Mosquito Biology and Ecology

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The Family Culicidae - Mosquitoes

- Worldwide distribution
- > 3450 species and subspecies (38 genera)
- Great habitat diversity
- Approximately 40 million years older than humans (fossils from Eocene, 38-54 mya)

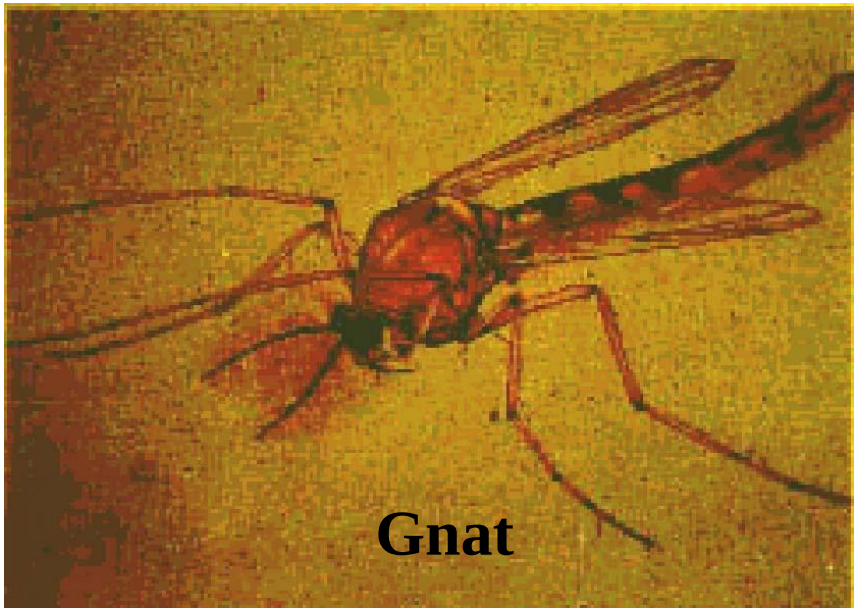
- **Anophelinae** (subfamily) **-** *Anopheles (genus)*
- **Culicinae** (subfamily) **-** *Aedes, Culex, Haemagogus, Mansonia, Ochlerotatus* and all other genera

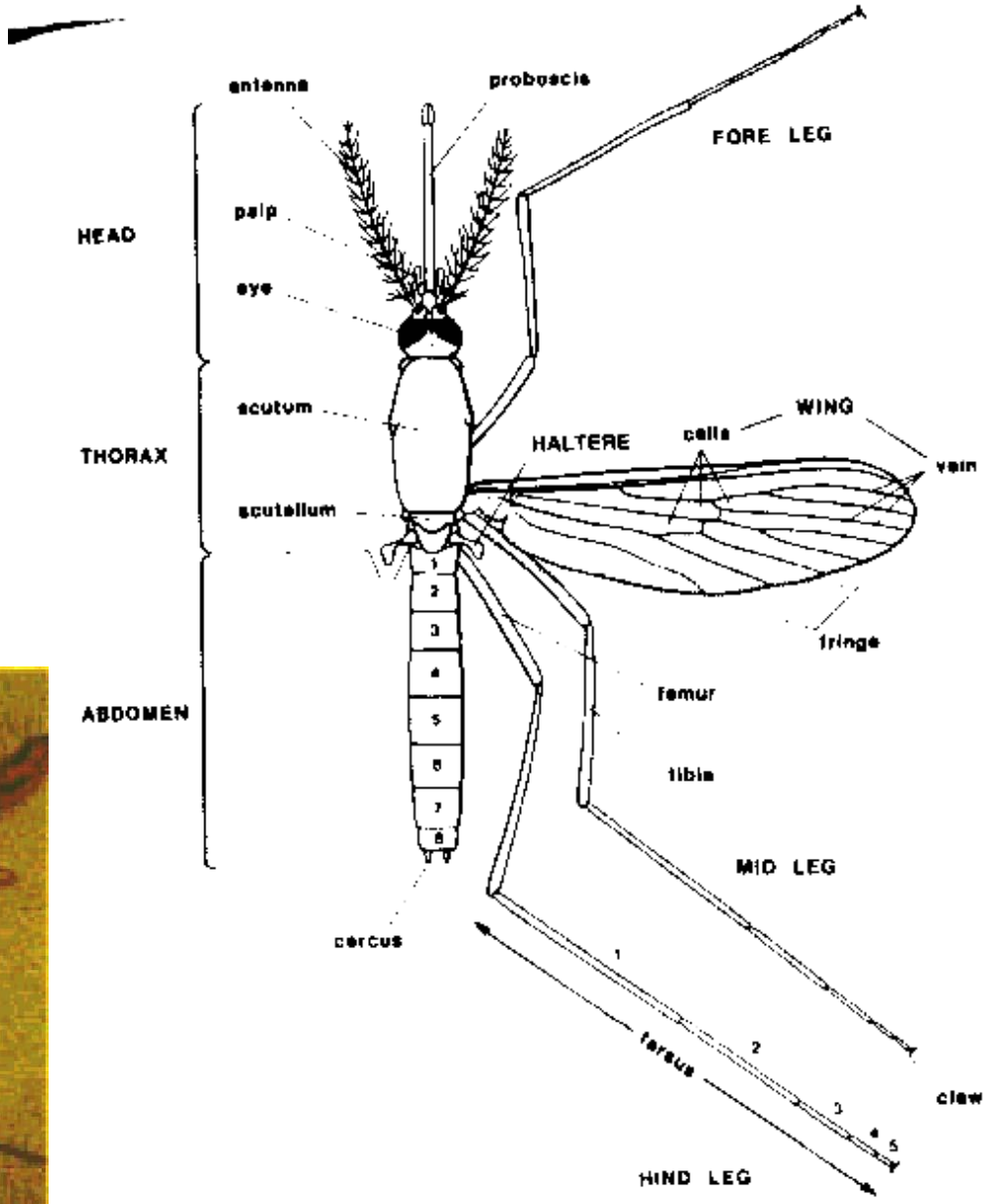
Mosquito Characteristics

- Conspicuous proboscis - forward projecting
- Scales on thorax, abdomen, legs & wing veins
- A fringe of scales along the posterior margin of the wings

Mosquito Characteristics (note conspicuous forward projecting proboscis)

Non-biting Gnat (note proboscis curved under head)





Mosquito Characteristics

- Bloodfeeding - only females take blood
- Males and females feed on plant sugars
- Gonotrophic cycle - feed, egg development, oviposition (half-gravid, gravid)
- Egg biology - oviposition location, type of egg, desiccation resistance, diapause
- Larval biology - aquatic, spiracle for breathing, filter-feeders, some cannibalistic, variable habitats

Mosquito Life Cycle

Eggs

Larva

Pupa

Adult

(1) Eggs – 3 strategies

- Singly on water surface
  - *Anopheles*
- Singly in a pile, on moist substrates
  - *Aedes/Ochlerotatus*
- Form of a raft, on water surface
  - Culex
  - Culiseta

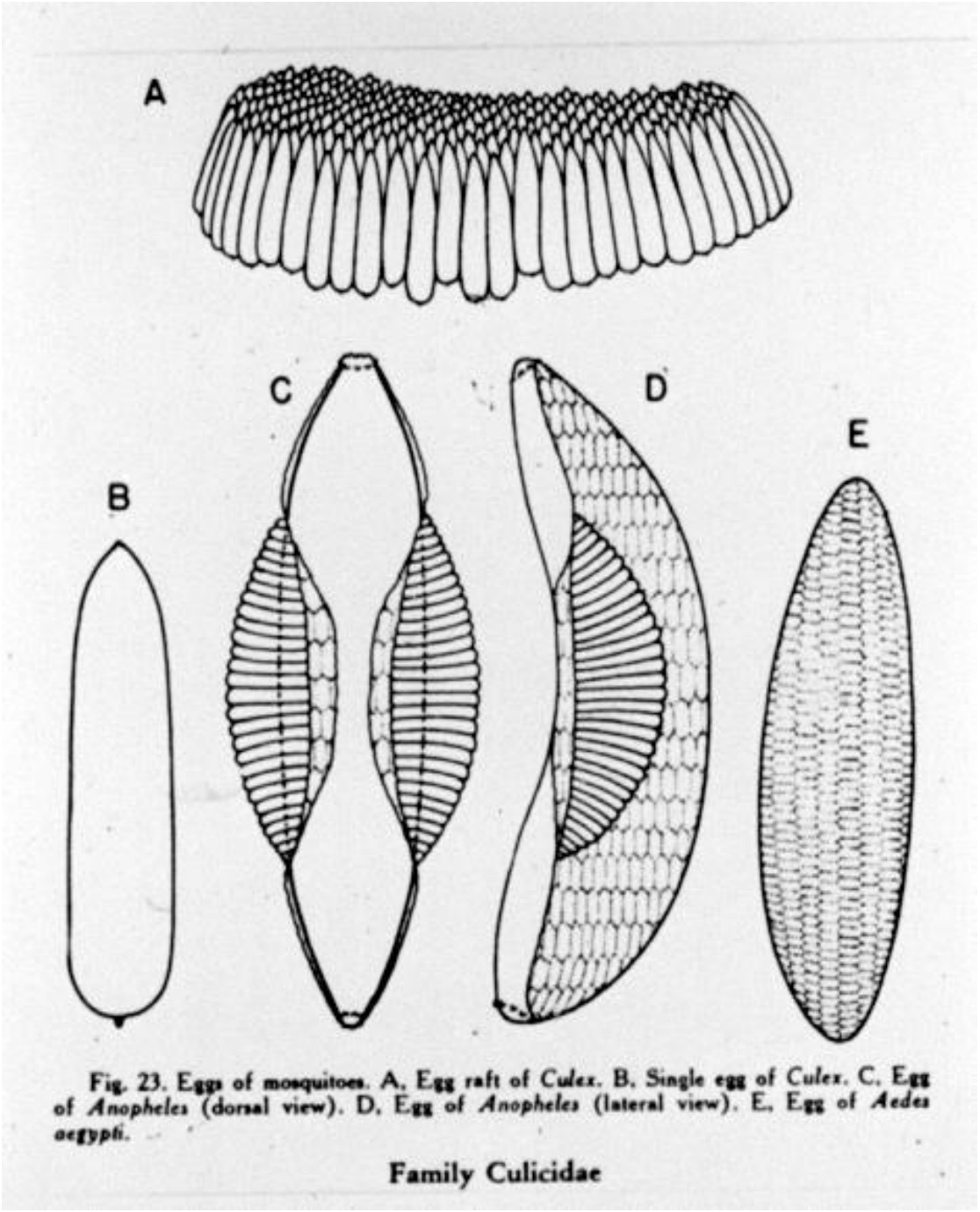


Fig. 23. Eggs of mosquitoes. A, Egg raft of *Culex*. B, Single egg of *Culex*. C, Egg of *Anopheles* (dorsal view). D, Egg of *Anopheles* (lateral view). E, Egg of *Aedes aegypti*.

Family Culicidae

Mosquito eggs:

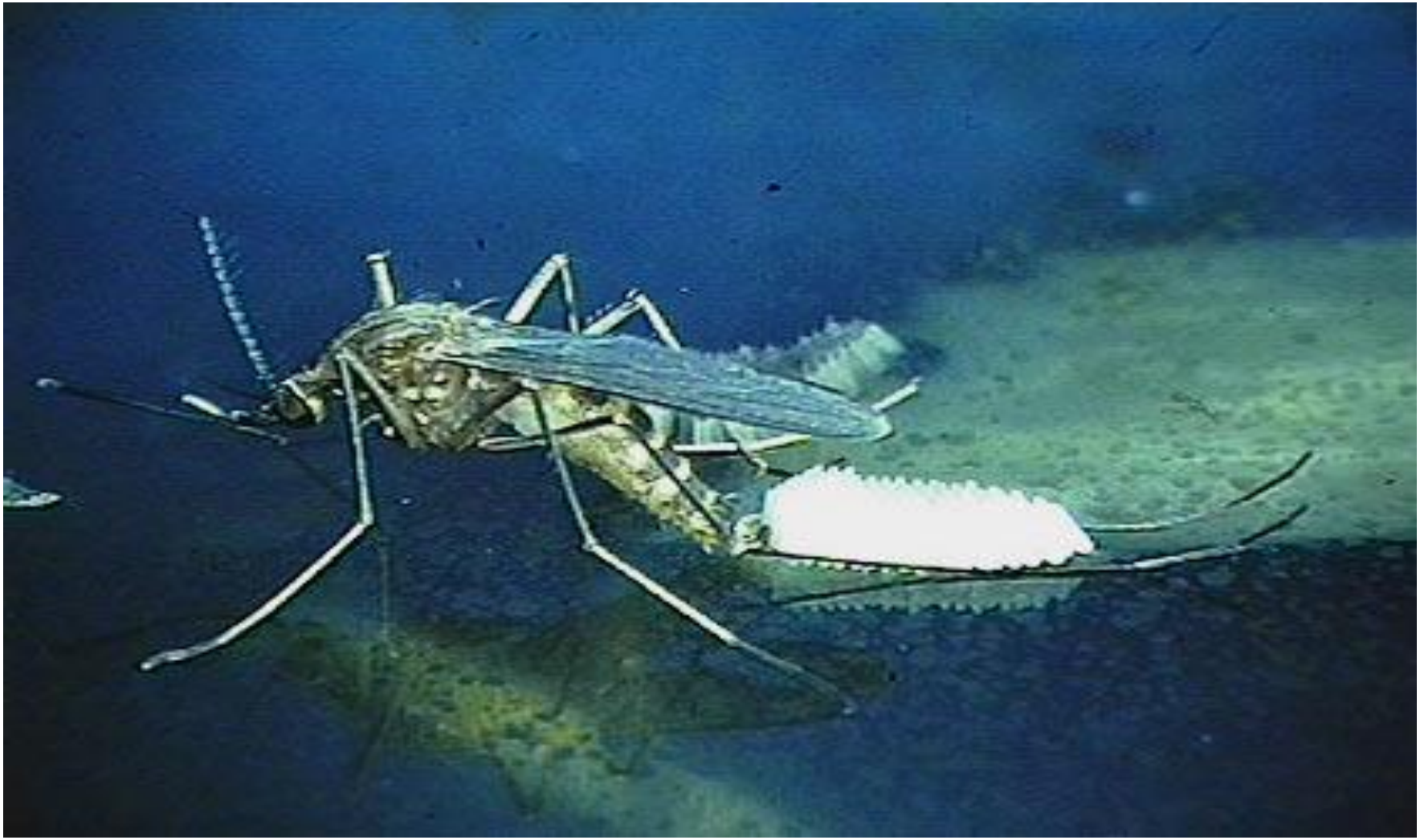
Culex egg raft

Anopheles egg with ‘floats’

Aedes egg

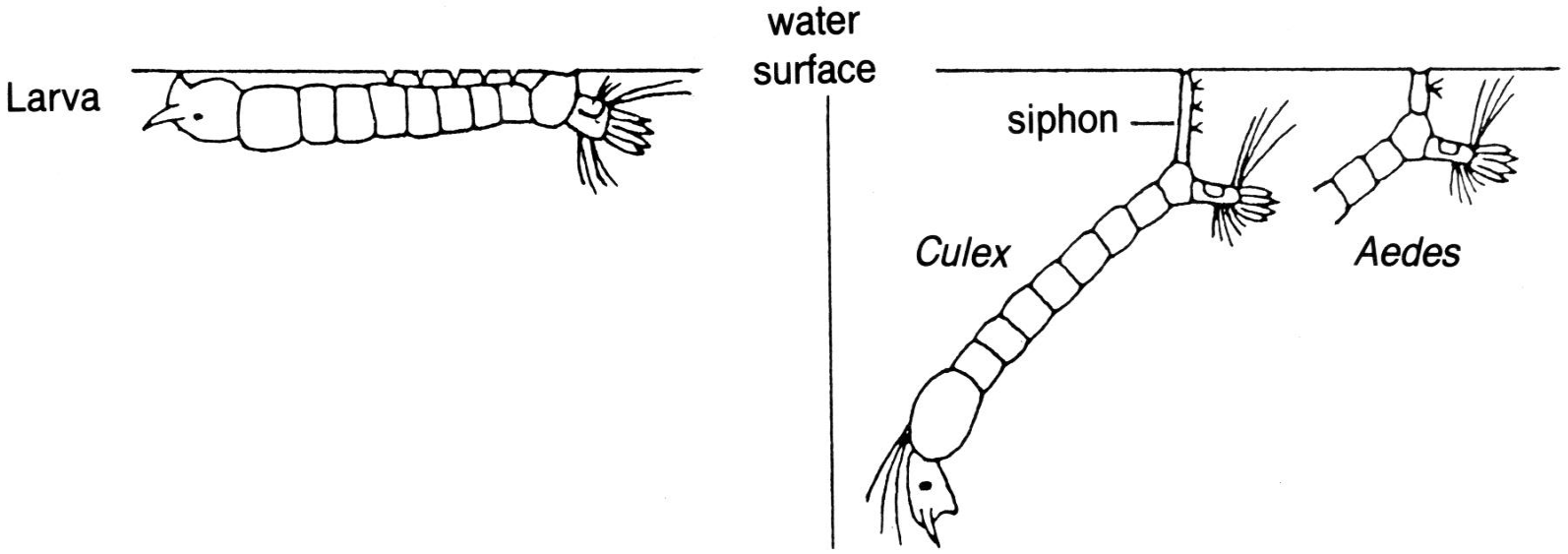
Patterns on the external egg surface are species specific

CULEX Egg Raft

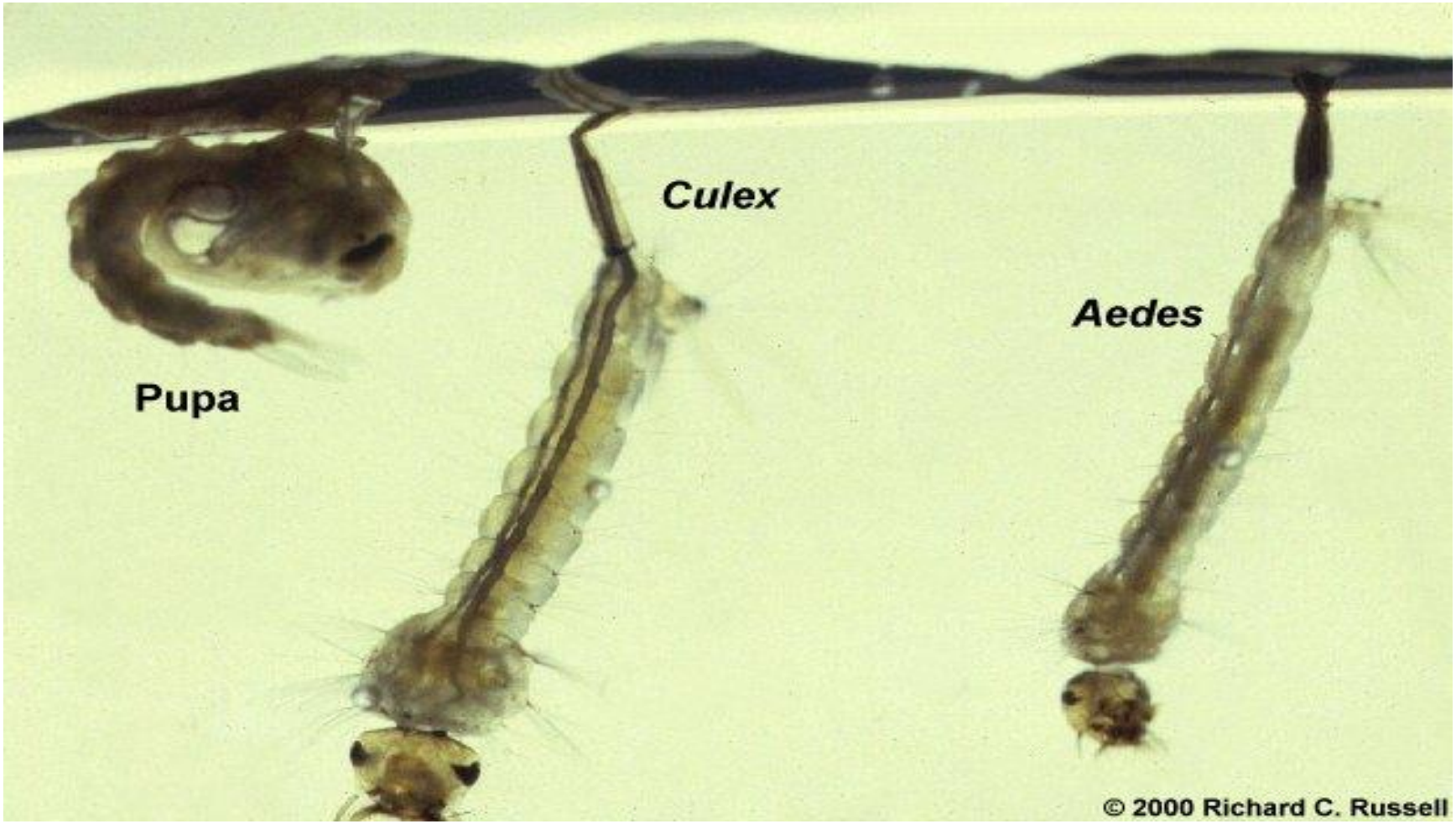


Larval Stage – Growth Stage

- Larval instars (4)
- Aquatic, Filter feeders
- Respiration



Mosquito Pupa and Larvae



Adults

- Emergence
- Mating
- Feeding

Adult Stage Comparison

Anopheline

Culicine

HABITAT


photo by Tim Deschamps

Mosquito-borne Disease Epidemiology

Haris Sohail

5/14/2024

Maine Arboviral Town Hall

Objectives

- Provide an overview of the three viruses that can be spread by mosquitoes in Maine
- Look at historical and recent arbovirus activity
- Review what the health department does to address the risks associated with mosquito-borne diseases
- Highlight guidance and services available to towns

Arboviruses (Arthropod-borne viruses)

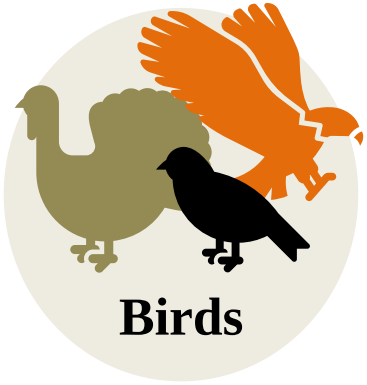
Photo Credit: US CDC and NPS

Local Mosquito-borne Arboviruses

Eastern Equine Encephalitis Virus (EEE)

Jamestown Canyon Virus (JCV)

West Nile Virus (WNV)



Icons from www.flaticon.com

Disease Transmission

Most commonly spread to people through the bite of an infected mosquito

Rarely, these viruses may also spread through:

- Blood transfusions
- Organ transplants
- Breastfeeding
- From mother to baby during pregnancy

Mild Symptoms of Arboviral Illness

Fever and Chills

Head and Body Aches

Nausea

Swollen Glands

Feeling Very Tired

Diarrhea

Icons from www.flaticon.com

Severe Symptoms of Arboviral Illness

Disorientation

Muscle Weakness

Coma

Neck Stiffness

Inflammation of the Brain

Icons from www.flaticon.com

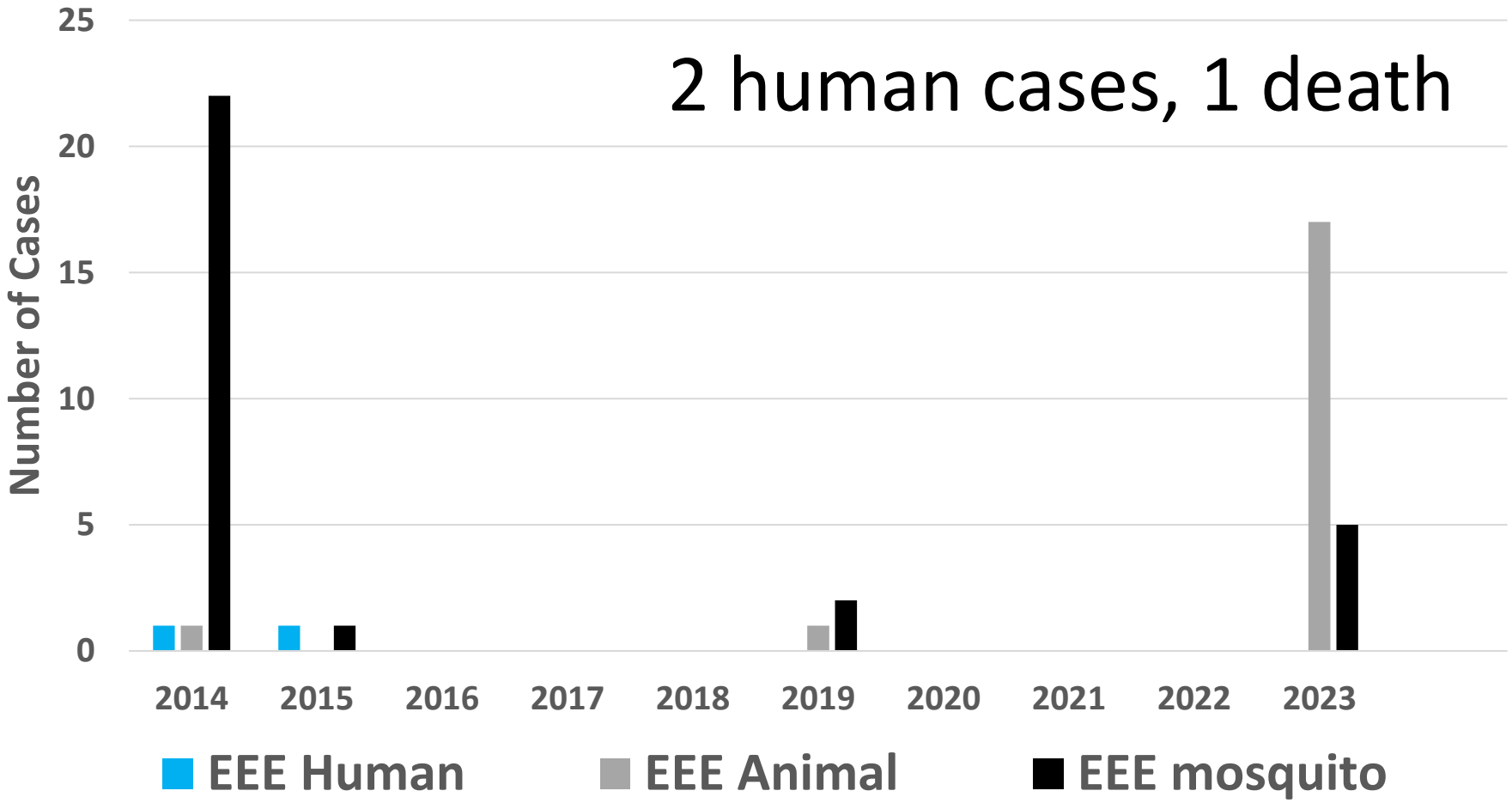
Treatment

- There is no specific treatment for these diseases, but some symptoms can be treated with over-the-counter drugs

- Severe illness usually requires supportive treatment in the hospital

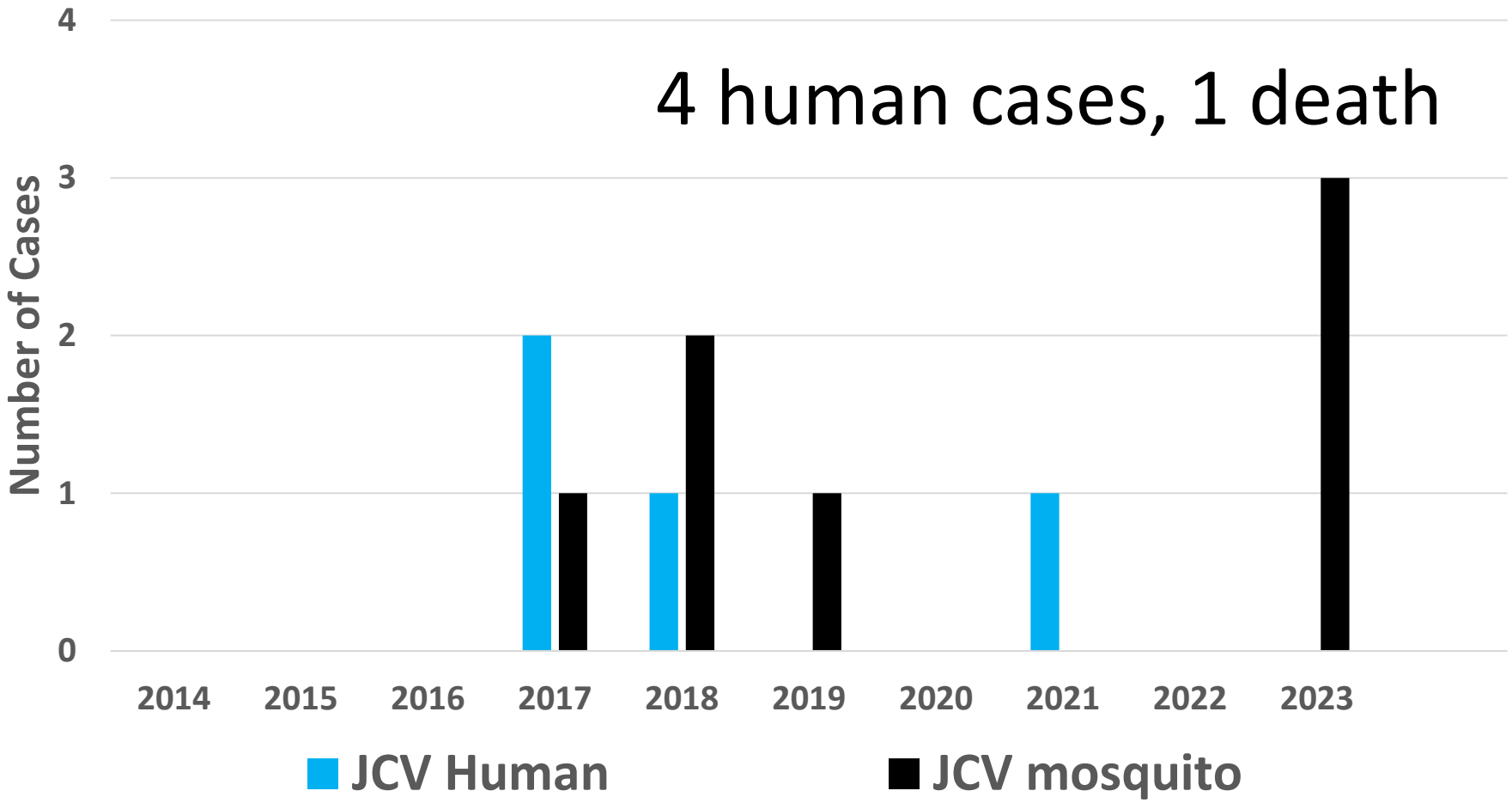
Image Credit: US CDC

Reported Human and Non-Human Cases of EEE – Maine, 2014-2023*



*data as of 3/13/2024

Reported Human and Non-Human Cases of JCV – Maine, 2014-2023*



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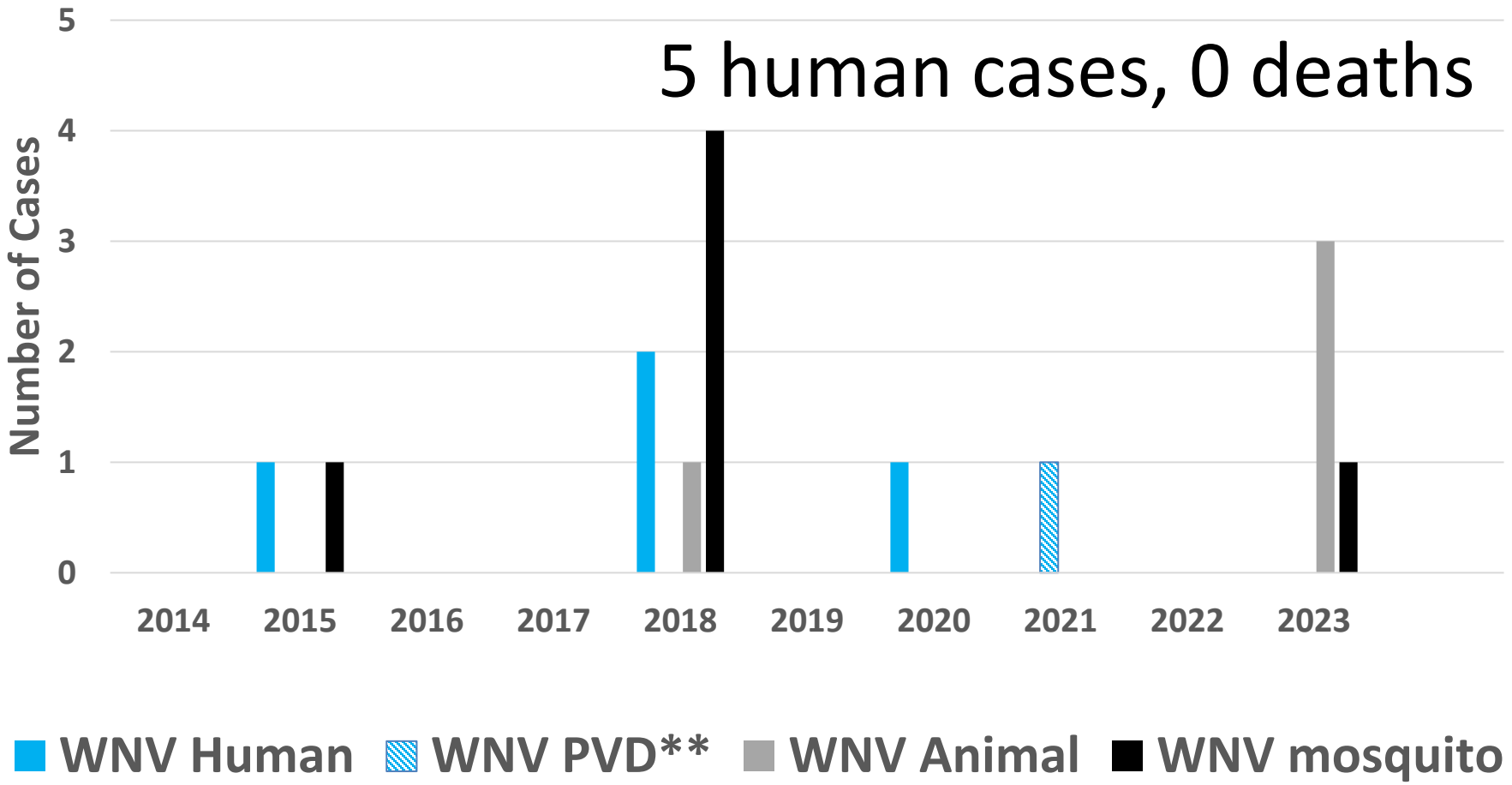
Reported Human and Non-Human Cases of WNV – Maine, 2014-2023*



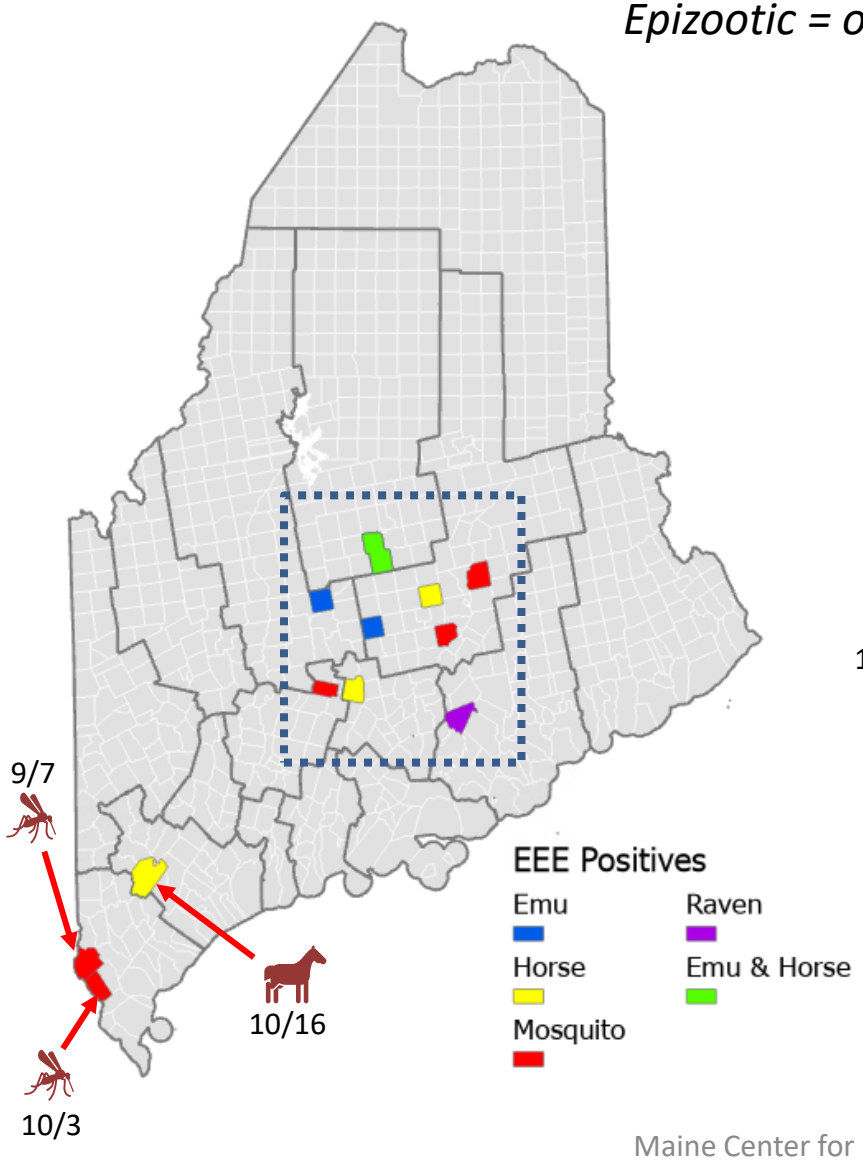
*data as of 3/13/2024

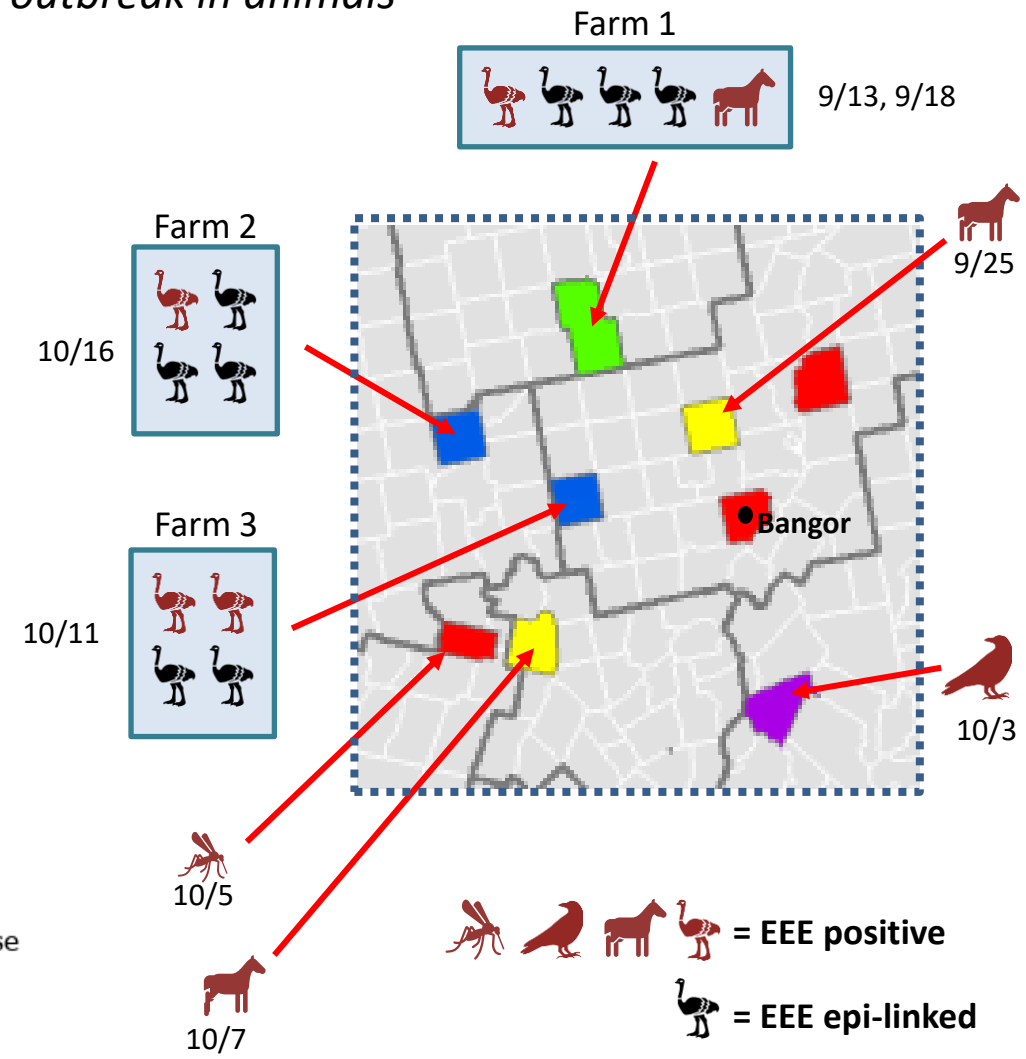
Maine Center for Disease Control and Prevention

** Presumptive Viremic Donor

EEE Epizootic in 2023

Epizootic = outbreak in animals



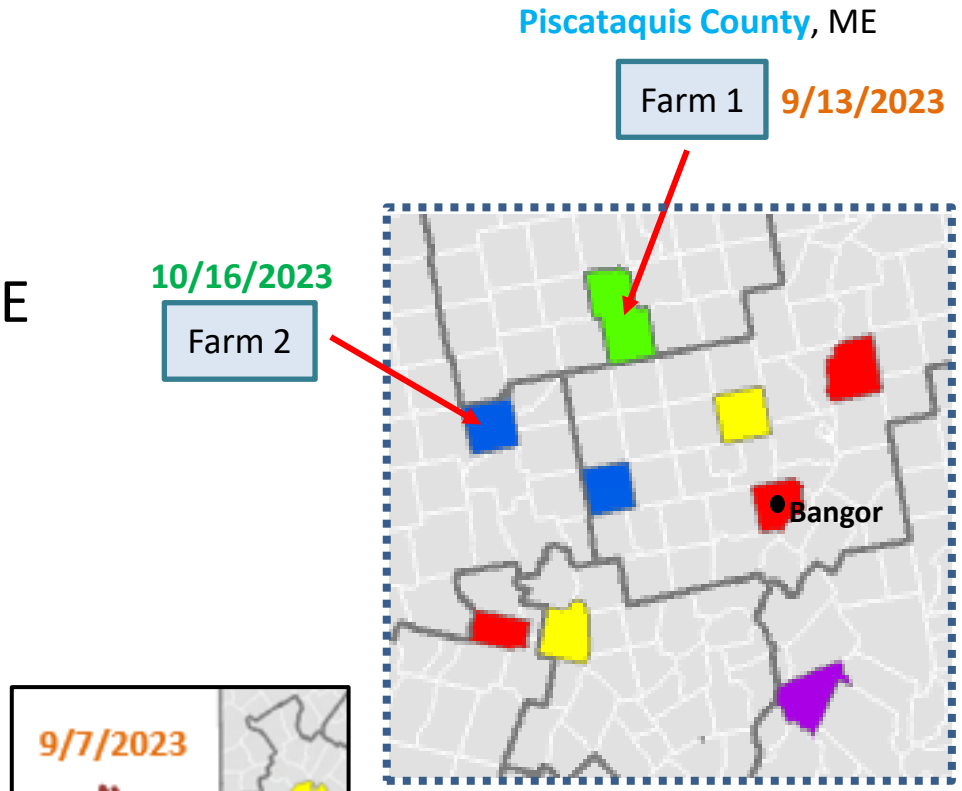


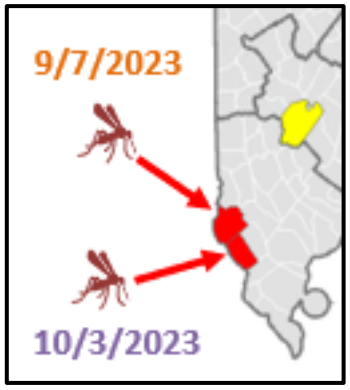
Maine Center for Disease Control and Prevention

Clipart from flaticon.com

EEE Epizootic in 2023

- Furthest **north** active EEE virus detected in Maine
- **Latest in the year** active EEE virus detected in Maine
- EEE detected in north-central Maine **one week after** virus detected in southern Maine
- Risk of local transmission can **persist** for 1+ months

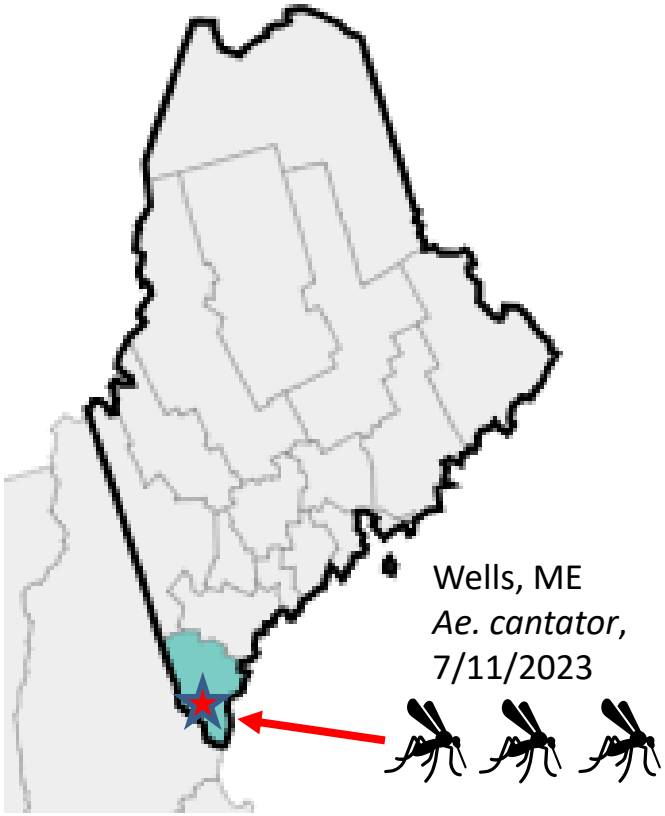




Clipart from flaticon.com

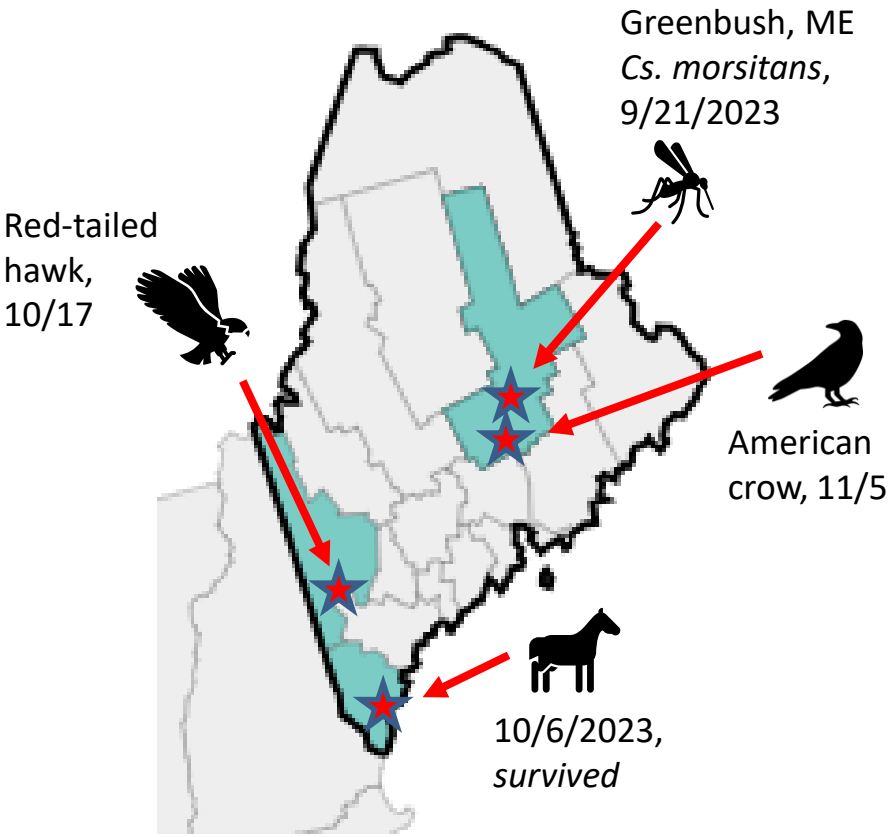
JCV & WNV Activity in 2023

Jamestown Canyon Virus



Non-human Jamestown Canyon virus (JCV) activity reported to ArboNET, by state — United States, 2023 (as of **November 18, 2023**)

West Nile Virus

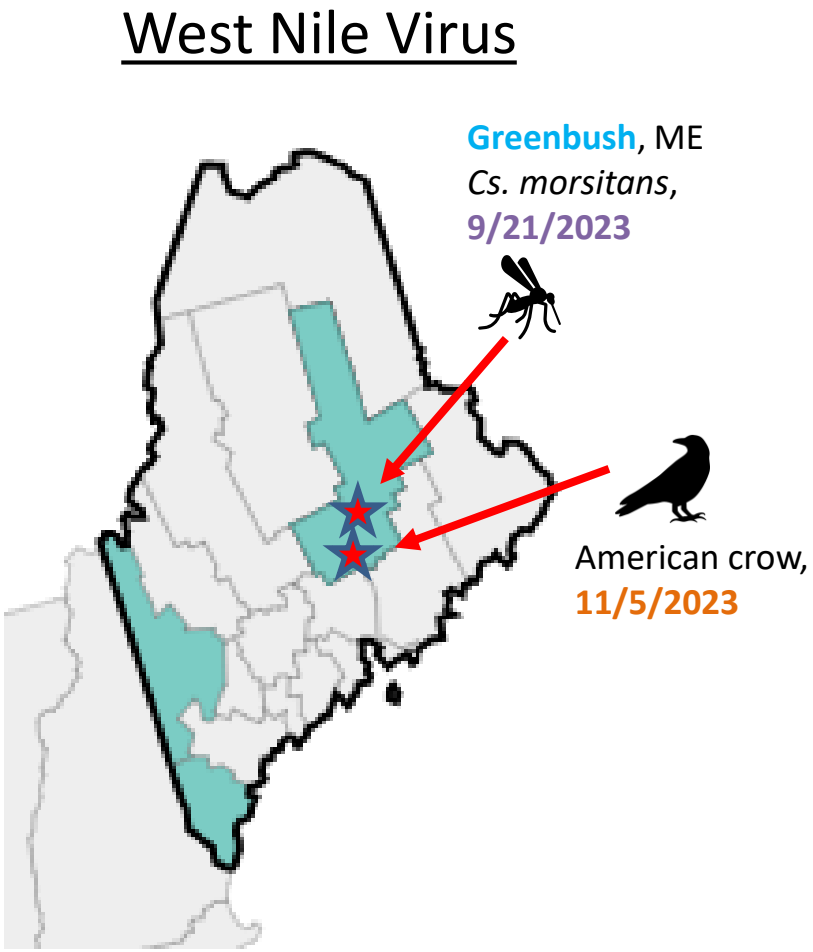


Non-human West Nile virus (WNV) activity reported to ArboNET, by state — United States, 2023 (as of **November 29, 2023**)

Clipart from flaticon.com

WNV Activity in 2023

- Furthest **north** active WNV detected in Maine
- First time active WNV detected in **November** in Maine
- Risk of local transmission can **persist** for 1+ months



Non-human West Nile virus (WNV) activity reported to ArboNET, by state — United States, 2023 (as of **November 29, 2023**)

Clipart from flaticon.com

Observations in 2023

- First year EEE, JCV, and WNV detected in local mosquitoes in a single surveillance season
- Highest number of Maine counties reporting local arboviral activity in a single season (9 out of 16 counties)

Cumberland County
Hancock County
Kennebec County
Oxford County
Penobscot County
Piscataquis County
Somerset County
Waldo County
York County

2024 Mosquito Season Outlook

- Seasonal temperature outlook: above average
- Seasonal precipitation outlook: above average

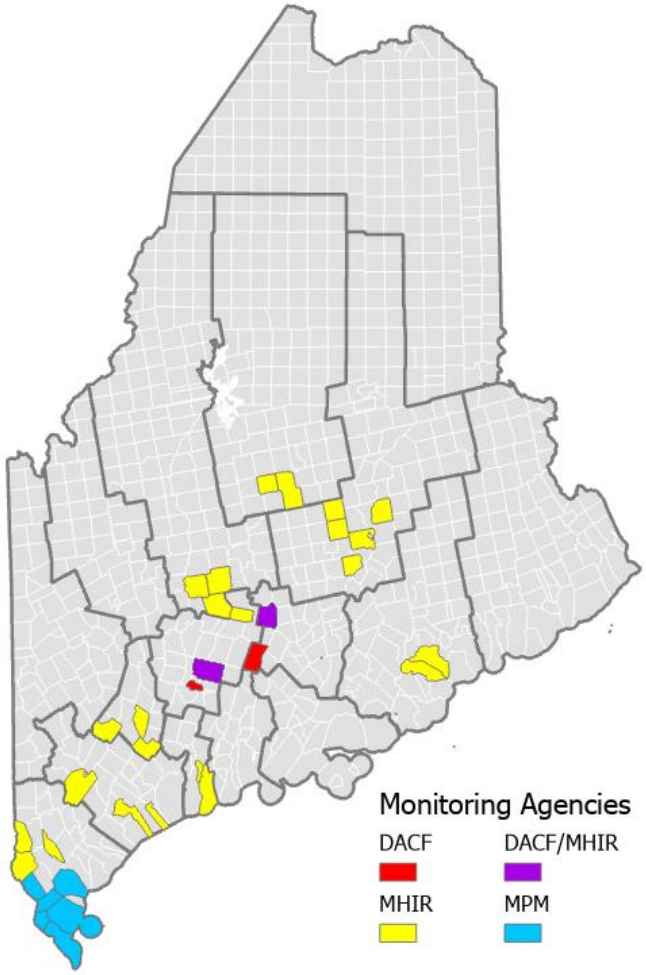
State Health Department Activities

- Mosquito surveillance
  - Routine surveillance
  - Rapid response
  - Arbovirus testing
  - Pesticide resistance monitoring
- Case and outbreak investigations
  - Humans, animals, and mosquitoes
- Consultation services
  - Healthcare providers, town officials, public
- Communications, education, and collaborations
  - Facilitate Maine Vectorborne Workgroup

Routine Mosquito Surveillance

- From May to October, mosquitoes are collected from different areas around the state and tested at the state lab
  - Early detection, early response

- In 2023, mosquitoes collected from 86 sites across 35 towns in 10 counties



Weekly Arboviral Surveillance Report

Maine Weekly Arboviral Surveillance Report

August 22, 2023

January 1, 2023 – August 19, 2023:

Local Arboviral Activity

Humans – Endemic arboviral illnesses

	Number Tested	WNV positive	EEE positive	JCV positive	POW positive
Current Week	1	0	0	0	0
2023 Year to Date	26	0	0	0	3

EEE, JCV, and WNV are endemic mosquito-borne arboviruses. POW is the only endemic arbovirus spread by ticks in Maine. Human arboviral testing performed at Maine's Health and Environmental Testing Laboratory (HETL). Testing may be performed year round. Confirmation testing performed at CDC Fort Collins

Humans – Travel-associated arboviral illnesses

	Chikungunya positive	Dengue positive	Zika positive
2023 Year to Date	0	0	0

Imported arboviral testing may be performed at HETL, CDC Fort Collins, or other national reference laboratories

Animals

	Number Tested	WNV positive	EEE Positive
Current Week	0	0	0
2023 Year to Date	0	0	0

Animal arboviral testing may be performed at HETL or through the National Veterinary Services Laboratory (NVSL); testing may be performed year round

Mosquitoes – Endemic arboviruses

	Pools Tested	WNV positive	EEE positive	JCV positive
Current Week	352	0	0	3
2023 Year to Date	460	0	0	3

Mosquito EEE and WNV testing performed at HETL; mosquito JCV testing performed at CDC Fort Collins; mosquito collection begins July 1 and continues through September 30

Only completed testing is included in this report.

EEE = Eastern Equine Encephalitis
CHIK = Chikungunya
DEN = Dengue
JCV = Jamestown Canyon Virus
POW = Powassan
SLE = Saint Louis Encephalitis
WNV = West Nile Virus
ZIK = Zika

2023 Maine positive results

Surveillance	Species	Collection Date	Town	County	Agent
Human		5/9/2023		Sagadahoc	POW
Human		6/18/2023		Kennebec	POW
Human		7/4/2023		Sagadahoc	POW

Mosquito	*Aedes cantator*	7/11/2023	Wells	York	JCV
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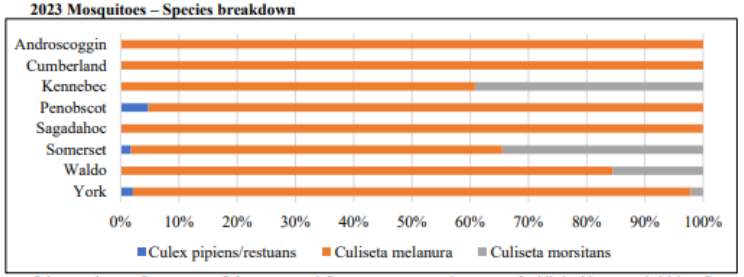
2023 Mosquitoes – Species breakdown



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National Arboviral Activity

2023 Locally-acquired human cases – United States

	Dengue positive	Zika positive*
Florida	15	0
Texas	1	0

* There is no current local transmission of Zika virus in the continental United States

International Arboviral Activity

2023 CDC travel health notices

Level	Disease	Location
2	Yellow Fever	Nigeria
1	Dengue	Bangladesh, Cambodia, Laos, Malaysia, Maldives, Myanmar, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam
1	Dengue	Côte d'Ivoire, Egypt, Mauritius, Sudan
1	Dengue	Argentina, Columbia, Cuba, Guadeloupe, Guatemala, Martinique, Nicaragua, Panama, Peru
1	Chikungunya	Paraguay

More information on travel health notices is available here: https://wwwnc.cdc.gov/travel/notices.

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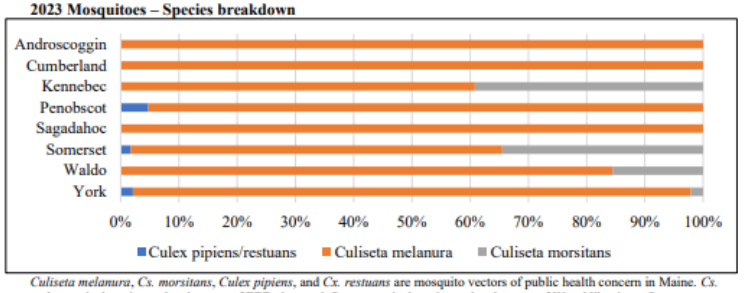

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1	Chikungunya	Paraguay

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2

Rapid Response Surveillance

When a person, animal, or mosquito tests positive for an arbovirus in Maine, the state may deploy rapid response surveillance

- Notify city and town officials of the positive result
- Conduct site visits, as appropriate
- Conduct additional mosquito surveillance around or at the location with positive arboviral activity
- Coordinate training and lend expertise to local health officials

State Mosquito Testing Services

- The state public health lab tests mosquitoes for
  - EEE and WNV from July to October
  - JCV from May to October
- Any local municipality can submit mosquito specimens to HETL for arboviral testing (free of charge)
- Municipalities are responsible for trapping, collecting, identifying, and submitting mosquitoes
- Those interested in this service can contact Maine CDC

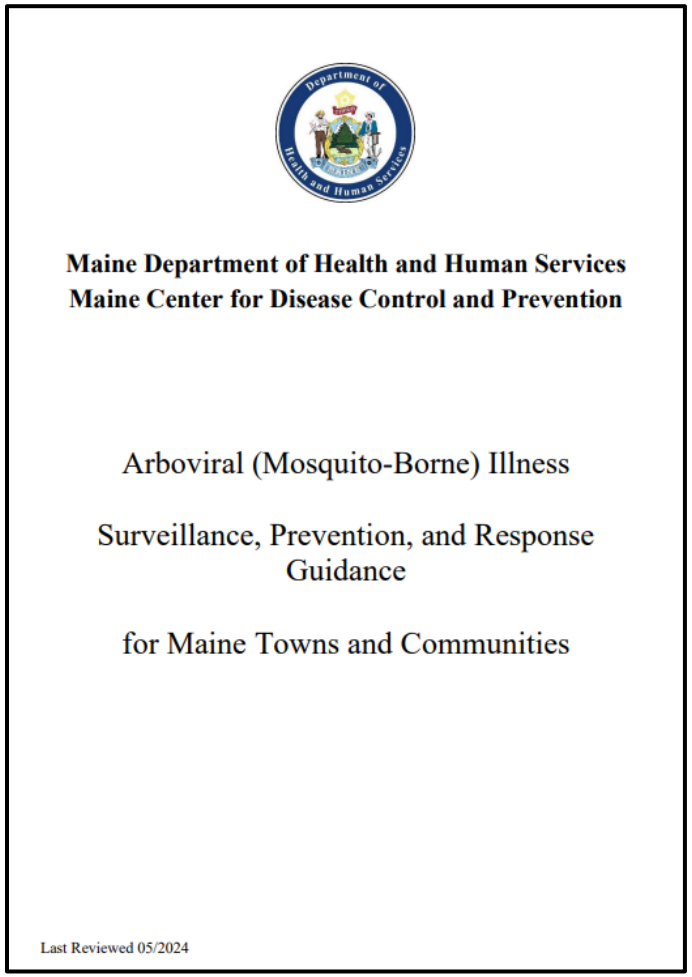
Public Health Threat or Emergency

- An Arboviral Public Health Threat or Emergency may be declared if certain conditions exist and if recommended by the arboviral emergency panel
  - A declaration may allow local jurisdictions the option to rapidly receive permits, help provide IPM authority, and implement other interventions

- Any local, county, or state official may request consideration of an arboviral public health threat or emergency

- Requests should be made to Maine CDC

Guidance for Maine Communities



Maine Department of Health and Human Services
Maine Center for Disease Control and Prevention

Arboviral (Mosquito-Borne) Illness

Surveillance, Prevention, and Response Guidance

for Maine Towns and Communities

Last Reviewed 05/2024

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Summary

- Mosquitoes can spread three viruses in Maine: EEE, JCV, and WNV
  - Most infections are mild, but some people can get very sick and die
- Although Maine reports little arboviral activity most years, local outbreaks occur every few years; viruses are being found further north and later in the season
  - 2023 was a bad year for mosquito-borne diseases in Maine
  - 2024 is predicted to be another bad year
- The state conducts different activities to address the risk from mosquito-borne diseases, including surveillance and testing
  - Refer to the Weekly Arboviral Report to assess the risk in your area
- Municipalities interested in developing a mosquito management program, using state mosquito testing services, or declaring an arboviral threat or emergency should contact Maine CDC

Contact Information

Haris Sohail, MS, MPH
Vectorborne & Zoonotic Epidemiologist
haris.sohail@maine.gov

Testing Service or Emergency Declaration Requests:
disease.reporting@maine.gov
1-800-821-5821

Resources for Municipalities:
www.maine.gov/dhhs/vectorborne
(data, education, and resources)

Maine Department of Agriculture, Conservation, and Forestry
Animal Health
Arboviral Town Hall

Dr. Rachael Fiske

Amanda E. Beal
Commissioner

Randy Charette
Deputy Commissioner

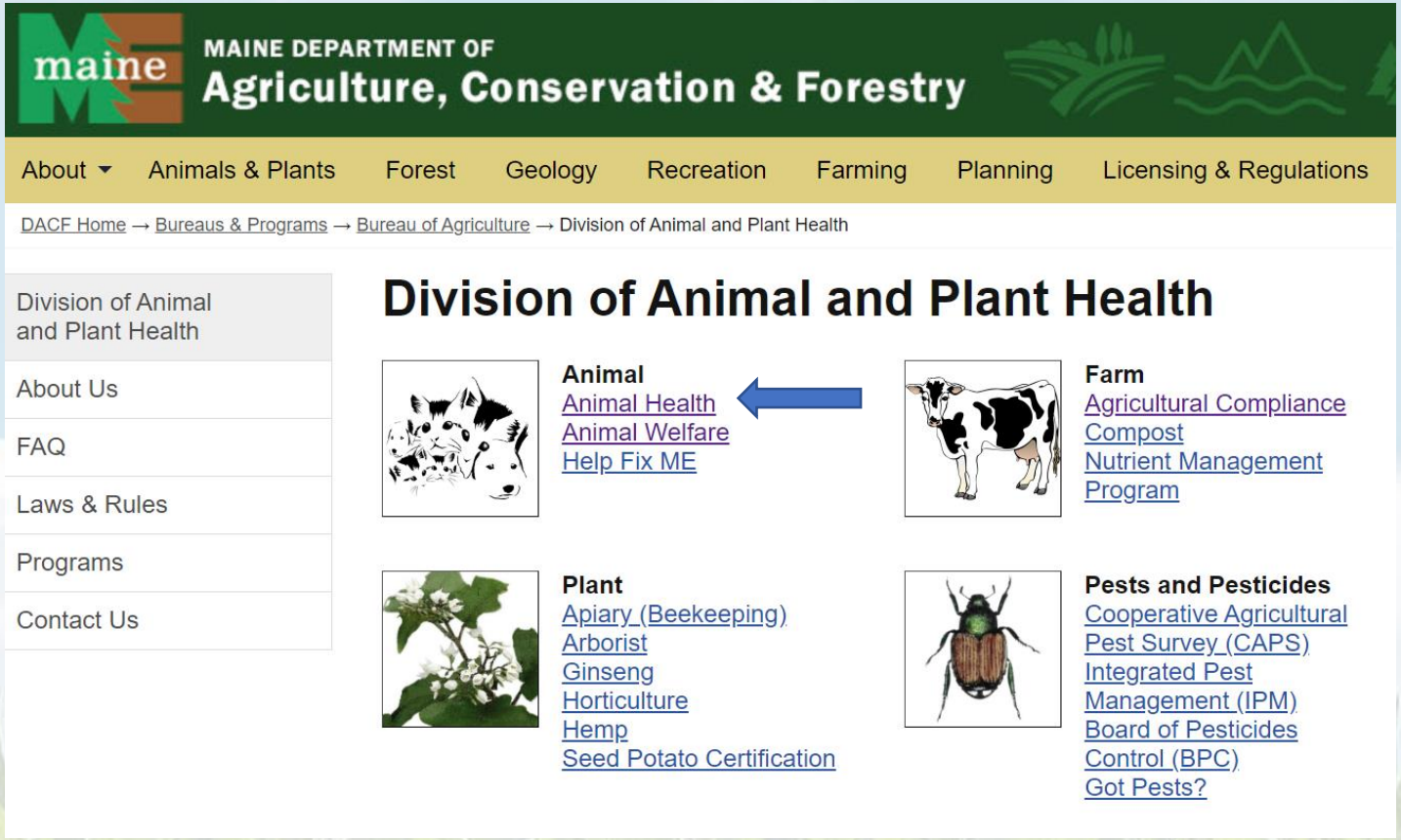
Nancy McBrady
Deputy Commissioner

18 Elkins Lane
Augusta, ME 04333

(207) 287-3200
www.maine.gov/dacf

How to find us

https://www.maine.gov/dacf/php/index.shtml



Animal Health & VBD

- ME DACF AH works with veterinarians
- Testing support for vets and their clients
- EEE, WEE, WNV in horses is reportable immediately
- Report of suspected or confirmed arboviral disease in any livestock species is appreciated
- Mosquito positives and animal cases can drive human health actions

Maine Reportable Diseases

Toxic Substance Exposure that may threaten animal health, human health or food safety

Any unexplained increase in dead or diseased animals

All exotic or eradicated diseases

To report a disease go to – http://www.maine.gov/agriculture/ahi/diseases/diseasereporting.html

Bovine

Immediate Reporting
Bluetongue
Bovine Spongiform Encephalopathy
Brucellosis
Malignant Catarrhal Fever
Tuberculosis
Any Vesicular Disease

Monthly Reporting
Anaplasmosis
Johne's Disease
Trichomoniasis

Equine

Immediate Reporting
Contagious Equine Metritis
Eastern/Western Equine Encephalitis
Equine Herpes Myeloencephaliti
Equine Infectious Anemia
Equine Piroplasmosis
Equine Viral Arteritis
Vesicular Stomatitis
West Nile Virus

Monthly Reporting
Equine Protozoal Myeloencephalitis
Potomac Horse Fever
Strangles

Porcine

Immediate Reporting
Brucellosis
Pseudorabies
Swine Influenza
Trichinellosis
Tuberculosis
Any Vesicular Disease

Monthly Reporting
Porcine Reproductive and Respiratory Syndrome

Caprine/Ovine

Immediate Reporting
Bluetongue
Brucellosis
Contagious Ecthyma
Scrapie
Tuberculosis
Any Vesicular Disease

Monthly Reporting
Johne's Disease
Toxoplasmosis

Poultry

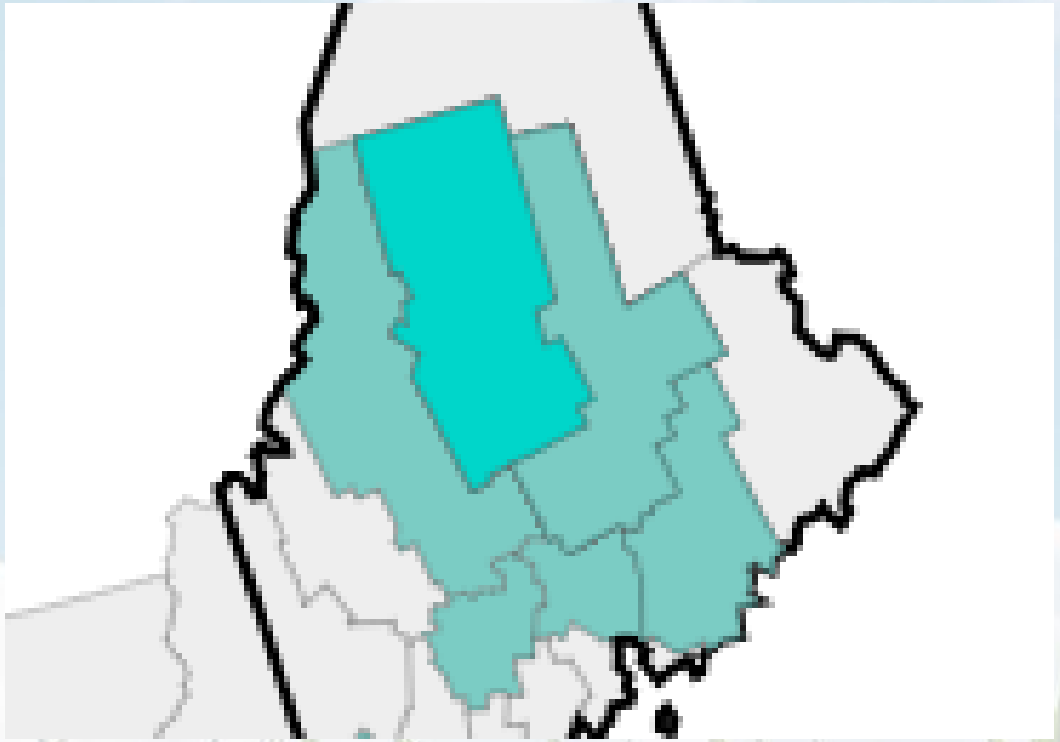
Immediate Reporting
Avian Chlamydiosis
Avian Influenza
Avian Pox
Exotic Newcastle Disease
Pullorum Disease/Fowl Typhoid
Salmonella Enteritidis

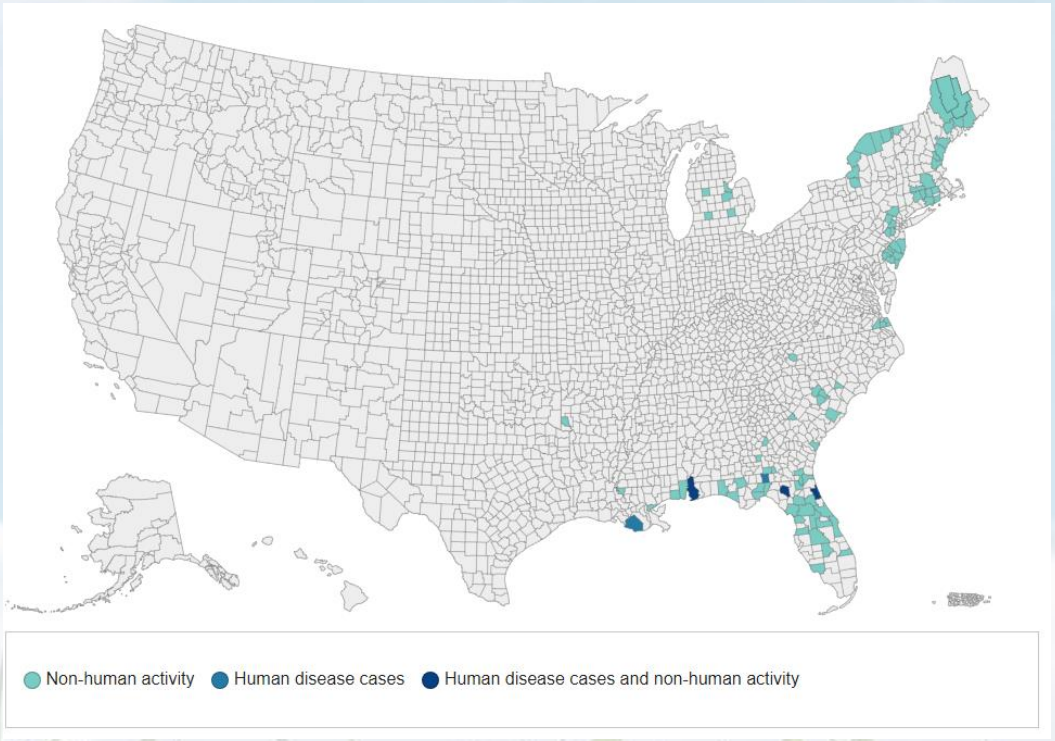
Monthly Reporting
Duck Plague
Erysipelas
Fowl Cholera
Infectious Coryza
Infectious Laryngotracheitis
Mycoplasma Gallisepticum/Synoviae-MG/MS
Other Salmonellosis

Multiple Species

Immediate Reporting
Anthrax
H1N1 Influenza in any species
Leptospirosis
Plague
Q Fever
Rabies
Tularemia

Monthly Reporting
Canine Influenza
Salmonellosis





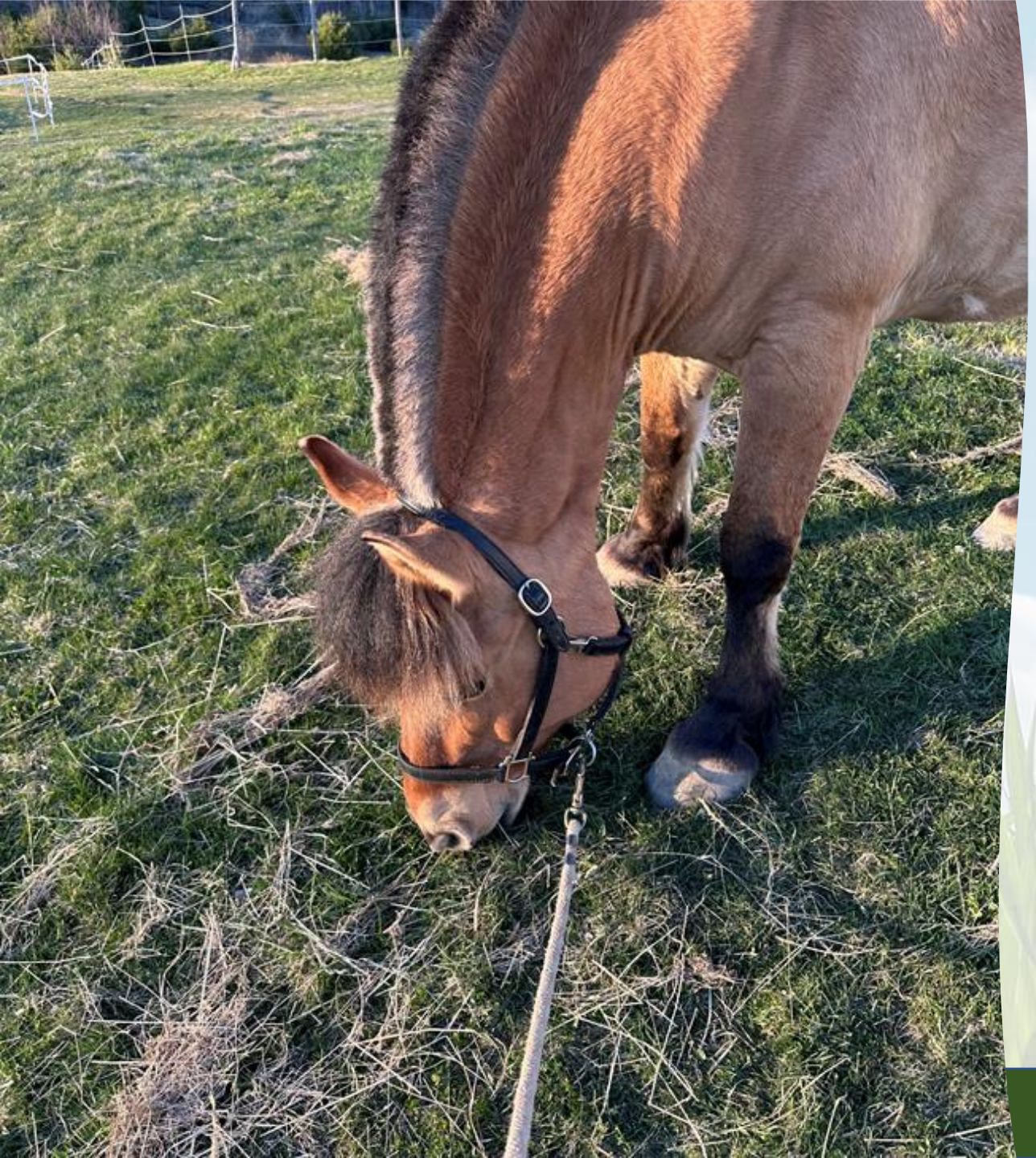
Eastern equine encephalitis virus non-human activity by county of residence, 2023*

Arboviral Trends in Livestock in Maine

Ratites (emus and ostriches) and game birds like pheasants, are susceptible to mosquito-borne diseases (MBDs). Equines and camelids are also at risk for MBDs.

	2023	2022	2021	2020	2019	2018
EEE, Animal	16	0	0	0	1	0
WNV, Animal	1	0	0	0	0	1

Total Arboviral Surveillance, Maine, 2023		
	Emus	Horses
EEE+	4	4
EEE epi-linked	8	0
JCV+	0	0
POW+	0	0
WNV+	0	1



Precautions to Help Protect Livestock Animals

- Environmental modifications to eliminate mosquito pools
- Vaccinate horses and utilize a booster dose if >6 months since the previous vaccine
- Work with your veterinarian to discuss off-label vaccination of camelids and susceptible birds (e.g., emus)

Know the Signs of Mosquito-borne Disease in Animals

- Animals with arboviral infection (EEE, WNV, others) may experience neurological or musculoskeletal signs: staggering, incoordination, weakness, fever or sudden death
- Contact your veterinarian and reach out to DACF Animal Health office

AnimalHealth.AGR@maine.gov

207-287-3701

Fight the Bite!

Educational Resources for Mosquito-Borne Disease Prevention

Megan Porter, DVM

Health Educator

Maine CDC Arboviral Town Hall Meeting

Mosquito Bite Prevention - Before

- **Avoid outdoor activity during high mosquito activity**
  - Mosquitoes in Maine are most active during dawn and dusk
- **Wear protective clothing**
  - Long sleeves and pants
  - Close-toed shoes
- **Treat clothes with permethrin**
  - Not for use on skin

Maine Center for Disease Control and Prevention

Image Credit: US CDC

Mosquito Bite Prevention: EPA-Approved Repellents

EPA-approved repellents:

- DEET
- Picaridin
- IR3535 (Ethyl butylacetylaminopropionate)
- Oil of Lemon Eucalyptus
- Permethrin

What does EPA-approved mean?

- The active ingredient works against mosquitoes
- The active ingredient is safe when used correctly

Maine Center for Disease Control and Prevention

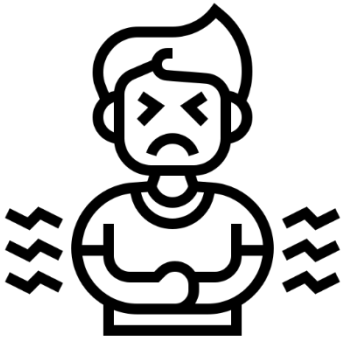
Photo Credit: Maine CDC

Symptoms of Arboviral Illness

Symptoms range from mild to severe – mild symptoms

Fever and Chills

Head and Body Aches



Nausea

Swollen Glands

Feeling Very Tired

Diarrhea

Icons from www.flaticon.com

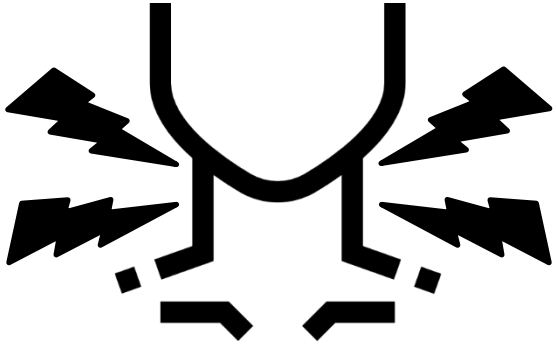
Symptoms of Arboviral Illness

Symptoms range from mild to severe – severe symptoms

Disorientation

Muscle Weakness

Coma



Neck Stiffness

Inflammation of the Brain

Icons from www.flaticon.com

What if I start to feel sick?

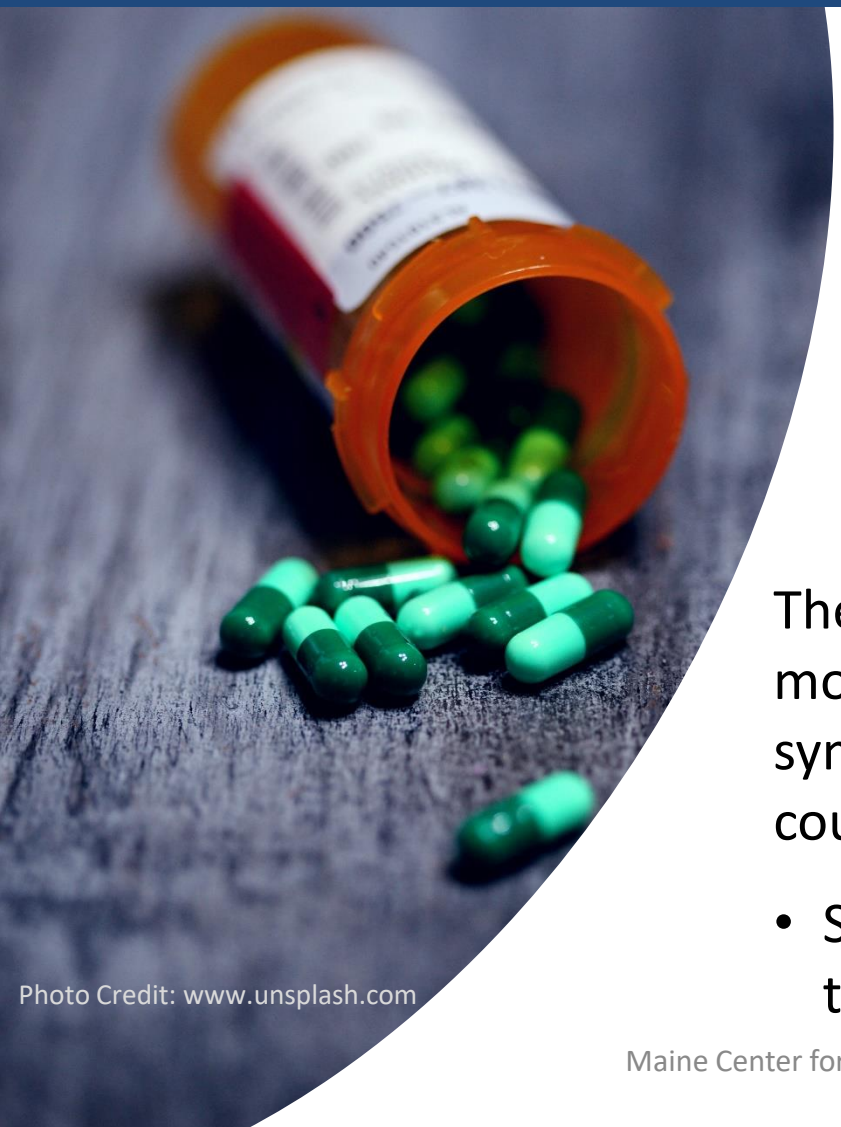


Photo Credit: www.unsplash.com

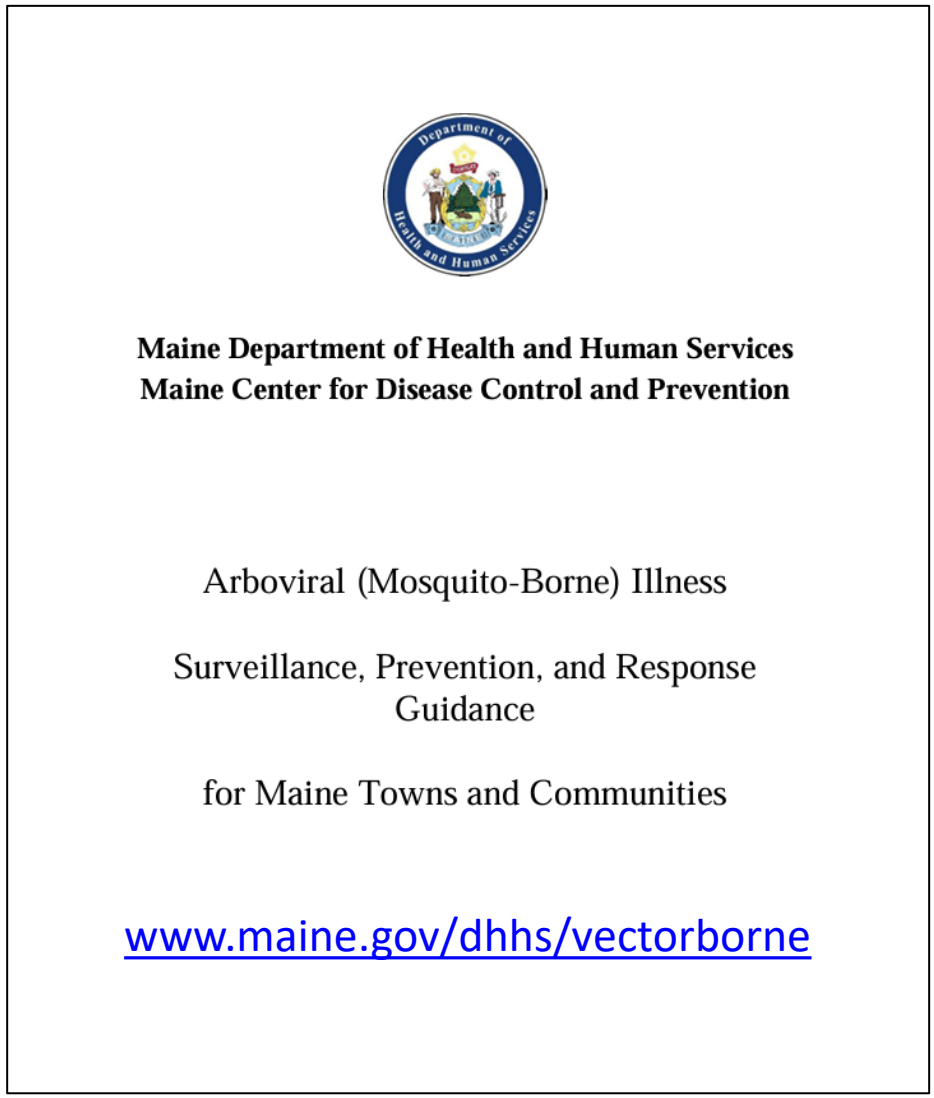
Talk to a health care provider if you feel flu-like symptoms and mention recent mosquito bites

Health care providers usually take samples of blood and cerebrospinal fluid to test for these viruses

There is no specific treatment for most mosquito-borne diseases in Maine, but some symptoms can be treated with over-the-counter drugs

- Severe illness usually requires supportive treatment in the hospital

Available Resources – For the Town



Maine Department of Health and Human Services
Maine Center for Disease Control and Prevention

Arboviral (Mosquito-Borne) Illness

Surveillance, Prevention, and Response Guidance

for Maine Towns and Communities

www.maine.gov/dhhs/vectorborne

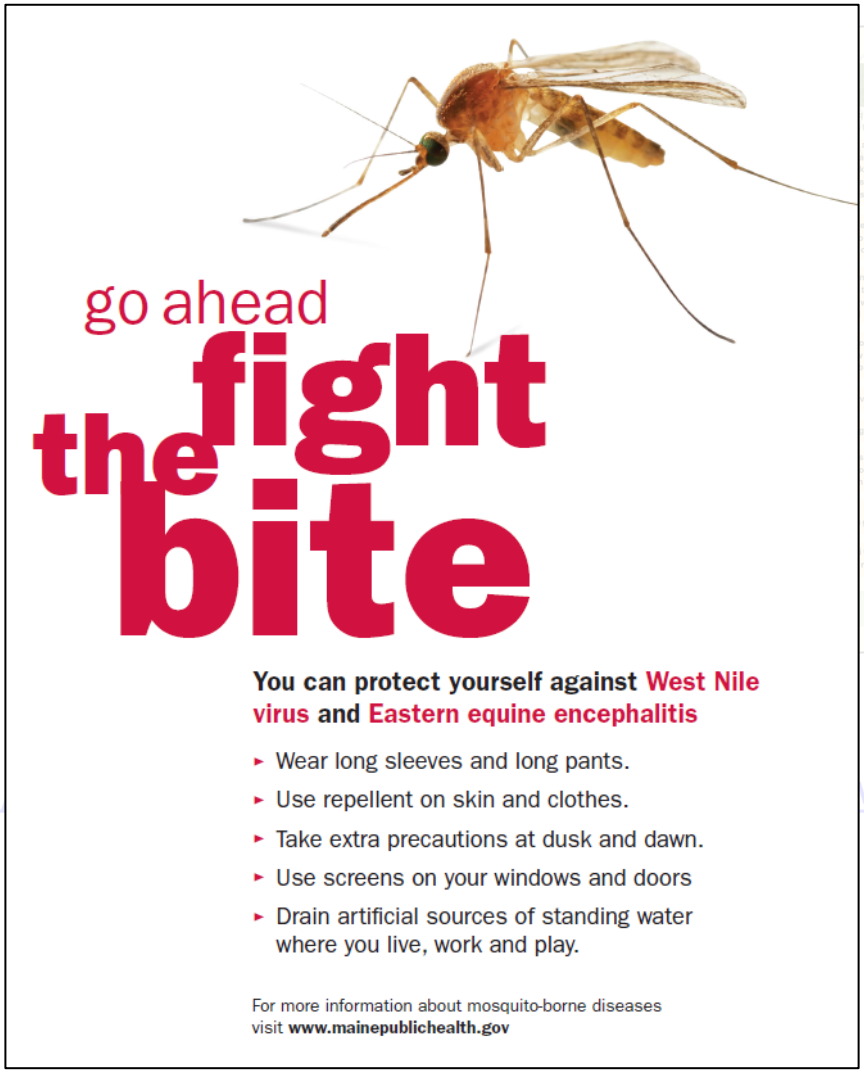
Available Resources – Print and Digital

Posters
www.maine.gov/dhhs/order

Fact Sheets
www.maine.gov/dhhs/vectorborne

Checklists
www.maine.gov/dhhs/vectorborne

Available Resources – Print and Digital



Posters
www.maine.gov/dhhs

Checklists
vw.maine.gov/dhhs/vectorborne

Available Resources – Print and Digital

Posters

www.maine.gov/dhhs/or

Eastern Equine Encephalitis (EEE)

Fact Sheet

Eastern Equine Encephalitis (EEE) is a rare but serious disease that spreads through the bite of an infected mosquito.

Anyone can get EEE, but people who spend time outdoors are at the highest risk. EEE can also infect horses, birds, and other animals.

Signs and Symptoms

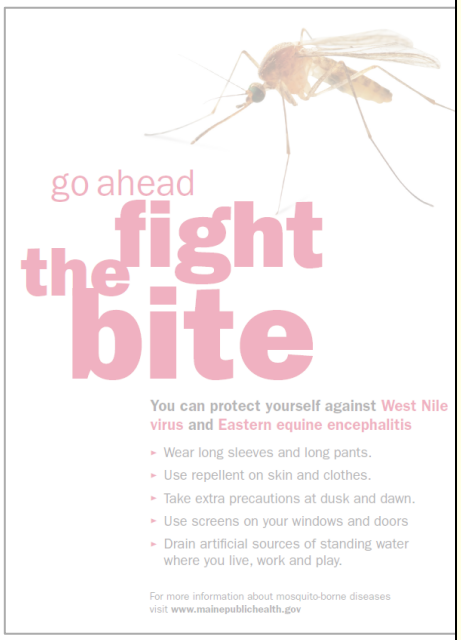
Signs and symptoms usually start four to ten days after being bitten by an infected mosquito and last one to two weeks. It is possible that some people infected with EEE will not show any signs of illness. Mild signs and symptoms include fever and chills, weakness, and body and muscle pain.

EEE can cause swelling of the brain and can lead to more severe illness. Signs and symptoms of severe illness include fever, headache, neck stiffness, confusion, seizures, and coma. About a third of people with EEE die. People over the age of 50 and under the age of 15 are at greatest risk for severe illness.

Checklists

www.maine.gov/dhhs/vectorborne

Available Resources – Print and Digital



Posters

www.maine.gov/dhhs/o

Checklists

ww.maine.gov/dhhs/vectorborne

Available Resources – Print and Digital

Maine CDC YouTube Channel

https://www.youtube.com/@MainePublicHealth

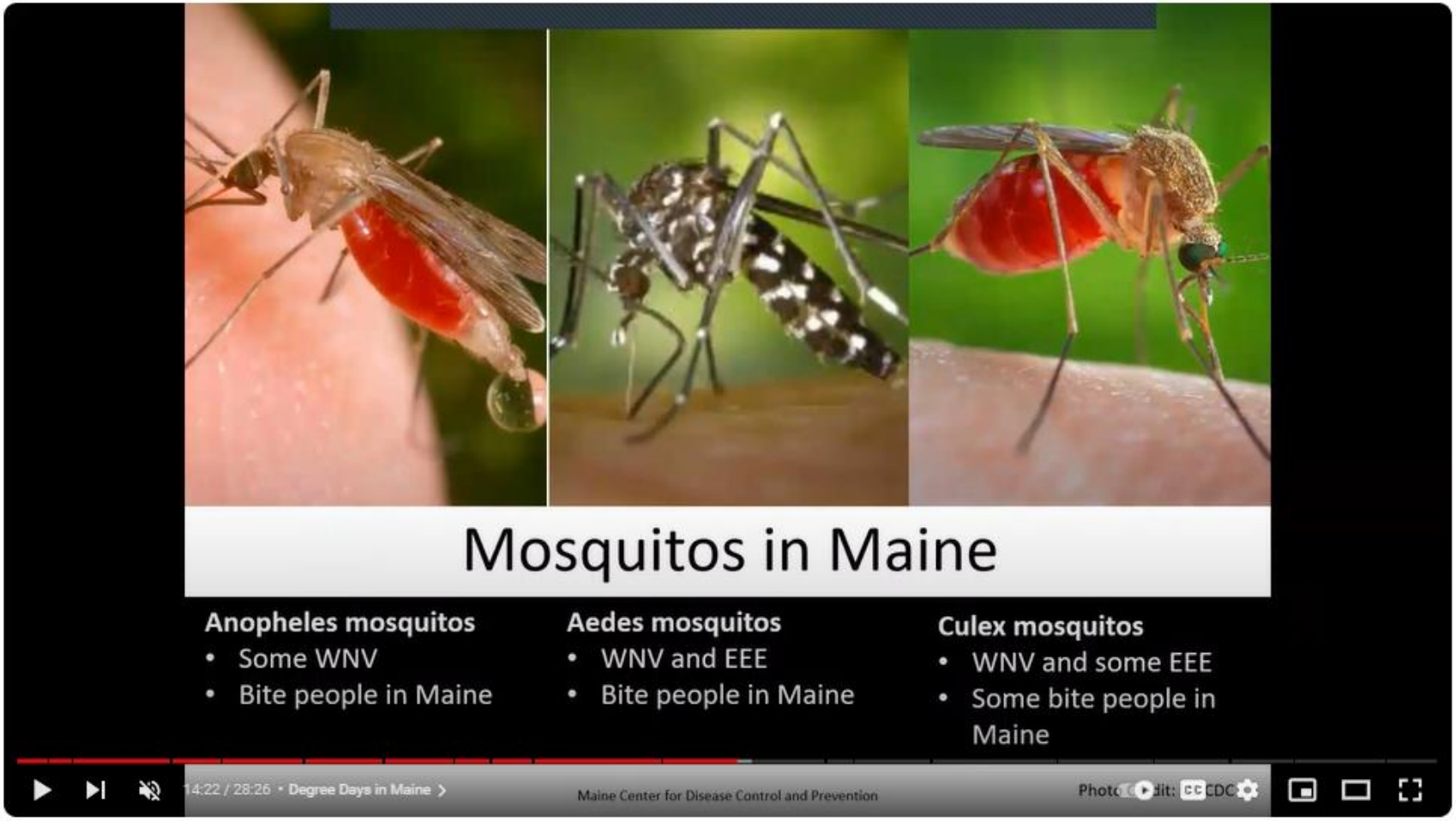
Mosquito and Tick School Curriculum

www.maine.gov/dhhs/schoolcurricula

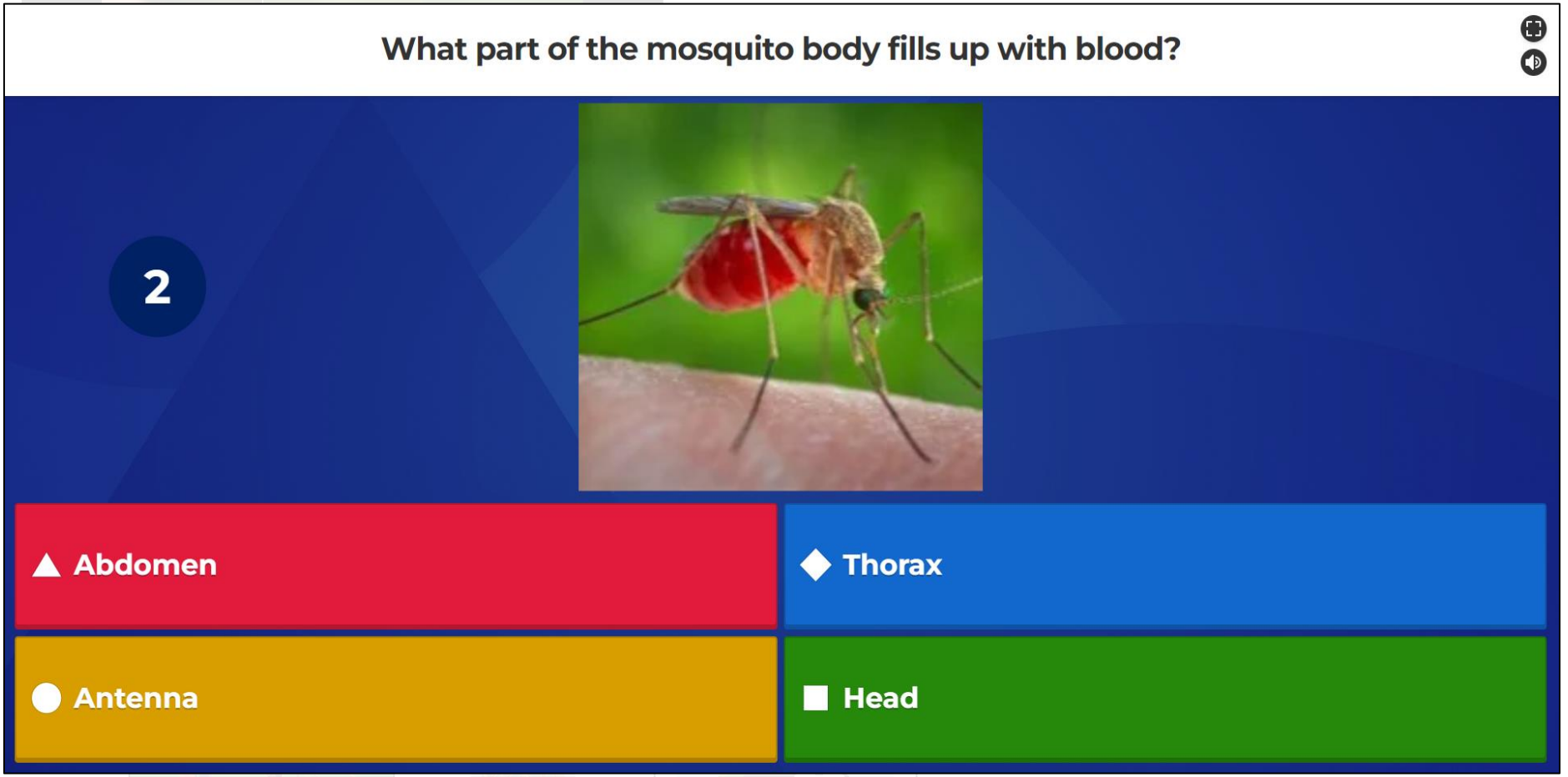
Vectorborne Disease Youth Workbook

www.maine.gov/dhhs/schoolcurricula

Available Resources – Print and Digital



Available Resources – Print and Digital



Available Resources – Print and Digital

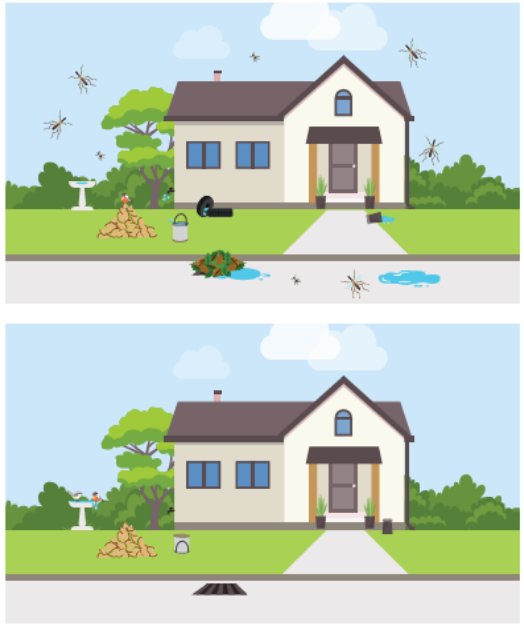
Where do mosquitoes live?

Mosquitoes need water to lay eggs and grow. Some mosquitoes use water around our yards. This might be in puddles from rain or melting snow or in man-made containers that fill with water around the yard.

Examples of man-made containers are: buckets, flower pots, old tires, pools, and birdbaths. What others can you think of?

Mosquito hotspots

Can you circle all 7 differences between the top and bottom pictures to get rid of the mosquitoes? Which yard is protected against mosquitoes?

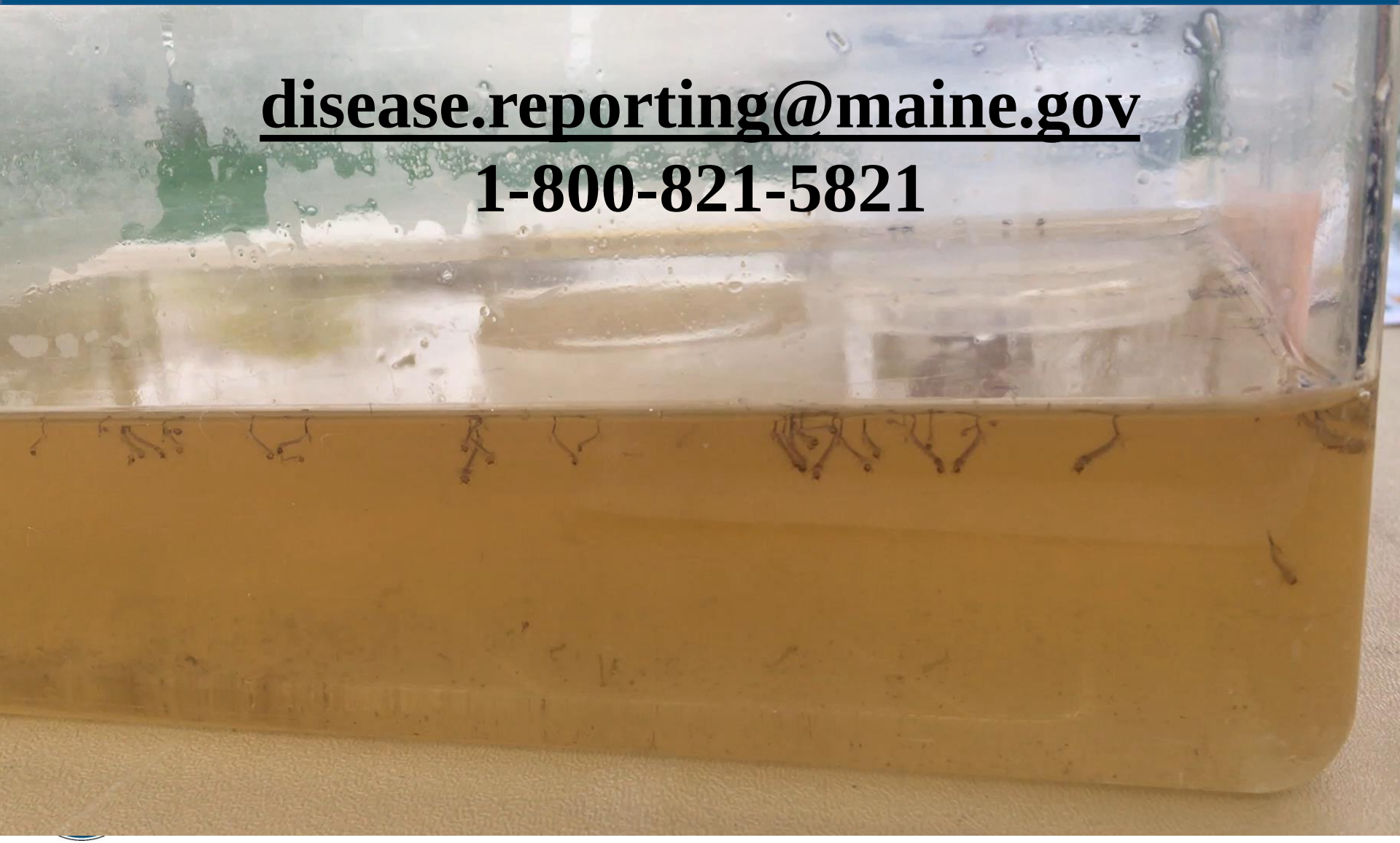


Available Resources – Social Media

Coming Soon! Social Media Toolkit!

www.maine.gov/dhhs/vectorborne

Questions?



disease.reporting@maine.gov

1-800-821-5821

Municipal Mosquito IPM

Gary Fish

Maine Department of Agriculture, Conservation and Forestry

gary.fish@maine.gov

www.maine.gov/ipm

Integrated mosquito management

- Monitoring,
- Disease surveillance,
- Source reduction,
- Public education,
- Community involvement,
- Control of all mosquito life stages, and
- Evaluation of actions taken

Monitoring is the IPM foundation

- Proper monitoring allows the municipality/district to:
  - Find breeding sites
  - Identify what mosquito species are present
  - Determine if any of those species are disease vectors
  - Set thresholds for when management is necessary
  - Determine when and if treatments are necessary
  - Evaluate the effectiveness of interventions

Natural Mosquito Breeding Habitats

Tree holes and red maple swamps

Disease surveillance

- Municipalities or Districts should partner with Maine CDC, DACF, Maine Health, or commercial mosquito control companies to collect mosquitoes and have them analyzed for vector-borne diseases like;
  - West Nile virus
  - Eastern equine encephalitis
  - Jamestown Canyon virus, and
  - Other diseases that move into Maine due to climate change

Source reduction

- Restoring tidal flow in salt marshes
- Proper construction and maintenance of stormwater retention basins and engineered wetlands
- Public sanitation efforts to remove breeding sites at neglected or abandoned properties (swimming pools, etc.)
- Public education campaigns to inform residents of the need to reduce breeding habitat



Recognize Mosquito Breeding Sites

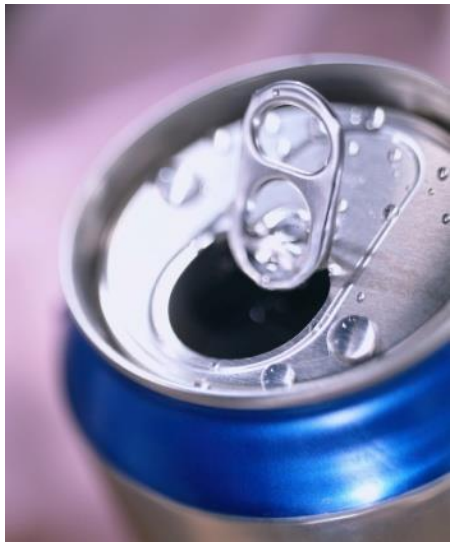


Culex Breeding Sites

- Prefer standing water rich in decomposing organic material
  - dead leaves, grass clippings, and algae break down to produce an attractive organic infusion
- Flooded wooded areas, catch basins, storm sewers, cisterns, and flood water pools

Aedes Breeding Sites

- Primarily man-made containers - cans, jars, cisterns, fountains, planters, plastic food containers, used tires, and tarps.
- Prefer fairly-clean water
- Need only ¼” of water - even bottle caps or puddles can be used



Is Your Structure Breeding Mosquitoes?

- Rain gutters
- Flat roofs
- Garbage cans and dumpsters without proper drainage
- Tarps

Clogged / Damaged Stormwater Drainage Systems

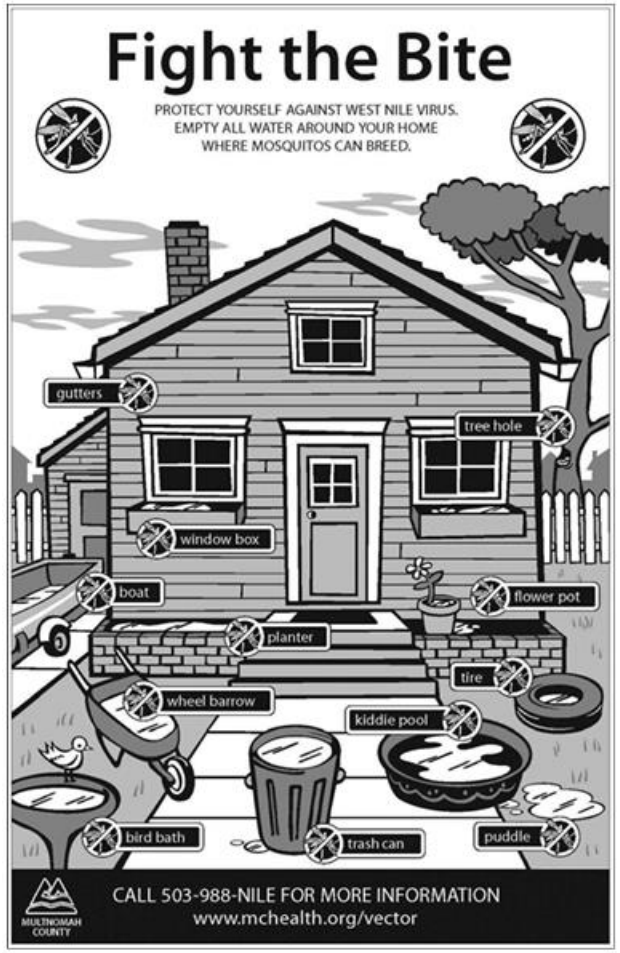
- Standing water = prime larval habitat
- Problems occur when drainage is blocked
- Long standing puddles, potholes

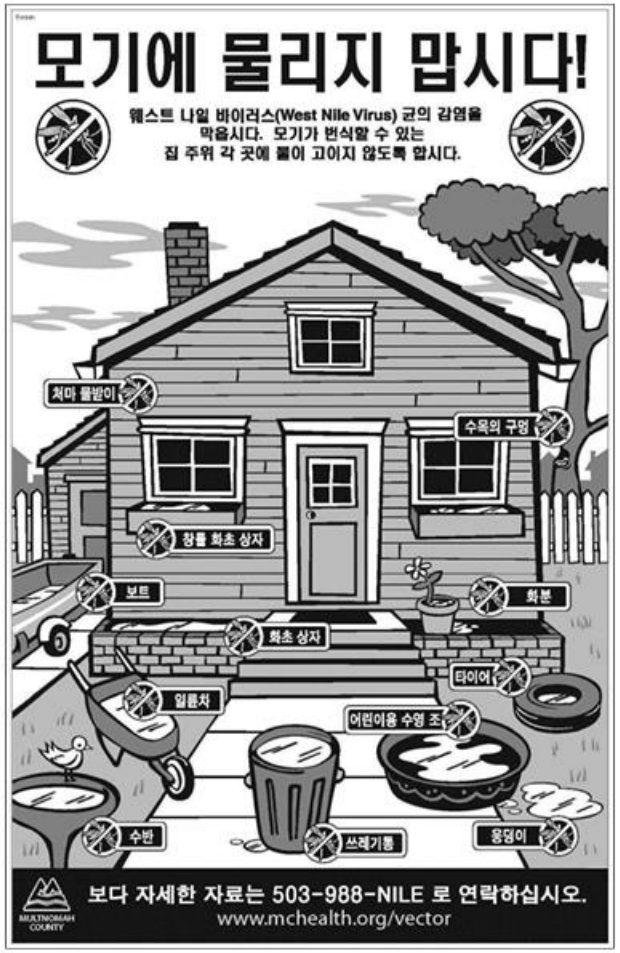
Tires and Sports Equipment

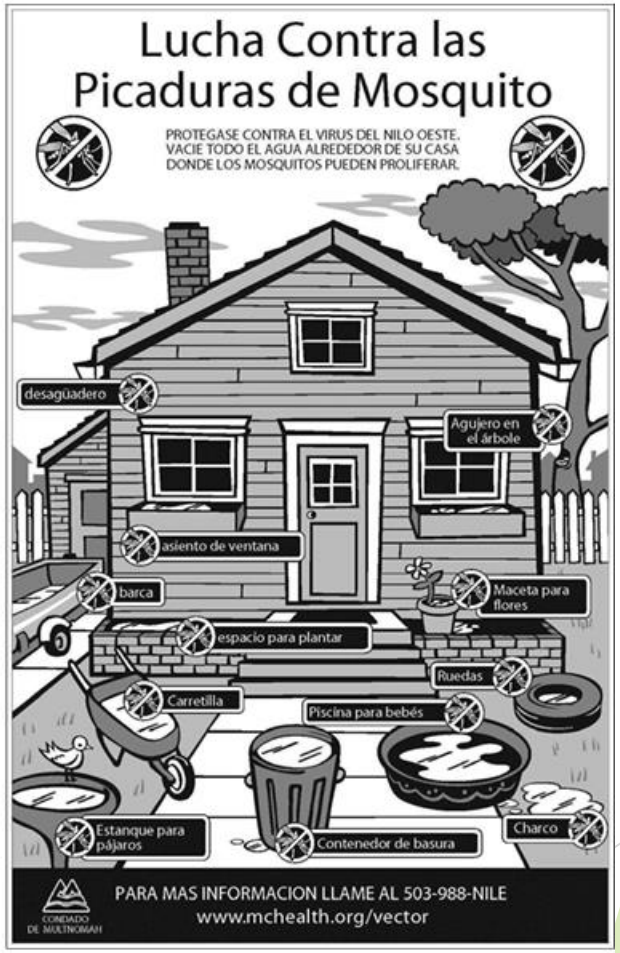
- Truck tires for football practice
- Perfect breeding area for *Aedes*
- Drill holes to drain water

Toys and children's play also equipment collect water

Community outreach is essential







An example of multi-lingual posters (in English, Korean, Spanish) from Multnomah County Vector Control in Oregon.

Community outreach is essential

go ahead the fight the bite

You can protect yourself against West Nile virus and Eastern equine encephalitis

- Wear long sleeves and long pants.
- Use repellent on skin and clothes.
- Take extra precautions at dusk and dawn.
- Use screens on your windows and doors
- Drain artificial sources of standing water where you live, work and play.

For more information about mosquito-borne diseases visit **www.mainepublichealth.gov**

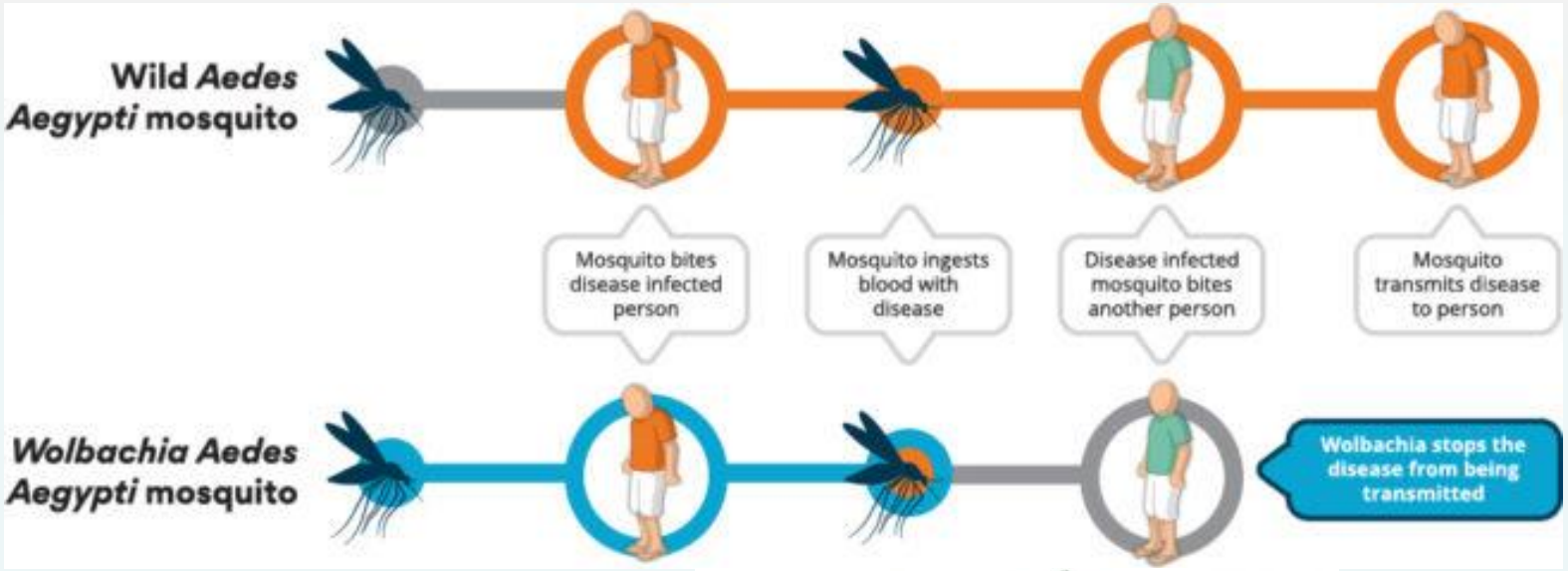
Mosquito management “control”

- Biological
  - Unfortunately, the only effective “biological” controls we have are registered insecticides. *Bacillus thuringiensis* Israelensis or Bti and *Bacillus* sphaericus are effective on the disease vectoring mosquitoes, but must applied according to the DEP and BPC rules.
  - The use of dragonflies is not recommended because:
    1. they have not been proven effective
    2. the available nymphs that come from North Carolina and Massachusetts are not 100% native species
    3. the water the nymphs are shipped in could contain invasive plants or microorganisms
  - Native copepods have been used in other states but not in Maine.
    - Efficacy in Maine unknown.

New Technologies for Mosquito Management

- 1) Sterile male mosquitoes –
  - Wolbachia bacteria

- 2) Genetically engineered sterile mosquitoes- Oxitec (Friendly Mosquitoes)™



Wolbachia

Eliminate or Treat Mosquito Breeding Sites

- *No person, firm, corporation, or other legal entity shall, for the purpose of controlling aquatic pests, apply any pesticide to or in any waters of the state as defined in 38 M.R.S.A. §361-A(7) without approval of the Maine Department of Environmental Protection.*

- *Also requires a commercial master pesticide applicator license*

- Using something like Bti (Mosquito dunks) is only allowed in shallow puddles that are not connected to streams or ponds.

Mosquito management “control”

- Mechanical/physical
  - Window screens
  - Source reduction
  - CO_2 traps
- Insecticides
  - Larvicides
    - Application to proper breeding sites can be controlled and confined to those sites
  - Adulticides
    - Greater risk of off-target effects
    - Pesticide drift is a concern
    - Only effective in disease management when applied to wide areas

Differences Between *Aedes* and *Culex* Matter

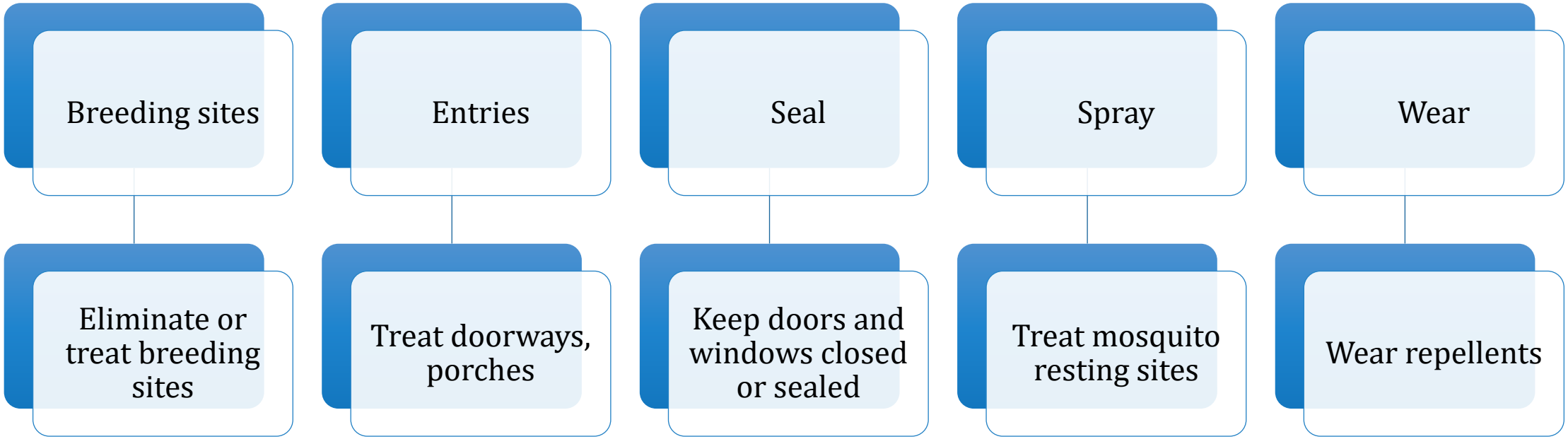
Culex

Resting sites 8–10 feet high

Aedes

Resting sites typically close to the ground

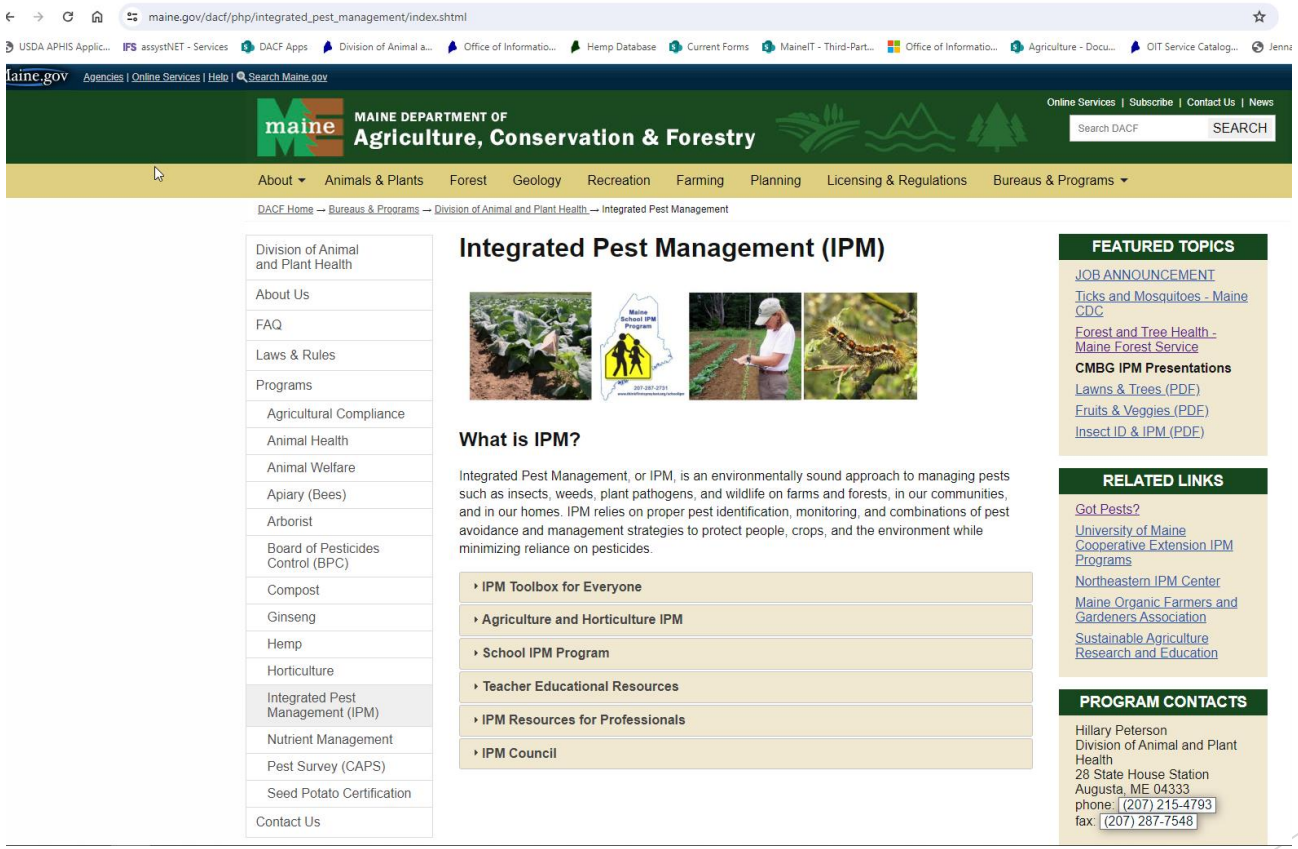
Treat the building entrance



Mosquito Deterrents

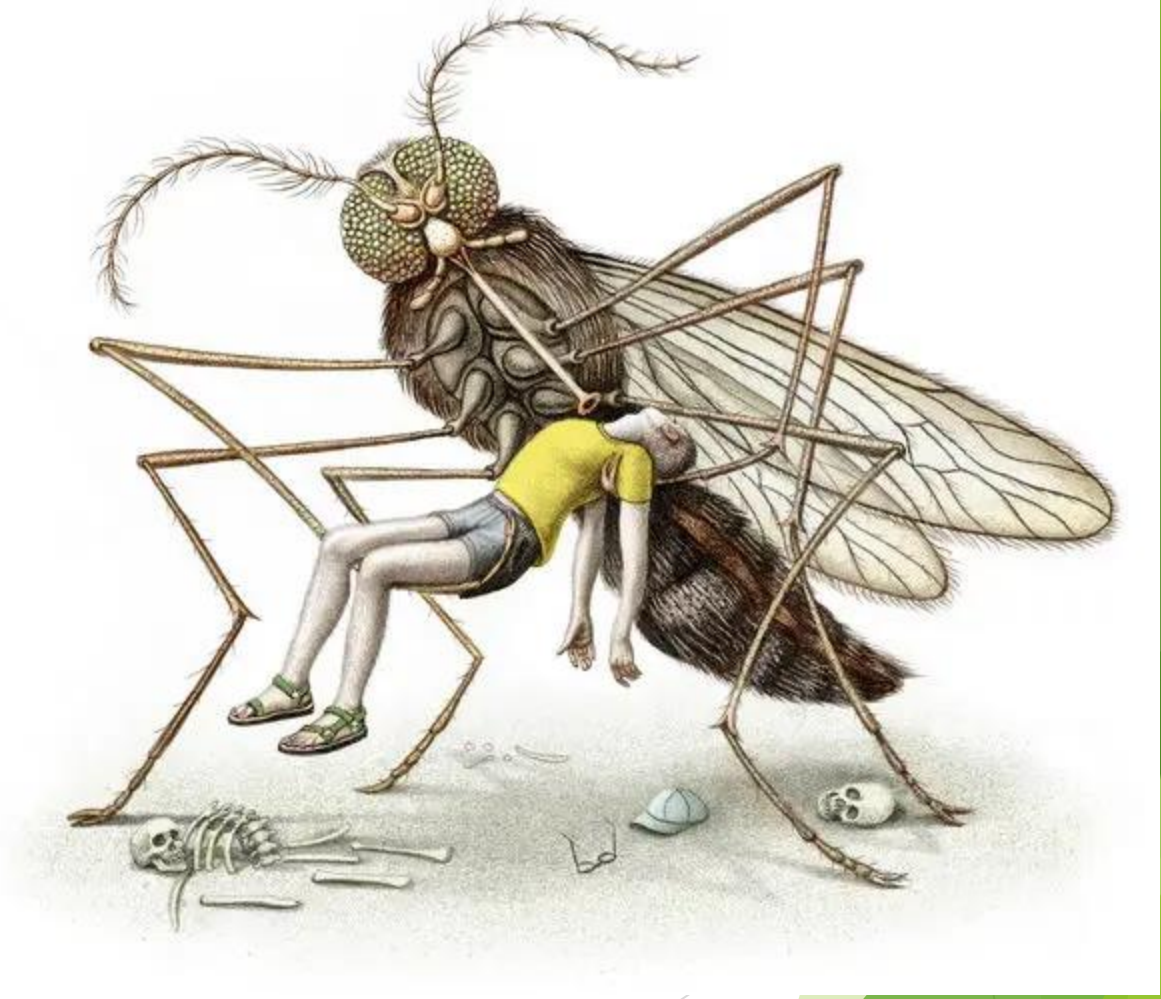
Resources

- Maine Department of Agriculture, Conservation and Forestry – IPM Specialist, Hillary Peterson, hillary.Peterson@maine.gov



Questions?

- gary.fish@maine.gov
- 207-287-7545



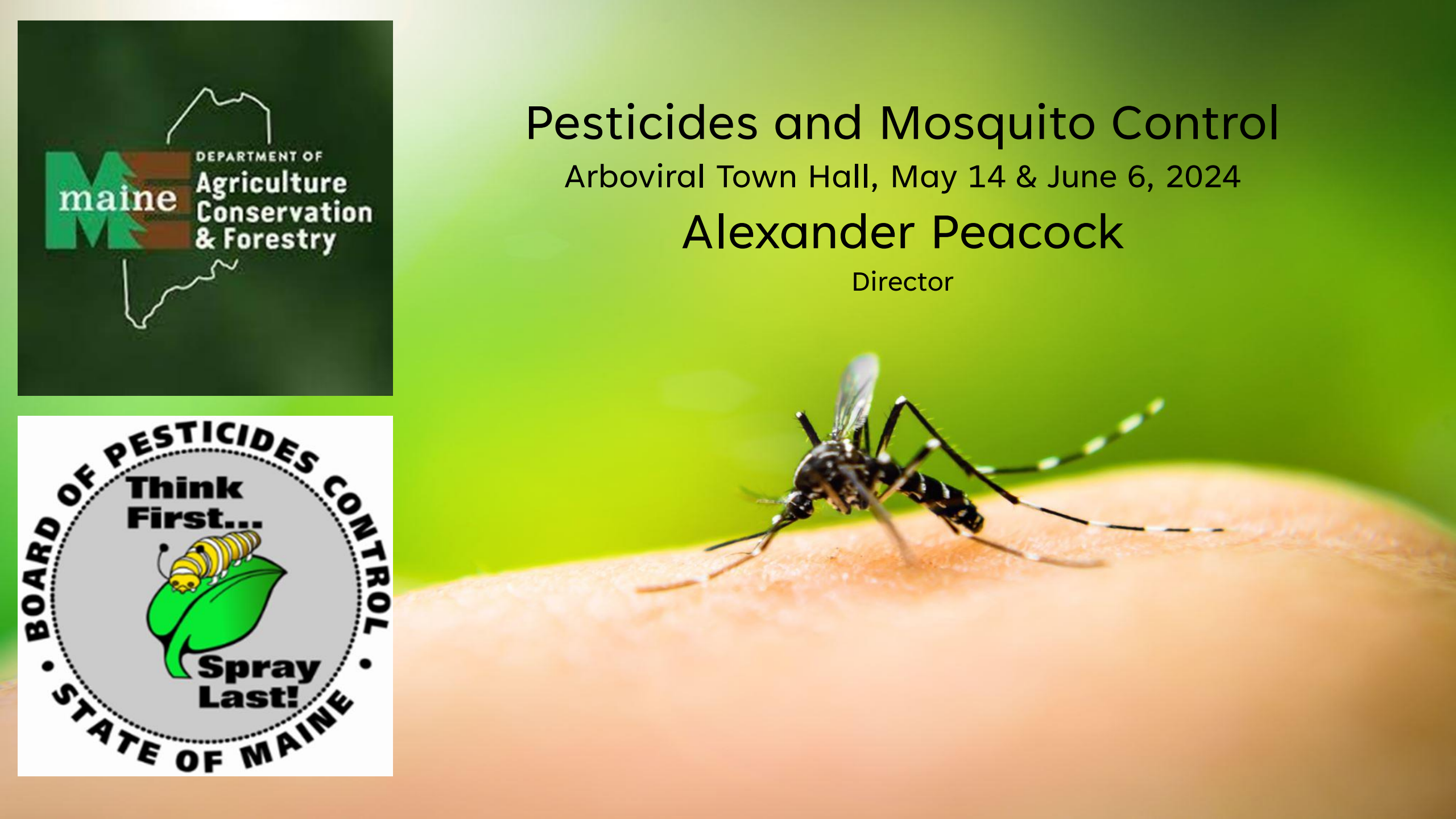
New York Times

Pesticides and Mosquito Control

Arboviral Town Hall, May 14 & June 6, 2024

Alexander Peacock

Director



"Pesticide" means any substance or mixture of substances intended for **preventing, destroying, repelling or mitigating any pest**; any substance or mixture of substances intended for use as a plant regulator, defoliant or desiccant.

"Spray Contracting Firm" means any person, including a corporation, employed or contracted to conduct a public or private custom application of one or more pesticides.

"Custom application" means an application of a pesticide under contract or for which compensation is received, pesticide application to area open and accessible to the public, in food/eating establishment or application as government employee.

"Commercial applicator/Master" (CMA) means a commercial applicator who is responsible for the major pest control decisions including, but not limited to, identifying unusual pests and choosing the appropriate pest control strategies and techniques, establishing policies relating to the operating practices of others applying pesticides within the company or agency including equipment maintenance and calibration, training, safety and hygiene, pesticide and container disposal, accident mitigation and ensuring that applications are conducted in compliance.

"Commercial applicator/Operator“ (COA) means a commercial applicator who applies or directs the application of a pesticide according to the instructions of the commercial master applicator.

An **unlicensed applicator** may make pesticide applications under the direct supervision of a CMA or COA.

Licensed Applicators 2024

Company Licenses 7E 80

- Commercial Master Applicator (CMA) 159
- Commercial Operator Applicator (COA) 339

Applicator Categories

Categories

- 1A Agricultural Animal
- 1B Agricultural Plant
- 1B1 Commercial Blueberry
- 1B2 Chemigation
- 1B3 Agricultural Fumigation
- 1B4 Post Harvest Treatment
- 2 Forest Pest Management
- 3A Outdoor Ornamentals
- 3B Turf
- 3C Indoor Ornamentals
- 4 Seed
- 5A Aquatic Pest Control
- 6A Right of Way Management
- 6B General Vegetation Mgt
- 7A Structural Pest
- 7B Structural Fumigation
- 7C1 Disinfectant and Biocide
- 7C2 Swimming Pool and Spa
- 7C3 Mold Remediation
- 7D Wood Preserving
- 7E Biting Fly and Other
- 7F Termites
- 8A Public Health – Biting Fly
- 8B Public Health – Other
- 9 Regulatory Pest Control
- 10 Demonstration & Research
- 11 Aerial

Licensed Applicators 2024

Companies Licensed for 7E (biting fly), 5A (Aquatics) & 11 (Aerial) - 1

Why is confirming pesticide registration in Maine important?

Chapter 20: SPECIAL PROVISIONS

Section 1. Registered Pesticides

B. The use of any pesticide not registered by the Maine Board of Pesticides Control in accordance with M.R.S. Title 7 § 607 is prohibited except as otherwise provided in this chapter or by FIFRA, Section 2(ee).

2024 Registered Pesticides for Mosquito Control

Total Products labeled for Mosquitoes – 1,270

Mosquito Control Outdoors – 622

Mosquito Control in Aquatic Areas
Larvicide – 50
Adulticide – 39

Common active ingredients for mosquito adult control:

Synthetic pyrethroids:

- Bifenthrin
- Permethrin
- Deltamethrin
- Cypermethrin

Organophosphates and Carbamates:

- Malathion
- Carbaryl

25b products (minimal risk pesticides, exempt from EPA registration)

- Rosemary oil
- Peppermint oil
- Cedarwood oil

Source U.S.E.P.A and S.O.M. B.P.C

Common active ingredients for mosquito larvae control:

Bacterial Insecticides:

Bacillus thuringiensis israelensis

Bacillus sphaericus

Organophosphate Insecticide:

Temephos (None registered for use in Maine)

Source: U.S.E.P.A.

01 DEPARTMENT OF AGRICULTURE, CONSERVATION AND FORESTRY

026 BOARD OF PESTICIDES CONTROL

Chapter 20: SPECIAL PROVISIONS

Section 4.Aquatic Applications

No person, firm, corporation or other legal entity shall, for the purpose of controlling aquatic pests, apply any pesticide to or in any waters of the state as defined in 38 M.R.S.A. §361-A(7) without approval of the Maine Department of Environmental Protection.

Contacts
Permits, Licenses, Certifications
Laws
Monitoring and Reporting
Programs
Rules
Publications and Resources

Aquatic Pesticides

Introduction

The Department has developed a general permit for the application (discharge) of aquatic pesticides for the control of mosquito-borne diseases. This general permit covers discharges of authorized aquatic pesticides by a licensed applicator to Class es AA, A, B, C, SA, SB , SC and waters having a drainage area of less than 10 square miles, that constitute breeding habitat for mosquito species known to be potential disease vectors and that meet the other provisions identified in the General Permit.

The Department has also developed general permits for the application of herbicides for the control of invasive aquatic plants and application of piscicides for the control of invasive fishes.

Contact (licensing)

- Gregg Wood (207) 287-7693, or call 287-7688 and ask to speak to someone in the "Waste Discharge Program".

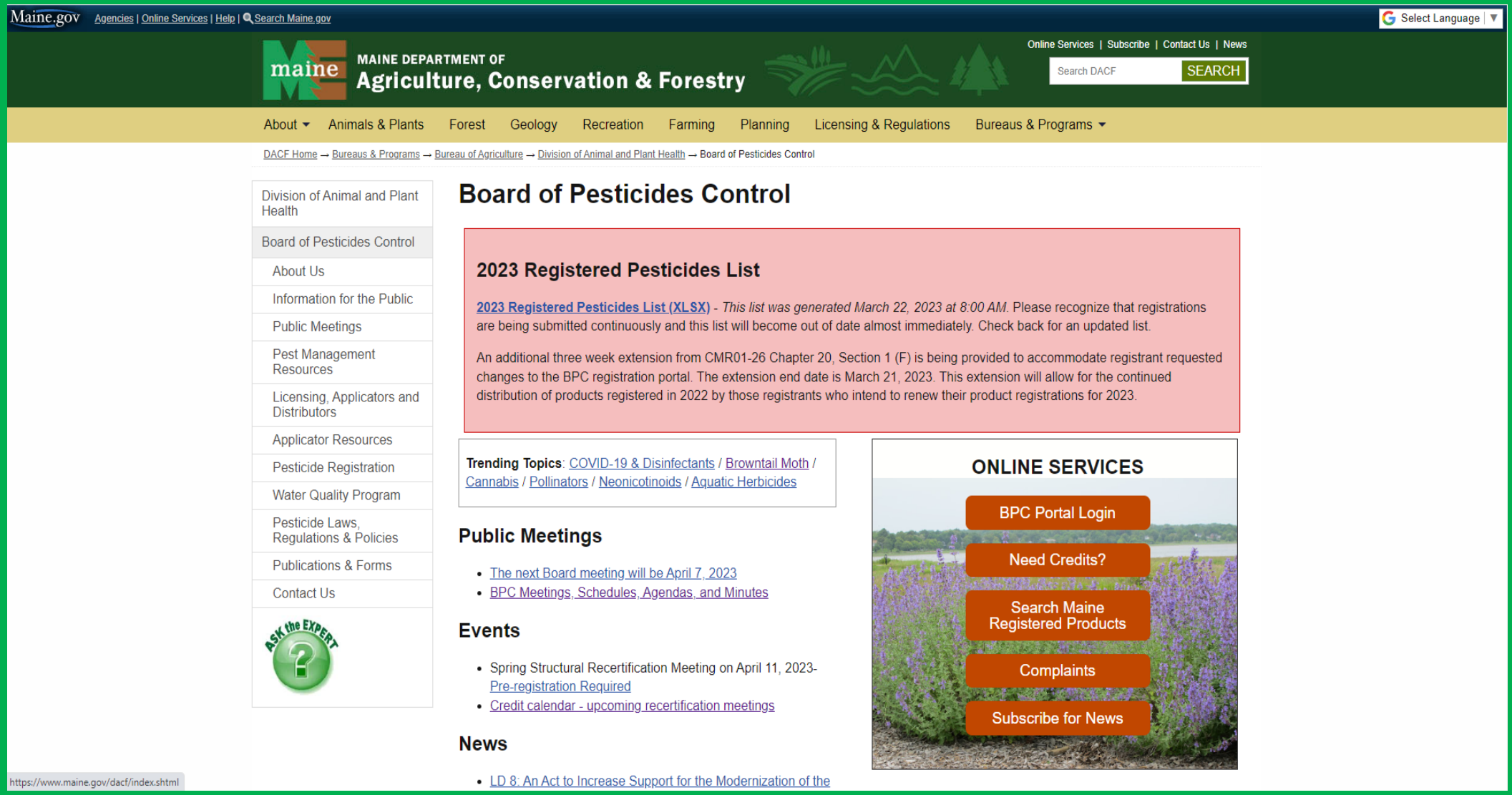
Text

- General Permit, Application of Aquatic Pesticides for the Control of Mosquito-borne Diseases, April 21, 2015 (PDF)

Forms

- Notice of Intent (NOI)

Finding an Applicator



Finding an Applicator

- LD 8: An Act to Increase Support for the Modernization of the Board of Pesticides Control by Increasing the Annual Pesticide Registration Fee

More News +

For the Public

- Information for the Public
- Environmental & Human Health
- Pesticide Notification
- Water Quality Program
- School IPM
- Identify a Pest
- Find a Licensed Applicator or Company
- Enivonmental Risk Advisory Committee
- National Pesticide Information Center
- University of Maine Cooperative Extension

For Registrants

- Product Registration
- Product Submission Instructions
- Creating a Login
- Creating a Company Profile
- Adjuvant Registrations
- CSF Submission Portal
- Neonicotinoids

For Applicators & Distributors

- Applicator Licensing
- Distributor Licensing
- Applicator Resources
- 2023 Non-Agricultural Pesticide Notification Registry (PDF) / (Excel)
- Critical Pesticide Control Areas
- Standards for Indoor Pesticide Applications
- Municipal Ordinances
- Special Local Needs Registrations
- Container Recycling

Credits

maine Department of Agriculture Conservation & Forestry

Information

- Maine.gov
- Site Policies
- Accessibility
- Document Viewers - including PDF and Word.
- Jobs @ DACF
- Grants & Loans
- Educational Resources
- DACF Home
- Sitemap

Connect with Us

- Facebook
- Twitter
- YouTube
- Instagram
- Email/Text Updates

Meeting & Event Calendar
See more social media

Support DACF Programs

- Maine State Park Passes
- Volunteer
- Specialty License Plates
- Outdoor Heritage Fund Lottery Ticket
- Donations & More

Contact Information

Department of Agriculture, Conservation & Forestry
22 State House Station
18 Elkins Lane
Augusta, ME 04333
Phone: (207) 287-3200
Fax: (207) 287-2400
TTY: Maine Relay 711
dacf@maine.gov
More Contacts

Division of Animal and Plant Health
Board of Pesticides Control
- About Us
- Information for the Public
- Public Meetings
- Pest Management Resources
- Licensing, Applicators and Distributors
- Applicator Resources
- Pesticide Registration
- Water Quality Program
- Pesticide Laws, Regulations & Policies
- Publications & Forms
- Contact Us

ASK the EXPERT

Board of Pesticides Control

Information for the Public

Pesticides can be important tools which, in the hands of an informed applicator, offer many potential benefits. But pesticides can also pose risks if improperly used. That's why the Maine Board of Pesticides Control (BPC) works hard to help people outsmart pests by arming them with the best available pest management science.

On this Page:

Pesticide Resources for the Public

- Pollinator Protection
- Grubs got your lawn? Before you act, read this!
- Pesticide Notification: Your Rights and Responsibilities
- Obsolete Pesticide Collection
- Have a problem with a pesticide application? How to file a complaint

LICENSED COMPANIES

- For Hire Pesticide Application Companies
- Licensed Companies Offering Mosquito and Tick Control
- Licensed Companies Offering Bat Proofing
- Licensed Commerical Appicators
- Tick and Mosquito Companies
- Terrestrial Invasive Plants Companies
- Browntail Moth, Hemlock Woolly Adelgid and/or Other Pests (PDF)
- Arborists That Prune Browntail Winter Webs (PDF)

PEST MANAGEMENT RESOURCES

- Master Gardeners
- Maine YardScaping Partnership
- Integrated Pest Management (IPM)
- School IPM
- Got Pests?

Regulations to take into consideration:

Chapter 20: SPECIAL PROVISIONS

Chapter 22: STANDARDS FOR OUTDOOR APPLICATION OF PESTICIDES BY POWERED EQUIPMENT IN ORDER TO MINIMIZE OFF-TARGET DEPOSITION

Chapter 29: STANDARDS FOR WATER QUALITY PROTECTION

Chapter 31: CERTIFICATION AND LICENSING PROVISIONS/COMMERCIAL APPLICATORS

Chapter 51: NOTICE OF AERIAL PESTICIDE APPLICATIONS

READ

THE

LABEL!

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Complaints/Inquiries

To submit a complaint or inquiry please contact the BPC at:

pesticides@maine.gov

207-287-2731

maine DEPARTMENT OF Agriculture Conservation & Forestry

Thank You

Questions?

Alexander Peacock

Alexander.r.peacock@maine.gov

www.thinkfirstspraylast.org

Mosquito Control at the Municipal Level in Maine

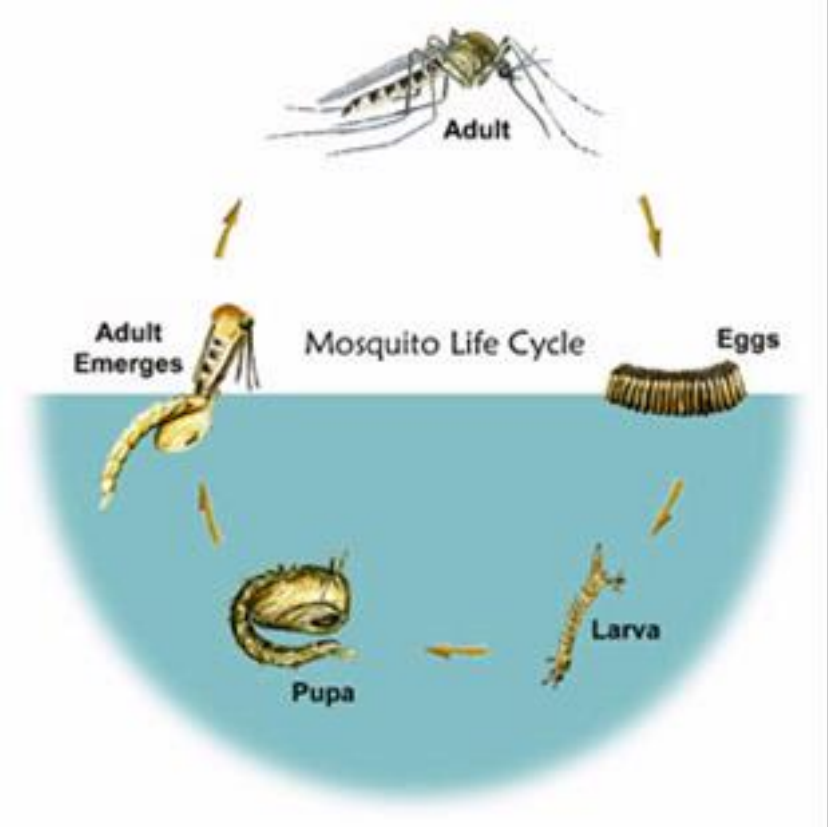
Michael Morrison , BS Entomology

Aquatic Entomologist

Municipal Pest Management Services, Inc

TEL: 603-231-1271 Mobile
e-mail:mummichog@comcast.net
Http://www.swamp-inc.com

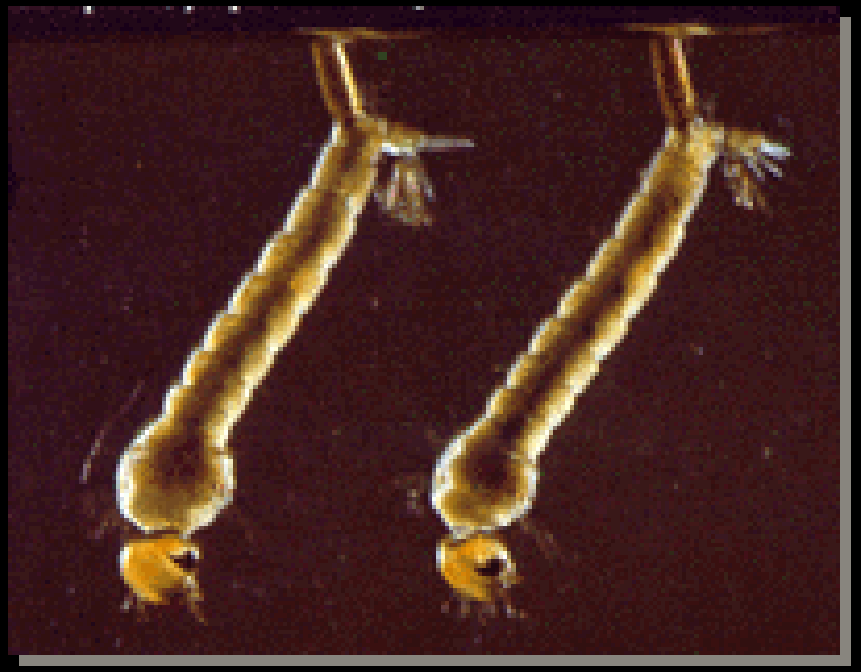
Life Cycle



- Life cycle consists of egg, larval, pupal, and adult stages
- All mosquitoes require water for complete development
  - Natural Containers
  - Artificial Containers

Larval Stage

- Also called “wigglers”
- Must have water to complete development
- Stagnant water is ideal
- 4 developmental stages “ larval instars”
- Air tube for breathing called a “siphon” that penetrates the surface of the water
- Feed on microorganisms and organic debris in water column



Adult Stage

- Newly emerged adults rest on the water surface while wings dry and harden
- Average adult lives from 2 to 3 weeks, over-wintering adults live 6 to 8 months
- Only females search for a blood meal
- Many mosquitoes stay very close to their breeding site
- Blood meal is used for egg development
- First batch of eggs in spring may be produced autogenously (without a blood meal)
- Males live only long enough to mate and do not feed on blood
- Females can lay as many as 200 eggs with each blood meal

Current Mosquito Control Programs in Maine

York and Kittery

Vector Control Program Together?

Larviciding primarily

Larval and Adult Surveillance

Why Mosquito Control ?

- Public Health
  - West Nile Virus (WNV)
  - Eastern Equine Encephalitis (EEE)
  - Jamestown Canyon Virus
  - Potential for occurrence of other introduced diseases

- Nuisance Reduction
  - Coastal Areas- salt marshes; flat topography
  - Urban
  - Residential
  - Recreational Facilities
    - Golf Courses
    - Ball Parks

Mosquito Control Myths

- Birds
- Bats
- Dragonflies
- Fish
- Plants
- Garlic Spray
- “Magnets”
- Ultrasonic Devices
- Catch Basin Vacuuming
- Mosquito Dunks
- Adulticiding Only
- No neighboring control program

HOW ?
Integrated Pest Management (IPM)

A pest management approach that reduces mosquitoes (disease vectors) by integrating both chemical and non-chemical control options.

Emphasis is placed on identifying mosquito species, monitoring mosquito populations, mapping breeding habitats and control applications.

IPM Components

- Arbovirus Testing
- Mosquito Biology
- Mosquito Breeding and Habitat Identification
- Mosquito Species Identification
- Ecological Monitoring and Surveillance
- Human Risk Assessment
- Appropriate Mosquito Control Options
- Wetland/ Salt Marsh restoration
- Emergency Contingency Planning and implementation

Surveys and Surveillance

- **Essential component in an IPM based mosquito control program**
- **<u>Mosquito Survey versus Mosquito Surveillance</u>**
  - Larvae and Adults
    - Species Identification
    - Mapping of larval mosquito habitat
    - Disease presence in the adult mosquito population
  - What species are common and what type of wetland habitats are present

Pesticide Control

- Larviciding
- Adulticiding

Larviciding

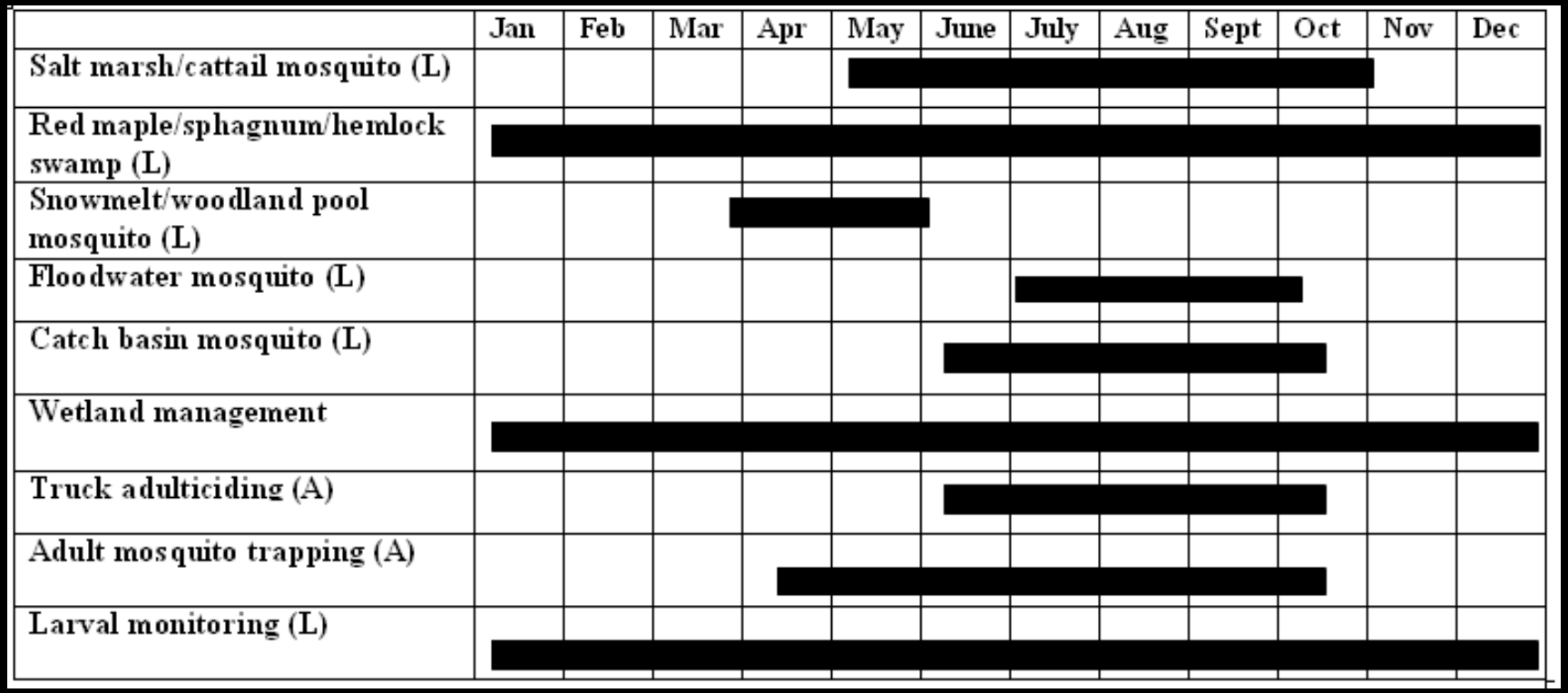
- Treatments dependant on species and stage of development
- Equipment
- Ground applications
- Organic- Bacterium (Bti, Bs)
- Catch basins
- Red maple swamps
- Salt marshes
- EEE crypts

Adulticiding

- Barrier and Perimeter treatments
- Ground ULV
- Identification of non target/sensitive areas
- Aerial- state declared emergencies

Mosquito Control Season

- The typical mosquito control season is 30 weeks long (April 1st thru October)
- A comprehensive mosquito control program is year round



Operations

- Cost Variables
- Off-season Activities
- Funding Strategies
- Personnel
- Equipment & Vehicles
- Recordkeeping
- Public Relations
- Security
- Pesticide Storage & Handling
- Insurance
- Mosquito species, plant species and habitat identifications
- Survey and Surveillance
- Consolidation of other municipal services
  - Sidewalk weed control, turf management, aquatic plant control, invasive plant control, poison ivy control and structural pest control

Source Reduction

- Tire Ordinances
- Public awareness programs
  - Clogged gutters
  - Stagnant water-holding containers
- Filling and grading depressions
- Clearing clogged drainage ditches
- Vegetation control in storm water basins

Water Management

- Storm Water Basins
- Beaver Dams
- Roadside Ditches & Swales
- Stream Corridor Clearing
- Invasive/ Vegetation Control
- Wetland Restoration
- Partnerships & Grants
- Equipment


LGP Dump Carriers


Positrack LGP Mower


Cat 307C LGP Wetland Excavator

Off Season Activities

- Spray equipment maintenance and over wintering
- Truck fleet and heavy equipment maintenance
- End of year summaries and reports
- Budget preparation for next season activities
- Wetland management/ restoration projects
- Landowner permission
- Develop EEE/WNV contingency plans
- School outreach
- Licensing and Permit applications
- Identify and larvicide EEE mosquito habitats
- Mapping
  - New streets and developments
  - catch basins
  - Red maple, sphagnum bogs
  - Salt Marshes

Emergency Contingency Planning

- Written Plans with Annual Updates
- Off Season Meetings and Year-end Summaries
- Roles of Town and City Departments
  - Recreation Department
  - Health Department/ officer
  - Administration
  - School Departments
  - Buildings and Grounds
  - Highway/public works departments
  - Police and fire departments
  - Emergency Management Teams
- Roles of State and Federal Agencies

Cost Variables

- Topography
- Wetland Type and Size
- City/ Town Size (square miles)
- Number of Catch Basins
- Urban vs. Rural Environment
- Typical Meteorological Conditions
- Human Population Density
- Human Demographics
- Pest vs. Disease Programs

Typical Costs for a Disease Surveillance Program

- Labor intensive
- Adult mosquito surveillance for arboviral testing
  - Transportation
  - Supplies
    - Light traps
    - Gravid Traps
    - Resting Boxes
    - Dry Ice
    - Batteries
  - Labor
    - Microscopic mosquito species identification
    - Laboratory preparation of specimens
    - Mapping
    - Data Collection
    - Trap placement
  - Approximately $700 per week (2 traps) from July 1st to October 15th

Typical Costs for a Disease Control Program

- Larviciding
  - Typical-April 1 to December 31 (39 weeks)
  - EEE (crypt and cattail) areas can be treated off season
  - Labor intensive
  - Transportation
  - Supplies and control materials
  - Low end cost: $1,000- $2,000 per week

  Source reduction/ water management
  - Grants
- Adulticiding
  - Barrier
    - Schools, parks, recreational fields)

Regulatory

- Maine
  - Board of Pesticide Control- Adulticiding and pesticide licensing
  - MDEP- Larviciding
    - Treatment justification/ mosquito monitoring/species specific
    - Bacterial larvicides only
- Sensitive Areas
  - Public and private water supplies
  - Ground water
  - Wetlands
  - Beekeepers
  - No-Sprays
- Water Management
  - State and Federal permit agencies
- Homeowner No No's
  - Overdosing
  - Lawn/barrier treatments without "mosquito" or "treatment area" on label
  - Larviciding
- Unlicensed Remedies (motor oil, kerosene, bleach, Lysol, mosquito dunks)
- Water Draining and Wetland Filling

Consolidation With Other Municipal Services Vector Control Programs

- Storm Water Management- ditches, basins
- Wetland Maintenance and Restoration
- Vegetation Control- invasives, poison ivy, sidewalks
- Turf Management- European chafer
- Pest Control- buildings, stinging insects, biting flies
- Shade Trees- disease and insect control
- Tick Management- strategies on public properties
- GIS Mapping