**Working Notes**

*Calibration and Refinement/Upgrade of Simulation Model After Publication of First Paper*

**Calibration**

Look at milkweed density and egg density.

Data Sources

1. *Teresa’s roadside data*
2. *MCSP National Monitoring Data*
3. *IADNR pilot monitoring data*
4. *Oberhauser roadside data*

Need to get some compiled data on milkweed density for different habitat types from all these sources. I created a spreadsheet (Summarized Milkweed and Egg Density.xlsx) to try to compile all these different sources into final density numbers I can use in the model or use to calibrate the model.

*Teresa’s Roadside Data*

*Data Description*

A brief description of Teresa’s data from my previous notes: Eggs were counted on 20 milkweed in 50x50m roadside plots, 7 x over the summer. She estimated the number of eggs in the plot by multiplying eggs/milkweed by total milkweed.

*Data History*

I’ve requested data from Teresa several times. In the Model Test Data folder, a folder called Teresa Data has 2 files from October 2017. These have some calibration results. Not sure if everything is in there.

The folder called Teresa Blader data has files from March 2017. These are mostly about egg density. This an old analysis and I think I will just archive it/stow it. I renamed the folder to “Teresa Blader egg density data – OLD” and moved it into the new folder.

I created a new folder called “Teresa Blader roadside data” to combine all of the stuff I have from Teresa.

I looked back in my emails to see what she originally sent:

* On January 9, 2018, she sent me an email with the attachment Roadside Data 2015.xlsx. This file was in the immature survival estimation folder. I moved a copy from that folder to Teresa Blader roadside data folder. The purpose of this email was to get data for the Bayesian survival estimation. It seems to just have the counts of eggs and larvae.
* On October 2, 2017, she sent me a shapefile called 50mAll\_2017 that has a bunch of her milkweed and egg data in it. Not sure what I did with that.

That’s all I can find. I wonder if there is something I’m missing. Sometimes she uses a gmail address, but the search function should have picked that up.

I found an .mxd of Teresa’s data called “Monarchs – Teresa’s Data.mxd”, so moved it to the “Teresa Blader roadside data” folder. It has a lot of work to develop the shapefiles to run the model and so forth. In C:\Users\tgrant\Documents\Repast\Monarch\data there are two shapefiles that I clearly ran models on: TeresaTestData and TeresaTestData2. They are in the Analysis shapefiles.mxd, but not in the other .mxd I just described.

Where are the simulation results?? There has to be some R code somewhere.

Finally found it in ToxSims.R in C:\Users\tgrant\Documents\Repast\Monarchs\output. Created a new R file and new workspace called TeresaData.R in the Teresa folder.

The calculations for the new probEggs are in Teresa\_data.xlsx.

On 12/4/18, I double-checked with Teresa when the calibration data was collected (2017, as I thought). She gave this comprehensive view of her work:

*Hi Tyler,*

*No bother at all.*

*To clarify : My studies:*

*1st - 2015 and 2016 : replicates of 50mx50m area where the same patches were revisited every week for 7 weeks on roads 114th and 260th (30 patches were revisited each week). These stems were NOT georeferenced, just the location of the patch to remember where to revisit. The 2015 data was what you based the paper that you are trying to publish that hasn't found the right journal yet.*

*2nd - 2017 : 4 random roads (each 1 mile in length) where individual stems were georeferenced and monitored ONCE. < what is being referenced on page 56.*

*3rd - 2015, 2016, AND 2017: 3 patch study (stems not georeferenced). 1,5,10 patch sizes on 4 different farms, monitored each week for 14 weeks. These were plants that I planted.*

*At first I was a little confused by the .dbf . However, I believe it is based on the second study, however you wanted the data in 50mx50m areas for the testing of your model. So I split my miles into 50mx50m sections and clipped the georeferenced data into those areas in arcMap. That is why there are 32 rows for each road, because a mile broken up into 50m blocks would make 32 blocks. The purpose of the data in the .dbf you sent me now was solely to match with your model. The 2nd study in my thesis will have results based on the 1 mile area, not 50mx50m blocks. What the data in the .dbf represents: data collected in 2017, where stems were observed once following the methods detailed in my thesis, but organized to pair with your model. I'm glad I put the coordinates in, because that was the only way I figured it out.*

*Clear as mud? The data during the second study was collected in one or two days with the exception of road 4, but we wrote the data on the leaves and went back and collected the coordinates of the stem later.*

*Teresa*

Another email conversation with Blader the data: Basically, there was different numbers of plants surveyed at the 30 sites, so total number of milkweed stems was not 30x20.

*Hi Tyler,*

*Close, but not quite. Not all patches had 20 stems in each patch. Some patches had less than 20 so all stems were looked at for smaller patches and ranged from 1-20 stems while other patches had more than 20 and 20 stems were randomly selected. It’s more like at most 20 stems we’re observed in each patch. I don’t have access to the spreadsheet at work that I would have sent you and am having a little trouble remembering if I put the totally number of stems in each patch for each observation for the summer in that spreadsheet. I’d imagine I did, but can’t remember.*

*Does that make sense?*

*Thanks,*

*Teresa*

*On Thu, Aug 15, 2019 at 11:12 AM Grant, Tyler J [NREM] <tgrant@iastate.edu> wrote:*

*Hi Teresa,*

*I calculated eggs per stem from your 2015 data. I wanted to double check with to make sure I did it right. I used the spreadsheet you sent called Roadside Data 2015.xlsx. According to my notes, and the spreadsheet, on 140th street you visited 15 sites and checked 20 milkweed per site. At 260th street you also had 15 sites and checked 20 milkweed per site. So you that adds up to 600 milkweed you checked, and you checked them 7x over the summer. The total eggs between the two sites was 513+627=1140. So eggs per milkweed, over the entire summer, was 1140/300 = 1.9. Obviously eggs per milkweed on any particular visit was lower, but I’m trying to look at egg production over the entire summer.*

*I’m pretty sure this right, just double-checking.*

*Thanks,*

*Tyler*

*MSCP National Monitoring Data*

If I understand this spreadsheet correctly (FWS 2017 Iowa Plot Results for TGrant.xlsx), there were 53 surveys in Iowa in 2017. Plots had between 1 and 5 surveys per plot. Total number of eggs was 73 over all surveys, so not a lot. It also appears that the datasheets and metadata .docx he sent has all the datasheets.

I need to figure out this issue of plots and subplots. The spreadsheet says there are 150 subplots per plot. Pat Ward wanted to know if I wanted data by subplot. Ward sent the SOP3 from the MCSP monitoring plan. It says subplots are 1 m2 and their selection is described in SOP1. I downloaded SOP1 from the Google Drive site.

Looking at the geodatabase he sent, it looks like there are 5 plots in Jasper County, at Neal Smith Refuge I presume. There are also 5 plots in southern Iowa in Ringgold County, in that Prairie Chicken Refuge, I presume. There are also 5 more plots just across the border in Missouri. There are also 4 in Wisconsin. There are 270 in total in the geodatabase, but most are in Texas.

There are several types of habitat. The original type is in the plot label: PRG = Protected Grassland, AGC = Agriculture with crops or orchard, UPG = unprotected grassland. That’s all, 3 types. When they get to the plot, they check the type, and that is called the verified type, of which there are a few more types: CRP = Conservation Reserve Program (protect the location of these), RDS = roadsides.

For my state shapefiles developed by the techs, Jasper Co. is from the Brooke1 set. Ringgold Co. is from the Jackie1 set. Downloaded 2017 NAIP photography to compare to the plots in Jasper and Ringgold Cos and found the PADUS gdb I had from somewhere. I put into the spreadsheet the habitat type I had in my model (Brooke and Jackie’s shapefiles) compared to the type they had. All the Neal Smith plots are grass/pasture in real life, but in my model one is corn and one is beans. They appear to have recently been converted to protected grassland – probably new parts of the refuge. The other 5 are near or in the Kellerton Bird Conservation Area. CDL seems to have a hard distinguishing between grassland and ag sometimes, esp other crops, so there are some plots down here that don’t jive very well with my model and show up in my model as corn, beans, or other.

Six plots in the spreadsheet are missing from the geodatabase. So in total, there are 16 Iowa plots.

SOP 3 has a weird thing where they count eggs and milkweed between subplots. This makes is unclear what the area is for density calculations. I will speak to Pat Ward about this and see how he calculated it.

Emailed Pat Ward and said I would like to discuss the milkweed density and egg density calculations to make sure they are right. Also asked for gdb with all the plots and 2016 data, if it’s not too much trouble.

It looks like there may not be much data available to test egg density, because there aren’t many different habitat types, and I need to look at the difference between habitat types. But I can use the milkweed density data, combined with other milkweed density.

Spoke with Pat Ward on the phone. On June 9, 2018, I got an email from Pat with new estimates of density and the missing survey subplot areas. Didn’t open until Nov 29, 2018. Barely any eggs found in 2017, so don’t think I can use the data. A total of 8 eggs were found.

Calculated mean egg density and milkweed density per habitat type to put into a summary spreadsheet of empirical densities. Calcs in spreadsheet Pat sent me. Also compared habitat classification from their data to my model classification, which matched up quite well. Sometimes grasslands from their field data was classified as Other in my model, and sometimes they went to ag sites that were CRP when they got there.

The shapefiles Pat sent me the first time didn’t seem to have all the sites that were in the spreadsheet, so he sent me shapefiles again on June 9, 2018. The missing transects appear to all be roadside transects.

So, got all of the crosswalk done and calculated milkweed per ha and eggs per ha and put into Summarized Milkweed and Egg Density.xlsx, but not gonna run simulations on the USFWS data. Sample size of 8 is too small so too much randomness.

*IADNR Pilot Monitoring Data*

I mentioned to Karen Kinkead I was interested in the IADNR pilot monitoring program data to compare to my model results. Stephanie Shepherd contacted me Jan 23, 2017 and we exchanged several emails and she sent me the data.

Methods, from Stephanie’s email:

*It's neither of those. It was our own rogue data collecting pilot:). We were mostly curious about how this would actually work for a volunteer and we were also a little concerned about the adult monitoring protocols the MSCP was testing and wanted to try something different. So Karen picked 10 sites to try things out on. The most important thing is that it is not duplicate of what you have or are asking for.*

*For the data you are looking for (egg density by land use or site-type and milkweed density), we pretty much followed exactly the MLMP protocols.*

*Egg Density was collected by walking into the site, throwing a pen to choose a somewhat random direction in which to walk and then walking a straight line in that direction and examining every milkweed that fell within arm span for eggs and larvae.*

*Milkweed Density was also collected along transects. Direction was chosen as above and then the transect was walked, stopping every five strides and then placing a meter squared quadrat and counting all milkweed plants that fall within it.*

*There are two worksheets in the excel file. I included the raw data for the eggs we saw - I did not include any other larvae. It is summed across the survey and there are numbers for both total number of eggs and total number of plants with eggs as well as number of plants sampled.*

They offered to send me a shapefile of the site locations, but it’s not really necessary. They didn’t collected the data in a way that can easily be converted to eggs/ha. They followed the MLMP protocol and it’s the same issue I’ve seen elsewhere – the protocol says to run the transect until the habitat ends or you get the full number of milkweed. So if they don’t check the distance they went, it’s impossible to get it. Milkweed density can be calculated though, because milkweed is only counted in 1 sq m quadrats.

Sent Stephanie Shepherd an email 11-30-18 to follow up on density.

I got an email from Karen 12/7/18. Essentially the plots were not chosen in a way that would make them very representative, so I shouldn’t use them. The only category I don’t have is urban-suburban anyway.

*Oberhauser Roadside Data*

There were a few datasets sent from the Oberhauser lab, from Karen and Kyle Kasten. One dataset I had to delete because it had geolocated CRP data (see 12/6/2017 email from Kyle Kasten).

The data I have is from a 1/27/2017 email from Karen Oberhauser (oberh001@umn.edu). The data was used in the Kasten et al. 2016 paper “Can roadside habitat lead monarchs on a route to recovery?” I took the average milkweed and egg density from this paper.

*Oberhauser other data*

Oberhauser had some other data that was from certain plots, but they made be delete it because it was geolocated CRP data. I think all the sites were in Minnesota though.

**Model Upgrades**

Change potential eggs laid to ~700 and realized eggs laid ~300.

Expanding perceptual range

Probabilistic movement choice – doesn’t always move based on habitat around it, sometimes just flies

Variable step length – Kelsey found step lengths of 1-275 m or something like that, direct flights of up to 1.1 km in low-signal environment. Agent needs to change mode between just flying and responding to habitat.

Density dependence probability of egg-laying

Nectar resources affect movement – Wayne Thogmartin idea

Fix random number generators???

Methods and Results Writeup

**Methods**

Data from several different studies was used to further calibrate the model. These studies were: 1) a survey of milkweed and monarch eggs and larvae in roadside habitat in Story County, Iowa, in 2015 by Teresa Blader, a graduate student at Iowa State University; 2) data from the pilot year and first year of the new national monitoring program for monarch butterflies collected primarily by the U.S. Fish and Wildlife Service in 2016 and 2017; 3) data from a pilot monitoring program by the Iowa Department of Natural Resources in 2015; and 4)