January 25, 2021 Theory Working Group Call

Attendees: Lynda Bradley, Mike Dietze, Christy Rollinson, Amanda Gallinat, Jody Peters, Will Pearse, Abby Lewis

Agenda:

1. Announcement: EFI's Operating Principles and Procedures was ratified last Friday by the founding steering committee. Memberships will be open for renewal for 3 year terms and we will have an upcoming vote for 2 new steering committee members
    a. Still have the RCN steering committee handling day-to-day operation of RCN.
    b. Larger EFI Steering Committee - focused on longer term mission of EFI and being proactive on that.
    c.

2. Look at the last question on the Tick Example and the Phenology Example
    a. Ticks: we are generating a forecast of tick abundance at NEON sites.
        i. Agreement about level of organization = population level
        ii. Phylogenetic scale = species
        iii. Trophic scale - trying to use small mammal data or is that above and beyond what is possible for tick forecasts
        iv. Life stages - as output or input of forecast different life stages. Forecasting nymphs separately from adults
        v. Forecast Challenge rules - goal is to predict nymphal abundance. Teams are allowed/ but not required from assisting with this - so could use mammal data or adult tick data
        vi. John Foster's forecast use 3 life stages and uses environmental covariates to affect survival probability, etc
        vii. NEON does not collect mast data. But other labs do collect mast data at sites at or adjacent to NEON's sites. Ostfeld's paper suggests 2 year lead time between mast to mice to ticks.
        viii. For RCN technically can't use the mast data because it is not publicly available yet.
        ix. What is the trophic scale of the forecast - nymph abundance.
        x. Lynda - lab is participating in the challenge. Trying to get small mammal data to learn an agent based model - a mechanistic model that will be useful for different models. Has been an interesting process for trying to compile all the datasets.
        xi. Forecast horizon - John thinks it is 1 week, maybe 2. Mike is surprised at this from looking at the output of John's models. He thinks longer term. If drawing a figure like that in cell A3, expect it will be slow to asymptote. Expect to be doing better than chance a year out. Is that R2 level of 0.08. This is a big question mark.
        xii. Can the forecast go so far out because of overwintering? Is it a consequence of tick biology?

1. Ostfeld's classic Of Mice and Mast paper - 2 year cycle.
2. But clear that not all things are equal. A large population going into dormant season getting hammered by a hard winter. But if we understand the environmental drivers well enough then can correct the longer length predictability.
3. John's answer of 1-2 weeks might also come from changing the question to can you predict peak abundance within a season.
4. Within season predictions are hard. Not as skillful at tick phenology as well as with the vegetation phenology

xiii. Tick abundance forecast is not the same as tick phenology.

1. Does the model combine abundance and phenology?
    a. If you want to predict tick numbers that you catch in the drag, you need to understand the observed abundance is a combination of latent abundance and phenology

xiv. Relevant spatial scale - is the goal to be able to forecast across sites?

1. Unknown. Relevant info - ticks don't move very far on their own. Meter-10s of meter
2. Most small mammals also don't move very far. So NEON plot is relevant size. Move 10s-100s of meter. Don't expect there will be much movement between plots
3. Larger mammals like deer will move ticks further and the occasional movement of ticks by birds.
4. This is the dispersal part of the problem
5. The climate variability is at a larger spatial scale. 10s-100s of km. This is also likely the spatial scale for masts.
6. Small mammals have larger migration once in a while move (e.g., mice moving up a mountain)
7. NEON's method to sweep net for ticks, does not pick up species specific well. If you are a tick that only stays on one species you may not get picked up with NEON's method. So this will have a big impact on estimates.
8. Mike strongly expects - dispersal mechanisms aren't strong enough to drive spatial synchrony due to dispersal, expect synchrony is due to climate
    a. This is an open question that these forecasts will inform
    b. If we want forecasts to be valuable to society, need to know the radius of collection site that will have skills.
9. How much heterogeneity is there across plots at sites. Depending on what scale managers are working at, how much heterogeneity will influence decisions being made
    a. Sites are going to differ in landscape scale heterogeneity. Some are in steep areas and some are flat. Ordway Swisher has lots of vegetation heterogeneity, but only

varies by about a meter in elevation. Bartlett has genuine topography.
    b. Land use history is complex. All the sites are eastern temperate sites so have complex land use histories. Don't think there is a single NEON site in the east that wasn't logged in the last 200 years and many more recently.
10. Don't know if anyone will be trying to forecast across sites. There are 22 plots in 7 sites that are in this first round of the forecast.

b. Question
    i. If we divide the time between t=0 and the forecast horizon into thirds, what input uncertainty do you think dominates the forecast uncertainty at each point in time (first ⅓, middle ⅓, or last ⅓ of the forecast).
    ii. Uncertainties: initial conditions, drivers, parameters, random effects, process error
    iii. See if there are rules that we can make for the theory of forecasting. Or hypotheses we can come up with from these different examples when different uncertainties will dominate.
    iv. Agreement from the group that the initial conditions dominate first ⅓ of the forecast.
    v. Driver uncertainty -
        1. Mike: hypothesize first and last. First = phenology driven phase, Last = interannual phase. But process error is probably really important for phenology which is in first ⅓ to ⅔
            a. In NEON challenge none of the sites are one that ticks are just arriving at. So expect that the sites are all within endemic range of ticks.
            b. Will - Process vs random effect error - if everything is equilibrated, then random effect may be more
        2. Christy: I hypothesize that driver uncertainty dominates when processes and parameter error are relatively low.
        3. Lynda: At what point does the phenology play into the process error. Process error - is it only the biological tick process that has climate/phenology in it?
            a. Mike defines process error differently than Carl Boettiger. If you have 0 observation error and could measure system perfectly, then process error and observation error are the same thing. This is separate to a theoretician but not separate to a statistician.
            b. Process error is definitely throughout, but where is it dominant?
            c. Mike's thought are formed because his understanding of population is stronger than his understanding of phenology
    vi. Is some of the overlap from where we expect uncertainty between leaf and tick because of the phenology? If we remove the phenology from the

ticks and are just talking about demographic processes, do we expect the timing of the dominant uncertainties to change?

1. Not sure if the phenological time scales of leafs and ticks are the same. But hit on an important point that there are spatial and temporal scales that will be same if they are phenologically driven.
2. Comparing the two examples may be difficult because the element of phenology is important.

c. Next steps for next call
    i. Turn back to the manuscript for the next call. See what we can apply to the manuscript now that we have talked through 2 different forecasts to see if we can refine hypotheses.
    ii. Amanda and Abby will follow up with homework for the next call.

3. Draft Outline of Theory group manuscript
    a. This is based upon previous TG meetings and in particular the Forecasting Hypotheses document
    b. Focus on the definition of predictability and the potential to merge Ecological Questions 1 & 2
        i. Questions:
        ii. 1. How does predictability relate to spatiotemporal variability?
        iii. 2. What factors limit predictability (skill) across scales?
        iv. 3. When does predictability in one context imply transferability to other contexts?