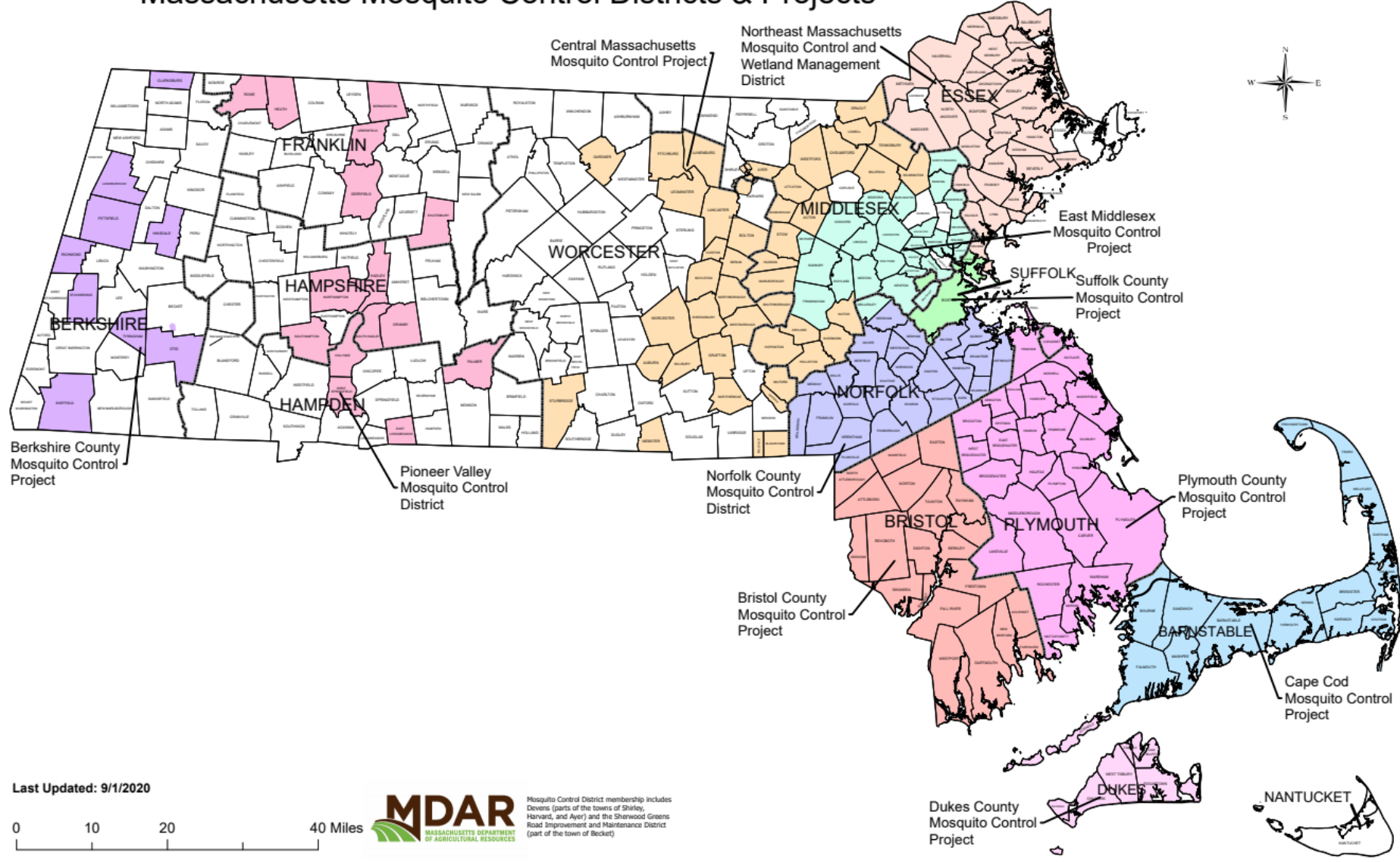


Managing Mosquitoes in Marshes



Aubrey Paolino
Cape Cod Mosquito Control Project

Massachusetts Mosquito Control Districts & Projects





Cape Cod Mosquito Control Project

- First organized mosquito control project in Massachusetts
- Established in 1928 to manage the mosquito populations below a nuisance level
 - 50 sq mi of salt marsh
 - 5 sq mi of freshwater swamps





Mosquitoes

Mosquitoes are the deadliest animals in the world

- Transmit pathogens that cause disease
 - Over 700,000 deaths per year globally
 - 400,000 of these are malaria



Mosquitoes

Mosquitoes are the deadliest animals in the world

- Transmit pathogens that cause disease
 - Over 700,000 deaths per year globally
 - 400,000 of these are malaria
- Mosquito-borne diseases of concern in Massachusetts:
 - West Nile Virus (WNV)
 - Eastern Equine Encephalitis (EEE)



Adult Mosquitoes

- Male and female mosquitoes feed on plant nectar for energy
- **Male mosquitoes do not bite or feed on blood**
- **Female mosquitoes take a blood meal** for egg development



<https://www.in.gov/isdh/28232.htm>



Adult Mosquitoes



A common house mosquito, *Culex pipiens*, covered in tansy pollen. (Mike Hrabar), Author provided

Photo#1456592

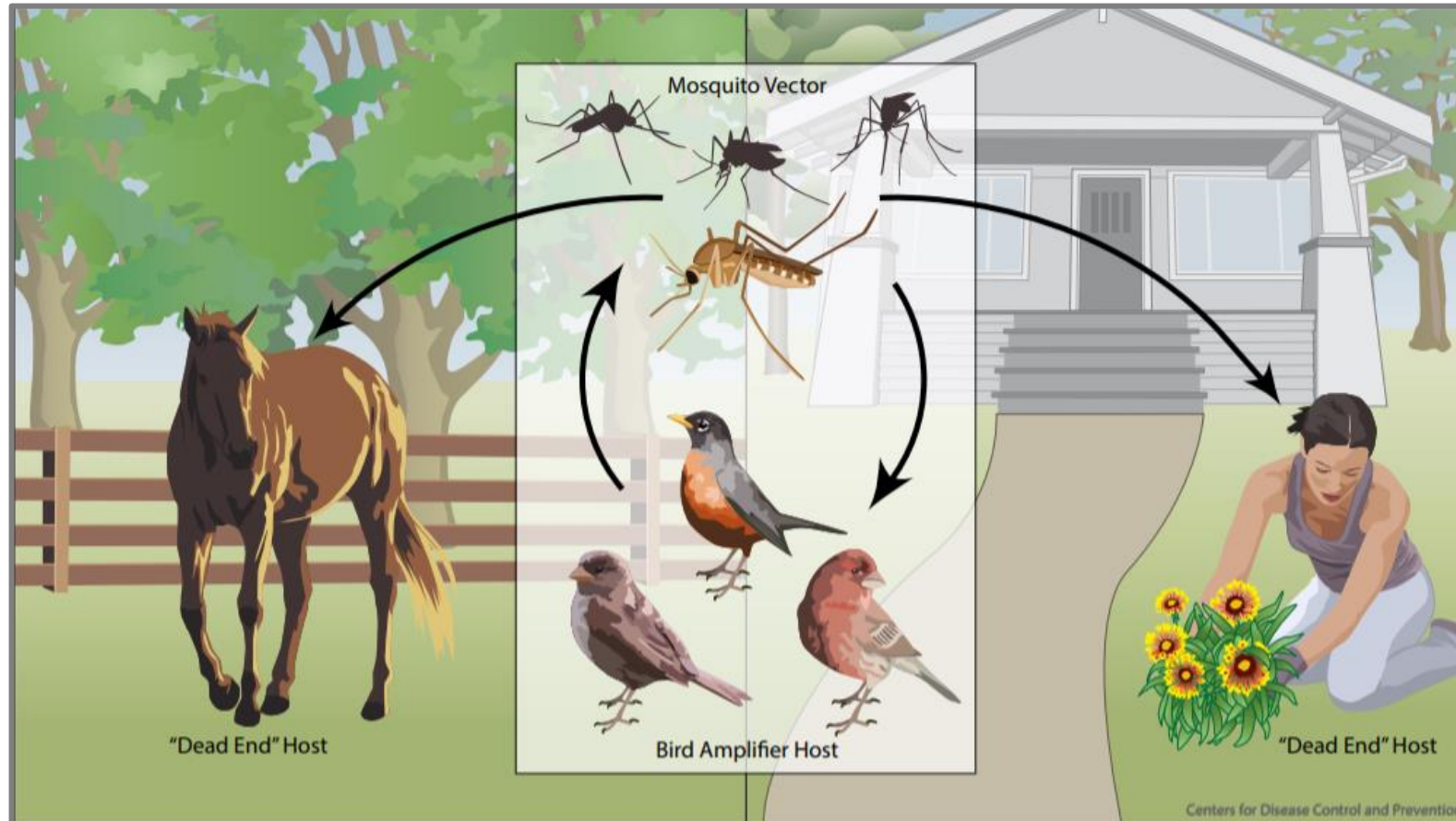


© Theresa Bayoud 2017

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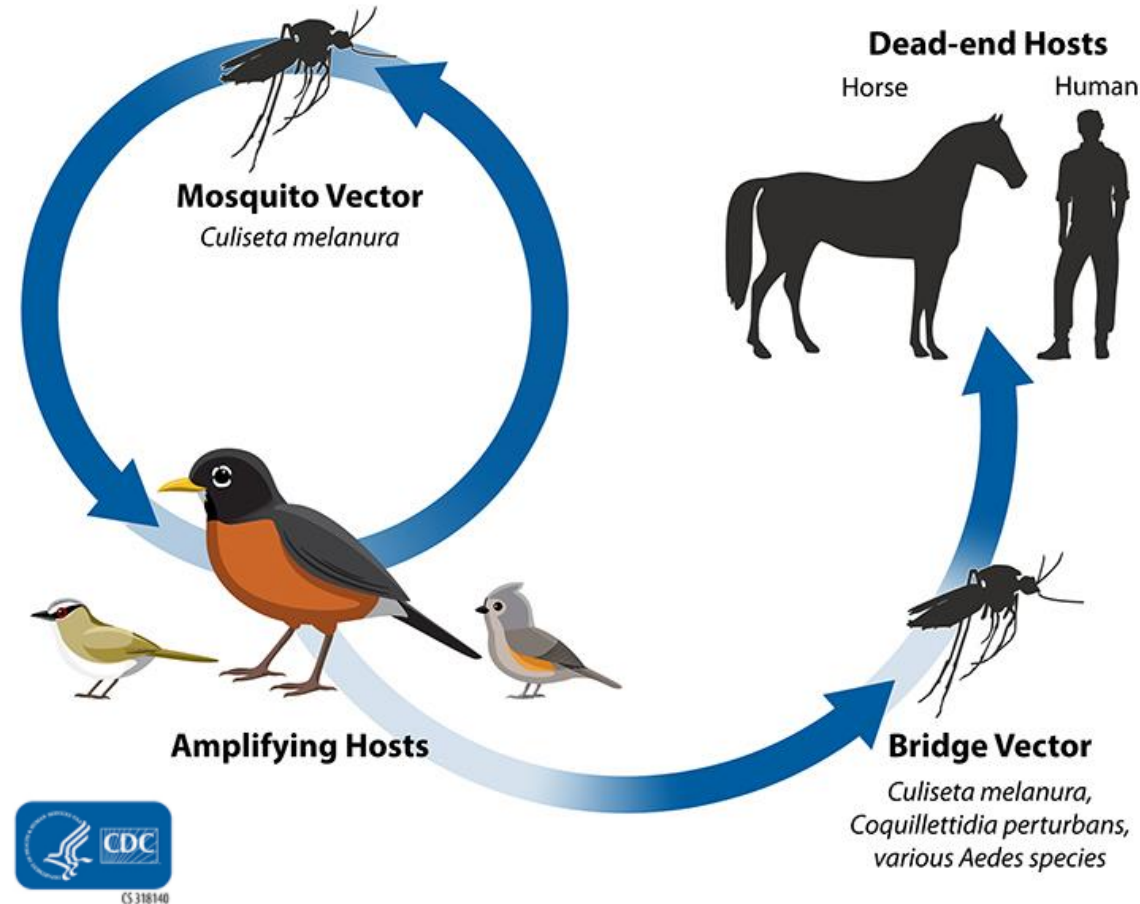


West Nile Virus



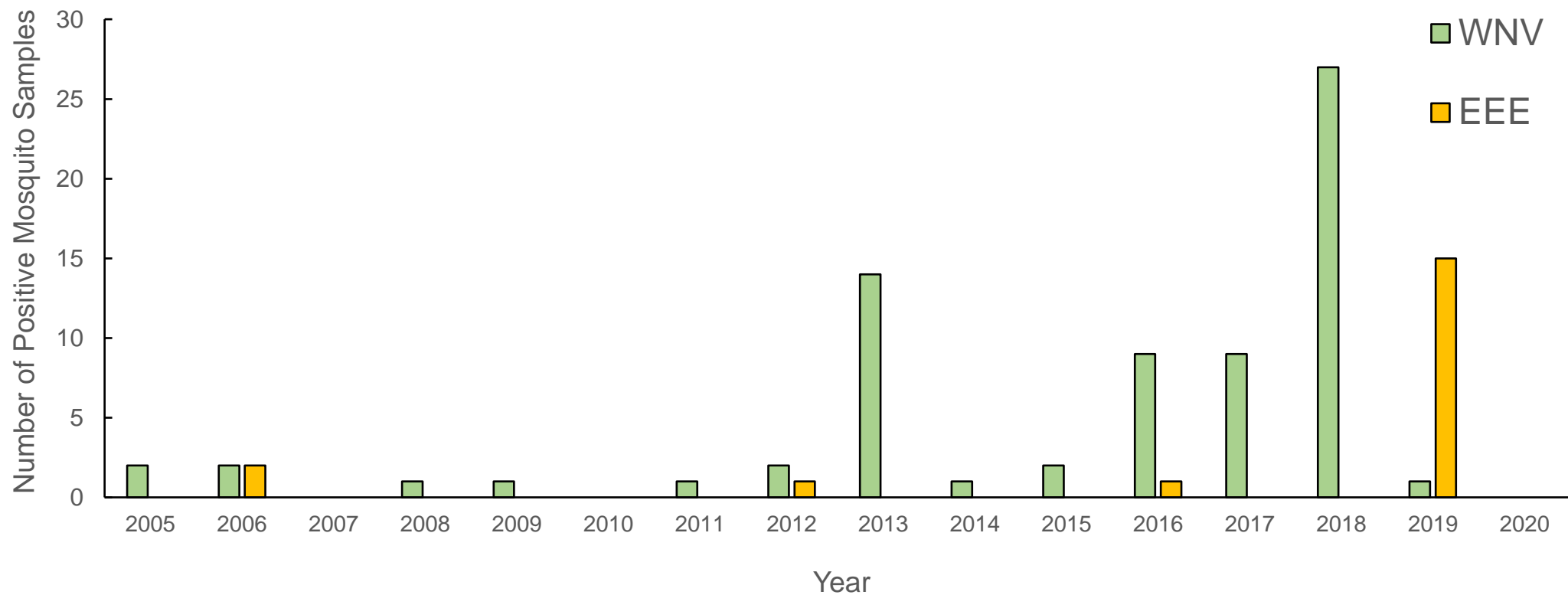


Eastern Equine Encephalitis





Barnstable County





Integrated Mosquito Management

1. Inspection

- Which mosquito species are present?
- What life stage are the mosquitoes?



Integrated Mosquito Management

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- What life stage are the mosquitoes?

2. Pest threshold

- We consider the results of inspection, time of year, and disease risk



Integrated Mosquito Management

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- We want to use strategies and products that are:
 - Effective in reducing the mosquito population
 - Minimize impacts to the environment
 - Optimize our resources



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4. Monitoring

- Rechecking throughout the year



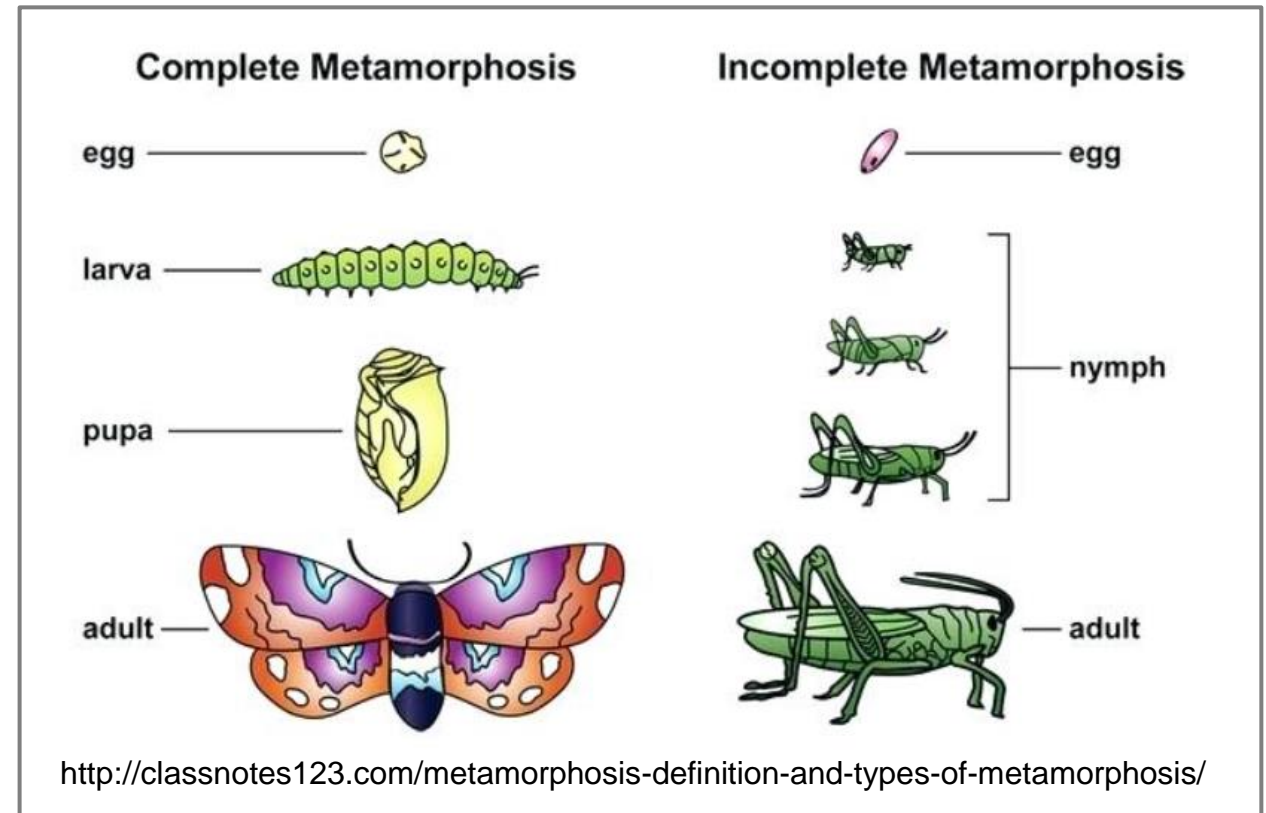
Mosquito Diversity

- Over 3,000 species of mosquitoes worldwide
- 176 species in the USA
- 51 Species in Massachusetts
- 32 species collected on Cape Cod
 - Container species
 - Brackish and freshwater species
 - Salt marsh species



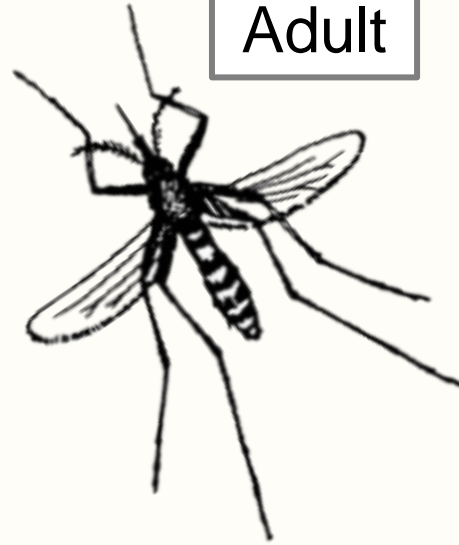
Mosquito Life Cycle

- Undergo complete metamorphosis
- Adult mosquitoes are terrestrial
- Immature mosquitoes are aquatic
 - Ideally, we try to target immature stages for control before they are adults and able to bite



Terrestrial

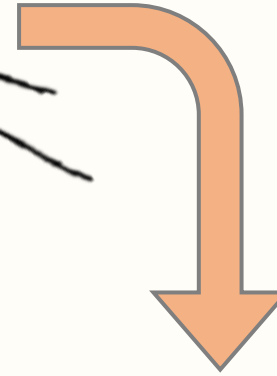
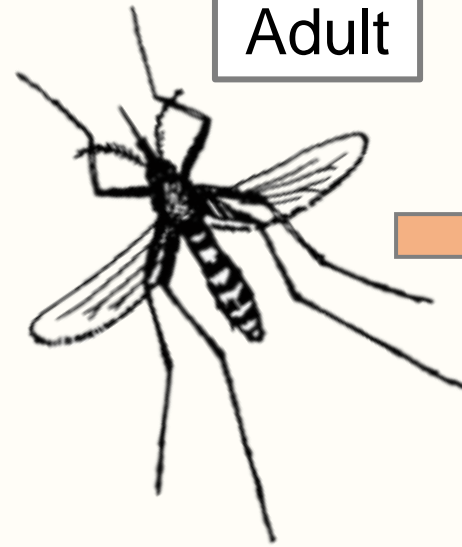
Adult



Aquatic

Terrestrial

Adult



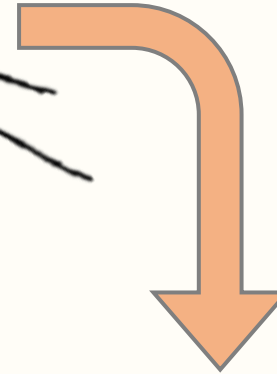
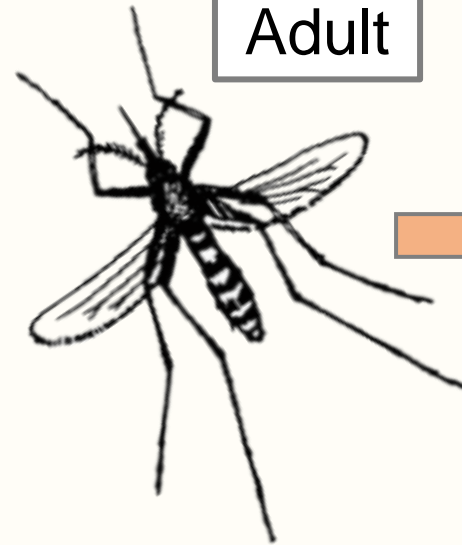
Eggs



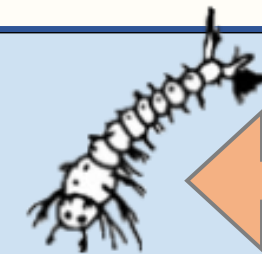
Aquatic

Terrestrial

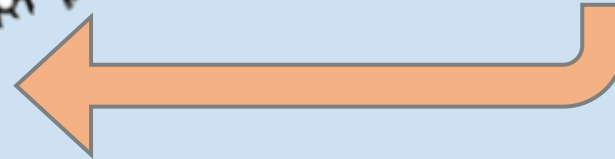
Adult



Eggs



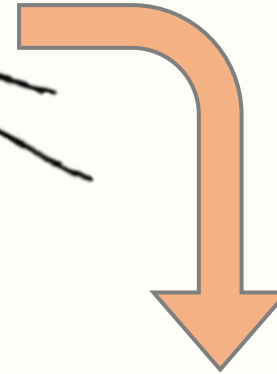
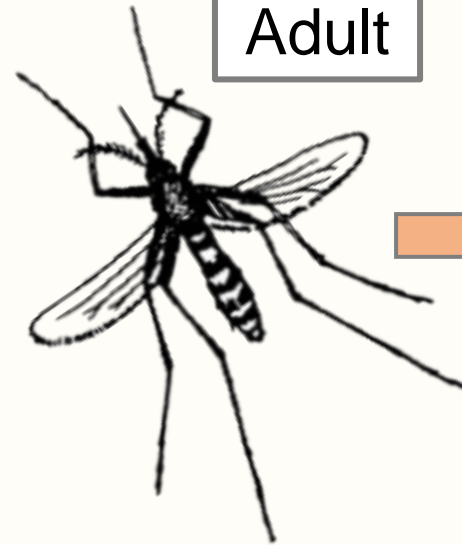
Larva



Aquatic

Terrestrial

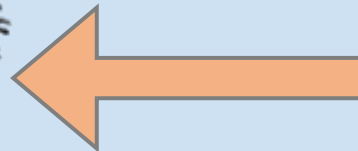
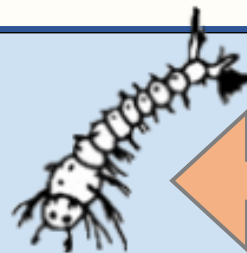
Adult



Eggs



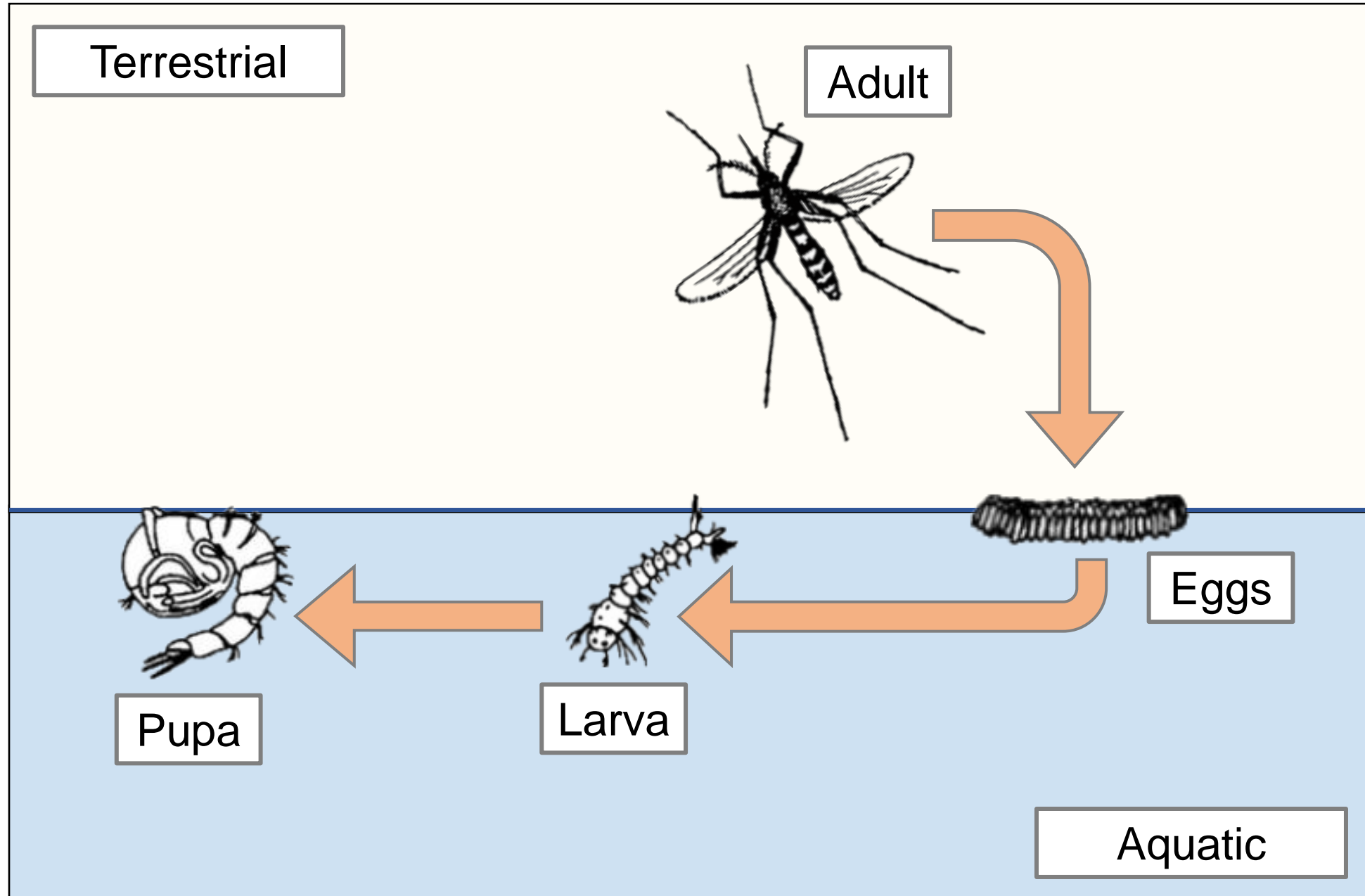
Larva

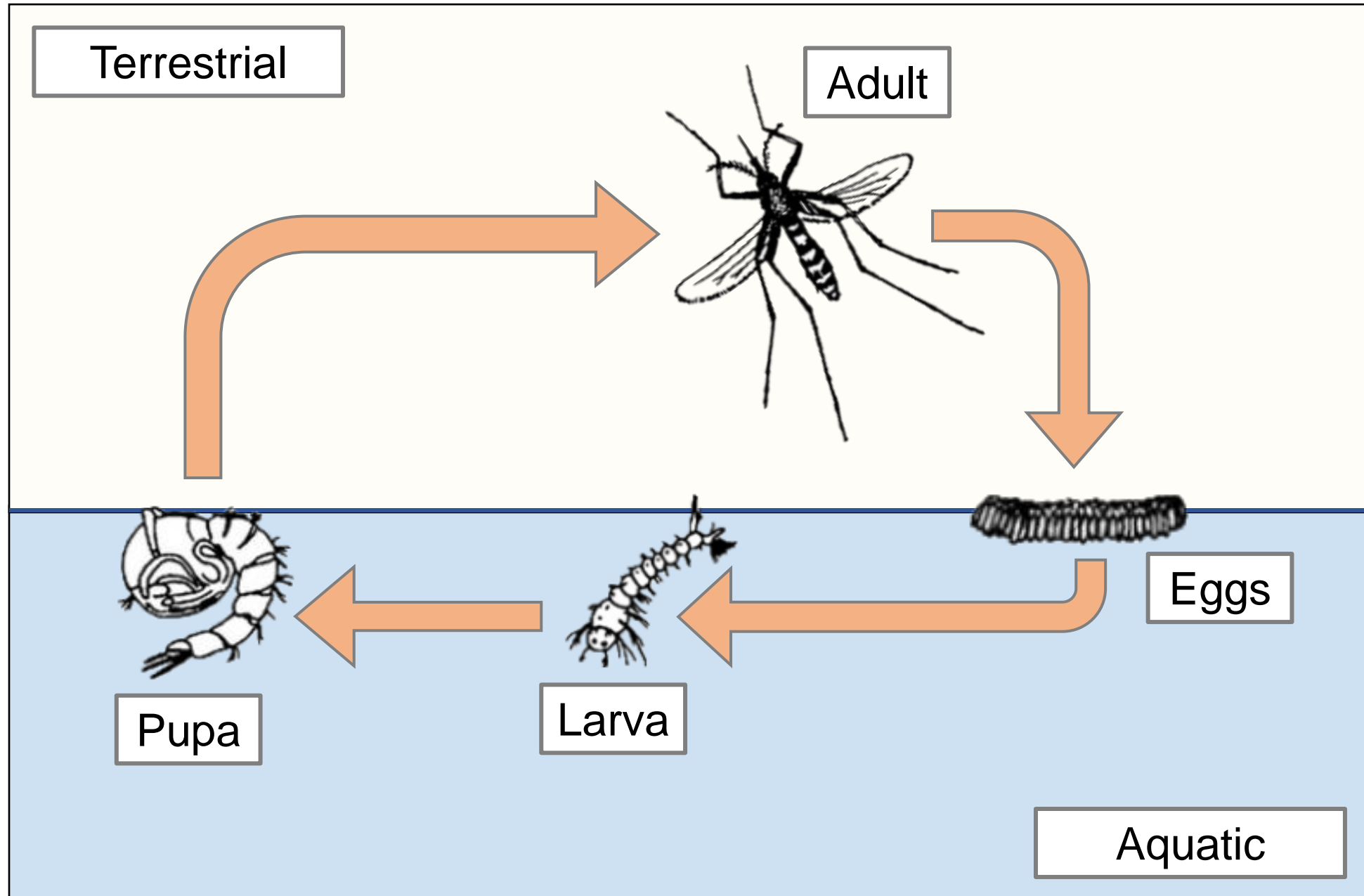


Pupa



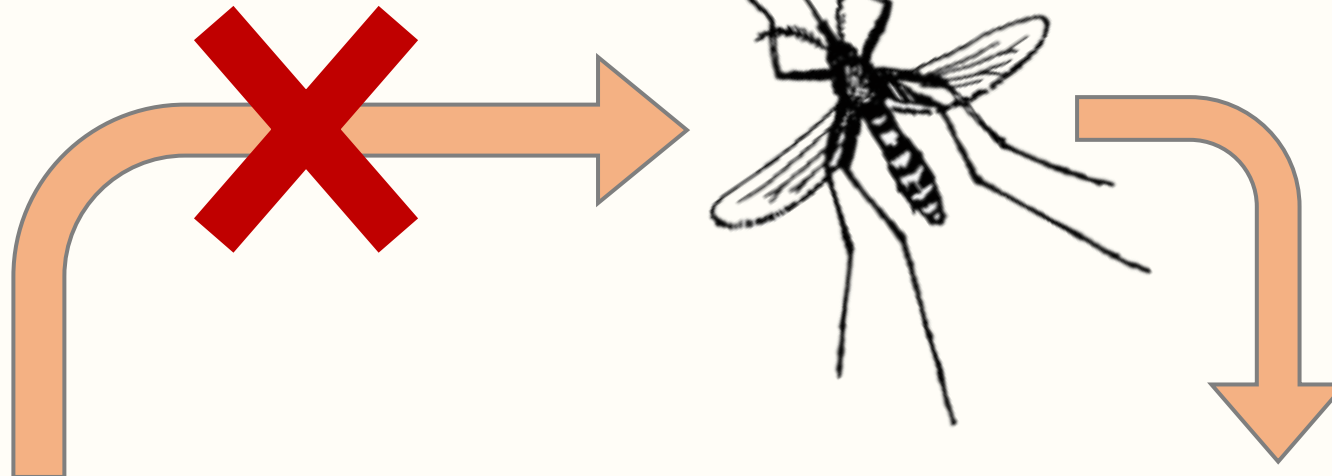
Aquatic





Terrestrial

Adult

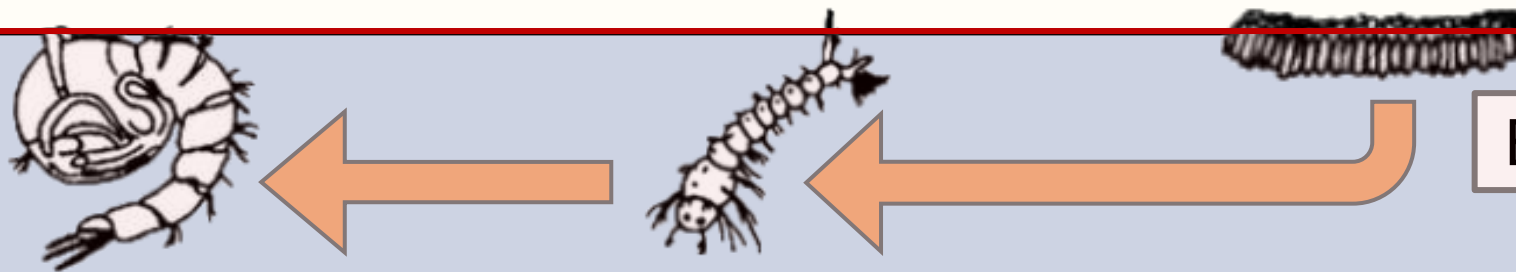


Eggs

Larva

Pupa

Aquatic





Larval Management on Cape Cod

Larval Habitat	Management Technique	
	Water Management	Larvicide Applications
Containers	✓	
Catch Basins		✓
Freshwater	✓	✓
Saltwater	✓	✓



Larval Management on Cape Cod

Larval Habitat	Management Technique	
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Containers	✓	
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Tidal Salt Marsh

- Flooded and drained by tides
 - Low salt marsh - flooded by daily tides
 - High salt marsh - flooded by spring tides and seasonal high tides
- Mosquito eggs are laid:
 - On standing water at the marsh edges
 - In moist soil on the high marsh



Brackish Species

- Eggs are laid on the water surface on the edges of the marsh
- Immature mosquitoes can tolerate a range of salinity
- Have multiple generations per year
- WNV and EEE virus isolations have been made from these species

Ochlerotatus cantator



Culex salinarius





Floodwater Species

- Eggs are laid above the water line in moist soil and must experience a period of desiccation before they can hatch
- Have multiple generations per year
- WNV and EEE virus isolations have been made from these species

Ochlerotatus taeniorhynchus



Photograph by Michelle Cutwa, University of Florida.

Ochlerotatus sollicitans



WALTER REED BIOSYSTEMATICS UNIT



Floodwater Species





Water Management

- In the 1930s, an estimated 1,500 miles of salt marsh ditches were dug in Barnstable County



Water Management

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- Ditches function to manage mosquito abundance by:
 - Reducing the number and size of water-holding ponds in which larvae live
 - Allowing predatory fish access to larval mosquito habitat



Water Management

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- Ditches function to manage mosquito abundance by:
 - Reducing the number and size of water-holding ponds in which larvae live
 - Allowing predatory fish access to larval mosquito habitat
- CCMCP conducts, on average, approximately 8.3 miles of salt marsh ditch maintenance per year on existing ditches



Water Management





Water Management





Larvicide Applications





Larvicide Applications

Bti (*Bacillus thuringiensis* subspecies *israelensis*)

- Naturally-occurring bacterium found in soils
- Produces a toxin that causes larval midgut to rupture
- Ineffective for pupae because it must be ingested





Larvicide Applications

Bti (*Bacillus thuringiensis* subspecies *israelensis*)

- Naturally-occurring bacterium found in soils
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Surface oil

- Mineral Oil
- Creates a physical barrier at the water surface
- Causes larvae and pupae to drown





2020 Waquoit Bay Salt Marsh

Water Management

Ditch maintenance	1300 ft
-------------------	---------

Pipes opened	1
--------------	---



2020 Waquoit Bay Salt Marsh

Water Management

Ditch maintenance	1300 ft
Pipes opened	1

Larvicide Applications (31 sites)

Checks	135
Untreated	109
Treated	26



Salt Marsh

Marsh ditch systems:

- Function well to manage mosquito abundance
- Increase marsh drainage and reduce the extent of ponds
- May cause loss in marsh elevation

How can we make management decisions that balance managing mosquito abundance and promoting marsh sustainability over decades and centuries?



Salt Marsh Collaborative Research

NOAA NERRS Science Collaborative (NSC) project

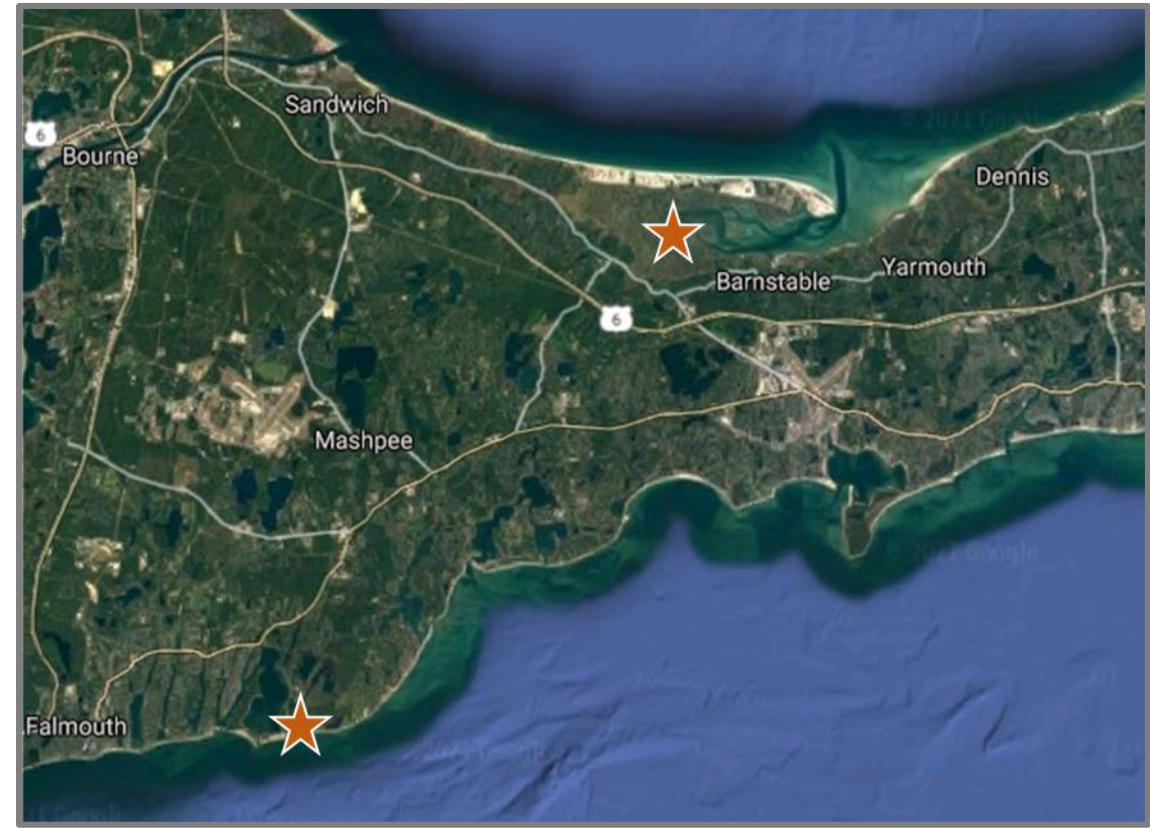
Scientists and end users:

- Cape Cod Mosquito Control Project
- Louisiana State University
- National Park Service
- United States Fish and Wildlife Service, Rachel Carson National Wildlife Refuge
- United States Geologic Survey
- Waquoit Bay National Estuarine Research Reserve
- Woods Hole Oceanographic Institution



Salt Marsh Collaborative Research

- Researches developed a model for pond dynamics in salt marshes
- Great Barnstable Marsh – 3.6m spring tidal range
- Waquoit Bay Sage Lot Pond Marsh – 0.7m spring tidal range



End-User Decision Support Tool

Select environmental parameters that best describe your marsh.

1. Tidal Classification:

Mesotidal (Spring Tidal Range ~ 3.8m) ▾

2. Suspended sediment concentration:

5 (mg/l) ▾

3. Future sea-level rise rate:

3 (mm/yr) ▾

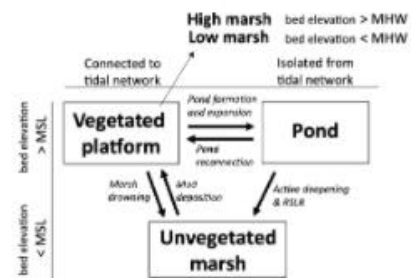
4. Future maintenance:

0 (%) maintenance ▾

5. Time horizon:

Present Day (modeled) ▾

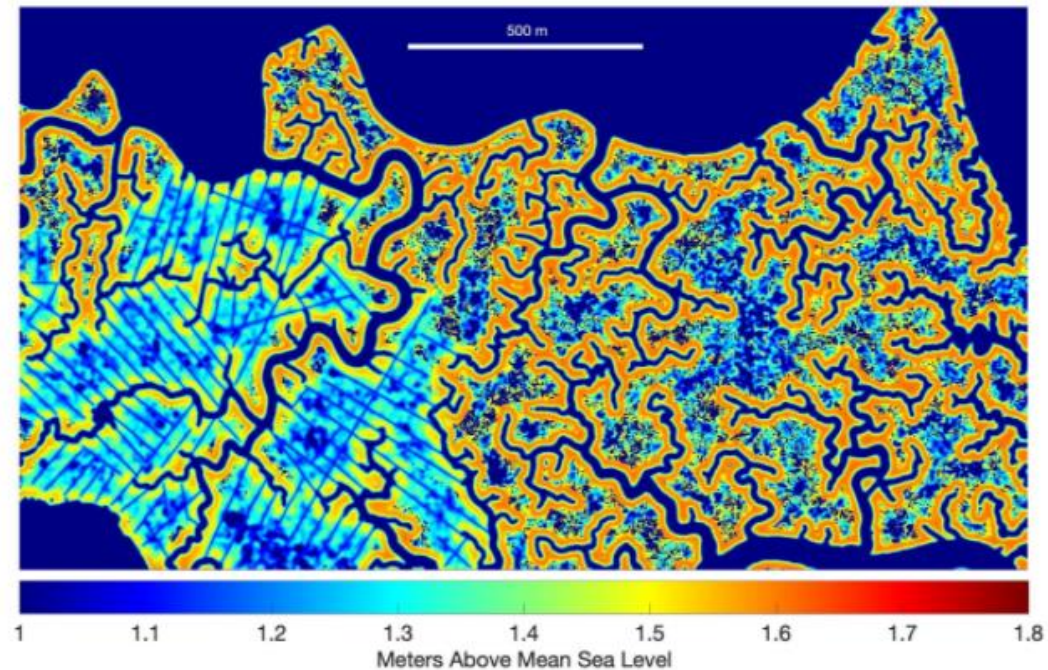
Enter



Elevation Results

Accretion Results

Summary



<https://www2.whoi.edu/site/marshsustainabilityandhydrology/generalized-decision-support-tool/>



Personal Protection

Use an EPA-approved repellent anytime you're outdoors.



Wear long pants, long sleeves and socks to reduce exposed skin outdoors.



Repair torn screens early in the season to keep mosquitoes outdoors.



Remove standing water around the house to prevent mosquitoes from breeding.



Dusk to dawn is peak biting time for mosquitoes that carry disease.



<https://www.mass.gov/info-details/mosquito-borne-disease-prevention>

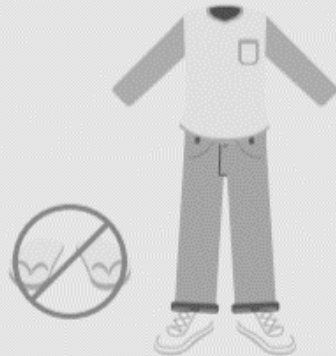


Personal Protection

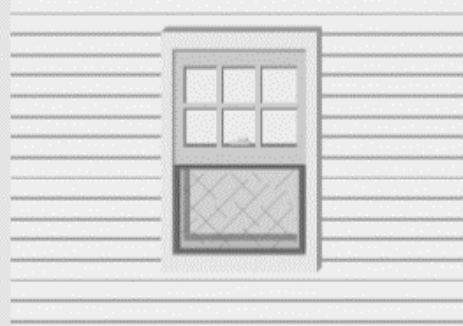
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<https://www.epa.gov/insect-repellents/find-repellent-right-you>

How much time will you need to be protected from biting insects? ⓘ

Any ▾

Do you need protection from mosquitoes, ticks or both ?

Mosquitoes and ticks ▾



All products work against mosquitoes, and not all against ticks.

You can refine your search by specifying one or more of the following options:

Which product are you interested in?

You can leave blank to get a list of all products which fall under your criteria

Are you interested in a particular [active ingredient](#)?


All Ingredients ▾

Are you looking for a specific company name?

All Companies ▾

Do you know the EPA registration number of the product you are looking for? ⓘ

You can leave blank to get a list of all products which fall under your criteria.

 [Export the entire insect repellent dataset to PDF format](#)

Search Reset



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Cape Cod Mosquito Control Project

www.ccmcp.net

(508) 775-1510

APaolino@ccmcp.net



Greenhead Fly Control



Audrey Russano