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THE STATE UNIVERSITY OF NEW JERSEY

ROLE OF CLIMATE VARIATION ON THE POPULATION DYNAMICS OF SPOTTED-WING DROSOPHILA

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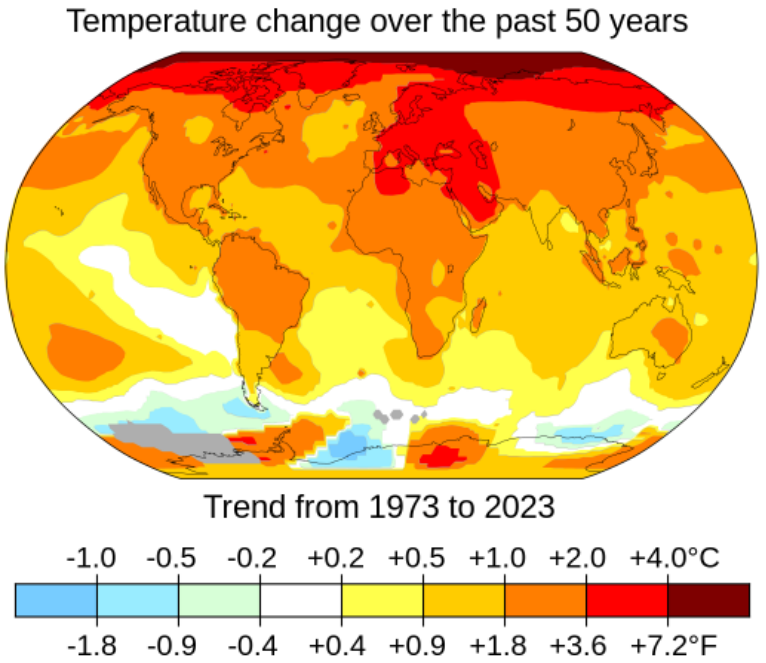
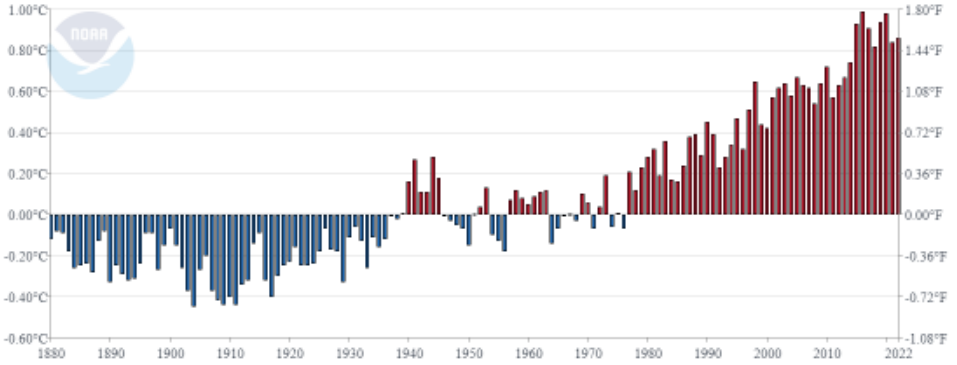
North American Raspberry & Blackberry Association
February 27, 2024

A Changing Climate

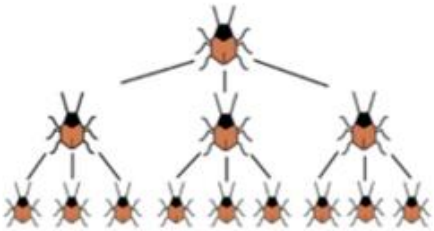
- The significant variation of average weather conditions becoming, for example, warmer, wetter, or drier—over several decades or longer.
- Many climate change impacts have been felt in recent years, with 2023 the warmest on record.
- Higher temperatures are causing more intense storms, droughts, and other weather extremes.





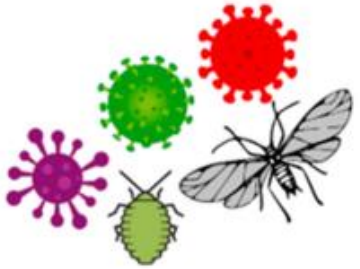
A Changing Climate

HOW DOES TEMPERATURE INCREASE AFFECTS INSECT PESTS?



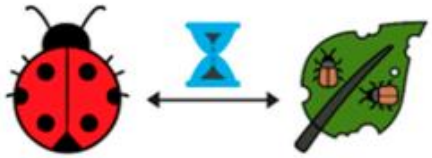
Increased number of generations

Expansion of geographic range



Outbreak of plant diseases transmitted by insects

Increased overwintering survival



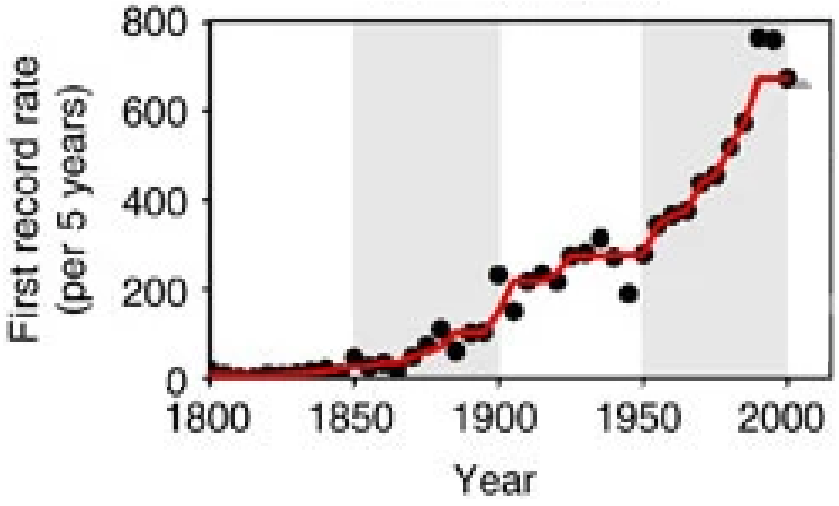
Desynchronization of insects and their natural enemies

Loss of synchrony with the host plant

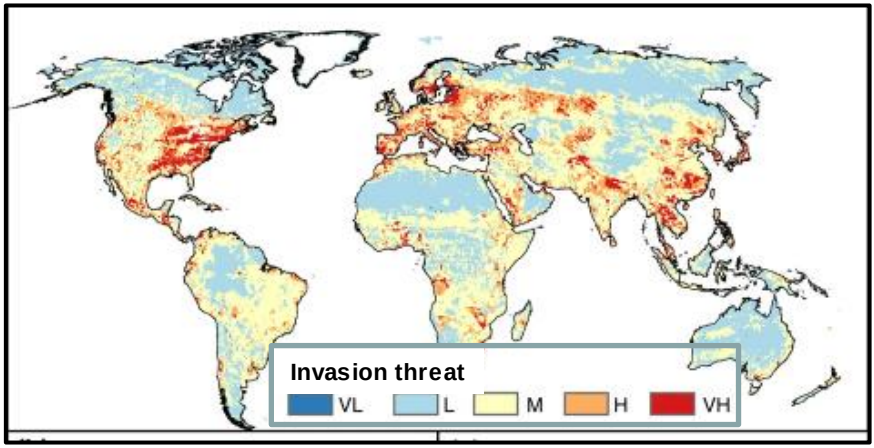
Skendžić et al. 2021

Biological Invasions

- Annual rate of first insect records worldwide has increased during the last 200 years (Seebens et al. 2017).



- Global economic costs over the last 50 years estimate > US$1.288 trillion (Zenni et al. 2021).



- Most economically developed regions are highly vulnerable to invasion (Early et al. 2016).

Spotted-Wing Drosophila

SWD, *Drosophila suzukii*

- Invasive pest from Asia.
- First detected in 2008 in California and in 2011 in the Northeast.
- Many hosts: strawberries, raspberries, cherries, blueberries.
- Females with prominent serrated ovipositor.

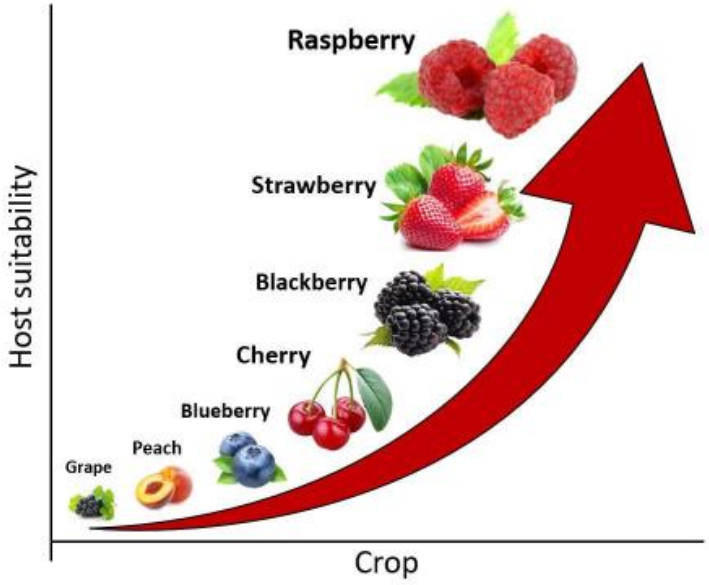
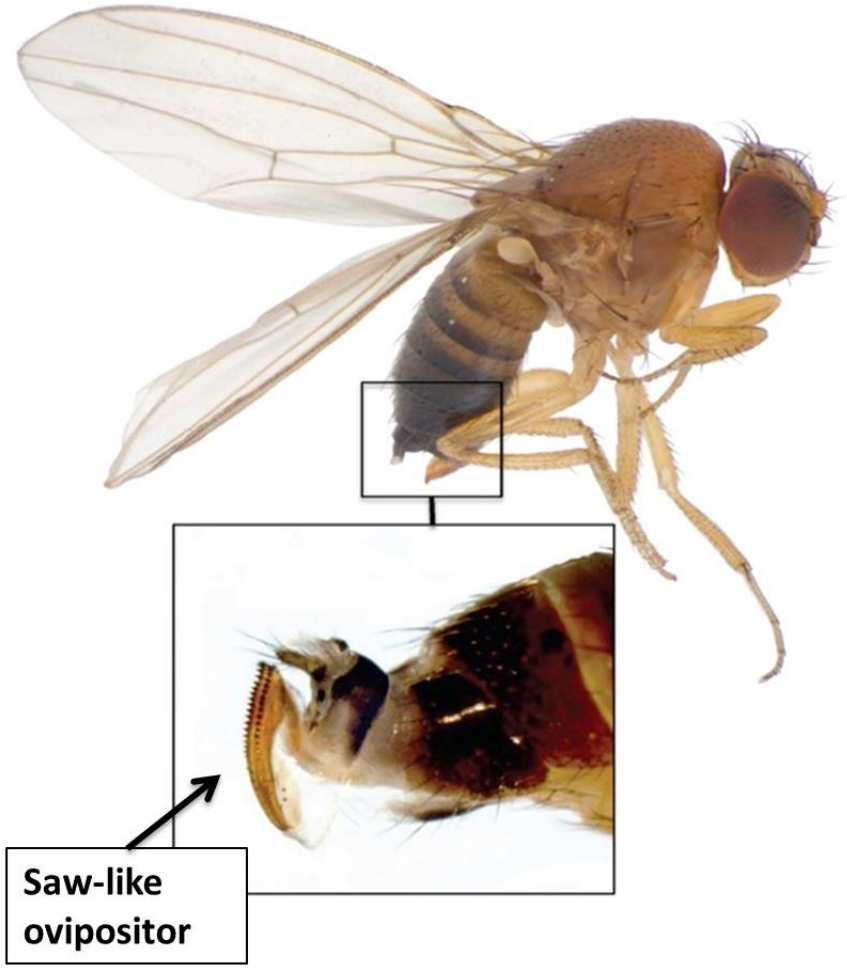


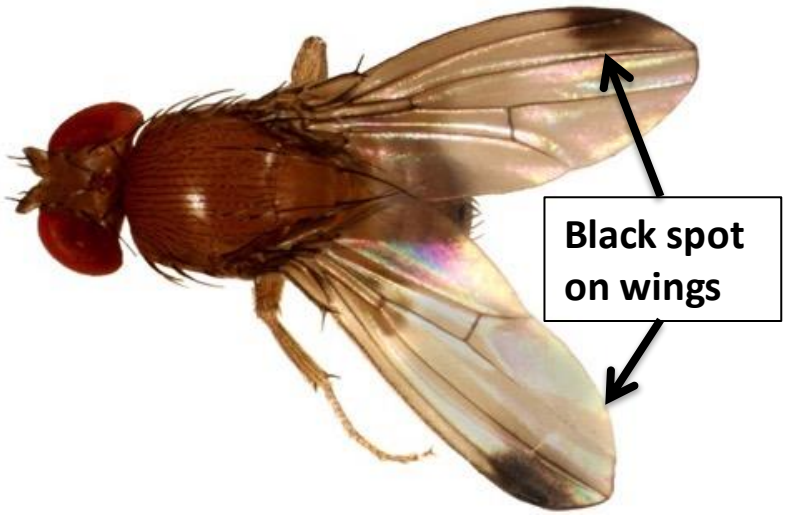
Illustration: Marco Rossi-Stacconi, © Oregon State University

Identification

Female



Male



Biology

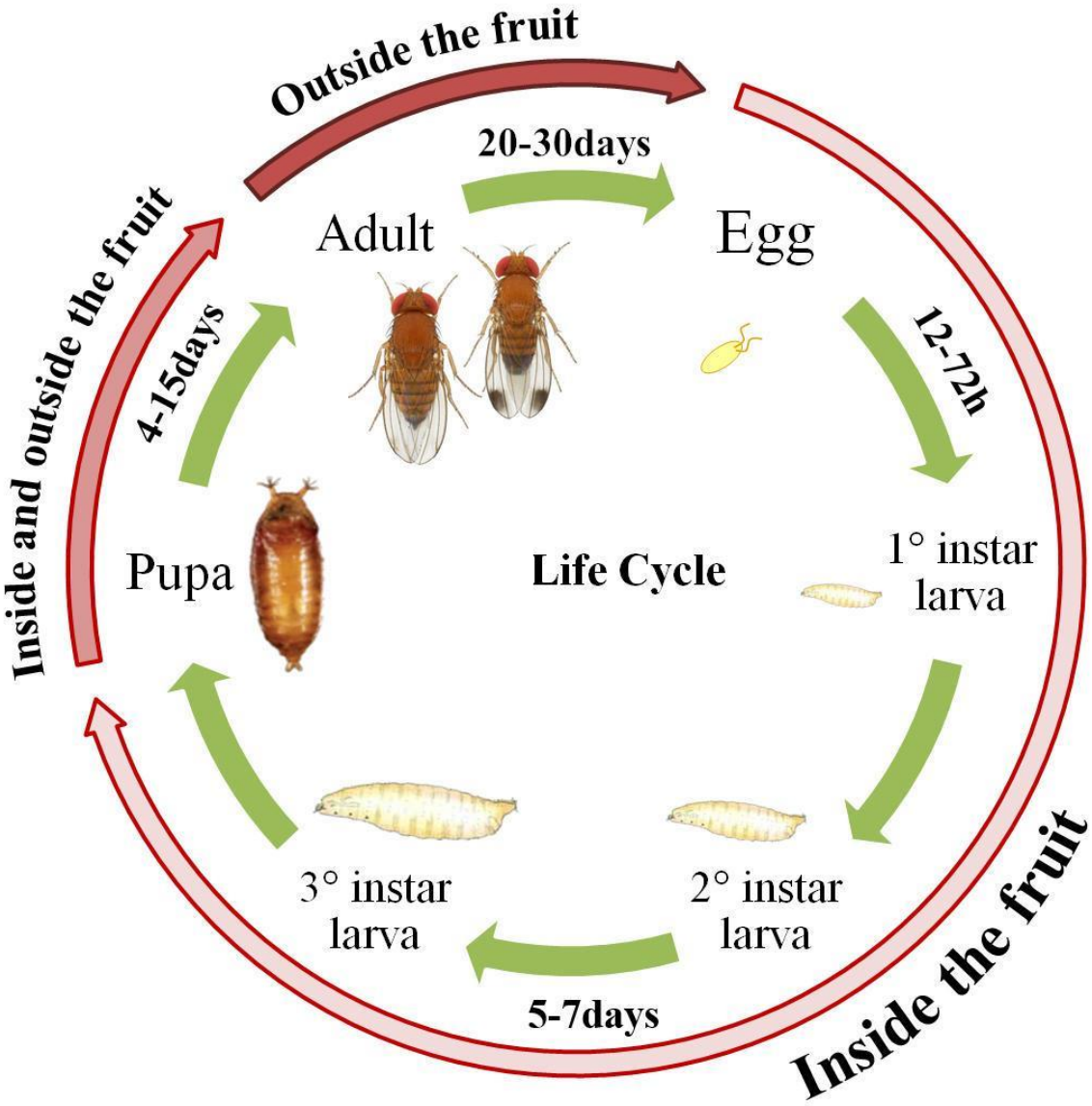
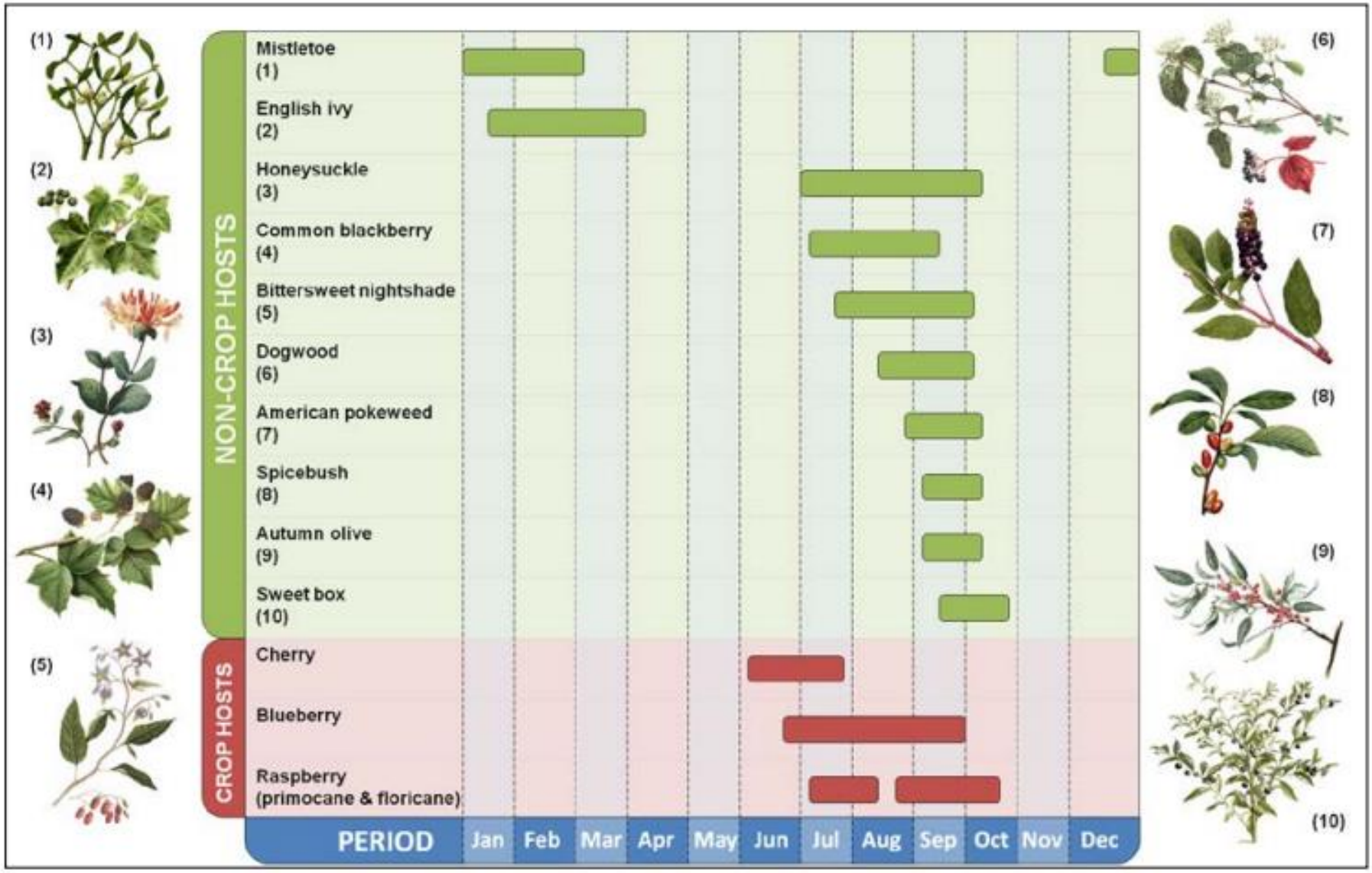


Illustration: Marco Rossi-Stacconi, © Oregon State University

Non-Crop Hosts



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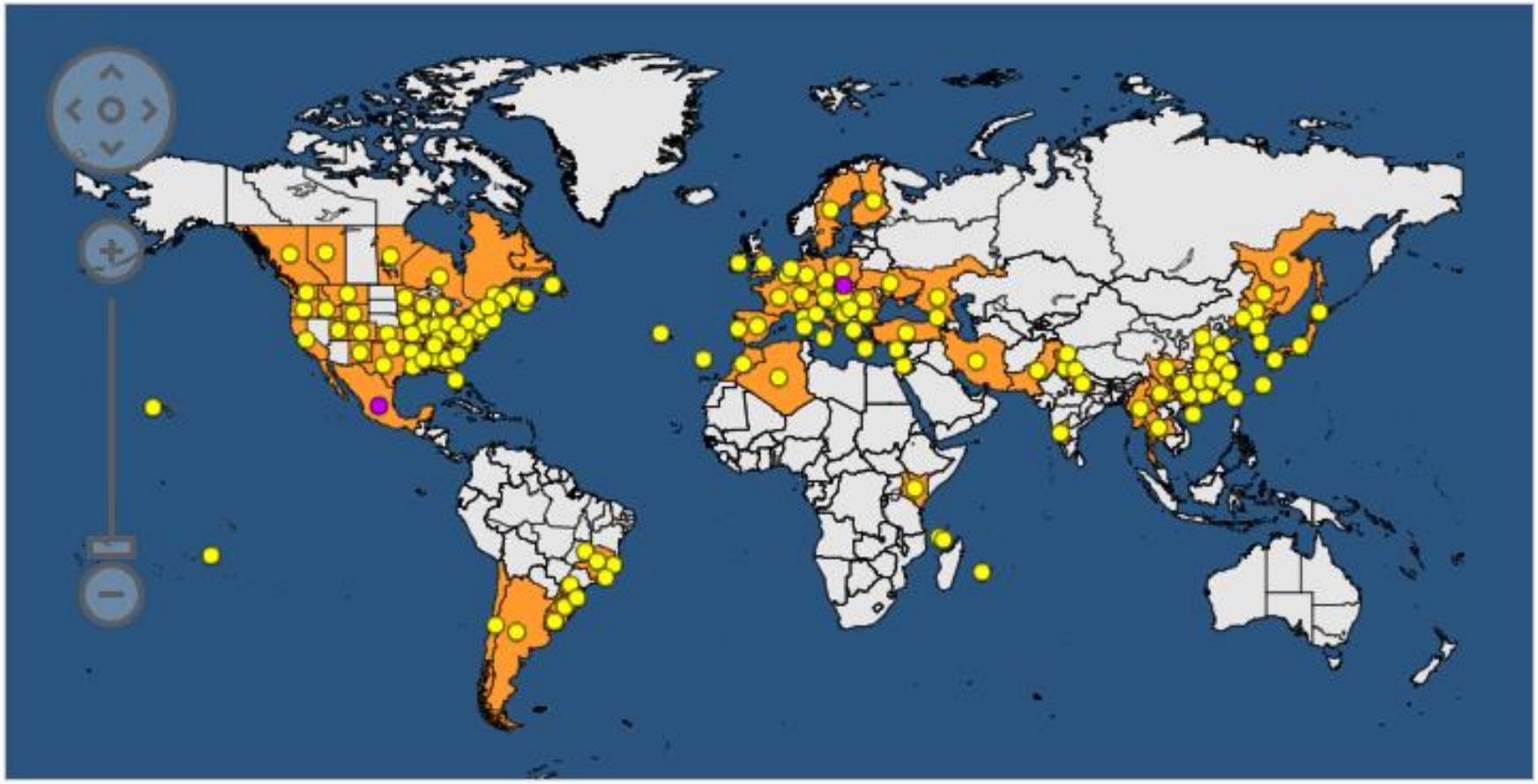
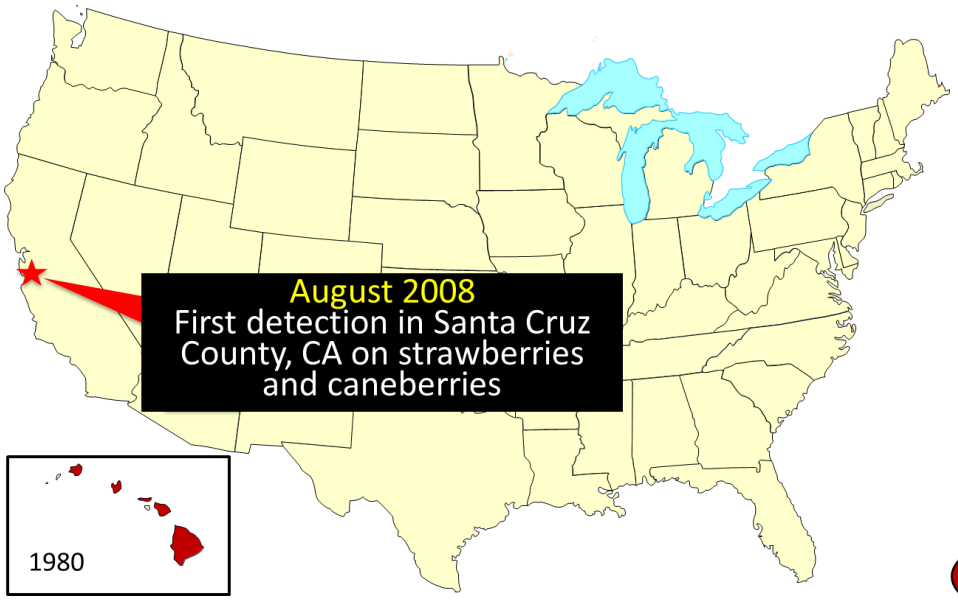
Distribution Worldwide



Legend: Present Transient

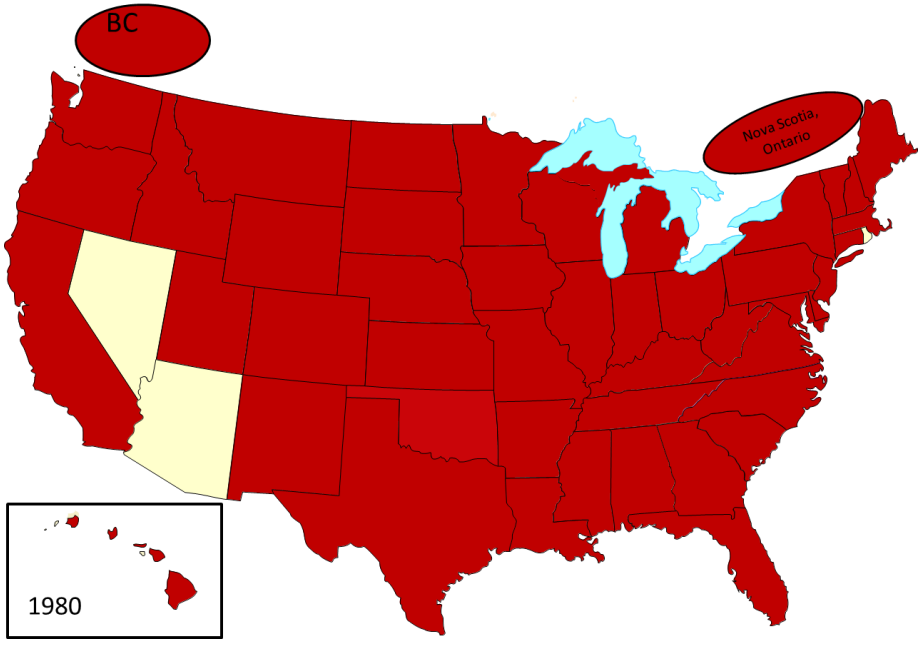
EPPO Global Databas

Distribution in the USA



2008

2015

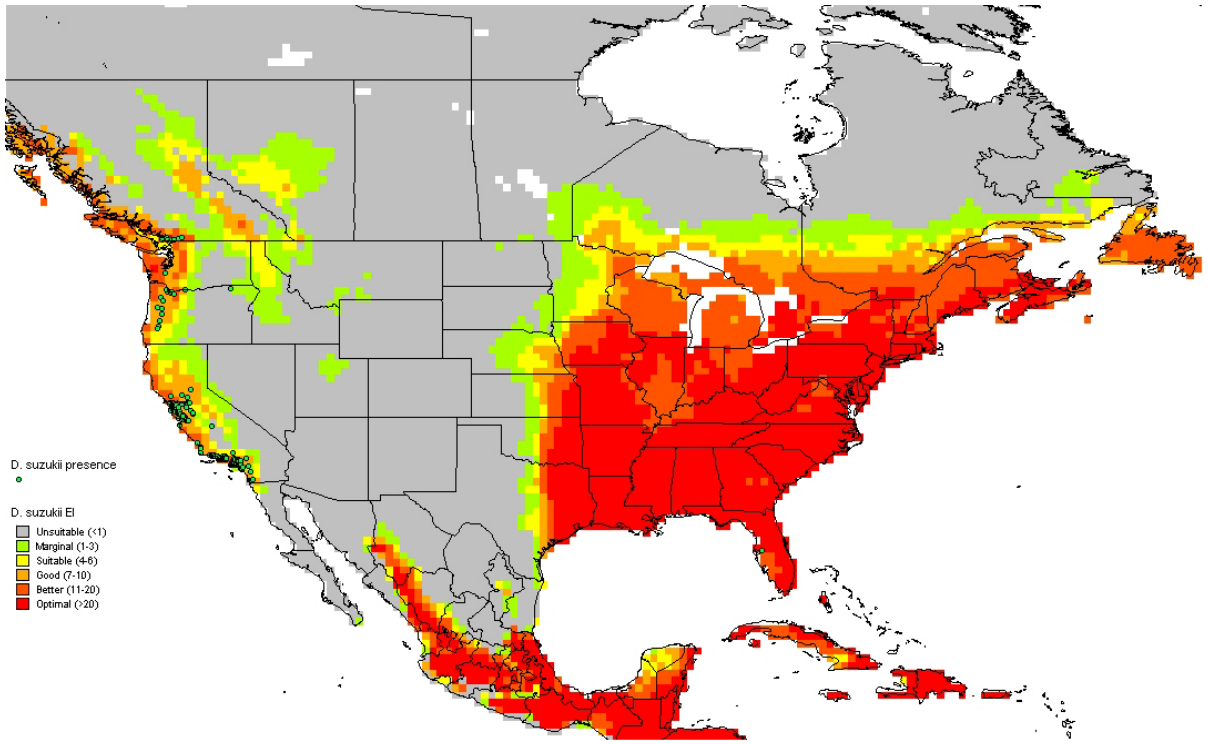


Distribution in the USA

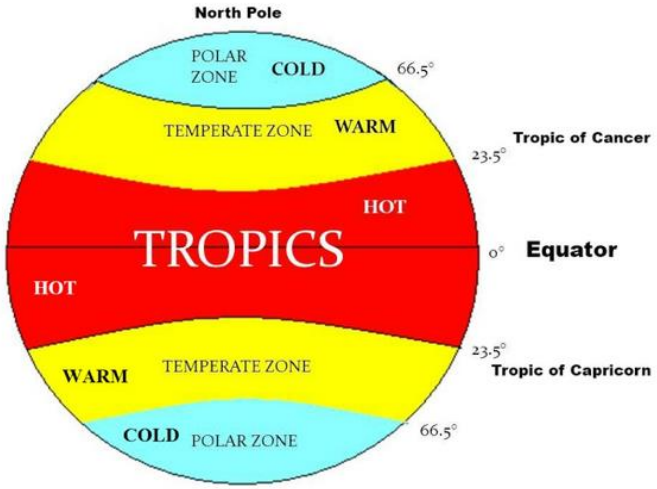
OPTIMUM ACTIVITY:

68 – 86°F (20 – 30°C)

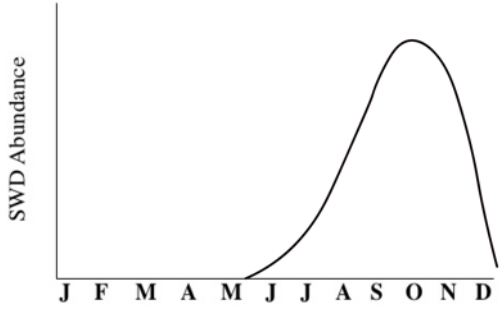
Limited by high temperatures, low humidity



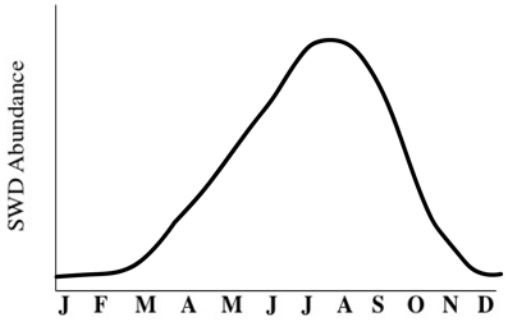
Seasonality



Northern Temperate

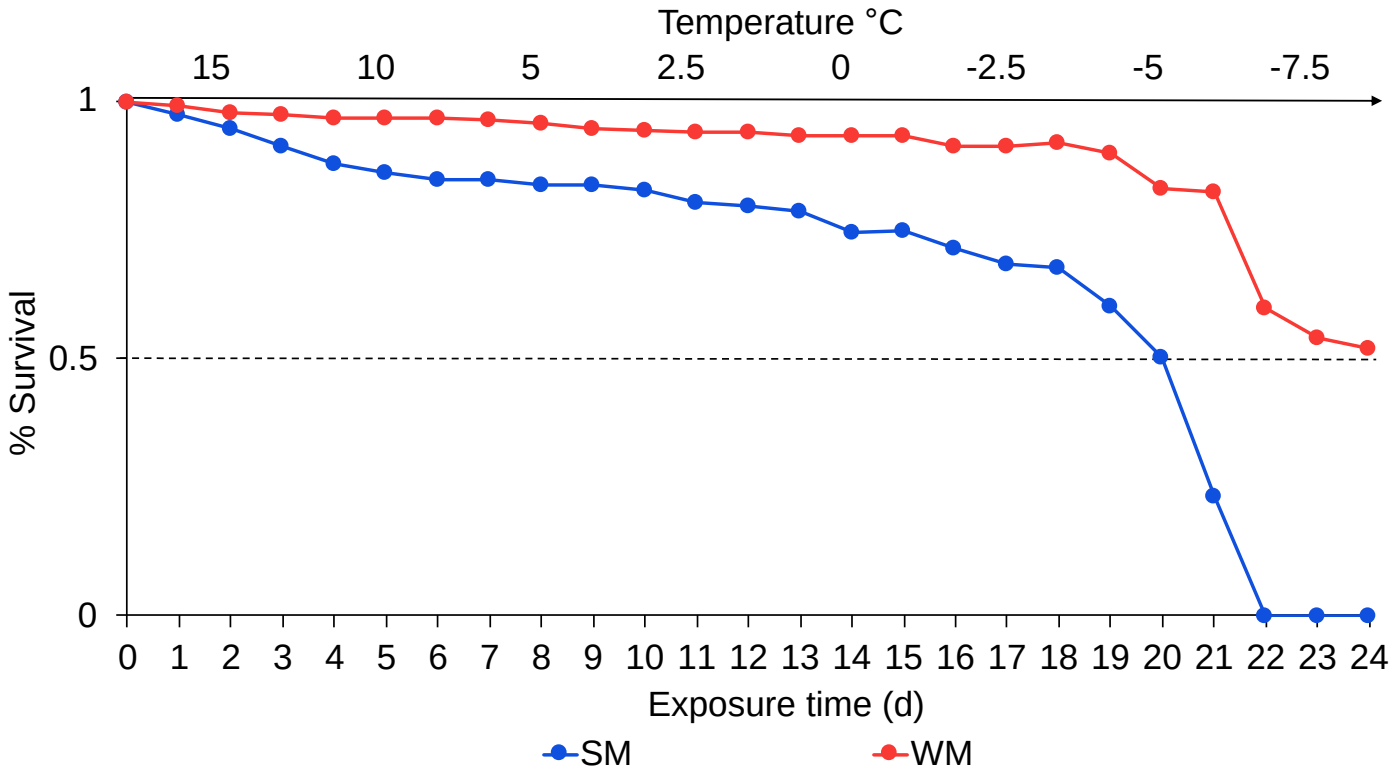


Temperate



Mediterranean

Seasonality



Summer morph **Winter morph**

Winter-morph flies survive below freezing temps with acclimation; require food for long term survival.

Infestation risk is related to severity of winter.

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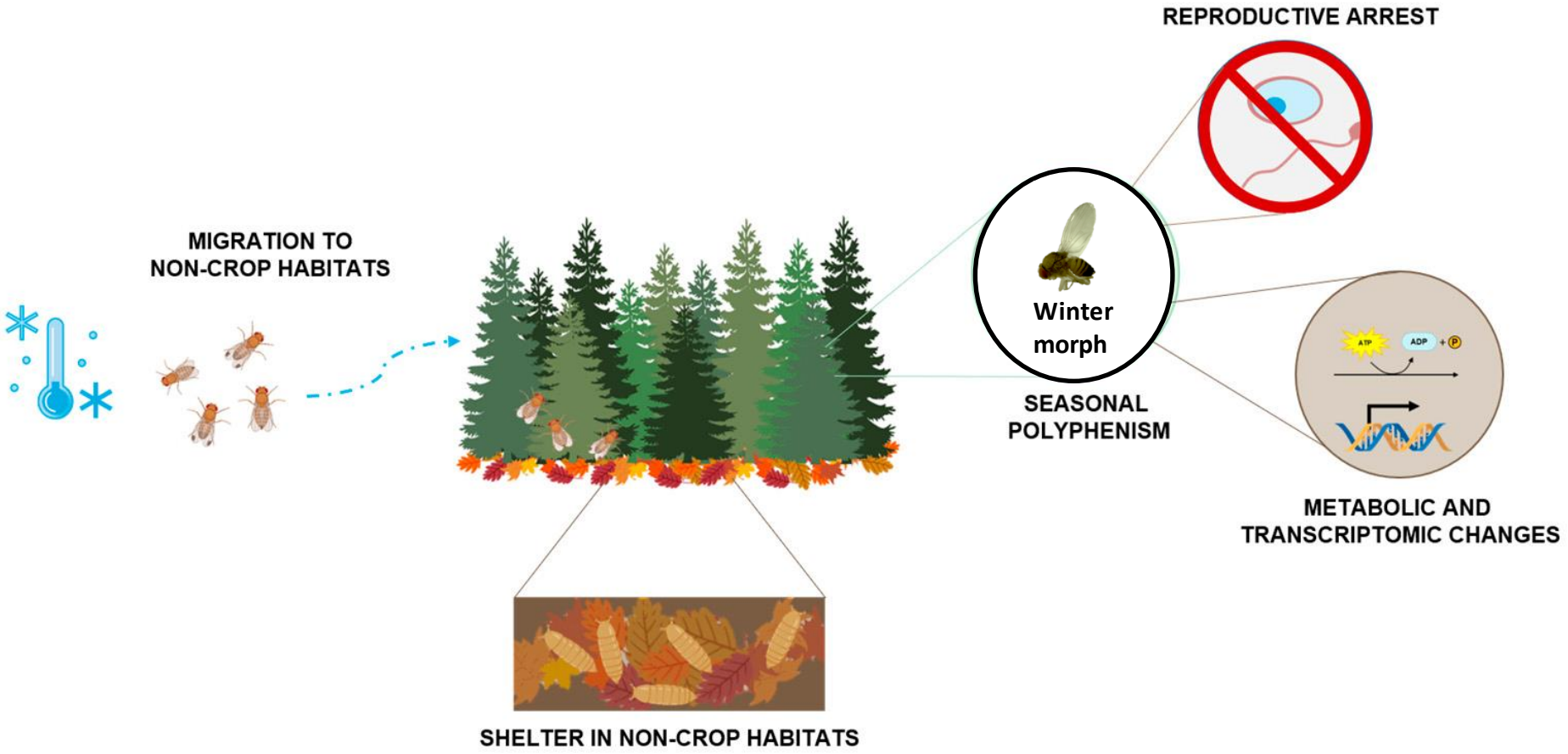
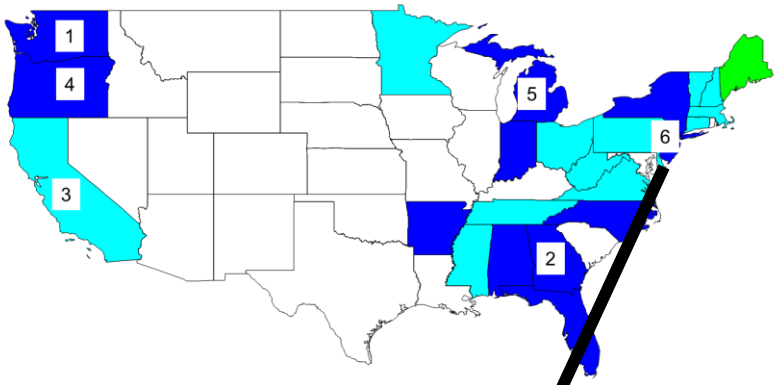
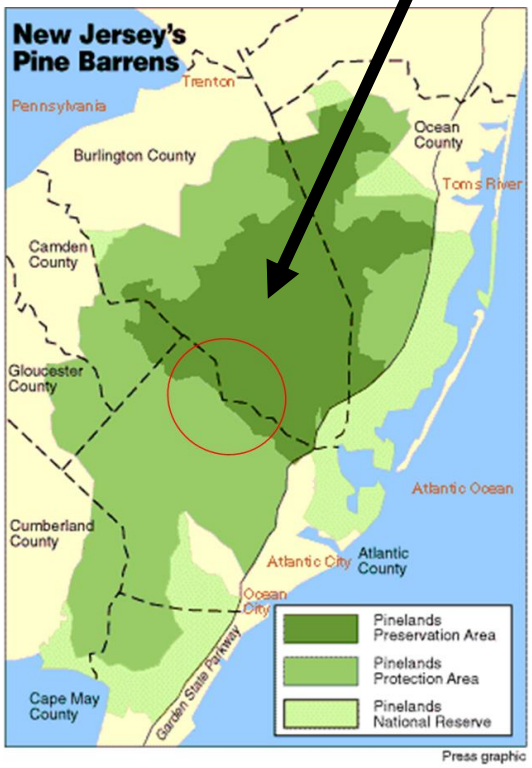
Seasonality



Sario at al. Biology 2023

Blueberry Production in New Jersey





- Only northern highbush blueberries (*Vaccinium corymbosum*) are grown in New Jersey
- $65 million industry in New Jersey, predominantly in Atlantic & Burlington Counties grown in 9,300 acres
- New Jersey is the sixth largest producer in US
- More than 75% of New Jersey production for fresh market

Native Blueberry Pests

Blueberry Maggot Fly
(*Rhagoletis mendax*)

NATIVE

Historically, the blueberry maggot fly was the driver of insecticide application during harvest.

SWD has supplanted the blueberry maggot as main target of insecticide in New Jersey

Interaction of SWD and the blueberry maggot has not been documented

Question: Do local climate influences population numbers and activity of SWD and blueberry maggot?

Trapping Data

- Average weekly captures across 41 highbush blueberry farms in Burlington and Atlantic counties
  - Blueberry maggot: 72 sites
  - SWD: 54 sites
- Deployed around Memorial Day, ~when 'Duke' variety starts to turn blue
- Completed at the end of August
- Compare **peak** blueberry maggot and **average July** SWD captures

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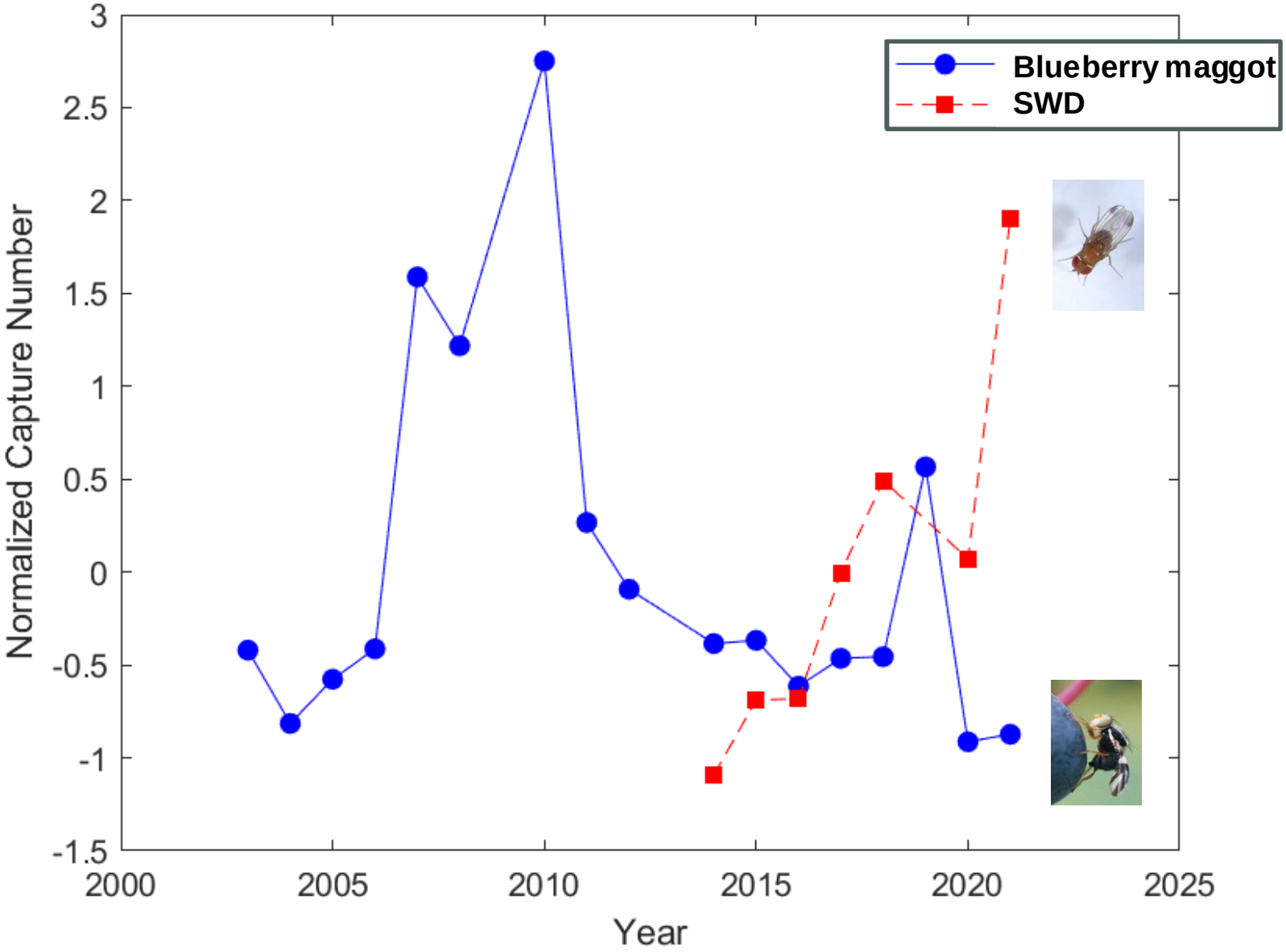
Average Trap Captures



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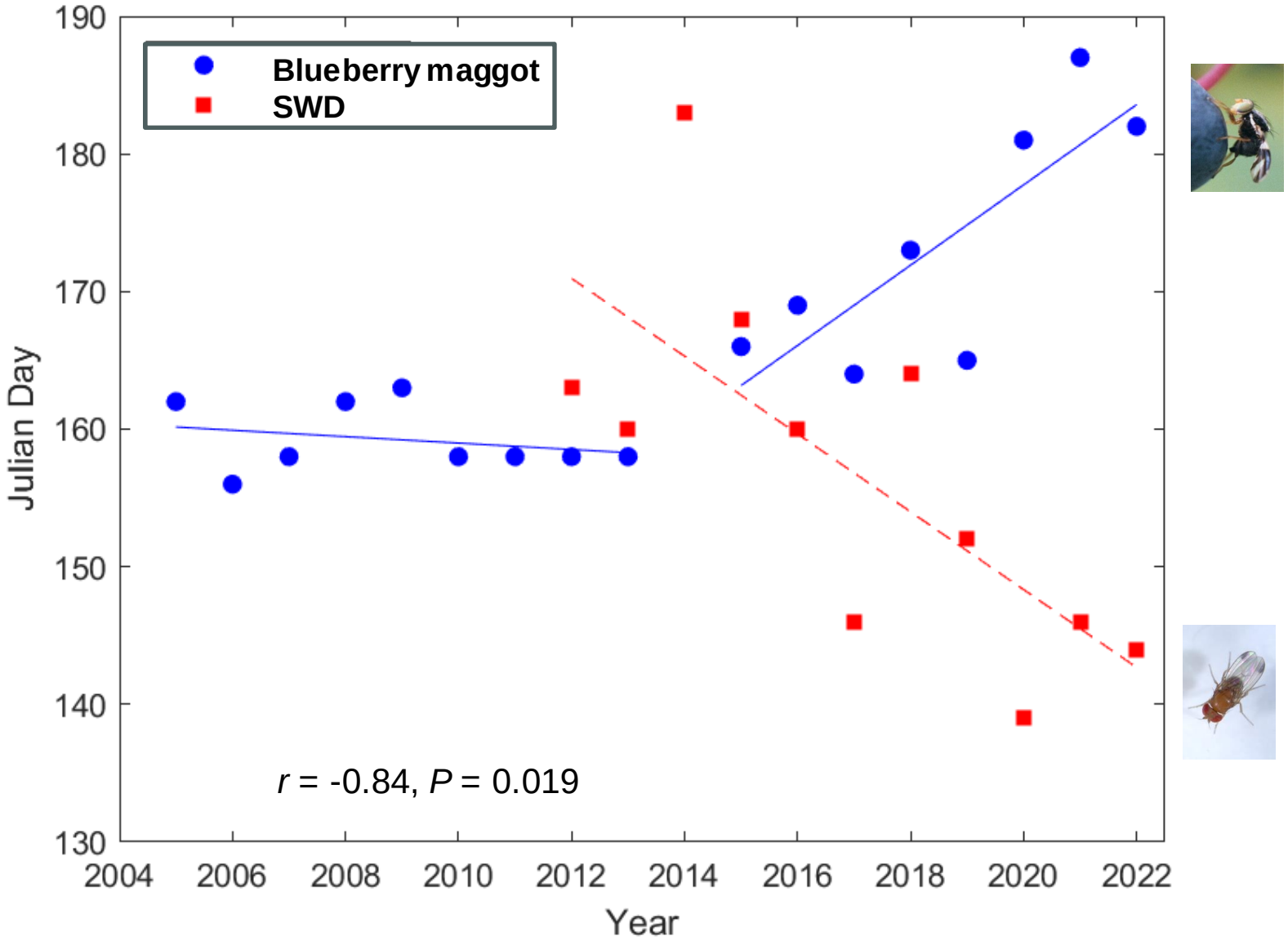
First Capture Days



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Capture Summary

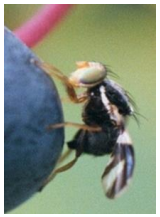
Blueberry maggot peak captures decrease from 2015 to present

SWD mid-season captures increase from 2015 to present

Likely a case of **competitive displacement**

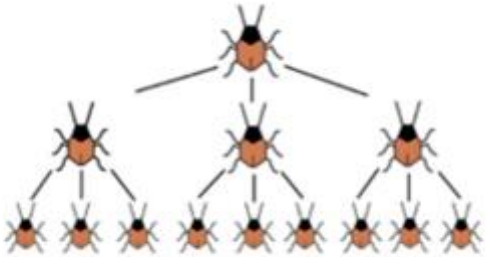
Blueberry maggot first captures

- Prior to 2013: Jun 5 – Jun 12
- 2021: Jul 6



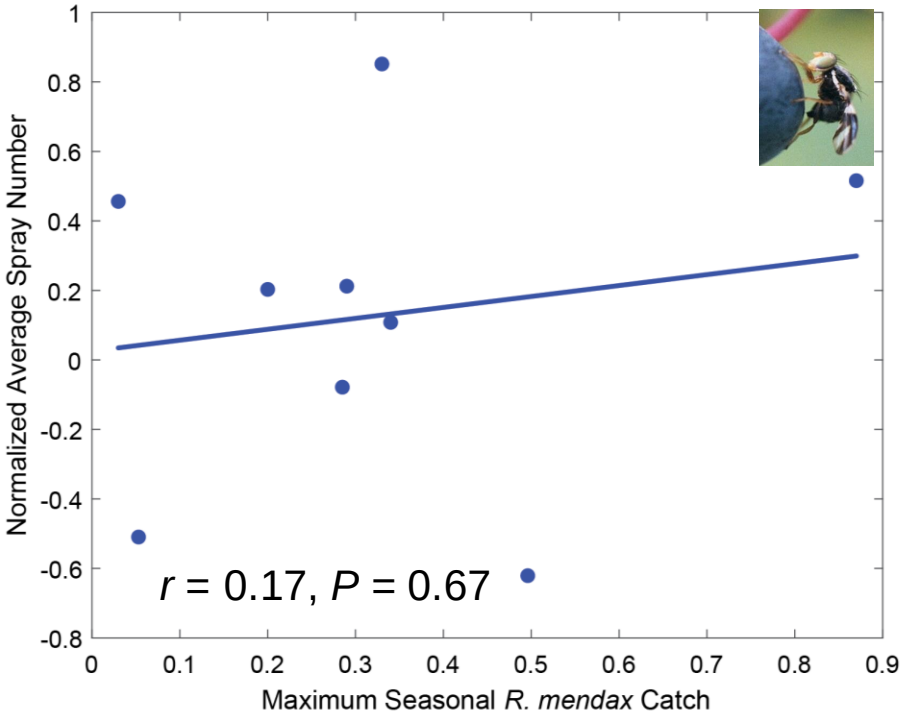
SWD first captures

- 2015: Jun 17
- 2022: May 24

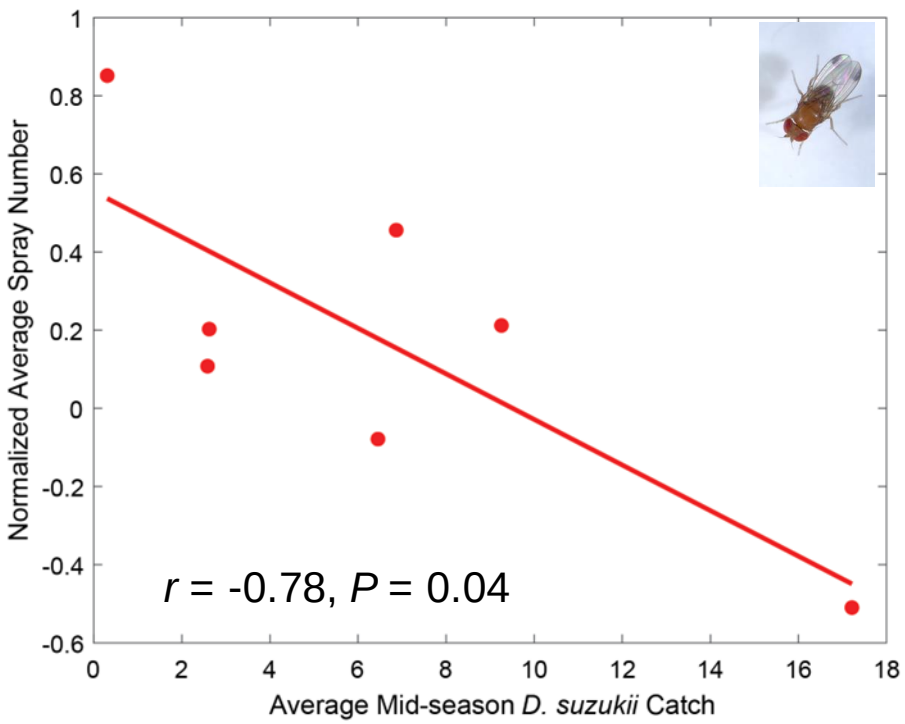


Increased number of generations

Insecticide applications do not account for these trends



Blueberry Maggot



Spotted-Wing Drosophila

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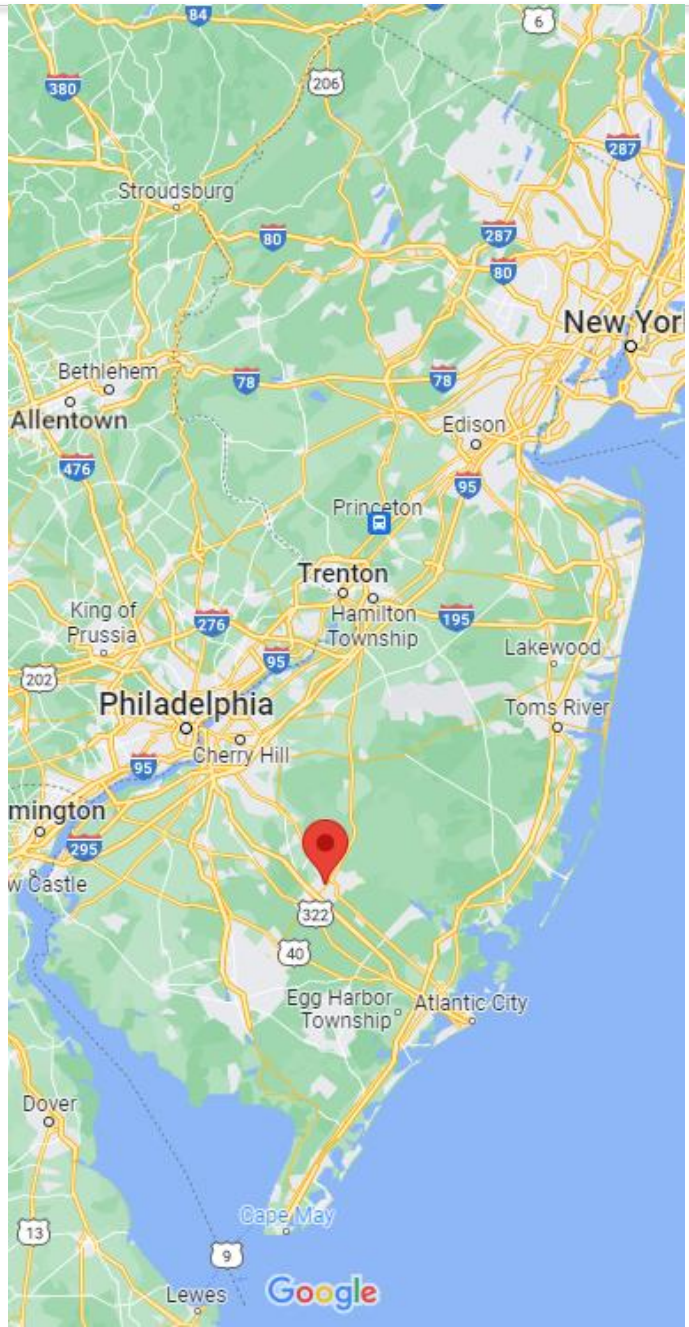
Seasonal Climate Factors



Climate records of daily:

- Average temperature
- Precipitation
- Dew point
- Vapor pressure deficit

Dr. James Shope
Department of
Environmental Sciences

Oregon State's PRISM data set

PRISM CLIMATE GROUP

Summarized by season

- Winter (Dec – Feb)
- Spring (Mar – May)
- Summer (Jun – Aug)
- Fall (Sep – Nov)

First Capture Dates vs. Climate Factors

Variable	SWD 2015–2022	Blueberry maggot 2005–2022	Blueberry maggot 2005–2013	Blueberry maggot 2015–2022
Winter Freezing Degree Days	**0.85**	0.14	−0.31	0.36
Summer Average Temperature	**−0.86**	0.04	−0.52	0.36
Summer Average Dew Point	**−0.87**	0.29	**−0.76**	0.62
Summer Growing Degree Days	**−0.86**	0.04	−0.52	0.36
Summer Average Precipitation	−0.04	0.35	−0.28	**0.73**

*Bolded numbers indicate significant correlations with $P \leq 0.05$.

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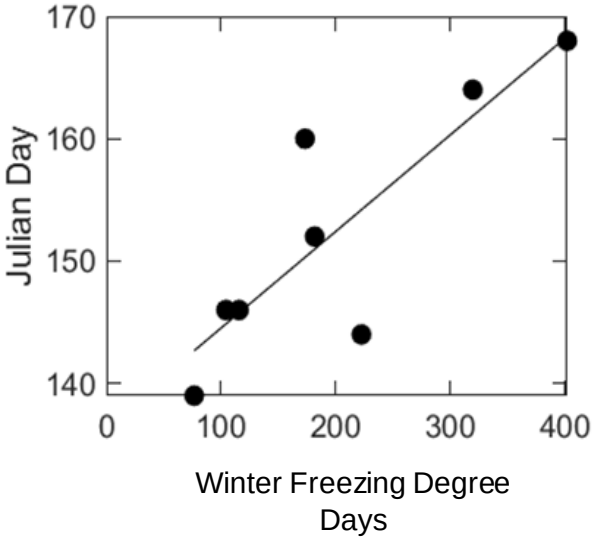
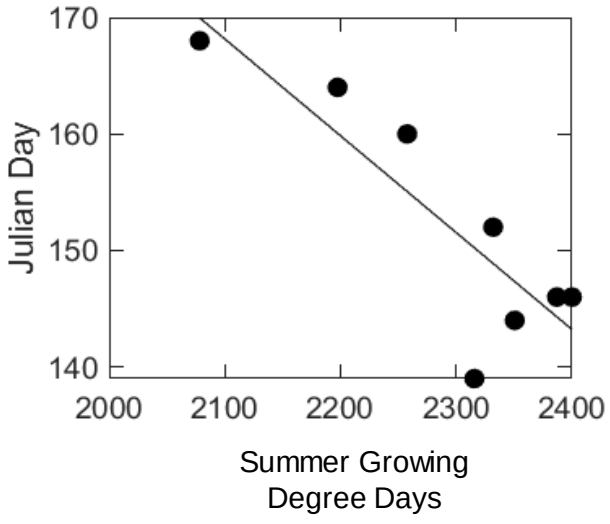
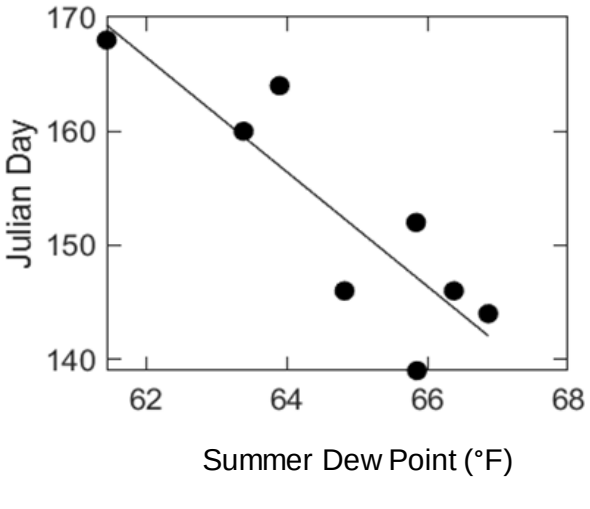
First Capture Dates vs. Climate Factors







Winter and summer temperatures account for these trends

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Climate Summary

Blueberry Maggot

Capture Numbers

- Not correlated with seasonal conditions

First Captures

- Prior to SWD invasion: Summer dew point
- After SWD invasion: Summer rainfall

Increased overwintering survival

Spotted-Wing Drosophila

Capture Numbers

- Not correlated with seasonal conditions

First Captures

- **Winter freezing temperatures, summer temperatures, summer dew point**

SWD Predictive Model

Based on **winter and prior summer conditions**

Climate projection data from: NOAA's Applied Climate Information System

- Temperatures, precipitation

Goals

1 – help project annual SWD arrival in New Jersey blueberry fields for IPM usage

2 – inform how climate change may affect SWD arrival dates over the next 20–30 years

ACIS Applied Climate Information System

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SWD First Capture Model

Linear Model	Coefficient(s)	Intercept	r^2	RMSE (days)	AIC
Winter DD_{32}	0.079	136.636	0.72 (0.69)	6.034	53.2
Summer DD_{50}	−0.083	342.626	0.74 (0.69)	5.792	52.5
Winter DD_{32} + Summer DD_{50}	$0.0378_{\text{Winter DD32}}$, $-0.0490_{\text{Summer DD50}}$	257.043	0.78 (0.69)	5.849	53.2

Preliminary 2024 projection:

Winter – May 22

Summer – June 10

Winter + Summer – June 01

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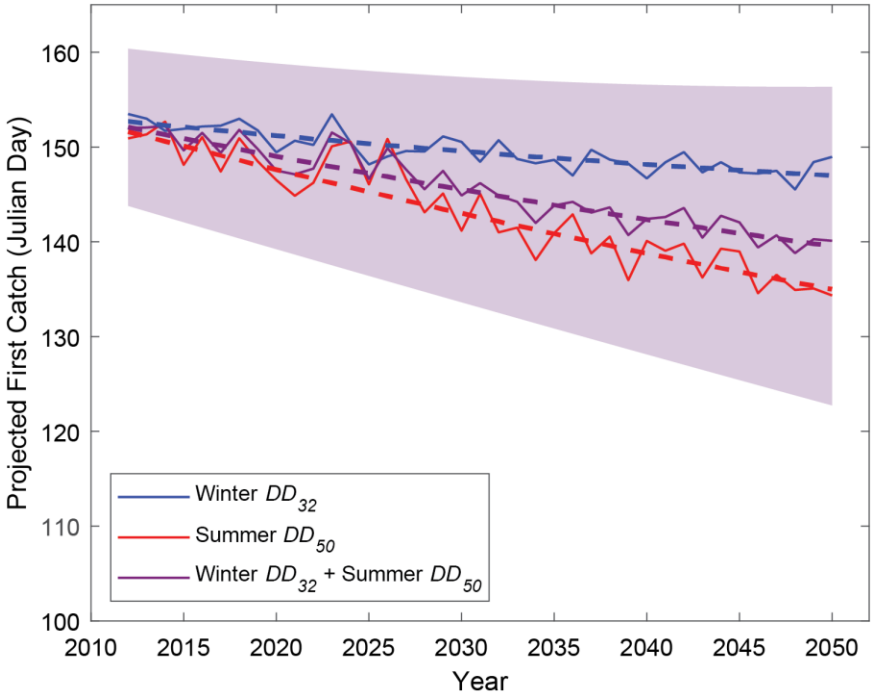
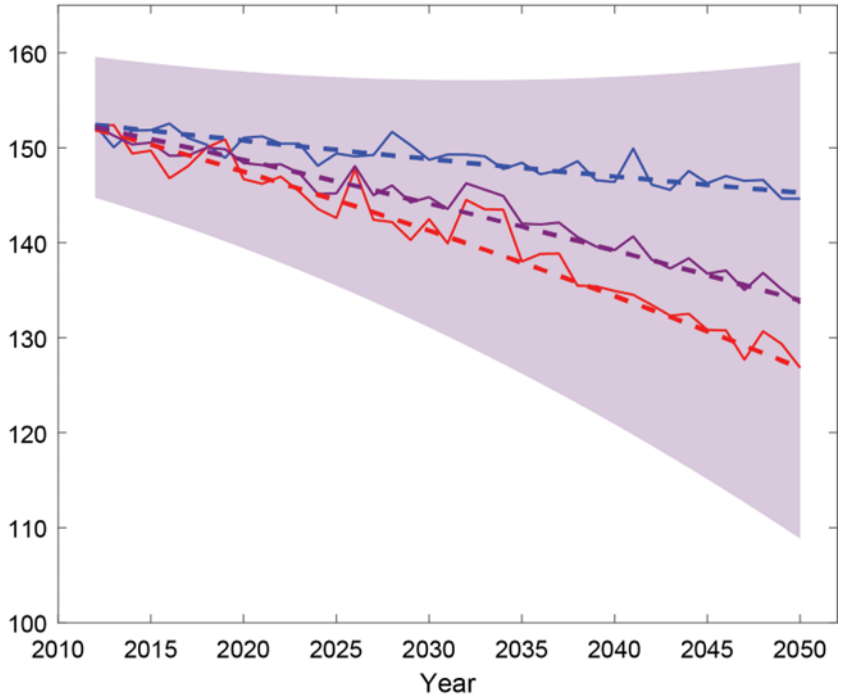
SWD Future Climate Projection

Moderate Greenhouse Gas Emissions



High Greenhouse Gas Emissions



Change from 2020

2030: 3.6 earlier

2050: 9.7 days earlier

2030: 3.9 days earlier

2050: 14.5 days earlier

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Takeaways

1. SWD is likely out-competing the blueberry maggot for resources

2. As SWD population grows and arrives earlier each year, the blueberry maggot population drops and arrives later

3. As an invasive, SWD is heavily influenced by seasonal temperatures
   - Summer degree days and winter freezing degree days heavily influence SWD activity
   - No tangible seasonal climate influence on the blueberry maggot

4. Simple projection indicates SWD likely to arrive 4 days earlier on average by 2030 and 10-14 days earlier by 2050

5. Population and activity of the blueberry maggot are likely to continue to decline

PLOS ONE

RESEARCH ARTICLE

The contrasting role of climate variation on the population dynamics of a native and an invasive insect pest

James Shope[1]*, Dean Polk[2], Carrie Mansue[3], Cesar Rodriguez-Saona[4]

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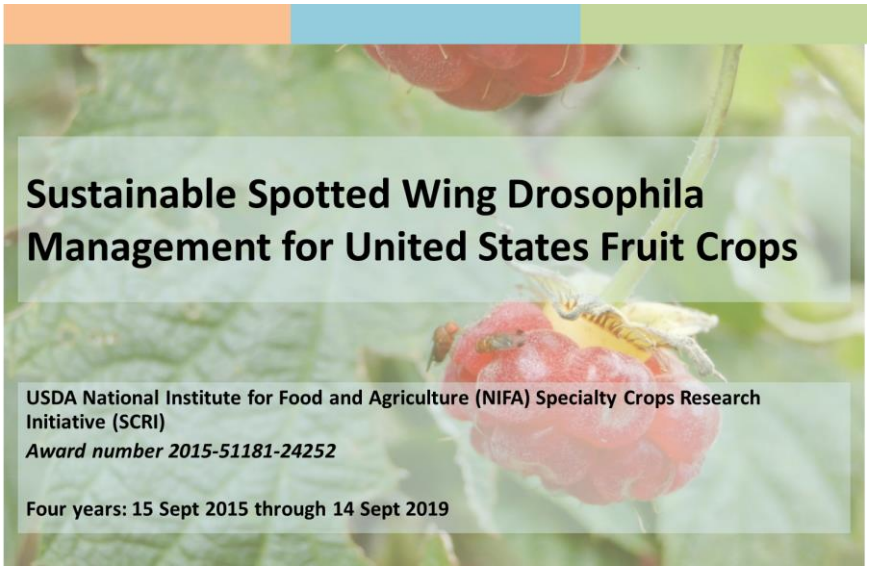
Sustainable SWD Management



MOVING FROM CRISIS RESPONSE TO LONG-TERM INTEGRATED MANAGEMENT OF SWD: A KEYSTONE PEST OF FRUIT CROPS IN THE UNITED STATES

USDA National Institute of Food and Agriculture, Specialty Crop Research Initiative (SCRI)

Award No. 2020-51181-32140

USDA NIFA

United States Department of Agriculture
National Institute of Food and Agriculture

SWD NATIONAL IMPACT SURVEY

WHAT ARE WE DOING?

We are conducting a national survey to better understand **the impact of research conducted by land-grant university faculty on spotted wing drosophila (SWD) mitigation** across the United States.

WHY ARE WE DOING THIS?

To **advance research efforts** focused on **developing more effective and efficient** SWD **management tools** to **meet your needs.**

HOW DO YOU PARTICIPATE?

By **scanning** the **Qrcode** or **click the link** https://ufl.qualtrics.com/jfe/form/SV_9B5kHcjLIRgW9gO

WHEN?

Now!

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