use would not be applied. Thus, residents in neighborhoods would be subject to exposure to high levels of bites during peak mosquito periods which or may not directly correlate to a health and safety risk.

Mosquitos can cause immunologically mediated reactions. While these mosquito allergies can be small to large and localized, others can be systemic. The reaction is sometimes called “skeeter syndrome;” however there is no specific threshold for number of bites that cause this effect rather it is related to the specific health status of the individual. The immune reaction is largely in response to proteins that exist within the mosquito saliva. Some 30 different proteins are present in the saliva and they include antiplatelet, anticoagulant, and vasodilator to facilitate feeding and sugar digestive and bacteriolytic enzymes (Crisp and Johnson 2013). Most of the population will exhibit some level of reaction but large localized reactions were reported in only 2.5% of the population in one study and individuals at greatest risk are those with greatest potential exposure (outdoor workers and those with lacking acquired immunity (Crisp and Johnson 2013). It has been shown that most people that experience immediate and delayed local reactions to mosquito bites that are immunologically mediated will see a decrease over time (Crisp and Johnson 2013; Peng and Simons 2007).

With any break in the skin, there is the potential for secondary (indirect) bacterial infection resulting from mosquito bites. These issues are generally minor and short-term and resolve without medical intervention. Some can result in cellulitis (inflammation of dermal and subcutaneous layers of the skin) with the potential to become more serious (Nasci 2013); however, these circumstances are less common. However, mosquito control of more serious outbreaks would be allowed under an emergency clause to protect human health and safety.

Short-term health impacts could also be experienced to health and safety if high dosages of mosquito controls had to be applied in an emergency spray scenario. As discussed above under natural resources, alternative D could increase insecticide use by private landowners because limitations of District treatment adjacent to Refuge lands. Increasing private use of permethrin products may result in over use and would cause negligible cumulative impacts.

***Cumulative Impacts:*** It is estimated that alternative D would increase insecticide use by private landowners lesser treatment by the District in areas adjacent to the Refuge. Increasing private use of permethrin products may result in over use and cause negligible to major cumulative impacts.

***Health and Safety Conclusion:*** Moderate to major short-term and long-term adverse impacts are associated with this alternative. Negligible to major adverse cumulative impacts could be identified,

### 4.7 Environmentally Preferred Alternative

Alternative C has been identified as the Environmentally Preferred Alternative since it is the alternative that will promote the environmental policy expressed in the National Environmental Policy Act (NEPA) (Sec. 101 (b). The specific objectives of NEPA that will be met by Alternative B include the following:

- *Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.*
    - Alternative C will provide negligible long-term impacts to natural resources and will not have any long-term adverse impacts on the environment.
- *Ensure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.*
    - Alternative C will improve the esthetics of the refuge’s natural communities by minimizing the bulk of the mosquito population without introducing added pesticides to the environment.
- *Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.*

- Alternative C will reduce the impact to the natural communities while still providing for the health and safety of the community. This alternative is cognizant of health and safety issues and provides safe procedures in implementing mosquito management.

- *Preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice.*
    - Alternative C will not impact preserve historic, cultural and natural aspects of our heritage. It will provide for protections to cultural and natural environments in a way that will enhance the Refuge visitor's understanding, use, appreciation, and enjoyment of these resources.
- *Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities; and*
    - Alternative C will improve mosquito control and thus increase opportunities for visitors and residents to enjoy the natural features in the Refuge.
- *Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.*
    - Alternative C will not have any adverse impact on renewable resources or depletable resources. Mosquitos are a natural component of the ecosystem and adding options for addressing mosquito management only enhances the Refuge's ability to be more efficient in mosquito management, thereby reducing waste of depletable resources.

## 4.8 Summary of Environmental Consequences

The following tables (Table 6 and 7) summarize and compare the likely results of implementing the No Action (*Status Quo*) Alternative, the Preferred (Phased) Alternative, the Larvicide Only Alternative and the No Chemical Control Alternative as they relate to the environment.

**Table 6. Summary of Environmental Consequences for Alternatives A and B.**

| Impact Topic | Alternative A - No Action | Alternative B - Preferred |
|---|---|---|
| **Natural Resources (Water, Vegetation and Wildlife)** | Short-term: Moderate to major adverse<br>Long-term: Moderate to major adverse but species specific<br>Cumulative: Negligible to minor adverse | Short-term: Minor to moderate adverse depending on level implemented and species<br>Long-term: Minor to major adverse impact but species specific<br>Cumulative: Negligible to Minor beneficial |
| **Visitor Use and Aesthetics** | Short-term: Minor adverse impact localized<br>Long-term: Negligible beneficial impact<br>Cumulative: Negligible beneficial or adverse impact | Short-term: Minor adverse impact localized<br>Long-term: Negligible beneficial and adverse impact<br>Cumulative: Negligible beneficial or adverse impact |

| | | |
|---|---|---|
| **Public Use and Surrounding Community** | Short-term: Negligible adverse impact<br>Long-term: Negligible beneficial impact<br>Cumulative: No beneficial or adverse impact | Short-term: Negligible to minor adverse impact<br>Long-term: Negligible beneficial impact<br>Cumulative: Negligible beneficial impact |
| **Health and Safety** | Short-term: Minor to major beneficial impact<br>Long-term: Negligible adverse impact associated with chemical exposure coupled with major beneficial impacts associated with disease<br>Cumulative: Negligible adverse and localized | Short-term: Minor to major beneficial impact<br>Long-term: Negligible adverse impact associated with chemical exposure coupled with major beneficial impacts associated with disease<br>Cumulative: Negligible adverse and localized |

**Table 7. Summary of Environmental Consequences for Alternatives C and D.**

| Impact Topic | Alternative C – Larvicide only | Alternative D – No Mosquito Management |
|---|---|---|
| **Natural Resources (Water, Vegetation and Wildlife)** | Short-term: Major beneficial<br>Long-term: Major beneficial<br>Cumulative: Negligible to minor beneficial | Short-term: Major beneficial or minor adverse (emergency spray)<br>Long-term: Major beneficial impact<br>Cumulative: Negligible to minor beneficial and negligible to major adverse. |
| **Visitor Use and Aesthetics** | Short-term: Minor adverse impact and minor beneficial<br>Long-term: Minor adverse impact and minor beneficial<br>Cumulative: Minor beneficial impact and adverse impact | Short-term: Minor adverse impact and minor beneficial<br>Long-term: Moderate adverse impact and minor beneficial<br>Cumulative: Minor beneficial impact |
| **Public Use and Surrounding Community** | Short-term: Minor to moderate adverse impact, sporadic events<br>Long-term: Minor to moderate adverse impact<br>Cumulative: Minor adverse impact | Short-term: Minor to moderate adverse impact<br>Long-term: Major adverse impact<br>Cumulative: Negligible adverse impacts |
| **Health and Safety** | Short-term: Minor to moderate adverse impact associated with disease, major beneficial associated with reduction in chemical exposure<br>Long-term: Minor to moderate adverse impact, major beneficial associated with reduction chemical exposure<br>Cumulative: Minor adverse impact | Short-term: Moderate to major adverse impact associated with disease and chemical exposure (emergency treatment)<br>Long-term: Moderate to major adverse impact associated with disease unless emergency treatment associated chemical exposure<br>Cumulative: Negligible to major adverse impact |

## 4.9 Mitigation

Mitigation measures are available for potential impacts of the proposed alternative even if those impacts are minor. Mitigation may be required under the special conditions of the SUP (special use permit) issued by the Refuge. The conditions of the permit may include mitigation measures if and when the environmental parameters exist to meet the conditions of a particular phase of the proposed action if implemented or as routine practice. Possible mitigation measures could be, but are not limited to, the following topics.

A. **Planting of host plant-** Host plant augmentation could mitigate impacts to critical habitat by creating habitat or enhancing habitat quality. Bartram's hairstreak and Florida leafwing butterflies are known to require the host plant *Croton linearis* to occupy an area (Salvato 1999). Bartram's scrub hairstreak butterflies that currently occupy Big Pine Key have been observed in areas greater than 1 hectare is size with an average density of croton plants of 0.1 plants/$m^2$ (USFWS unpublished data). To achieve this density of host plant, 1000 *Croton linearis* plants would be installed within a 1 hectare area. Monitoring and performance standards will be developed and included as a condition of the SUP. Any additional compliance (i.e., Section 106 of NHPA) that might be required to fulfill host plant augmentation mitigation would be addressed through the completion a detailed mitigation strategy.
B. **Monitoring-** Monitoring will be considered to be a method to reduce or eliminate the amount of potential impacts to resources over time. Studies that lead to improvement of management techniques, maximize efficiencies (refine buffer areas), refine protocols, or more effectively detect effect of mosquito management techniques on the environment will be used in an adaptive method to reduce and/or eliminate impacts to resources. Topics such as, but not limited to, monitoring of pesticide drift, product application rate and concentration efficacy, and impacts to resources may be required as mitigation under the special conditions of the SUP. Performance standards for monitoring projects will be defined under the conditions of the SUP if and when implemented.
C. **Habitat Improvement-** Habitat with the Refuge has changed drastically overtime leading to reductions in habitat for the Bartram's scrub hairstreak, Cape Sable thoroughwort, semaphore cactus, Florida leafwing, sand flax, wedge spurge, Big Pine partridge pea, and Blodgett's silver bush (USFWS 1998, USFWS 1999, USFWS 2013 (Fed. Reg. 79 FR 1551 1590 and 78 FR 49878 49901)). Mitigations which improve habitat would compensate for any potential impact by replacing or providing additional habitat which has been shown to benefit the aforementioned species. Habitat could be improved through exotic treatments, prescribed fire or mechanical treatments; the rare plant species listed above have been shown to benefit from and require disturbance to maintain sub-climax pine rockland (Carlson et al. 1993, Snyder 2005, Liu et al. 2005, Slapcinsky et al. 2010, Anderson et al. 2012). Monitoring and performance standards will be determined provided and determined annually through the SUP process. At such time when this mitigation measure is implemented compliance under section 106 of NHPA will be completed prior to any actions.

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**63795-63821   10/24/2013   1018-AY08 Docket ID: FWS-ES-R4-2012-0076**
***Action: Final rule.***

U.S. Fish and Wildlife Service.  2013. Endangered Species Status for the Florida Bonneted Bat **61003-61043   10/02/2013   1018-AY15 Docket ID: FWS-R4-ES-2012-0078**  ***Action: Final rule.***

U.S. Fish and Wildlife Service. 2014. Designation of Critical Habitat for Chromolaena frustrata (Cape Sable Thoroughwort)  **1551-1590   01/08/2014   1018-AZ51 Docket ID: FWS-R4-ES-2013-0029**  ***Action: Final rule.***

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The Refuge would like to acknowledge the contribution of large sections of this document as being developed by the San Pablo NWR and the Stone Lakes NWR. Chemical toxicity information was also provided by the National Integrated Pest Management Coordinator, Cindy Kane. Sections pertaining to policy and chemical profiles that were appropriate and applicable to this refuge were adopted with limited edits. In addition, portions of the CCP were utilized in the affected environment section of this document. Specific acknowledgements for their contributions include:

Mari K. Reeves (FWS R7)
Anne Morekill (FWS R8)
Don Brubaker (FWS R8)
Giselle Block (FWS R8)
Winnie Chan (FWS R8)

Reviewers included:

Cindy Kane, National Integrated Pest Management Coordinator, FWS
Whit Lewis, Regional Integrated Pest Management Coordinator, FWS
Richard Warner, Regional NEPA Coordinator, FWS
Maury Bedford, Deputy Area Supervisor, Area II, Region 4, FWS
Sylvia Pelizza, Area Supervisor, Area II, Region 4, FWS

## *7.0 List of Agencies, Tribes, Individuals, and Organizations Consulted*

*This list represents a partial list of individuals that will receive a copy of this document for review. Anyone requesting a copy of the EA will be provided one within the comment period. Any omission is inadvertent.*

| | | |
|---|---|---|
| Dana Brian<br>Florida Park Service<br>Mail Stop 530, Carr Bldg<br>3900 Commonwealth Blvd<br>Tallahassee, Fl 32399-3000 | Randy Grau, FWC<br>FKs Wildlife & Environ. Area<br>P. O. Box 43041<br>Big Pine Key, FL 33043 | Florida Keys Eco-Discovery Center<br>33 East Quay Rd.<br>Key West, FL 33040 |
| Florida DEP<br>2796 O/S Hwy<br>Marathon, FL 33050 | Libby Moore<br>Florida Keys Land & Sea Trust<br>5550 O/S Hwy<br>Marathon, FL 33050 | Florida Fish & Wildlife CC<br>Project Wild Coordinator<br>501 15th Court NE<br>Winter Haven, FL 33881 |
| Watchable Wildlife Program<br>620 S. Meridian St<br>Tallahassee, FL 32399-1600 | Larry Williams, Field Supervisor<br>US FWS Ecological Services | Sean Morton, Superintendent<br>Florida Keys National Marine Sanctuary |

| | | |
|---|---|---|
| | South Florida Field Office<br>1339 20th Street<br>Vero Beach, FL 32960-3559 | 33 East Quay Road<br>Key West, FL 33040 |
| Endangered Species Branch Chief<br>NMFS Protected Resources Division<br>263 13th Ave. South<br>St. Petersburg, FL 33701 | James E. Billie<br>Chairman, Tribal Council<br>Seminole Tribes of Florida<br>6300 Sterling Rd.<br>Hollywood, FL 33024 | Colley Billie<br>Chairman General Council<br>Miccosukee Tribe of Indians of Florida<br>P. O. Box 440021<br>Miami, FL 33144-0021 |
| Land Resources Manager<br>Miccosukee Tribe of Indians of Florida<br>Real Estate Services<br>P.O. Box 440021<br>Miami, FL 33144-0021 | Muscogee (Creek) Nation of Oklahoma<br>A. D. Ellis, Principal Chief<br>P. O. Box 580<br>Okmulgee, OK 74447 | Park Manager<br>Dry Tortugas National Park<br>P.O. Box 6208<br>Key West, FL 33041 |
| United States Coast Guard<br>100 Trumbo Rd.<br>Key West, FL 33040 | Ed Barnham, Naval Air Station Key West Natural Resources Division, Code N45<br>Building A629<br>P. O. Box 9001<br>Key West, FL 33040 | Lower Keys Chamber of Commerce<br>Director<br>P. O. Box 430<br>Big Pine Key, FL 33043-0511 |
| Commissioner George Nuegent<br>25 Ships Way<br>Big Pine Key, FL 33043 | Monroe County Growth Management<br>Marathon Government Center<br>2798 Overseas Highway<br>Marathon, FL 33050 | Mark Rosch<br>Monroe County Land Authority<br>1200 Truman Avenue, Suite 207<br>Key West, FL 33040 |
| Director<br>Florida Keys Mosquito Control District<br>5224 College Road<br>Key West, FL 33040 | Monroe County Environmental Resource Department.<br>2798 Overseas Highway<br>Marathon, FL 33050 | Florida Keys Audubon Society<br>P.O. Box 1573<br>Key West, FL 33040 |
| Monroe County Tourist Development Council<br>1201 White St., Suite 102<br>Key West, FL 33040 | President<br>Big Pine Key Civic Association<br>P.O. Box 430190<br>Big Pine Key, FL 33043 | Keynoter Publishing Company<br>P. O. Box 500158<br>Marathon, FL 33050-0158 |
| Director<br>Key West Botanical Garden<br>P. O. Box 2436<br>Key West, FL 33045 | President<br>Last Stand<br>P. O. Box 146<br>Key West, FL 33041 | Chairperson<br>Florida Keys Council for People, with Disabilities<br>1100 Simonton Street, Suite2-257<br>Key West, FL 33040 |

| | | |
|---|---|---|
| Reef Relief, Inc.<br>P. O. Box 430<br>Key West, FL  33041 | Rita Cotter<br>Monroe County Director for Congressman Joe Garcia<br>1100 Simonton Street<br>Suite 1-213<br>Key West, Fl 33040 | Florida Department of Transportation<br>1000 NW 111th Avenue<br>Miami, FL  33172 |
| The Free Press - Marathon<br>6363 Overseas Highway<br>Marathon, FL  33050 | Key West Citizen<br>3420 Northside Dr.<br>Key West, FL  33040 | News Barometer<br>Steve Estes, Editor<br>P. O. Box 431639<br>Big Pine Key, FL  33043-1639 |
| Miami Blue Chapter<br>P.O. Box 141667<br>Coral Gables, FL  33114 | Michelle B. Nowlin<br>Supervising Attorney and Senior Lecturing Fellow<br>Duke Environmental Law and Policy Clinic<br>210 Science Drive, Box 90360<br>Durham, NC  27708-0360 | Jeffrey Glassberg, Ph.D.<br>President, NABA<br>4 Delaware Rd.<br>Morristown, NJ 07960 |
| Florida Division of Forestry<br>400 Key Deer Blvd.<br>Big Pine Key, FL  33043 | Florida Department of Environmental Protection<br>3900 Commonwealth Blvd.<br>Tallahassee, FL  32399 | USDA<br>APHIS Wildlife Services<br>2820 East University Avenue<br>Gainesville, FL 32641 |
| Park Manager<br>Bahia Honda State Park<br>36850 Overseas Highway<br>Big Pine Key, FL  33043 | Florida Department of Transportation<br>1000 NW 111th Avenue<br>Miami, FL  33172 | South Florida Water Management District, Suite B<br>10 High Point Road<br>Tavernier, FL  33070 |
| Institute for Regional Conservation<br>22601 SW 152 Avenue<br>Miami, FL  33170 | Key Deer Protection Alliance<br><br>P. O. Box 430224<br>Big Pine Key, FL  33043-0224 | Florida Fish and Wildlife Conservation Commission<br>8535 Northlake Blvd.<br>West Palm Beach, FL 33412 |
| Superintendent<br>Everglades and Dry Tortugas National Parks<br>40001 State Road 9336<br>Homestead, FL 33034 | FAVOR<br>P. O. Box 431840<br>Big Pine Key, FL  33043-1840 | The Nature Conservancy<br>Florida Keys Office 127 Industrial Road, Suite D Big Pine Key, FL 33043 |

The above listing is not intended to be a complete listing.  Additional distribution is expected.

**Public Comment**

If you wish to comment on the environmental assessment (EA), you may mail comments to the name and address below. This environmental assessment will be on public review for 30 days. The EA has been posted and is available for public review on the Refuges web site at http://www.fws.gov/nationalkeydeer/ and click on the "*Mosquito Management Plan EA*" link. Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment – including your personal identifying information – may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

COMMENTS MUST BE RECEIVED BY April 10, 2014. Written comments may be received later if postmarked by April 10, 2014. Please address written comments to:

Refuge Manager
Florida Keys National Wildlife Refuge Complex
28950 Watson Blvd
Big Pine Key, Florida 33043

Comments may also be submitted to the Refuges email address at keydeer@fws.gov

# 8.0 Appendices

*Appendix A* – Compatibility Determination for Mosquito Control Operations on the Refuge

*Appendix B* – Example Pesticide Use Proposals

*Appendix C* – Program Response Guidelines to Mosquito-Borne Arboviral Activity

*Appendix D* – Monitoring of immature and adult mosquitoes on the Refuge: Historical Values and Established Thresholds

*Appendix E* – Pesticide product descriptions /MSDS

*Appendix F* – Effects of the larvicide Bti (Bacillus thuringiensis var. israelensis) used in mosquito control

*Appendix G* – Effects of pyrethroid adulticides used in mosquito control

*Appendix H* - Florida Department of Health Response Plan for Mosquito-borne Diseases

## Appendix A: Compatibility Determination for Mosquito Control Operations on the Refuge

Extracted from the Refuge CCP (USFWS 2009):

**Description of Use:** *Mosquito Control Operations (National Key Deer Refuge and Great White Heron NWR)*

The Florida Keys Mosquito Control District (District) conducts a program to monitor, research, and control mosquito populations on the National Key Deer Refuge and Great White Heron NWR. Due to the diversity of the mosquito fauna in the Keys, the subtropical climate, and the proximity of the Keys to the Caribbean, where active transmission of several disease organisms is ongoing, the District believes that a potential exists for the transmission and spread of mosquito-borne diseases. These diseases include malaria, St. Louis encephalitis, eastern equine encephalitis, and West Nile virus.

The District's work is performed under a refuge-issued special use permit. The District and the refuges have developed an integrated pest management program that includes the use of both larvicide (*Bacillus thuringiensis israelensis* or BTI) and adulticide (naled) to control mosquitoes. BTI is a selective microbial insecticide targeting mosquito larvae and some other nontarget dipterans, with minimal impact to other non-target species. By treating mosquito breeding areas on the backcountry keys with BTI, the District has demonstrated that it can dramatically reduce the need to use broad-spectrum adulticides on the mainline keys to control mosquitoes. Refuge sites 206 Lower Florida Keys Refuges to be treated with larvicide include all areas within the National Key Deer Refuge and Great White Heron NWR that are serviced by primary and secondary roads. In addition, islands not connected by roads (e.g., Annette, Mayo, Porpoise, Johnson, Horseshoe, Howe, Raccoon, Pumpkin, Johnston, Little Pine Keys, Johnson Keys, and Water Keys) may be aerially treated with BTI.

Naled has been used as a mosquito adulticide in the Keys for more than 30 years. Refuge lands are interspersed with private property and development, making it impossible to develop separate mosquito spraying programs for both public and private lands. Control of mosquitoes in developed areas of the Keys requires that some refuge lands be treated. Areas to be treated will consist of all refuge lands adjacent to and interspersed within existing human development and serviced by primary and secondary roads. This includes refuge lands on Big Pine, No Name, Middle Torch, and Big Torch Keys, consisting of 6,000 acres; however, naled will not be applied in the Watson Hammock or Cactus Hammock areas on Big Pine Key or on the southern half of No Name Key. On more isolated refuge lands of Cudjoe, Sugarloaf, and Boca Chica Keys, as well as the Saddlebunch Keys, only privately owned and developed areas will be sprayed; therefore, refuge properties on these Keys will not be affected by mosquito spraying.

The District and Service continue to collaboratively assess the effectiveness of mosquito control activities and evaluate impacts on priority species; consequently, operations will continue to be reviewed and adjusted as necessary.

**Availability of Resources:** All aspects of this mosquito spraying program will be financed and administered by the District. Refuge and Ecological Services' staffs will participate in the annual review and evaluation of mosquito control operations and special use permit compliance, and oversee field studies on biological impacts of mosquito spraying on non-target species.

**Anticipated Impacts of the Use:** Naled is a broad-spectrum adulticide that can kill a wide variety of insects, fish, and wildlife. Naled is characterized as highly toxic to bees and aquatic invertebrates, moderately to highly toxic to fish, moderately to highly toxic to birds, and moderately toxic to mammals; however, the Environmental Protection Agency has determined that naled used in mosquito control programs according to label directions does not pose unreasonable risks to wildlife or the environment. With the exception of the Stock Island tree snail (*Orthalicus reses reses*), the South Florida Multi-Species Recovery Plan does not list mosquito spraying as an identified threat to any federally listed threatened or endangered species in the Lower Keys.

Environmental risk assessments conducted on the Key deer, silver rice rat, eastern indigo snake, and Lower Keys marsh rabbit suggest that naled is not likely to cause acute or chronic poisoning given the application rates and application frequencies proposed by the District with stipulations under the refuge special use permit. Because the Level of Concern standards for endangered species are much higher than those set for other wildlife, it can be assumed that the aerial application of naled is not likely to result in acute or chronic toxicity in other resident and nonresident wildlife species. As a result of pesticide drift, some naled may inadvertently contaminate aquatic environments; however, aerially applied naled will reach the water surface at reduced concentrations and degrade rapidly, thus posing little or no risk to fish populations in the Keys.

Laboratory studies have shown that naled is highly toxic to bees and estuarine/marine invertebrates. It can be assumed that terrestrial invertebrates, including butterflies and tree snails, are also highly susceptible to naled poisoning. Any adverse effects of naled to vertebrate and invertebrate communities would be minimized through the application of the pesticide in concert with an expanded use of BTI throughout the Lower Keys. Reduced application frequencies would minimize the numbers of invertebrates directly poisoned by naled. Reduced applications would also result in applications being spaced farther apart in time. This would allow unaffected eggs, larvae, pupae, and adult's time to complete their life cycles, allowing for a rapid buildup of invertebrate populations to pre-application levels.

BTI is a microbial larvicide that is applied to aquatic habitats where mosquito larvae occur since it must be ingested to be effective. Because it must be ingested by the mosquito larvae, it is largely species-specific and poses a minimal threat to non-target vertebrate and invertebrate species. This bacterium produces a crystal-containing spore that causes fragment toxicity when ingested by the mosquito larvae. It is species-specific and affects the larvae of mosquitoes, black flies, and midges. Of these, only mosquitoes are found in the Keys in any numbers. Experimental testing has shown no demonstrated effect against other aquatic insects, including dragonflies, damselflies, mayflies, stoneflies, caddis flies, and water beetles. Other invertebrates, such as Daphnia, cyclops, rotifers and crustaceans, are also not susceptible to BTI. A summary review of mammalian toxicity studies has revealed no known mammalian health effects resulting from BTI. It is not a phytotoxic and has shown no effect on seed germination or plant vigor.

**Public Review Comment:** Public meetings were held on June 9 and 10, 2008 in Monroe County, Florida. The public review and comment period for the compatibility determinations coincided with the review of the Draft Comprehensive Conservation Plan and Environmental Assessment for the Lower Florida Keys Refuges as they were included in Appendix F. Comments were accepted for a month-long period ending June 23, 2008.

**Determination (check one below):**

___ Use is Not Compatible
_X_ Use is Compatible with Following Stipulations

**Stipulations Necessary to Ensure Compatibility:**

- Areas to be treated with naled will be limited to refuge lands on Big Pine, No Name, Middle Torch, and Big Torch Keys.
- Naled will be aerially applied at rates of 0.0785 pounds active ingredient/acre or less.
- Naled will be applied at the optimal droplet size of 22-29 microns using ultra-light volume spray equipment.
- All applications of naled will be made during favorable weather conditions for maximum effectiveness against mosquitoes and to avoid drift.
- The application of naled is prohibited in Watson Hammock and Cactus Hammock on Big Pine Key, as well as all areas on No Name Key south of Watson Boulevard.
- Naled will be applied in concert with the expanded use of BTI to reduce the number of applications of naled to nine per season with applications spaced no closer than 5 days apart. This will minimize the adverse effects to invertebrates from this broad-spectrum adulticide.
- Refuge sites to be treated with BTI include all areas within the National Key Deer Refuge and Great White Heron NWR serviced by primary and secondary roads. Treatment of backcountry islands with BTI will be limited to Annette, Mayo, Porpoise, Horseshoe, Howe, Raccoon, Pumpkin, Johnston, and Little Pine Keys, Water Keys, and Johnson Keys.

**Justification:** Refuge lands are tightly interspersed with private property and residential and commercial development, making it impossible to separate mosquito control programs for the two areas. Controlling mosquitoes in developed areas of the Keys requires that some refuge lands also be treated. It is the desire of the refuges to ensure that the required control of mosquitoes in the Lower Florida Keys Refuges conducted with as little use of the adulticide naled as possible. The District believes much of the naled applied on refuge lands is the result of mosquitoes migrating from large hatches on adjacent backcountry islands; therefore, the Service has agreed to allow larvicide application on backcountry wilderness islands for an anticipated reduction in the overall application of naled.

Mosquito control is necessary to protect the general public from the threat of mosquito-borne diseases in the Florida Keys. Furthermore, a mosquito control program which reduces nuisance pests is vital in supporting the ability of the Florida Keys to remain a tourist destination, as well as maintaining a comfortable environment for both residents and tourists alike. The Service must strive to be a good neighbor and develop management programs that not only protect its trust resources but that also do not adversely affect the communities that surround them.

**Mandatory 10-year Re-evaluation Date: 09/14/2019**

**Appendix B: Example Pesticide Use Proposals (example provided is 2013 Larvicide PUP)**

PUP Number: R4-13-41580-002
Treatment Site: National Key Deer Refuge
Product Trade Name: VectoBac CG
Region: 4 Org Code: 41580 Year: 2013
State/County: FL/MIAMI-DADE
Duty Station: National Key Deer Refuge
Management Unit(s): National Key Deer Refuge, Great White Heron NWR
Map Attached: Yes
Status: Approved by WO with Modifications
Pesticide Use Pattern:
Need for Treatment: Public Health Protection
Treatment Site: Aquatic & Wetlands
Management Action/Economic Threshold:
Bacillus thuringiensis israelensis (Bti) will be applied year-round when larva of mosquitos are detected.

How does this pest(s) interfere with achieving habitat and/or wildlife management objectives?:
Mosquitos may cause spread of unwanted disease in dense populations of endangered species, such as Key deer. However, there are no direct or immediate causes of interference to habitat or wildlife management objectives.

Target Pest(s): Mosquitoes (Aedes sp.)
Mosquitoes (Culex sp.)
Mosquitoes, black salt marsh (Ochlerotatus taeniorhynchus)
Mosquitoes (Psorophora sp.)
Mosquitoes (Culiseta sp.)
Mosquitoes, Brads (Anopheles bradleyi)
Mosquitoes, common malaria (Anopheles quadrimaculatus)

Pesticides:
Trade Name: VectoBac CG
Common Name: Bacillus thuringiensis israelensis
U.S. EPA Registration Number: 73049-19
Manufacturer: Valent BioSciences, Corp.
Label URL: http://www.myadapco.com/res/pdf/labels/VectoLex%20CG%20Label.pdf
MSDS URL: http://www.myadapco.com/res/pdf/msds/VectoLex%20CG%20MSDS.pdf

Pesticide Details:
Restricted Use Pesticide (Y/N): N
Is the treatment site type listed on the label (Y/N): Y
Is pest listed on label: Y

If the crop, type of vegetation, or site type is not listed, is there a current Section 18 exemption under which you are proposing to operate (Y/N): N
If the crop, type of vegetation, or site type is not listed, is there a current Section 24c exemption under which you are proposing to operate (Y/N): N
Supplemental Label for Proposed Use (Y/N): N

Tank Mix (Y/N): Y
Adjuvants: None
Other Ingredients: insecticidal toxins
Number of Applications: 20
Application Period: January - December
Application(s):
Note: Proposed pesticide applications in this PUP may not reflect actual on-the-ground pesticide applications. Specifically, PUPs may include different application scenarios (e.g., spray equipment and rate combinations) to capture the breadth of application options that could be used to treat target species. Actual pesticide applications must be compliant with the pesticide label(s). The completed pesticide usage report will contain actual usage information associated with this PUP.

| Trade Name | Rate & Unit | Method | Equipment |
|---|---|---|---|
| VectoBac CG | 10 lbs/acre | Broadcast | Hand broadcast |
| VectoBac CG | 10 lbs/acre | Aerial | Helicopter |

Size of Treatment Area: 13,000.00 acres
REI (Restricted Entry Interval): 5 Days
Applicator Information: Other Agency

Approved IPM Plan (Y/N): N
IPM Plan Year:
Non-Chemical Controls Considered (Y/N): Y
IPM Strategy:
Bti larvicide is a non-chemical strategy for limiting chemical pesticide use. This technique has been shown to reduce chemical mosquitocide use by approximately 80-90%.The Florida Keys Mosquito Control District is authorized under a Refuge Special Use Permit to apply the mosquito larvicide Bti to control mosquito populations and minimize the use of adulticiding on refuge lands. Bti larvicide may be applied on Refuge lands within the National Key Deer Refuge serviced by primary and secondary roads. In addition, backcountry keys in the Great White Heron NWR including Annette Key, Mayo Key, Porpoise Key, Johnson Keys, Horsehoe Key, Howe Key, Raccoon Key, Pumpkin Key, Johnston Key, Water Keys, Little Knockemdown Key, Top Tree Hammock Key, and Little Pine Key may be treated with Bti. The goal of this integrated approach is to minimize the frequency of adulticide missions refuge-wide by applying larvicide in the backcountry to kill emerging mosquitoes that migrate from backcountry islands to the human-inhabited islands; and consequently, to minimize the use of broad-spectrum adulticides and their potential effect on threatened and endangered species in concert with the District's mission to reduce public nuisance and health threats caused by high

numbers of mosquitoes. Treatment replicates per site are highly variable (spatially and temporally) as areas can change with tides, rain, wind direction, and other factors. Treatments may occur 1 to 40 times in any given marsh location. However, only small percentages of the total project area are treated during any given mission. Areas are only treated in mosquito larvae are located by on the ground staff to ensure the need treatment.

Best Management Practices:

Application at wind speeds less than 10 mph (but not inversion conditions) - must follow label.

Calibrate application equipment.

Field scouting/monitoring before pesticide application.

Pesticide application buffers around sensitive areas.

Use lowest effective application rate.

Vegetative buffers.

Additional Best Management Practices:

Treatment Site Conditions:

Distance to Nearest Non-Target Surface Water:  N/A

Non-Target Surface Water Type:  N/A

Non-Target Species At/Near Treatment Area during or immediately after treatment (taxonomic groups):

Amphibians, Crustaceans, Fish, Fish-eating birds, Honeybees, Mammals, Mussels, Native Lepidopterans, Native Pollinating Insects, None, Passerines, Reptiles, Sensitive Plants, Shorebirds, Waterfowl

Are Impacts to Non-Target Species Expected? (Y/N): N

Federally Listed Species and Critical Habitat(s):

Key:

NE = No Effect

NLAA = Not Likely to Adversely Affect

LAA = Likely to Adversely Affect

JAM = Jeopardy/Adverse Modification

NJNAM = No Jeopardy/No Adverse Modification

Note: ESA Documentation is required for NE, NLAA, LAA, JAM and NJNAM Effects Determinations. Please ensure you are in compliance with the current Endangered Species consultation procedures.

| Species Common Name/Critical Habitat | Effects | Optional: Provide ESA text here or attach documents |
| --- | --- | --- |
| Bartram's hairstreak Butterfly | NLAA | |
| Big Pine partridge pea | NLAA | |
| Blodgett's silverbush | NLAA | |
| Cape Sable Thoroughwort | NLAA | |

Deltoid spurge NLAA
Eastern indigo snake NLAA
Elkhorn coral NLAA
Florida leafwing Butterfly NLAA
Garber's spurge NLAA
Key deer NLAA
Key tree cactus NLAA
Lower Keys marsh rabbit NLAA
Rice rat NLAA
Sand flax NLAA
Stock Island tree snail NLAA

Are there any other federally listed, proposed or candidate species or critical habitat(s) that occur (or may occur) at or near the site that are not listed above? (Y/N): N

Are there any state listed, proposed or candidate species or their habitats or other species of concern that may be affected by the proposed activity? (Y/N): N

Contact Person: Chad Anderson
Phone: 305-872-2239x205
Fax: 305-872-3675

Project Leader: Chad Anderson
Phone: 305-872-2239x205
Fax: 305-872-3675

Alternate Contact: Nancy Finley
Phone: 305-872-2239 X209
Fax: 305-872-3675

Submitter Comments:

Reviewer Information:
Date: 08/07/2013
Reviewer: chad_anderson@fws.gov
Reviewer Type: Field (Dis)Approver
Action Taken: Reviewed by Field (Dis)Approver and forwarded to RO
Comments: N/A
To the best of the Field Approver's knowledge, this PUP is accurate, complete, and the information provided is in compliance with the pesticide label(s), with Service Policy, and with any pertinent local and State laws, regulations, and restrictions concerning each pesticide's use.

Date: 08/08/2013
Reviewer: whit_lewis@fws.gov

Reviewer Type: Regional (Dis)Approver
Action Taken: Reviewed by RO (Dis)Approver and forwarded to WO
Comments: N/A

Date: 01/09/2014
Reviewer: cindy_kane@fws.gov
Reviewer Type: National Reviewer
Action Taken: Reviewed by WO Reviewer with modifications
Comments: review the number of product applications for 2013 to inform the 2014 proposed applications.

Approval Period: 1 year Approval Expires: 12/31/2013

## Appendix C: Program Response Guidelines to Mosquito-Borne Arboviral Activity

**Florida Keys Mosquito Control District**
**Program Response Guidelines to Mosquito-Borne Arboviral Activity**
**Big Pine Key & No Name Key**
**(West Nile Virus, Dengue, Chikungunya)**
**Revised Feb. 17, 2014**

### Level 0 - Inter-epidemic Periods

**Status:**

- No human cases of any mosquito-borne diseases occurring on or near Big Pine Key or No Name Key
- Disease vector mosquito activity average to low (based on historical data for Big Pine Key and No Name Key)
- Mosquito infection rates: 0 (if testing occurring)
- WNV Vector index: 0 (if testing occurring)

**Operational Response:**

1. Routine analysis of comparison of present surveillance data with historical data; assess response and efficacy.
2. Analyze and map data from prior years to develop surveillance strategy and review placement of mosquito-trapping sites.
3. Continue standard surveillance (CO2-baited light traps, Landing Rate Counts)
4. No mosquito testing
5. Adult mosquito treatments with methods and in locations specified in other sections of this document.

**Communication Activities:**

1. Updating of public outreach plan with any new information (e.g. at-risk populations).
2. Update FAQ's and other information on FKMCD website that may be needed if disease management spraying occurs.

### Level I - Increased Risk

**Status:**

- No human cases reported
- Evidence of average or higher than average *Culex* or *Ae. aegypti* species mosquito populations (as compared to available historical population data for the area)
- Mosquito WNV infection rates* >0 (if mosquitoes are being tested)
- WNV Vector index* >0 (if mosquitoes are being tested)

**Probability of Human Outbreak:** Low

**Operational Response:**

1. Continue standard surveillance program ($CO_2$-baited light traps) but cease Landing Rate Counts in areas of suspected disease foci due to transmission risk to FKMCD employees

2. Consider adding Gravid Traps to focus on egg-carrying Culex females in a grid pattern across Big Pine Key / No Name Key if the concern is WNV; If the concern is DENV or CHIKV, consider adding BG traps (or equivalent) to focus on Aedes aegypti or Ae. albopictus (if present)
3. Consider placing additional traps in areas of potential disease foci (e.g., near suspected human cases, near bird roosting sites)
4. Consider testing of mosquitoes for suspected virus
5. Intensify larval control against suspected vector mosquito species.
6. Brief Refuge Manager and Health Department on surveillance activities, mosquito-borne virus epidemiology and trigger points for recommendation of emergency control measures.
7. In addition to standard adult control specified elsewhere in this document, consider handheld, truck ULV treatments and/or barrier treatments in sections of the Critical Habitat areas if disease foci are suspected.

**Communication Activities:**

1. Establish communication channels between appropriate Heath Department and Refuge staff.
2. Ensure online information is up to date and prepare for ongoing, timely updates.
3. Initiate public education program on mosquito source reduction and risk reduction practices

**Communication Topics:**

- West Nile Virus, dengue, and/or Chikungunya basics
- Wear repellent
- Eliminate breeding sites

**Level II – Low Disease Activity**

**Status:**

• Sporadic human cases are being reported
• No infected human blood donors have been reported
• Vector mosquito populations increasing, but below historical average for that time period
• WNV Mosquito infection rate* < 2 per thousand (0.2%)
• WNV Vector Index* < 0.5

**Probability of Human Outbreak:** Low – Moderate

**Operational Response:**

1. Increase density of CO2/light traps weekly locations.
2. Initiate Gravid Traps to focus on egg-carrying Culex females in a grid pattern across Big Pine Key / No Name Key if the concern is WNV; If the concern is DENV or CHIKV, initiate BG traps (or equivalent) to focus on Aedes aegypti or Ae. albopictus (if present)
3. Analyze and map surveillance data to identify areas of increased risk.
4. Initiate or intensify mosquito pool submissions from surveillance program
5. Brief Refuge Manager and Health Department on surveillance findings and need for quick action if activity rapidly increases.
6. Continue all methods indicated in previous Levels.

7. Increase larval monitoring and control where necessary.
8. Perform barrier treatments and/or handheld ULV spraying at homes, and at adjacent homes of known or suspected cases and suspected adult mosquito harborage areas (This may occur in Critical and/or Occupied areas with consultation with FWS, using techniques which minimize potential impact on threatened or endangered species [e.g., adulticiding during hours outside of butterfly flight times, when wind direction is less likely to drift insecticide over host plants, etc.])
9. Begin truck adulticide control in areas where there is evidence of arbovirus activity.

**Communication Activities:**

1. Notify local agencies, media and the public of positive findings.
2. Increase public education activities
3. Continue to regularly update online information, including maps illustrating risk areas.
4. Optional: targeted outreach to high-risk areas including:
    a. Door hangers
    b. Online outreach
    c. Posters and signage
    d. Coordination with Monroe County School District regarding educational programs and potential treatments at schools.

**Communication Topics Overall:**

- Disease transmission basics
- Wear repellent
- Eliminate breeding sites
- Spraying decision parameters
- How to get notified of mosquito spraying

**Communication Topics To Targeted Areas:**

- Disease risks and symptoms
- Wear repellent
- Spraying decision parameters
- How to get notified of mosquito spraying

### Level III – Increasing Disease Activity

**Status:**

• More than one human case being reported per week in Lower Keys – OR –
• More than one positive human blood donor reported for the season.

-AND-

• Vector mosquito populations increasing and at or above historical average by 1 standard deviation for that time period

– OR –

• *Culex* Mosquito infection rates* of > 3.0 per thousand (0.3%) and increasing – OR –

• WNV Vector index* > 0.75 and increasing

**Probability of Human Outbreak:** High

**Operational Response:**

1. Enhanced communications between FKMCD and Health Department regarding positive findings and anticipated response activities. Refuge Manager apprised of threat levels and activities on an ongoing basis.
2. Identify geographic areas, by mapping surveillance data, where virus transmission appears most active.
3. Continue all methods indicated in previous Levels.
4. Commence ground adulticide operations in all areas of Big Pine and No Name Keys which have potential disease transmission activity (This may occur in Critical and/or Occupied areas with consultation with FWS, using techniques which minimize potential impact on threatened or endangered species [e.g., adulticiding during hours outside of butterfly flight times, when wind direction is less likely to drift insecticide over host plants, etc.]). Begin aerial adulticiding.

**Communication Activities:**

1. Coordinate press releases and a wide range of other activities to keep the public informed of affected areas, focusing on exposure risk reduction practices and public education of the disease threat.
2. Intensify existing public education activities and initiate public education/information on the adulticide program
3. Notify residents of affected and adjacent areas and people on the subscription notification list.
4. Notify appropriate agricultural interests (i.e. bee keepers, organic growers, etc.) and pesticide sensitive individuals of intended adulticiding activities, times, affected areas, etc. Also notify residents in nearby areas that will *not* be part of the adulticide applications.

**Communication Topics**

- Disease risks and symptoms
- Wear repellent
- WNV policy and spraying decision parameters
- How to get notified of mosquito spraying

**Level IV – Emergency Level Status:**

• One or more serious human cases (eg., neuroinvasive if WNV, or hemorrhagic fever if dengue) on Big Pine/No Name, or adjacent islands with risk of transmission on Big Pine/No Name Keys

- AND –

• Vector mosquito populations increasing and at or above historical average by 1 standard deviation for that time period

- AND –

• Sustained *Culex* mosquito infection rates* of > 5.0 per thousand (0.5%)

– OR –

• WNV Vector Index* > 0.75.

**Probability of Human Outbreak:** In progress

**Operational Response:**

1. Expand mosquito surveillance activities (i.e. population densities, WNV Vector Index* and infection rates*) to direct mosquito control efforts where risk to exposure is greatest and to monitor pre- and post-adulticide treatment conditions.
2. Continue all methods indicated in previous Levels.
3. Initiate aerial adulticiding in all areas of Big Pine/No Name Keys inhabited by the vector species (if the species of vector mosquito is reasonably susceptible to the aerial method); consider using methods which minimize potential impact on threatened or endangered species [e.g., adulticiding during hours outside of butterfly flight times, when wind direction is less likely to drift insecticide over host plants, etc.]) Complete emergency consultation with FWS as appropriate.
4. Secure any needed emergency funding and document costs associated with outbreak control.

**Communication Activities:**

1. Focus as many resources as possible on public education and information; intensify all activities and involve public officials as spokespersons.
2. Consider emergency measures to restrict outdoor activities.
3. Continue public education and information on the adulticide program including pesticides to be used, toxicity, application times, area of application, exposure reduction suggestions, justification, FAQ's, etc.
4. Notify residents on the subscription notification list.
5. Notify appropriate agricultural interests (i.e. bee keepers, organic growers, etc.) and pesticide sensitive individuals of any continued adulticiding activities, times, affected areas, etc.

**Communication Topics:**

- Disease risks and symptoms
- Wear repellent
- WNV policy and spraying decision parameters
- How to get notified of mosquito spraying

* Because there have not been enough cases of WNV in the Florida Keys as of 2013, Keys-specific WNV or dengue infection rate, and WNV Vector Index thresholds, have not yet been established. This value will likely need to be updated in the future.

**Appendix D: Monitoring thresholds of immature and adult mosquitoes on the Refuge would be conducted by the District- historical values and established thresholds.**

Mosquito control operational thresholds were determined using historical landing rate count data from 2003-2013 (n = 77,430 individual landing rate counts) (FKMCD, unpublished data).

| | Larvicide Application | Ground-based adulticide on private lands outside of critical habitat | Ground-based adulticide on Refuge lands outside of critical habitat | Ground-based adulticide within designated critical habitat | Aerial adulticide |
|---|---|---|---|---|---|
| Alt A | Historical larval presence; confirmed larval presence | Increase in population by neighborhood (0.5-5 mosquitoes/min) | N/A | N/A | 3 mosquitoes/min average across Big Pine Key; 10 mosquitoes/min average across No Name Key |
| Alt B | Historical larval presence; confirmed larval presence | 3 mosquitoes/min | 3 mosquitoes/min average by neighborhood | 10 mosquitoes/min average by neighborhood | 10 mosquitoes/min average across Big Pine Key; 40 mosquitoes/min average across No Name Key |
| Alt C | Historical larval presence; confirmed larval presence | N/A | N/A | N/A | N/A |
| Alt D | N/A | N/A | N/A | N/A | N/A |

Alternative B Summary:

Determination of historic base populations for Big Pine and No Name Keys was made by analyzing mosquito count data collected by the District from 2003 to 2013. Data are archived in the District's Vector Control Management System (VCMS) database. Calculation of daily mean mosquito numbers is the arithmetic mean of all count stations on each island. There are 24 count stations on Big Pine Key and 3 on No Name Key. For truck-based operations on Big Pine Key outside of designated critical and/or occupied habitat, a threshold of 3 mosquitoes/minute average in all sites within a given treatment unit (i.e. Whispering Pines neighborhood) with a 24 hour period, will be used for ground truck treatments. The treatment threshold is based upon the Florida Department of Agriculture and Consumer Services 5E-13.036 – Demonstrable Increase or Other Indicator of Arthropod Population Level. The base population of adult mosquitoes across all neighborhoods on Big Pine Key from 2003 to 2013 was 1.0 mosquitoes/minute (FKMCD, unpublished data), thus the proposed threshold is a three-fold increase over historic base population. It is presumed that a 3 fold increase in mosquito activity would translate to a commensurate increase in disease risk given the potential in the region (Liu *et al*, 2009; Ruiz *et. al.* 2004 and Whelan *et al*., 2003). Applications will be made according to label instructions and will not exceed 0.18 pounds of permethrin per acre in any given season (up to 25 applications).

For truck-based operations within designated critical habitat, a threshold of 10 mosquitoes/minute will be used in each particular neighborhood/zone, based on multiple landing rate counts recorded each weekday. This threshold represents a ten-fold increase over historic base adult populations in specific neighborhoods. This threshold has been reached an average of 3.3 times/season/neighborhood since 2003.

For aerial adulticide operations across all of Big Pine Key, a threshold of 10 mosquitoes/minute will be used, with the exception of known occupied habitat. This threshold represents a ten-fold increase over base adult populations across the entire island of Big Pine Key. It is presumed that a 10 fold increase in mosquito activity would translate to a commensurate increase in disease risk given the potential in the region (Liu *et al*, 2009; Ruiz *et. al.* 2004 and Whelan *et al*., 2003). Occurrences of this magnitude have happened on average of 2.1 times per year since 2003. (i.e., from 2003 to 2013: 0, 0, 0, 14, 0, 1, 1, 0, 3, 1, and 3 times this 10 mosquitoes/minute aerial threshold was reached).

On No Name Key, a threshold of 40 mosquitoes/minute will be used for aerial treatments, as the base population on No Name Key is 3.4 mosquitoes/minute. The threshold represents a 12-fold increase over base population. Occurrences of this magnitude have happened on average of 4 times per year since 2003. (i.e., from 2003 to 2013: 0, 8, 7, 1, 1, 1, 0, 0, 20, 0, and 6 times this 40 mosquitoes/minute aerial threshold was reached on No Name Key).

Literature Cited:

Liu, A., V. Lee, D. Galusha, M. D. Slade, M. Diuk-Wasser, T. Andreadis, M. Scotch, and P. M. Rabinowitz. 2009. Risk factors for human infection with West Nile Virus in Connecticut: a multi-year analysis. International Journal of Health Geographics 8:67 doi:10.1186/1476-072X-8-67

Ruiz, M. O., C. Tedesco, C. J. McTighe, C. Austen, and U. Kitron. 2004. Environmental and social determinants of human risk during a West Nile virus outbreak in the greater Chicago area, 2002. International Journal of Health Geographics **3**:8 doi:10.1186/1476-072X-3-8

Whelan, P. I., S. P. Jacups, L. Melville, A. Broom, B. J. Currie, V. L. Krause, B.Brogan, F. Smith, P. Porigneaux. 2003. Rainfall and vector mosquito numbers as risk indicators for mosquito-borne disease in central Australia. Communicable Diseases Intelligence Quarterly Report 27:110-116.

## Appendix E: Pesticide product descriptions /MSDS

```
                  MATERIAL SAFETY DATA SHEET              PAGE 1
VectoBac® GS
MSDS# BIO-0636 Rev. 1                                    ISSUED 01/02/12
-----------------------------------------------------------------------

1.  CHEMICAL PRODUCT AND COMPANY IDENTIFICATION
-----------------------------------------------

MATERIAL NAME: VectoBac® GS
               EPA Registration No. 73049-10


MANUFACTURER:  Valent BioSciences Corporation
               870 Technology Way, Suite 100
               Libertyville, Illinois  60048

EMERGENCY TELEPHONE NUMBERS
Emergency Health or Spill:
     Outside the United States:  651-632-6184
     Within the United States:   877-315-9819

2.  COMPOSITION/INFORMATION ON INGREDIENTS
------------------------------------------

  INGREDIENT NAME: Bacillus thuringiensis, subsp. israelensis
    CONCENTRATION: 2.80 %
CAS/RTECS NUMBERS: 68038-71-1 / N/A
OSHA-PEL  8HR TWA: N/L
             STEL: N/L
          CEILING: N/L
ACGIH-TLV 8HR TWA: N/L
             STEL: N/L
          CEILING: N/L
OTHER     8HR TWA: N/A
LIMITS       STEL: N/A
          CEILING: N/A

  INGREDIENT NAME: Inert Ingredients - identity withheld as a Trade
                   Secret
    CONCENTRATION: 97.20 %
CAS/RTECS NUMBERS: N/A / N/A
OSHA-PEL  8HR TWA: N/L
             STEL: N/L
          CEILING: N/L
ACGIH-TLV 8HR TWA: N/L
             STEL: N/L
          CEILING: N/L
OTHER     8HR TWA: N/A
LIMITS       STEL: N/A
          CEILING: N/A
```

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## 2. COMPOSITION/INFORMATION ON INGREDIENTS, continued

EEC (European Community): N/A
Symbol Designation: N/A
Risk Phrases: N/A
Safety Phrases: N/A

## 3. HAZARDS INFORMATION

EMERGENCY OVERVIEW: Product is non-toxic by ingestion, skin contact, or inhalation. Direct contact with eyes or skin may cause mild irritation.

ROUTE(S) OF ENTRY: Skin: No
Inhalation: No
Ingestion: No

SKIN CONTACT: Non-irritant

SKIN SENSITIZATION: N/D

EYE CONTACT: Non-irritant

TARGET ORGANS: N/D

CARCINOGENICITY RATING: NTP: N/L IARC: N/L OSHA: N/L ACGIH: N/L
None

SIGNS AND SYMPTOMS: Direct contact with eyes or skin may cause mild irritation.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: N/D.

## 4. FIRST AID MEASURES

EYES: Remove from source of exposure. Flush with copious amounts of water. If irritation persists or signs of toxicity occur, seek medical attention. Provide symptomatic/supportive care as necessary.

SKIN: Remove from source of exposure. Flush with copious amounts of water. If irritation persists or signs of toxicity occur, seek medical attention. Provide symptomatic/supportive care as necessary.

INGESTION: Remove from source of exposure. If signs of toxicity occur, seek medical attention. Provide symptomatic/supportive care as necessary.

INHALATION: Remove from source of exposure. If signs of toxicity occur, seek medical attention. Provide symptomatic/supportive care as necessary.

## 5. FIRE FIGHTING PROCEDURES

FLASH POINT: N/A
FLASH POINT METHOD: N/D
LOWER EXPLOSIVE LIMIT(%): N/D
UPPER EXPLOSIVE LIMIT(%): N/D
AUTOIGNITION TEMPERATURE: N/D

FIRE & EXPLOSION HAZARDS: Non-flammable and no explosive properties.

EXTINGUISHING MEDIA: Use appropriate medium for underlying cause of fire.

FIRE FIGHTING INSTRUCTIONS: Wear protective clothing and self-contained breathing apparatus.

## 6. ACCIDENTAL RELEASE MEASURES

SPILL OR RELEASE PROCEDURES: Recover product. Place into appropriate container for disposal. Avoid dust. Ventilate and wash spill area.

## 7. HANDLING AND STORAGE

HANDLING: N/D.

STORAGE: Store in a cool, dry place.

SPECIAL PRECAUTIONS: N/A

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Use local exhaust.

RESPIRATORY PROTECTION: Not usually required. However, mixers/loaders and applicators not in enclosed cabs or aircraft must wear a dust/mist respirator meeting NIOSH standards of at least N-95, R-95 or P-95.

SKIN PROTECTION: Impervious gloves, clothing to minimize skin contact.

EYE PROTECTION: Not usually required. If necessary, use safety glasses or goggles.

OTHER PROTECTION: Wash thoroughly with soap and water after handling.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| APPEARANCE/PHYSICAL STATE: | Granular solid. |
| ODOR: | Mild |
| BOILING POINT: | N/A |
| MELTING/FREEZING POINT: | N/A |
| VAPOR PRESSURE (mm Hg): | N/A |
| VAPOR DENSITY (Air=1): | N/A |
| EVAPORATION RATE: | N/D |
| BULK DENSITY: | 27 ± 4 lb/cu.ft. |
| SPECIFIC GRAVITY: | N/D |
| SOLUBILITY: | N/A |
| pH: | 5.4 ± 1.0 (10% slurry) |
| VISCOSITY: | N/A |

## 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable

INCOMPATIBILITIES: Alkalinity inactivates product.

HAZARDOUS DECOMPOSITION PRODUCTS: N/D.

HAZARDOUS POLYMERIZATION: Will not occur.

## 11. TOXICOLOGICAL INFORMATION

Acute Toxicity

ORAL LD50: LD50 (rat) > 5,000 mg/kg

DERMAL LD50: LD50 (rabbit) > 5,000 mg/kg

INHALATION LC50: N/D. No lethality was observed in rats after a 4 hour exposure at the highest obtainable inhalation exposure chamber concentration (2.84 mg/l) to VectoBac® Technical Powder.

CORROSIVENESS: N/D. Not expected to have any corrosive properties.

DERMAL IRRITATION: N/D. Transient, slight or mild irritation noted in a dermal toxicity study with VectoBac® Technical Powder.

OCULAR IRRITATION: N/D. VectoBac® Technical Powder was mildly irritating in an eye irritation test in rabbits.

DERMAL SENSITIZATION: N/D

SPECIAL TARGET ORGAN EFFECTS: N/D

CARCINOGENICITY INFORMATION: N/D. None of the components are classified as carcinogens.

## 12. ECOLOGICAL INFORMATION

ECOLOGICAL INFORMATION: N/D

## 13. DISPOSAL CONSIDERATIONS

Do not contaminate potable water, food or feed by storage or disposal. Dispose of product in accordance with federal, state, and local regulations.

WASTE DISPOSAL METHODS:

**Pesticide Disposal:** Wastes resulting from use of this product may be disposed of on site or at an approved waste disposal facility.

**Container Disposal:** Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

## 14. TRANSPORTATION INFORMATION

DOT STATUS: Not Regulated
PROPER SHIPPING NAME: N/A
HAZARD CLASS: N/A
UN NUMBER: N/A
PACKING GROUP: N/A
REPORTABLE QUANTITY: N/A

IATA/ICA0 STATUS: Not Regulated
PROPER SHIPPING NAME: N/A
HAZARD CLASS: N/A
UN NUMBER: N/A
PACKING GROUP: N/A
REPORTABLE QUANTITY: N/A

IMO STATUS: Not Regulated
PROPER SHIPPING NAME: N/A
HAZARD CLASS: N/A
UN NUMBER: N/A
PACKING GROUP: N/A
REPORTABLE QUANTITY: N/A
FLASH POINT: N/A

## 15. REGULATORY INFORMATION

TSCA STATUS: Exempt

CERCLA STATUS: N/D

SARA STATUS: N/D

RCRA STATUS: N/D

PROP 65 (CA): N/D

## 16. OTHER INFORMATION

REASON FOR ISSUE: MSDS Reviewed.
APPROVAL DATE: 01/02/12
SUPERSEDES DATE: 06/24/11

LEGEND: N/A = Not Applicable
N/D = Not Determined
N/L = Not Listed
L = Listed
C = Ceiling
S = Short-term
(R) = Registered Trademark of Valent BioSciences
(TM) = Registered Trademark of Valent BioSciences

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VALENT BIOSCIENCES CORPORATION
870 Technology Way, Suite 100
Libertyville, IL 60048 - 800-323-9597

**VectoLex® CG**
**MSDS# BIO-0042 Rev. 4** **ISSUED 01/02/12**

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## 1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATERIAL NAME: VectoLex® CG
VectoLex® G
VectoLex® WSP
VectoLex® 7.5 GR
EPA Registration No. 73049-20
List Number: 5722

MANUFACTURER: Valent BioSciences Corporation
870 Technology Way, Suite 100
Libertyville, Illinois 60048

EMERGENCY TELEPHONE NUMBERS
Emergency Health or Spill:
Outside the United States: 651-632-6184
Within the United States: 877-315-9819

## 2. COMPOSITION/INFORMATION ON INGREDIENTS

INGREDIENT NAME: Bacillus sphaericus Serotype H-5a5b, strain 2362
CONCENTRATION: 7.50 %
CAS/RTECS NUMBERS: N/A / N/A
OSHA-PEL 8HR TWA: N/L
STEL: N/L
CEILING: N/L
ACGIH-TLV 8HR TWA: N/L
STEL: N/L
CEILING: N/L
OTHER 8HR TWA: N/A
LIMITS STEL: N/A
CEILING: N/A

INGREDIENT NAME: Inert Ingredients - identity withheld as Trade Secret
CONCENTRATION: 92.50 %
CAS/RTECS NUMBERS: N/A / N/A
OSHA-PEL 8HR TWA: N/L
STEL: N/L
CEILING: N/L
ACGIH-TLV 8HR TWA: N/L
STEL: N/L
CEILING: N/L
OTHER 8HR TWA: N/A
LIMITS STEL: N/A
CEILING: N/A

## 3. HAZARDS INFORMATION

EMERGENCY OVERVIEW: Product is non-toxic by ingestion, skin contact, or inhalation. Direct contact with eyes or skin may cause mild irritation.

ROUTE(S) OF ENTRY: Skin: No
Inhalation: No
Ingestion: No

SKIN CONTACT: Non-irritant

SKIN SENSITIZATION: Non-sensitizer

EYE CONTACT: Non-irritant

TARGET ORGANS: N/D

CARCINOGENICITY RATING: NTP: N/L IARC: N/L OSHA: N/L ACGIH: N/L
None

SIGNS AND SYMPTOMS: Direct contact with eyes or skin may cause mild irritation.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: N/D. Data suggest pre-existing skin or eye lesions.

## 4. FIRST AID MEASURES

EYES: Remove from source of exposure. Flush with copious amounts of water. If irritation persists or signs of toxicity occur, seek medical attention. Provide symptomatic/supportive care as necessary.

SKIN: Remove from source of exposure. Flush with copious amounts of water. If irritation persists or signs of toxicity occur, seek medical attention. Provide symptomatic/supportive care as necessary.

INGESTION: Remove from source of exposure. If signs of toxicity occur, seek medical attention. Provide symptomatic/supportive care as necessary.

INHALATION: Remove from source of exposure. If signs of toxicity occur, seek medical attention. Provide symptomatic/supportive care as necessary.

## 5. FIRE FIGHTING PROCEDURES

FLASH POINT: N/A
FLASH POINT METHOD: N/A
LOWER EXPLOSIVE LIMIT(%): N/A
UPPER EXPLOSIVE LIMIT(%): N/A

AUTOIGNITION TEMPERATURE: N/D

FIRE & EXPLOSION HAZARDS: Non-flammable and no explosive properties.

EXTINGUISHING MEDIA: Use appropriate medium for underlying cause of fire.

FIRE FIGHTING INSTRUCTIONS: Wear protective clothing and self-contained breathing apparatus.

## 6. ACCIDENTAL RELEASE MEASURES

SPILL OR RELEASE PROCEDURES: Recover product. Place into appropriate container for disposal. Avoid dust. Ventilate and wash spill area.

## 7. HANDLING AND STORAGE

HANDLING: N/D.

STORAGE: Store in a cool, dry place.

SPECIAL PRECAUTIONS: Wash thoroughly with soap and water after handling.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Use local exhaust.

RESPIRATORY PROTECTION: Not usually required. However, mixers/loaders and applicators not in enclosed cabs or aircraft must wear a dust/mist respirator meeting NIOSH standards of at least N-95, R-95 or P-95.

SKIN PROTECTION: Impervious gloves, clothing to minimize skin contact.

EYE PROTECTION: Not usually required. If necessary, use safety glasses or goggles.

OTHER PROTECTION: Wash thoroughly with soap and water after handling.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE/PHYSICAL STATE: Granules
ODOR: Characteristic odor
BOILING POINT: N/A
MELTING/FREEZING POINT: N/A
VAPOR PRESSURE (mm Hg): N/A
VAPOR DENSITY (Air=1): N/A
EVAPORATION RATE: N/A
BULK DENSITY: 35 ± 3 lb/cu.ft.
SPECIFIC GRAVITY: N/D
SOLUBILITY: Partially suspends/soluble in water
pH: N/A
VISCOSITY: N/A

## 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable.

INCOMPATIBILITIES: Alkalinity inactivates product.

HAZARDOUS DECOMPOSITION PRODUCTS: N/D.

HAZARDOUS POLYMERIZATION: Will not occur.

## 11. TOXICOLOGICAL INFORMATION

Acute Toxicity

ORAL LD50: N/D. LD50 (rat) > 5,000 mg/kg for Technical Powder.

DERMAL LD50: N/D. LD50 (rabbit) > 2,000 mg/kg for Technical Powder.

INHALATION LC50: N/D. No lethality in rats after a 4-hour exposure at the maximum obtainable inhalation exposure chamber concentration (0.09 mg/l) to VectoLex® Technical Powder.

CORROSIVENESS: N/D. Not expected to have any corrosive properties.

DERMAL IRRITATION: N/D. Transient, slight to mild irritation noted in a dermal toxicity study with VectoLex® Technical Powder.

OCULAR IRRITATION: N/D. VectoLex® Technical Powder caused mild to moderate eye irritation in tests with rabbits.

## 11. TOXICOLOGICAL INFORMATION, continued

DERMAL SENSITIZATION: N/D. Results from tests with a similar formulated material were negative.

SPECIAL TARGET ORGAN EFFECTS: N/D

CARCINOGENICITY INFORMATION: N/D. None of the components are classified as carcinogens.

## 12. ECOLOGICAL INFORMATION

ECOLOGICAL INFORMATION: N/D

## 13. DISPOSAL CONSIDERATIONS

Do not contaminate potable water, food or feed by storage or disposal. Dispose of product in accordance with federal, state, and local regulations.

WASTE DISPOSAL METHODS:

**Pesticide Disposal:** Wastes resulting from use of this product may be disposed of on site or at an approved waste disposal facility.

**Container Disposal:** Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

For Water Soluble Pouches, dispose of empty outer foil bag in trash.

## 14. TRANSPORTATION INFORMATION

DOT STATUS: Not Regulated
PROPER SHIPPING NAME: N/A
HAZARD CLASS: N/A
UN NUMBER: N/A
PACKING GROUP: N/A
REPORTABLE QUANTITY: N/A

IATA/ICA0 STATUS: Not Regulated
PROPER SHIPPING NAME: N/A
HAZARD CLASS: N/A
UN NUMBER: N/A
PACKING GROUP: N/A
REPORTABLE QUANTITY: N/A

## 14. TRANSPORTATION INFORMATION, continued

IMO STATUS: Not Regulated
PROPER SHIPPING NAME: N/A
HAZARD CLASS: N/A
UN NUMBER: N/A
PACKING GROUP: N/A
REPORTABLE QUANTITY: N/A
FLASH POINT: N/A

## 15. REGULATORY INFORMATION

TSCA STATUS: Exempt

RCRA STATUS: N/D

CERCLA STATUS: N/D

PROP 65 (CA): N/D

SARA STATUS: N/D

## 16. OTHER INFORMATION

REASON FOR ISSUE: MSDS Reviewed.
APPROVAL DATE: 01/02/12
SUPERSEDES DATE: 11/24/10

LEGEND: N/A = Not Applicable
N/D = Not Determined
N/L = Not Listed
L = Listed
C = Ceiling
S = Short-term
® = Registered Trademark of Valent BioSciences
(TM) = Registered Trademark of Valent BioSciences



VALENT BIOSCIENCES CORPORATION
870 Technology Way, Suite 100
Libertyville, IL 60048 - 800-323-9597

# Material Safety Data Sheet

**PERMANONE® 30-30**

MSDS Number: 102000013918
MSDS Version 2.0
Revision Date: 12/08/2010

## SECTION 1. CHEMICAL PRODUCT AND COMPANY INFORMATION

| | |
|---|---|
| **Product name** | PERMANONE® 30-30 |
| **MSDS Number** | 102000013918 |
| **EPA Registration No.** | 432-1235 |

Bayer Environmental Science
2 T.W. Alexander Drive
Research Triangle PK, NC 27709
USA

For MEDICAL, TRANSPORTATION or other EMERGENCY call: 1-800-334-7577 (24 hours/day)
For Product Information call: 1-800-331-2867

## SECTION 2. HAZARDS IDENTIFICATION

*NOTE: Please refer to Section 11 for detailed toxicological information.*

| | |
|---|---|
| **Emergency Overview** | Caution! Harmful if swallowed or absorbed through skin. Moderate eye irritation. Avoid contact with skin, eyes and clothing. Avoid inhalation of vapour or mist. |
| **Physical State** | liquid |
| **Odor** | mild |
| **Appearance** | amber |
| **Exposure routes** | Skin contact, Ingestion, Inhalation, Eye contact |
| **Immediate Effects** | |
| **Eye** | Moderate eye irritation. Avoid contact with eyes. |
| **Skin** | Causes skin irritation. Harmful if absorbed through skin. Avoid contact with skin and clothing. |
| **Ingestion** | Harmful if swallowed. Do not take internally. |
| **Inhalation** | May be harmful if inhaled. Avoid inhalation of vapour or mist. |
| **Chronic or Delayed Long-Term** | This product or its components may have target organ effects. This product or its components may have long term (chronic) health effects. |
| **Potential Environmental Effect** | Highly toxic to bees. Extremely toxic to fish and aquatic invertebrates. |

## SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

| Hazardous Component Name | CAS-No. | Average % by Weight |
|---|---|---|
| Permethrin | 52645-53-1 | 30.00 |
| Piperonyl butoxide | 51-03-6 | 30.00 |

## SECTION 4. FIRST AID MEASURES

**General** When possible, have the product container or label with you when calling a poison control center or doctor or going for treatment.

**Eye** Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a physician or poison control center immediately.

**Skin** Take off contaminated clothing and shoes immediately. Wash off immediately with plenty of water for at least 15 minutes. Call a physician or poison control center immediately.

**Ingestion** Call a physician or poison control center immediately. Rinse out mouth and give water in small sips to drink. DO NOT induce vomiting unless directed to do so by a physician or poison control center. Never give anything by mouth to an unconscious person. Do not leave victim unattended.

**Inhalation** Move to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call a physician or poison control center immediately.

**Notes to physician**

**Hazards** This product contains a pyrethroid.

**Treatment** Appropriate supportive and symptomatic treatment as indicated by the patient's condition is recommended. There is no specific antidote.

## SECTION 5. FIRE FIGHTING MEASURES

**Flash point** 129.5 °C / 265.1 °F

**Suitable extinguishing media** Carbon dioxide (CO2), Dry chemical, Foam, Water

| | |
|---|---|
| **Fire Fighting Instructions** | Keep out of smoke. Fight fire from upwind position. Cool closed containers exposed to fire with water spray. Do not allow run-off from fire fighting to enter drains or water courses.<br><br>Firefighters should wear NIOSH approved self-contained breathing apparatus and full protective clothing. |

## SECTION 6. ACCIDENTAL RELEASE MEASURES

| | |
|---|---|
| **Personal precautions** | Keep unauthorized people away. Isolate hazard area. Avoid contact with spilled product or contaminated surfaces. |
| **Methods for cleaning up** | Soak up with inert absorbent material (e.g. sand, silica gel, acid binder, universal binder, sawdust). Collect and transfer the product into a properly labelled and tightly closed container. Clean contaminated floors and objects thoroughly, observing environmental regulations. |
| **Additional advice** | Use personal protective equipment. Do not allow to enter soil, waterways or waste water canal. |

## SECTION 7. HANDLING AND STORAGE

| | |
|---|---|
| **Handling procedures** | Use only in area provided with appropriate exhaust ventilation. Handle and open container in a manner as to prevent spillage.<br><br>Keep away from heat and sources of ignition. |
| **Storing Procedures** | Store in a cool, dry place and in such a manner as to prevent cross contamination with other crop protection products, fertilizers, food, and feed. Store in original container and out of the reach of children, preferably in a locked storage area. |
| **Work/Hygienic Procedures** | Wash hands thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco, using the toilet or applying cosmetics.<br><br>Remove Personal Protective Equipment (PPE) immediately after handling this product. Before removing gloves clean them with soap and water. Remove soiled clothing immediately and clean thoroughly before using again. Wash thoroughly and put on clean clothing. |
| **Min/Max Storage Temperatures** | Recommended minimum transport/storage temperature: 4 °C / 39 °F |

## SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

| | |
|---|---|
| **General Protection** | Follow all label instructions. Train employees in safe use of the product. |

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and warm/tepid water. Keep and wash PPE separately from other laundry.

**Eye/Face Protection** Safety glasses with side-shields

**Hand protection** Chemical resistant nitrile rubber gloves

**Body Protection** Wear long-sleeved shirt and long pants and shoes plus socks.

**Respiratory protection** When respirators are required, select NIOSH approved equipment based on actual or potential airborne concentrations and in accordance with the appropriate regulatory standards and/or industry recommendations.

**Exposure Limits**

| | | | | |
|---|---|---|---|---|
| Permethrin | 52645-53-1 | OES BCS* | TWA | 10 mg/m3 |
| | | TX ESL | ST ESL | 50 ug/m3 |
| | | TX ESL | AN ESL | 5 ug/m3 |
| Piperonyl butoxide | 51-03-6 | OES BCS* | TWA | 500 ppm |

*OES BCS: Internal Bayer CropScience "Occupational Exposure Standard"

## SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

**Appearance** amber

**Physical State** liquid

**Odor** mild

**Density** ca. 0.99 g/cm³ at 20 °C

**Bulk density** 8.25 lb/gal

## SECTION 10. STABILITY AND REACTIVITY

**Incompatibility** Strong oxidizing agents

**Chemical Stability** Stable under recommended storage conditions.

## SECTION 11. TOXICOLOGICAL INFORMATION

Only acute toxicity studies have been performed on this product as formulated. The non-acute information pertains to the two technical-grade active ingredients, permethrin and piperonyl butoxide.

| | |
|---|---|
| **Acute oral toxicity** | male/female combined rat: LD50: 993 mg/kg |
| **Acute dermal toxicity** | rat: LD50: > 2,000 mg/kg |
| **Acute inhalation toxicity** | rat: LC50: > 2.2 mg/l<br>Exposure time: 4 h<br>Determined in the form of liquid aerosol.<br><br>rat: LC50: > 8.8 mg/l<br>Exposure time: 1 h<br>Determined in the form of liquid aerosol.<br>Extrapolated from the 4 hr LC50. |
| **Skin irritation** | rabbit: Moderate skin irritation. |
| **Eye irritation** | rabbit: Mild eye irritation. |
| **Sensitisation** | guinea pig: Non-sensitizing. |
| **Chronic toxicity** | Permethrin caused neurobehavioral effects (e.g., tremors) and/or organ effects (liver, lung, kidney) in chronic studies in rats, mice and dogs.<br><br>Piperonyl butoxide caused decreased body weights and/or increased organ weights (liver, kidney, adrenal) in chronic studies in rats and dogs. |

**Assessment Carcinogenicity**

Permethrin has low oncogenic potential in mice and no oncogenic potential in rats, therefore, EPA has concluded the likelihood of oncogenicity effects in humans from permethrin to be extremely low or nonexistent.

Piperonyl butoxide gave no evidence of a carcinogenic potential in a lifetime feeding study in rats. In an oncogenicity study in mice, piperonyl butoxide caused an increased incidence of liver tumors. The US EPA has categorized piperonyl butoxide as a group C carcinogen, possible human carcinogen, based on limited evidence of cancer in laboratory animals.

**ACGIH**
None.
**NTP**
None.
**IARC**

| | | |
|---|---|---|
| Permethrin | 52645-53-1 | Overall evaluation: 3 |
| Piperonyl butoxide | 51-03-6 | Overall evaluation: 3 |

**OSHA**
None.

| | |
|---|---|
| **Reproductive toxicity** | REPRODUCTION:<br>Permethrin was not a reproductive toxicant in multi-generation reproduction studies in rats. |

| | |
|---|---|
| | Piperonyl butoxide was not a reproductive toxicant in a two-generation study in rats.<br><br>DEVELOPMENTAL TOXICITY:<br>Permethrin was not a primary developmental toxicant in rats, mice and rabbits. Developmental effects (e.g., decreased fetal weights) were observed in rats and rabbits but were considered secondary to maternal toxicity.<br><br>Piperonyl butoxide did not cause developmental, embryotoxic or teratogenic effects in developmental toxicity studies in rats and rabbits. |
| **Assessment neurotoxicity** | Permethrin caused neurobehavioral effects (e.g., tremors) in an acute and subchronic neurotoxicity screening study in rats without any correlating neuropathological changes.<br><br>Piperonyl butoxide did not demonstrate the potential to cause neurotoxicity in standard toxicity studies submitted to the Agency. EPA has concluded that there is not a concern for neurotoxicity resulting from exposure to piperonyl butoxide. |
| **Mutagenicity** | Permethrin was not mutagenic or genotoxic in a battery of in vitro and in vivo mutagenicity studies.<br><br>Piperonyl butoxide does not have significant potential for mutagenicity based on sufficient evidence. |

## SECTION 12. ECOLOGICAL INFORMATION

| | |
|---|---|
| **Environmental precautions** | Do not apply when weather conditions favor runoff or drift. Drift and runoff from treated areas may be hazardous to aquatic organisms in adjacent sites. Do not allow to get into surface water, drains and ground water. Do not contaminate surface or ground water by cleaning equipment or disposal of wastes, including equipment wash water. Apply this product as specified on the label.<br><br>Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area. |

## SECTION 13. DISPOSAL CONSIDERATIONS

| | |
|---|---|
| **General Disposal Guidance** | Pesticide, spray mixture or rinse water that cannot be used according to label instructions may be disposed of on site or at an approved waste disposal facility. |
| **Container Disposal** | Triple rinse containers. Then offer for recycling or reconditioning or puncture and dispose of in a sanitary landfill or incineration, or if allowed by State and Local authorities, by burning. If burned, stay out of smoke. |

**RCRA Information** Characterization and proper disposal of this material as a special or hazardous waste is dependent upon Federal, State and local laws and are the user's responsibility. RCRA classification may apply.

## SECTION 14. TRANSPORT INFORMATION

**CFR** Not dangerous goods / not hazardous material

**IMDG**

| | |
|---|---|
| UN-Number | **3082** |
| Class | 9 |
| Packaging group | III |
| Marine pollutant | Marine Pollutant |
| Description of the goods | ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (PERMETHRIN, PIPERONYL BUTOXIDE SOLUTION) |

**IATA**

| | |
|---|---|
| UN-Number | **3082** |
| Class | 9 |
| Packaging group | III |
| Description of the goods | ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (PERMETHRIN, PIPERONYL BUTOXIDE SOLUTION ) |

This transportation information is not intended to convey all specific regulatory information relating to this product. It does not address regulatory variations due to package size or special transportation requirements.

Freight Classification: INSECTICIDES OR FUNGICIDES, N.O.I., OTHER THAN POISON

## SECTION 15. REGULATORY INFORMATION

**EPA Registration No.** 432-1235

**US Federal Regulations**

**TSCA list**

Piperonyl butoxide 51-03-6

**US. Toxic Substances Control Act (TSCA) Section 12(b) Export Notification (40 CFR 707, Subpt D)**

None.

**SARA Title III - Section 302 - Notification and Information**

None.

**SARA Title III - Section 313 - Toxic Chemical Release Reporting**

| | | |
|---|---|---|
| Permethrin | 52645-53-1 | 1.0% |
| Piperonyl butoxide | 51-03-6 | 1.0% |

**US States Regulatory Reporting**

**CA Prop65**

This product does not contain any substances known to the State of California to cause cancer.

This product does not contain any substances known to the State of California to cause reproductive harm.

**US State Right-To-Know Ingredients**

| | | |
|---|---|---|
| Permethrin | 52645-53-1 | NJ |
| Piperonyl butoxide | 51-03-6 | NJ |

**Canadian Regulations**

**Canadian Domestic Substance List**

| | |
|---|---|
| Piperonyl butoxide | 51-03-6 |

**Environmental**

**CERCLA**

None.

**Clean Water Section 307 Priority Pollutants**

None.

**Safe Drinking Water Act Maximum Contaminant Levels**

None.

**International Regulations**

**European Inventory of Existing Commercial Substances (EINECS)**

| | |
|---|---|
| Permethrin | 52645-53-1 |
| Piperonyl butoxide | 51-03-6 |

## SECTION 16. OTHER INFORMATION

NFPA 704 (National Fire Protection Association):

Health - 2    Flammability - 1    Reactivity - 0    Others - none

0 = minimal hazard, 1 = slight hazard, 2 = moderate hazard, 3 = severe hazard, 4 = extreme hazard

Reason for Revision: Updated due to new system and numbering scheme. Updated for general editorial purposes.

Revision Date: 12/08/2010

This information is provided in good faith but without express or implied warranty. The customer assumes all responsibility for safety and use not in accordance with label instructions. The product names are registered trademarks of Bayer.

# Material Safety Data Sheet

Date last revised: 24 June 2005

## I. General Information

| | |
|---|---|
| **Chemical Name and Synonyms**<br>Permethrin<br>Piperonyl Butoxide | **Trade Name & Synonyms**<br>Biomist 30+30 ULV |
| **Chemical Family**<br>Synergized Synthetic Pyrethroid | **EPA Registration Number**<br>8329-42 |
| **Proper DOT Shipping Name**<br>Agricultural Insecticide, N.O.I., Non-Hazardous | **DOT Hazard Classification**<br>Non-Hazardous |
| **Manufacturer**<br>Clarke Mosquito Control Products, Inc. | **Manufacturer's Phone Number**<br>(630) 894-2000 |
| **Manufacturer's Address**<br>159 North Garden Avenue<br>Roselle, Illinois 60172 | **INFOTRAC (Transportation/Spill Emergency)** 1-800-535-5053<br>**Poison Control Center (Medical Emergency)** 1-800-214-7753 |

## II. Ingredients

| Principal Hazardous Components | CAS # | Percent |
|---|---|---|
| Permethrin (3-Phenoxyphenyl)methyl (+) cis, trans-3-(2,2-dichlorethenyl)-2,2-dimethyl-cyclopropanecarboxylate | 52645-53-1 | 30% |
| Piperonyl Butoxide, Technical – Equivalent to 80% (butylcarbityl) (6-propyliperonyl) ether and 20% related compounds | 51-03-6 | 30% |
| Inert Ingredients*<br>*Contains petroleum distillates | | 40% |

## III. Physical Data

| | |
|---|---|
| **Boiling Point (°F):** Not Established | **Specific Gravity ($H_2O$ = 1):** 1.0000 |
| **Vapor Pressure (mm Hg.):** Not Established | **Vapor Density (Air = 1):** Not Established |
| **Solubility in Water:** Not Established | **pH:** Not Applicable |
| **Appearance:** Liquid, light brown color | **Odor:** Odorless |

## IV. Fire & Explosion Hazard Data

**Flash Point (Test Method** : 302°F (Tag Closed Cup)

**Extinguishing Media**: Foam, carbon dioxide, or dry chemical

**Special Fire Fighting Procedures:** Use self-contained breathing apparatus. Cool fire exposed areas and equipment. Do not use direct stream of water. Material may float and ignite.

## V. Health Hazard Data

| | |
|---|---|
| **Toxicity: Oral $LD_{50}$:** 891 mg/kg:<br>**Dermal $LD_{50}$:**>2,000 mg/kg | **Acute Inhalation $LC_{50}$:** >4.3 mg/liter (4 hr), >17.2 mg/liter (1 hr) |
| **Primary Route of Entry:** Inhalation, Dermal, Oral | **Effect of Acute Overexposure:** Blurred vision |

**Exposure Limits:** Not established by OSHA or ACGIH

**EMERGENCY FIRST AID**

**Skin Contact:** Remove contaminated clothing and wash affected areas of skin with soap and water.

**Eye:** Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. Call a poison control center or doctor for treatment advice.

**Inhalation:** Remove affected person to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. Get medical attention.

**Ingestion:** Call a physician or Poison Control Center immediately. **Do not induce vomiting**. Do not give anything by mouth to an unconscious person.

**Note to Physician:** Product contains petroleum distillate. Gastric lavage is indicated if material was taken internally. Vomiting may cause aspiration pneumonia.

# Material Safety Data Sheet

Date last revised: 24 June 2005

Biomist 30+30 ULV

## VI. Reactivity Data

| | |
|---|---|
| **Stability:** | Stable: Do not store near heat or flame |
| **Incompatibility** | Not Available |
| **Hazardous Decomposition Products** | None |

## VII. Environmental Protection Procedures

**Spill Response:** In case of spill or leakage, soak up with an absorbent material such as sand, sawdust, Fuller's earth, etc. Clean spill area of residues and absorbent. Contaminated absorbent should be disposed of according to local, state and federal regulations.

**Storage:** Store product sealed and upright at room temperature, in its original labeled container, in a dry locked place out of the reach of children. Do not contaminate water, food, or feed by storage or disposal. Avoid exposure to extreme temperatures.

**Waste Disposal:** Pesticide, spray mixture or rinse water that cannot be used according to label instructions must be disposed of at or by an approved waste disposal facility. Container Disposal: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or dispose of in a landfill or by other approved State and local procedures. For guidance, contact your State Water Board or Regional Office of the EPA.

**Other Precautions:** Do not contaminate water by cleaning of equipment or disposal or wastes.

## VIII. Special Protection Information

| | |
|---|---|
| **Eye Protection:** OSHA-approved safety glasses, goggles or face shield suggested when mixing or loading tank. | **Skin Protection:** Handlers should wear protective clothing and chemical resistant gloves when mixing or loading tank |
| **Respiratory Protection:** Not likely to be needed | **Ventilation:** Not required. |

**Other:** IMPORTANT. Read and observe all precautions and instructions on the label.

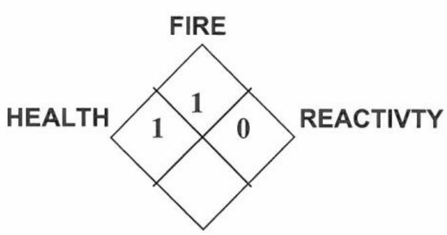
## IX. Additional Regulatory Information

**SARA Title III Data**

**Section 313: (Title III Superfund Amendment and Reauthorization Act)**

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

| Ingredient | CAS Number | Percentage (by weight) |
|---|---|---|
| Permethrin | 52645-53-1 | 30.0% |
| Piperonyl butoxide | 51-03-6 | 30.0% |




**NFPA Code** Key
- 4 = Severe
- 3 = Serious
- 2 = Moderate
- 1 = Slight
- 0 = Minimal

**The information and statements herein are believed to be reliable but are not to be construed as a warranty or representation for which we assume legal responsibility. Users should undertake sufficient verification and testing to determine the suitability for their own particular purpose of any information or products referred to herein. NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE IS MADE.**

# MATERIAL SAFETY DATA SHEET

Vector GROUP

**SECTION 1: PRODUCT AND COMPANY IDENTIFICATION**

**PRODUCT NAME:** Evoluer 30-30 ULV
**EPA REG. NUMBER:** 769-983
**PRODUCT NUMBER:** 51030, 51031, 51032, 51033, 51034

**MANUFACTURER:** Value Garden Supply
**ADDRESS:** P.O. Box 585, St. Joseph, MO 64502
**WEBSITE:** www.allprovector.com

**MANUFACTURER PHONE:** (888) 603-1008
**MANUFACTURER FAX PHONE:** (952) 884-6149
**EMERGENCY PHONE:** (800) 858-7378

**PRODUCT USE:** For effective control of Adult Mosquitoes. For application by Public Health Officials and Trained Personnel of Mosquito Abatement Districts and Other Mosquito Control Programs.

**SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS**

| INGREDIENTS*: | CAS NO. | % WT | OSHA TWA | OSHA STEL | ACGIH TWA | ACGIH STEL |
|---|---|---|---|---|---|---|
| Permethrin: | 52645-53-1 | 30.0% | N/A | NE | N/A | NE |
| Piperonyl Butoxide: | 51-03-6 | 30.0% | N/A | NE | N/A | NE |
| White Mineral Oil | 8042-47-50 | <40.% | 5mg/M3 | N/A | 5mg/M3 | 10mg/M3 |

* All ingredients in quantities > 1.0 % (0.1 % for carcinogens or teratogens) that are **potentially** hazardous per OSHA definitions

N/A = not applicable NE = not established

**SECTION 3: HAZARDS IDENTIFICATION**

**EMERGENCY OVERVIEW:** Potential Health Effects

**POTENTIAL HEALTH EFFECTS:** Eye and skin contact, inhalation. Prolonged or frequent repeated skin contact with permethrin may cause allergic reaction in some individuals. Repeated and prolonged skin contact with piperonyl butoxide may cause skin irritation. This product may cause temporary eye irritation.

**SYMPTOMS OF ACUTE EXPOSURE:** Large, toxic doses of permethrin, administered to laboratory animals, have produced central nervous system effects with symptoms that include diarrhea, salivation, bloody nose, tremors and intermittent convulsions. Overexposure to permethrin via inhalation also produced hyperactivity and hypersensitivity.

**CARCINOGENICITY:** Permethrin: A statistically significant increase of lung and liver tumors was observed in female mice receiving diets containing 375 and 750 mg/Kg/day over 85 weeks. Piperonyl Butoxide: Marginally higher incidences of benign liver tumors in mice were observed following lifetime high dose exposures. The significance of this observation is questionable and under review. The doses at which tumors were observed greatly exceeded human dietary intake. At anticipated dietary exposure levels, it is highly unlikely that piperonyl butoxide would result in carcinogenic effects. IARC has also concluded that there is no evidence for the carcinogenicity of white oils when administered by routes other than by interperitoneal injection. The solvent is not carcinogenic according to the OSHA Hazard Communication Standard.

**SECTION 4: FIRST AID MEASURES**

**EYES:** Immediately flush eyes with large amounts of water and continue flushing until irritation subsides. If irritation persists, seek medical attention (based on solvent).

**SKIN:** Take off contaminated clothing. Rinse skin immediately with plenty of water for 15 to 20 minutes. Call a Poison Control Center for treatment advice.

**INGESTION:** Immediately call a physician or Poison Control Center or doctor. Do not induce vomiting unless told by a poison control center or a doctor. Do not give any liquid to the person. Do not give anything by mouth to an unconscious person.

**INHALATION:** The solvent in this product has a low vapor pressure and is not expected to present an inhalation exposure hazard during mixing and loading. Follow directions for use on product packaging when applying this product.

**NOTE TO PHYSICIAN:** Contains petroleum distillate – vomiting may cause aspiration hazard

## SECTION 5: FIRE-FIGHTING MEASURES

**FLAMMABILITY CLASSIFICATION:** Non-flammable Liquid

**FLASH POINT:** 200°F

**AUTOIGNITION TEMPERATURE:** NE

**EXTINGUISHING MEDIA:** Use water fog, dry chemical, foam or CO2 extinguishing media.

**SPECIAL FIRE FIGHTING PROCEDURES:** Wear full protective clothing and self-contained breathing apparatus. Evacuate nonessential personnel from the area to prevent human exposure to fire, smoke, fumes or products of combustion. Prevent use of contaminated buildings, area and equipment until decontaminated. Use as little water as possible to prevent spread of contaminated runoff.

**UNUSUAL FIRE AND EXPLOSION HAZARDS:**

| NFPA HAZARD CLASSIFICATION: | HEALTH | FIRE | REACTIVITY | SPECIFIC |
|---|---|---|---|---|
| Non-fire | 1 | 0 | 0 | N/A |

| NFPA HAZARD RATING CODES: | INSIGNIFICANT | SLIGHT | MODERATE | HIGH | EXTREME |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |

## SECTION 6: ACCIDENTAL RELEASE MEASURES

**STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:** Wear chemical safety glasses with side shields or chemical goggles, rubber gloves, rubber boots, long-sleeved shirt, long pants, to prevent contact with spilled material. For small spills, cover the spill with an absorbent material such as pet litter. Sweep up and place in an approved chemical container. Wash the spill area with water containing a strong detergent, absorb with pet litter or other absorbent material, sweep up and place in a chemical container. Seal the container and handle in an approved manner. Flush the area with water to remove any residue. Do not allow wash water to contaminate water supplies.

## SECTION 7: HANDLING AND STORAGE

**HANDLING AND STORAGE:** Store the material in a well-ventilated, secure area, out of the reach of children and domestic animals. Do not store food, beverages or tobacco products in the storage area. Prevent eating, drinking, tobacco usage, and cosmetic application in areas where there is a potential for exposure to the material. Always wash thoroughly after handling.

## SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

The employee must wear protective clothing and related safety equipment. Good ventilation should be sufficient for most conditions. Positive pressure self contained breathing apparatus should be used for confined spaces and high exposure operations. The employee should shower at the end of the workday. The employee must wear clean clothes every day or after a spill if the clothes become contaminated. Always wash hands and face with soap and water prior to eating, drinking, smoking or using toilet facilities. It is best not to wear contact lenses but use safety prescription glasses.

## SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

**APPEARANCE:** Clear Amber

**VAPOR PRESSURE (mmHg):** Solvent - <1 mm Hg @ 70°F

**ODOR:** Slight solvent and licorice

**pH ):** N/A

**PHYSICAL STATE:** Liquid

**BOILING POINT:** NE

**MELTING POINT:** N/A

**FREEZING POINT:** N/A

**WATER SOLUBILITY:** Oil Solution will not mix in water

**SPECIFIC GRAVITY:** 0.8530

**PERCENT VOLATILE BY VOLUME:** Solvent 39%

**VISCOSITY:** 600 cps

**AUTO IGNITION:** N/A

**OTHER SOLUBILITIES:** NE

## SECTION 10: STABILITY AND REACTIVITY

**STABILITY:** Stable

**INCOMPATIBILITY (MATERIAL TO AVOID):** Flame, heat, ignition sources and strong oxidizers or reducing agents.

**HAZARDOUS POLYMERIZATION:** Will not occur.

## SECTION 11: TOXICOLOGICAL INFORMATION

**ACUTE ORAL EFFECTS:** Oral LD50 (Rat): >500 to <5,000 mg./Kg. (female) >5,000 mg./Kg. (male)

**ACUTE DERMAL EFFECTS:** Dermal LD50 (Rat): >2,000 mg/Kg.

**CARCINOGENICITY:** Permethrin: A statistically significant increase of lung and liver tumors was observed in female mice receiving diets containing 375 and 750 mg/Kg/day over 85 weeks. Piperonyl Butoxide: Marginally higher incidences of benign liver tumors in mice were observed following lifetime high dose exposures. The significance of this observation is questionable and under review. The doses at which tumors were observed greatly exceeded human dietary intake. At anticipated dietary exposure levels, it is highly unlikely that piperonyl butoxide would result in carcinogenic effects. IARC has also concluded that there is no evidence for the carcinogenicity of white oils when administered by routes other than by interperitoneal injection. The solvent is not carcinogenic according to the OSHA Hazard Communication Standard.

**EYE EFFECTS:** Minimally irritating

**INHALATION:** 4-hour LC50 (Rat): >2.02 mg./L.

**SKIN CONTACT:** Non-irritating.

**SKIN SENSITIZE:** Permethrin is a skin sensitizer in some individuals.

**MUTAGENIC POTENTIAL:** Permethrin and Piperonyl Butoxide did not produce any mutagenic effects when tested in the Ames test.

**REPRODUCTIVE HAZARD POTENTIAL:** Permethrin and Piperonyl Butoxide were not teratogenic when tested in rats.

**HAZARDOUS DECOMPOSITION PRODUCTS:** Carbon monoxide and/or carbon dioxide. Chlorine and hydrogen chloride may be formed.

## SECTION 12: ECOLOGICAL INFORMATION

Permethrin and piperonyl butoxide are highly toxic to fish and other aquatic organisms. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark other than as instructed on the product label. Do not contaminate water by disposing of equipment washwater. Apply this product only as specified on the label.

## SECTION 13: DISPOSAL CONSIDERATIONS

**WASTE DISPOSAL METHOD:** Do not reuse product containers. Dispose of product containers, waste containers, and residues according to Federal, State and local health and environmental regulations.

# MATERIAL SAFETY DATA SHEET

**PHYSICAL STATE:** Liquid

**BOILING POINT:** NE

**MELTING POINT:** N/A

**FREEZING POINT:** N/A

**WATER SOLUBILITY:** Oil Solution will not mix in water

**SPECIFIC GRAVITY:** 0.8530

**PERCENT VOLATILE BY VOLUME:** Solvent 39%

**VISCOSITY:** 600 cps

**AUTO IGNITION:** N/A

**OTHER SOLUBILITIES:** NE

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**INCOMPATIBILITY (MATERIAL TO AVOID):** Flame, heat, ignition sources and strong oxidizers or reducing agents.

**HAZARDOUS POLYMERIZATION:** Will not occur.

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**HAZARDOUS DECOMPOSITION PRODUCTS:** Carbon monoxide and/or carbon dioxide. Chlorine and hydrogen chloride may be formed.

## SECTION 12: ECOLOGICAL INFORMATION

Permethrin and piperonyl butoxide are highly toxic to fish and other aquatic organisms. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark other than as instructed on the product label. Do not contaminate water by disposing of equipment washwater. Apply this product only as specified on the label.

## SECTION 13: DISPOSAL CONSIDERATIONS

**WASTE DISPOSAL METHOD:** Do not reuse product containers. Dispose of product containers, waste containers, and residues according to Federal, State and local health and environmental regulations.

# MATERIAL SAFETY DATA SHEET

## SECTION 14: TRANSPORT INFORMATION

***DOT HAZARD DESCRIPTION:** Not Regulated

(*) U.S Department of Transportation

## SECTION 15: REGULATORY INFORMATION

**SARA TITLE III CLASSIFICATION:**
Section 311/312: Acute Health Hazard – Yes
Chronic Health Hazard – Yes
Fire Hazard – No
Sudden release of pressure hazard – No
Reactivity hazard – No
Section 313 chemicals:
Permethrin (30%) (CAS # 52645-53-1)
Piperonyl Butoxide (30%) (CAS # 51-03-6)

**TSCA STATUS:** Exempt from TSCA

**This product contains a toxic chemical or chemicals subject to the reporting requirements of Section 313 of Title III and of 40 CFR 372. Any copies or redistribution of this MSDS must include this notice.**

**INDIVIDUAL STATES:** N/A

## SECTION 16: OTHER INFORMATION

This information is provided in good faith, but without express or implied warranty. For additional information, refer to the American Conference of Governmental Industrial Hygienists (ACGIH) documentation of TLV's (Threshold Limit Values) for individual components and the DOT Emergency Response Guidebook.

# MATERIAL SAFETY DATA SHEET

## SECTION 1 - IDENTIFICATION

**Product identifier** : **FYFANON ULV MOSQUITO**

**Product Code(s)** : None reported.

**Product Use** : Active ingredient in insecticides.

**Chemical Family** : Mixture

**Supplier's name and address:**

**Cheminova, Inc.**
One Park Drive, Suite 150
PO Box 110566
Research Triangle Park, NC, USA
27709

**Manufacturer's name and address:**

Cheminova A/S
PO Box 9
DK-7620
Lemvig, , Denmark

**Information Telephone #** : 919-474-6600 (8:00 AM - 5:00 PM, EST, Monday-Friday)

**24 Hr. Emergency Tel #** : Chemtrec 1-800-424-9300 (Within Continental U.S.); Chemtrec 703-527-3887 (Outside U.S.).
For Medical Emergencies: (800) 303-6950

## SECTION 2 - HAZARDS IDENTIFICATION

**Classification** : OSHA: This material is classified as hazardous under OSHA regulations (29CFR 1910.1200). Hazardous classification: Unstable (reactive); Acute Health Hazard; Chronic Health Hazard.

WHMIS information: This product is a Pest Control Product and is not regulated as a Controlled Product under the Hazardous Products Act (HPA). For informational purposes, this product would have the following WHMIS classification: Class D2B (Materials Causing Other Toxic Effects, Toxic Material); Class F (Dangerously Reactive Material).

**Emergency Overview** : Colourless to light yellow liquid. Slightly aromatic odour.
Warning! Dangerous exothermic decomposition may occur at temperatures greater than 212°F / 100°C. May be harmful if inhaled or swallowed. May cause eye irritation. Contains material which can cause nervous system damage. May be dangerous for the environment. Malathion is toxic to birds, fish, aquatic invertebtates, aquatic life stages of amphibians and highly toxic to bees.

### POTENTIAL HEALTH EFFECTS:

**Signs and symptoms of short-term (acute) exposure**

*Inhalation* : Fyfanon (Malathion) is a cholinesterase inhibitor of low mammalian toxicity. However storage at too high temperatures may induce formation of the much more toxic and synergistic contaminant isomalathion (LD50 acute oral, rat = 89 mg/kg). Malathion and isomalathion can affect you when breathed in and can cause organophosphorous poisoning. Symptoms of poisoning may include headache, nausea, vomiting, blurred vision, tightness in chest, drooling, frothing of mouth and nose, convulsions, coma and death.

*Skin* : Direct skin contact may result in little or no irritation. Malathion and isomalathion can be rapidly absorbed through all skin surfaces. Causes symptoms similar to those listed for inhalation.

*Eyes* : Direct contact causes eye irritation. Malathion and isomalathion can be rapidly absorbed through all skin and eye surfaces. Causes symptoms similar to those listed for inhalation.

*Ingestion* : Malathion and isomalathion are poisons through ingestion. Causes symptoms similar to those listed for inhalation.

**Effects of long-term (chronic) exposure**
: Prolonged or repeated overexposure may cause behavioral changes.

**Carcinogenic status** : See TOXICOLOGICAL INFORMATION, Section 11.

**Additional health hazards** : Cholinesterase inhibitor. See TOXICOLOGICAL INFORMATION, Section 11.

**Potential environmental effects**
: Malathion is toxic to birds, fish, aquatic invertebtates, aquatic life stages of amphibians and highly toxic to bees. See ECOLOGICAL INFORMATION (Section 12).

## SECTION 3 - COMPOSITION/INFORMATION ON INGREDIENTS

| Ingredients | CAS # | Wt.% |
|---|---|---|
| Malathion | 121-75-5 | 60.00 - 100.00 |

## SECTION 4 - FIRST AID MEASURES

**Inhalation** : Immediately remove person to fresh air. If breathing has stopped, give artificial respiration. Seek immediate medical attention/advice.

**Skin contact** : Immediately flush skin with running water for at least 15 minutes, while removing contaminated clothing. If irritation persists, seek prompt medical attention. Wash contaminated clothing before re-use.

**Eye contact** : Flush eyes thoroughly with running water for at least 20 minutes, holding eyelids open to ensure complete flushing. Seek immediate medical attention/advice.

**Ingestion** : Do NOT induce vomiting. Have victim rinse mouth with water, then give one to two glasses of water to drink. Induce vomiting ONLY under the direct supervision of qualified medical personnel or a poison control centre. Never give anything by mouth to an unconscious person. Seek immediate medical attention/advice.

**Notes For Physician** : Malathion is a cholinesterase inhibitor affecting the central and peripheral nervous systems and producing respiratory and cardiac depression. Decontamination procedures such as whole body washing, gastric lavage and administration of activated charcoal are often required. If symptoms are present, administer atropine sulphate in large doses. Two to four mg intravenously or intramuscularly as soon as possible. Repeat at 5 to 10 minute intervals until signs of atropinization appear and maintain full atropinization until all organophosphorous is metabolised. Obidoxime chloride (Toxogonin), alternatively pralidoxime chloride (2-PAM), is a pharmacological antidote and may be administered as an adjunct to, but not a substitute for atropine, which is a symptomatic and often life-saving antidote. At first sign of pulmonary edema, the patient should be given supplemental oxygen and treated symptomatically. Continued absorption of Malathion may occur and relapse may occur after initial improvement. VERY CLOSE SUPERVISION OF THE PATIENT IS INDICATED FOR AT LEAST 48 HOURS.

## SECTION 5 - FIRE FIGHTING MEASURES

**Fire hazards/conditions of flammability**

: This product is considered non-flammable. Material will decompose rapidly when exposed to heat (>212oF / 100oC) and flame, increasing the risk of explosion. Heat of decomposition may cause closed containers to build up pressure and explode.

**Flammability classification (OSHA 29 CFR 1910.1200)**

: Non-flammable.

**Oxidizing properties** : None known.

**Explosion data: Sensitivity to mechanical impact / static discharge**

: Not expected to be sensitive to mechanical impact or static discharge.

**Suitable extinguishing media** : Carbon dioxide or dry chemical for small fires. For large fires, use water spray or foam.

**Special fire-fighting procedures/equipment**

: Firefighters should wear proper protective equipment and self contained breathing apparatus with full face piece operated in positive pressure mode. Move containers from fire area if safe to do so. Water spray may be useful in cooling equipment exposed to heat and flame. Avoid spreading burning liquid with water spray used for cooling purposes.

**Hazardous combustion products**

: Carbon oxides; Oxides of phosphorus; oxides of sulphur; dimethyl sulfide; irritating fumes and smoke.

**NFPA Rating** 0 - Minimal 1 - Slight 2 - Moderate 3 - Serious 4 - Severe

: *Health:* 1 *Flammability:* 1 *Instability:* 1 *Special Hazards:* None

## SECTION 6 - ACCIDENTAL RELEASE MEASURES

**Personal precautions** : Restrict access to area until completion of clean-up. Ensure clean-up is conducted by trained personnel only. All persons dealing with clean-up should wear the appropriate protective equipment including self-contained breathing apparatus. Refer to Section 8, EXPOSURE CONTROLS AND PERSONAL PROTECTION, for additional information on acceptable personal protective equipment.

**Environmental precautions** : Ensure spilled product does not enter drains, sewers, waterways, or confined spaces. If necessary, dike well ahead of the spill to prevent runoff into drains, sewers, or any natural waterway or drinking supply. Do not flush into surface water or sanitary sewer system. Uncontrolled discharge into water courses must be alerted to the appropriate regulatory body.

**Spill response/cleanup** : Remove all sources of ignition. Ventilate area of release. Stop the spill at source if it is safe to do so. Contain and absorb spilled material with inert, non-combustible absorbent material, such as sand. Sweep up and shovel into suitable containers for disposal. Notify the appropriate authorities as required. Carefully cover spilled material with soda ash or quicklime to neutralize. Do not flush into surface water or sanitary sewer system. For large spills on surfaces other than pavement (e.g. soil or sand), spills may be handled by digging up and removing the affected surface and placing it in approved containers.

Spills in water should be contained as much as possible by isolation of the contaminated water. The contaminated water must be collected and removed for treatment or disposal. Uncontrolled discharge into water courses must be alerted to the appropriate regulatory body. The used containers should be properly closed and labelled. Notify the appropriate authorities as required.

**Prohibited materials** : None known.

**Special spill response procedures**

: If a spill/release in excess of the EPA reportable quantity is made into the environment, immediately notify the national response center in the United States (phone: 1-800-424-8002).
US CERCLA Reportable quantity (RQ): Malathion (100 lbs / 45.4 kg)

## SECTION 7 - HANDLING AND STORAGE

**Safe Handling procedures** : This material is a toxic liquid. Wear chemically resistant protective equipment during handling. Use only in well-ventilated areas. Avoid contact with skin, eyes and clothing. Do not breathe vapours or spray mist. Do not use near welding operations, flames or hot surfaces. Malathion should never be heated above 131oF / 55oC and also local heating above this temperature should be avoided. Keep away from acids and other incompatibles. Keep containers tightly closed when not in use. Wash thoroughly after handling. Use caution when opening cap.

**Storage requirements** : Store in a cool, dry, well ventilated area. Keep away from incompatibles. Storage area should be clearly identified, clear of obstruction and accessible only to trained and authorized personnel. Inspect periodically for damage or leaks. No smoking in the area. Inspect periodically for damage or leaks. Product should be stored at temperatures not exceeding 68 to 77oF (20 to 25oC). Protect against physical damage.

**Incompatible materials** : Strong alkalies, amines and strong oxidizing compounds. The product can corrode iron, steel, tin plate and copper. Fyfanon is rapidly hydrolysed at pH > 7.0.

**Special packaging materials** : Always keep in containers made of the same materials as the supply container.

## SECTION 8 - EXPOSURE CONTROLS AND PERSONAL PROTECTION

### Exposure Limits

| | ACGIH TLV | | OSHA PEL | |
|---|---|---|---|---|
| Ingredients | TWA | STEL | PEL | STEL |
| Malathion | 1 mg/m³ (inhalable) | N/Av | 15 mg/m³ (total dust) | N/Av |

**Ventilation and engineering measures**

: Provide sufficient ventilation to keep vapour concentration below the given TLV and/or PEL.

**Respiratory protection** : Respiratory protection is required if the concentrations exceed the TLV. Wear a pesticide respirator jointly approved by the MSHA and NIOSH. Seek advice from respiratory protection specialists.

**Skin protection** : Wear impervious gloves, such as barrier laminate, butyl rubber, nitrile rubber or viton. Advice should be sought from glove suppliers.

**Eye / face protection** : Safety glasses with side-shields or chemical splash goggles.

**Other protective equipment** : Wear appropriate protective clothing to prevent skin contact, such as coveralls or long sleeved shirt, long pants, and shoes and socks. Other protective equipment, such as an eyewash station and safety shower, may be required depending on exposure and on workplace standards.

**General hygiene considerations** : Avoid contact with skin, eyes and clothing. Remove soiled clothing and wash it thoroughly before reuse. Separate contaminated work clothes from street clothes. Always wash hands, face and arms with soap and water before smoking, eating or drinking. After work, take off all protective equipment, work clothes and shoes, and wash with soap and water. Respirator should be cleaned and filter replaced according to manufacturer's instructions. Wear only clean, uncontaminated clothes when leaving place of work. Persons working with this product for a longer period should have frequent blood tests for cholinesterase levels. If the cholinesterase levels fall below a critical point, no further exposure should be allowed until it has been determined, by means of blood tests, that cholinesterase levels have returned to normal.

## SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

| | | | |
|---|---|---|---|
| **Physical state** | : Liquid | **Appearance** | : Colourless to light yellow liquid. |
| **Odour** | : Slightly aromatic odour. | **Odour threshold** | : N/Av |
| **pH** | : 3.7 - 3.8 (equal amounts of Fyfanon and distilled water) | | |
| **Boiling point** | : 313 - 315°F / 156 - 157°C | **Specific gravity** | : 1.23 g/mL @ 20°C |
| **Melting/Freezing point** | : 37.1°F / 2.85°C | **Coefficient of water/oil distribution** | : Kow = 560 |
| **Vapour pressure (mmHg @ 20° C / 68° F)** | : 3.4 x 10 -6 mmHg @ 25°C; 1.4 x 10 -4 mmHg @ 45°C | **Solubility in water** | : 148.2 mg/L @ 25°C |
| **Vapour density (Air = 1)** | : N/Av | **Evaporation rate (n-Butyl acetate = 1)** | : N/Av |
| **Volatile organic Compounds (VOC's)** | : N/Av | **Volatiles (% by weight)** | : N/Av |
| **Flash point** | : 325°F / 163°C | | |
| **Flash point Method** | : PMCC | **Auto-ignition temperature** | : 532°F / 278°C |
| **Lower flammable limit (% by vol.)** | : N/Av | **Upper flammable limit (% by vol.)** | : N/Av |
| **Flame Projection Length** | : N/Ap | **Flashback observed** | : N/Ap |

## Section 10: Stability And Reactivity

**Stability and reactivity** : Stable if handled below 131oF / 55oC. At higher temperatures decomposition may take place, and the released heat from decomposition can raise the temperature further and accelerate decomposition. Malathion can corrode iron, steel, tin plate and copper. It can be rapidly hydrolysed at pH >7.

**Hazardous polymerization** : Above 284oF / 140oC Fyfanon will decompose rapidly, significantly increasing the risk of inducing explosions. Direct local heating such as electric heating or by steam must be avoided. The decomposition is to a considerable extent dependant on time as well as temperature due to self-accelerating exothermic and autocatalytic reactions. The reactions involve rearrangements and polymerisation releasing volatile, malodorous and inflammable compounds such as dimethyl sulfide.

**Conditions to avoid** : Open flames, sparks, high heat, direct sunlight, and close proximity to incompatible substances.

**Materials To Avoid And Incompatibility** : Incompatible materials (see Section 7).

**Hazardous decomposition products** : Storage at too high temperatures may induce formation of the more toxic and synergistic contaminant isomalathion. Refer to Section 5 for additional 'Hazardous combustion products'.

## SECTION 11 - TOXICOLOGICAL INFORMATION

**Target organs** : Eyes, skin, respiratory system, digestive system, central nervous system.

**Routes of exposure** : *Inhalation:* YES *Skin Absorption:* YES *Skin & Eyes:* YES *Ingestion:* YES

| | | |
|---|---|---|
| **Toxicological data** | : | Fyfanon:<br>LC50 Inhalation (rat): > 5.2 mg/L / 4 Hrs<br>LD50 Oral (rat): 5500 mg/kg<br>LD50 Dermal (rat): > 2000 mg/kg |
| **Carcinogenic status** | : | No components are listed as carcinogens by ACGIH, IARC, OSHA or NTP. |
| **Reproductive effects** | : | Not expected to have other reproductive effects. |
| **Teratogenicity** | : | Not expected to be a teratogen. |
| **Mutagenicity** | : | Not expected to be mutagenic in humans. |
| **Epidemiology** | : | Not available. |
| **Sensitization to material** | : | None known. |
| **Synergistic materials** | : | Not available. |
| **Irritancy** | : | May cause eye and skin irritation. May cause irritation to upper respiratory system. |
| **other important hazards** | : | Cholinesterese inhibitor May cause central nervous system depression. Contains a material which can cause peripheral nervous system damage. |
| **Conditions aggravated by overexposure** | : | None known. |

## SECTION 12 - ECOLOGICAL INFORMATION

| | | |
|---|---|---|
| **Ecotoxicity** | : | This product is an insecticide. Malathion is toxic to birds, fish, aquatic invertebtates, aquatic life stages of amphibians and highly toxic to bees. The toxicity of the active ingredients to wildlife species is measured to be:<br>Fish - 96-hr LC50, Rainbow Trout (Salmo gairdneri) = 0.18 mg/L; 37-day NOEC: 21 µg/L<br>Invertebrates - 48-hr EC50, Daphnids (Daphnia magna) = 0.72 mg/L; 21-day NOEC: 0.06 µg/L<br>Algae - Green algae (Selenastrum capricornutum) 72-Hr LC50= 4.06 mg/L<br>Birds - LD50, Bobwhite quail (Colinus virginianus) = 359 mg/kg; 5-day dietary LC50: 3497 mg/kg<br>LD50, Mallard duck (Anas platyrhynchos) = 1485 mg/kg<br>Earthworms - 14-day LC50, (Eisenia foetida foetida) = 613 mg/kg soil<br>Bees - LD50, worker honey-bees, acute oral = 0.38 µg/bee.<br>LD50, worker honey-bees, topical = 0.27 µg/bee |
| **Mobility** | : | Under normal conditions, the active ingredient is of medium mobility in soil, but it is degraded rapidly. |
| **Persistence** | : | The active ingredient, Malathion, is readily biodegradable. It undergoes rapid degradation in the environment and, without problems, in sewage treatment plants. No adverse effects are observed at concentrations up to 100 mg/L in waste water treatment plants. Degradation occurs both aerobically and anaerobically, and biologically as well as abiologically. Under normal conditions, Malathion is of medium mobility in soil, but is degraded rapidly. The product should not be allowed to enter drains or water courses or be deposited where it can affect ground or surface waters. Do not discharge product unmonitored into the environment. |
| **Bioaccumulation potential** | : | The bioconcentration factor (BCF) of Malathion is 95 (average for several fish species). |
| **Other Adverse Environmental effects** | : | This product is an insecticide. Malathion is toxic to birds, fish, aquatic invertebtates, aquatic life stages of amphibians and highly toxic to bees. The product should not be allowed to enter drains or water courses, or be deposited where it can affect ground or surface waters. |

## SECTION 13 - DISPOSAL CONSIDERATIONS

| | | |
|---|---|---|
| **Handling for Disposal** | : | Handle waste according to recommendations in Section 7. |
| **Methods of Disposal** | : | Do not contaminate water, foodstuffs, feed or seed by storage or disposal. Triple rinse (or equivalent) containers, then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill. Dispose in accordance with all applicable federal, state, provincial and local regulations. Contact your local, state, provincial or federal environmental agency for specific rules. |
| **RCRA** | : | If this product, as supplied, becomes a waste in the United States, it may meet the criteria of a hazardous waste as defined under RCRA, Title 40 CFR 261. It is the responsibility of the waste generator to determine the proper waste identification and disposal method. |

## SECTION 14: TRANPORT INFORMATION

| Regulatory Information | UN Number | Shipping Name | Class | Packing Group | Label |
|---|---|---|---|---|---|
| 49CFR/DOT | UN3082 | ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (malathion) | 9 | III |  |
| **49CFR/DOT Additional information** | None. | | | | |
| TDG | UN3082 | ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (malathion) | 9 | III |  |
| **TDG Additional information** | Only regulated for marine transport. | | | | |

## SECTION 15 - REGULATORY INFORMATION

**US Federal Information:**

OSHA: This material is classified as hazardous under OSHA regulations (29CFR 1910.1200).

CERCLA Reportable Quantity (RQ) (40 CFR 117.302): See Section 6

SARA TITLE III: Sec. 302, Extremely Hazardous Substances, 40 CFR 355: No Extremely Hazardous Substances are present in this material.

SARA TITLE III: Sec. 311 and 312, MSDS Requirements, 40 CFR 370 Hazard Classes: Acute Health Hazard; Chronic Health Hazard. Under SARA Sections 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are 500 pounds for the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SARA TITLE III: Sec. 313, Toxic Chemicals Notification, 40 CFR 372: This product may be subject to SARA notification requirements, since it contains Toxic Chemical constituents above their de minimus concentrations. This product contains: Malathion

**US State Right to Know Laws:**

California Proposition 65: To the best of our knowledge, this product does not contain any chemicals known to the State of California to cause cancer or reproductive harm.

**International Information:**

This product is a Pest Control Product and is not regulated as a Controlled Product under the Hazardous Products Act (HPA).

**This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.**

## SECTION 16 - OTHER INFORMATION

**HMIS Rating** :

| ⋆- Chronic hazard | 0 - Minimal | 1 - Slight | 2 - Moderate | 3 - Serious | 4 - Severe |
|---|---|---|---|---|---|
| *Health:* | *1 | *Flammability:* | 1 | *Reactivity:* | 1 |

**Legend** :

ACGIH: American Conference of Governmental Industrial Hygienists
CAS: Chemical Abstract Services
CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR: Code of Federal Regulations
DOT: Department of Transportation
EPA: Environmental Protection Agency
HMIS: Hazardous Materials Identification System
HSDB: Hazardous Substances Data Bank
IARC: International Agency for Research on Cancer
Inh: Inhalation
N/Ap: not applicable
N/Av: not available
NFPA: National Fire Protection Association
NIOSH: National Institute of Occupational Safety and Health
NTP: National Toxicology Program

OEHHA - Office of Environmental Health Hazard Assessment
OSHA: Occupational Safety and Health Administration
PEL: Permissible exposure limit
PMCC - Pensky Martins Closed Cup
RCRA: Resource Conservation and Recovery Act
RTECS: Registry of Toxic Effects of Chemical Substances
SARA: Superfund Amendments & Reauthorization Act
STEL: Short Term Exposure Limit
TDG: Canadian Transportation of Dangerous Goods Act & Regulations
TLV: Threshold Limit Values
TPQ: Threshold Planning Quantity
TSCA: Toxic Substance Control Act
TWA: Time Weighted Average
WHMIS: Workplace Hazardous Materials Identification System

**References** : 1. ACGIH, Threshold Limit Values and Biological Exposure Indices.
2. International Agency for Research on Cancer Monographs.
3. Canadian Centre for Occupational Health and Safety, CCInfoWeb databases, (Chempendium, HSDB, RTECs).
4. Material Safety Data Sheet from manufacturer.
5. US EPA Title III List of Lists.
6. California Proposition 65 List.

| | |
|---|---|
| **Prepared for:**<br>Cheminova Inc<br>PO Box 110566<br>One Park Drive, Suite 150<br>Research Triangle Park NC 27709<br>Please direct all enquiries to Cheminova. | |
| **Prepared by:**<br>ICC The Compliance Center Inc.<br>http://www.thecompliancecenter.com | The Compliance Center Inc. HAZARDOUS MATERIALS REGULATIONS SPECIALISTS |

## DISCLAIMER OF LIABILITY



**Preparation Date (dd/mm/yyyy)** : 19/08/2003

**Reviewed Date (dd/mm/yyyy)** : 16/03/2010

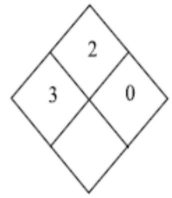
**Revision No.** : 3

**Revision Information** : (M)SDS sections updated: All

**END OF DOCUMENT**

# MATERIAL SAFETY DATA SHEET

## 1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION




**PRODUCT NAME: DIBROM® CONCENTRATE**
**GENERAL USE: Insecticide**
**PRODUCT DESCRIPTION: Off-white to straw yellow liquid with a sharp, pungent odor**
**EPA REGISTRATION NUMBER: 5481-480**
**MSDS NUMBER: 260_11**
**CURRENT REVISION DATE: 13 December, 2011**

**MANUFACTURER:**
**AMVAC CHEMICAL CORPORATION**
**4100 E. Washington Blvd.**
**Los Angeles, CA 90023-4406**
**PHONE: 323-264-3910**
**FAX: 323-268-1028**

**EMERGENCY TELEPHONE NUMBERS:**
**MANUFACTURER: 323-264-3910**
**TRANSPORTATION (24 HOURS)**
**CHEMTREC: 800-424-9300**
**OTHER (24 HOURS)**
**AMVAC: 323-264-3910**

## 2. COMPOSITION/INFORMATION ON INGREDIENTS

| **Component** | **Naled** | **DDVP** | **Naphthalene** |
|---|---|---|---|
| **Synonyms** | 1,2-Dibromo-2,2-dichloroethyl dimethylphosphate; DIBROM® | 2,2-Dichloroethenyl dimethylphosphate; DICHLORVOS | |
| **CAS Number** | 300-76-5 | 62-73-7 | 91-20-3 |
| **Hazard** | Poison; Corrosive | Poison, Possible carcinogen | Possible Carcinogen |
| **Wt%, Typical** | 87.4% | less than 2% | less than 1% |
| **Exposure Limits** | OSHA PEL: 3 $mg/m^3$ ACGIH TLV: 0.1 $mg/m^3$ | OSHA PEL: 1 $mg/m^3$ ACGIH TLV 0.1 $mg/m^3$ | OSHA PEL: 10 ppm ACGIH TLV: 10 ppm ACGIH STEL: 15 ppm |

DIBROM is a Registered Trademark of AMVAC Chemical Corporation.

## 3. HAZARDS IDENTIFICATION

**EMERGENCY OVERVIEW:**

**DANGER! POISON! CORROSIVE! An off-white to straw yellow liquid with a sharp, pungent odor that causes irreversible eye and skin damage. May be fatal if swallowed, inhaled or absorbed through skin and eyes. Is a cholinesterase inhibitor. Rapidly absorbed through skin. Repeated inhalation or skin contact may, without symptoms, progressively increase susceptibility to organophosphate (including Naled) poisoning. May be an aspiration hazard. May cause an allergic reaction.**

**PRODUCT is combustible.**

**TOXIC to fish, birds, and other wildlife.**

**KEEP OUT OF THE REACH OF CHILDREN!**

### POTENTIAL HEALTH EFFECTS

**ROUTE(S) OF ENTRY:** May be fatal if swallowed, inhaled or absorbed through skin and eyes. May produce acute cholinesterase depression. May cause corrosive destruction of the skin, mucous membranes and the eyes.

**SIGNS OF ACUTE OVEREXPOSURE:** Acute cholinesterase depression may be evidenced by headache, nausea, vomiting, diarrhea, abdominal cramps, excessive sweating, salivation and tearing, constricted pupils, blurred vision, tightness in chest, weakness, muscle twitching and confusion; in extreme cases, unconsciousness, convulsions, severe respiratory depression and death may occur.

This product is expected to be corrosive to the eyes. The degree of injury will depend on the amount and duration of the contact and the speed and thoroughness of the first aid treatment. Expected adverse health effects resulting from direct exposure to the eye may include pain, tears, swelling, redness, blurred vision, irreversible eye damage and possibly blindness.

This product is expected to be corrosive to the skin. The degree of injury will depend on the amount and duration of the contact and the speed and thoroughness of the first aid treatment. The expected adverse health effects resulting from a direct exposure to the skin may include pain or a feeling of heat, discoloration, swelling, blistering, and irreversible tissue damage.

This product is expected to be corrosive to the digestive tract, and, if ingested, may cause nausea, vomiting and diarrhea.

This product is expected to be corrosive to the respiratory tract, and, if inhaled, may cause symptoms that include nasal discharge, sore throat, coughing, bronchitis, pulmonary edema, and difficulty in breathing.

## 3. HAZARDS IDENTIFICATION, cont'd

**SIGNS OF CHRONIC OVEREXPOSURE:** Repeated exposures to small doses of Naled and other organophosphates may lower the cholinesterase to levels where the above symptoms of acute overexposure are observed.

**CARCINOGENICITY:** There is no evidence of carcinogenicity in laboratory animals with Naled Technical. EPA under its 1999 proposed Guidelines for Carcinogen Risk Assessment has classified DDVP, an impurity in Naled, as having "suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential.". IARC lists DDVP (Dichlorvos) as being possibly carcinogenic to humans (Group 2B). Based on the results of testing in mice, the IARC has recently classified Naphthalene, a component of the solvent used for this formulation, as being possibly carcinogenic to humans (Group 2B). **CARE SHOULD BE EXERCISED IN HANDLING THIS FORMULATION.**

**MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:** Preexisting conditions which lower cholinesterase levels increase vulnerability to cholinesterase depression. These include: (for plasma) genetic cholinesterase deficiency; advanced liver disease; chronic alcoholism; malnutrition; dermatomyositis; existing toxicity from exposure to carbon disulfide; benzalkonium salts, organic mercury compounds, ciguatoxins or solanines; and (for RBC) hemolytic anemias.

## 4. FIRST AID MEASURES

**DIBROM® CONCENTRATE CONTAINS A CHOLINESTERASE INHIBITOR (NALED). A PHYSICIAN SHOULD BE CONTACTED IN ALL CASES OF EXPOSURE TO NALED AND ITS FORMULATIONS.**

**THIS PRODUCT IS CORROSIVE TO EYES AND SKIN.**

**EYES:** Immediately flush the eyes with copious amounts of clear, cool running water for a minimum of 15 minutes. Hold the eyelids apart during the flushing to ensure rinsing of the entire surface of the eyes and lids with water. Contact a physician immediately. If there will be a delay in getting medical attention, rinse the eyes for at least another 15 minutes.

**INHALATION:** Remove victim to fresh air. If breathing has ceased, clear the victim's airway and start mouth-to-mouth artificial respiration. If breathing is difficult, give oxygen. Contact a physician immediately.

**INGESTION:** DO NOT induce vomiting. If victim is conscious, administer an 8 oz. glass of water containing 2 tbsp. activated charcoal. Have person lie on their left side to slow down absorption of the ingested material. Never give anything by mouth to an unconscious person. Contact a physician immediately.

**SKIN:** Immediately flush all affected areas with large amounts of clear water for at least 15 minutes. Remove contaminated clothing. Do not attempt to neutralize with chemical agents. Wash clothing before reuse. Contact a physician immediately.

## 4. FIRST AID MEASURES, cont'd

**NOTE TO PHYSICIANS: This is an Organophosphate (OP) Insecticide.** Do not wait for laboratory confirmation to treat patients with strong clinical evidence of poisoning. In the USA and other countries, contact your local or national poison control center for more information.

**Do Not** handle the patient without the following protective equipment in place: chemical resistant gloves and apron (preferably nitrile). Remove contaminated clothing and do not reuse without thorough cleaning with detergent and hot water. Dispose of heavily contaminated clothing, including shoes, as a hazardous waste.

Establish airway and oxygenation. IV Atropine sulfate is the antidote of choice. Moderately severe poisoning: use 0.4-2.0 mg in adults or 0.05 mg/kg in children. Repeat every 15 minutes until atropinization is achieved. Severe poisoning may require larger doses. Cholinergic toxicity may recur as atropinization wears off; monitor patient closely. Draw blood for RBC and plasma cholinesterase. In addition, Pralidoxime (2-PAM) is indicated during the first 36 hours in severe poisonings. Slow IV administration (no less than 2 minutes) of 1 g in adults or 20-50 mg/kg in children may be repeated in 1 to 2 hours if muscle weakness, twitching, and/or respiratory depression persist. Avoid morphine, aminophylline, phenothiazines, reserpine, furosemide and ethacrynic acid.

Bathe and shampoo contaminated skin and hair. If ingested, empty stomach. Due to the presence of aromatic solvents, gastric lavage should be considered following intubation with a cuffed endotracheal tube to prevent aspiration of vomitus. Activated charcoal is useful to further limit absorption.

## 5. FIRE FIGHTING MEASURES

**FLAMMABLE PROPERTIES**

Flash Point: 151°F (closed cup)
Autoignition Temperature: No data available
Flammable Limits:
Lower flammable limit: No data available
Upper flammable limit: No data available
Flammability: This is a combustible liquid that will burn when heated (NFPA rating = 2)

**EXPLOSIVITY**

Mechanical Impact: Not explosive
Static Discharge: Will not occur

**HAZARDOUS COMBUSTION PRODUCTS:** This product will emit toxic fumes when burned, including hydrogen chloride, hydrogen bromide, phosphorous oxides and carbon monoxide. Vapors of the unburned product may also be hazardous. Contact with the fumes and vapors should be avoided by staying upwind and by wearing impervious clothing and positive pressure self-contained breathing apparatus.

**EXTINGUISHING MEDIA:** Foam, dry chemical, carbon dioxide, water spray (fog).

## 5. FIRE FIGHTING MEASURES, cont'd

**FIRE FIGHTING INSTRUCTIONS:** Evacuate nonessential personnel from the area. Keep upwind. Wear self-contained breathing apparatus and impervious clothing, including gloves and eye protection. Clean all clothing before reuse.

## 6. ACCIDENTAL RELEASE MEASURES

**GENERAL**: Evacuate personnel and thoroughly ventilate the area. Use adequate ventilation and air-supplied respirators, as well as impervious clothing and safety goggles. Keep bystanders upwind and away from the spill.

**SMALL SPILL:** Cover with nonflammable absorbent (clay, sand, oil dry, kitty litter, etc.) to absorb the liquid. Sweep into an open plastic drum. Decontaminate the area and equipment with dilute alkali or ammonia (less than 5% solution) and detergent. Flush the area with water. Absorb and sweep into the same open plastic drum. Close the drum and dispose of as a hazardous waste.

**LARGE SPILL:** Dike the spill to prevent contamination of local water sources. Siphon the majority of the liquid into drums for use or disposal, depending on the circumstances. Clean the area as described for a small spill.

## 7. HANDLING AND STORAGE

**HANDLING:** Prevent skin contact. Do not breathe fumes. Wear appropriate personal protective equipment (See Section 8). Wash thoroughly and change clothes after handling. Keep product away from food drink, cosmetics, and tobacco products. See product label for more detailed handling procedures.

**STORAGE:** Do not contaminate water, food or feed by storage or disposal. Store product in a cool, dry, locked place out of reach of children. Store in original container.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

**ENGINEERING CONTROLS:** A well-ventilated area is recommended for handling DIBROM® CONCENTRATE. Use of mechanical or local exhaust systems is recommended.

**RESPIRATORY PROTECTION:** When respiratory protection is required, or concentrations may exceed the PEL, use a NIOSH/MSHA approved air-purifying respirator equipped with organic vapor cartridges or canisters. For emergency and other conditions where the exposure limit may be greatly exceeded, use an approved positive-pressure, self-contained breathing apparatus or positive-pressure airline with auxiliary self-contained air supply.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION, cont'd

**SKIN PROTECTION:** Chemical resistant gloves (preferably nitrile), body covering clothing that has long sleeves and long pants, and chemical resistant shoes or boots, are required to prevent skin contamination. A chemical resistant apron is required when there is a risk of spillage or splashing. Wear clean clothes daily. Wash well with soap and water after handling this product. See the label for more specific instructions.

**EYE PROTECTION:** Safety glasses should be worn whenever working with chemicals. Goggles or a faceshield are required if there is a chance of splashing.

**OTHER PROTECTION:** There should be an eyewash station and a safety shower in the work area.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| **PHYSICAL STATE:** | Liquid |
| **APPEARANCE:** | An off-white to straw yellow color |
| **ODOR:** | Sharp, pungent, with overtones of aromatic solvent |
| **ODOR THRESHOLD:** | No data available |
| **BOILING POINT:** | 320°F/160°C |
| **FREEZING/MELTING POINT:** | 60°F/15°C |
| **SPECIFIC GRAVITY:** | 1.794 to 1.831 |
| **BULK DENSITY:** | 14.97 to 15.28 lb/gal |
| **VAPOR PRESSURE (mm/Hg):** | 10 mm Hg @ 100°F |
| **VAPOR DENSITY:** | Heavier than air |
| **PERCENT VOLATILE BY VOLUME:** | 5% |
| **SOLUBILITY IN WATER:** | 0.2% |
| **SOLUBILITY (Other):** | This product is soluble in aromatic hydrocarbons, chlorinated hydrocarbons, ketones, and esters |
| **PARTITION COEFFICIENT (O/W):** | Approx. 100 (a.i.) at ambient temperatures |
| **pH:** | Not available |
| **EVAPORATION RATE:** | Not available |

## 10. STABILITY AND REACTIVITY

**CHEMICAL STABILITY:** This product is stable under normal use and storage conditions. It may be photochemically reactive.

**INCOMPATIBILITY:** Unstable in the presence of iron or alkaline media. Corrosive to iron, aluminum and magnesium. Hydrolyzes slowly under neutral or acid conditions.

**HAZARDOUS DECOMPOSITION PRODUCTS:** Heating product to decomposition will cause emission of acrid smoke and fumes of hydrogen chloride, hydrogen bromide, phosphorous oxides, carbon oxides and unknown organic compounds.

**HAZARDOUS POLYMERIZATION:** This product will not polymerize.

## 11. TOXICOLOGICAL INFORMATION

**GENERAL:** The following information is available for Naled technical and two related formulations, DIBROM® 8 and DIBROM® 14:

| | | |
|---|---|---|
| **INGESTION**: | Oral $LD_{50}$ (rat): | >50 mg/kg <500 mg/kg (Naled Technical) |
| **INHALATION:** | Inhalation $LC_{50}$ (rat): | 1.51/>2.07 mg/L (male/female), 4 hr (DIBROM® 8) |
| **DERMAL:** | Skin $LD_{50}$ (rabbit): | 4037 mg/kg (female/male) Naled Technical) |
| **IRRITATION:** | Eye irritation: | Corrosive (DIBROM® 14) Tox. Cat. I |
| | Skin irritation: | Corrosive (DIBROM® 14) Tox. Cat. I |
| **SENSITIZATION:** | Skin sensitization: (guinea pig) | Weak Skin Sensitizer (Naled Technical) |

**TERATOGENICITY**: Maternal toxicity in rats was observed at 40 mg/kg/day (body weight loss, tremors, painful or difficult breathing, and decreased activity) using Naled Technical (a.i.). No developmental effects were observed at this dose level. The maternal NOEL was 10 mg/kg/day. The developmental NOEL was 40 mg/kg/day.

**REPRODUCTIVE TOXICITY**: In a two-generation rat reproduction study with Naled Technical (a.i.), a decrease in male body weight gain was observed at 18 mg/kg/day; however, no effects on reproduction were found in adult animals. Decreases in offspring survival, number of pups born and decreased pup weights were noted at 18 mg/kg/day. The NOEL for both adults and offspring was 6 mg/kg/day.

**MUTAGENICITY**: No evidence of mutagenicity activity from *in vitro* and *in vivo* tests, using Naled Technical (a.i.).

**CARCINOGENICITY:** No evidence of carcinogenicity in laboratory animals with Naled Technical. However, EPA under its 1999 proposed Guidelines for Carcinogen Risk Assessment has classified DDVP, an impurity in Naled, as having "suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential." Based on the results of testing in mice, the IARC has recently classified Naphthalene, a component of the solvent used for this formulation, as being possibly carcinogenic to humans (Group 2B).

**TOXICOLOGICALLY SYNERGISTIC PRODUCTS:** No data available.

## 12. ECOLOGICAL INFORMATION

**GENERAL**: This product is toxic to fish, birds, and other wildlife. Keep out of any body of water. Do not contaminate water when disposing of equipment washwaters or wastes.

## 13. DISPOSAL CONSIDERATIONS

**WASTE DISPOSAL:** Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture or rinsate is a violation of Federal law. If these wastes cannot be disposed by use according to label instructions, contact your nearest State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA regional office for guidance. Open dumping is prohibited.

## 13. DISPOSAL CONSIDERATIONS, cont'd

**CONTAINER DISPOSAL:** Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of container in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke. Contact your nearest State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA regional office for guidance. Open dumping is prohibited.

## 14. TRANSPORTATION INFORMATION

| | |
|---|---|
| **DOT CLASS:** | 8*, 6.1 |
| **CANADA SHIPPING CLASS:** | 8, 6.1 |
| **ADR CLASS (road):** | 8, 6.1 |
| **AUSTRALIAN SHIPPING CLASS:** | 8, 6 Subsection 111 |
| **UN NUMBER:** | UN2922 |
| **IMDG CLASS (sea):** | 8, 6.1 |
| **IATA CLASS (air):** | 8, 6.1 |
| **MARINE POLLUTANT:** | Yes |
| **PACKING GROUP:** | III |
| **HAZARD LABEL(S):** | CORROSIVE, TOXIC |
| **PROPER SHIPPING NAME(S):** | Corrosive liquids, toxic, n.o.s. (Naled) |
| **REPORTABLE QUANTITY: (DOT, 172.101, Appendix A)** | Yes |
| **TYPICAL PACKAGING : (General Description)** | 30 gallon polyethylene drums |

* **NOTE:** A study run with Naled Technical showed that it is considered non-corrosive by DOT criteria when applied to the intact skin of albino rabbits. However, DIBROM® 8 Emulsive, a similar product to DIBROM® Concentrate, is corrosive to carbon steel at a rate exceeding 0.25 inches per year, so it is a packing group III corrosive for DOT purposes.

## 15. REGULATORY INFORMATION

**U.S. FEDERAL REGULATIONS:** This product is registered under EPA/FIFRA Regulations. It is a violation of Federal Law to use this product in any manner inconsistent with its labeling. Read and follow all label directions. This product is excluded from listing requirements under EPA/TSCA.

**CANADIAN REGULATIONS:** This product is not registered under the Pest Control Product Act of Canada.

**EUROPEAN UNION REGULATIONS:** This product is not registered in the European Union.

## 15. REGULATORY INFORMATION, cont'd

**SARA TITLE III DATA**

**Section 311 & 312 Hazard Categories:**

| | |
|---|---|
| Immediate Health Hazard: | Yes |
| Delayed Health Hazard: | Yes |
| Fire Hazard: | Yes |
| Reactive Hazard: | No |
| Sudden Pressure Release Hazard: | No |

**Section 302 Extremely Hazardous Substances:** DDVP (Dichlorvos, 62-73-7)

**Section 313 Toxic Chemicals:** Naled (300-76-5); DDVP (Dichlorvos, 62-73-7); Naphthalene (91-20-3)

**CERCLA/EHS Reportable Quantities:** DDVP (Dichlorvos) - 10 lbs; Naled - 10 lbs; Naphthalene -100 lbs; Product (calc'd) - 11 lbs (based on Naled content)

**STATE REGULATIONS:**

**CALIFORNIA (Proposition 65):** This product contains chemicals known to the State of California to cause cancer - DDVP, Naphthalene.

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## 16. OTHER INFORMATION

**MSDS STATUS:**

**Date This Revision: 13 December, 2011**
**Date Previous Revision: 24 October, 2008**
**Person Responsible for Preparation: Gary A. Braden**

**REASONS FOR REVISION:** Annual review. Reference to registration in Australia was removed. Minor formatting changes were made throughout the msds.

**DISCLAIMER:** This information is provided for the limited guidance to the user. While AMVAC believes that the information is, as of the date hereof, reliable, it is the user's responsibility to determine the suitability of the information for its purposes. The user is advised not to construe the information as absolutely complete since additional information may be necessary or desirable when particular, exceptional, or variable conditions or circumstances exist (like combinations with other materials), or because of applicable regulations. No express or implied warranty of merchantability or fitness for a particular purpose or otherwise is made hereunder with respect to the information or the product to which the information relates.

## 16. OTHER INFORMATION, cont'd

**ABBREVIATIONS:**

| | | |
|---|---|---|
| a.i. | - | active ingredient |
| ACGIH | - | American Conference of Governmental Industrial Hygienists |
| ADR | - | Mark used to indicate European Approval for the Transport of Dangerous Goods by Road |
| CERCLA | - | Comprehensive Environmental Response, Compensation, and Liability Act |
| DOT | - | Department of Transportation (USA) |
| EPA | - | Environmental Protection Agency |
| FIFRA | - | Federal Insecticide, Fungicide, and Rodenticide Act |
| IARC | - | International Agency for Research on Cancer |
| IATA | - | International Air Transport Association |
| IMDG | - | International Maritime Dangerous Goods |
| NTP | - | National Toxicology Program |
| SARA | - | Superfund Amendments and Reauthorization Act |
| Tox. Cat. | - | Toxicity Category |
| TSCA | - | Toxic Substances Control Act |

This is the last page of this MSDS. There should be 10 pages.

# Natular™ G30

To be used in governmental mosquito control programs, by professional pest control operators, or in other mosquito or midge control operations.

| | |
|---|---|
| Active Ingredient (dry weight basis): | |
| spinosad (a mixture of spinosyn A and spinosyn D)* | 2.5% |
| Other ingredients | 97.5% |
| Total | 100.00% |

U.S. Patent No. 5,362,634 and 5,496,931

* A Naturalyte® Insect Control product

Natular G30 is a 2.5% extended release granule.

| Group | 5 | INSECTICIDE |
|---|---|---|

Keep Out of Reach of Children

## CAUTION

### Precautionary Statements

**Hazards to Humans and Domestic Animals**

Harmful if swallowed. Causes moderate eye irritation. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco. Avoid contact with eyes or clothing. Wear protective eyewear (such as goggles, face shield, or safety glasses).



| First Aid | |
|---|---|
| **If swallowed:** | • Call a poison control center of doctor immediately for treatment advice.<br>• Have person sip a glass of water if able to swallow.<br>• Do not induce vomiting unless told to do so by a poison control center or doctor.<br>• Do not give anything to an unconscious person. |
| **If in eyes:** | • Hold eye open and rinse slowly and gently with warm water for 15-20 minutes.<br>• Remove contact lenses, if present, after the first 5 minutes, then continue rinsing.<br>• Call a poison control center or doctor for treatment advice. |
| Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact 1-800-214-7753 for emergency medical treatment information. | |

**Environmental Hazards**

This product is toxic to aquatic organisms. Non-target aquatic invertebrates may be killed in waters where this pesticide is used. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

### Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read all Directions for Use carefully before applying.

**General Information**

Natular G30 is a Naturalyte® product for killing mosquito and midge larvae. This product's active ingredient, spinosad, is biologically derived from the fermentation of Saccharopolyspora spinosa, a naturally occurring soil organism. Natular G30 releases effective levels of spinosad for up to 30 days under typical environmental conditions. Natular G30 may be applied with ground or aerial equipment.

**General Use Precautions**

**Integrated Pest Management (IPM) Programs**

Natular G30 is intended to kill mosquito and midge larvae. Mosquitoes are best controlled when an IPM program is followed. Larval control efforts should be managed through habitat mapping, active adult and larval surveillance, and integrated with other control strategies such as source reduction, public education programs, harborage or barrier adult mosquito control applications, and targeted adulticide applications.

**Insecticide Resistance Management (IRM)**

Natular G30 contains a Group 5 insecticide. Insect biotypes with acquired resistance to Group 5 insecticides may eventually dominate the insect population if appropriate resistance management strategies are not followed. Currently, only spinetoram and spinosad active ingredients are classified as Group 5 insecticides. Resistance to other insecticides is not likely to impact the effectiveness of this product. Spinosad may be used in rotation with all other labeled products in a comprehensive IRM program.

To minimize the potential for resistance development, the following practices are recommended:

- Base insecticide use on comprehensive IPM and IRM programs.
- Routinely evaluate applications for loss of effectiveness.
- Rotate with other labeled effective mosquito larvicides that have a different mode of action.
- In dormant rice fields, standing water within agricultural/crop sites, and permanent marine and freshwater sites, do not make more than 5 applications per year.
- Use insecticides with a different mode of action (different insecticide group) on adult mosquitoes so that both larvae and adults are not exposed to products with the same mode of action.
- Contact your local extension specialist, technical advisor, and/or Clarke representative for insecticide resistance management and/or IPM recommendations for the specific site and resistant pest problems.
- For further information or to report suspected resistance, you may contact your local Clarke representative by calling 800-323-5727.

**Application**

Proper application techniques help ensure adequate coverage and correct dosage necessary to obtain optimum kill of mosquito and midge larvae. Apply Natular G30 prior to flooding as a prehatch application to areas that breed mosquitoes, or at any stage of larval development after flooding in listed sites. Do not allow this product to drift onto neighboring crops or non-crop areas or use in a manner or at a time other than in accordance with label directions.

**Ground Application**

Use conventional ground application equipment that provides even coverage at labeled rates.

**Aerial Application**

Fixed wing aircraft or helicopters equipped with granular spreaders capable of applying rates from 5 to 20 lb per acre may be used to apply Natular G30. Aerial application equipment should be carefully calibrated before use to be sure it is working properly and delivering a uniform distribution pattern. Avoid overlaps that will increase the dosage of Natular G30 above labeled limits.

AL0152

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather related factors determine the potential for spray drift. The applicator and the treatment coordinator are responsible for considering all these factors when making application decisions.

**Application Sites and Rates**

Apply Natular G30 at 5 to 20 lb per acre. Rates are equivalent to 5 to 20 g per 100 sq ft of water surface for efficacious kill of mosquito and midge larvae in the listed habitat sites. Within this range, use lower rates when water is shallow, vegetation and/or pollution are minimal, and mosquito populations are low. Do not use less than the labeled minimum rate. Use higher rates when water is deep, vegetation and/or pollution are high, and mosquito populations are high. Natular G30 may be applied at rates up to 20 lb per acre in waters high in organic content, deep-water mosquito habitats or those with dense surface cover, and where monitoring indicates a lack of kill at typical rates. Reapply after 30 days. More frequent applications may be made if monitoring indicates that larval populations have reestablished or weather conditions have rendered initial treatments ineffective.

**Non-Crop Sites**

Apply Natular G30 in the following non-crop sites to kill mosquito larvae species:

**Temporary Standing Water:** Woodland pools, snow pools, roadside ditches, retention ponds, freshwater dredge spoils, tire tracks and other natural or manmade depressions, rock holes, pot holes and similar areas subject to holding water.

**Other Freshwater Sites:** Natural and manmade aquatic sites; edges of lakes, ponds, canals, stream eddies, creek edges, and detention ponds.

**Freshwater Swamps and Marshes:** Mixed hardwood swamps, cattail marsh, common reed wetland, water hyacinth ponds, and similar freshwater areas with emergent vegetation.

**Marine/Coastal Areas:** Intertidal areas above the mean high water mark, mangroves, brackish water swamps and marshes, coastal impoundments and similar areas.

**Stormwater/Drainage Systems:** Storm sewers, catch basins, drainage ditches, and similar areas.

**Wastewater:** Sewage effluent, sewers, sewage lagoons, cesspools, oxidation ponds, septic ditches and tanks, animal waste lagoons and settling ponds, livestock runoff lagoons, wastewater impoundments associated with fruit and vegetable processing, and similar areas.

**Dormant Rice Fields:** Impounded water in dormant rice fields (for application only during the interval between harvest and preparation of the field for the next cropping cycle).

**Natural and Artificial Containers:** Tree holes, bromeliads, leaf axils, and other similar natural water holding containers; cemetery urns, bird baths, flower pots, rain barrels, buckets, single tires, tires stockpiled in dumps, landfills, recycling plants and other similar areas, abandoned swimming pools, ornamental ponds, flooded roof tops and similar water holding sites; landfill containers, salvage yards, abandoned vehicles.

**Agricultural/Crop Sites Where Mosquito Breeding Occurs**

Apply Natular G30 at the rate of 5 to 20 lb per acre in standing water within agricultural/crop sites where mosquito breeding occurs to kill mosquito larvae species: pastures/hay fields, rangeland, orchards, vineyards, and citrus groves. Do not apply to waters intended for irrigation.

## STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage and disposal.

**Pesticide Storage:** Store in a cool dry place in original container only.

**Pesticide Disposal:** Wastes resulting from the use of this product must be disposed of on site or at an approved waste disposal facility.

**Container Handling:** Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

## Warranty

To the extent consistent with applicable law, CLARKE MOSQUITO CONTROL PRODUCTS, INC. makes no warranty, express or implied, concerning the use of this product other than as indicated on the label. Buyer assumes all risk of use/handling of this material when use and/or handling is contrary to label instructions.

Naturalyte ® is a Trademark of Dow AgroSciences LLC

Natular™ is a Trademark of Clarke Mosquito Control Products, Inc.

Manufactured for
Clarke Mosquito Control Products, Inc.
159 North Garden Avenue
Roselle, IL 60172 U.S.A.

Made in the U.S.A. EPA Reg. No. 8329-83
EPA Est.8329-IL-03

Net Contents: 40 lbs / 18.14 kg
Lot/Batch No:

# MATERIAL SAFETY DATA SHEET

**TALSTAR® PROFESSIONAL INSECTICIDE**

**MSDS Ref. No.:** 82657-04-3-149
**Date Approved:** 01/16/2008
**Revision No.:** 3

This document has been prepared to meet the requirements of the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200 and Canada's Workplace Hazardous Materials Information System (WHMIS) requirements.

# 1. PRODUCT AND COMPANY IDENTIFICATION

| | |
|---|---|
| **PRODUCT NAME:** | TALSTAR® PROFESSIONAL INSECTICIDE |
| **PRODUCT CODE:** | 6339 |
| **ACTIVE INGREDIENT(S):** | Bifenthrin |
| **CHEMICAL FAMILY:** | Pyrethroid Pesticide |
| **MOLECULAR FORMULA:** | $C_{23}H_{22}ClF_3O_2$ (bifenthrin) |
| **SYNONYMS:** | FMC 54800; (2-methyl[1,1'-biphenyl]-3-yl)methyl 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate; IUPAC: 2-methylbiphenyl-3-ylmethyl (Z)-(1RS)-cis-3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate |

U.S. EPA REGISTRATION NUMBER: 279-3206

## MANUFACTURER

FMC CORPORATION
Agricultural Products Group
1735 Market Street
Philadelphia, PA 19103
(800) 321-1362 (General Information)
msdsinfo@fmc.com (Email - General Information)

## EMERGENCY TELEPHONE NUMBERS

(800) 331-3148 (Medical - U.S.A. & Canada)
(651) 632-6793 (Medical - Collect - All Other Countries)

For leak, fire, spill, or accident emergencies, call:
(800) 424-9300 (CHEMTREC - U.S.A. & Canada)
(703) 527-3887 (CHEMTREC - Collect - All Other Countries)

# 2. HAZARDS IDENTIFICATION

## EMERGENCY OVERVIEW:

- Beige liquid with a bland odor.
- Slightly combustible. May support combustion at elevated temperatures.
- Thermal decomposition and burning may form toxic by-products.
- For large exposures or fire, wear personal protective equipment.

- Highly toxic to fish and aquatic organisms. Keep out of drains and water courses.

**POTENTIAL HEALTH EFFECTS:** Effects from overexposure may result from either swallowing, inhaling or coming into contact with the skin or eyes. Symptoms of overexposure include bleeding from the nose, tremors and convulsions. Contact with bifenthrin may occasionally produce skin sensations such as rashes, numbing, burning or tingling. These skin sensations are reversible and usually subside within 12 hours.

**MEDICAL CONDITIONS AGGRAVATED:** None presently known.

# 3. COMPOSITION / INFORMATION ON INGREDIENTS

| Chemical Name | CAS# | Wt.% | EC No. | EC Class |
|---|---|---|---|---|
| Bifenthrin | 82657-04-3 | 7.9 | None | R25-20-43-50/53; S1/2-23-24-37-38-45-29 |
| Propylene Glycol | 57-55-6 | <6.2 | 200-338-0 | Not classified |

# 4. FIRST AID MEASURES

**EYES:** Flush with plenty of water. Get medical attention if irritation occurs and persists.

**SKIN:** Wash with plenty of soap and water.

**INGESTION:** Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything to an unconscious person.

**INHALATION:** Remove to fresh air. If breathing difficulty or discomfort occurs and persists, contact a medical doctor.

**NOTES TO MEDICAL DOCTOR:** This product has low oral, dermal and inhalation toxicity. It is practically non-irritating to the eyes and is non-irritating to the skin. Reversible skin sensations (paresthesia) may occur and ordinary skin salves have been found useful in reducing discomfort. Treatment is otherwise controlled removal of exposure followed by symptomatic and supportive care.

# 5. FIRE FIGHTING MEASURES

**EXTINGUISHING MEDIA:** Foam, $CO_2$ or dry chemical. Soft stream water fog only if necessary. Contain all runoff.

**FIRE / EXPLOSION HAZARDS:** Slightly combustible. This material may support combustion at elevated temperatures.

**FIRE FIGHTING PROCEDURES:** Isolate fire area. Evacuate downwind. Wear full protective clothing and self-contained breathing apparatus. Do not breathe smoke, gases or vapors generated.

## 6. ACCIDENTAL RELEASE MEASURES

**RELEASE NOTES:** Isolate and post spill area. Wear protective clothing and personal protective equipment as prescribed in Section 8, "Exposure Controls/Personal Protection". Keep unprotected persons and animals out of the area.

Keep material out of lakes, streams, ponds and sewer drains. Dike to confine spill and absorb with a non-combustible absorbent such as clay, sand or soil. Vacuum, shovel or pump waste into a drum and label contents for disposal.

To clean and neutralize contaminated area, scrub area with a solution of detergent (e.g. commercial product such as SuperSoap™, Tide®, Spic and Span®, or other high pH detergent) and water. Let solution sit for 5 minutes. Use a stiff brush to scrub affected area. Repeat if necessary to remove visible staining. Additional decontamination can be made by applying bleach (Clorox® or equivalent) to affected area.

Absorb wash-liquid as noted above, remove visibly contaminated soil and place into recovery / disposal container (plastic, open-top steel drum or equivalent). Place all clean-up material in a container, seal and dispose of in accordance with the method outlined in Section 13 "Disposal Considerations" below.

For further information on spill clean-up, waste disposal, or return of salvaged product, call the FMC Emergency Hotline number listed in Section 1 "Product and Company Identification" above.

## 7. HANDLING AND STORAGE

**HANDLING AND STORAGE:** Store in a cool, dry, well-ventilated place. Do not use or store near heat, open flame or hot surfaces. Store in original containers only. Keep out of reach of children and animals. Do not contaminate other pesticides, fertilizers, water, food or feed by storage or disposal.

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**ENGINEERING CONTROLS:** Use local exhaust at all process locations where vapor or mist may be emitted. Ventilate all transport vehicles prior to unloading.

### PERSONAL PROTECTIVE EQUIPMENT

**EYES AND FACE:** For splash, mist or spray exposure, wear chemical protective goggles or a face shield.

**RESPIRATORY:** For splash, mist or spray exposure wear, as a minimum, a properly fitted air-purifying respirator with an organic vapor cartridge (OV) or canister with any R, P or HE prefilter (approved by U.S. NIOSH/MSHA, EU CEN or comparable certification organization). Respirator use and selection must be based on airborne concentrations.

**PROTECTIVE CLOTHING:** Depending upon concentrations encountered, wear coveralls or long-sleeved uniform and head covering. For larger exposures as in the case of spills, wear full body cover barrier suit, such as a PVC suit. Leather items - such as shoes, belts and watchbands - that become contaminated should be removed and destroyed. Launder all work clothing before reuse (separately from household laundry).

**GLOVES:** Wear chemical protective gloves made of materials such as rubber, neoprene, or PVC. Thoroughly wash the outside of gloves with soap and water prior to removal. Inspect regularly for leaks.

**WORK HYGIENIC PRACTICES:** Clean water should be available for washing in case of eye or skin contamination. Wash skin prior to eating, drinking, chewing gum, or using tobacco. Shower at the end of the workday.

### COMMENTS:

Personal protective recommendations for mixing or applying this product are prescribed on the product label. Information stated above provides useful, additional guidance for individuals whose use or handling of this product is not guided by the product label.

---

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| **ODOR:** | Bland |
| **APPEARANCE:** | Beige liquid |
| **DENSITY / WEIGHT PER VOLUME:** | 8.53 lb/gal. (1024 g/L) |
| **FLASH POINT:** | > 100 °C (> 212 °F) (TCC) |
| **MOLECULAR WEIGHT:** | 422.9 (bifenthrin) |
| **pH:** | 6.7 |
| **SOLUBILITY IN WATER:** | Disperses |
| **SPECIFIC GRAVITY:** | 1.024 @ 20°C (water =1) |

# 10. STABILITY AND REACTIVITY

| | |
|---|---|
| **CONDITIONS TO AVOID:** | Excessive heat and fire. |
| **STABILITY:** | Stable |
| **POLYMERIZATION:** | Will not occur |
| **HAZARDOUS DECOMPOSITION PRODUCTS:** | Carbon monoxide, carbon dioxide, chlorine, fluorine, hydrogen chloride and hydrogen fluoride. |

# 11. TOXICOLOGICAL INFORMATION

**EYE EFFECTS:** Practically non-irritating

**SKIN EFFECTS:** Non-irritating

**DERMAL $LD_{50}$:** > 2,000 mg/kg (rabbit)

**ORAL $LD_{50}$:** 632 mg/kg (rat)

**INHALATION $LC_{50}$:** 11.58 mg/l (1 h) (rat)

**ACUTE EFFECTS FROM OVEREXPOSURE:** This product has low oral, dermal and inhalation toxicity. It is practically non-irritating to the eyes and is non-irritating to the skin. Large doses of bifenthrin ingested by laboratory animals produced signs of toxicity including convulsions, tremors and bloody nasal discharge. Bifenthrin does not cause acute delayed neurotoxicity. Experience to date indicates that contact with bifenthrin may occasionally produce skin sensations such as rashes, numbing, burning or tingling. These sensations are reversible and usually subside within 12 hours. In humans, ingestion of large amounts of propylene glycol has resulted in symptoms of reversible central nervous system depression including stupor, rapid breathing and heartbeat, profuse sweating and seizures.

**CHRONIC EFFECTS FROM OVEREXPOSURE:** No data available for the formulation. In studies with laboratory animals, bifenthrin did not cause reproductive toxicity or teratogenicity. Tremors were associated with repeated exposure of laboratory animals to bifenthrin. In lifetime feeding studies conducted with laboratory animals, a slight increase in the incidence of urinary bladder tumors at the highest dose in male mice was considered to be an equivocal response, not evidence of a clear compound-related effect. The overall absence of genotoxicity has been demonstrated in mutagenicity tests with bifenthrin. Repeated overexposure to propylene glycol can produce central nervous system depression, hemolysis and minimal kidney damage.

### CARCINOGENICITY:

| | |
|---|---|
| **NTP:** | Not listed |
| **IARC:** | Not listed |
| **OSHA:** | Not listed |
| **OTHER:** | Not Listed (ACGIH) |

## 12. ECOLOGICAL INFORMATION

Unless otherwise indicated, the data presented below are for the active ingredient.

**ENVIRONMENTAL DATA:** In soil, bifenthrin is stable over a wide pH range and degrades at a slow rate that is governed by soil characteristics. Bifenthrin will also persist in aquatic sediments. Bifenthrin has a high Log Pow (6.6), a high affinity for organic matter, and is not mobile in soil. Therefore, there is little potential for movement into ground water. There is the potential for bifenthrin to bioconcentrate (BCF <2,000).

**ECOTOXICOLOGICAL INFORMATION:** Bifenthrin is highly toxic to fish and aquatic arthropods and $LC_{50}$ values range from 0.0038 to 17.8 µg/L. In general, the aquatic arthropods are the most sensitive species. Care should be taken to avoid contamination of the aquatic environment. Bifenthrin had no effect on mollusks at its limit of water solubility. Bifenthrin is only slightly toxic to both waterfowl and upland game birds ($LD_{50}$ values range from 1,800 mg/kg to >2,150 mg/kg).

## 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** Open dumping or burning of this material or its packaging is prohibited. If spilled material cannot be disposed of by use according to label instructions, an acceptable method of disposal is to incinerate in accordance with local, state and national environmental laws, rules, standards and regulations. However, because acceptable methods of disposal may vary by location and regulatory requirements may change, the appropriate agencies should be contacted prior to disposal.

**EMPTY CONTAINER:** Non-returnable containers that held this material should be cleaned, prior to disposal, by triple rinsing. Containers which held this material may be cleaned by being triple-rinsed, and recycled, with the rinsate being incinerated. Do not cut or weld metal containers. Vapors that form may create an explosion hazard.

## 14. TRANSPORT INFORMATION

### U.S. DEPARTMENT OF TRANSPORTATION (DOT)

| | |
|---|---|
| **PACKAGING TYPE:** | Non-Bulk |
| **ADDITIONAL INFORMATION:** | This material is not a hazardous material as defined by US Department of Transportation at 49 CFR Parts 100 through 185. |

| | |
|---|---|
| **PACKAGING TYPE:** | Bulk |
| **PROPER SHIPPING NAME:** | Environmentally hazardous substance, liquid, n.o.s. |
| **TECHNICAL NAME(S):** | Bifenthrin |
| **PRIMARY HAZARD CLASS / DIVISION:** | 9 |
| **UN/NA NUMBER:** | UN 3082 |
| **PACKING GROUP:** | III |
| **MARINE POLLUTANT:** | Bifenthrin |
| **LABEL(S):** | 9 |
| **PLACARD(S):** | 9 |
| **MARKING(S):** | 3082 |

## INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG)

| | |
|---|---|
| **PACKAGING TYPE:** | Non-Bulk |
| **PROPER SHIPPING NAME:** | Environmentally hazardous substance, liquid, n.o.s. |
| **TECHNICAL NAME(S):** | Bifenthrin |
| **PRIMARY HAZARD CLASS / DIVISION:** | 9 |
| **UN/NA NUMBER:** | UN 3082 |
| **PACKING GROUP:** | III |
| **MARINE POLLUTANT:** | Bifenthrin |
| **LABEL(S):** | 9 |
| **PLACARD(S):** | 9 |
| **MARKING(S):** | Environmentally hazardous substance, liquid, n.o.s. (bifenthrin), UN3082 + Marine Pollutant |
| **ADDITIONAL INFORMATION:** | EmS Number: F-A, S-F |

## ADR - EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD

| | |
|---|---|
| **PACKAGING TYPE:** | Non-Bulk |
| **PROPER SHIPPING NAME:** | Environmentally hazardous substance, liquid, n.o.s. |
| **TECHNICAL NAME(S):** | Bifenthrin |
| **PRIMARY HAZARD CLASS / DIVISION:** | 9 |
| **CLASSIFICATION CODE:** | M6 |
| **UN/NA NUMBER:** | UN3082 |
| **PACKING GROUP:** | III |
| **HAZARD IDENTIFICATION NUMBER:** | 90 |
| **MARINE POLLUTANT:** | Bifenthrin |
| **LABEL(S):** | 9 |
| **PLACARD(S):** | 9 |
| **MARKING(S):** | UN3082 + Marine Pollutant |

## INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) / INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

| | |
|---|---|
| **PACKAGING TYPE:** | Non-Bulk |
| **PROPER SHIPPING NAME:** | Environmentally hazardous substance, liquid, n.o.s. |
| **TECHNICAL NAME(S):** | Bifenthrin |
| **PRIMARY HAZARD CLASS / DIVISION:** | 9 |
| **UN/NA NUMBER:** | UN3082 |
| **PACKING GROUP:** | III |
| **LABEL(S):** | 9 |
| **LIMITED QUANTITY:** | Y914 / 30 kg |
| **LIMITED QUANTITY: PASSENGER / CARGO:** | 914 / No limit |
| **LIMITED QUANTITY: CARGO:** | 914 / No limit |
| **ADDITIONAL INFORMATION:** | When shipped by air within the USA, this product is not regulated as a Marine Pollutant in non-bulk packages and does not require identification as a Marine Pollutant; however, when shipped by air within, to and/or from ADR signatory countries, identification as Marine Pollutant is required.<br>Marks: Environmentally hazardous substance, liquid, n.o.s. (bifenthrin), |

UN3082 + Marine Pollutant

**OTHER INFORMATION:**
HARMONIZED SYSTEM NUMBERS:
Import to the U.S.A.: 3808.91.2500
Export from the U.S.A.: 3808.91.0000

# 15. REGULATORY INFORMATION

## UNITED STATES

**SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

**SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355, APPENDIX A):**
Not listed

**SECTION 311 HAZARD CATEGORIES (40 CFR 370):**
Immediate, Delayed

**SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370):**
The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lbs; however, this product contains the following ingredients with a TPQ of less than 10,000 lbs.: None

**SECTION 313 REPORTABLE INGREDIENTS (40 CFR 372):**
This product contains the following ingredients subject to Section 313 reporting requirements: Bifenthrin

**CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT)**

**CERCLA DESIGNATION & REPORTABLE QUANTITIES (RQ) (40 CFR 302.4):**
Not listed

**FEDERAL INSECTICIDE FUNGICIDE RODENTICIDE ACT**
U.S. EPA Signal Word: CAUTION

## INTERNATIONAL LISTINGS

Australian Hazard Code: 3Z

## HAZARD, RISK AND SAFETY PHRASE DESCRIPTIONS:

Bifenthrin:

| | | |
|---|---|---|
| EC Symbols: | T | (Toxic) |
| | Xn | (Harmful) |
| | N | (Dangerous for the environment) |

| | | |
|---|---|---|
| EC Risk Phrases: | R25 | (Toxic if swallowed.) |
| | R20 | (Harmful by inhalation.) |
| | R43 | (May cause sensitization by skin contact.) |
| | R50/53 | (Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.) |
| EC Safety Phrases: | S1/2 | (Keep locked up and out of reach of children.) |
| | S23 | (Do not breathe gas, fumes, vapor, or spray) |
| | S24 | (Avoid contact with skin.) |
| | S37 | (Wear suitable gloves.) |
| | S38 | (In case of insufficient ventilation, wear suitable respiratory equipment.) |
| | S45 | (In case of accident or if you feel unwell, seek medical advice immediately - show the label where possible.) |
| | S29 | (Do not empty into drains.) |

**Notes For Preparation:**

CLASSIFICATION: Mandatory labeling (self-classification) of hazardous substances: applicable

# 16. OTHER INFORMATION

__NFPA__

| | |
|---|---|
| Health | 1 |
| Flammability | 1 |
| Reactivity | 0 |
| Special | None |

No special requirements

NFPA (National Fire Protection Association)

Degree of Hazard Code:
4 = Extreme
3 = High
2 = Moderate
1 = Slight
0 = Insignificant

**REVISION SUMMARY:**
This MSDS replaces Revision #2, dated October 18, 2007.
Changes in information are as follows:
Section 2 (Hazards Identification)
Section 4 (First Aid Measures)
Section 16 (Other Information)

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| | |
|---|---|
| Date Issued: | February, 2012 |
| Supersedes: | September, 2011 |

# MATERIAL SAFETY DATA SHEET

## ZOECON® ALTOSID XR EXTENDED RESIDUAL BRIQUETS

| | |
|---|---|
| **Manufacturer:** | Wellmark International |
| **Address:** | 1501 East Woodfield Road, Suite 200W, Schaumburg, IL 60173 |
| **Emergency Phone:** | 1-888-914-2082 |
| **Transportation Emergency Phone:** | CHEMTREC: 1-800-424-9300 |

## 1. CHEMICAL PRODUCT INFORMATION

| | |
|---|---|
| **Product Name:** | Zoecon® Altosid XR Extended Residual Briquets |
| **Chemical Name/Synonym:** | (S)-Methoprene; isopropyl (2E,4E,7S)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate |
| **Chemical Family:** | Terpenoid |
| **Formula:** | $C_{19} H_{34} O_3$ |
| **EPA Registration No.:** | 2724-421 |
| **RF Number:** | RF-292 |

## 2. COMPOSITION/INFORMATION ON INGREDIENTS

| Component (chemical, common name) | CAS Number | Weight | Tolerance |
|---|---|---|---|
| (S)- Methoprene: Isopropyl (2E,4E,7S)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate | 65733-16-6 | 2.1% | Not established |
| Inert ingredients (non-hazardous and/or trade secret) | | 97.9% | |

## 3. HAZARD INFORMATION

**PRECAUTIONARY STATEMENT**
**KEEP OUT OF REACH OF CHILDREN**
**HAZARDS TO HUMANS AND DOMESTIC ANIMALS – CAUTION**
**CAUSES MODERATE EYE IRRITATION. HARMFUL IF ABSORBED THROUGH SKIN. AVOID CONTACT WITH SKIN, EYES, OR CLOTHING. WASH THOUROUGHLY WITH SOAP AND WATER AFTER HANDLING.**

### SIGNS AND SYMPTOMS OF OVEREXPOSURE

PRIMARY ROUTE OF ENTRY — Dermal/Eye: Yes — Oral: No — Inhalation: No

| ACUTE TOXICITY | |
|---|---|
| **Oral:** | No specific hazard identified |
| **Dermal:** | Harmful if absorbed though skin |
| **Inhalation:** | No specific hazard identified |

### OTHER TOXICOLOGICAL INFORMATION

| | |
|---|---|
| **Skin Irritation:** | Mild irritating |
| **Eye Irritation:** | Moderate eye irritant |
| **Sensitizer:** | Not a skin sensitizer |

## 4. FIRST AID MEASURES

**If in eyes:**
- Hold eye open and rinse slowly and gently with water for 15-20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing.
- Call a poison control center or doctor for treatment advice.

**If on skin:**
- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15-20 minutes.
- Call a poison control center or doctor for treatment advice.

**Note to Physician:** There is no specific antidote. Treatment of overexposure should be directed at the control of symptoms and the clinical condition.

## 5. FIRE FIGHTING MEASURES

**NFPA Rating:** **Health: 1** **Fire: 0** **Reactivity: 0**

**Flammability Class:** Solid

**Flash Point:** Does not flash

**Explosive Limits (% of Volume):** N/A

**Extinguishing Media:** Water, foam, dry chemical

**Special Protective Equipment:** Firefighters should wear protective clothing, eye protection, and self contained breathing apparatus.

**Fire Fighting Procedures:** Normal procedures. Do not allow run-off to enter waterways inhabited by aquatic organisms.

**Combustion Products:** None known

**Unusual Fire/Explosion Hazards:** None

## 6. ACCIDENTAL RELEASE MEASURES

**Steps to be taken:** Sweep up material and place in a container for disposal. Do not allow spill to enter waterways inhabited by aquatic organisms.

**Absorbents:** Not necessary due to product form and packaging

**Incompatibles:** None

## 7. HANDLING AND STORAGE

**Handling:** Avoid contact with eyes, skin or clothing. Do not remove briquets from container except for immediate use. Avoid breathing dust. Wash thoroughly with soap and water after handling.

**Storage:** Store in a cool, dry place. Do not contaminate food or feed by storage or disposal. Keep away from children.

## 8. EXPOSURE CONTROL / PERSONAL MEASURES

**Exposure Limits:** Not Applicable

**Ventilation:** Use with adequate ventilation.

**Personal Protective Equipment:** Avoid contact with skin, eyes and clothing. Wash thoroughly with soap and water after handling. Use good Industrial Hygiene practices including protective gloves and eyewear. If prolonged exposure to high levels of dust is expected, approved respiratory protection may be required.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| **Appearance and Odor:** | White to Grey solid with slight hydrocarbon odor. |
| **Boiling Point:** | N/A |
| **Melting Point:** | N/A |
| **Vapor Pressure (mm Hg):** | N/A |
| **Vapor Density (Air = 1):** | N/A |
| **Specific Gravity:** | 1.8492 g/cc |
| **Bulk Density:** | N/A |
| **Solubility:** | 1 ppm |
| **Evaporation Rate:** | N/A |
| **pH:** | N/A |

## 10. STABILITY AND REACTIVITY

| | |
|---|---|
| **Stability:** | Stable |
| **Reactivity:** | Non-reactive |
| **Incompatibility w/ Other Materials:** | None |
| **Decomposition Products:** | None |
| **Hazardous Polymerization:** | Will not occur |

## 11. TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

Acute oral toxicity: LD50 >5,100 mg/kg
Acute dermal toxicity: LD50 >2100 mg/kg
Acute inhalation: LC50 >5.19 mg/L (S-methoprene)
Skin irritation: Mild skin irritant
Eye irritation: Moderate eye irritant
Not a dermal sensitizer

CHRONIC TOXICITY **[Based on (RS)-Methoprene Technical]**

**(R,S)-Methoprene** is not considered a carcinogen. The NOEL for non-carcinogenic effects in an 18 month mouse study was 250 ppm.

DEVELOPMENTAL/REPRODUCTIVE TOXICITY **[Based on (RS)-Methoprene Technical]**

(R,S)-Methoprene is not a teratogenic compound. The NOEL for maternal and embryotoxicity in rabbits was 200 mg/kg/day. The NOEL for reproductive effects in rats was 500 ppm.

MUTAGENICITY **[Based on (RS)-Methoprene Technical]**

**(R,S)-Methoprene** is not a mutagen.

## 12. ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE **[Based on (RS)-Methoprene]**

| | |
|---|---|
| **Hydrolysis:** | T1/2 > 4 weeks |
| **Photolysis:** | T1/2 < 10 hours |
| **Soil half life:** | ~ 10 days |
| **Water solubility:** | 0.52 ppm |

ECOTOXICITY **[Based on (S)-Methoprene]**

**Acute Toxicity:** **fish:** $LC_{50}$ (trout): 760 ppb, (bluegill): > 370 ppb ((S)-Methoprene); **aquatic invertebrates:** $LC_{50}$ (Daphnia): 360 ppb ((S)-Methoprene)
This product is toxic to aquatic dipteran.

## 13. DISPOSAL CONSIDERATIONS

Wastes resulting from use of this product should be disposed of in accordance with all federal, state and local requirements. For additional regulatory information, see section 15 of this document.

## 14. TRANSPORT INFORMATION

| | |
|---|---|
| **DOT49CFR Description:** | Not regulated as hazardous by D.O.T. |
| **Freight Classification:** | Insecticides, NOI other than poison in boxes or drums. NMFC 155050 |

## 15. REGULATORY INFORMATION

| | |
|---|---|
| **CERCLA (Superfund):** | Not regulated |
| **RCRA:** | Not regulated as hazardous |

**SARA 311/312 HAZARD CATEGORIES**

| | |
|---|---|
| **Immediate Health:** | Yes (irritation) |
| **Delayed Health:** | No |
| **Fire:** | No |
| **Sudden Pressure:** | No |
| **Reactivity:** | No |

*The information presented herein, while not guaranteed, was prepared by technically knowledgeable personnel and to the best of our knowledge is true and accurate. It is not intended to be all inclusive and the manner and conditions of use and handling may involve other or additional considerations.*

| | |
|---|---|
| Date Issued: | November, 2004 |
| Supersedes: | November, 2003 |

# MATERIAL SAFETY DATA SHEET
## ZOECON ALTOSID® XR-G

**Manufacturer:** Wellmark International

**Address:** 1501 E. Woodfield Rd., Suite 200-West, Schaumburg, IL 60173

**Emergency Phone:** 1-800-248-7763

**Transportation Emergency Phone:** CHEMTREC: 1-800-424-9300

## 1. CHEMICAL PRODUCT INFORMATION

**Product Name:** Zoecon Altosid® XR-G

**Chemical Name/Synonym:** (S)- Methoprene; isopropyl (2E,4E,7S)-11-methoxy-3,7,11 trimethyl-2,4-dodecadienoate

**Chemical Family:** Terpenoid

**Formula:** $C_{19} H_{34} O_3$

**EPA Registration No.:** 2724-451

**RF Number:** 9010

## 2. COMPOSITION / INFORMATION ON INGREDIENTS

| Component (chemical, common name) | CAS Number | Weight | Tolerance |
|---|---|---|---|
| (S)-Methoprene: Isopropyl (2E,4E,7S)-11-trimethyl-2,4-dodecadienoate | 65733-16-6 | 1.50 % | Not established |
| Inert ingredients (trade secret and/or non-hazardous): | | 98.50% | |
| Silica, Crystalline-Quartz | 140808-60-7 | | 10 $mg/m^3$ OSHA<br>.1 $mg/m^3$ ACGIH |

## 3. HAZARD INFORMATION

**PRECAUTIONARY STATEMENT**

Caution: Keep out of the reach of children. Avoid contact with skin or eyes. In case of contact immediately flush eyes or skin with plenty of water. Get medical attention if irritation persists.

**SIGNS AND SYMPTOMS OF OVEREXPOSURE**

No adverse reactions have resulted from normal human exposure during research and testing

**PRIMARY ROUTE OF ENTRY** Dermal/Eye: Yes Oral: No **Inhalation:** No

**ACUTE TOXICITY**

**Oral:** $LD_{50}$ (rat): >34,000mg/kg (HDT-highest dose level tested) **(S)**-Methoprene)

**Dermal:** $LD_{50}$ (rabbit)>2,000 mg/kg (HDT) **(S)- Methoprene)**

**Inhalation:** LC50 (rat) > 5.19 mg/L air **(S) Methoprene**

### OTHER TOXICOLOGICAL INFORMATION

| | |
|---|---|
| **Skin Irritation:** | Non- irritating (rabbit) (Based on **(S) Methoprene)** |
| **Eye Irritation:** | Practically non-irritating (rabbit) (Based on **(S) Methoprene)** |
| **Sensitizer:** | Not considered a sensitizer (guinea pig) (Based on **(S) Methoprene)** |

## 4. FIRST AID MEASURES

| | |
|---|---|
| **Eye:** | Hold eyelids open and rinse slowly and gently with water for 15 – 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eyes. |
| **Skin:** | Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. |
| **Ingestion:** | Give 1-2 glasses of water and try to induce vomiting. Refer victim to medical personnel. Never give anything by mouth to an unconscious person. |
| **Inhalation:** | Not likely due to product form. Remove to fresh air. |
| **Note to Physician:** | Treat symptomatically |

## 5. FIRE FIGHTING MEASURES

| | |
|---|---|
| **NFPA Rating:** | **Health: 0** **Fire: 0** **Reactivity: 0** |
| **Flammability Class:** | N/A |
| **Flash Point:** | Does not flash |
| **Explosive Limits (% of Volume):** | Not applicable |
| **Extinguishing Media:** | Water, foam, $CO_2$ |
| **Special Protective Equipment:** | Firefighters should wear full protective clothing including self contained breathing apparatus |
| **Fire Fighting Procedures:** | Normal procedures. Do not allow fire fighting water to escape into waterways or sewers |
| **Combustion Products:** | None known |
| **Unusual Fire/Explosion Hazards:** | None known |

## 6. ACCIDENTAL RELEASE MEASURES

| | |
|---|---|
| **Steps to be taken:** | Sweep up material. Place in a container for disposal. Do not allow spill to enter waterways inhabited by aquatic organisms |
| **Absorbents:** | Due to product form none necessary. If in liquid form absorb with clay granules, sawdust, dirt or equivalent |
| **Incompatibles:** | None known |

## 7. HANDLING AND STORAGE

| | |
|---|---|
| **Handling:** | Avoid contact with skin or eyes. |
| **Storage:** | Store closed containers in a cool dry place. Do not contaminate water, food or feed by storage or disposal. |

## 8. EXPOSURE CONTROL / PERSONAL MEASURES

| | |
|---|---|
| **Exposure Limits:** | Silica, Amorphous, Precipitated = 6 mg/m3 (OSHA PEL) and 10 mg/m3 (ACGIH TLV) |
| **Ventilation:** | Use with adequate ventilation. |
| **Personal Protective Equipment:** | Due to the size and abrasiveness of the granule, use protective eyewear and clothing to minimize exposure during loading and handling. |

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| **Appearance and Odor:** | Dark gray to black granules with a slight hydrocarbon odor |
| **Boiling Point:** | Not Applicable |
| **Melting Point:** | Not Applicable |
| **Vapor Pressure (mm Hg):** | Not Applicable |
| **Vapor Density (Air = 1):** | Not Applicable |
| **Specific Gravity:** | 1.04 where $H_20$=1 |
| **Bulk Density:** | Not Applicable |
| **Solubility:** | 1ppm |
| **Evaporation Rate:** | Not Applicable |
| **pH:** | Not Applicable |

## 10. STABILITY AND REACTIVITY

| | |
|---|---|
| **Stability:** | Stable |
| **Reactivity:** | Non-Reactive |
| **Incompatibility w/ Other Materials:** | None Known |
| **Decomposition Products:** | None Known |
| **Hazardous Polymerization:** | Will not occur |

## 11. TOXICOLOGICAL INFORMATION

CHRONIC TOXICITY **[Based on (RS)- Methoprene]**
Methoprene is not considered as an oncogenic compound. The NOEL for non-carcinogenic effects in an 18 month mouse study was 250 ppm.

DEVELOPMENTAL/REPRODUCTIVE TOXICITY **[Based on (RS)- Methoprene]**

Methoprene is not a teratogenic compound. **The NOEL for maternal and embryo toxicity in rabbits was 200 mg/kg/day. The NOEL for reproductive effects in rats was 500 ppm.**

MUTAGENICITY **[Specific to Ingredient(s)]**
Methoprene is not a mutagenic compound. **(Based on (RS)- Methoprene)**

CARCINOGEN [Silica Crystalline Quartz (Sand)] The process by which silica dust in the sand is agglomerated and coagulated by the cross-linked protein to form an essentially dust-free granule. The granule is glazed with a protein/charcoal coating that effectively seals the sand, and any concomitant silica, within the granule. Any dust that results from abrasion during handling, will consist of protein and charcoal. Exposure to silica dust from the finished product will not be expected to occur. Finished product not considered carcinogenic.

## 12. ECOLOGICAL INFORMATION

**ENVIRONMENTAL FATE(Based on Active Ingredients Only)**

**Hydrolysis:** Not hydrolyzed up to 30 days

**Photolysis:** Rapidly degraded in sunlight

**Soil half life:** 10-14 days, rapidly hydrolyzed in soil

**Water solubility:** Disperses in water

**ECOTOXICITY [Based on Active Ingredients Only]**

**Acute Toxicity:** Fish: Trout LC50 760 ppb Bluegill >370 ppb
**Aquatic Invertebrates:** Daphnia LC50 360 ppb

## 13. DISPOSAL CONSIDERATIONS

Do not contaminate water, food or feed by disposal. **Pesticide Disposal:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. **Container Disposal:** Completely empty into application equipment. Then dispose of empty container in a sanitary landfill or by incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.

## 14. TRANSPORT INFORMATION

**DOT49CFR Description:** Not regulated as hazardous by D.O.T

**Freight Classification:** Insecticides, NOI other than poison

## 15. REGULATORY INFORMATION

**CERCLA (Superfund):** Not regulated

**RCRA:** Not regulated

**SARA 311/312 HAZARD CATEGORIES**

**Immediate Health:** Yes (irritant)

**Delayed Health:** No

**Fire:** No

**Sudden Pressure:** No

**Reactivity:** No

*The information presented herein, while not guaranteed, was prepared by technically knowledgeable personnel and to the best of our knowledge is true and accurate. It is not intended to be all inclusive and the manner and conditions of use and handling may involve other or additional considerations.*

25 24 047

# Material Safety Data Sheet

Date last revised: 10 October 2005

## I. General Information

| | |
|---|---|
| **Chemical Name and Synonyms**<br>None: mixture/blend | **Trade Name & Synonyms**<br>**DUET® Dual-action Adulticide** |
| **Chemical Family**<br>Synergized Synthetic Pyrethroid | **EPA Registration Number**<br>1021-1795-8329 |
| **Proper DOT/ICAO/IATA Shipping Name**<br>Insecticides, Insect or Animal Repellent, Liquid, N.O.S. | **DOT/ICAO/IATA Hazard Classification**<br>Non-Hazardous |
| **Registrant**<br>Clarke Mosquito Control Products, Inc. | **Registrant's Phone Number**<br>(630) 894-2000 |
| **Address**<br>159 North Garden Avenue<br>Roselle, Illinois 60172 | **INFOTRAC (Transportation/Spill Emergency)** 1-800-553-5053<br>**Poison Control Center (Medical Emergency)** 1-888-740-8712 |

## II. Ingredients

| Principal Hazardous Components | Wt.% | CAS # | EINECS# |
|---|---|---|---|
| Prallethrin (ETOC®) | 1.0 | 023031-36-9 | 245-387-9 |
| d-Phenothrin (Sumithrin®) | 5.0 | 026002-80-2 | 247-404-5 |
| Piperonyl Butoxide | 5.0 | 000051-03-6 | 200-076-7 |
| Aromatic Hydrocarbon | 15-25 | 070693-06-0 | Not Avail. |
| Hydrotreated Paraffinic Oil | 50-75 | 072623-84-8 | Not Avail. |

COMMENTS: Ingredients not identified are proprietary or non-hazardous. Values are not product specifications.

## III. Physical Data

| | |
|---|---|
| **Boiling Point (°F):** Not Available | **Specific Gravity ($H_2O$ = 1):** 0.904 at 20 °C (68 °F) |
| **Vapor Pressure (mm Hg.):** Not Available | **Vapor Density (Air = 1):** Heavier than air |
| **Solubility in Water:** Immiscible in water | **pH:** Not Determined |
| **Appearance**: Clear, light yellow liquid (Gardner Scale 2) | **Odor:** Aromatic solvent |
| **Viscosity:** 17 CPS at 24 °C (75.2 °F) Brookfield | **(VOC):** < 1% |

## IV. Fire & Explosion Hazard Data

**Flash Point (Test Method** : > 93.3 °C (200 °F) TAG Closed Cup

**Flammable Class:** This product is NOT classified as flammable or combustible by OSHA

**Extinguishing Media**: Foam, carbon dioxide, or dry chemical

**Hazardous Combustion Products:** This product is classified as Non-Combustible, however in the extreme temperatures that fires may produce, some of the constituents of this formula may decompose to give off such gases as carbon dioxide, carbon monoxide, and nitrogen oxides.

**Special Fire Fighting Procedures:** Treat as an oil fire. Use a full-faced self-contained breathing apparatus along with full protective gear. Keep nearby containers and equipment cool with a water stream.

**Sensitive to Static Discharge:** Yes, use proper bonding and/or grounding procedures

## V. Health Hazard Data

**EMERGENCY OVERVIEW:** CAUTION. Harmful if swallowed. Contains petroleum distillates; vomiting may cause aspiration pneumonia. Take prudent precautions to avoid contact with skin, eyes, and clothing. Do not use or store near heat or open flame.

**POTENTIAL HEALTH EFFECTS & EMERGENCY FIRST AID**

**Skin Contact:** Can cause skin irritation. Can cause a burning or prickling sensation on more sensitive areas (face, eyes, mouth). May be harmful if absorbed through the skin. Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

**Eye:** May cause temporary irritation, tearing, and blurred vision. Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing the eye. Call a poison control center or doctor for treatment advice.

**Inhalation:** Excessive inhalation of mists can cause nasal and respiratory irritation. Remove affected person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call a poison control center or doctor for further treatment advice.

# Material Safety Data Sheet

**DUET® Dual-action Adulticide**

Date last revised: 10 October, 2005

**Ingestion:** Harmful if swallowed. Small amounts of this product aspirated into the respiratory system during ingestion or vomiting may cause mild to severe lung injury. If swallowed, IMMEDIATELY call a poison control center or doctor for treatment advice. DO NOT give any liquid to the person. DO NOT induce vomiting unless told to do so by a poison control center or a doctor. Never give anything by mouth to an unconscious person.

**Chronic:** None known

**NOTES TO PHYSICIAN:** Contains pyrethroids and petroleum distillates; vomiting may pose an aspiration pneumonia hazard. For skin effects, a highly efficient therapeutic agent for pyrethroid exposure is topical application of Tocopherol Acetate (Vitamin E).

## VI. Reactivity Data

| | |
|---|---|
| **Stable:** | YES |
| **Incompatibility** | Strong acidic or alkaline materials. Not compatible with strong oxidizers. |
| **Hazardous Polymerization:** | NO |

## VII. Environmental Protection Procedures

**Spill Response:** Stop release, if possible without risk. Dike or contain release, if possible, and if immediate response can prevent further damage or danger. Isolate and control access to the release area. Take actions to reduce vapors. For large spills, collect product into drums, storage tanks, etc. via drains, pumps, etc. Absorb with appropriate absorbent such as sand, or vermiculate. Clean spill area of residues and absorbent.

**Environmental Precautions:** Water Spill: Contains pyrethroids which are toxic to fish and other aquatic invertebrates. Contaminated absorbent and wash water should be disposed of according to local, state/provincial and federal/national regulations.

**Storage:** Store in a cool, dry place. Keep container closed. Do not contaminate water, food or feedstuffs by storage, handling, or by disposal.

**Disposal Considerations:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Triple rinse (or equivalent) empty containers and offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other approved State and Local procedures

**RCRA/EPA Waste Information:** None of the ingredients in this product appear on the RCRA lists (40 CFR 261.24, 40 CFR 251.33) or CERCLA Hazardous Substance list (40 CFR Part 302 Table 302.4).

## VIII. Special Protection Information

| **Exposure Guidelines (TWA)** | **OSHA PEL** | **ACGIH TLV** | **Supplier OEL** |
|---|---|---|---|
| Prallethrin (ETOC®) | None | None | None |
| d-Phenothrin (Sumithrin®) | None | None | None |
| Piperonyl Butoxide | None | None | None |
| Aromatic Hydrocarbon | None | None | 17 ppm - 100 mg/m3 |
| Hydrotreated Paraffinic Oil | 5 mg/m3 | 5 mg/m3 | None |

**Eye Protection:** Take prudent precautions to avoid contact with eyes.

**Skin Protection:** Take prudent precautions to avoid contact with skin and clothing.

**Respiratory Protection:** Wearing a respirator is not normally required when handling this product. Use in well ventilated areas. Take prudent precautions to avoid breathing vapors and/or spray mists of this product.

**Engineering Controls:** Mechanical ventilation should be used when handling this product in enclosed spaces. Local exhaust ventilation may be necessary.

**Work/Hygienic Practices:** DO NOT SMOKE, EAT, OR DRINK, OR APPLY COSMETICS IN WORK AREA. Wash promptly if skin becomes contaminated. Wash at the end of each work shift and before eating, smoking, or using the toilet.

## IX. Toxicological Information

| | |
|---|---|
| Acute Dermal LD50 > 5000 mg/kg (albino rabbit) | Acute Oral LD50 > 5000 mg/kg (albino rat) |

Inhalation LC50: The acute inhalation LC50 of this material places it in EPA toxicity category IV.

Eye Effects: Irritation clearing in 24 hours.

Skin Effects: Slight irritation at 72 hours. Irritation index = 0.9

Sensitization: Negative; Not considered to be a dermal sensitizer.

COMMENTS: None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA, or ACGIH as being carcinogens.

# Material Safety Data Sheet

**DUET® Dual-action Adulticide**

Date last revised: 10 October, 2005

## X. Additional Regulatory Information

**SARA Title III (Superfund Amendments and Reauthorization Act)**

311/312 Hazard Categories:

| | | | |
|---|---|---|---|
| FIRE: NO | PRESSURE GENERATING: NO | REACTIVITY: NO | ACUTE: YES |

313 Reportable Ingredients (Component, CAS#, Max %) :
Piperonyl butoxide, 000051-03-6, 5.0
d-Phenothrin (Sumithrin®), 026002-80-2, 5.00

302/304 Emergency Planning
Emergency Plan: There are no SARA Title III Section 302 extremely hazardous substances present in this formulation (40 CFR 355).

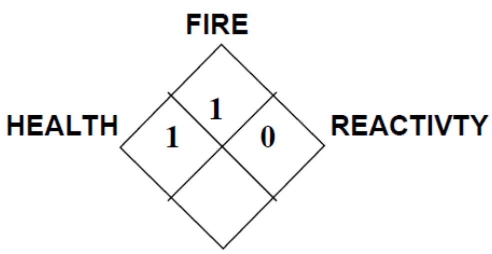
There are no components that are subject to emergency requirements under CERCLA Section 103(a) (40 CFR 302.4) in this formulation.

**TSCA (Toxic Substance Control Act)**

TSCA Status: All chemical substances found in this product comply with the Toxic Substances Control Act's inventory reporting requirements.

**State Regulations**

Volatile Organic Compounds (VOC): This product contains less than 1% VOCs.




**NFPA Code** Key
4 = Severe
3 = Serious
2 = Moderate
1 = Slight
0 = Minimal

**The information and statements herein are believed to be reliable but are not to be construed as a warranty or representation for which we assume legal responsibility. Users should undertake sufficient verification and testing to determine the suitability for their own particular purpose of any information or products referred to herein. NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE IS MADE.**

**Material Safety Data Sheet**
**May be used to comply with**
**OSHA's Hazard Communication Standard,**
**29 CFR 1910.1200. Standard must be consulted**
**for specific requirements.**

**U.S. Department of Labor**
**Occupational Safety and Health Administration**
**(Non-Mandatory Form)**
**Form Approved**
**OMB No. 1218-0072**

**IDENTITY (As Used on Label and List)**
**Bonide Mosquito Larvicide**

**ID NO. 4195**
**Date: November 27, 1998**

## Section I

Bonide Products, Inc.
2 Wurz Ave.
Yorkville, NY 13495

(800) 424-9300
(315)736-8231

## Section II - Hazardous Ingredients/Identity

| Hazardous Components (Specific Chemical Identity: Common Name(s) | OSHA PEL | ACGIH TLV | Other Limits | % (Optional) |
|---|---|---|---|---|
| Mineral Oil CAS No. 64742-30-9 | | | | 98.0 |
| Emulsifier | | | | 2.0 |

## Section III - Fire and Explosion Hazard Data

FLASH POINT (Method used): NA
EXTINGUISHING MEDIA CO2
SPECIAL FIRE FIGHTING PROCEDURES: NA
FLAMMABLE LIMITS: N/A
UNUSUAL FIRE AND EXPLOSION HAZARDS: None

## Section IV - Reactivity Data

STABILITY: Stable
INCOMPATIBILITY (Materials to Avoid): None
CONDITIONS TO AVOID: Store in a cool, dry place.
HAZARDOUS POLYMERIZATIONS: Will not occur.
HAZARDOUS DECOMPOSITION OR BYPRODUCTS: None

## Section V - Health Hazard Data

PRECAUTIONS: Avoid breathing spray. If swallowed, do not induce vomiting. Notify physician.
FIRST AID: EYE CONTACT: If splashed into eyes, flush with clear water for 15 minutes or until irritation subsides. If irritation persists call a physician. SKIN CONTACT: Remove any contaminated clothing & wash skin thoroughly with soap. INHALATION: Remove from exposure & call a physician if breathing is irregular or has stopped, start resuscitation. INGESTION: DO NOT induce vomiting; call a physician immediately. Product has a low order of acute toxicity. NOTE TO PHYSICIAN: None

## Section VI - Spill or Leak Procedures

PRECAUTIONS: Recover free product. Add sand, earth or other suitable absorbent to spill area. Minimize breathing vapors. Minimize skin contact. Open all windows and doors. Keep product out of sewers and watercourses by diking or impounding. DISPOSAL: Do not reuse container. Wrap in paper and discard in trash.

## Section VII - Storage and Handling

STORAGE: Store in a cool, dry place inaccessible to children or pets. Avoid contamination of feed and foodstuffs.
HANDLING PRECAUTIONS: Handle in a well ventilated area. Avoid contact with eyes or skin. Wash skin and clothing after use.
CONTAINER DISPOSAL: Do not reuse container. Wrap in paper and discard in trash.

## Section VIII - Additional Information/Hazards

Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite or calcium hypochlorite. Exposure limit for total product: 5mg/kg for oil
Mist in air: Basis: OSHA Regulation 29 CER 1910.1000
Stability: Stable Hazardous Polymerization: Will not occur.

## Section IX - Additional Characteristics

BOILING POINT: 1BP appr. 199°C (390°F) by ASTM D 2287
VAPOR PRESSURE: Less than 0.01 mm HG at 20°C
VAPOR DENSITY (Air=1): Greater than 5
SOLUBILITY IN WATER: Negligible; less than 0.1%
SPECIFIC GRAVITY ($H_2O$=1): (15.6°C/15.6°C) 0.84
APPEARANCE & ODOR: Clear water-white liquid - mild odor

## KEEP OUT OF REACH OF CHILDREN

### ABBREVIATION KEY

| | |
|---|---|
| N/A: NOT AVAILABLE OR APPLICABLE | N/E: NOT ESTABLISHED |
| TLV: THRESHOLD LIMIT VALUE | TWA: TIME WEIGHTED AVG./8 HOUR WORKDAY |
| STEL: SHORT TERM EXPOSURE LIMIT | D.O.T.: DEPARTMENT OF TRANSPORTATION |

## DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES

Buyer assumes all risks of use, storage and handling of this material not in strict accordance with directions given herewith.

MATERIAL SAFETY DATA SHEET

Date Issued: 11/01/2012
MSDS No:CMP118.2.r3

# COCOBEAR™

## 1. PRODUCT AND COMPANY IDENTIFICATION

**PRODUCT NAME: COCOBEAR™**

**PRODUCT DESCRIPTION:** Mosquito Larvicide Oil

**EPA REGISTRATION NUMBER:** 8329-93

**ACTIVE INGREDIENT(S): White Mineral Oil (10% w/w)**

**MANUFACTURER**

Clarke Mosquito Control Products, Inc.
110 E. Irving Park Rd., 4th Floor
Roselle, Illinois 60172
**Manufacturer's Phone Number: (630) 894-2000**

**24 HR. EMERGENCY TELEPHONE NUMBERS**

**INFOTRAC (Transportation/Spill Emergency): (800) 553-5053**
**PROSAR (Medical Emergency): 1-800-214-7753**

## 2. HAZARDS IDENTIFICATION

**EMERGENCY OVERVIEW**

**IMMEDIATE CONCERNS:** CAUTION. Harmful if swallowed. If ingested, this material presents an aspiration pneumonia hazard. Call a poison control center or doctor immediately

**POTENTIAL HEALTH EFFECTS**

**EYES:** Contact with eyes may cause mild irritation

**SKIN:** This product may cause temporary irritation to the skin

**INGESTION:** Harmful if swallowed. Aspiration pneumonia hazard. Ingestion of large amounts may produce gastrointestinal disturbances including irritation, nausea, and diarrhea.

**INHALATION:** Inhalation of vapors or mists may be irritating to the respiratory tract

**CHRONIC EFFECTS:** Prolonged or repeated exposure may cause skin irritation.

**COMMENTS:** This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

## 3. COMPOSITION / INFORMATION ON INGREDIENTS

| Chemical Name | Wt.% | CAS | TWA |
|---|---|---|---|
| White Mineral Oil | 10.000% | 8042-47-5 | 5 mg/m3 |
| | | | |

**COMMENTS:** Ingredients not identified are proprietary or non-hazardous. Values are not product specifications.

## 4. FIRST AID MEASURES

**EYES:** Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after first 5 minutes, then continue rinsing the eye. Call a poison control center or a doctor for treatment advice.

**SKIN:** Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

**IF SWALLOWED:** Immediately call a poison control center of doctor. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give ANY liquid to the person. Do not give anything by mouth to an unconscious person.

**INHALATION:** Remove to fresh air. If not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth. Call a poison control center or doctor for further treatment advice.

**NOTES TO PHYSICIAN:** The decision to induce vomiting should be made by an attending physician. If ingested, this material presents aspiration and chemical pneumonitis hazard. Induction of emesis is not recommended. Consider activated charcoal and/or gastric lavage.

## 5. FIRE FIGHTING MEASURES

**FLASHPOINT AND METHOD:** > 95° C (203° F) Tag Closed Cup

**FLAMMABLE CLASS:** This product is NOT classified as flammable or combustible by OSHA.

**EXTINGUISHING MEDIA:** Foam, carbon dioxide, alcohol foam, dry chemical.

**UNUSUAL FIRE & EXPLOSION HAZARDS:** Porous material such as rags, paper, insulation, or organic clay wetted with this material may be combustible. Under fire conditions this product may support combustion and may decompose to give off toxic gases such as carbon monoxide, carbon dioxide, and nitrogen oxides.

**FIRE FIGHTING PROCEDURES:** Treat as an oil fire. Use a full-faced self-contained breathing apparatus and full protective gear. Keep nearby containers and equipment cool with a water stream.

## 6. ACCIDENTAL RELEASE MEASURES

**SPILL RESPONSE:** Contain spill by diking to keep out of sewers. Eliminate ignition sources. Absorb spills with dry material such as sand and sweep up for disposal. This material will float on water. Absorbent pads and similar materials can be used. For large spills, barricade area and consult manufacturer.

**WASTE DISPOSAL:** Dispose in accord with local, state, and federal regulations.

**ENVIRONMENTAL PRECAUTIONS:** Concrete may be slowly deteriorated by contact; avoid recurring drips or leaks, and clean up spills promptly. Prevent further leakage or spillage if safe to do so. Prevent entry into waterways.

## 7. HANDLING AND STORAGE

**HANDLING:** Avoid application equipment, pumps, lines, and fittings made of the following materials: natural or nitrile rubber, neoprene, tygon, brass, bronze, copper, lead, tin, zinc. Do not use personal protection equipment made of natural, nitrile, or neoprene rubber. Do not contaminate water, food or feedstuffs, by storage, handling, or by disposal. Wash thoroughly after handling.

**STORAGE:** Store at temperatures below 110°F (54°C). Keep container closed. Always store pesticides in the original container. For bulk storage, vessels, pumps, pipes, and transfer lines can be carbon steel, but 316 or 304 stainless steel is preferred. Rubber hoses are not recommended for extended use.

**KEEP OUT OF REACH OF CHILDREN.**

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**Exposure Guidelines (TWA):** ACGIH TLV and OSHA PEL is 5.0 MG/M3 for mineral oil.

**Engineering Controls:** Control airborne concentrations below the exposure guideline. Use only with adequate ventilation. Local exhaust is suggested for use in enclosed or confined spaces.

**Personal Protective Equipment:** Mixers, loaders, applicators and other handlers must wear long-sleeved shirt and long pants, shoes plus socks. Contact with the eyes and prolonged contact with the skin shold be avoided. Do not use personal protection equipment made of natural, nitrile, or neoprene rubber.

**Work Hygienic Practices:** DO NOT SMOKE, EAT, OR DRINK, OR APPLY COSMETICS IN WORK AREA! Wash promptly if skin becomes contaminated. Wash at the end of each work shift and before eating, smoking, or using the toilet.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

**APPEARANCE:** clear oily liquid
**ODOR:** detergent-like odor
**DENSITY:** 0.868 g/mL at 24.0°C
**VISCOSITY:** 4.5 centipoises at 20°C
**pH:** ND

**VAPOR DENSITY:** Not Determined
**BOILING POINT:** Not Determined
**FREEZING POINT:** Not Determined
**FLASHPOINT & METHOD:** see Section 5
**SOLUBILITY IN WATER:** Not soluble

## 10. STABILITY AND REACTIVITY

**STABLE:** Stable at normal conditions

**HAZARDOUS DECOMPOSITION PRODUCTS:** Alcohols

**CONDITIONS TO AVOID:** Strong oxidizers. Keep away from extreme heat, sparks, open flame and strong oxidizing conditions.

## 11. TOXICOLOGICAL INFORMATION (test substance is COCOBEAR)

**ACUTE**

**Dermal $LD_{50}$ > 5050 mg/kg**
**Oral $LD_{50}$: > 5000 mg/kg**
**Inhalation LC50 > 2.16 mg/L**

Single dose oral toxicity is slight. Exposure incidental to industrial handling and prescribed use are not likely to cause injury.

**EYE EFFECTS:** Mildly irritating to the eye.

**SKIN EFFECTS:** Mildly irritating to the skin.

**SENSITIZATION:** Not a skin sensitizer

**COMMENTS:** None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as being carcinogenic.

## 12. ECOLOGICAL INFORMATION

Do not apply directly to water, except as directed for use.

## 13. DISPOSAL CONSIDERATIONS

**DISPOSAL METHOD:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

**EMPTY CONTAINER: See container label for instructions on cleaning the container.** Offer for recycling (if appropriate), or reconditioning, or puncture and dispose of container in a sanitary landfill, or by other procedures approved by State and Local authorities.

**RCRA/EPA WASTE INFORMATION:** This product contains the following RCRA/CERCLA Hazardous wastes/substances: None

## 14. TRANSPORT INFORMATION

**DOT (DEPARTMENT OF TRANSPORTATION)**

**PROPER SHIPPING NAME**
This material is not regulated as a hazardous material by the DOT (Shipping name: Insecticides, Insect or Animal Repellents, Liquid, N.O.S.)

**PRIMARY HAZARD CLASS/DIVISION:** none

**AIR (ICAO/IATA)**

**SHIPPING NAME:** not regulated
**PRIMARY HAZARD CLASS/DIVISION:** none

**VESSEL (IMO/IMDG)**

**SHIPPING NAME:** Not Available

## 15. REGULATORY INFORMATION

**CERCLA**

**Reportable Quantity:** there is no RQ for this product

**Superfund Amendments and Reauthorization Act of 1986 (SARA)**

Section 302 extremely hazardous substances: No
Section 311 hazardous chemical: No

COCOBEAR™

**California Prop. 65 Components**

This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive effects

## 16. OTHER INFORMATION

| | NFPA HAZARD RATINGS | | HMIS HAZARD RATINGS | |
|---|---|---|---|---|
| 0 - Minimal | | | | |
| 1 - Slight | Health | 1 | Health | 1 |
| 2 - Moderate | Flammability | 1 | Flammability | 1 |
| 3 - Serious | Instability | 0 | Physical | 0 |
| 4 - Extreme | Special | none | PPE | X |

Notes: We assign NFPA and HMIS ratings to this product based on the hazards of its ingredient(s). Since the user is most aware of the applications and conditions of use, he or she must ensure that the proper Personal Protective Equipment is provided, consistent with the information contained in Sections 7 and 8 of the MSDS.

The data contained herein are based on information currently available to Clarke Mosquito Control Products, Inc. and, to the best of our knowledge, are accurate and based on sound expert opinion. Our statements herein, however, are not to be taken as a warranty or representation for which Clarke Mosquito Control Products, Inc. assumes legal responsibility.

## Mineral Oil Products Profile (Source: Mari Reeves, FWS)

Toxicological endpoint and environmental fate data listed in this chemical profile will be periodically reviewed and updated. New information, including, but not limited to, completion of national section 7consultation in accordance with the federal Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended, between the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency on individual pesticide registrations and all federally listed and proposed species and proposed and designated critical habitat, may change ecological risk assessments, pesticide use patterns, best management practices, and/or justification for use. Consultations occur now at the local level for listed and proposed species and proposed and designated critical habitat on specific use of individual pesticides in specific project areas.

| | | | | | |
|---|---|---|---|---|---|
| **Date:** | 1/9/14 | | | | |
| **Pesticide Class:** | Aliphatic Hydrocarbons | **Common Chemical Name(s):** | Mineral Oil, Paraffin Oil | **Pesticide Type:** | Insecticide |
| **Trade Name(s):** | BVA 2 Mosquito Larvicide Oil,<br><br>Cocobear,<br>Kontrol Mosquito Larvicide,<br>Mosquito Larvicide GB-1111 | **EPA Registration Number:** | 70589-1,<br><br>8329-93,<br><br>73748-10,<br><br>8329-72 | **CAS Number:** | 8042-47-5, 64742-55-8, &/or 72623-84-8,<br>8042-47-5,<br><br>64742-30-9,<br><br>8042-47-5 |
| **Other Ingredients:** | **BVA 2 Mosquito Larvicide Oil:** 97% MNO, 3% proprietary ingredients (1a); **Cocobear:** 10% MNO, including petroleum distillates, 90% proprietary ingredients (1b); **Kontrol Mosquito Larvicide:** 98% MNO, including petroleum distillates, 2% proprietary ingredients (1c); **Mosquito Larvicide GB-1111:** 98.7% MNO, including petroleum distillate, 1.3% proprietary ingredients (1d) | | | | |
| **Justification for Use:** | | | | | |
| **Specific Best Management Practices (BMPs):** | | | | | |

**Toxicological Endpoints** — Endpoints highlighted yellow are selected for use in a screening-level ecological risk assessment. Endpoints selected are typically the most toxic endpoint for the most sensitive species listed in following summaries.

| | |
|---|---|
| **Mammalian LD$_{50}$:** | **MNO: (Tech.):**<br>*Guinea Pig*: Mild dermal irritation effect at 100 mg for 24 h (2), very little is absorbed through the skin (2),<br>*Rabbit*: Mild dermal irritation effect at 100 mg for 24 h (2), very little is absorbed through the skin (2),<br>*Rat*: Acute, oral = 28,000 mg/kg bw (2), Single dose, 14-d observation period, age unk.. > 5,000 mg/kg bw (2), 90-d dietary study, female, age unk.: NOAEL, microgranulomas in the mesenteric lymph nodes = 2 mg/kg bw (2), NOAEL, liver microgranulomas = 190 mg/kg bw (2), [See Bioaccumulation/Bioconcentration |

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| | Section.]<br><br>**NOTE**: Virtually no toxic effects to mammals (2). |
| **Mammalian $LC_{50}$:** | **MNO:** No information in references. |
| **Mammalian Reproduction:** | **MNO: (Tech.):**<br>*Rat*: 1-generation reproductive/developmental study: No adverse effects on growth weights, food consumption, fertility, mating indices in either gender, and at necropsy, organ weights and histopathology were normal) (2). |
| **Avian $LD_{50}$:** | **MNO: (99% AI):**<br>*Bobwhite*: Single dose, 14-d observation period, 17 weeks old > 2,250 mg/kg bw (6), 14-d NOEL = 2,250 mg/kg bw (6), Single dose, 14-d observation period, 18 weeks > 2,250 mg/kg bw (6), 14-d NOEL = 2,250 mg/kg bw (6).<br><br>**NOTE**: Virtually no toxic effects to birds (although there is the potential for impairing the hatching of eggs if the eggs are exposed directly to the oil) (2). |
| **Avian $LC_{50}$:** | **MNO: (98.75-100% AI):**<br>*Bobwhite*: 5-d, 10 d old > 5,620 ppm (6), 5-d NOEL = 1,000 ppm (6), 5-d, 10 d old > 5,518 ppm (6), 5-d NOEL = 5,518 ppm (6), 5-d, 10 d old > 5,620 ppm (6), 5-d NOEL = 5,620 ppm (6),<br>*Mallard*: 5-d, 10 d old > 5,620 ppm (6), 5-d NOEL = 5,620 ppm (6). |
| **Avian Reproduction:** | **MNO: (97% AI):**<br>*Chicken*: Eggs sprayed (without rotation) 2-3 times over several weeks with plant mister (simulating spray in field/drift), approximately 1.5 mL of product, embryo development was terminated irrespective of the timing of treatment (4),<br>*Ring-billed Gull*: Eggs sprayed (without rotation) 2-3 times over several weeks with plant mister (simulating spray in field/drift), approximately 1.5 mL of product, all eggs failed to hatch (4). |
| **Fish $LC_{50}$:** | **MNO: (Tech.):**<br>*Rainbow Trout*: 96-h LC50, age unk. = 410 ppm (7), 21-d NOEC = 64.6 ppm (7). |
| **Fish ELS/ Life Cycle:** | **MNO: (98.75-100% AI):**<br>*Bluegill*: 96-h LC50, av. wt. 0.34 g > 500,000 ppm (4,6), 96-h NOEL = 500,000 ppm (4,6), 96-h LC50, av. wt. 0.46 g > 100 ppm (4,5,6),<br>*Rainbow Trout*: 96-h LC50, av. wt. 0.48 g > 100 ppm (4,5,6), 96-h LC50, av. wt. 0.4 g > 120 ppm (4,6), 96-h NOEL = 120 ppm (4,6),<br>*Sheepshead Minnow*: 96-h LC50, av. wt. 0.36 g > 118 ppm (4,6), 96-h NOEL = 118 ppm (4,6). |
| **Amphibians/ Reptiles:** | **MNO:** No information in references. |
| **Invertebrates/ Plants:** | **MNO: (Tech.):**<br>*Daphnia magna*: 48-h EC50, immobility = 1.28 ppm (7), 21-d NOEC = 0.005 ppm (7),<br>*Earthworm*: 14-d LC50, age unk. > 750 mg/kg dry soil (7), 14-d LC50, age unk. > 375 mg/kg dry soil (7),<br>*Green Algae*: 96-h NOEC, growth = 0.04 ppm (7),<br>*Honeybee*: 48-h LD50, age unk. = 1,474 µg/bee (7).<br><br>**(98.75-100% AI):**<br>*Daphnia magna*: 48-h EC50, immobility, < 24 h old = 0.021 ppm (4,6), 48-h NOEL = |

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| | 0.008 ppm (4,6), 48-h EC50, immobility, < 24 h old = 0.11 ppm (6), 48-h NOEL = 0.023 ppm (4,6),<br>*Eastern Oyster*: 96-h EC50, immobility, spat = 6.07 ppm (4,6), 96-h NOEL = 3.24 ppm (4,6),<br>*Honey Bee*: 48-h LD50, contact, adult > 1,830 µg/bee (4,6), 48-h NOEL = 1,830 µg/bee (4,6), 48-h LD50, contact, adult > 100 µg/bee (6), 48-h NOEL = 100 µg/bee (6), 48-h LD50, contact, adult > 25 µg/bee (6), 48-h NOEL = 25 µg/bee (6),<br>*Mysid Shrimp*: 96-h LC50, juvenile = 0.7 ppm (4,6), 96-h NOEL = 0.51 ppm (4,6).<br><br>**NOTE**: No phytotoxic concerns (2). |
| **Other:** | **MNO:** Neurotoxic: Negative (7); Carcinogenic: Possible (5,7) if the mineral oil is contaminated with aromatic hydrocarbons (2); Teratogenic: Negative (7); Mutagenic: Negative (2,7); Genotoxic: Negative (2); Endocrine disruption: Negative (7). |

**Ecological Incident Reports**

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| Based on USEPA's Ecological Incident Information System (EIIS) database (1996 to present), last accessed on December 11, 2013, there have been 6 incidents, all of which were limited to plants, primarily crops, of varying acreages. These incidents were all found to be possible. (R. Miller, U.S. Environmental Protection Agency, Washington, D.C., personal communication) |

**Environmental Fate**

| | |
|---|---|
| **Water solubility ($S_w$):** | **MNO:** Negligible (1c,d), Very low (2), Insoluble (1a,b,2), 20ºC = 0.01 mg/L (7). |
| **Soil Mobility ($K_{oc}$):** | **MNO:** High sorption to organic matter, low mobility (2), = $9.09 \times 10^6$ (7). |
| **Soil Persistence ($t_{½}$):** | **MNO:** No information in references. |
| **Soil Dissipation ($DT_{50}$):** | **MNO:** Aerobic, typical = 65 d (7), Aerobic, Lab at 20ºC = 65 d (7). |
| **Aquatic Persistence ($t_{½}$):** | **MNO:** = 2 – 3 d (2). |
| **Aquatic Dissipation ($DT_{50}$):** | **MNO:** No information in references. |
| **Potential to Move to Groundwater (GUS score):** | **MNO:** = -5.36 (low leachability) (7). |
| **Vapor Pressure (mm Hg):** | **MNO:** 20ºC < 0.1 (1c,d), Low to very low (2), 20ºC < 0.5 (2), 25ºC = $1.23 \times 10^{-8}$ (7). |
| **Octanol-Water Partition Coefficient ($K_{ow}$):** | **MNO:** High (2), 20ºC, pH 7 = $1.35 \times 10^{12}$ (7). |
| **Bioaccumulation/ Biocentration:** | **MNO: BAF:** Able to accumulate in mammalian tissues and cause microgranulomas in the liver and mesenteric lymph nodes, however, these are considered to be a non-specific, adaptive change and of low toxicological concern because they are not associated with an inflammatory response or necrosis, do not progress to adverse lesions (2).<br>**BCF:** No information in references. |

**Worst Case Ecological Risk Assessment**

| | |
|---|---|
| **Max Application Rate (ai lbs/acre – ae basis)** | **Habitat Management:**<br>**Croplands/Facilities Maintenance:**<br>Assumes X applications w/ XX-day application interval. |
| **EECs** | **Terrestrial (Habitat Management):**<br>**Terrestrial (Croplands/Facilities Maintenance):**<br>**Aquatic (Habitat Management):**<br>**Aquatic (Croplands/Facilities Maintenance):** |

Habitat Management Treatments:

| **Presumption of Unacceptable Risk** | | **Risk Quotient (RQ)** | |
|---|---|---|---|
| | | **Listed (T&E) Species** | **Nonlisted Species** |
| Acute | Birds | [0.1] | [0.5] |
| | Mammals | [0.1] | [0.5] |
| | Fish | [0.05] | [0.5] |
| Chronic | Birds | [1.0] | [1.0] |
| | Mammals | [1.0] | [1.0] |
| | Fish | [1.0] | [1.0] |

Cropland/Facilities Maintenance Treatments:

| **Presumption of Unacceptable Risk** | | **Risk Quotient (RQ)** | |
|---|---|---|---|
| | | **Listed (T&E) Species** | **Nonlisted Species** |
| Acute | Birds | [0.1] | [0.5] |
| | Mammals | [0.1] | [0.5] |
| | Fish | [0.05] | [0.5] |
| Chronic | Birds | [1.0] | [1.0] |
| | Mammals | [1.0] | [1.0] |
| | Fish | [1.0] | [1.0] |

**References:**


[1a] _____. 2011. BVA 2 Mosquito Larvicide Oil specimen label & MSDS. BVA Oils, New Hudson, MI, 1 & 3 pp., respectively.

[1b] _____. 2013 & 2012, respectively. Cocobear specimen label & MSDS. Clarke Mosquito Control Products, Inc., Roselle, IL. 4 & 2 pp., respectively.

[1c] _____. 2011. Kontrol Mosquito Larvicide specimen label & MSDS. Univar USA, Inc., Austin, TX. 3 & 2 pp., respectively.

[1d] _____. 2011 & 2009, respectively. Mosquito Larvicide GB-1111 specimen label & MSDS. Clarke Mosquito Control Products, Inc., Roselle, IL. 1 & 2 pp., respectively.

[2] U.S. Environmental Protection Agency. 2006. Reregistration eligibility decision (RED) for Aliphatic Solvents. Office of Prevention, Pesticides, and Toxic Substances, Washington, D.C. 83 pp.

[3] European Food and Safety Authority. 2012. Scientific opinion on mineral oil hydrocarbons in food. EFSA Journal 10(6):2704.

[4] US Environmental Protection Agency. 2007. ECOTOX User Guide: ECOTOXicology Database System. Version 4.0: http:/www.epa.gov/ecotox; Last accessed 27 November 2013.

[5] _____. 2011. Kegley, S.E., B.R. Hill, S. Orme, and A.H. Choi., PAN Pesticide Database, Pesticide Action Network, San Francisco, CA; Last accessed 27 November 2013.

[6] US Environmental Protection Agency. Office of Pesticide Program's Pesticide Ecotoxicity Database: http://www.ipmcenters.org/ecotox/DataAccess.cfm; Last accessed 27 November 2013.

[7] The Pesticide Properties Database (PPDB) developed by the Agricultural & Environment Research Unit (AERU), 2009, University of Hertfordshire, funded by UK national sources and the EU-funded FOOTPRINT project (Hatfield, UK); Last accessed: 27 November 2013.

## Appendix F: Effects of the larvicide Bti (*Bacillus thuringiensis* var. *israelensis*) used in mosquito control

### Mammals

Tests against rodents, whether single oral doses or daily dietary exposure over periods as long as three months, failed to demonstrate toxicity or pathogenicity (de Barjac et al, 1980, Shadduck 1980, Siegel et al. 1987, McClintock et al. 1995). Tests for inhalation pathogenicity and dermal toxicity of Bti to rats, mice, and rabbits were negative, as were subcutaneous injections into mice and guinea pigs and ocular challenge to rabbits (de Barjac et al. 1980, Siegel et al. 1987, Siegel and Shadduck 1990). Intraperitoneal injection is the most highly challenging route of exposure (WHO 1999). Four separate studies evaluated this route of exposure to mice, rats, and guinea pigs. Only 1 animal of 56 so challenged died, a mortality rate of 1.79% (de Barjac et al. 1980, Shadduck 1980, Siegel et al. 1987).

### Birds

Laboratory challenge of bobwhite quail (*Colinus virginianus*) and mallard ducks (*Anas platyrhynchus*) with high doses of Bti via oral gavage did not result in toxicity or pathogenicity (Lattin 1990a, b). No studies have shown any direct effect of Bti on wild birds (Boisvert and Boisvert 2000, Lagadic et al. 2014).

### Fish

Bluegill (*Lepomis macrochirus*), rainbow trout (*Oncorhynchus mykiss*), and sheepshead minnow (*Cyprinodon variegatus*) exposed to Bti at concentrations (aqueous and dietary) as much as 500 times the environmental concentration showed no pathology (Christensen 1990a, b, c).

### Aquatic Insects

WHO (1999) summarized the results of nearly 20 different laboratory and field studies on the effects of Bti on nontarget organisms such as chironomid midges, beetles, mayflies, water boatmen, backswimmers, and dragonflies. Some of these studies were direct challenges and others involved feeding Bti-intoxicated mosquito larvae to predatory insects. The only group to suffer significant mortality was the chironomid midges, which are phylogenetically related to mosquitoes. The dose required to kill chironomid midges was much higher than the doses used for routine mosquito control operations.

### Lepidoptera

Hribar and Fussell (2005) reviewed the literature concerning toxicity of Bti to Lepidoptera; 21 identified species were challenged. For many species, contradictory studies exist, in which a given lepidopteran species was found to be susceptible and not susceptible to Bti. Where mortality was seen it occurred after application of doses far above label rate for mosquitoes. In one particularly illuminating example, the $LC_{50}$ for moth larvae was over 18 times that for mosquitoes (Ignoffo et al. 1981).

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Boisvert, M., and J. Boisvert. 2000. Effects of *Bacillus thuringiensis* var. *israelensis* on target and nontarget organisms: a review of laboratory and field experiments. Biocontrol Science and Technology 10: 517-561.

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## *Bacillus* Products Profile (Source: Mari Reeves, FWS)

Toxicological endpoint and environmental fate data listed in this chemical profile will be periodically reviewed and updated. New information, including, but not limited to, completion of national section 7consultation in accordance with the federal Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended, between the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency on individual pesticide registrations and all federally listed and proposed species and proposed and designated critical habitat, may change ecological risk assessments, pesticide use patterns, best management practices, and/or justification for use. Consultations occur now at the local level for listed and proposed species and proposed and designated critical habitat on specific use of individual pesticides in specific project areas.

| | | | | | |
|---|---|---|---|---|---|
| **Date:** | 1/9/14 | | | | |
| **Pesticide Class:** | Microbial Pest Control Agents | **Common Chemical Name(s):** | *Bacillus thuringiensis* & *B. sphaericus* | **Pesticide Type:** | Insecticide |
| **Trade Name(s):** | ***Bt[a]*** | **EPA Registration Number:** | | **CAS Number:** | |
| | Agree WG, | | 70051-47, | | 68038-71-1, |
| | XenTari | | 73049-40, | | 68038-71-1, |
| | ***Bt[i]*** | | | | |
| | AquaBac 200 G, | | 62637-3, | | 68038-71-1, |
| | AquaBac 400 G, | | 62637-1, | | 68038-71-1, |
| | AquaBac Primary Powder, | | 62637-7, | | 68038-71-1, |
| | AquaBac xt, | | 62637-1, | | 68038-71-1, |
| | Bactimos PT, | | 73049-452, | | 68038-71-1, |
| | FourStar SBG, | | 85685-1, | | 68038-71-1 & 143447-72-7, |
| | Gnatrol, | | 73049-11, | | 68038-71-1, |
| | Gnatrol WDG, | | 73049-56, | | 68038-71-1, |
| | Mosquito Dunks, | | 6218-47, | | 68038-71-1, |
| | Summit Bti Briquets, | | 6218-47, | | 68038-71-1, |
| | Teknar CG, | | 73049-403, | | 68038-71-1, |
| | Teknar G, | | 73049-403, | | 68038-71-1, |
| | Teknar SC, | | 73049-435, | | 68038-71-1, |
| | VectoBac 12AS, | | 73049-38, | | 68038-71-1, |
| | VectoBac 1200L, | | 73049-38, | | 68038-71-1, |
| | VectoBac G, | | 73049-10, | | 68038-71-1, |
| | VectoBac GR, | | 73049-486, | | 68038-71-1, |
| | VectoBac GS, | | 73049-10, | | 68038-71-1, |
| | VectoBac WDG, | | 73049-56, | | 68038-71-1, |
| | ***Bt[i] & Bs*** | | | | |
| | FourStar Briquets 45, | | 83362-3, | | 68038-71-1 & 143447-72-7, |
| | FourStar Briquets 90, | | 83362-3, | | 68038-71-1 & 143447-72-7, |
| | FourStar Briquets 180, | | 83362-3, | | 68038-71-1 & 143447-72-7, |
| | FourStar CRG, | | 85685-2, | | 68038-71-1 & |

| | | | | | |
|---|---|---|---|---|---|
| | FourStar MBG,<br><br>FourStar WSP,<br><br>VectoMax FG,<br><br>VectoMax WSP,<br><br>***Bs***<br>,Spheratax SPH,<br>Spheratax SPH WSP,<br>VectoLex FG,<br>VectoLex WDG,<br>VectoLex WSP, | | 85685-3,<br><br>85685-3,<br><br>73049-429,<br><br>73049-429,<br><br><br>84268-2,<br>84268-2,<br>73049-20,<br>73049-57,<br>73049-20, | | 143447-72-7,<br>68038-71-1 &<br>143447-72-7,<br>68038-71-1 &<br>143447-72-7,<br>68038-71-1 &<br>143447-72-7,<br>68038-71-1 &<br>143447-72-7,<br><br>143447-72-7,<br>143447-72-7,<br>143447-72-7,<br>143447-72-7,<br>143447-72-7, |
| **Other Ingredients:** | **Agree WG (Bacillus thuringiensis [Bt]):** 50% Bt (subspecies *aizawai* [*a*]), 50% proprietary ingredients (1a); **AquaBac 200 G:** 2.86% Bt (subspecies *israelensis* [*i*]), 97.14% proprietary ingredients (1b); **AquaBac 400 G:** 5.71% Bt[*i*], 94.29% proprietary ingredients (1c); **AquaBac Primary Powder:** 100% Bt[*i*] (1d); **AquaBac xt:** 8% Bt[*i*], 92% proprietary ingredients (1e); **Bactimos PT:** 12.3% Bt[*i*], 87.7% proprietary ingredients (1f); **FourStar Briquets 45:** 6% (**Bacillus sphaericus [Bs]**), 1% Bt[*i*], 93% proprietary ingredients (1g); **FourStar Briquets 90:** 6% Bs, 1% Bt[*i*], 93% proprietary ingredients (1h); **FourStar Briquets 180:** 6% Bs, 1% Bt[*i*], 93% proprietary ingredients (1i); **FourStar CRG:** 9% Bs, 1% Bt[*i*], 90% proprietary ingredients (1j); **FourStar MBG:** 3% Bs, 3% Bt[*i*], 94% proprietary ingredients (1k); **FourStar SBG:** 2.15% Bt[*i*], 97.85% proprietary ingredients (1l); **FourStar WSP:** 3% Bs, 3% Bt[*i*], 94% proprietary ingredients (1m); **Gnatrol:** 6.38% Bt[*i*], 93.62% proprietary ingredients (1n); **Gnatrol WDG:** 37.4% Bt[*i*], 62.6% proprietary ingredients (1o); **Mosquito Dunks:** 10.31% Bt[*i*], 89.69% proprietary ingredients (1p); **Spheratax SPH:** 5% Bs, 95% proprietary ingredients (1q); **Spheratax SPH WSP:** 5% Bs, 95% proprietary ingredients (1r); **Summit Bti Briquets:** 10.31% Bt[*i*], 89.69% proprietary ingredients (1s); **Teknar CG:** 1.7% Bt[*i*], 98.3% proprietary ingredients (1t); **Teknar G:** 1.7% Bt[*i*], 98.3% proprietary ingredients (1u); **Teknar SC:** 5.6% Bt[*i*], 94.4% proprietary ingredients (1v); **VectoBac 12AS:** 11.61% Bt[*i*], 88.39% proprietary ingredients (1w); **VectoBac 1200L:** 1.2% Bt[*i*], 98.8% proprietary ingredients (1x); **VectoBac G:** 2.8% Bt[*i*], 97.2% proprietary ingredients (1y); **VectoBac GR:** 2.8% Bt[*i*], 97.2% proprietary ingredients (1z); **VectoBac GS:** 2.8% Bt[*i*], 97.2% proprietary ingredients (1aa); **VectoBac WDG:** 37.4% Bt[*i*], 62.6% proprietary ingredients (1bb); **VectoLex FG:** 7.5% Bs, 92.5% proprietary ingredients (1cc); **VectoLex WDG:** 51.2% Bs, 48.8% proprietary ingredients (1dd); **VectoLex WSP:** 7.5% Bs, 92.5% proprietary ingredients (1ee); **VectoMax FG:** 2.7% Bs, 4.5% Bt[*i*], 92.8% proprietary ingredients (1ff); **VectoMax WSP:** 2.7% Bs, 4.5% Bt[*i*], 92.8% proprietary ingredients (1gg); **XenTari:** 54% Bt[*a*], 46% proprietary ingredients (1hh) | | | | |
| **Justification for Use:** | | | | | |
| **Specific Best Management Practices (BMPs):** | | | | | |

| **Toxicological Endpoints** | Endpoints highlighted yellow are selected for use in a screening-level ecological risk assessment. Endpoints selected are typically the most toxic endpoint for the most sensitive species listed in following summaries. |
|---|---|
| **Mammalian** | **Bt[*a*]:** No information in references; |

| | |
|---|---|
| **$LD_{50}$:** | **Bt[*i*]:** *General*: Considered to pose little threat to mammalian safety (5), Toxins that are responsible for pathogenic effect in mosquito larvae have no effect on vertebrates, including fish, birds and mammals (10),<br>*Mice/Rats*: No mortality associated with ingestion (single oral dose) (4), No mortality associated with repeated oral exposure (ingestion) for 21 d, normal weight gain was observed in all treated rodents (4),<br>*Rat*: No toxicity or infectivity associated with dietary exposure (4 g/kg/day) for 3 mo (4),<br>*Mouse*: (immune-suppressed): No mortality after 27 d after injection (2.7 x $10^7$ CFU/mouse) (8).<br><br>**Bt[*a*] & Bt[*i*]:** *Rat*: No toxicity or infectivity following oral administrations at doses up to 4.7 x $10^{11}$ CFU/kg bw (4).<br><br>**Bs:** *General*: The specificity of *Bs* for mosquito larvae completely eliminates its direct risk to vertebrates, including fish, birds and mammals (10),<br>*Rat*: > 5,000 mg/kg bw (11),<br>*Rat/Mice*: Administration by conventional routes of $10^7$ to $10^8$ spores did not cause any changes in mortality, clinical signs, body weight gain or gross pathology parameters (11). |
| **Mammalian $LC_{50}$:** | **Bt[*a*]:** No information in references.<br><br>**Bt[*i*]:** *General*: Considered to pose little threat to mammalian safety (5), Toxins that are responsible for pathogenic effect in mosquito larvae have no effect on vertebrates, including fish, birds and mammals (10).<br><br>**Bs:** *General*: The specificity of *Bs* for mosquito larvae completely eliminates its direct risk to vertebrates, including fish, birds and mammals (10). |
| **Mammalian Reproduction:** | **Bt[*i*]:** *General*: Considered to pose little threat to mammalian safety (5).<br><br>**Bt[*a*] & Bt[*i*]:** *Mammals (general)*: Changes in prey abundance due to *Bt* applications could apply some environmental stresses on some animals that rely mainly on insects for food (6),<br>*Small mammals* (Woodland jumping mice, deer mice, short-tailed shrews, common shrews, red-backed voles, and eastern chipmunks): Field study in Canada showed small mammals continued breeding throughout treatment period and data indicated that *Bt* applications did not harm the species complex inhabiting the treatment areas (6).<br><br>**Bs:** No information in references [See Mammalian LD50/LC50 sections]. |
| **Avian $LD_{50}$:** | **Bt[*a*]:** *Bobwhite*: No toxicity or pathogenicity observed at 1,714 mg (3.4 x $10^{11}$ CFU)/kg/day (4); Mallard: No toxicity or pathogenicity observed at 1,714 mg (3.4 x $10^{11}$ CFU)/kg/day (4).<br><br>**Bt[*i*]:** *General*: Toxins that are responsible for pathogenic effect in mosquito larvae have no effect on vertebrates, including fish, birds and mammals (10).<br><br>**(%AI Unk):**<br>*Mallard*: Practically nontoxic after 3,100 mg/kg bw/day for 5 days (2); Practically nontoxic after 5 mL/kg/day for 5 days (2), No toxicity or pathogenicity observed at 3,077 mg (6.2 x $10^{11}$ CFU)/kg/day (4),<br>*Bobwhite*: Practically nontoxic after 3,100 mg/kg bw/day for 5 days (2); Practically nontoxic after 5 mL/kg/day for 5 days (2), No toxicity or pathogenicity observed at |

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| | 3,077 mg (6.2 x $10^{11}$ CFU)/kg/day (4).<br><br>**(98.0% AI):** *Mallard*: Single dose, 14-d observation period, age unk.: > 5,000 mg/kg bw (7).<br><br>**Bt[*a*] & Bt[*i*]:** *Bobwhite & Mallard*: When administered daily at high doses to young birds, no toxicity or pathogenicity was observed, no differences in feed consumption and weight gain (4).<br><br>**Bs:** The specificity of *Bs* for mosquito larvae completely eliminates its direct risk to vertebrates, including fish, birds and mammals (10). |
| **Avian $LC_{50}$:** | **Bt[*a*]: (%AI Unk):**<br>*Mallard*: > 16,700 mg/kg bw (1a,2,8), > 8,570 mg/kg bw (2),<br>*Bobwhite*: > 16,700 mg/kg bw (1a,2), > 8,570 mg/kg bw (2).<br><br>**Bt[*i*]:** *General*: Toxins that are responsible for pathogenic effect in mosquito larvae have no effect on vertebrates, including fish, birds and mammals (10).<br><br>**Bs:** The specificity of *Bs* for mosquito larvae completely eliminates its direct risk to vertebrates, including fish, birds and mammals (10). |
| **Avian Reproduction:** | **Bt[*a*] & Bt[*i*]:** *Avians (general)*: Changes in prey abundance due to *Bt* applications could apply some environmental stresses on some animals that rely mainly on insects for food (6).<br><br>**Bt[*i*]:** *Black-throated Blue Warbler*: Significant reduction in the number of nesting attempts per bird per year was observed after *Bt* application and in the number of caterpillars in diet, no difference in caterpillar abundance was observed two years after treatment (6),<br>*Black-capped & Chestnut-backed Chickadees*: In year 1, no difference in reproductive success or nestling growth was observed, however, in year 2, a significant reduction in fledgling success was observed at treatment sites (6).<br><br>**Bt[*i*], (11.61% AI, <u>VectoBac 12AS</u>):** *House Martin*: Mean laying date and hatching success of the first brood were similar between control and treated sites; however, clutch size and the number of young fledged were significantly smaller at treated sites. Although treated sites had a larger proportion of second clutches (40% vs. 63%), overall breeding success remained significantly lower at treated sites (13).<br><br>**Bs:** No information in references [See Avian LD50/LC50 sections]. |
| **Fish $LC_{50}$:** | **Bt[*a*]: (%AI Unk):**<br>*Trout* (sp. not specified): (Aquous, time/age unk) > 3.9 x $10^{7}$ CFU/mL (2), (Oral, time/age unk) > 1.5 x $10^{10}$ CFU/g food (2),<br>*Sheepshead Minnow*: (Aqueous, time/age unk) > 1.6 x $10^{10}$ CFU/g food (2), (Oral, time/age unk) > 1.6 x $10^{10}$ CFU/g food (2).<br><br>**Bt[*i*]** *General*: Fish are not affected either in the laboratory or after field applications (5), Toxins that are responsible for pathogenic effect in mosquito larvae have no effect on vertebrates, including fish, birds and mammals (10), No formulations tested produced deleterious effects when label rates were used, mortality only observed in juvenile trout when concentrations 70 time greater and an exposure 192 times longer were used for black fly control, mortality was attributed to formulation components and not to *Bti* toxins (10). |

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| | **(%AI Unk):**<br>*Rainbow Trout*: (Aqueous, time/age unk) > 8.7 x $10^9$ CFU/L (2), (Oral, time/age unk) > 1.7 x $10^{10}$ CFU/g food (slightly toxic) (2), (Aqueous, time/age unk) > 1.4 x $10^{10}$ CFU/L (2), (Oral, time/age unk) > 5.3 x $10^9$ CFU/g food (2), 32 d at 1.1 x $10^{10}$ CFU/L water = no significant toxicity or pathology (4), 32 d at 1.7 x $10^{10}$ CFU/g diet = no significant toxicity or pathology (4,5),<br>*Bluegill*: (Aqueous, time/age unk) > 8.9 x $10^9$ CFU/L (2), (Oral, time/age unk) > 1.3 x $10^{10}$ CFU/g food (slightly toxic) (2), (Aqueous, time/age unk) > 1.6 x $10^{10}$ CFU/L (2), (Oral, time/age unk) > 4.3 x $10^9$ CFU/g food (2), 30 d at 1.2 x $10^{10}$ CFU/L water = no significant toxicity or pathology (4), 30 d at 1.3 x $10^{10}$ CFU/g diet = no significant toxicity or pathology (4,5),<br>*Sheepshead Minnow*: (Oral, time/age unk) > 2 x $10^{10}$ CFU/g food (2), (NOEL, time unk) > 2.0 x $10^{10}$ CFU/g food (2), (Time/age unk) > 7.2 x $10^9$ CFU/g food (practically nontoxic) (2), 30 d at 1.3 x $10^{10}$ CFU/L water = no significant toxicity or pathology (4), 30 d at 2.1 x $10^{10}$ CFU/g diet = no significant toxicity or pathology (4,5),<br>*Coho*: No effects during 96-h test at recommended manufacturer application rate; product contained 2.9 x $10^8$ CFU/g dry product (9).<br><br>**Bs:** The specificity of *Bs* for mosquito larvae completely eliminates its direct risk to vertebrates, including fish, birds and mammals (10). |
| **Fish ELS/ Life Cycle:** | **Bt[*a*] & Bt[*i*]:**<br>*Fish (general)*: Changes in prey abundance due to *Bt* applications could apply some environmental stresses on some animals that rely mainly on insects for food (6), No evidence has been found that consumption of *Bt*-infected insects have adversely affected fishes to any noticeable degree (6).<br><br>**Bs:** No information in references [See Fish LC50 section]. |
| **Amphibians/ Reptiles:** | **Bt[*i*]:** Appears to have very low toxicity to amphibians (3).<br><br>**Bt[*a*] & Bt[*i*]:** World Health Organization reviewed laboratory and field studies on frogs (*Rana temporaria*), newts (*Taricha torosa*), and toads (*Bufo sp.*). No adverse effects were reported (4,5,6).<br><br>**Bs:** No information in references. |
| **Invertebrates/ Plants:** | **Bt[*a*]: (%AI Unk):**<br>*Honey Bee*: (LC50, time unk) = 15 ppm (highly toxic) (2,8),<br>*Green Lace-wing*: (NOEL, larvae) = 10,000 ppm (2),<br>Parasitic hymenoptera: (NOEL) = 100 ppm (2); Predatory Mite: (NOEL) = 100 ppm (2),<br>*Predaceous coleopteran*: (NOEL) = 10,000 ppm (2),<br>*Daphnia*: 21-d estimated EC50 is between 0.8 and 2.7 ppm, highly toxic (2), (21-d NOEC) = 6.4 x $10^8$ CFU/L (highly toxic) (2).<br><br>**Bt[*i*]:** *General*: *Bti*-susceptible non-target species are found in several families of Nematocera including, Simuliidae, Chironomidae, Tipulidae, Psychodidae, Chaoboridae, Sciaridae, and Blepharoceridae (10), Larvae of predatory beneficial mosquitos in the genus *Toxorhynchites* are susceptible to *Bti* if they feed upon larvae of prey species (10).<br><br>**(%AI Unk):**<br>*Honey Bee*: (5-d LC50) > 7 x $10^7$ CFU/g diet (2), Not toxic to bees (5,8),<br>*Green Lace-wing*: (16-d LC50, larvae) > 1.5 x $10^8$ CFU/g diet, (16-d NOEL) = 2.5 x |

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| | $10^4$ CFU/g diet (2),<br>*Parasitic hymenoptera*: (30-d LC50) > 7.9 x $10^7$ CFU/g diet (2),<br>*Predaceous coleoptera*: (9-d LC50) > 1.8 x $10^8$ CFU/g diet (2),<br>*Daphnia*: 21-d LC50 is between 5 and 50 ppm, moderately toxic (2),<br>*Grass Shrimp*: (NOEL, time unk) > 2.0 x $10^{10}$ CFU/g food (2), (NOEL, time unk) > 4.2 x $10^9$ CFU/g food (practically nontoxic) (2),<br>*Copepod*: (NOEL, time unk) = 50 mg/kg sediment (2),<br>*Dragonfly & Damselfly* (naiads): No affect on duration of development from time of exposure to emergence after fed mosquito larvae that were intoxicated with extremely high doses of Bt[*i*] (4),<br>*Mayfly*: (nymphs) no notable effects were observed after application to mosquito larvae (4),<br>*Lepidopterans*: LC50s, time/age unk: *Trichoplusia ni* = 0.1096 ppm, *Heliothis zea* = 0.0193 ppm, *H. virescens* = 0.0276 ppm) (5),<br>Invertebrate Predators (Plecoptera, Odonata, Megaloptera, Trichoptera, Diptera): No negative impacts observed over a three year period in the field and laboratory (6).<br><br>**Bt[*i*], (11.61% AI, <u>VectoBac 12AS</u>):** *Daphnia pulex* & *magna*: Little to no effect on demographic toxicological endpoints (14).<br><br>**Bt[*i*], (2.8% AI, <u>VectoBac G</u>):** 1-year Study on Franz Lake National Wildlife Refuge with treatment plots sprayed (7.8 kg/ha) three times at 9-10 d apart, results indicate that one season of B.t.i use did not have a significant effect on the shoreline macroinvertebrate community (16),<br>*Closterium* sp. and *Chlorella* sp.: Growth and densities of both algal species were significantly suppressed by the treatment (17).<br><br>**Bt[*a*] & Bt[*i*]:**<br>*Earthworm*: No effect of *Bt* treatment at 100 times the recommended rate (4,6);<br>*Plants*: Those pollinated exclusively or mainly by lepidopterans may experience a temporary drop in seed set; however, plants are unlikely to be affected by the reduced pollination since they are expected to be pollinated by species which were not at the vulnerable instar stages when spraying took place (6),<br>*Swallowtail butterflies*: (early instar) in genus *Papilio* were sensitive to treated foliage up to 30 d after application (6); *Lepidoptera* (general, larvae): Species richness in sprayed areas the year of treatment and one year after treatment experienced significant reductions, but recovered in the second year (6), Permanent changes in non-target populations are unlikely, except in habitats that support small isolated populations that are highly vulnerable to *Bt*,<br>*Honey Bee*: No studies have reported any adverse effects when bees were exposed to *Bt* sprayed foliage under field or simulated field conditions (6).<br><br>**Bs:** *General*: *Bs* is specific for mosquitos and safe for the vast majority of non-target species, including a variety of mosquito predators, chironomids, and other species of Nematocera (10),<br>*Closterium* sp. and *Chlorella* sp.: Growth and densities of both algal species were significantly suppressed by the treatment (17). |
| **Other:** | **Bt[*a*] & Bt[*i*]:** Neurotoxic: Negative (3); Carcinogenic: Not likely (3); Teratogenic: Negative (3); Mutagenic: Negative (3,6), strains of *B.t.* that contain the beta-exotoxin that is mutagenic in mammals is not permitted in commercial formulations of *B.t.* in the U.S. (3); Genotoxic: No information in references; Endocrine disruption: Negative (2,3).<br><br>**Bs:** Neurotoxicity, Carcinogenicity, Teratogenicity, Mutagenicity, Genotoxicity and Endocrine disruption are all unknown (19), No information in references. |

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| | **NOTE:** Bt[*i*] strains exhibit activity against Dipteran species with limited activity against Lepidopteran and Coleopteran species; while Bt[*a*] strains display some activity against Coleopteran species but more activity against Lepidopteran (2); Fish that ingest *Bti* spores can spread viable spores within the aquatic environment (4,5); Bt[*i*] generally regarded as specific to larvae of Nematocera (includes filter-feeding mosquitos, blackflies, sandflies which are susceptible and included midges, craneflies, and gall flies, some of which are susceptible), Chironomidae and Tipulidae also show some susceptibility (5) |

* CFU /vol. – colony forming unit per volume quantity, representative of the number of viable spores present in volume given; used as a practical measure to relative exposure, not possible to relate back to application rate (3)

**Ecological Incident Reports**

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| Based on USEPA's Ecological Incident Information System (EIIS) database (1996 to present), last accessed on December 11, 2013, there has been only one incident involving *Bacillus thuringiensis*. This incident, determined as possible, occurred in Pensylvania and involved three hives of honey bees. (R. Miller, U.S. Environmental Protection Agency, Washington, D.C., personal communication) |

**Environmental Fate**

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| **Water solubility ($S_w$):** | **Bt[*a*]:** Suspends readily in water (1hh).<br><br>**Bt[*i*]:** Disperses/suspends well in water (1n,o,v,w,x,bb).<br><br>**Bs:** Partially suspends/soluble in water (1cc,ee), Suspends readily in water (1dd). |
| **Soil Mobility ($K_{oc}$):** | **Bt[*a*] & Bt[*i*]:** Relatively immobile in soil (4,8).<br><br>**Bs:** No information in references. |
| **Soil Persistence ($t_{½}$):** | **Bt[*a*]:** Showed an exponential loss of insecticidal activity, microbial activity believed responsible for loss of activity (4).<br><br>**Bt[*i*]:** Pellet/briquette formulations have greater persistence due to formulations designed to enhance residual activity (5), Sunlight inactivates (5,6,8), May persist longer in leaf litter due to spore recycling in host cadavers (12).<br><br>**Bt[*a*] & Bt[*i*]:** *Bt* spores are inactivated rapidly when exposed to UV radiation (4), *Bt* formulations on foliage frequently have half-lives up to 10 d, while unformulated *Bt* may have a half-life of only a few hrs; commercially applied *Bt* may persist at low levels for considerable periods of time (e.g. > 1 yr on balsam fir after spruce budworm spray) (4), *Bt* spore counts in soil declined by a factor of 10 in the first 2 weeks after application and then remained constant for 8 months (4), Dependent on microbial competitions, rapidly diminishes in unsterilized soils (6).<br><br>**Bs:** Persistent in the environment, mainly due to its ability to colonize cadavers of host organisms (11), Sensitive to high temperature, high pH, UV light (300-400 nm), and high organic content. May survive in the environment for up to 9 mo without a decrease in toxicity; Dormant spores resistant to extreme physical conditions (11). |
| **Soil Dissipation ($DT_{50}$):** | **Bt[*a*] & Bt[*i*]: [**See soil persistence.]<br><br>**Bs:** [See soil persistence.] |

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| **Aquatic Persistence ($t_{½}$):** | **Bt[*i*]:** Spores remain viable for shorter time periods when in moving water in comparison to static water (4), When bacterial particles adsorp to soil, larvicidal activity is lost, although spores remain viable and inactivation can be reversed when soil is washed away (4), Provide good control (e.g. mosquitos) initially (within days of application), it does not persist in most situations, young mosquito larvae can appear 3-4 d after treatment (5), Reduced toxicity with reduced water temperatures; in general, an increase in vegetation results in decreased efficacy (5), Insensitive to variations in water pH (5), Sunlight inactivates (5,6,8), Limited persistence, undergoes photolysis and adsorption to particulate matter with a few days following application (14), Particulate Study: Sand had no effect on settling of bacteria or toxin, clay-silt produced a large loss of spores and toxin (18), and charcoal also produced a large (> *Bs*) drop in both spores and toxin (18).<br><br>**Bt[*a*] & Bt[*i*]:** May persist for at least 22 d in sediment in aquatic systems and spores can be mobilized during floods (4), = Av. 4 mos (8).<br><br>**Bs:** Persistent in the environment, mainly due to its ability to colonize cadavers of host organisms (11), Sensitive to high temperature, high pH, UV light (300-400 nm), and high organic content. May survive in the environment for up to 9 mo without a decrease in toxicity; Dormant spores resistant to extreme physical conditions (11), Increased loss of spore viability in seawater (salinity 18-32 ppt) compared to freshwater (15), Freshwater Pond Study: A drop of 74% in the number of heat resistant (dormant) sores in 4 wks was observed with a water temperature ranging from 12.5ºC to 26ºC (18), Varied levels of salinity and temperature (in saline suspensions) had no effect on spore dormancy (18), Seawater = 10 d (18), Half-life of the half-life (75% loss) = 41 d (18), A 98% reduction in heat resistant spore counts observed after 131 d (18), Particulate Study: Sand had no effect on settling of bacteria or toxin, clay-silt produced detectable settling of spores and toxin (18), and charcoal also produced a large drop in both spores and toxin (18). |
| **Aquatic Dissipation ($DT_{50}$):** | **Bt[*a*] & Bt[*i*]:** No information in references. [See aquatic persistence.]<br><br>**Bs:** No information in references. [See aquatic persistence.] |
| **Potential to Move to Groundwater (GUS score):** | **Bt[*a*] & Bt[*i*]:** Unlikely to contaminate groundwater (8).<br><br>**Bs:** No information in references. |
| **Vapor Pressure (mm Hg):** | **Bt[*a*]:** Not determined (1hh).<br><br>**Bt[*i*]:** Not applicable (1a,b,e).<br><br>**Bs:** Negligible (11). |
| **Octanol-Water Partition Coefficient ($K_{ow}$):** | **Bt[*a*] & Bt[*i*]:** No information in references.<br><br>**Bs:** No information in references. |
| **Bioaccumulation/ Biocentration:** | **BAF: Bt[*a*] & Bt[*i*]:** No information in references.<br><br>**BCF: Bt[*a*] & Bt[*i*]:** No information in references.<br><br>**Bs:** No information in references. |

**Worst Case Ecological Risk Assessment**

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| **Max Application Rate (ai lbs/acre – ae basis)** | **Habitat Management:**<br>**Croplands/Facilities Maintenance:**<br>Assumes X applications w/ XX-day application interval. |
| **EECs** | **Terrestrial (Habitat Management):**<br>**Terrestrial (Croplands/Facilities Maintenance):**<br>**Aquatic (Habitat Management):**<br>**Aquatic (Croplands/Facilities Maintenance):** |

## Habitat Management Treatments:

| **Presumption of Unacceptable Risk** | | **Risk Quotient (RQ)** | |
|---|---|---|---|
| | | **Listed (T&E) Species** | **Nonlisted Species** |
| Acute | Birds | [0.1] | [0.5] |
| | Mammals | [0.1] | [0.5] |
| | Fish | [0.05] | [0.5] |
| Chronic | Birds | [1.0] | [1.0] |
| | Mammals | [1.0] | [1.0] |
| | Fish | [1.0] | [1.0] |

## Cropland/Facilities Maintenance Treatments:

| **Presumption of Unacceptable Risk** | | **Risk Quotient (RQ)** | |
|---|---|---|---|
| | | **Listed (T&E) Species** | **Nonlisted Species** |
| Acute | Birds | [0.1] | [0.5] |
| | Mammals | [0.1] | [0.5] |
| | Fish | [0.05] | [0.5] |
| Chronic | Birds | [1.0] | [1.0] |
| | Mammals | [1.0] | [1.0] |
| | Fish | [1.0] | [1.0] |

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**Appendix G: Effects of pyrethroid adulticides used in mosquito control**

GENERAL

Pyrethroids are esters and are rapidly degraded in the environment. Permethrin has a half life in silt and clay soils of 1-3 weeks, and up to 15 weeks in organic soils. In estuarine waters, the half life of permethrin is less than 2.5 days (Smith and Stratton 1986). Davis et al. (2007) conducted a risk analysis of three pyrethroid insecticides and determined that when applied for mosquito control the risk quotients of these chemicals were low. Davis et al. (2007) further commented that there is variability and uncertainty in the models used, and even in the source data. For example, the input values used by EPA conflict with (and in some cases are multiples of) the input values in the United States Department of Agriculture-Agricultural Research Service (USDA-ARS) database.

PERMETHRIN

Data from tests of permethrin in aquatic systems often result from direct application of permethrin to the water at rates far in excess of those used for control of adult mosquitoes. District application rate is just under 7.2 g/ha. Results of twelve laboratory studies quantifying acute toxic doses of permethrin for various invertebrate and vertebrate freshwater and marine organisms are presented by WHO (1990). Permethrin can be degraded by the bacteria *Aeromonas sobria*, *Erwinia carotovora*, and *Yersenia fredriksenii* (Lee 2004, Liu 2005).

Aquatic

Algae

Permethrin was found to be of low toxicity to two species of green algae (*Chlorella pyregnoidosa* and *Scenedesmus quadricaudata*) but toxic to three cyanobacteria (*Anabaena* spp.) (Stratton and Corke 1982).

Invertebrates

Much of the work done on nontarget effects of permethrin on aquatic invertebrates is based on use of permethrin as a larvicide, something not done by the District (Smith and Stratton 1986). With the exception of mollusks, aquatic invertebrates are more sensitive to permethrin than are fish (WHO 1990). A number of laboratory studies demonstrate this. During 28 day tests, the caddisfly *Brachycentrus americanus* and the stonefly *Pteronarcys dorsata* died at very low concentrations (Anderson 1982). Three hour exposures of *Daphnia pulex* to permethrin did not prove fatal, but the lethal concentration depended on the isomer being tested (Miyamoto 1976). *Daphnia magna*, however, were more sensitive to permethrin (Stratton and Corke 1981). *Homarus americanus* lobster responded differently to technical permethrin and an isomer. The isomer was 17.5 times more toxic than was technical permethrin (Zitko et al. 1979). Interestingly, oyster larvae are far more tolerant of permethrin, with $LC_{50}$ values in excess of 1000 μg/l (Zitko et al.

1979). The mayfly *Hexagenia rigida* was sensitive to permethrin, but the sensitivity depended on presence or absence of sediment and in some cases 100% mortality was seen only after 7 days of continuous exposure (Friesen et al. 1983).

Application of permethrin to ponds at high rates (56 g/ha and 112 g/ha) resulted in lower numbers of chironomid midges, aquatic beetles, mayflies, copepods, and ostracods (Mulla et al. 1975). Kaushik et al. (1985) applied permethrin directly to enclosures in a lake at rates of 0.5, 5, and 50 µg/l and saw reductions in numbers of various zooplanktonic species. Copepods and daphnids were most susceptible, whereas rotifers were unaffected except at the highest application rate.

Helson et al. (1986) placed amphipods (*Gammarus pseudolimnaeus*) and mosquito larvae (*Aedes aegypti*) downwind from an application of permethrin to spruce trees for defoliator control. Application rate was 36 g AI / ha, five times District application rate. Product was applied via backpack sprayer. Mortality decreased with distance and the recommendation was to leave a 30 m buffer between backpack sprayer applications of permethrin and aquatic habitats.

Kingsbury (1976) applied permethrin aerially (a method currently illegal in Florida) to a creek at a rate of 70g AI / ha; the concentration that reached the creek was only 13.4 g/ha. Short term increase in drift of aquatic insects was noted but no permanent effects were seen. Later, Kingsbury and Kreutzweiser (1980) made another aerial application of permethrin to a stream at 17.5 g AI/ha and again noted increased drift of insects.

It has been demonstrated that the oligochaete *Lumbriculus variegatus* does not bioaccumulate permethrin, due to biotransformative processes within the body (You et al. 2009).

Fish

Laboratory studies consistently demonstrate toxicity of permethrin to fish, however, toxicity is linked to the particular isomer tested (Miyamoto 1976). Atlantic salmon (*Salmo salar*), sheepshead minnows (*Cyprinodon variegatus*), flagfish (*Jordanella floridae*), and white sucker (*Catastomus commersoni*) all have low $LC_{50}$ values for permethrin, but survival can be extended with provision of food (Zitko et al. 1979, Hansen et al. 1983, Holdway and Dixon 1988). The inland silverside, *Menidia beryllina*, is also sensitive to permethrin (Schimmel et al. 1983).

In field studies, sensitivity to permethrin is also noted. Mulla et al. (1981) however, treated ponds containing mosquitofish and desert pupfish with permethrin applied at 28 g/ha and 140 g/ha, and found both species of fish actually increased their numbers in treated ponds as opposed to untreated ponds. Kingsbury (1976) applied permethrin aerially (illegal in Florida) to a creek at a rate of 70g AI / ha; the concentration that reached the creek was only 13.4 g/ha. No mortality of caged or native fish was noted. Kingsbury and Kreutzweiser (1980) made another aerial application of permethrin to a stream at 17.5 g AI/ha and reported no adverse effects on caged yellow perch (*Perca fluvescens*). Milam et al. (2000) reported that fathead minnows (*Pimephales promelas*) and mosquitofish (*Gambusia affinis*) were less susceptible to application of permethrin than were the cladocerans *Daphnia pulex*, *Daphnia magna*, and *Ceriodaphnia dubia*.. Their data also show that aerial application of permethrin results in much higher mortalities than does truck application. Aerial application of permethrin is illegal in Florida.

Terrestrial

Insects

Laboratory and field studies have given differing pictures of effects of permethrin on nontarget insects. Cox and Wilson (1984) individually treated honeybees with 0.09 µg AI / bee and saw no mortality but demonstrable changes in bee behavior. Pike et al. (1982) made aerial applications of permethrin (illegal in Florida) to a corn (*Zea mays*) field six times per season (every three to six days) for three years and found mortality at the hives of foraging bees did not exceed that of control hives, but that permethrin had a repellant effect on honeybees. WHO (1990) summarized a number of field studies and found that permethrin applied at agricultural label rates was not harmful to predatory and parasitic insects. Coats et al. (1979) reported that permethrin was less toxic to predatory ladybird beetles than to phytophagous chrysomelid beetles. Interestingly, a eulophid wasp parasitoid of the leaf beetles was susceptible to permethrin.

Birds

Attempts to establish acute oral and dietary $LD_{50}$ values for birds have been unsuccessful due to the low toxicity of permethrin to birds. Studies using bobwhite quail (*Colinus virginianus*), mallard ducks (*Anas platyrhynchus*), Japanese quail *(Coturnix japonica*), ringnecked pheasant (*Phasianus colchicus*), starling (*Sturnus vulgaris*), and domestic chicken (*Gallus gallus domesticus*) revealed that the acute oral and dietary $LD_{50}$ values are in excess of 3000 mg/kg body weight (Worthington and Walker 1983, Hill and Camardese 1986, Ross et al. 1976a, b, c, d, e; 1977).

Mammals

Bat roosting boxes treated with wood preservative including permethrin showed no deleterious effects on pipistrelle bats (Racey and Swift 1986). Permethrin has an oral $LD_{50}$ to rats of 450 to over 4000 mg/kg body weight (Ware 1994).

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## RESMETHRIN

### General

Resmethrins degrade rapidly in the environment (WHO 1989). In soils, resmethrin is adsorbed onto soil articles where it is degrades via hydrolysis, photodegradation, and oxidation by soil microorganisms (Roberts and Hutson 1999). Its estimated half life is 30 days but can be as much as 200 days in loamy soils (Augustijn-Beckers et al. 1994, Kamrin 1997).

### Aquatic

Resmethrin is highly toxic to fish in laboratory studies but due to low solubility in water and microbial and photochemical degradation in the environment the impact is less in operational situations (Sjogren 1985, Norwood 1986, Pierce 1986). WHO (1989) summarized three studies involving 5 fish species: white sucker (*Catostomus commersoni*), sheepshead minnow (*Cyprinodon variegatus*), goldfish (*Carassius auratus*), bluegill (*Lepomis macrochirus*), and fingerling snook (*Centropomus undecimalis*). In operational situations all species except white sucker showed “good” survival (0-27% mortality) (Sjogren 1985, Norwood 1986, Pierce 1986). Acute toxicity levels in laboratory studies for carp (*Cyprinus carpio*), killifish (*Oryzias latipes*), rainbow trout (*Oncorhynchus mykiss*), Coho salmon (*Oncorhynhchus kisutch*), bluegill (*Lepomis macrochirus*), steelhead trout (*Oncorhynchus gaidneri*), and yellow perch (*Perca flavescens*) are actually below those for water fleas (*Daphnia pulex*), cladocerans (*Moina macropoda*), aquatic bugs (*Sigara substriata*, *Micronecta sedula*), a mayfly (*Cloeon dipterum*), dragonflies (*Orthetrum albistylum speciosum*, *Sympetrum frequens*), and a predacious diving beetle (*Erectes sticticus*) (Miyamoto 1976, Mauck et al. 1976, Nishiuchi 1982). The inland silverside, *Menidia beryllina*, is also sensitive to resmethrin (Tietze et al. 1992). Zulkosky et al. (2005) demonstrated that resmethrin is toxic to lobster larvae in continuous exposure tests, but that concentrations in natural waters rarely reached toxic levels, even immediately after spray events.

### Terrestrial

Data from numerous studies show that resmethrin is essentially harmless to birds and mammals due to extremely high $LC_{50}$ and $LD_{50}$ values... The species used in the studies were Japanese quail, mallard ducks, domestic chickens, rats, mice, rabbits, and dogs (WHO 1989). Ridlen et al. (1984) studied the effects of optical isomers of resmethrin administered orally at a rate of 10 mg.kg body weight on lactating Jersey cattle and found that the cattle rapidly absorbed, metabolized, and excreted the chemical. Christopher et al. (1989) later demonstrated much the same thing with laying white Leghorn hens.

Resmethrin has been shown to have lethal and sublethal effects on Monarch butterflies (*Danaus plexippus*) (Oberhauser et al. 2009). The authors determined that butterflies directly in the path of the spray would suffer the most serious deleterious effects..

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## SUMETHRIN (δ-PHENOTHRIN)

### General

Sumethrin (δ-phenothrin) degrades rapidly in the environment; it has a half life of less than a day on plants and other surfaces (Nambu et al. 1980, WHO 1990, Samsonov and Makarov 1996). Sumethrin (δ-phenothrin) is highly toxic to fish and aquatic arthropods but essentially harmless to birds (WHO 1990).

### Aquatic

Killifish (*Oryzias latipes*), bluegill (*Lepomis macrochirus*), and trout (*Oncorhynchus gaidneri*) have LC50 values between 17 and 10,000 μg/l depending on the isomer tested, whereas *Daphnia pulex* LC50 values range from 25,000 to 50,000 μg/l (Miyamoto 1976, Worthing and Walker 1987). Mulla et al. (1980) applied δ-phenothrin to ponds at rates of 28 and 56 g/ha and observed mortality of mosquito larvae and mayfly naiads, but no serious deleterious effects on odonate (damselfly and dragonfly) naiads, aquatic beetle larvae, or ostracods.

### Terrestrial

Antwi and Peterson (2009) examined the toxicity of sumethrin (δ-phenothrin) to adult European house cricket, (*Achaeta domestica*), adult convergent lady beetle (*Hippodamia convergans*), and larval fall armyworm (*Spodoptera frugiperda*). Crickets were most sensitive to phenothrin, followed by lady beetles; armyworm larvae were least sensitive.

The $LD_{50}$ for rats and mice is in excess of 5000 mg/kg of body weight. Studies on rats, mice, and dogs, some lasting as long as two years, revealed very high NOELs (No Observed Effect Levels), around 300 mg/kg diet (WHO 1990). Ware (1989) reported an acute oral $LD_{50}$ to rats in excess of 10,000 mg/kg body weight, Acute oral $LD_{50}$ values for bobwhite quail are in excess of 2500 mg/kg and acute dietary $LD_{50}$ values for bobwhite and mallard ducks exceed 5000 mg/kg.

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PRALLETHRIN

General

Prallethrin is insecticidal but much less so than permethrin (Katsuda 2012). It is used in some countries as an insect repellant (Katsuda et al. 2008), in indoor household pest control situations (Matsunaga et al. 1987), and in compound insecticides to provoke excitation and movement so the mosquitoes encounter droplets of more toxic pesticides (Cooperband et al. 2010). As with other pyrethroids, toxicity varies with the isomer tested (Matsuo and Miyamoto 1997). Prallethrin inhibits attachment of barnacles to surfaces without significant toxicity (Feng et al 2009). Prallethrin is "less soluble" in water (Krieger 2001). Rats eliminated all prallethrin from their bodies after administration via oral or subcutaneous routes (Shiba et al.1988). As with other pyrethroid insecticides, prallethrin is of low toxicity to mammals and is essentially nontoxic to birds (WHO 2004). Prallethrin is one of the active ingredients in Mosquito Halt®, a topical veterinary product used to repel biting arthropods from horses (e.g., Warner et al. 2005).

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BIFENTHRIN

General

Bifenthrin is stable in the environment at pH levels from 5-9 (at 21$^{o}$ C); it is labile at higher pH values. It has a half life of 225 days in natural daylight but in soils its half life is about 65 – 125 days (Roberts and Hutson 1999). As recently as 1996, bifenthrin was one of only two insecticides approved for incorporation into potting soil pre-purchase (Oi and Williams 1996). Bifenthrin in sludge can be degraded by the yeast *Candida pelliculosa* (Chen et al. 2012) and the bacterium *Stenotrophomonas acidaminiphila* (Lee 2004, Liu et al. 2005b). Activity by *Stenotrophomonas acidaminiphila* can reduce the half life of bifenthrin from more than 700 hours to between 30 and 131 hours; adsorption of bifenthrin to sediments can inhibit the action of the bacterium (Lee 2004).

Aquatic

Bifenthrin is toxic to rainbow trout, carp, and tilapia (Liu et al. 2005a, Velisek et al. 2009a, b). Daphnia magna showed reproductive effects during 21 day continuous exposure tests (Wang et al. 2009). It has been demonstrated that the oligochaete *Lumbriculus variegatus* does not bioaccumulate bifenthrin, due to biotransformative processes within the body (You et al. 2009). Residential use of bifenthrin for structural pest control and lawn care was believed to be responsible for the almost complete elimination of the amphipod *Hyalella azteca* from a creek system in a residential neighborhood in California (Weston et al. 2005).

Terrestrial

Qualls et al. (2010) challenged honeybees (*Apis mellifera*) with serial dilutions of bifenthrin in acetone for 15, 30, and 60 minutes, and for 24 hours. Mortality was positively correlated with dose and exposure time. Bifenthrin is toxic to red imported fire ants (Oi and Williams 1996, Brinkman and Gardner 2004). Potter et al. (1994) investigated the effects of 20 pesticides and plant growth regulators on earthworms (*Aporrectodia turgida*, *Allolobophora caliginosa*, *Aporrectodia trapezoides*, *Lumbricus terrestris*, and *Eisenia* sp.), one of which was bifenthrin. No harmful effect of bifenthrin on earthworms was found. Ware (1989) reported an acute $LD_{50}$ to rats of 55 mg/kg body weight and an acute dermal $LD_{50}$ to rabbits in excess of 2000 mg.kg body weight. Cilek (2008) reviewed the literature relevant to use of bifenthrin as a barrier spray for mosquito control but did not mention nontarget effects.

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## Appendix H: Florida Department of Health Response Plan for Mosquito-borne Diseases

### Florida Department of Health Response Plan for Mosquito-borne Diseases

Mosquito-borne disease cycles are complex and often involve multiple mosquito species and several vertebrate host species including humans. Virus transmission can be sporadic (spatially and temporally dispersed) or focal (spatially and temporally isolated). This response plan for mosquito-borne diseases is intended for use by county health department public information officers and mosquito control districts. The plan can also be used regionally for adjoining counties with similar habitats and ecologies, but it is not a response plan for the state as a whole.

The need for mosquito-borne disease advisories and alerts is determined by the CHD Director/Administrator after consultation with local mosquito control experts and the State Health Office. A number of important factors should be considered prior to the issuance of an advisory or alert. These include, but are not limited to: animal surveillance activity (sentinel chicken surveillance, wild bird surveillance, and domestic animals) in the same or surrounding counties, weather information, the time of year, vector surveillance (the abundance and age structure of known vectors), epidemiology of the virus in question, historic arbovirus distribution records, and the presence of human and equine cases in the same or contiguous counties.

The CHD Director/Administrator also facilitates the response to mosquito-borne diseases. This includes working closely with the Bureau of Environmental Public Health Medicine, local and state mosquito control personnel, physicians, veterinarians, emergency room personnel, and officials in neighboring counties.

The DACS Bureau of Entomology and Pest Control may provide technical support and leadership to effected counties, mosquito surveillance in areas lacking capability, coordination and delegation of mosquito control activity, aerial mosquito control through their Operational Support Section, and emergency mosquito control funds. The DACS Bureau of Entomology and Pest Control response plan is included below.

In addition to the Florida Department of Health Response Plan, a document has been developed by a team coordinated by Dr. Walter Tabachnick, Florida Medical Entomology Laboratory, to guide the mosquito control response for WNV at various levels of mosquito activity. These response guidelines have been approved by the Florida Coordinating Council on Mosquito Control and are included in Surveillance and Control of Mosquito-Borne Diseases guidebook.

The Department of Health response plan is also appropriate for the response to outbreaks of locally-acquired exotic or non-endemic arthropod-borne diseases such as Chikungunya virus. However, animal surveillance data will not always be available or utilized in the evaluation of these introductions and outbreaks.

The Department of Health (DOH) plan includes the following levels:

**Level 1: No activity**

This level describes the absence of cycling arboviruses in Florida.

- DOH Response:
  - Surveillance (human and animal sentinel surveillance, mosquito-borne disease surveillance)
  - Distribution of weekly arbovirus surveillance reports

- Mosquito Control Response:
  - Operations targeting nuisance and/or disease-carrying mosquitoes
  - Surveillance in sentinel chickens, mosquitoes, and birds
  - Coordinate communication with county health department regarding real time surveillance results.

**Level 2: Background activity**
Describes time periods when mosquito-borne virus activity does not exceed average historical levels.

- DOH Response: (in addition to the response outlined above)
  - Public announcements about personal protection

- Mosquito Control Response: (in addition to the response outlined above)
  - Monitor potential hot spots using surveillance tools
  - Public announcements about personal protection
  - Coordinate communication with county health department regarding real time surveillance results

- DACS Bureau of Entomology and Pest Control Response:
  - Monitor activity detected through existing surveillance programs
  - Routinely disseminate surveillance information to mosquito control programs

**Level 3: Mosquito-Borne Illness Advisory**
Mosquito-Borne Illness Advisories are declared when animal and mosquito surveillance data indicate a rise in virus transmission activity and an increased potential for human infections, or when a locally-acquired single human case of exotic or endemic arboviral disease has been confirmed. Mosquito-Borne Illness Advisories may be declared in a county or region where the surveillance data indicate:

1. One sporadic, locally-acquired confirmed human case or blood donor

   OR

   where the animal surveillance data over a two-week period indicate:

2. Two or more confirmed horse cases

   OR

3. 10% higher than baseline seroconversion rate in the sentinel chickens in a single county (11% current year vs. 1% baseline)

OR

4. 10% higher than historical background levels in corvid mortality

OR

5. 10% higher than historical background levels in the minimal infection rate (MIR) of vector mosquitoes

- DOH Response: (in addition to the response outlined above)
    - Dissemination of health care provider advisories
    - Disseminate internally via EpiCom

- Mosquito Control Response: (in addition to the response outlined above)
    - Mosquito control targeting high risk vector mosquito populations and areas commensurate with arbovirus indicators for risk by performing repetitive nightly spraying operations in high risk areas until vector is suppressed to background levels
    - Consideration for increased surveillance using sentinels in high risk areas with attention to measuring mosquito transmission frequencies using chicken baited mosquito traps or exit traps on sentinel chicken coops
    - Coordinate communication with county health department regarding real time surveillance results
    - Preventive ULV and aerial post-epic rainfall brood reduction directed at vector species, and control of nuisance mosquitoes as a lower priority

- DACS Bureau of Entomology and Pest Control Response: (in addition to the response outlined above)
    - Support of surveillance of adult mosquitoes in Level 2 areas not covered by a county or district
    - Assist in public information dissemination

Mosquito-Borne Illness Advisories are lifted by the CHD when activity has returned to background levels. The Arbovirus Surveillance Coordinator at DOH should be notified of the status change. A press release stating the reason for lifting the advisory can also be issued if desired by the CHD. CHDs should also notify local partners when advisories are lifted.

**Level 4: Mosquito-Borne Illness Alert**

Mosquito-Borne Illness Alerts are declared when additional human cases of locally-acquired endemic or exotic arboviral disease have been confirmed, suggestive of a potential disease clustering, or when evidence of intense virus transmission activity has been detected in animal surveillance systems. Mosquito-Borne Illness Alerts may be declared in a county or region where the surveillance data indicate:

1. A cluster of two or more locally-acquired confirmed human cases and/or blood donors

OR

where the animal surveillance data over a two-week period indicate:

2. Elevated arbovirus antibody detection in sentinel chickens (above historical background levels):
   a. 50% higher than baseline seroconversion rate in sentinel chickens in a county
   OR
   b. 50% higher than baseline seroconversion rate in sentinel chickens in a single flock.
   OR
3. 50% increase in corvid mortality above historical background levels

- DOH Response: (in addition to the response outlined above)
  - Work with the local mosquito control districts and the Interagency Arbovirus Task Force as needed to assess the risk of human disease and sufficiency of implemented mosquito control activities

- Mosquito Control Response: (in addition to the response outlined above)
  - Focus mosquito control efforts to high risk mosquito populations and areas commensurate with arbovirus indicators for risk, adulticiding hot spots
  - Consideration for aerial adulticiding if not already in place with focus in high risk areas where wide area control measures are required to respond to the increased level of risk in a timely manner
  - Increased surveillance to obtain estimates of mosquito transmission frequency in targeted areas
  - Coordinate communication with county health department regarding real time surveillance results.

- DACS Bureau of Entomology and Pest Control Response: (in addition to the response outlined above)
  - Consideration of aerial or ground control activities through Operational Support Section
  - Deployment of contracted aerial or ground control activities if funding available and requested by local government (county or city)
  - Local government request should include:
    - citizen notification of dates and times
    - delineation of areas to be treated, and areas to be avoided including delineation of public lands and sensitive areas
    - surveillance support

Mosquito-Borne Illness Alerts are lifted after a significant decrease in animal surveillance activity and 6 weeks or more after the onset of the last human case (or sample date in the case of blood donors). The Arbovirus Surveillance Coordinator at DOH should be notified of the status change. A press release stating the reason for lifting the advisory can also be issued if desired by the CHD. CHDs should also notify local partners when advisories are lifted.

**Level 5: Mosquito-Borne Illness Threat**

When there is a potential for a widespread distribution of large numbers of human cases, the State Health Officer may declare a Mosquito-Borne Illness Threat. A mosquito-borne illness threat is a declaration by the State Health Officer that "a threat to the public health exists" as per Ch. 388.45, F.S. The same statute provides the Commissioner of Agriculture the authority to declare "a Threat to Animal Health". These official declarations also allow DACS to respond with actions allowing more liberal use of arthropod control measures on certain public lands and movement of mosquito control personnel and equipment into affected counties from other areas of the state as appropriate.

- DOH Response: (in addition to the response outlined above)
  - Consider distributing daily arbovirus surveillance updates to responsible governmental agencies and other partners
  - Work with local mosquito control district to assess their resource needs for mosquito control activities
  - Advise local authorities on the potential need for elevated disease prevention efforts, such as canceling outdoor events/activities, closing campgrounds, etc

- Mosquito Control Response: (in addition to the response outlined above)
  - Advise county health departments on the justification for elevated disease prevention efforts, such as canceling outdoor events/activities, closing campgrounds, etc
  - Conduct aggressive aerial / truck adulticiding, considering control on protected lands with approval from DACS, DEP, FWC, private owners etc., as needed, based on justified widespread danger to public health
  - Provide regional inter-county/district and DACS support as indicated for counties in emergency status
  - Request state (DACS) and federal emergency management agency (FEMA) support for mosquito control operations as needed
  - Coordinate communication with county health department regarding real time surveillance results

- DACS Bureau of Entomology and Pest Control Response: (in addition to the response outlined above)
  - Acquire and distribute emergency funds
  - Activate Emergency Operation Center functions
  - Implement Incident Command System protocols

Mosquito-Borne Illness Threats are down-graded after mosquito surveillance data (such as abundance, age structure, or infectivity) indicate a decrease in risk for human arbovirus transmission. If disease risk still exists but no longer meets the standard for a Threat declaration, a new Mosquito-borne Disease Advisory or Alert should be issued as appropriate.

Under a Level 5 threat, the CHD in the affected county will notify:

1. Community health care providers concerning the potential for transmission of SLEV, WNV or EEEV to people, and the need for physicians and veterinarians to report new cases
2. The County Mosquito Control Director
3. CHD Directors/Administrators and Mosquito Control Directors in contiguous counties of the mosquito-borne illness threat
4. Local media, education representatives, senior citizen groups and other citizen groups as appropriate

The Division of Environmental Health will notify DACS and DEP within 24 hours of the declaration of a mosquito-borne illness threat (Ch. 388.45, F.S.)

**Non-disease Mosquito Control Emergencies:**
State declared emergencies following hurricane or other flooding events may result in elevated mosquito populations that hinder emergency response without posing an immediate mosquito-borne disease threat. In such cases DACS will coordinate response within the state Emergency Management structure, and a FEMA developed protocol with requirements to qualify for federal re-imbursement for local mosquito control efforts will be distributed to impacted local Emergency Management Centers.