Butterfly Informatics: Access, Visualization, and Analysis of Butterfly Monitoring Data

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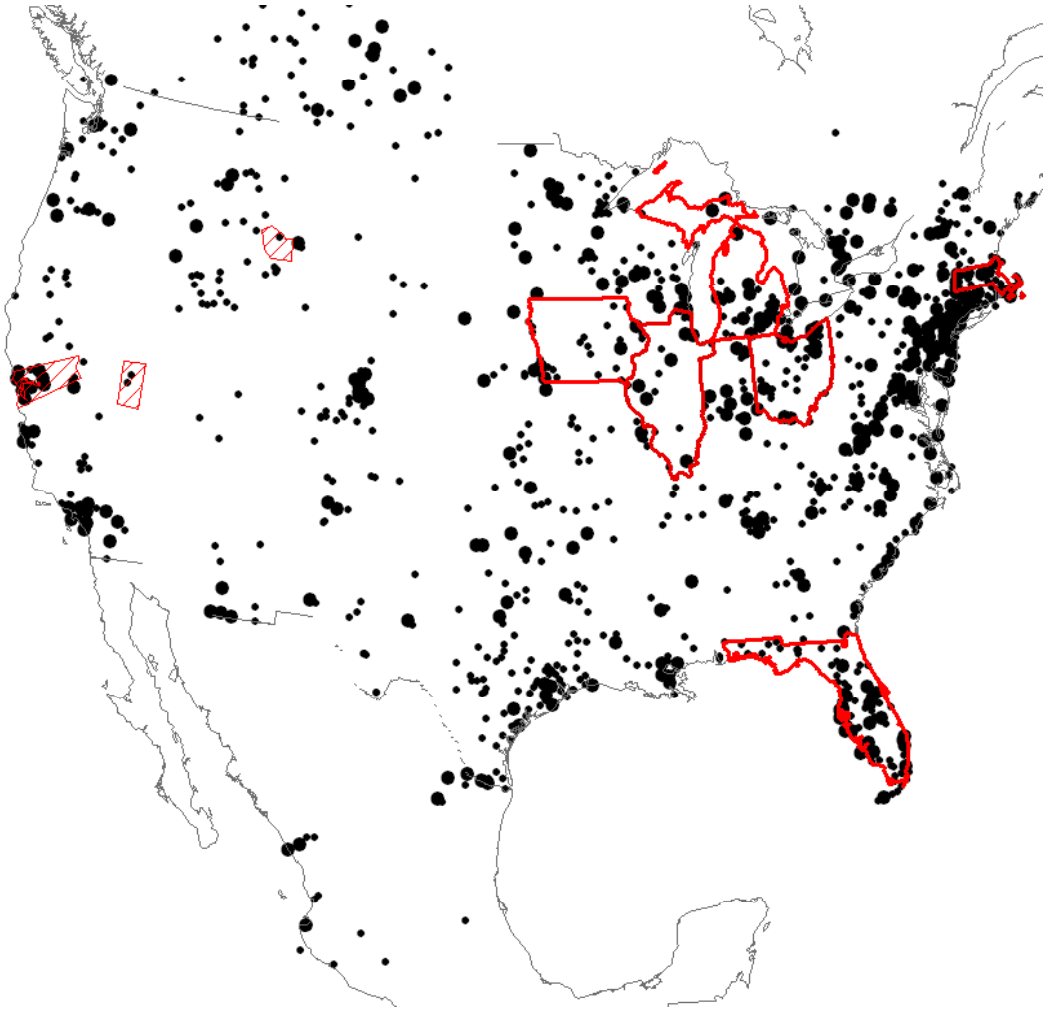
Main goals

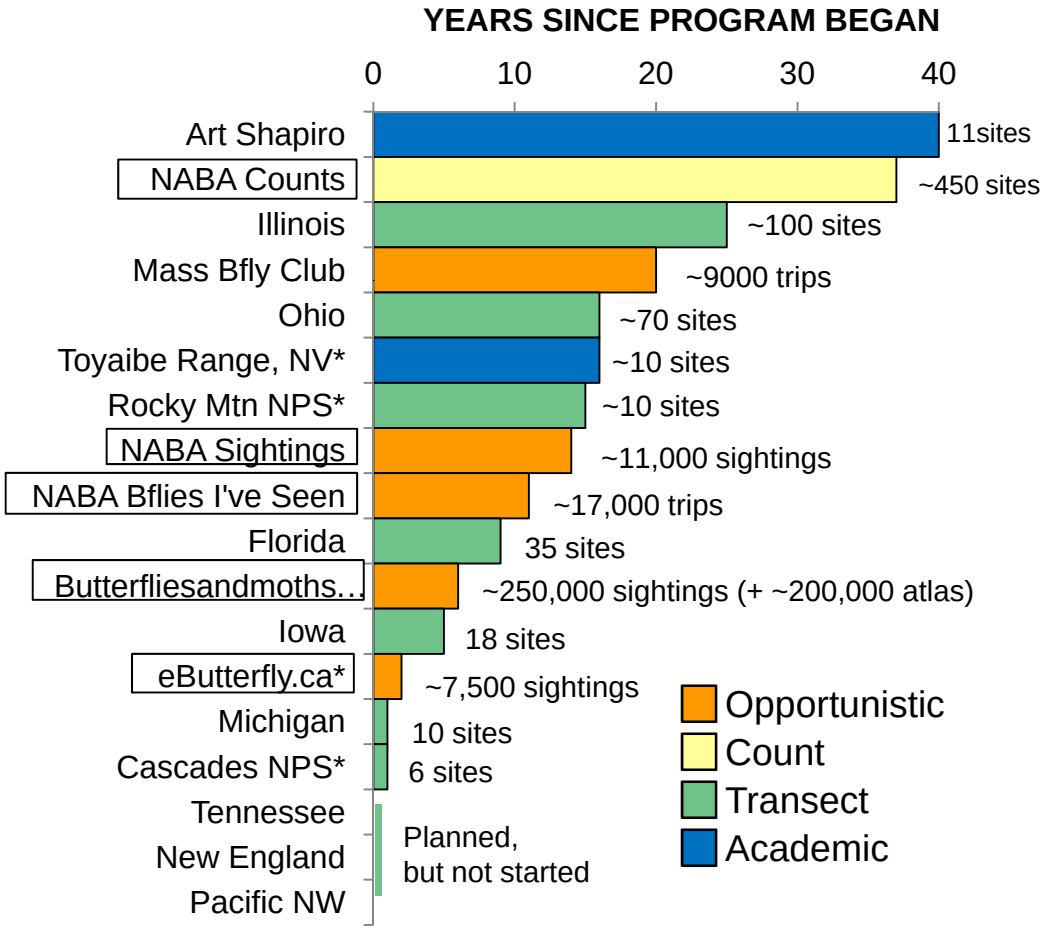


- Public access to monitoring data – for scientists and the general public
  - NABA
  - State programs
  - Academic programs
- Visualization tools for data exploration
  - Maps
  - Trend graphs
- Knowledgebase for North American butterflies (US, Can, Mexico)
  - Life history data
  - Parameter values from published studies
- Analytical approaches for monitoring data. Goals are to account for:
  - Asynchronous nature of butterfly populations
  - Influences of weather on detectability and phenology

Inaugural Workshop

- Workshop was held at SESYNC on May 9-11, 2012
- Workshop included most major general butterfly monitoring groups, groups planning to launch monitoring programs, and informatics experts to offer support and advice for their plans
- Monarch-centric groups were not included at this workshop, but were represented as a whole

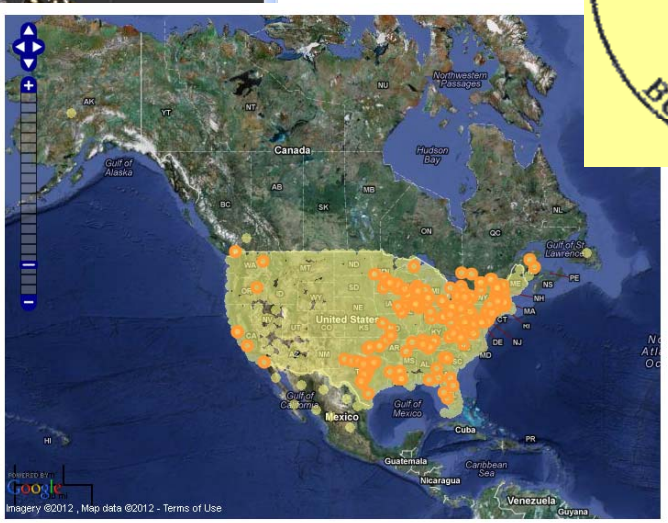
1. AN INVENTORY OF NORTH AMERICAN BUTTERFLY MONITORING PROGRAMS



Does not include monarch-centric programs

Opportunistic/sightings/field trips

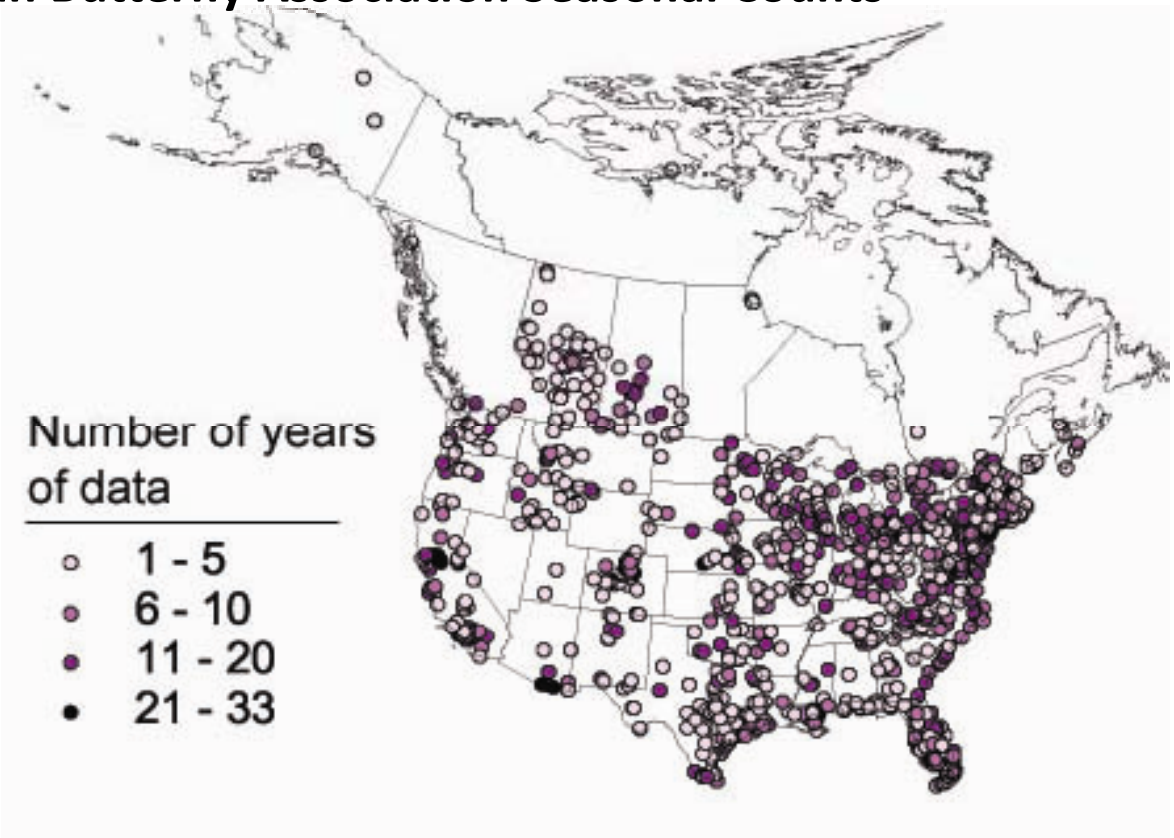
- No protocols
  - Information captured: location, species, date, sometimes count
  - Field trips are distinguished from sightings in that all species seen are recorded and numbers of each species are usually recorded



Counts

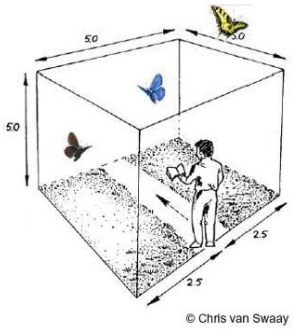
- Casual protocols
  - Information captured: defined area (which can be very large), effort, weather, date, species list with counts
  - Generally one time per year (now allowed 3x per year)

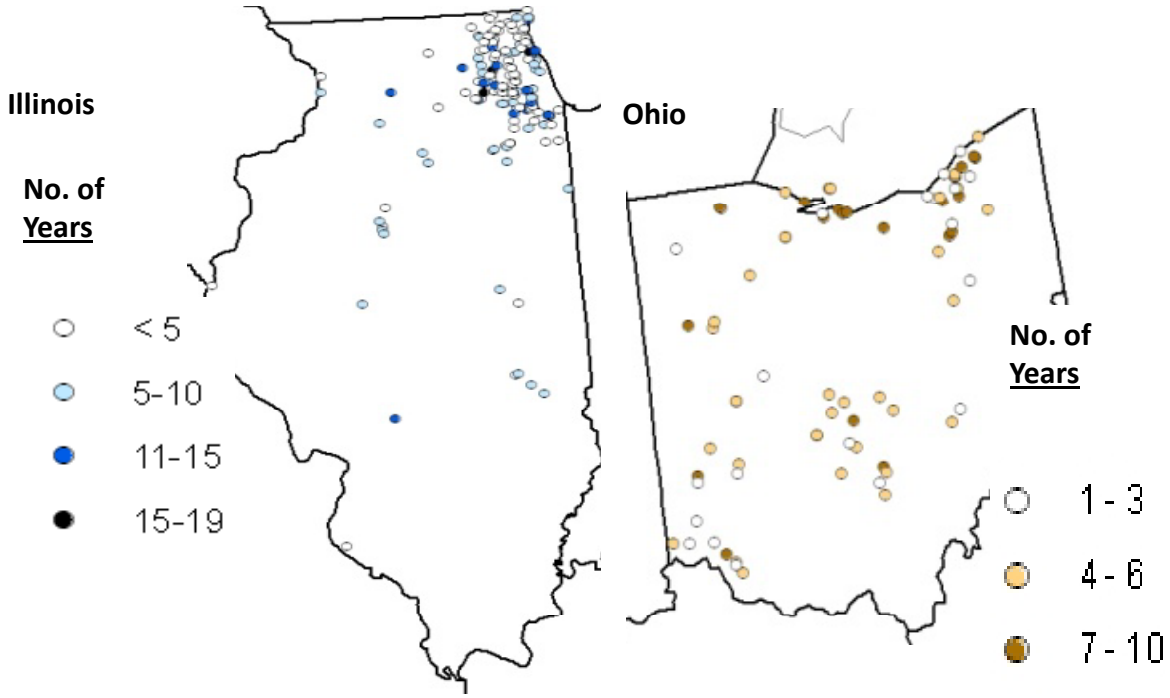
North American Butterfly Association Seasonal Counts



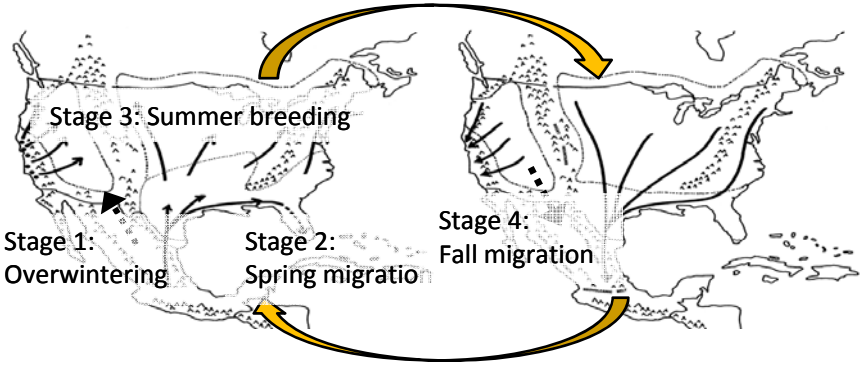
Transects/Academic

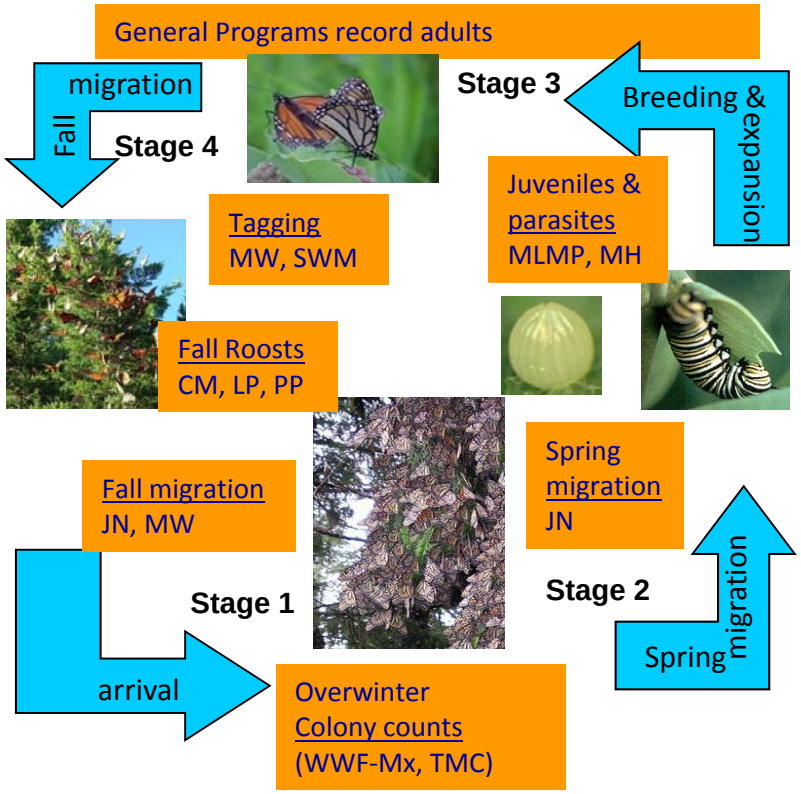
- Stricter protocols (usually one consistent volunteer)
  - Information captured: transect start, time spent, weather, date, species list with counts
  - Usually multiple times per year (goal is weekly or biweekly)
  - Academic programs have strictest protocols, but cover smallest areas





Monarch-centric programs





STAGE 1:

- WWF-Mx*: World Wildlife Fund in Mexico
- TMC*: Thanksgiving Monarch Counts

STAGE 2 and 3:

- JN*: Journey North
- MLMP: Monarch Larvae Monitoring Project
- MH*: Monarch Health
- Adult numbers are captured by general surveys

STAGE 4:

- JN*: Journey North
- MW*: MonarchWatch
- SWM*: Southwest Monarchs
- CM*: Cape May roost monitoring
- LP*: Long Point roost monitoring
- PP*: Peninsula Point roost monitoring

*Not yet official members of our network

- Mozilla Firefox

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net.uga.edu

MONARCH NET

The North American network of monarch butterfly monitoring programs

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Monarch Abundance Data

On this page you can access summary data on monarch abundance from most of our partnering programs. Click the buttons on the left to select the data set and region, and results may be viewed as a graph or table. Note that only data from the 10 most recent years is displayed in tabular form. To access summary data from all years, we ask you to register below. This is only so we can track the usage of the data, and no contact info will be shared.

You may select the data sets to plot here.
Then click "Go".

Results of your selection will be shown here. Descriptions of data sets are in the Partners pages.
The NABA data is divided into multiple regions. See the region map on the NABA page.

Check all | Clear all

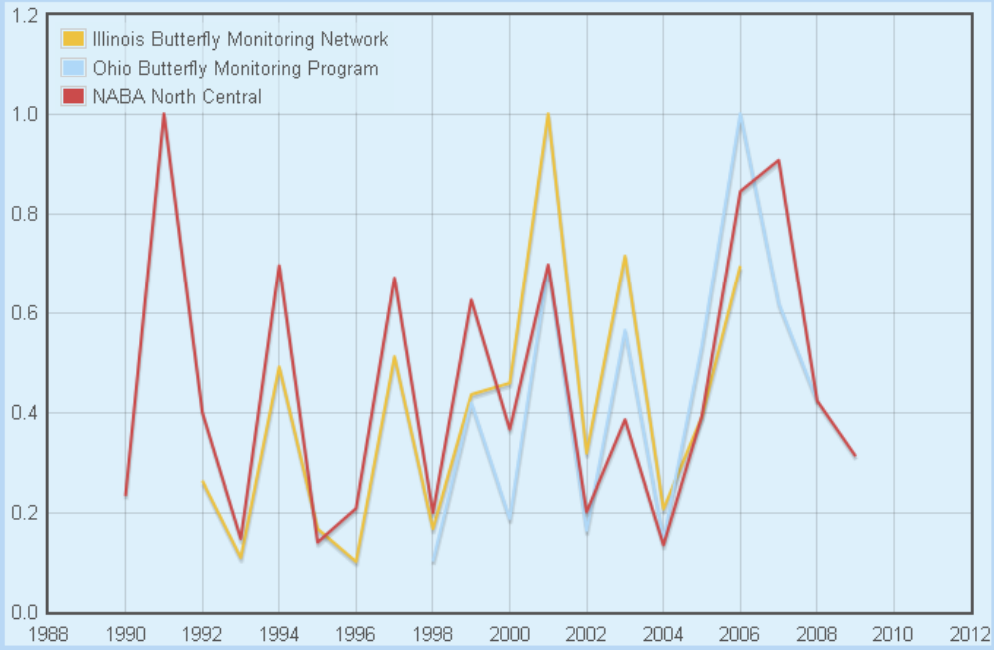
Overwintering Estimates
- ☐ Mexico Overwintering Colony Size
- ☐ Western Monarch Thanksgiving Count

Spring Migration Estimates
- ☐ Journey North (Migration Index)

Summer Breeding Estimates
- ☑ Illinois Butterfly Monitoring Network
- ☑ Ohio Butterfly Monitoring Program
- ☐ NABA East Central
- ☐ NABA California
- ☐ NABA Mid-Central
- ☑ NABA North Central
- ☐ NABA North East
- ☐ NABA South

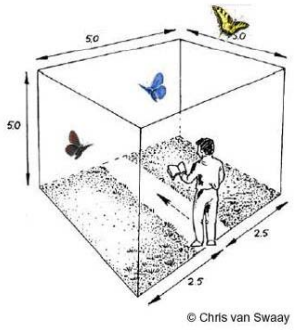
Fall Migration Estimates
- ☐ Cape May
- ☐ Peninsula Point

View output as a
◉ graph or ○ table.



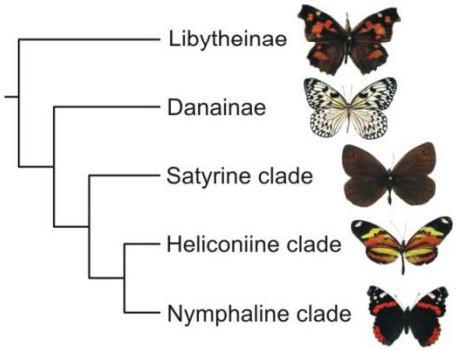
2. PROTOCOLS AND DATA STANDARDIZATION

- Goals are to standardize as much as feasible
- Only the transect programs have the goal of a shared data management system
  - Programs with other protocols are more interested in having agreed-upon data standards to foster increased data sharing and analysis



Standardizing survey protocols

Standardizing route establishment

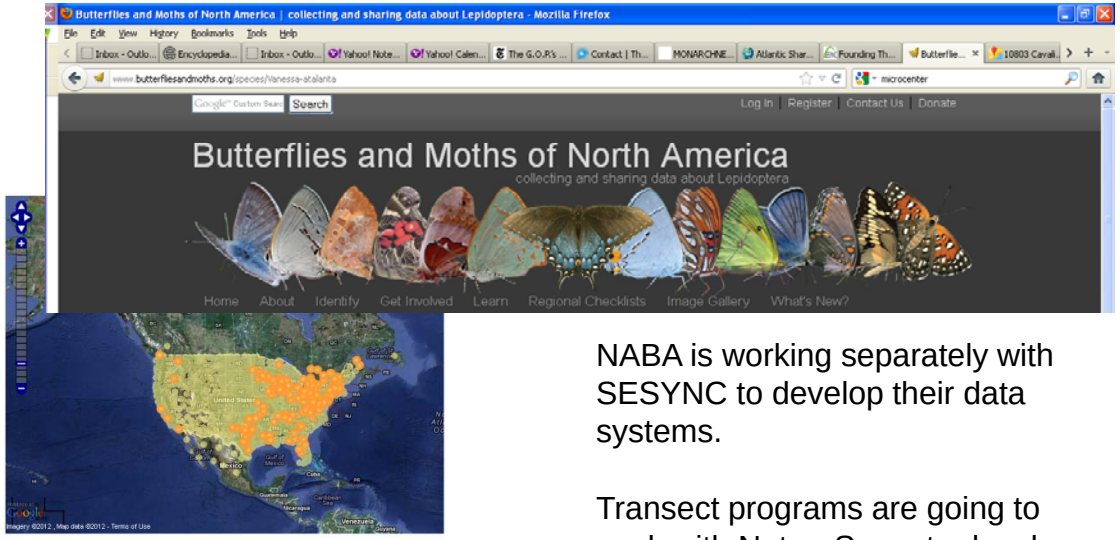


Resolving differences in taxonomies

Where standardization isn't possible, than metadata will highlight differences and allow resolutions

3. SYSTEMS FOR DATA MANAGEMENT

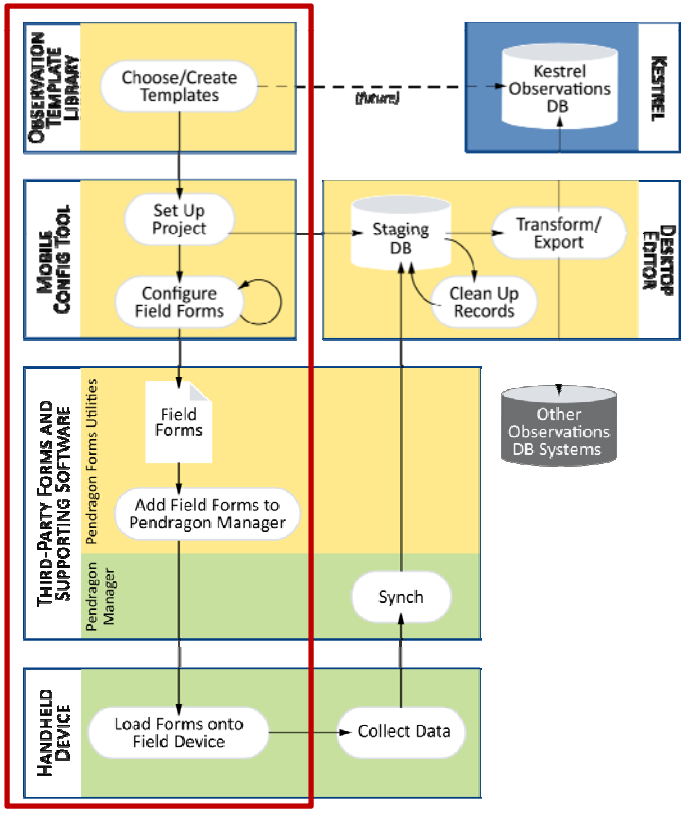
- Data entry and management systems to support programs and free up managers for volunteer recruitment and management
- Templates and guides to help new groups get off the ground and also keep to standard practices
- Developing mobile entry systems



Opportunistic programs are currently operating independently and these are not currently the focus of our efforts (requires a separate effort)

NABA is working separately with SESYNC to develop their data systems.

Transect programs are going to work with NatureServe to develop and make available common templates – but will probably implement and manage systems with BAMONA.

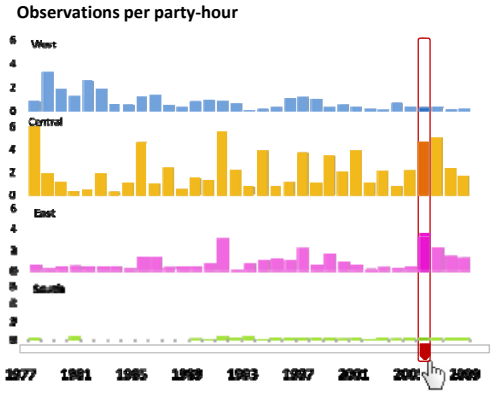


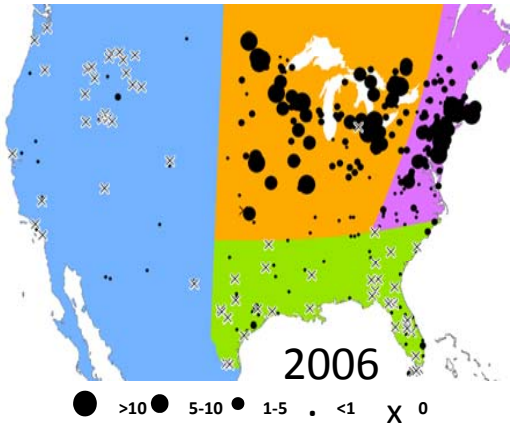
4. DATA SHARING AND VISUALIZATION

- Our goal is to promote the greatest use of our data for our volunteers, the general public, management agencies, and the scientific community.
- Our initial focus will be maps and trend graphs with the option to download table versions of those visualizations
- APIs will be developed to foster online “mash-ups”

BAMONA and Art Shapiro already offer some visualization and download capabilities

<u>Goal for Count/Transect programs:</u>
Coupled map and trend graphs with an option to view in table form for easy data downloads
<u>Visualization model:</u>
http://www.nytimes.com/interactive/2011/04/28/us/tornado-deaths.html





5. EXPANDING CAPACITY AND MAXIMIZING VALUE

Our main goals moving forward are to:

- Increase recruitment of volunteers, especially under-represented groups, by directing website visitors to volunteer opportunities that they may be unaware of or partnering with other organizations that can help us meet our goals
- Target under-served regions to recruit volunteers for new survey establishment (fill in data gaps)
- Develop materials to support volunteer programs (especially new ones) in recruiting and training volunteers, setting up survey networks, working with land owners, managing data
- Expose the programs to management agencies and scientists to increase use of the data (more use equals more exposure)

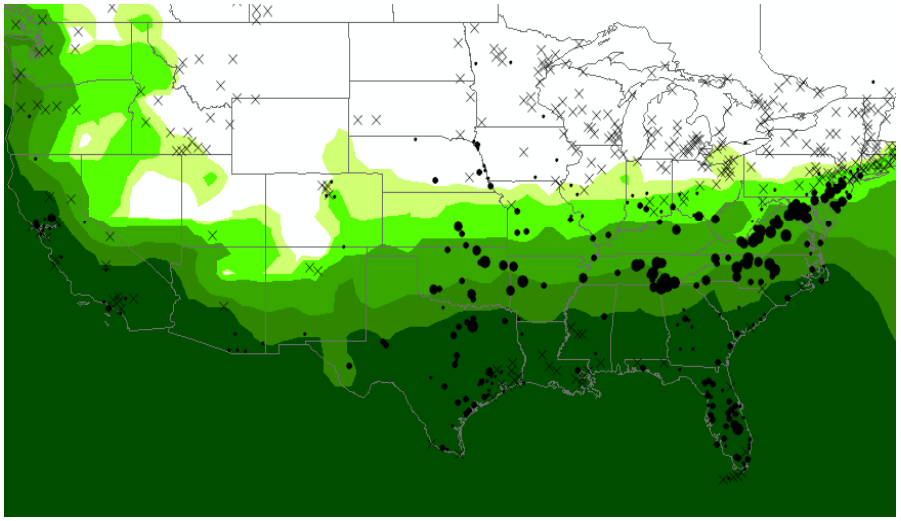
Species Distribution Models: Mechanistic Approach

- Mechanistic models translate environmental conditions into biologically relevant metrics (survivorship or fecundity) and can be used to predict distributions on large scales.
- BENEFITS:
  - Specific mechanisms are identified a priori
  - Allows independent distribution data to test predictions and identify specific weaknesses and strengths of the models
- DRAWBACKS:
  - Lack of model development for most organisms
  - Lack of model transferability between species

I FOCUS ESPECIALLY ON GROWING DEGREE DAY MODELS, WHICH COULD BE A UNIFYING FRAMEWORK FOR INVERTEBRATE SYSTEMS

Comparing observed distributions to a GDD model for the sachem butterfly (*Atalopedes campestris*)

One advance of this model implementation is the matching of the climate data to the distribution data – something often not taken into consideration in SDMs

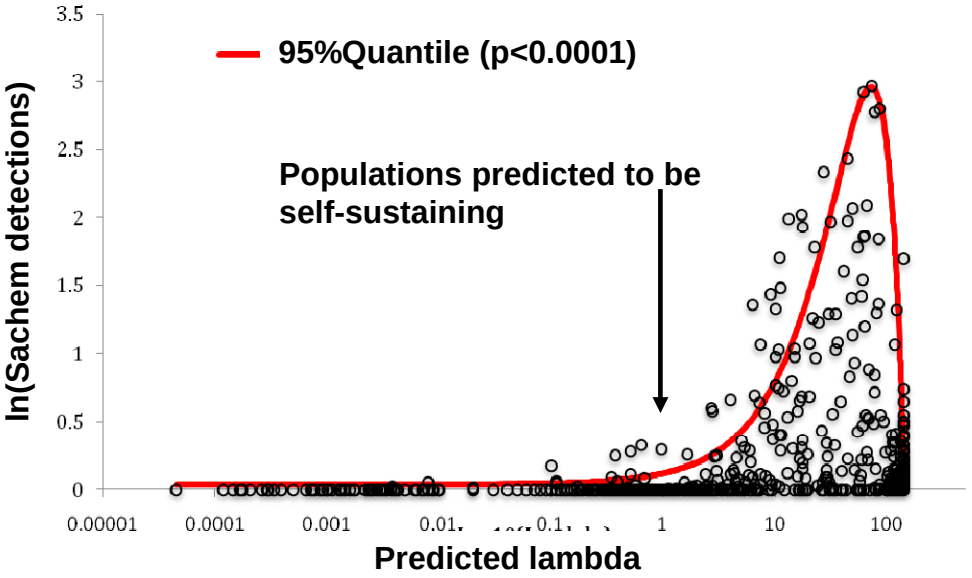


Predicted lambda:

- 0 - 1
- 1 - 2
- 2 - 10
- 10 - 50
- 50 - 100
- >100

Observed abundances:

- 0
- <0.1
- 0.1-1
- 1-5
- >5

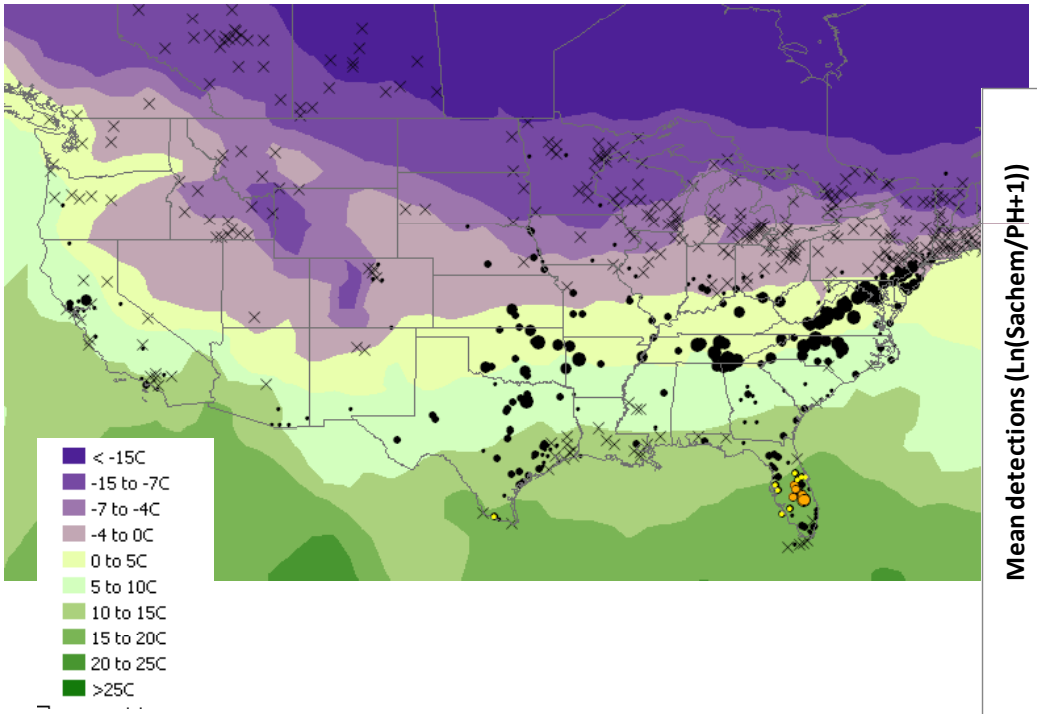


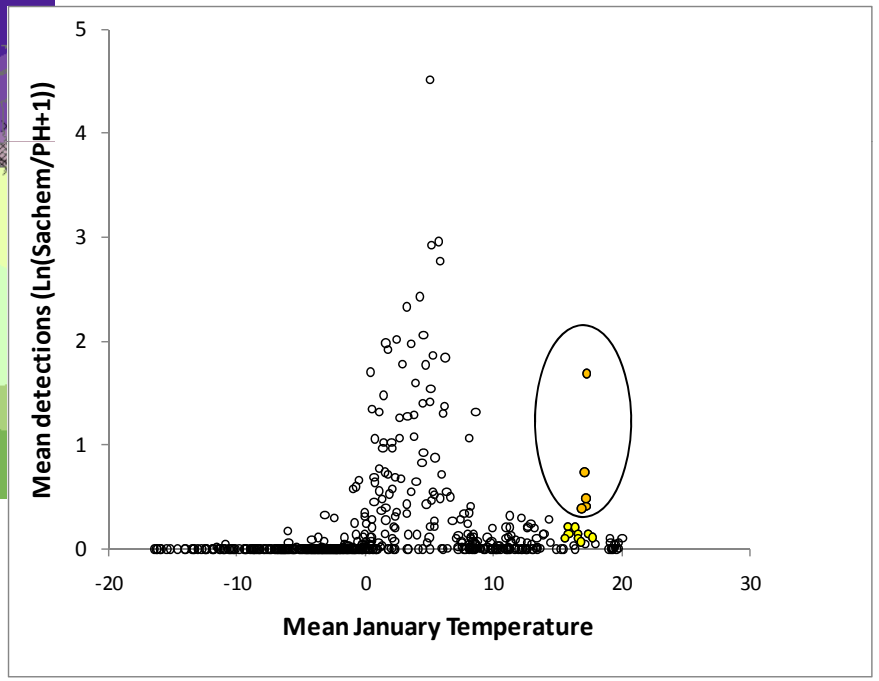
Turner, Ries, Mueller, and Crozier, in prep

Although the model clearly scales lamdba incorrectly, it seems to capture an important threshold (lambda = 1), and there is a clear limiting relationship within a certain climate

January mean temperatures

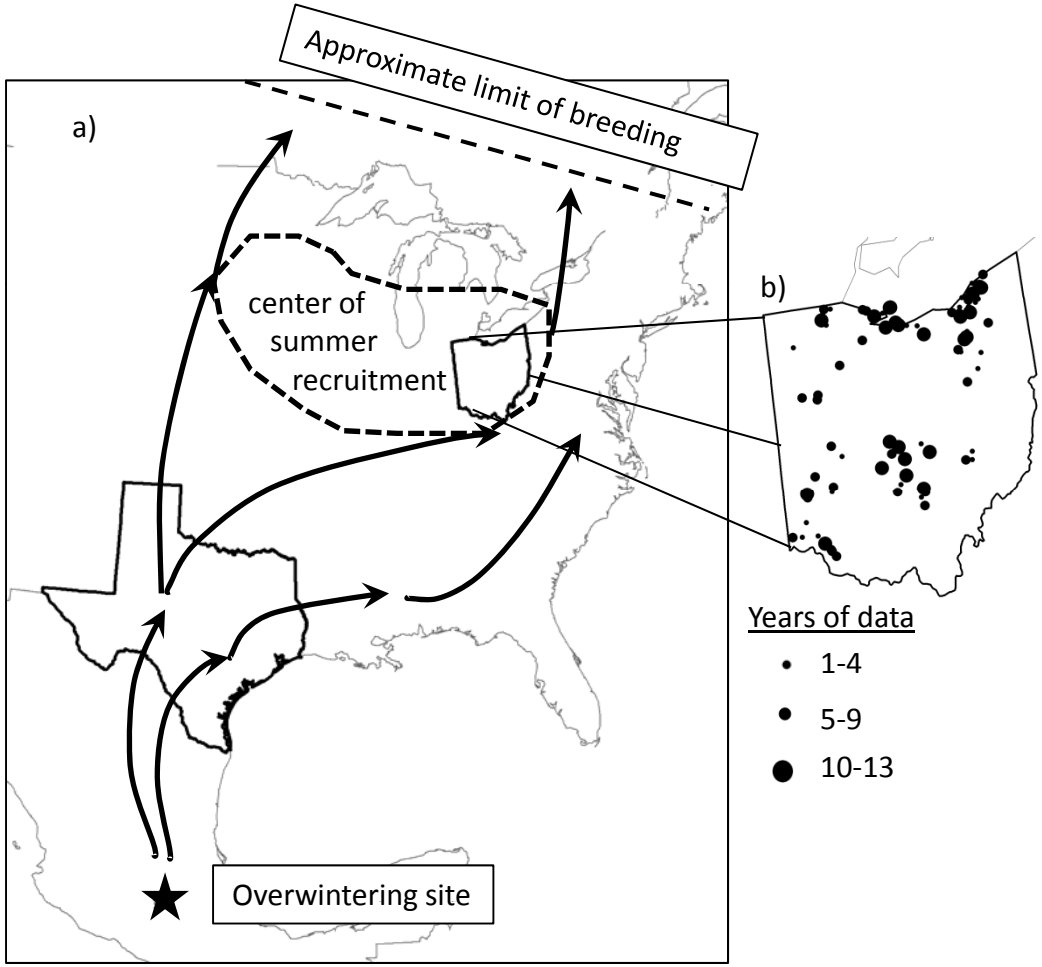
- The relationship between mean January temperature and sachem abundance shows the clearest relationship with climate – and also highlights outliers



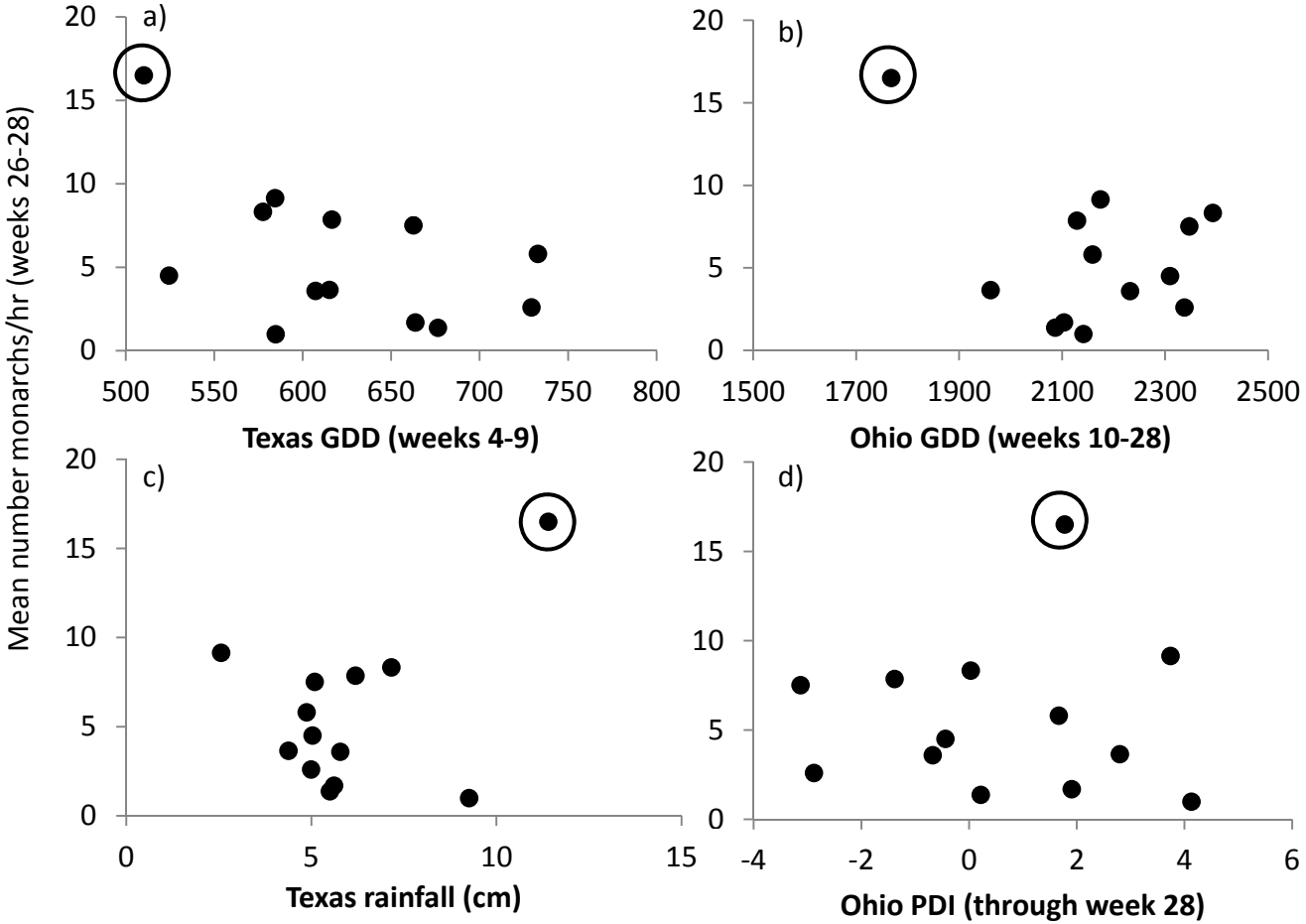


- The group of outliers is clustered in Florida and shows an interesting deviation from the larger pattern. Could this be a case of local adaptation to warmer temperatures?

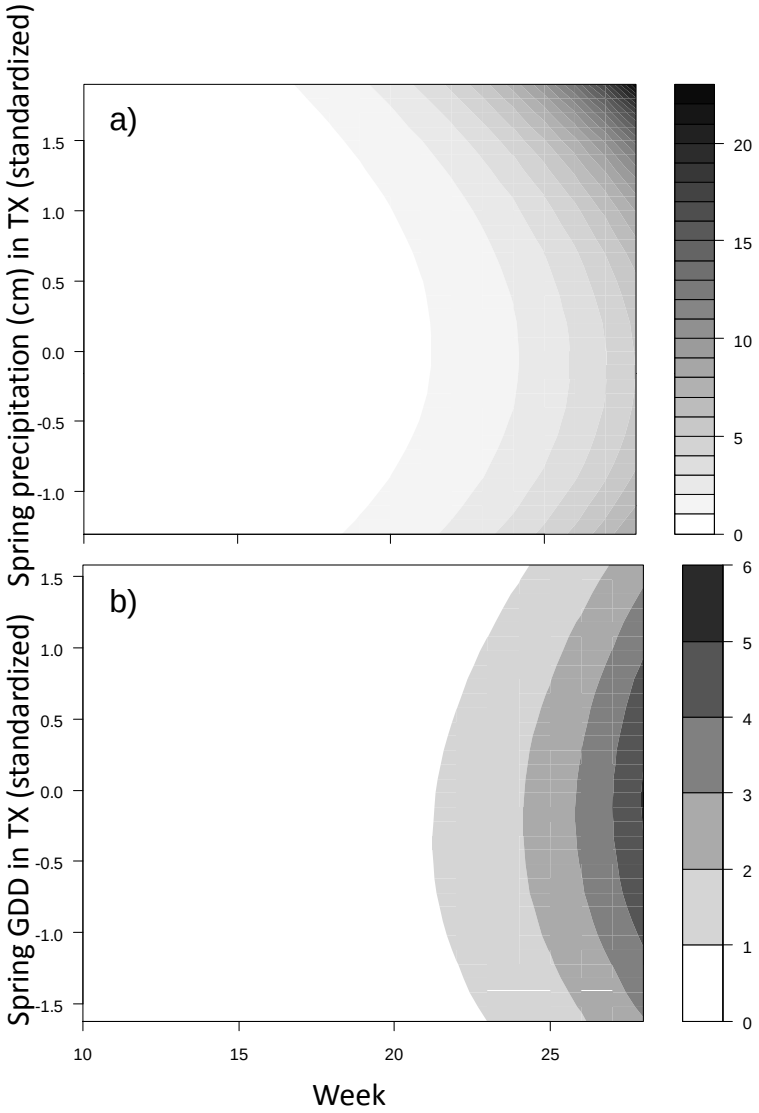
Tracking climate's impacts on a long-distance, multi-generational migrant

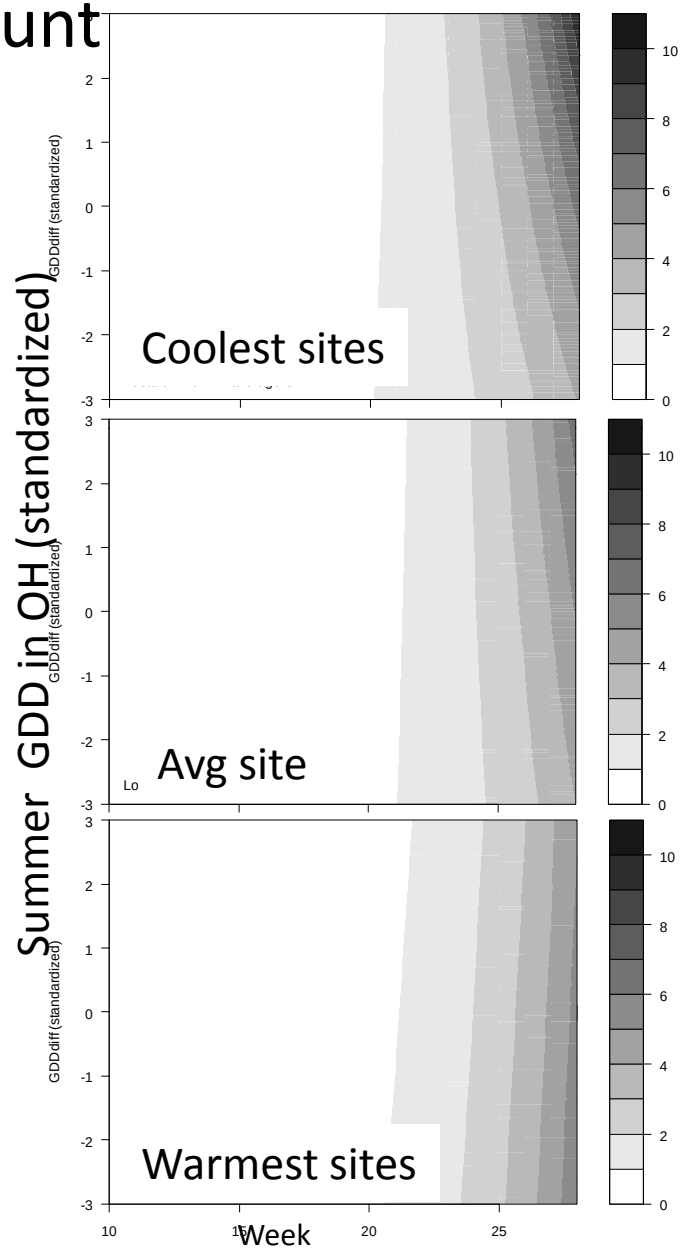


Patterns based on simple state-wide metrics aren't informative



Meaningful patterns emerge when patterns are evaluated in a multiple regression framework, taking site characteristics into account

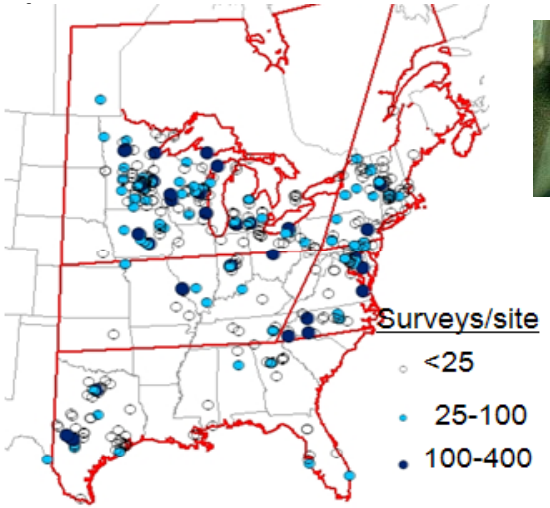




Is there a signal in the field for potentially lethal or sub-lethal temperatures?

- Lethal and sub-lethal degree days are times when a temperature exceeds the predicted GDD tolerance (e.g., above Tmax) and potentially could slow growth or kill developing larvae
- The Monarch Larvae Monitoring Project now has over 200 stations where volunteers monitor milkweed patches and count the number of eggs and larvae (by instar) over the gro
  - Started in 1996
  - Some volunteers rear individuals

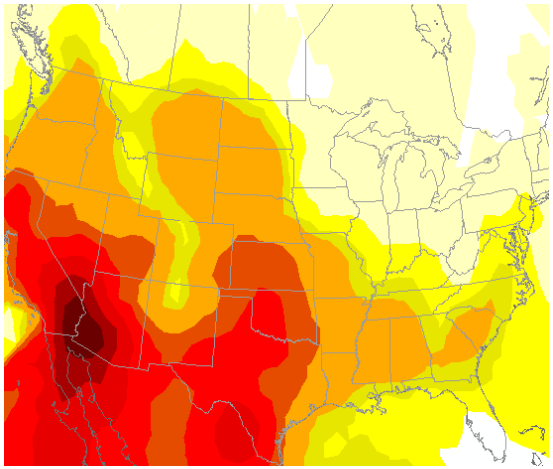
  to measure parasitism rates



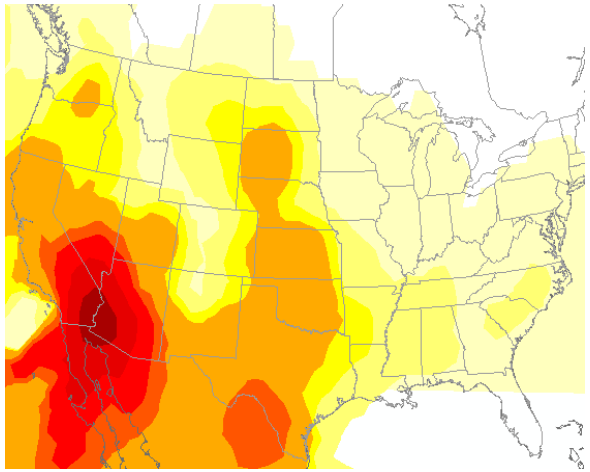
- Our goal is to measure the relationship between temperature, development rates, larval survivorship and parasitism in the field *and* improve the current GDD model for monarchs

Preliminary examination: lethal and sub-lethal zones

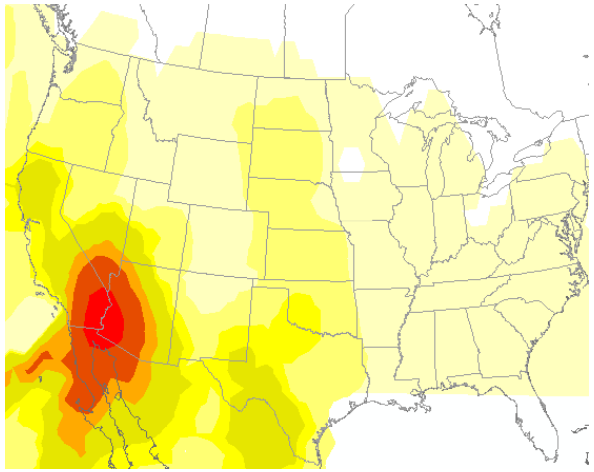
ABOVE 38



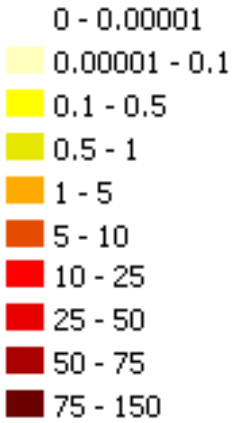
ABOVE 40



ABOVE 42

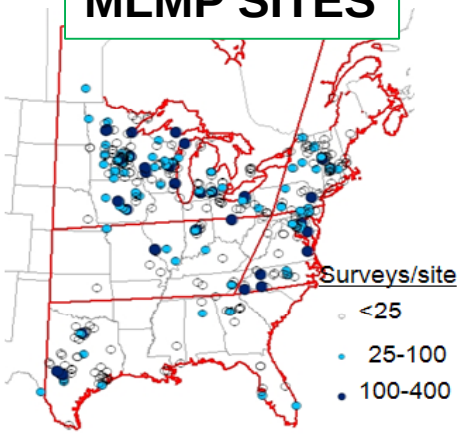


AVG NUMBER OF DAYS

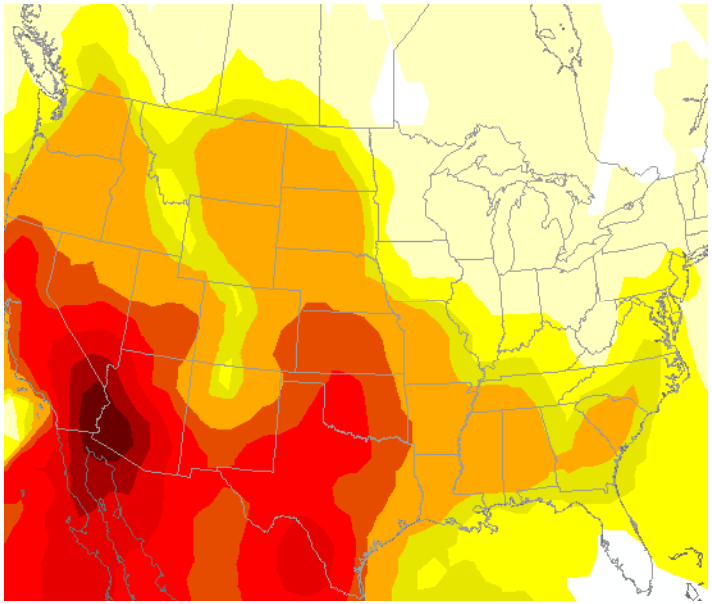


- Lethal and sub-lethal temperatures seem to correspond to limits in population densities, especially in the midwest
- Next up:
  - Comparing lethal temperatures to larval development observed in the field

MLMP SITES

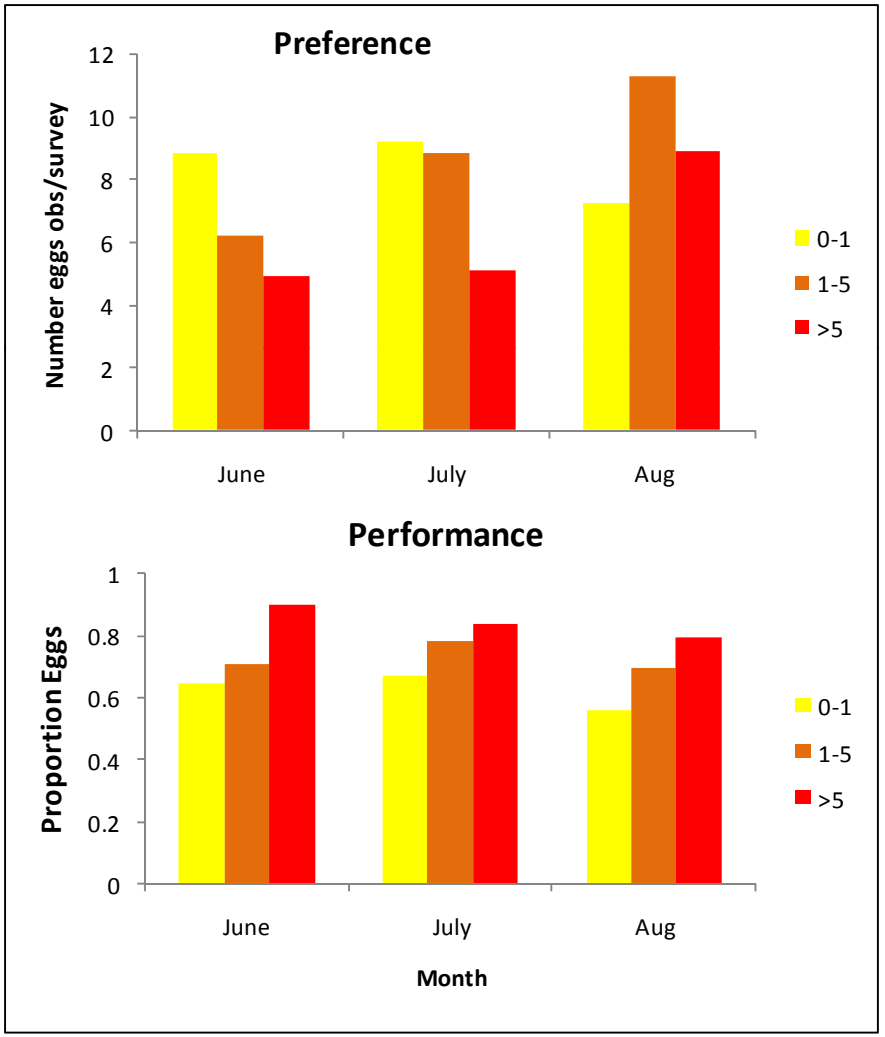


Preference and performance relative to mean number of days >38C

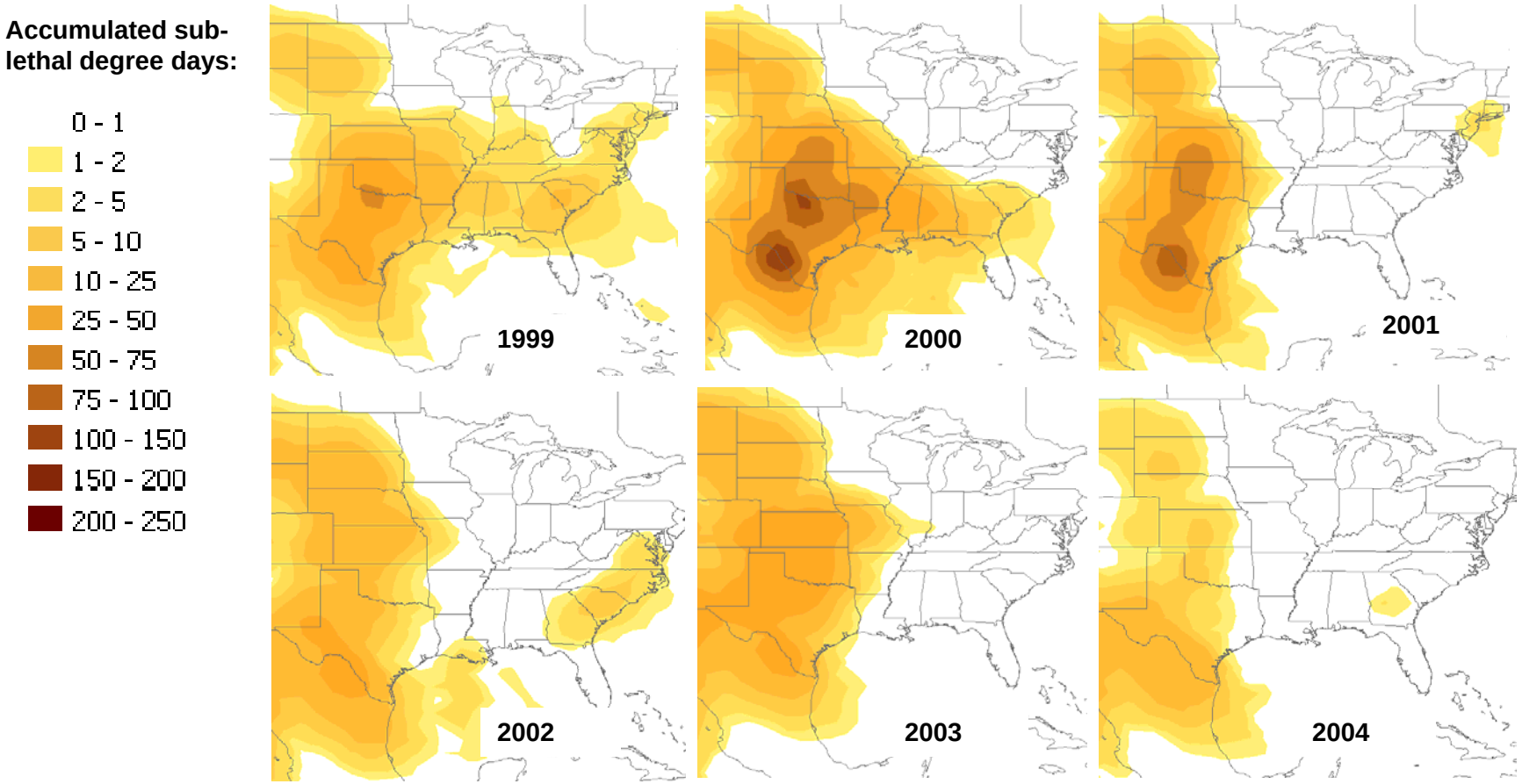


0 - 0.00001
0.00001 - 0.1
0.1 - 0.5
0.5 - 1
1 - 5
5 - 10
10 - 25
25 - 50
50 - 75
75 - 150

Mean number of days with temps >38C

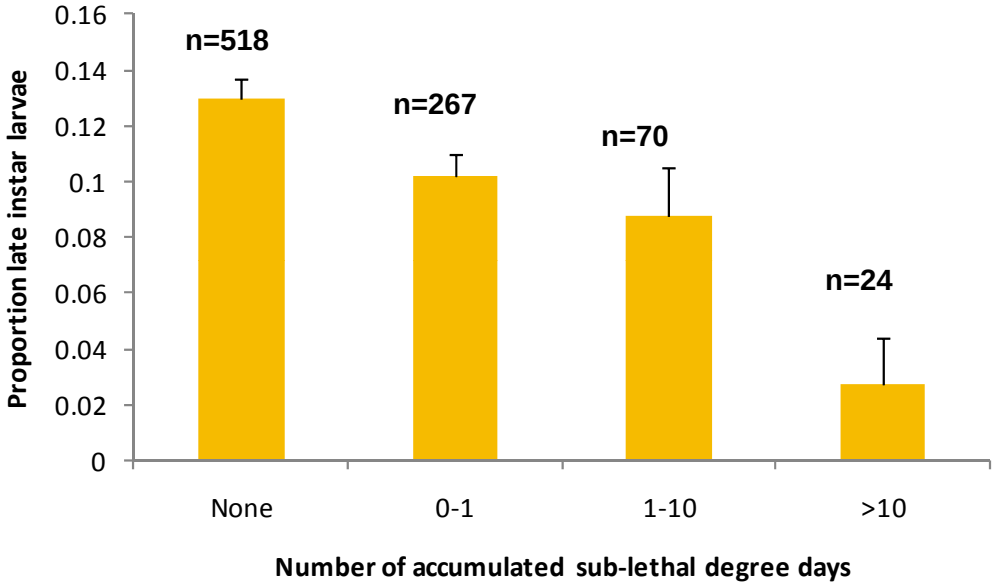


Our ultimate goal: take into account spatiotemporal patterns of temperature



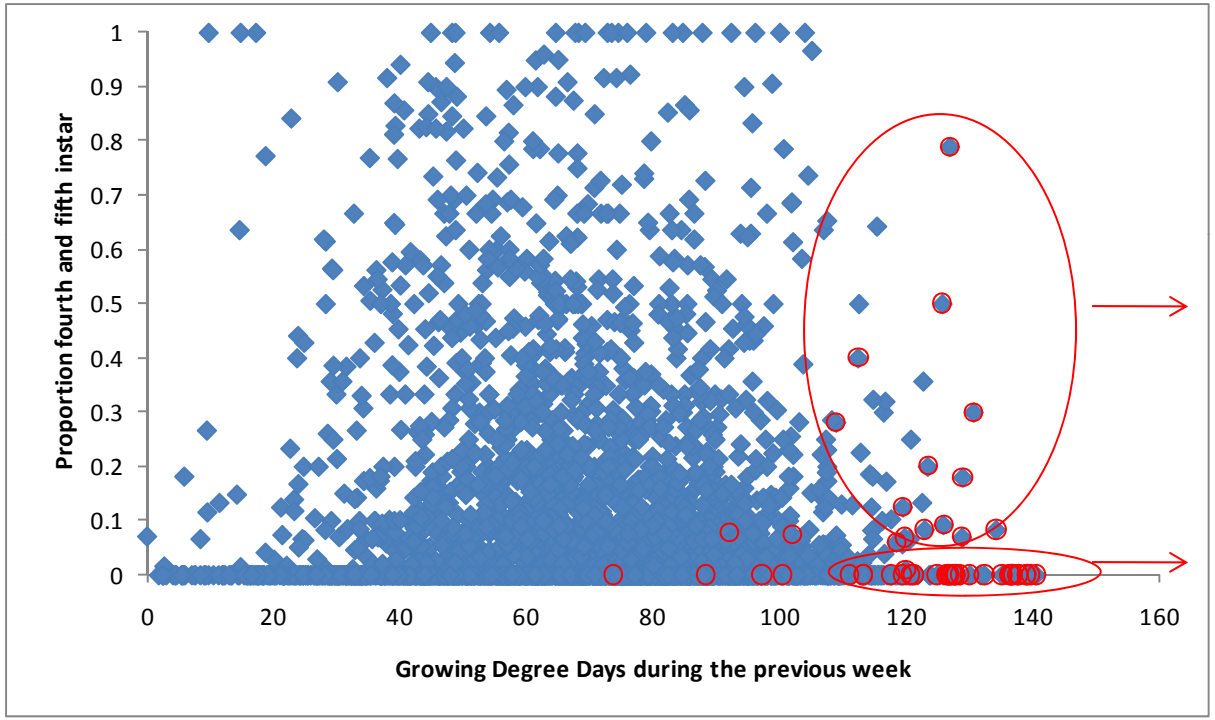
- These are accumulated over the main summer growing season (2 months)
- To truly test the impacts of sub-lethal and lethal temperatures, we need to tie temperature events to survey dates

Relationship between development and accumulated sub-lethal degree days



- Next steps
- Relate proportion of late instar larvae to sub-lethal temperatures in the preceding two weeks
- Examine relationship between parasitism rates and sub-lethal temperatures

Relationship between development and growing degree days accumulated during the previous 7 days

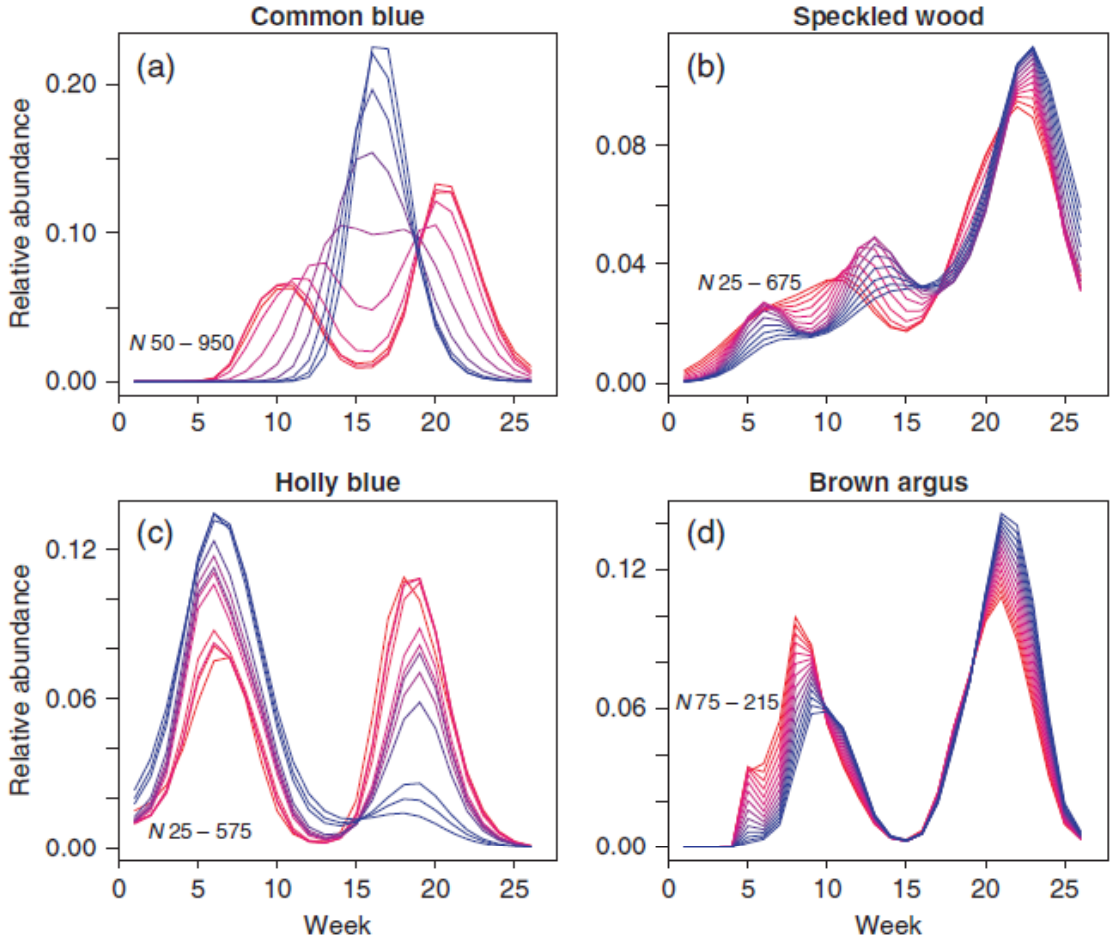


These accumulated fewer sub-lethal degree days

Many of these accumulated more sub-lethal degree days

Surveys that accumulated *any* sub-lethal degree days are circled in red

A framework for analyzing spatio-temporal patterns in phenology



Hodgson et al. 2010. Predicting insect phenology across space and time. GCB