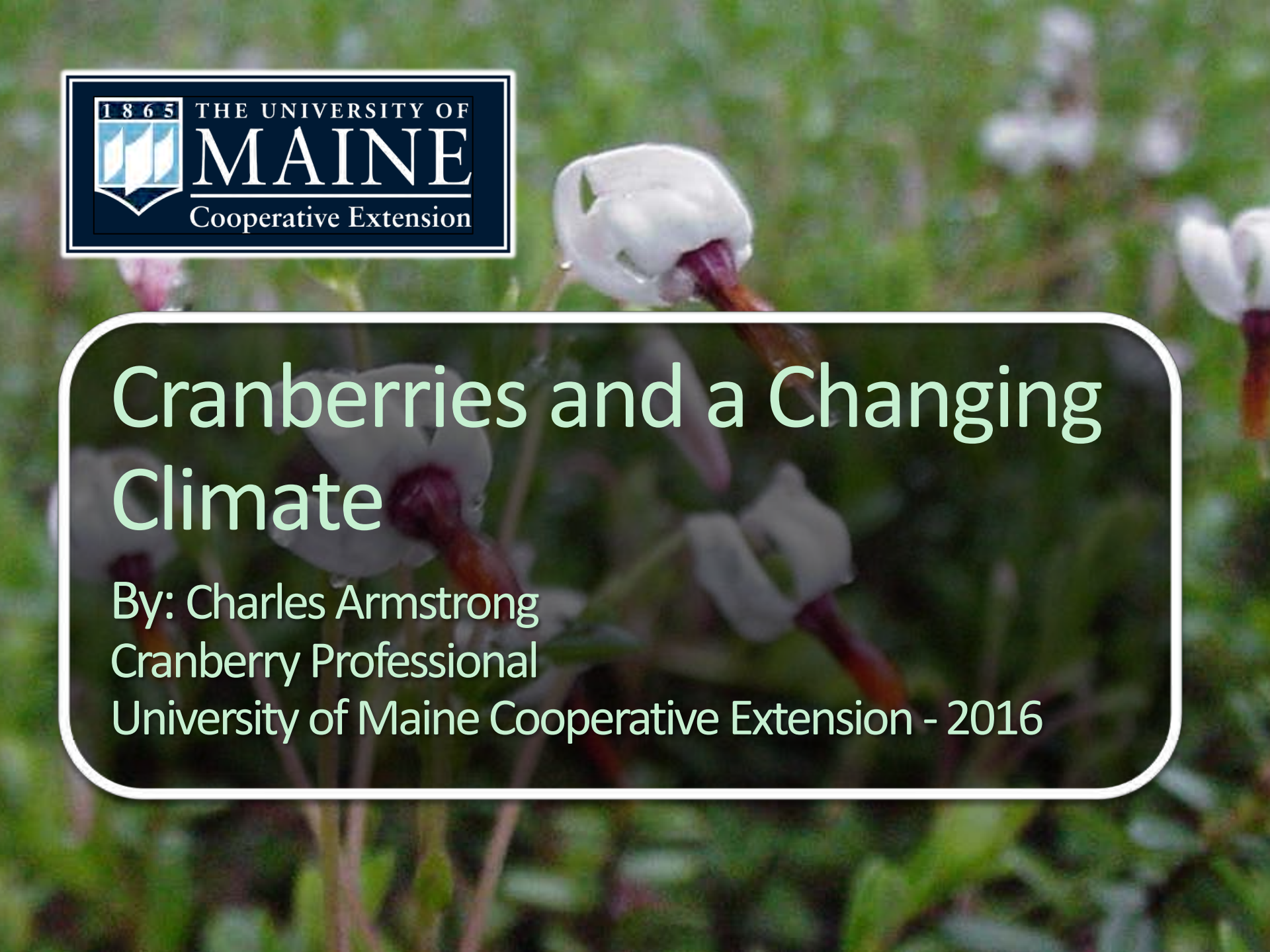


Cranberries and a Changing Climate

By: Charles Armstrong
Cranberry Professional
University of Maine Cooperative Extension - 2016

Family Ericaceae

[heather / heath family]

Genus *Vaccinium*:

- cranberry
- blueberry
- lingonberry
- bilberry (whortleberry)
- cowberry
- huckleberry

Vaccinium genus contains about 450 species, which are found mostly in the cooler areas of the Northern Hemisphere.

What do cranberries like/need?

- **Indigenous to the Temperate Zone** (native only to North America).
- **Acidic pH (4.0 to 5.5)**
- Full sun (generally the more sun, the better)
- **Optimum growth occurs from 60°F to 80°F.**
- **Cool temperatures when fruit are maturing** (as temperature goes down, anthocyanin production goes up)
- **Access to abundant water** ('boggy'/peat habitats).
- **Cold winters** (to satisfy the plant's chilling requirement)

Winter ‘resting’ period (chilling requirement)

Cranberry plants have what is called a “chilling requirement.” Abnormal blossoming has been observed to take place in Massachusetts when plants received less than 1500 hours (~62 days) below 45°F during the winter. This resulted in abnormal blossoming called **“Umbrella Bloom”** in which the stem above the flowers does not grow or does not grow very much.

There is also some evidence to suggest that the chilling hours may be lost during ‘ups and downs’ of temperatures that often occur in the Northeast in December and January, such that chilling hours may have to start accumulating all over again.

“Umbrella Bloom”

Without the 1” to 2” of stem growth (with accompanying leaves), there is very little photosynthetic carbon available to the upright; thus, usually no more than just *one* cranberry per stem is obtained on those stems, when otherwise two or more berries per stem would be possible.

Umbrella Bloom

Potentially a 50% yield reduction if going from 2 berries per stem to only 1 berry per stem.

Cranberry Pests — *How do they overwinter?*

- **Egg stage** (*least* vulnerable to cold) [cold temperatures & cold *duration*]
  - ✓ Blackheaded fireworm
  - ✓ Redheaded flea beetle
  - ✓ Gypsy moth
  - ✓ Green spanworm
  - √ Chainspotted gemeter
  - √ Cranberry blossomworm
  - √ Blunt-nosed leafhopper
- **Pupal or Larval stages** (a bit more vulnerable to cold):
  - ✓ Cranberry tipworm (pupa)
  - ✓ Brown spanworm (pupa)
  - ✓ Big cranberry spanworm (pupa)
  - √ Cranberry fruitworm (larva)

    Spends winter as larva inside a cocoon called a hibernaculum
- **Adult stage** (even *more* vulnerable to cold):
  - ✓ False armyworm moths
  - ✓ Cranberry weevils
  - ✓ Winter moth

Climate change projections of milder and shorter winters for the northeast should aid in the survival of these three pests!

Climate Projections for Northeast:

Temperature

- **Near-term (2010-2040):**
  - ✓ ~2.5°F rise in the annual average temperature
  - ✓ Slightly higher than 2°F rise in the spring and summer average
  - ✓ ~3.0°F to possibly 3.4°F rise in winter's average temperature
- **Mid-century (2040-2070):**
  - ✓ Between 3.8°F and 4.8°F rise in the annual average temperature
  - ✓ Similar rise (3.8°F to 4.8°F) for summer & fall; 3.5 to 4.1°F for spring
  - ✓ 4.0°F to 5.4°F rise in winter's average temperature
- **End-of-century (2070-2100):**
  - ✓ Between 5.4°F and 9.0°F rise in the annual average temperature (similar rise for winter, summer, and fall) (range of 4.2 to 10.8°F)
  - ✓ 5.0°F to 8.1°F rise in the spring average temperature
  - ✓ **Shorter winters** (snow season cut in half in Maine!)

Figures from a report by the USDOT's Federal Highway Administration (using data from USGCRP):
https://www.fhwa.dot.gov/environment/climate_change/adaptation/publications/climate_effects/

Climate Projections for Northeast:

Rise in number of "extreme heat days":

- **Near-term (2010-2040):**
  Boston: 4 to 8 more days per year above 90°F
- **Mid-century (2040-2070):**
  Boston: 12 to 29 more days per year above 90°F
- **End-of-century (2070-2100):**
  Many US Northeast cities ~13 to 63 more days reaching 90°F compared to years 2010-2016

Figures from a report by the USDOT's Federal Highway Administration (using data from USGCRP):
https://www.fhwa.dot.gov/environment/climate_change/adaptation/publications/climate_effects/

Likely Consequences

Higher Temperatures; Likely Consequences:

Warmer/earlier springs:

- Buds swelling sooner/faster (sensitive to frost *sooner* than growers are accustomed to)
- Potentially more nights needing to protect from frost

Higher Temperatures; Likely Consequences:

If warmer in late summer:

- Berry *scalding* - when berries are injured from the heat (already poses a challenge in NJ and MA)
- Poorer berry color resulting in less nutritious fruit (less anthocyanin) and reduced marketability

Higher Temperatures; Likely Consequences:

- **Hotter summers:**
  - Heat stress/injury to vines/flowers (especially when 90°F +)
  - More days of "too hot for bees".

Potentially fewer honeybees out pollinating!

Bee Protection:

Hotter summers will put added stress on the bees, so it will be more important than ever to consider bee toxicity when a pesticide is applied during any period when bees could be exposed. The list of products for cranberries is sure to look different in the future, but this is how it looks as of 2016:

Table of Relative Risk to Honey Bees

The lower the risk quotient, the safer the product is for bees.

Insecticide	Honey Bee Toxicity LD50 (µg / bee)	Rate Used (lbs / acre) a.i. per application	Relative Risk Quotient (use rate / toxicity)
Admire®	0.0037	0.5	135
Success®	0.003	0.15	50
Lorsban®	0.06	1.5	25
Diazinon®	0.09	2	22
Actara®	0.024	0.4	16
Delegate®	0.11	0.13	1.2
Assail®	8.09	0.1	0.01
Avaunt®	17.32	0.1	0.01
Intrepid®	100	0.25	0.002
Rimon®	>100	0.078	0.00078
Altacor®	>104	0.099	0.00095

Highly toxic to honey bees!

Higher Temperatures; Likely Consequences:

- **Shorter and milder winters:**
  - Chilling requirement more and more difficult to satisfy, giving rise possibly to more and more "umbrella bloom"
  - Better survival of insect pests, especially false armyworms, cranberry weevils, and winter moths . . . *but all the insect pests would stand to benefit*.

Greater risk of lower yields!

Higher Temperatures; Likely Consequences:

- ***more*** **False armyworm**
- ***more*** **Cranberry weevil**
- ***more*** **Winter moth**

Of all our cranberry pests, we should review or familiarize ourselves with the first two pests in particular since these two are already increasing in occurrence and have been a consistent problem on Maine cranberry beds yearly.

Winter moth has yet to be discovered on any of our cranberries but that could change if it continues to spread to more towns and regions of the state; it 'is' a large problem on Massachusetts cranberry bogs.


False Armyworm caterpillars
Xylena nupera (Lintner)

So what's so bad about False armyworm?

Life Cycle:

- There is a single generation per year.
- The moths which have overwintered mate in the early spring.
- Each female moth can lay roughly **600 eggs** in masses of sometimes 100 or more that they place on the cranberry stems or the undersides of the leaves in late April through early May.
- The eggs hatch typically in mid to late May.
- The caterpillars mature at the end of June, then move to the ground where they 'rest' for two to six weeks before pupating.
- The moths emerge from mid to late August through the end of September, and seek out protective places to spend the winter.

So what's so bad about False armyworm?

Cranberry Injury:

- **Early Season (late May through early June):** The caterpillars are the damaging stage, and when they are young, they can do great damage by chewing out the centers of the terminal buds before the new growth begins.
- **Summer:** The caterpillars grow hand in hand with the cranberry growth, eating more and more as they increase in size and feed on leaves, buds, and flowers, eventually reaching 1.5-2" in length at maturity. Upon reaching their larger size of 1" or more, they will begin to feed primarily if not exclusively at night in order to avoid being seen by predators.

False Armyworm Management:

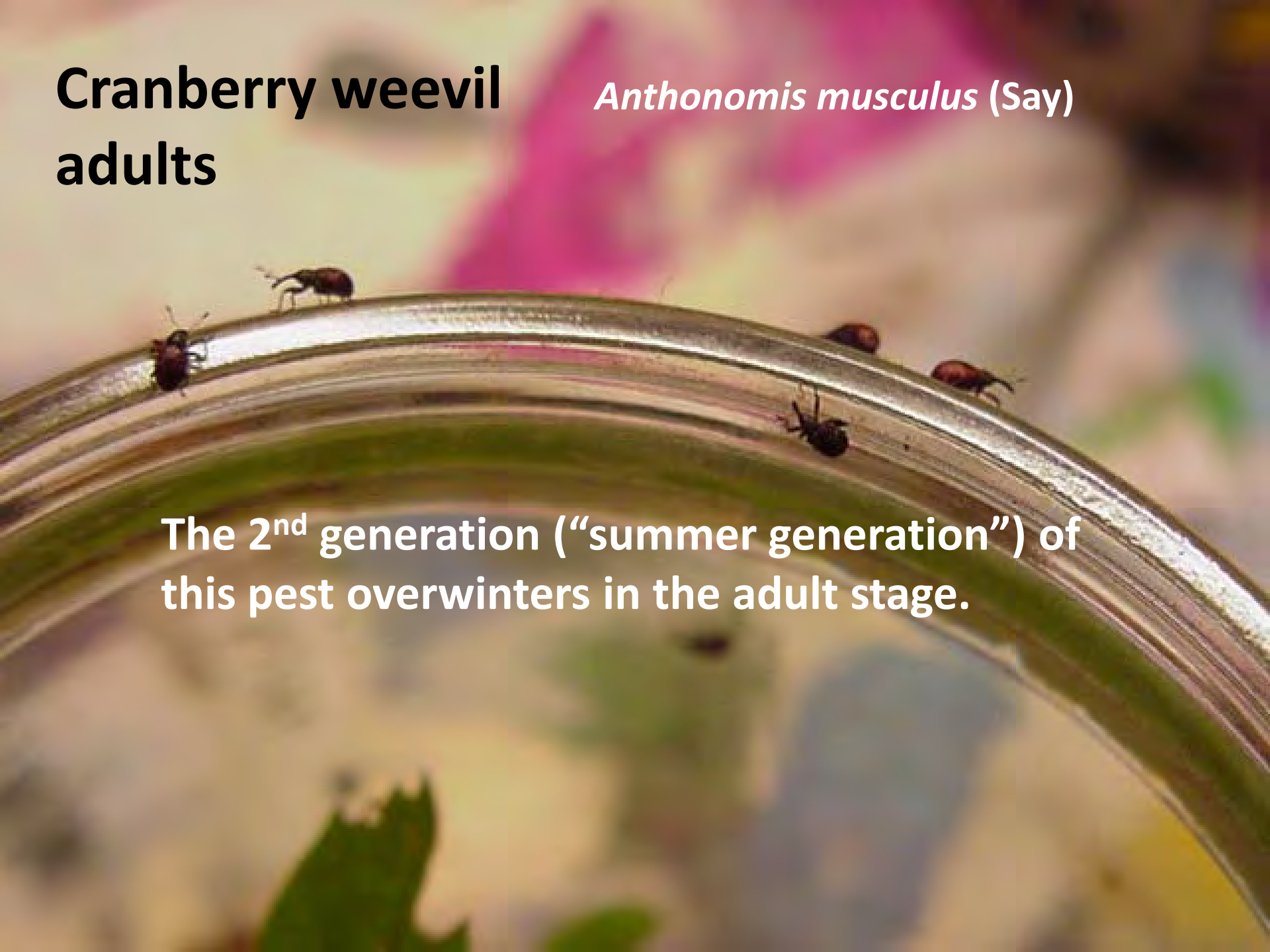
- **Sweeping**:
  - Sweep for the young larvae with a 12”-diameter sweep net starting around May 23rd in Maine; preferably earlier in warmer parts of the state.
  - Action Threshold is 4.5 to 7 larvae per 25 sweeps, depending on cranberry fruit price and individual comfort level; traditional threshold is 4.5
  - Early detection is important
- **The ‘Late Water’ Flood is *very* effective!**: This flood, applied starting around April 21st – April 26th, controls False armyworm, at least in Massachusetts if not also in Maine. It is a 30-day spring reflood applied several weeks after the winter flood has been removed and before the plants have fully lost their dormancy color.
- **Spray Choices (as of 2016)**:

✓ **Altacor®**	✓ **Orthene®**
✓ **Confirm®**	✓ **Sevin®**
✓ **Intrepid®**	✓ **Delegate®**
✓ **Diazinon®**	✓ **Avaunt®**
✓ **Lorsban®**	✓ ***Bt***
✓ **Hatchet®**	✓ **Entrust®**

Much more information about this pest may be found in UMass’s *Cranberry Insects of the Northeast* book:
http://www.umass.edu/cranberry/downloads/Cranberry%20Insects%20of%20the%20NorthEast.Averill.Sylvia.Franklin.2000.pdf

Cranberry weevil adults

Anthonomis musculus (Say)



The 2nd generation ("summer generation") of this pest overwinters in the adult stage.

So what's so bad about Cranberry weevils?

Cranberry Injury:

- **Springtime**: Weevils which have overwintered begin to move onto the beds from the surrounding uplands and will drill holes into old leaves and in the terminal buds.
- **Mid-June through early July**:
  - The weevils mate, and move to the new cranberry growth, especially new terminal growth and new buds which can be damaged severely from their feeding holes. Flower buds that are damaged often fail to open, dry up, and then eventually fall to the ground.
  - Eggs are deposited into the unopened blossom buds, where the subsequent weevil larvae develop. Females will chew on the pedicels after depositing their eggs, either severing them completely, or only partially, creating a point of weakness that often leads to the pedicel breaking off later on. Buds that remain attached but contain a larva turn from pink to a brownish-orange.

In short, a heavy infestation can destroy much of the prospective crop due to blossom bud losses, and the brand new weevils emerging from them may also damage any berries that are present.

Cranberry Weevil Management:

- **Sweeping**:
  - Sweep for the adults with a 12”-diameter sweep net during warm, sunny parts of the day (~noon to 2 pm) when they are most active;
  - During cold, wet or windy weather, they stay inactive on the bed floor;
  - Experts at ‘playing dead’ so care must be taken not to overlook them;
  - Action Threshold is 4.5 weevils per 25 sweeps in the spring; 9 weevils per 25 sweeps in the summer (‘summer’ weevils are more robust, so harder to kill).
- **Flooding is *not* effective!**: Cranberry weevil populations are not reduced noticeably by a winter flood or a ‘Late Water’ flood, presumably because the weevils are not present on the bed(s) during those periods.
- **Spray Choices (as of 2016)**:
  - ✓ **Lorsban®**
  - ✓ **Avaunt®** (Registered for *spring* populations only—no summer applications)
  - ✓ **Hatchet®**
  - ✓ **Actara®**
  - ✓ **Scorpion® or Venom®**
  - ✓ **Belay®** (summer applications only, *i.e.* post-bloom; very high bee toxicity)

Much more information about this pest may be found in UMass’s *Cranberry Insects of the Northeast* book:
http://www.umass.edu/cranberry/downloads/Cranberry%20Insects%20of%20the%20NorthEast.Averill.Sylvia.Franklin.2000.pdf

Climate Projections for Northeast:

Precipitation

- **Near-term (2010-2040):**
  - ✓ Summer precip projected to increase by 2% (range of -1 to +6%)
  - ✓ Single precip events likely to increase in intensity by ~7%
- **Mid-century (2040-2070) (with "business as usual" scenario):**
  - ✓ Summer precip up only 1 to 2% (least increase vs other seasons)
  - ✓ But . . . More than 8% rise in avg. amount of rain falling on any given day, *and* an 8-13% rise in amount during any 5-day period.
- **End-of-century (2070-2100) (with "business as usual" scenario):**
  - ✓ Greatest increase will be during the winter (11-17%) (range of 4-27%) and more and more in the form of **rain versus snow**.
  - ✓ Snow season for most of the Northeast reduced by **25** to **50%!**
  - ✓ Summer still the least affected of the seasons (just 2% rise), but the **intensity** of any particular precip event likely to increase by 12-13% on average.

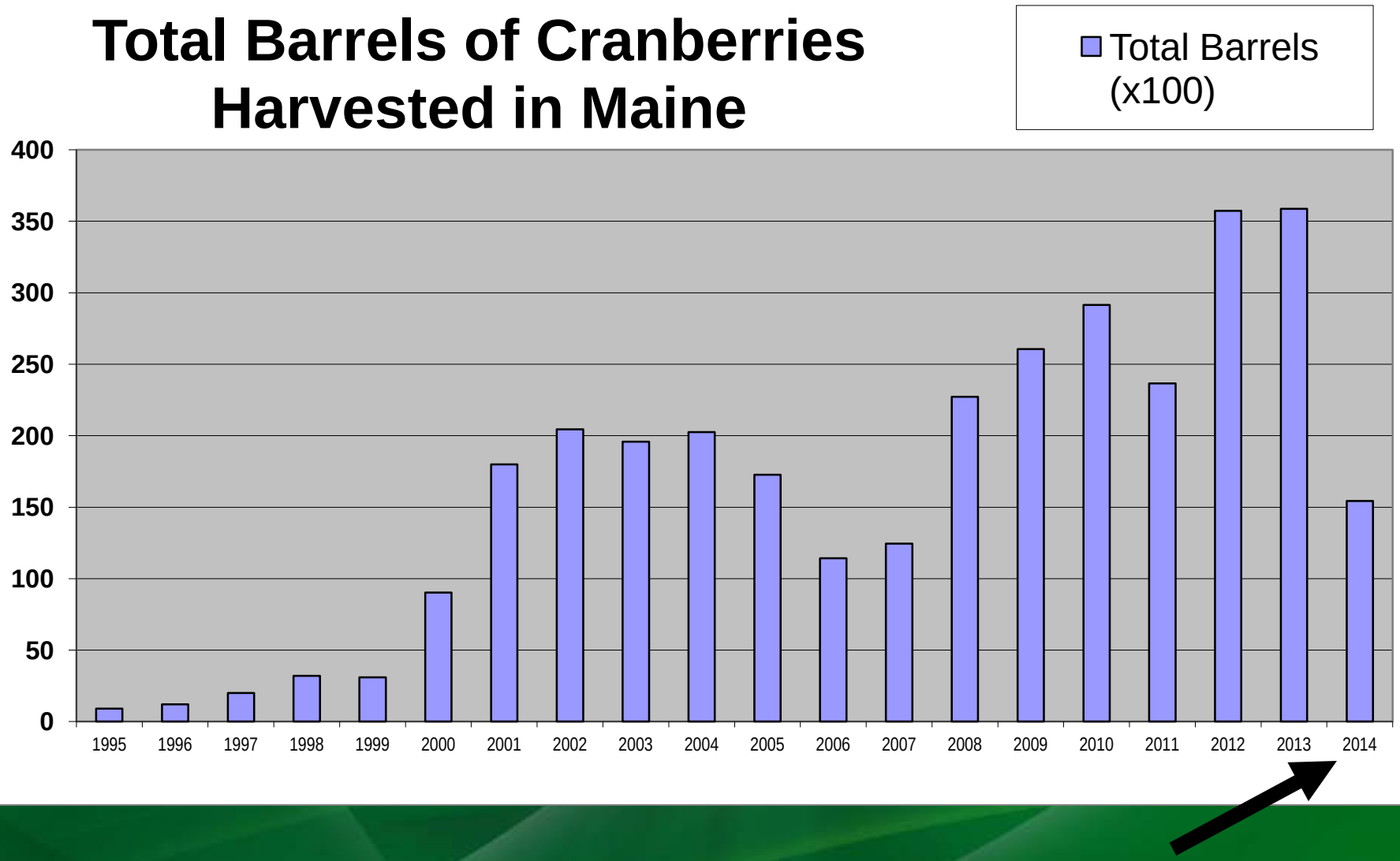
Figures from a report by the USDOT's Federal Highway Administration (using data from USGCRP):
https://www.fhwa.dot.gov/environment/climate_change/adaptation/publications/climate_effects/

Likely Consequences

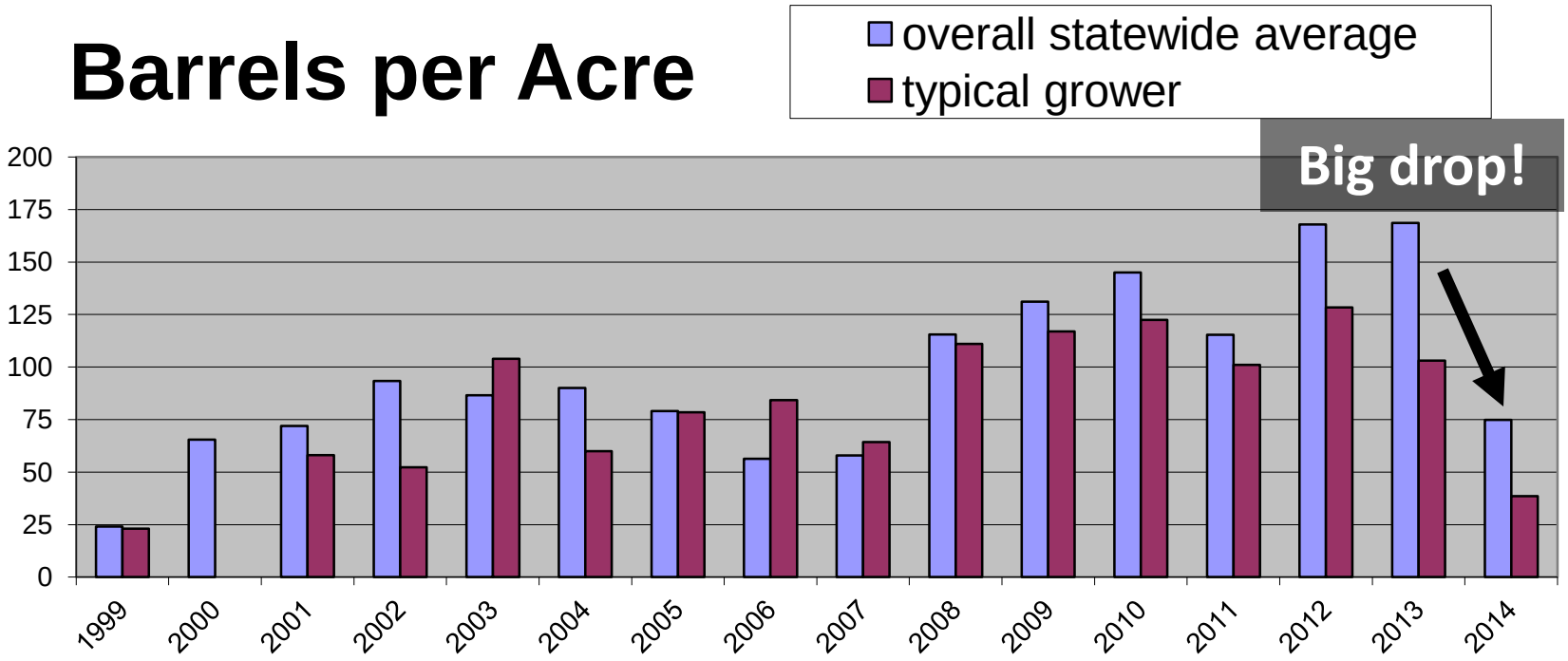
Rise in precipitation and/or its intensity:

- Winter (more rain vs snow): harder to keep layer of ice intact for protecting the plants
- Summer:
  - Amount: A 2% rise would likely have little impact to the crop, overall. But getting *less than* 3.2" of total rainfall during June awards 1 point to the 'Keeping Quality Forecast Model' (out of 16 total points in the model) (fruit rot fungi thrive in warm and wet conditions)
  - But, greater intensity? And its timing?: If a lot of rain falls during bloom, that could be *very* harmful!
    - ✓ Fruit rot infection occurs during bloom
    - ✓ Flowers knocked off (hard rain or hail)
    - ✓ Pollen washed away (less attractive to bees after)
    - ✓ Bees don't work in moderate to heavy rain

Total Barrels of Cranberries Harvested in Maine



What happened in 2014?!!!



Answer: ***Too much rain during bloom!!!***

- Bangor: **6.8”** of rain in July (close to the record 7.25” in 1983)
- **3.43”** fell in just 24 hours July 4th-5th when the plants were as much as 40% in bloom.

Summary

Likely Consequences…

Increasing Temperature

- Higher insect pest populations (especially false armyworms and cranberry weevils)
- Chilling requirement hard to obtain
- Poor berry color (less nutritious; less marketable)
- Loss of frost hardiness (more frost protection needed)
- Heat stress and berry scald (crop injury)
- Poor pollination (too hot for bees)

Increasing Precipitation

- Poor pollination / poor flower viability (if it occurs during bloom period)
- Higher fruit rot pressure and infection rates

Further Study:

Check out Cornell's Northeast Regional Climate Center at:
http://www.nrcc.cornell.edu/

Also, consider viewing the USDA report entitled: **"ADAPTATION RESOURCES FOR AGRICULTURE: Responding to Climate Variability and Change in the Midwest and Northeast."** It is meant to help producers prepare for, cope with, and recover from extreme weather and uncertain climate conditions and may be found online at:
http://www.climatehubs.oce.usda.gov/sites/default/files/adaptation_resources_workbook_ne_mw.pdf?utm_medium=email&utm_source=govdelivery

University of Maine Cooperative Extension
Pest Management Unit

17 Godfrey Drive
Orono, ME 04473
207.581.3880 • charles.armstrong@maine.edu
https://extension.umaine.edu/ipm/