State of Hawai‘i
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Forestry and Wildlife
Honolulu, Hawaii 96813

June 28, 2024

Chairperson and Members
Board of Land and Natural Resources
State of Hawai‘i
Honolulu, Hawai‘i

SUBJECT: INFORMATIONAL BRIEFING ON THE USE OF THE LARVICIDE *BACILLUS THURINGIENSIS ISRAELENSIS* (BTI) TO AID IN SUPPRESSING MOSQUITO POPULATIONS ON MAUI AND KAUA‘I

SUMMARY

Hawai‘i’s forest birds have the highest percentage of endemic species on earth. These endemic forest birds are ‘ohana, kūpuna, and ‘aumākua to Native Hawaiians, and the habitats in which they are found are sacred places. The endurance of these birds in native forests is essential to preserving biocultural and ecological landscapes. Climate change has led to the encroachment of the southern house mosquito (*Culex quinquefasciatus*), which vectors avian malaria, into the high-elevation forests that once served as refugia for Hawai‘i’s endangered forest birds. Owing to their high susceptibility to avian malaria, these species are threatened with extinction in the near term. The Department of Land and Natural Resources (DLNR) has received Board approval to commence landscape-scale mosquito control in critical forest bird habitat via the Incompatible Insect Technique (IIT). Funds have been secured and IIT suppression of southern house mosquitoes is underway on Maui and scheduled to commence on Kaua‘i in mid-January 2025.

Given the significant decline of forest bird populations on Maui and Kaua‘i, The Division of Forestry and Wildlife (Division) and its partners, the Maui and Kaua‘i Forest Bird Recovery Projects, seek to utilize another safe and effective tool, concurrent with IIT applications for southern house mosquito suppression in forest bird habitat on Maui and Kaua‘i. A commercially available larvicide that uses the bacterium *Bacillus thuringiensis israelensis*, or Bti, was tested during a pilot study on Maui and Kaua‘i in late 2023. This product killed larvae of southern house mosquitoes in the source habitats adjacent to the forest bird habitat on both islands. Further application is currently planned for Kaua‘i. Bti and IIT are planned for future concurrent use as part of a broader integrated pest

management approach to suppressing southern house mosquitoes to reduce the spread of avian malaria in forest bird habitats on both Maui and Kaua‘i.

BACKGROUND

Bacillus thuringiensis israelensis or Bti

Bti is a naturally occurring bacteria found in soils worldwide. It is a bacterial insecticide, not a chemical, that only kills the larval stage of mosquitoes, black flies, select non-biting midges, and other closely related flies. As a larvicide, Bti is very target-specific, with activity primarily restricted to mosquitoes and related flies. It is not toxic to beneficial insects, and numerous toxicology studies have shown Bti to be non-pathogenic and non-toxic to other forms of wildlife (birds, fish, mammals) and humans. As such, it is approved as an insecticide for organic applications registered by the Environmental Protection Agency (EPA). The World Health Organization has approved the use of Bti in drinking water.

Bti comes in many forms, including dunks, tablets, briquettes, pellets, granules, or liquid. It generally begins killing mosquito larvae within hours, with noticeable suppression in 48 hours. When used as directed, Bti can be applied safely to standing water where mosquitoes lay eggs without causing harm to food crops or water supplies. It can be applied using trucks, aircraft, handheld sprayers, or simply by hand broadcast.

Current Uses of Bti

Bti has undergone nearly 40 years of lab and field-based research and testing and over 30 years of large-scale operational use in various public health and nuisance control programs around the globe. It is currently used across the United States for mosquito control and is approved for aerial spraying, which has occurred in numerous states. It is also widely used in Canada and Europe, where Bti treatments are authorized for application in protected areas (e.g., areas included in the European Natura 2000 inventory). In Hawai‘i, Bti is currently being used on Kaua‘i (starting June 2024) across a 1200-acre treatment area on the Alaka‘i Plateau, where treatments include aerial applications by a helicopter-mounted boom sprayer every other week. Equipment used for aerial application generates a fine mist that settles to the ground and collects in existing pools of water that could host larval mosquitoes. This is currently the only known use of Bti for landscape-scale conservation.

Comparison of Bti to IIT

IIT uses the bacterium *Wolbachia* and targets adult mosquitoes. Via IIT, non-biting male southern house mosquitoes are released into upper-elevation forest bird habitats where the adult insects breed. These male mosquitoes carry a different or incompatible strain of Wolbachia than that harbored by the wild,

invasive mosquitoes already on the landscape. The incompatible male mosquitoes are released at a ratio of 10:1 for every wild mosquito in the release area. The released males then over-flood the wild male population and mate with females in the forest. However, given Wolbachia's incompatible strains, these female mosquitoes' eggs are rendered infertile.

By comparison, Bti targets the larval stage of the southern house mosquito and is applied specifically in areas where mosquitoes lay their eggs and the larvae develop. Larvae that hatch in treated areas simply ingest the Bti product and die. Preliminary results of the 2023 pilot project over 270 acres on Kauaʻi and 360 acres on Maui show that aerial application of Bti to larval habitats significantly affects larval mosquito populations. 36% of larvae in treated habitat survive to 48 hours vs. 81% in untreated habitat.

Integrated Pest Management

Integrated Pest Management (IPM) is an environmentally sensitive approach to managing pests that uses a combination of methods to control them and reduce the use of toxicants. IPM programs use current, comprehensive information on the life cycle of target pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means and with the least possible hazard to people, property, and the environment. Bti is increasingly incorporated into IIT programs worldwide because Bti can effectively target developing larval mosquito populations, thereby reducing overall adult mosquito abundance. A lower density of wild adult mosquitoes on the landscape may help decrease avian malaria transmission in and of itself and make the release of adult male IIT mosquitoes more effective. The lower the wild mosquito population density, the more effective the releases of incompatible male mosquitoes via the IIT method. Therefore, the use of Bti and IIT control strategies complement one another. Their simultaneous use to protect Hawaiʻi's native forest birds from avian malaria via controlling introduced mosquitos appears to be an effective strategy. Using both techniques will provide mosquito control over a larger area (approximately 4,200 acres in total on Kauaʻi, see Attachment A) than using either technique alone.

Chapter 343 Guidance and Government Approvals

Bti is registered by the EPA for widespread commercial and private use to control mosquitoes. The EPA and the World Health Organization consider it safe for drinking water and organic farming applications. According to the EPA, *Bti is a biological or naturally occurring bacterium found in soils... has no toxicity to people and is approved for pest control in organic farming operations... is approved for aerial spraying... can be sprayed over waterbodies such as ponds, lakes, rivers, and streams... is used to kill developing mosquito larvae*

by being applied to standing water where those larvae are found... no special precautions are needed for applying Bti... Bti has no toxicity to people, so it can be applied safely to mosquito habitats without a detrimental impact on food crops or water supplies... (https://www.epa.gov/mosquitocontrol/bti-mosquito-control). The Division consulted with the Hawaii Department of Agriculture to ensure this larvicide would be applied consistently with the label. DLNR's Chapter 343 exemptions, General Exemption Type 4, Part 1, No. 9, include "*Control of pests utilizing federal and state approved pesticides, herbicides, fungicides, and toxicants in conformance with label instructions; traps, snares, lures, and repellents; and other approved methods*."

Recommendations

This submittal is for informational purposes only. The Division is not seeking action by the board.

Respectfully submitted,

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David G. Smith, Administrator
Division of Forestry and Wildlife

APPROVED FOR SUBMITTAL:

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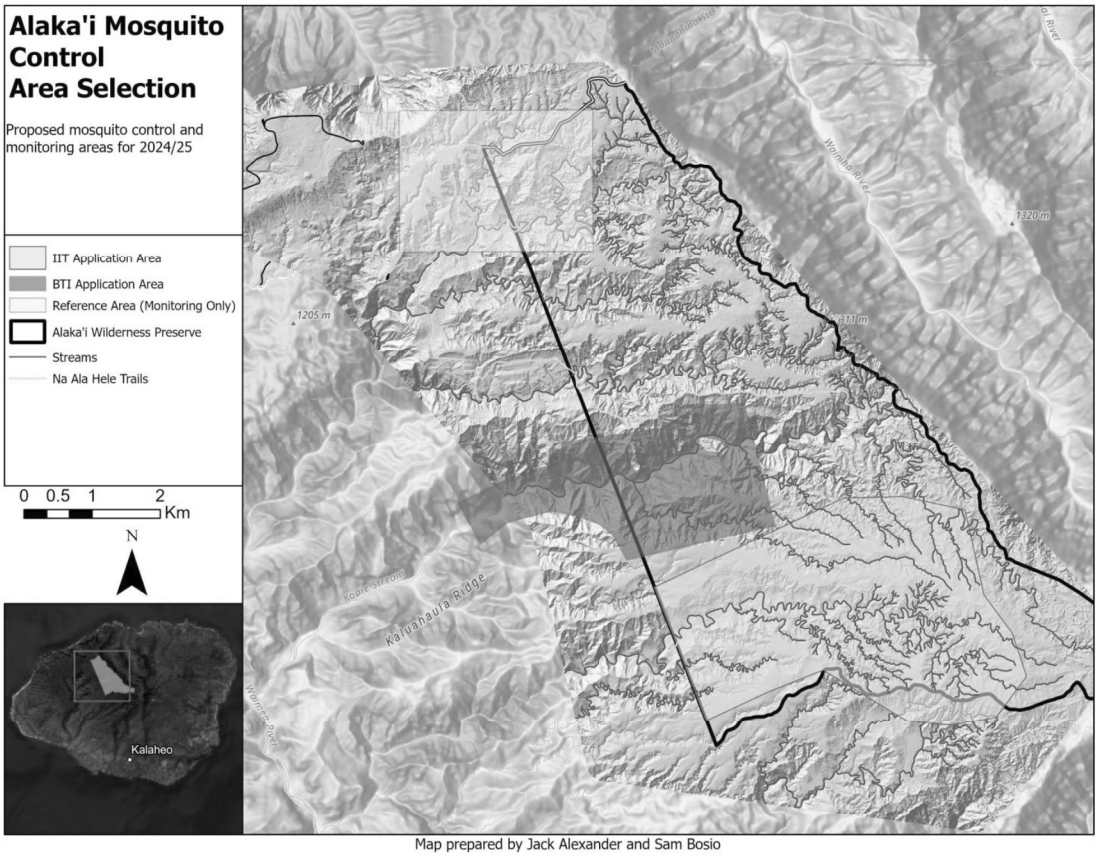
DAWN N.S. CHANG, Chairperson
Board of Land and Natural Resources

Attachment A: Figure 1. Treatment areas for IIT and Bti on Kaua'i.

Attachment A:

Figure 1. Treatment areas for IIT and Bti on Kauaʻi. The open areas of "holes" in the Bti Application Area represent locations where the product cannot be applied because of steep terrain. The Reference Area serves as a control across which neither IIT nor Bti will be implemented or applied; mosquito monitoring, however, will be conducted there.



Map prepared by Jack Alexander and Sam Bosio