Leveraging Long-term Moth Trap Data to Describe Regional Population Dynamics

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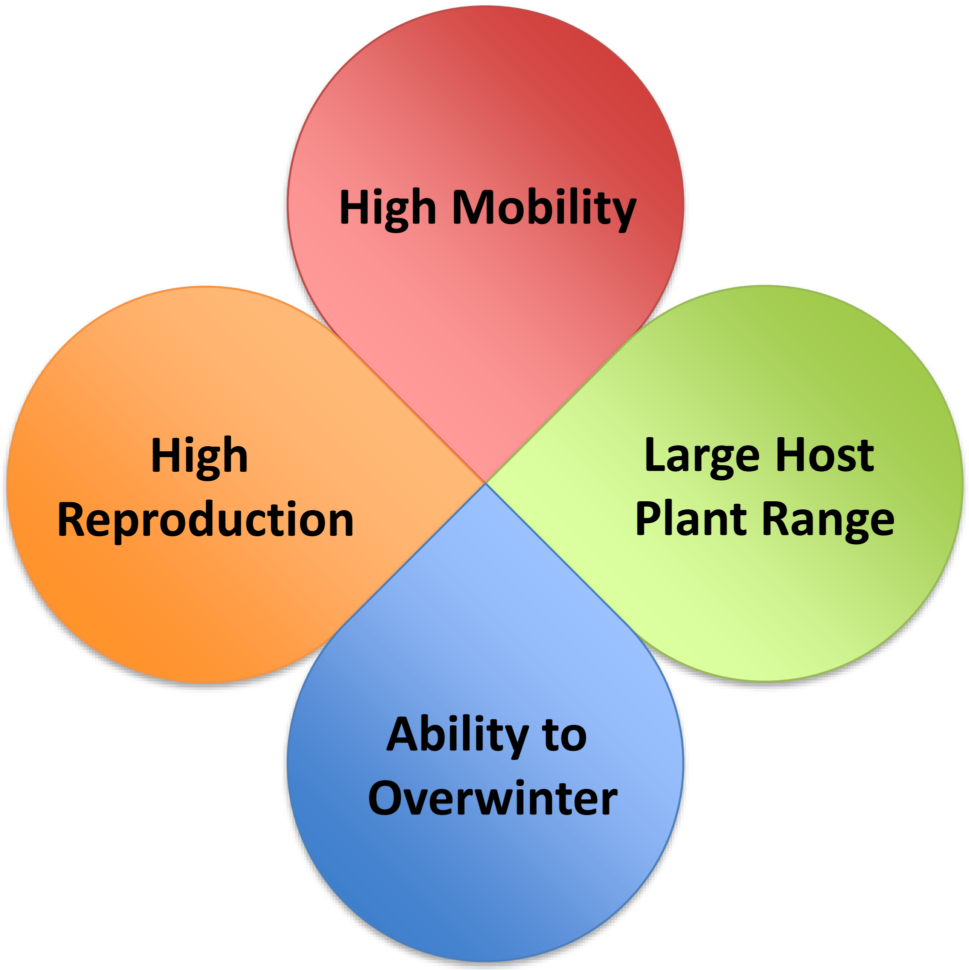
Four key factors that make migratory moths a persistent problem

- Lepidopteran pests (moths) are some of the most economically significant pests globally
- Interaction with crops and semi-natural places enable occupancy in many habitats
- Persistence in multiple crops can lead to increased risk for resistance selection
- Losses can lead to unequal impacts on farmers depending on crop value (specialty vs. row crops)

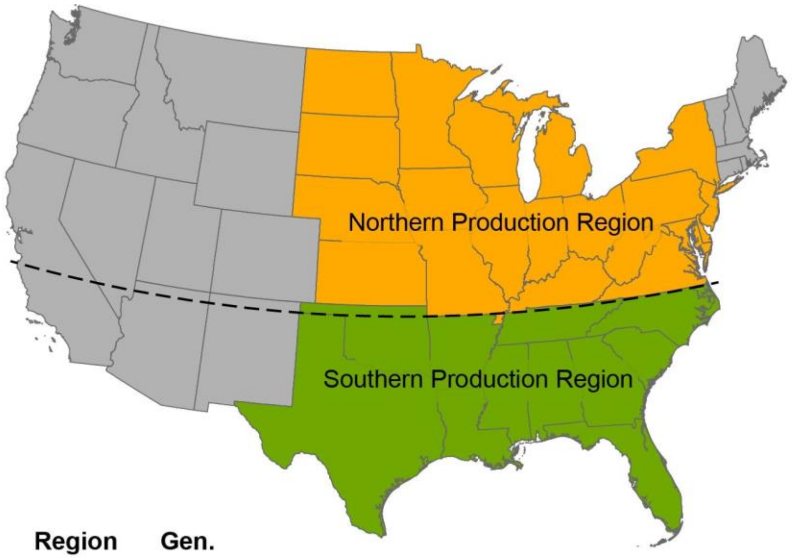
Recent range expansion of lepidopteran pests is an emerging concern

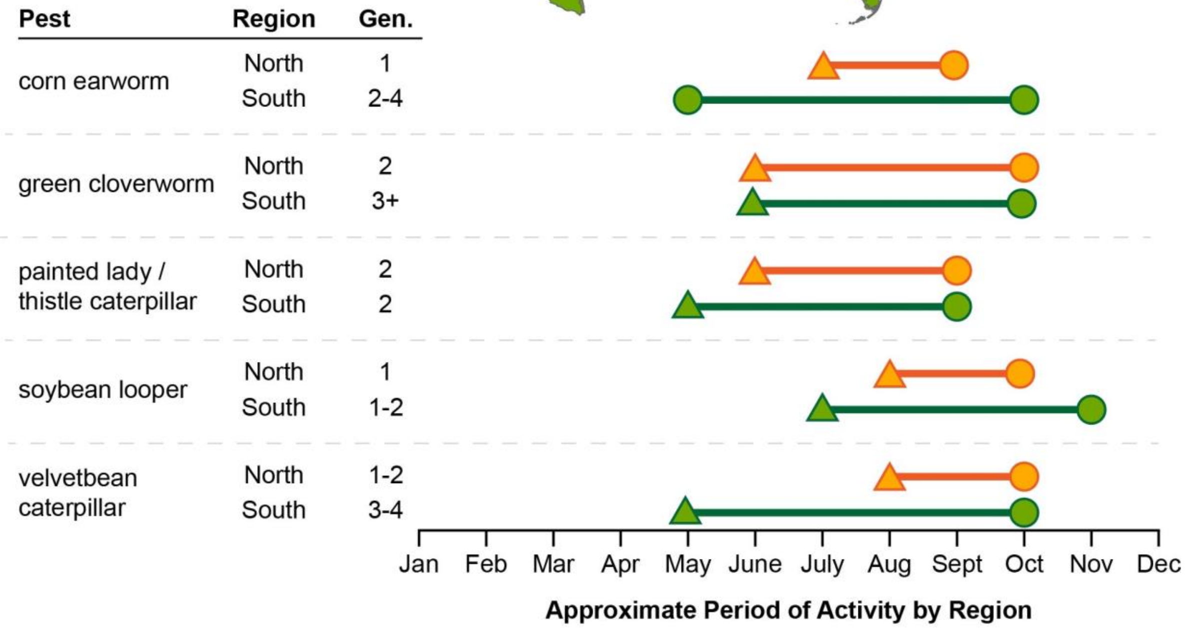


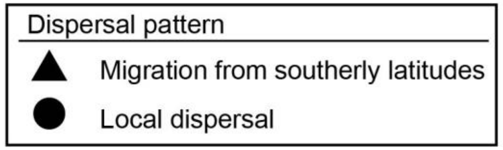
Fitt (1989). *Ann Rev. Entomol.* 34: 17-52

Migratory North American species can provide insight into drivers

- Several species can originate from southerly latitudes (Caribbean, Mexico, Southern U.S.)
- Dispersal patterns and timing depend on population dynamics
- Synoptic and extreme weather events can also favor long distance migration of moths and other insect pests







Huseth et al. (2021) *J Integrated Pest Manag.* 12: 11

Annual pests often have historical activity data that can be used for prediction

Field-scale measurements

Larvae
- Defoliation estimates
- Sweep net samples
- Drop cloth
- Pod, ear, boll injury

Adults
- Egg counts

Area-wide measurements

Larvae
- Scouting records
- Damage surveys
- Stalk surveys (ECB)

Adults
- Pheromone traps
- Black light traps

Are these long-term observational datasets useful for more than monitoring?

Thanks to all the countless collaborators and data authors!

<u>Paper Authors</u>:
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<u>Collaborators</u>:
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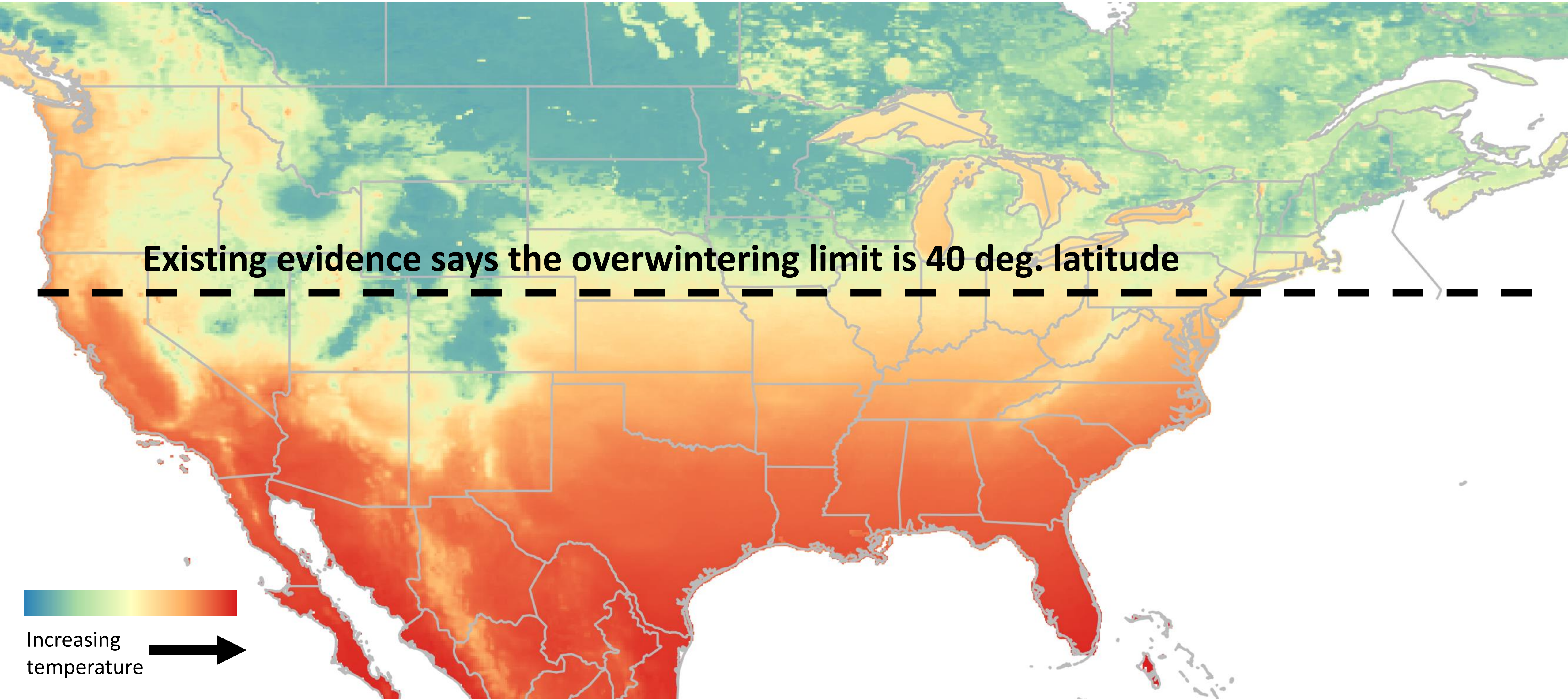
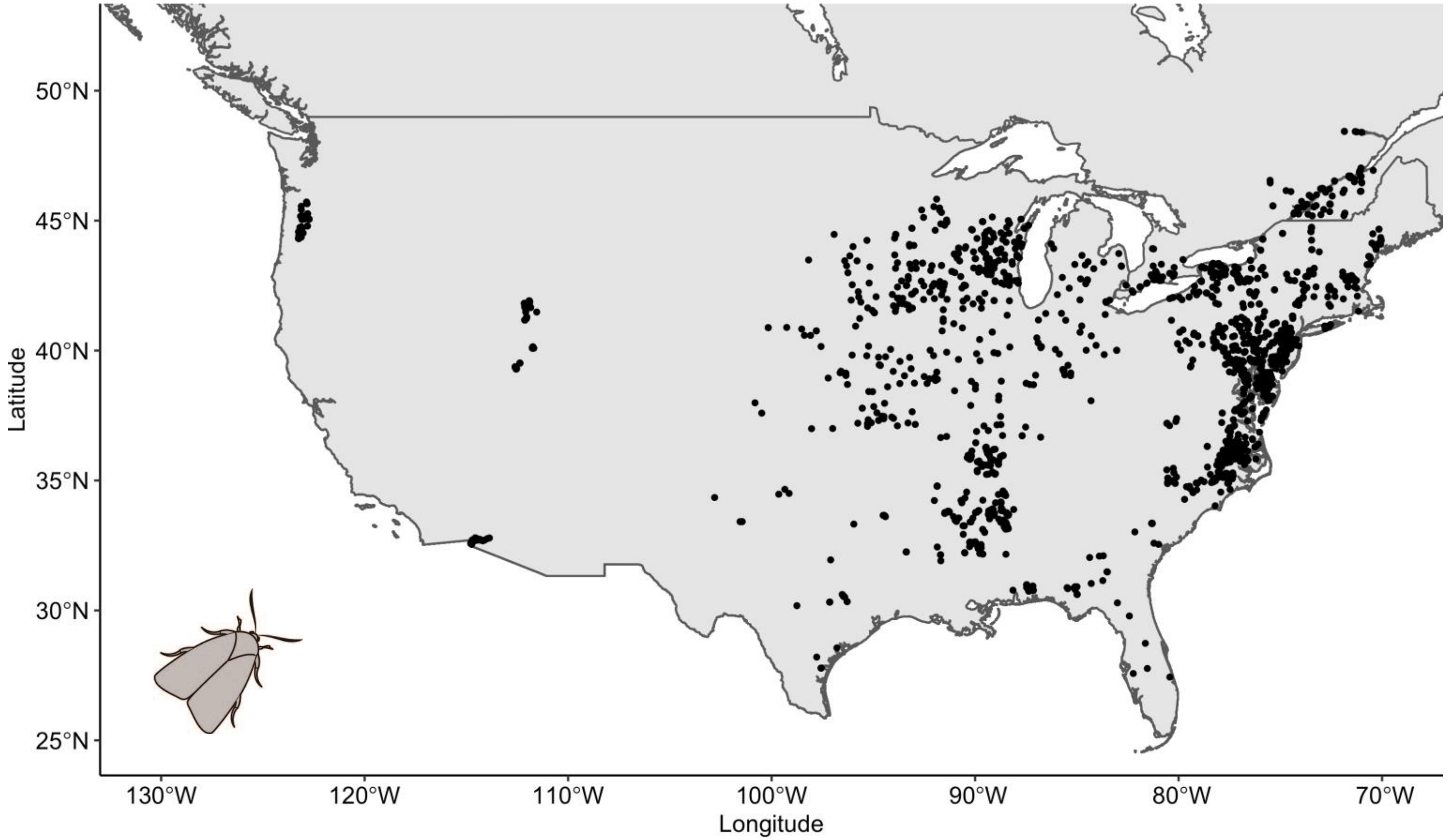
Motivating question: will corn earworm overwintering ranges change in the future?



Modeling corn earworm populations using an ecoinformatic approach

- We curated data from 1,986 unique pheromone and black light traps located in 37 states and one Canadian province (during COVID restrictions)
- Over 100,000 unique observations from the early 1980s to 2021



Black light trap

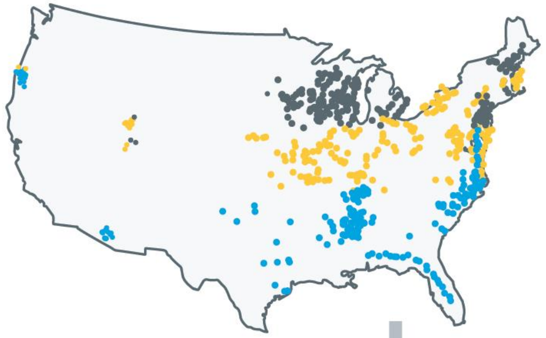
Hartstack pheromone trap

Lawton et al. 2022

Linking overwintering survival to population dynamics – our workflow

Current trends → Future predictions

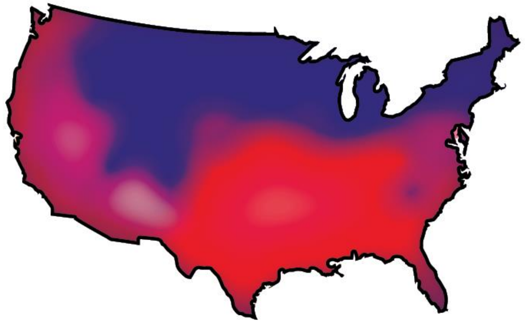
Historic moth population dynamics data



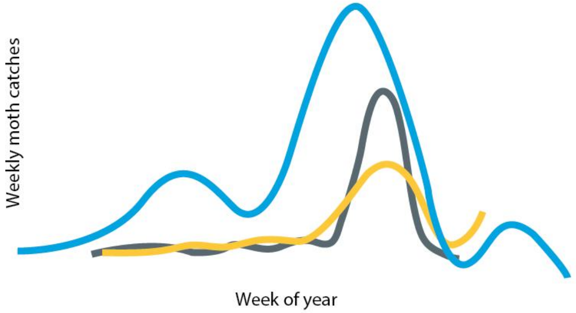
Overwintering zones

- Northern limits
- Transitional zone
- Southern range

Remotely sensed soil temperatures



Time series model



Predicted shift in overwintering zones

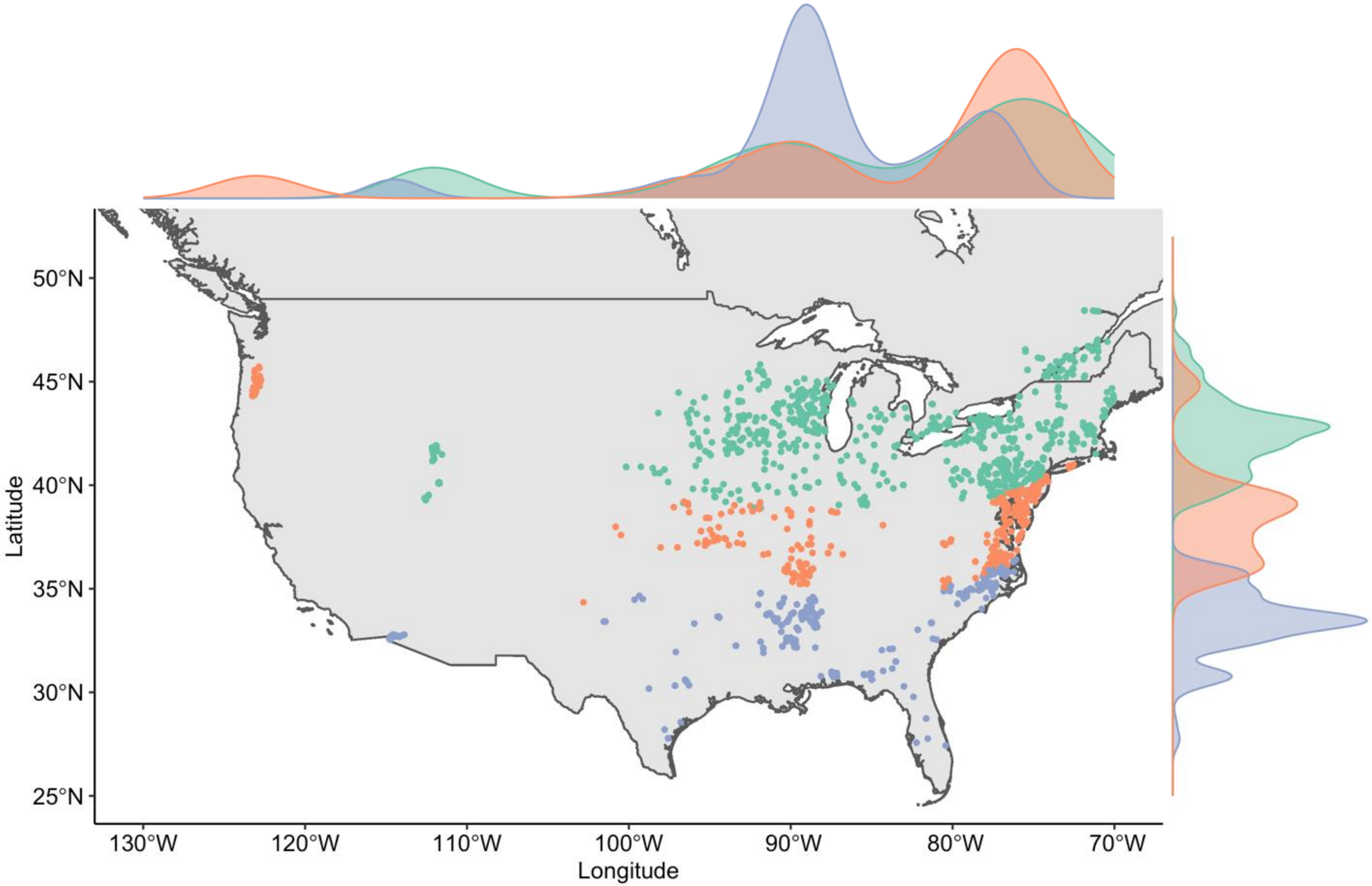
2077-2099

Lawton et al. 2022

We used cold tolerance data to spatially structure corn earworm activity zones on winter soil temperatures & anticipated migration patterns

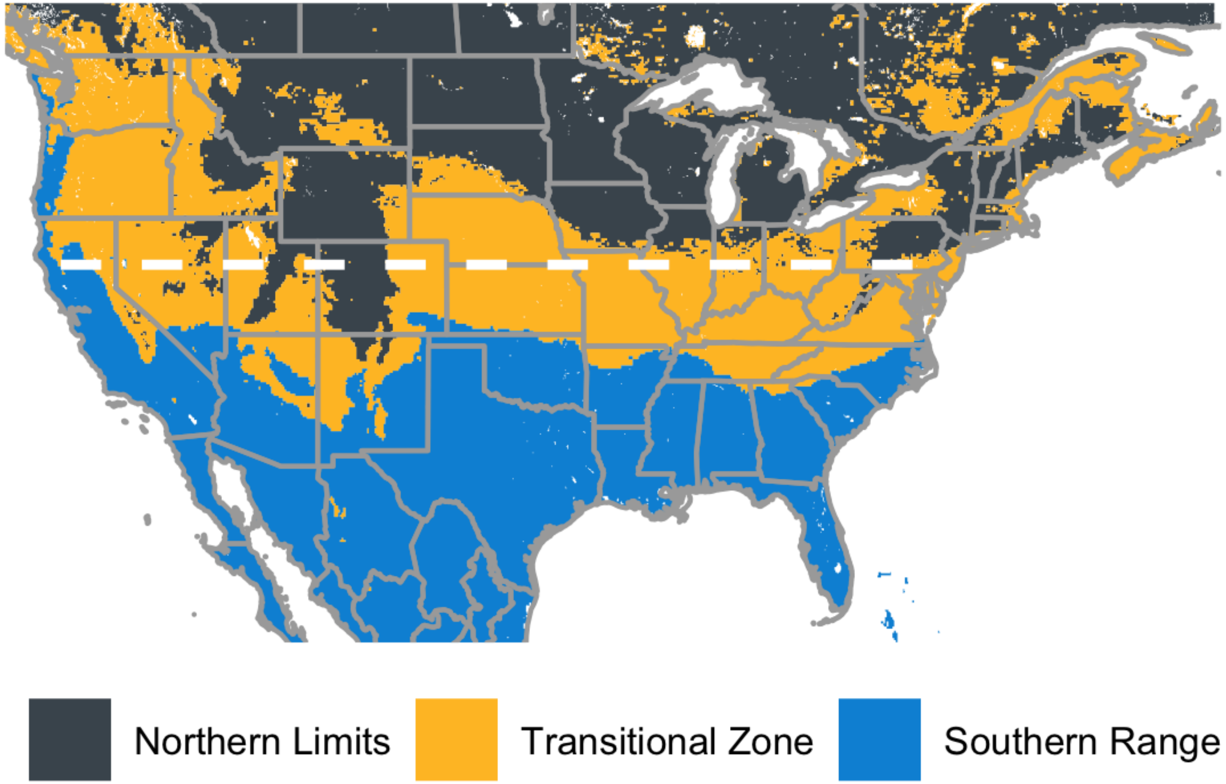
***Helicoverpa zea* overwintering zones**

- Northern Limits (migrants)
- Transitional Region (lethal in some years)
- Southern (winter temps adequate for survival)



Anticipated overwintering survival based on cold hardiness (Morey et al. 2012)

30 year average



Survival zones:
- Southern Range where the mean minimum soil temperature in winter is above 5°C
- Transitional Zone where the soil temperatures range from 0°C to 5°C
- Northern Limits where the soil temperature is below 0°C

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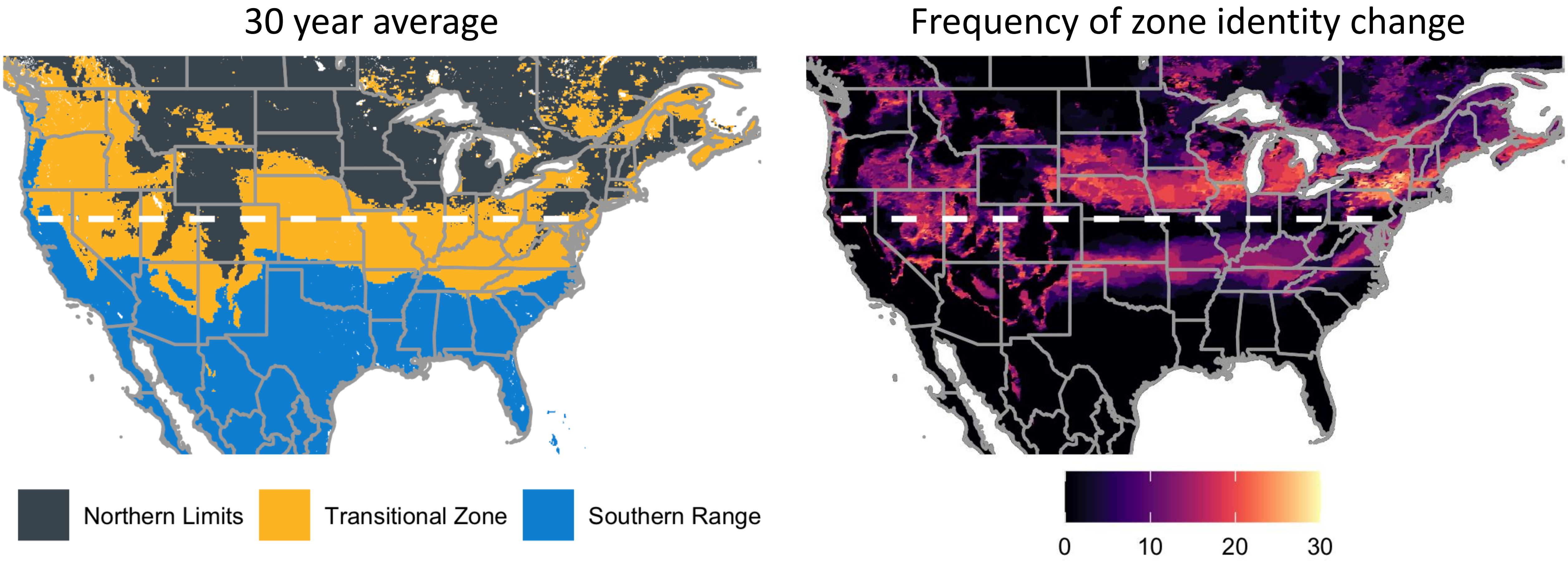

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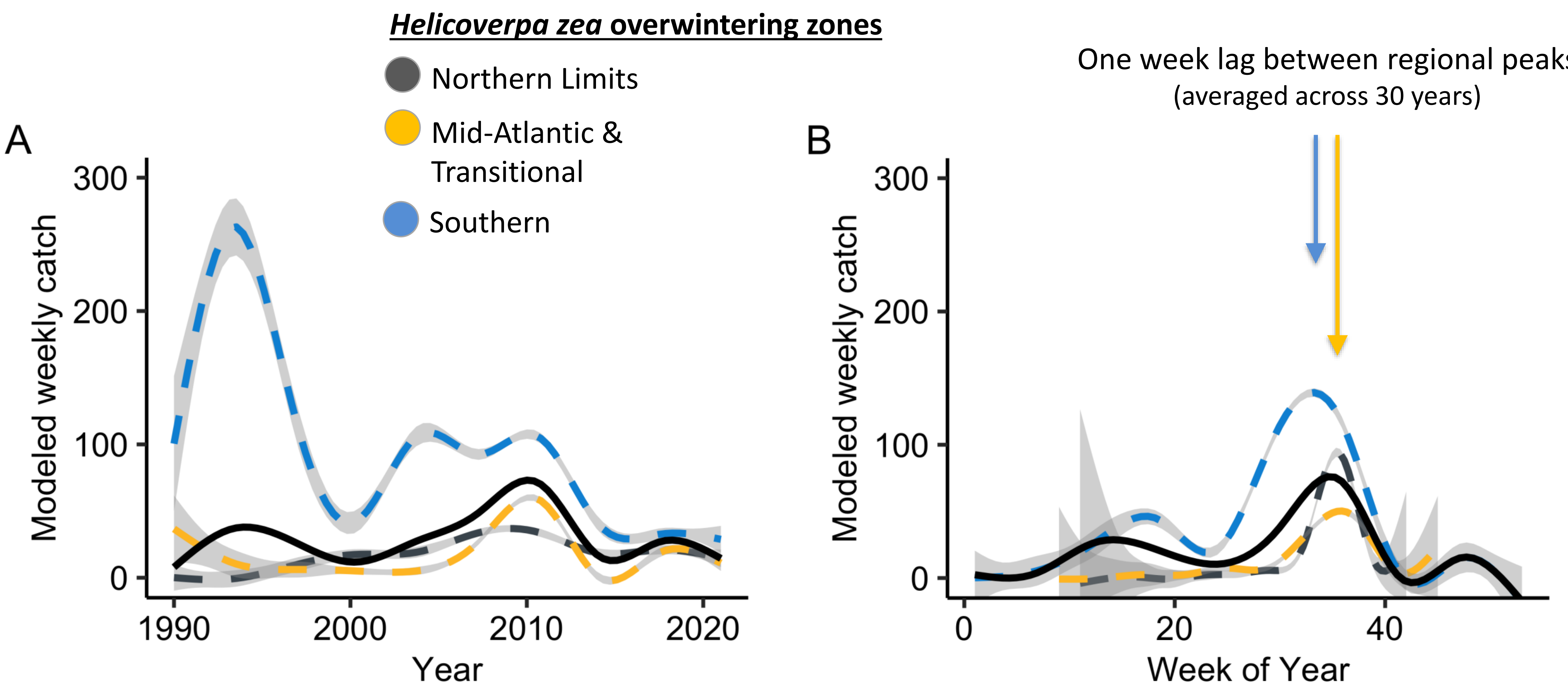
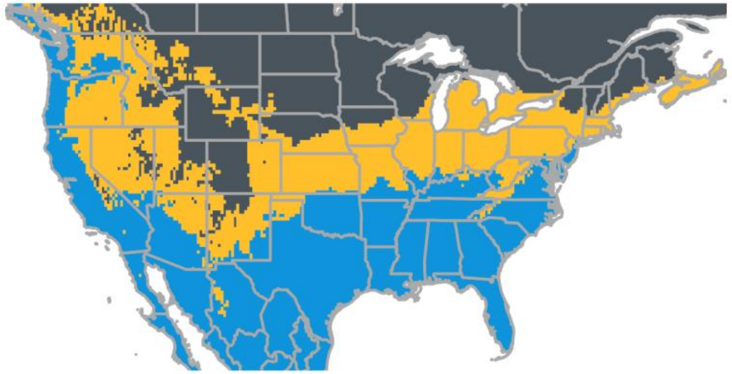
Annual population peaks in the South arrive just before Mid-Atlantic suggesting linked monitoring efforts could be useful



Lawton et al. *in press*

Overwintering zones were predictive of population dynamics – forecasting future zones

1950-2021



Corn earworm overwintering zones

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Lawton et al. *in press*

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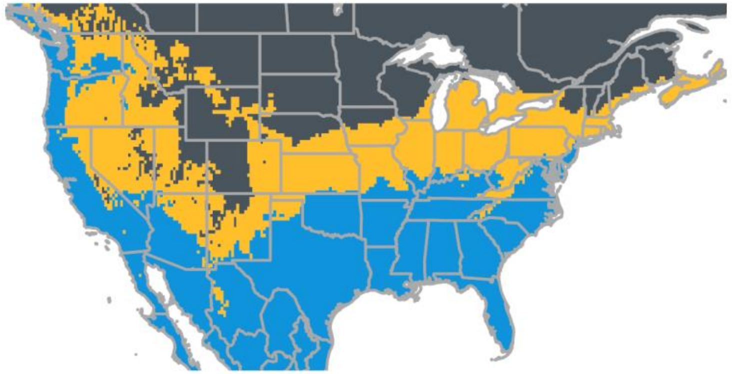
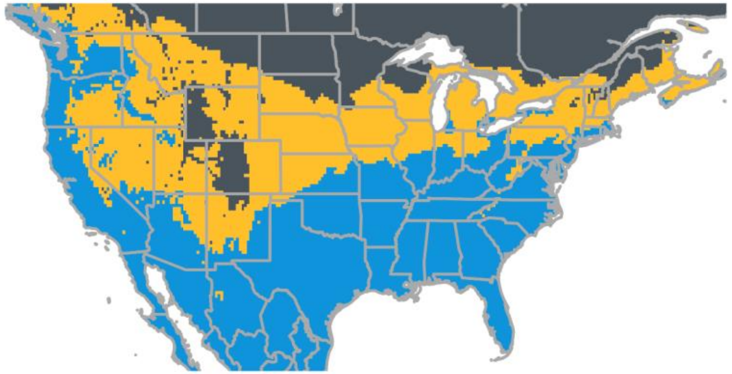


2022-2047



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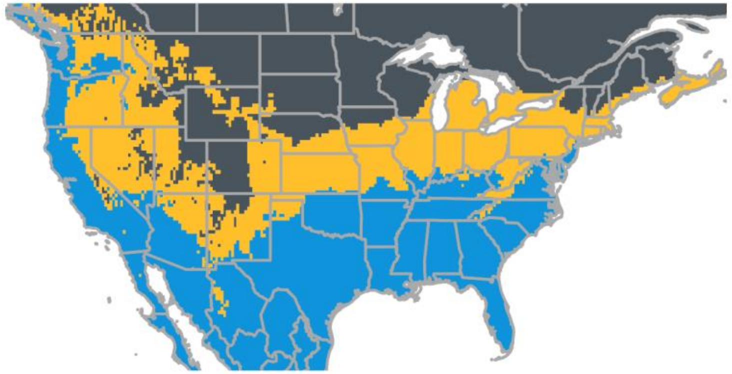

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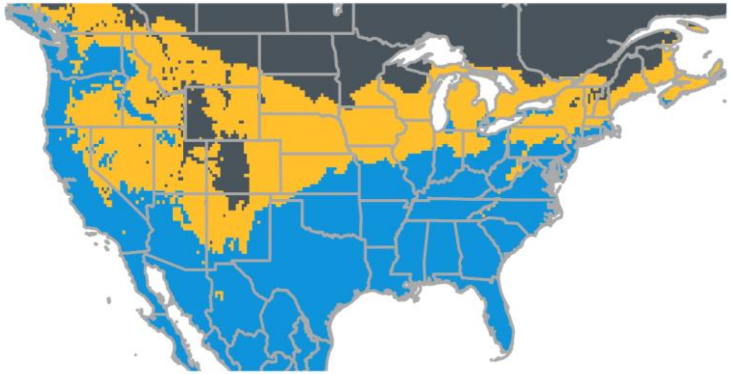
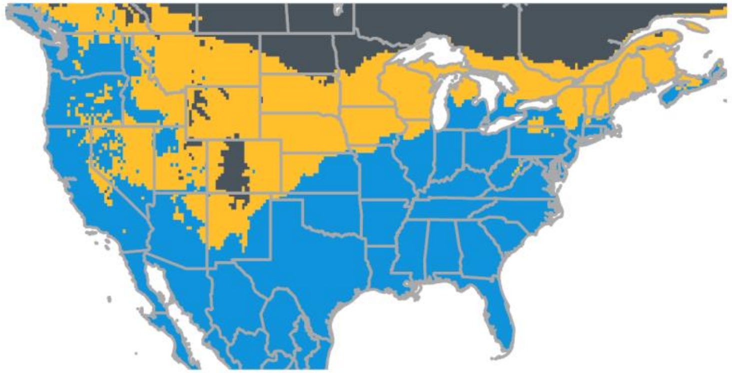


2048-2073



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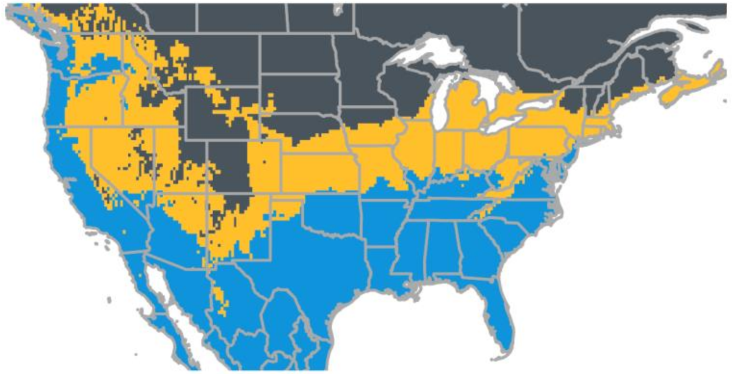
Lawton et al. *in press*

Overwintering zones were predictive of population dynamics – forecasting future zones

- Significant variation around the 40th latitude split for overwintering
- Future overwintering areas extend into the Corn Belt
- Range expansion could increase crop damage and selection for Bt resistance

1950-2021



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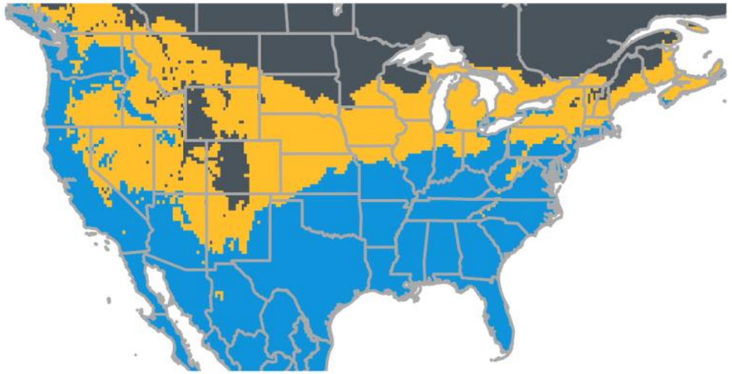

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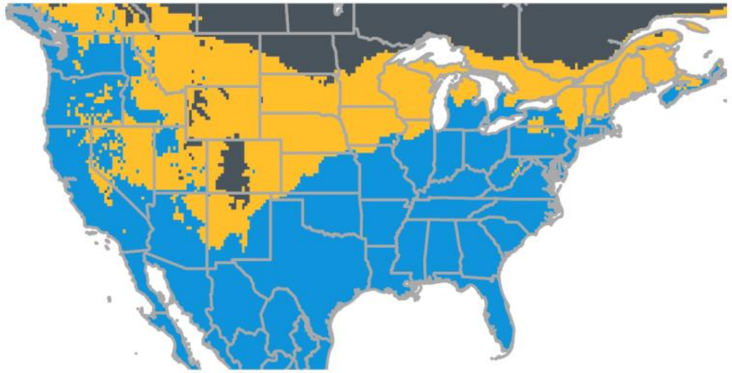
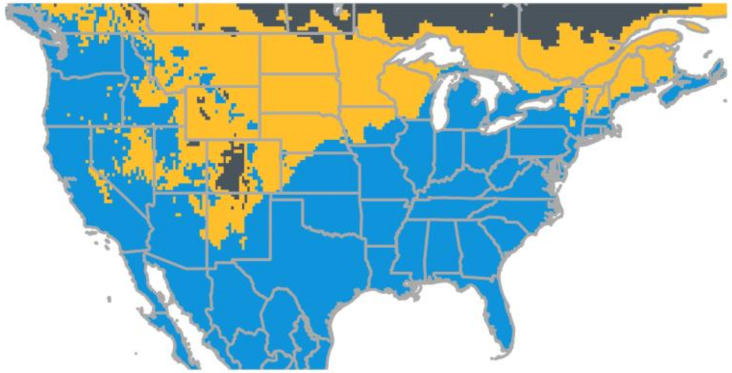


2074-2099



<u>Corn earworm overwintering zones</u>

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Thank you for your attention