

## Mosquitoes In Hawai'i



### **Mosquitoes in Hawai'i: Vectors for Zika, Dengue, Yellow fever, Heartworm, Bird Malaria and Bird Pox**

Emmalani Makepa- Foley  
Jennifer Kuwahara,  
Pauline W. U. Chinn,  
Kyle Kolomona Nakatsuka  
Puakea Nogelmeier

University of Hawai'i at Mānoa

Figure 1 *Aedes aegypti* (<http://health.hawaii.gov/docd/dengue-outbreak-2015/>)

**Title:** Hawai'i's Invasive Mosquitoes (Family *Culicidae*)

**Grades:** 4 -12

**Time:** 2 hours in class, 3-5+ days with school and community activities.

### **Nā Hopena A'o General Learner Outcomes**

1. **Strengthened Sense of Belonging:** understand how actions affect others; actively participate in school and community
2. **Strengthened Sense of Responsibility:** for self, family, community and the larger society
3. **Strengthened Sense of Excellence:** demonstrated by a love of learning
4. **Strengthened Sense of Aloha:** respond mindfully to what is needed.
5. **Strengthened Sense of Total Well-being:** feel safe physically and emotionally
6. **Strengthened sense of Hawai'i:** I am enriched by the uniqueness of this prized place.

### **NGSS Disciplinary Core Ideas LS1.A: Structure and Function:**

4-LS1-1; MS-LS1-4: Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

MSLS2-1: Ecosystems: Interactions, Energy, and Dynamics: Analyze and interpret data to provide evidence for the effects of resources availability on organisms and populations of organisms in an ecosystem;

MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems;

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

### **NGSS 4-ESS3 Earth and Human Activity: Cross-cutting Concepts: Influence of Science, Engineering and Technology on Society and the Natural World:**

4-ESS3-1: Over time, people's needs and wants change, as do their demands for new and improved technologies.

## Mosquitoes In Hawai‘i

### To the Teacher: Connections to Place & Culture(s)

Hawai‘i has six species of mosquitoes that feed on blood and two that feed only on plants. Mosquitoes that feed on blood serve as vectors that transmit human and animal diseases such as dengue, Zika, yellow fever, malaria, heartworm, bird pox and malaria.

Hawai‘i’s first mosquito, *makika*, the Southern House Mosquito, *Culex quinquefasciatus* likely arrived in 1826 on a ship traveling to Lahaina from Mexico (Van Dine, 1904). First reported by a Hawaiian who described a new singing night insect, the brown night-biter (Figure 2) is found on all islands where it transmits heartworm to dogs and avian malaria and avian pox to birds. Black-and-white striped “tiger mosquitoes” (Figure 1) *Aedes aegypti* and *Aedes albopictus* arrived by the end of the 19<sup>th</sup> Century (Winchester, 2011).

Avian pox (*Avipoxvirus spp*) and avian malaria caused by *Plasmodium relictum* arrived in Hawai‘i via infected birds. Readily transmitted by *C. quinquefasciatus* to native birds with no resistance to these new diseases, they contributed to the extinctions of several species of native birds in the 1920s and 1930s. Native birds living above 1,500 m elevation survived in the colder,



mosquito-free habitat. Now climate change enables mosquitoes to breed at higher elevations, shrinking this safe zone and threatening endemic Hawaiian birds, especially Hawaiian honeycreepers, that are highly susceptible to avian malaria, effective disease transmitters, and chronically-infected (Samuel, Woodworth, Atkinson, Hart, and LaPointe, 2015; Newbern, 2015).

Figure 2 *Culex* on `Iwi. Photo: Chris Johns/Nat. Geo. Creative

Warmer temperatures due to climate change speed up the life cycle of cold-blooded animals such as mosquitos and reduce the areas that are too cold for mosquitoes to breed. *Culex* mosquitoes may range several miles from breeding sites in water with rotting organic matter, including the rain-filled furrows of feral pigs. Thus controlling feral pigs is a strategy to protect native birds.

Black-and-white striped “tiger mosquitoes” (Figure 1) are day-biters. *Aedes aegypti* and *Aedes albopictus* are responsible for dengue outbreaks in Hawai‘i and American Samoa. They also transmit their viral relatives: Zika, yellow fever, and chikungunya. Zika affects nerves and can affect brain development of unborn babies, causing the condition called microcephaly. Air travel makes it easy for people infected with Zika to become sources of local transmission in Hawai‘i, American Samoa, or anywhere tiger mosquitoes were unintentionally introduced through trade and travel. (Zika is also transmitted through blood transfusions and sexual contact.) Tiger mosquitoes range only 100-150 yards from their breeding sites, so looking for and eliminating breeding sites in plants, rocks, and all types of containers that hold water is the an effective means of control

*Ua ‘elepaio ‘ia ka wa‘a.*The ‘elepaio has [marked] the canoe [log].

## Mosquitoes In Hawai‘i

Hawaiians closely observed the ‘*elepaio* (*Chasiempis sandwichensis*) when selecting a koa tree to be made into a canoe. If the insect-eating bird pecked at the wood, it was riddled with insects and useless for a canoe. More broadly, the saying speaks of close observation to guide future actions (Pukui, 1983, No. 2777).

An anonymous author of an 1856 Hawaiian language newspaper article, “Be Kind to the Small Birds,” comments on the role of birds as *biological controls*. The writer describes how irritating mosquitoes are in the summer and describes how swallows prey on mosquitoes and other insects. By estimating the number of insects a swallow eats per day, then estimating how many birds are in the area, the writer calculates 4,508,000 insect pests can be eliminated just by swallows between June and August. Through examining the food chain and using simple mathematics to estimate the impact of a predator on prey, the writer promotes the introduction of the swallow in Hawai‘i.

Following western contact, Hawaiians suffered from new diseases and biting mosquitoes, *makika* and wondered about possible connections between them. “The Fever Sickness and the Makika” written by Kookookalani (1862) discusses a new illness called *makika*. He describes fever, fever, chills, sweats, nausea, and weakness mixed with a foreign affliction and the great burden it has placed on the Wailupe community.

In the early 1800s some doctors thought that yellow fever, the feared disease called Yellow Jack by 19<sup>th</sup> century sailors could be spread by mosquitoes. Walter Reed’s experiments in which a human volunteer died established in 1900 that *A. aegypti* was a vector for yellow fever. In 1906 Thomas Bancroft showed it also transmitted dengue (Nelson and Williams, 2014). On October 30, 1910, the first case of shipboard yellow fever arrived at Honolulu but quarantine prevented its spread. A year later, a Hawaiian quarantine guard was reported to have yellow fever and efforts were made to control a possible epidemic. Though this was the only occurrence of yellow fever in Hawai‘i (Morris, 1995) the threat was an excuse to dredge the Ala Wai Canal and fill in *lo‘i kalo* and fishponds (Taking Waikiki, 1994).

Pennisi (2016) reports that *Platanthera obtusata*, a bog orchid common in the U.S., seems to rely on the blood-sucking insects for reproduction. Biologists at the University of Washington discovered they emit an odor just like the human body. Their target: tiger mosquitoes. Figure 3 Photo by Kiley Riffel.



[\*P. obtusata\* gives off some chemicals found in human body odor](#). Although this “body odor” is barely detectable by humans, it sets off electrical activity in the mosquito’s antennae, indicating it may attract the insects and suggesting it could lead to the identification of natural chemicals that could be used as bait in mosquito traps.

In American Samoa, the constant irritation of mosquitoes inspired the Samoan Mosquito Slap Dance. See [https://www.youtube.com/results?search\\_query=samoan+mosquito+dance](https://www.youtube.com/results?search_query=samoan+mosquito+dance).

## INSTRUCTIONAL ACTIVITIES

### 5 E LESSON

1. **Engage:** Connect to prior knowledge, engage learners in concept, process or skills to be learned.

- Share things you know about mosquitoes.
- What problems of people and animals are caused by mosquitoes?
- Describe or draw a mosquito. What are special feature of biting mosquitoes?
- Share what you know about the life cycle of mosquitoes.
- In what ways can climate change affect mosquitoes?

2. **Explore:**

- Interview an adult about mosquitoes, problems they cause, and how to address them.
- Lesson I: Home, school, community field trip: Walk around your home or school yard. Observe, identify, record, map and photograph places mosquitoes may be breeding. Remove, empty, or cover containers that hold water. Check and clear weekly. **Read “Fight the Bite Fact Sheet” and follow directions:**  
<http://health.hawaii.gov/docd/files/2015/11/Fight-the-Bite-Fact-Sheet.pdf>

3. **Explain:**

- What are the structures and behaviors of blood feeders and plant feeders?
- What are some human activities that directly and indirectly affect mosquito populations?
- How does climate change affect mosquitoes’ role as a disease vector?
- Explain your Field trip findings. Compile findings into a class map, discuss any patterns.
- Lesson 2. Fishbowl Discussion (See Instructional Activity Below)

4. **Elaborate/Extend:**

- What can you do personally to reduce mosquitoes in your home or community?
- Based on your field activities, what can you do to inform your peers and community about ways to reduce mosquito populations that spread disease?
- Mosquito Field guide: Make a photo field guide of all species of mosquitoes found in Hawai‘i. Where are they from, what is their life cycle, what is their role in the ecosystem, what diseases if any do they transmit? Are any harmless or even beneficial? How can disease spreading mosquitoes be controlled or eliminated?

5. **Evaluate:** How will students show/know what they have learned? Peer and teacher feedback, engagement and learning assessed via KWL, journals, pre-post tests, terminology and concepts, stories, presentations, posters, photos

**Teacher Reflection**, how could the lesson be more effective? What went well, what would you do differently?

### LESSON I. HAWAIIAN LANGUAGE NEWSPAPER ARTICLES

Read two articles by 19<sup>th</sup> writers about disease, mosquito, and mosquito controls. Questions follow the second article.

**Ka mai piva, a me ka makika.**

*Ka Hoku o ka Pakipika e:—Aloha oe.*

E hiki paha ia oe ke lawe aku i keia wahī puolo me ke aloha, aku, ina nse ua piha kou waihona, pau loa ae la no. Ua nui ka mai ma keia aia o Wailupe nei, iloko o keia mau mahina i hala ne nei; ua nui ka mai i loa i na keiki, a me na wahine, a me na kane.

Ua nui ka pilikia, a me ke kaumaha no keia ma i ikaika loa; ina no nae hoi o ka mai hookahi no ka piva, aole, he mui okoa no kekahi he "makika." O keia mai nae he makika, he mui Hawaii no, un uwili nae me ka mai haole.

Ua kuhihewa no ka mana'o o kanaka, hookahi no la hoi mai, i ke kii ana aku i ka laau haole, i kahi lu-pepa, a me kahi paakai, hoi mai la no hoi, hoiinu no i ka mui i kahi lu-pepa, noha no hoi ka mai, hoiinu aku la hoi i kahi paakai noha no, mahope olaila loa mai la no ka oluolu, pau no ka pilikia, o ka mai hookahi no ia i loa ia, a ina olua mai, o ka piva, a me ka makika, hakalia no, he oia paha? uole paha?

Pela no e noho ia nei i keia mau la, ke waiho nei no kekahi mai, ua hau ne hoi ke anu, a me ka wela, oia no ka mai haole, koe no nae ka makika o Hawaii nei; noho mai na akua iluna o ka mai, a olelo mai, na ko makou kahu no i olelo mai, he makemake ko makou kahu i ka tole ulaula, o kana puni ia o ka mea ula, ke kihei ula, muumuu ulaula, a o na puni ia a ua makani nei e olelo nei iluna o ka mai.

O keia wahī makika e kani nei ma Wailupe nei, he wahī makika no ua ane wiwi, hoholen no ke ike aku. Owau no hoi kekahi i loa i keia mai, o ka piva, i ke anu, a me ka wela; ua nui mai no hoi ka ikaika o ka wela, ua like no me ka wai e paila ana, me he lapalapa nui la iloko o ka lolo, a aneane maoli no hoi i ka pilikia, aka, ina paha e uwili pu me kela mai makika, ina ua hualele ia ka la ka mea mehana.

Auhea oukou e na makamaka, ina oukou e loa i ka mai piva, e hoomalu no ka pono, i kii i lu-pepa, a i paakai, a me ka aila hoona-ha, ua nui loa ma kahi o na Kauka haole, me ka malama pono no nae i na tula, a me na kanawai o ka laau.

KOKOOKALANI.

Wailupe, Oct..25, 1862.

**The fever, and the makika.**

*Ka Hoku o ka Pakipika e: Aloha oe.*

You could perhaps compassionately take this packet of information, but if your files are full, then it is finished. There is much illness here in Wailupe, within these past few months the ailment has spread to the children, the women, and to the men.

There is great difficulty and sadness about this very powerful illness: it would be one thing if the illness was just the fever, but it is not, there is another illness called "makika," (mosquito). This illness, makika, it is an illness known to Hawai'i, it's been mixed with a foreign illness.

It has been people's wrongful assumption that there is just one sickness. When they fetch the western medicine, the rhubarb (purgative) and certain salts, and then go back and treat the sickness with rhubarb, the patient is purged, and then treated with the salt and is further purged, whereupon comfort is found, the affliction is through, and that is just the one sickness that was caught. But if there are two sicknesses, the fever and the makika, might they be cured? Perhaps not?

That is how it has been these days, the ill person is left, then the chills strike, and the sweats, that is the foreign illness, but there is still the makika sickness of Hawaii; the akua (ghosts or spirits) settle on the patient, saying "Our attendant says she wants red clothing, that her favorite things are red things, a red shawl, a red dress," and these are the favorites that the wind speaks of over the sick person.

This makika that is buzzing here at Wailupe is a thin little makika and looks rather pared down. I too am one of those afflicted with this illness, the fever, the chills, and the sweats; the intensity of the temperature is like water boiling to a high boil in the brain, and very near to distress, but, if it had been mixed with that makika, then the sun would be abandoned as a source of warmth.

Listen friends, if you get the fever, you should protect yourself and get the rhubarb, and salts and castor oil, the western doctors have a lot. Do, however, adhere to the rules and the

restrictions of the medicine.

Kookookalani.

Wailupe, Oct. 25, 1862

Published in *Ka Hoku o ka Pakipika* 30

October 1862

### HANA MAIKAI O NA MANU LIILII.

Noho ae la kekahi kanaka mea aina, ma kahi o Amerika Huipua, me ka pilikia nui no na nalo, makika, a me na mea e ae ano like, nui wale. I ka wa wela, oia no i na malama o Iune, Iulai a me Aukake, piha loa ke ea a me na hale i keia mau mea ino; pilikia na kanaka a me na holoholona no ia mau mea; aka, i ka malama o Mei i hala'ku la, lele mai la kekahi mau manu liilii, o sualo ka inoa, (swallow,) he 140 ka nui o lakou. A hana'ku la lakou i ka lakou mau punana he 70, ma ka aoao o ka hale—holoholona nui malalo iho o ka pali. Kokuu'ku la ke kanaka nona ua hale la ia lakou me ka papa laau i paaia ma ka aoao oia hale malalo iho o kahi o na punana i hoomaka ia, a hana'ku la na sualo me ke akamai a me ke mele olioli ana. O ka ai o kela mau manu liilii, o na nalo, me na makika, a me na mea e ae ano like; nolaila, lele ae la lakou i kela aoao keia aoao eimi i mea ai, a nui na nalo a me makika i make, a pau koke ka pilikia o na kanaka oia wahi. No ka mea, iloko o kela punana keia punana, he 4 paha a he 6 paha keiki manu liilii i makemake ai, a he 350 lakou a pau, a me na manu makua 140, huiia he 490, Ua mana'ia e na mea nasuao i noonoo i keia mea, e ai ia na nalo he 100 e ka manu hookahi i ka la hookahi. Ina paha, o ka nui o na nalo a me makika i ai ia e na manu 490 i ka la hookahi, he 49,000 no ia; a iloko o na la 92 o Iune a Aukake, he 4,508,000! Nolaila, sole he mea kupanaha ia, ka hoopau koke ana o ka pilikia o ua kanaka la.

Heaha ka mea e hiki ole ai ke loa'ia mai ia mau ano maikai ma keia pae aina?

### LESSON I. Hawaiian Newspaper Articles

1. How do introduced diseases impact Hawai'i's isolated plants and animals?
2. What are reasons for and against introducing swallows as a biocontrol for mosquitoes?
3. What you can do to prevent introduction and/or help to control invasive species?

**Note:** Though unlikely mosquitoes were involved in these illnesses, the writer may have been aware of ideas that mosquitoes transmitted disease.

### The Good Work of the Small Birds

A landowner lived in a part of the United States where he had great trouble because of the many flies, mosquitoes, and other similar things. In the summer; that is, the months of June, July, and August; the air and the house were completely full of these harmful things, and people and animals alike were plagued by them; but last May, some small birds flew in, their name, the sualo (swallow), 140 of them. They made their 70 nests beside the large barn just below the cliff. The owner of that barn helped them with wooden boards that were affixed to the side of the building, just below where the nests had been started, and the swallows worked away, skillfully, singing happily. The birds' food was the flies, the mosquitoes, and other similar things; therefore, they flew all over the place for food, and numerous flies and mosquitoes died, quickly ending the people's trouble there. This is because within each and every nest, 4-6 young birds were expected, 350 of them total, and with 140 adult birds, equaling 490. It was estimated by educated folk who considered this topic that 100 flies are eaten by each bird per day. If so, the number of flies and mosquitoes eaten by 490 birds in one day would be 49,000, and within the 92 days of June to August, it would be 4,508,000! Therefore, it's no wonder that the man's troubles were so quickly ended. Why can't we get those fine birds on these islands?

Published in *Ka Hae Hawaii* 3 December 1856

## LESSON II. HOME, SCHOOL, COMMUNITY MOSQUITO SURVEY AND CONTROL

1. Engage students and elicit prior knowledge
2. Read and discuss “Fight the Bite Fact Sheet” and follow directions:  
<http://health.hawaii.gov/docd/files/2015/11/Fight-the-Bite-Fact-Sheet.pdf>
3. Develop, discuss, decide on a periodic monitoring plan for school, home, community
4. Field research: monitoring and control
  - Apply mosquito repellent
  - Visit, observe, record, map and photograph places mosquitoes may be breeding.
  - Collect larval samples to study life cycle and to identify mosquito.
  - Remove, empty, or cover containers that hold water.
  - Check and clear weekly.
  - Report findings in class and share with wider community.
5. Optional: Coffee cup egg traps: (<https://www.sciencealert.com/this-innovative-mosquito-egg-trap-could-help-in-the-fight-against-zika>)
  - Put a coffee cup “sleeve” inside the cup.
  - Fill with water to the lower edge of the “sleeve”
  - Leave in a sheltered, shady place for 1 week.
  - Check weekly for mosquito eggs. If present, replace sleeve and reset trap. Count eggs—each represents one fewer mosquito—then discard sleeve, or keep in a ziplock for life cycle demonstration or identification—*Culex* or *Aedes*.
6. Present findings: make a poster or public service announcement, enter science fairs
7. Create a Mosquito Field guide: Classify mosquitoes from kingdom through species then make a photo field guide of all species of mosquitoes found in Hawai‘i. Where did they from, what is their life cycle, what is their role in the ecosystem, what diseases if any do they transmit? Are any harmless or even beneficial? How can disease spreading mosquitoes be controlled or eliminated?
8. MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems:
  - Diagram and explain the role of *Culex* and *Aedes* mosquitoes in Hawaii’s communities and ecosystems

## LESSON III. FISHBOWL: A DISCUSSION STRATEGY

**What is Fishbowl?** (see <https://www.facinghistory.org/resource-library/teaching-strategies/fishbowl>)

“Fishbowl” is a teaching strategy that helps students practice being contributors and listeners in a discussion. Students ask questions, present opinions, and share information when they sit in the “fishbowl” circle, while students on the outside of the circle listen carefully to the ideas presented and pay attention to process. Then the roles reverse. This strategy is especially useful when you want to make sure all students participate in the discussion, when you want to help

students reflect on what a “good discussion” looks like, and when you need a structure for discussing controversial or difficult topics. Fishbowls make excellent pre-writing activities, often unearthing questions or ideas that students can explore more deeply in an independent assignment.”

Follow the link for detailed information and ideas on running a fishbowl discussion with your class: "Fishbowl." *Facing History and Ourselves*. Facing History and Ourselves, 2015.  
<https://www.facinghistory.org/for-educators/educator-resources/teaching-strategy/fishbowl>

**Instructional Procedure:**

1. **Propose the following question to students:** “*Should we make a worldwide effort to eradicate disease carrying mosquitoes?*”
2. **Assign groups to represent stakeholders the discussion:** All groups should consider things like: human health, ecological impacts, sustainability, resources needed (financial, environmental, social).

Group	Potential Organizations/Stakeholders
1	World Health Organization
2	Hawai’i State Department of Health
3	International Pediatric Association
4	International Federation of Gynecology & Obstetrics (FIGO)
5	Scientists involved in genetic modification
6	Insecticide Company Representatives
7	Tourism Authorities for various countries
8	University Professors in ecology

3. **Assign readings from a variety of resources for students to read and analyze prior to the discussion:**
  - Center for Disease Control Website: <http://www.cdc.gov/zika/>, [www.cdc.gov/dengue/](http://www.cdc.gov/dengue/)
  - World Health Organization Website:
  - Hawaii State Dept. of Health website:  
[http://health.hawaii.gov/docd/dib/disease/zika\\_virus/](http://health.hawaii.gov/docd/dib/disease/zika_virus/)
  - Articles on dengue, zika, chikungunya, yellow fever.
  - Data on mosquito borne illness
  - Information on ecological connections mosquitoes have to other organisms
  - Impacts of eradication chemicals on biotic and abiotic components of environment

**STUDENT WORKSHEET FOR FISHBOWL DISCUSSION**

**Elements of a strong socio-scientific justification (Source: NSTA The Science Teacher)**

Makings of a strong justification	<b>Which means...</b>
Decision	A position (claim) is clearly stated. The decision relates directly to the ethical question.
Facts	The facts and science content can be confirmed or refuted regardless of personal or cultural views. These can be used as evidence to support the claim.
Ethical considerations	Ethical considerations may include respect for persons, maximizing benefits and minimizing harm, and justice. These can serve as evidence to support the claim.
Stakeholder views	There are a variety of views and interests in the decision, and more than one individual or group will be affected by the outcome.
Alternative options and rebuttals	No one decision will satisfy all parties. A through justification considers strengths and weaknesses of various positions.
Reasoning and logic	A logical explanation that connects the evidence to the claim provided

**Student:**

- 1. Use the table below to help you prepare for your participation in the debate**
- 2. Name of the organization/stakeholder your group is representing:**

\_\_\_\_\_

<b>Justifying your position</b>	<b>Statements your stakeholder/organization might use during the debate</b>
Decision/Position	
Facts	
Ethical considerations	
Alternative options and rebuttals	
Reasoning and logic behind your views and position	
Final Statement to drive home your point/position about the debate	

EVALUATE: In what ways did learning activities support Na Hopena A’o General Learner

Outcomes: (<http://www.hawaiipublicschools.org/DOE%20Forms/NaHopenaAoE3.pdf>)

- 1. Strengthened Sense of Belonging:** understand how actions affect others; actively participate in school and community
- 2. Strengthened Sense of Responsibility:** for self, family, community and larger society

3. **Strengthened Sense of Excellence:** demonstrated by a love of learning
4. **Strengthened Sense of Aloha:** respond mindfully to what is needed.
5. **Strengthened Sense of Total Well-being:** feel safe physically and emotionally
6. **Strengthened sense of Hawai'i:** I am enriched by the uniqueness of this prized place.

## RESOURCES

1. [Augenbraun, E.](http://www.scientificamerican.com/video/zika-virus-hitches-a-ride-with-human-loving-mosquitoes/?WT.mc_id=SA_ENGYSSUS_20160204) (Feb. 1, 2016). Zika Virus Hitches a Ride with Human-Loving Mosquitoes (2 minute video) [http://www.scientificamerican.com/video/zika-virus-hitches-a-ride-with-human-loving-mosquitoes/?WT.mc\\_id=SA\\_ENGYSSUS\\_20160204](http://www.scientificamerican.com/video/zika-virus-hitches-a-ride-with-human-loving-mosquitoes/?WT.mc_id=SA_ENGYSSUS_20160204)
2. Bussewitz, C. (March 15, 2016). Hawaii tries to ward off Zika amid pesticide fears and limited resources. <http://www.latimes.com/science/la-adna-hawaii-zika-fears-20160313-story.html>
3. Centers for Disease Control and Prevention (Feb. 12, 2016) Zika in the Pacific Islands <http://wwwnc.cdc.gov/travel/notices/alert/zika-virus-pacific-islands>
4. Fang, J. (2010). Ecology: A World without Mosquitoes. Nature.com. Nature Publishing Group, <http://www.nature.com/news/2010/100721/full/466432a.html>
5. *Hana maikai o na manu liilii* (3 December 1856). *Ka Hae Hawaii*.
6. Hawaii News Now (Mar. 21, 2012). Rare mosquito found at Honolulu airport prompts ‘call to action.’ <http://www.hawaiinewsnow.com/story/17205906/rare-mosquito-found-in-honolulu-prompts-call-to-action>
7. Hawaii Newspaper Digital Project (n.d.). Mosquitoes in Hawaii. <https://sites.google.com/a/hawaii.edu/ndnp-hawaii/Home/subject-and-topic-guides/mosquitoes-in-hawaii>
8. *Kookoolani* (Oct. 30, 1862). *Ka mai piva, a me ka makika. Ka Hoku o ka Pakipika*.
9. [Maron, D. F.](http://www.scientificamerican.com/article/zika-virus-threatens-u-s-from-abroad1/?WT.mc_id=SA_SP_20160201) (Feb. 12, 2016). Zika Virus Threatens U.S. from Abroad (interactive map) [http://www.scientificamerican.com/article/zika-virus-threatens-u-s-from-abroad1/?WT.mc\\_id=SA\\_SP\\_20160201](http://www.scientificamerican.com/article/zika-virus-threatens-u-s-from-abroad1/?WT.mc_id=SA_SP_20160201)
10. Maui Forest Bird Recovery Project (n.d.) *Avian Disease*. <http://www.mauiforestbirds.org/articles/17>
11. Morris, A.D. (1995). The epidemic that never was: yellow fever in Hawaii, *Hawaii Med J.* 54(11):781-4.
12. Nelson, K. and Williams, C. (2014). *INFECTIOUS DISEASE EPIDEMIOLOGY, THIRD ED*, Jones and Bartlett Learning.
13. Newbern, E. (2015). How malaria hurts birds. <http://www.audubon.org/news/how-malaria-hurts-birds>.
14. Pennisi, E. (Jan. 4, 2016), Orchids give off human ‘body odor’ to attract mosquitoes. <http://www.sciencemag.org/news/2016/01/orchids-give-human-body-odor-attract-mosquitoes>.
15. Pukui, M. K. (1983). *‘Ōlelo No‘eau: Hawaiian Proverbs and Poetical Sayings*. Honolulu: Bishop Museum Press.
16. Samuel, M. D., B. L. Woodworth, C. T. Atkinson, P. J. Hart, and D. A. LaPointe (2015). Avian malaria in Hawaiian forest birds: infection and population impacts across species and elevations. *Ecosphere* 6(6):104. <http://dx.doi.org/10.1890/ES14-00393.1>

17. State of Hawaii, Department of Education (n.d.). Nā Hopena A‘o (HĀ)  
<http://www.hawaiipublicschools.org/TeachingAndLearning/StudentLearning/HawaiianEducation/Pages/HA.aspx>.
18. State of Hawaii, Department of Health (n.d). Dengue Outbreak 2015–2016. Information on dengue, map of Big Island dengue sites, links to description and life cycle of *A. aegypti* and *albopictus*, current (1/29/16) FAQ sheet, dengue brochures in different languages  
<http://health.hawaii.gov/docd/dengue-outbreak-2015/>
19. State of Hawai`i, Department of Health, Vector Control Branch (2011). Mosquitoes  
[http://health.hawaii.gov/about/files/2013/06/VCB-bulletin\\_03\\_11.pdf](http://health.hawaii.gov/about/files/2013/06/VCB-bulletin_03_11.pdf)
20. State of Hawaii, Department of Health (Jan. 2016). HDOH confirms past Zika infection in baby born with microcephaly,  
<http://health.hawaii.gov/docd/>;[http://www.cdc.gov/zika/pdfs/control\\_mosquitoes\\_chikv\\_denv\\_zika.pdf](http://www.cdc.gov/zika/pdfs/control_mosquitoes_chikv_denv_zika.pdf)
21. Taking Waikiki, 1994 video <https://www.youtube.com/watch?v=vgBc4wfft84>
22. USGS. (July 17, 2015). As Climate Warms Hawaiian Forest Birds Lose More Ground to Mosquitoes. <http://www.usgs.gov/newsroom/article.asp?ID=4270#.VrnFMNCqGVY>
23. Van Dine, D. L. (1904). MOSQUITOES IN HAWAII. Retrieved from  
<http://scholarspace.manoa.hawaii.edu/bitstream/10125/25496/2/B-6.pdf>
24. World-wide dengue and Zika map (N.D.). Constantly updated. Click on red spots for media stories. <http://www.healthmap.org/dengue/en/>