November 16, 2021 Theory Working Group Call

Theory Notes from the October 19, 2021 Call HERE

Attendees: Caleb Robbins, Glenda Wardle, Cole Brookson, Christy Rollinson, Noel Juvigny-Khenafou, Andrew Allyn, Elyssa Collins, John Foster, Abby Lewis, Steph Brodie
Regrets: Jonathan Tonkin, Amanda Gallinat, Nick Record

Agenda:

1. Manuscript Text HERE. Black text is new text ready for review/edits. Gray text is draft outline leftover from previous versions that may not match with the current framing.
    a. Section 2 New horizons of ecological research and predictability - can we use forecasts across sites to understand general predictability
        i. Hypothesis 1 - predictability will decrease with increasing forecast horizons
        ii. Maybe something more that can be said about the rate of decline of predictability over forecast horizons. Perhaps can look at this in the future, but don't have data about that currently.
        iii. Hypothesis 1 then sets up for Hypothesis 2
        iv. Think nuance can be added to Hypothesis 1. Predicting variance or variability of systems. You can predict succession after a disturbance. You might not get everything right, but can predict an increase in biomass. Or the landscape mosaic - at the large scale there is predictable stability. Signal to noise when thinking about NPP cycles Might not get the exact number, but could get into the right ballpark.
        v. Christy can add some nuance to this section for this.
        vi. There may be intermediate states that are hard to predict - add this
        vii. Because Abby is not defining predictability in reference to a null model thinks it is easier to say that predictability will decrease over time.
        viii. Decreases over time even despite seasonal patterns, if you are averaging over an entire year. If there is a transition event that will happen in the next two weeks, the transition point may be unforecastable and cant' make a valid predict 30 days in the future, but it will be easier to predict the transition point 2 weeks in the future than 4 weeks in the future
        ix. Is the key - for a constant temporal grain and unit, not letting that grain extend. If predicting a year into the future, predicting a day instead of a season
        x. Think the 3 paragraphs prior to H1 sets H1 up well.
        xi. Abby didn't include forecast changing with spatial or temporal grain because didn't think we were in consensus as a group on that over the past couple of years of discussion

xii. Glenda - wonder if this point can be made more explicit. If thinking long time in the future and investing money, we just want to make money. But thinking close up we want to know how much money we are making
    1. Could pull the insight up front about the timescale. There is an assumption that we are not aware of that the grain is shifting. We talk about with weather forecasting that is easier to predict seasonal patterns then to predict 14 days out.
    2. So if we want to know if the 2022 season is wet or dry. But when we are here we know the actual moisture level in the next week and that sets a high bar to pass. So we get more tolerant of a wide band for a future expectations. Our expectations are changing.
    3. Think this manuscript can expose thinking like that really well. So we can see where the skill gets compared for predictions.

xiii. Hypothesis 2 - predictability increase with increasing (complexity?) for ecological processes
    1. How will the forecast skill differ between variables?
    2. Dan McGlinn added a number of bullets for this
    3. Andrew's paper that he found on environmental suitability and its relationship to population local abundance, may be this similar idea. You might find a correlative general idea of the suitability of a location and the relative abundance of that species at that location, but you can't use the suitability to predict the true species abundance. This might be related to this piece.
    4. Steph's example - it is really difficult to model for an individual animal, but it is easier to predict where a whole species will be distributed. Think that aligns with this topic.
    5. Abby has been thinking about it for a forest. Hard to predict biomass for an individual tree since it could die in any given year, but is easier to predict the biomass of a forest.
    6. Has the same issue of what we said before. The units you can predict change. You will be off by a greater magnitude of biomass for a forest then you will for a tree.
    7. Christy: Worried about the word "complexity" when we try to represent the full complexity of an ecosystem process, there are compounding biases. The simpler model typically does better than a complex model. Think it is a scaling issue rather than a complexity issue.
    8. Elyssa - a word that comes to here is our ability to generalize. Going back to the idea of overfitting and how forecasting can allow us to avoid overfitting and that is related to generality. Generalizing by not focusing on one forest or one animal. Generalizing to a whole population. Looking at the predictors

correlated to the outcome. Thinking about it at the large scale. Thinking about in terms of transferability, it might be easier to transfer a model

9. Christy: Is about going back to sample/population size? It's easier to estimate the characteristics of the population than a single value?
    a. It is like micro vs macro economics. Easier to predict large scale emergent behavior with the full distribution where you are in the bell part of the bell curve instead of predicting a single event where it is stochastic.
    b. How much of it is scale vs law of large numbers?
10. It is not a satisfying answer though - in different units so can't make a direct comparison. Is it possible to do something in the same unit?
    a. Forest example - have a forest where more trees will be less stochastic overall compared to a forest with fewer trees. Also similar to diversity relationships in ecology.
    b. If we get away from strict spatial or temporal scale are we talking about a certain level? Populations are easier to predict than individuals. For climate - easier to predict regionally compared to your backyard.
    c. Easier to predict at the higher level because it washes away the variability
    d. Thinking about ecological organization level
        i. Think it will be a non-linear trend
    e. For fisheries - we can make pretty good models for a poputlin. Stock recruit model can be accurate, but food web model is rarely accurate. Is there a peak of predictability on your scale/ if you try to predict food web at a whole you do poorly, btu predict at a smaller scale can predict
    f. Predictability scales non-linearly with level of biological organization?
    g. Be explicit and keep the units constant as we change scales of biological organization
        i. If units are the absolute magnitude between prediction and observation (e.g., units of biomass)
        ii. But if units are R2 or correlation between observation and prediction, then expect you might see the nonlinear relationship
        iii. Noel: Comparing models with a number of variables/parameters vs models with few parameters

1. Marquette paper - one of the papers in the spreadsheet states to have good theory need to have as few parameters as possible
2. From Noel's experience working with stressors, try to keep the number of stressors low

h. Looking at aggregate measurements will be simpler than looking at the finer scale. If you look at species dynamics it will be a different story the scale you are looking at.
i. From Glenda - same point as micro and macro economics:
    i. Have been down a rabbit hole thinking about statistical mechanics. In physics, statistical mechanics is a mathematical framework that applies statistical methods and probability theory to large assemblies of microscopic entities. It does not assume or postulate any natural laws, but explains the macroscopic behavior of nature from the behavior of such ensembles.
    ii. Can borrow from statistical mechanics
j. Cole: yeah, if you're trying to model biomass in a food web by summing predicted biomass of 50 species, then that's going to go poorly. But you could model the predicted biomass of the food web via some ecosystem model then you'll do better
k. Can't just scale up from individual to population to food web. Predictability will be higher at the higher level. Or the process can be explained with a simpler model
l. Is statistical mechanics the same as thinking of your response as a statistical distribution? Yes
    i. In terms of tree death, you may not know what tree will die, but will be able to predict the percentage of trees that will die.

11. Fun to tie in the statistical mechanics and macro/microeconomics. If we do mention it in the paper, don't want to distract from the ecology. But does help to refer to the same concept in other disciplines so that would be a general point to make.
12. Especially since we don't have a lot of data on this ecology, being able to point to other disciplines.

b. Think about hypotheses for the Section 2
    i. H1: ecological forecasts are not dominated by initial conditions (in contrast to weather forecasts)
        1. We have seen that initial condition uncertainty decreases over time.

ii. H2: the importance of initial condition uncertainty to toal forecast uncertainty decreases with increasing complexity of ecological process (biological organization)
iii. Wonder if we can add a third hypothesis? Steph doesn't see the dichotomy
iv. The progression of ideas was thinking about uncertainty partitioning and transferability and predictability were the 3 points to hit on. But could combine. Need to make the connection clearer
v. Another question - tipping points in forecasts and thinking about alternative stable states lead to a highly relying on initial conditions.
    1. If Cole could go through and put in references to relevant papers where people have been thinking about initial conditions in ecological context would be very valuable
    2. Noel - new branch of research in multiple stressors and depending on what order you have will influence the outcome. Recent paper in Oikos - depending on what level is influenced first will influence the outcome, so it depends on the initial state
    3. From Christy - end with hypothesis 2.1 that ecological forecasts [Jody didn't catch this]
    4. Wonder if initial conditions are not as important because many people are using simple models that don't have that level of individual variation compared to weather forecasts that are more highly detailed.
    5. Have we decided as a community that we are going to use coarse representation of ecological processes where initial conditions do not matter?
        a. Glenda - wonder what counts as initial condition. For individual think about genetic makeup as an initial condition.
        b. We are assuming the processes are up and running and then are trying to predict forward. Where many others studies are thinking about the part of getting things up and running. Mutation and it's fixation rate.
        c. Succession - old work was about if that was deterministic or stochastic and how orderly succession is and what we see or is ti about who gets there first
        d. This for us has been a very useful exercise because it is bumping us to think theoretically. We don't want to have a prepackaged set of ideas that people have to acetp. Forecasting is so inspirational to our way of thinking.
        e. Think in this manuscript we will raise a lot more questions than we answer. Talk about this on the next

call. Talk about the last section which is totally outline right now about the Roadmap.

f. Homework - think through what is needed and what are we proposing for the community to be able to answer these questions.

2. Authorship Guidelines
    a. Will come back for a broader conversation. Had originally planned to have individuals be in charge of text but currently Abby has drafted much of the text with input from the group. So thinking about
    b. But at this point thinking that there will be a list of 5 actions and co-authors are expected to fulfill 2 of them
        i. Conceptual development through working group, slack, zoom meetings, etc
        ii. Writing the outline and text
        iii. Reviewing and editing drafts
        iv. Draft figures
        v. Supervision and administration
    c. Abby's plan is to talk through this with the group more

3. Spreadsheet to compile literature on forecasting papers that shed light on theory topics from the manuscript and non-forecasting papers on theory/ecology that are key for the manuscript
    a. Continue to add papers to the spreadsheet

4. Homework - First section - forecasting uses prediction to advance prediction. Have broader conversation about the use of prediction in ecology and how forecasts contribute to that.
    a. Continue to edit to the section we went over today
5. Abby hasn't had a chance to look through the spreadsheet yet, but will get to that over the next month. People can continue to add to that

Other Items Previously Discussed that Jody is leaving in for reference

1. Authorship Guidelines Reminder
    a. If anyone has suggestions/edits to the guidelines, put it in Slack and we can discuss updates.

2. Old Draft Outline of Theory group manuscript
    a. Updates from:
        i. Ecology question 1: How does predictability relate to spatiotemporal variability? How do forecasts change over a forecast horizon

1. Materials from previous calls: Google doc for Q1 notes, Slides

ii. Ecology question 2: What can we learn about ecological theory through the transferability of forecasts?

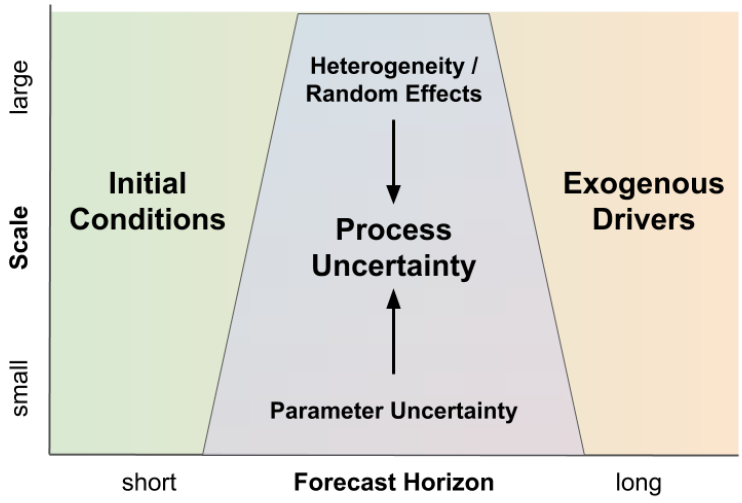
1. Materials from previous calls: Google doc for Q2 notes, Slides

b. Next steps

3. Forecasting Vocab Terms
   a. Abby is working to compile the terms for a box for Anna Sjodin and Gretchen Stokes manuscript. Vocab Box
   b. From Nov call, the goals was to compare these terms with how they are used in the Forecast Standards to make sure they are consistent

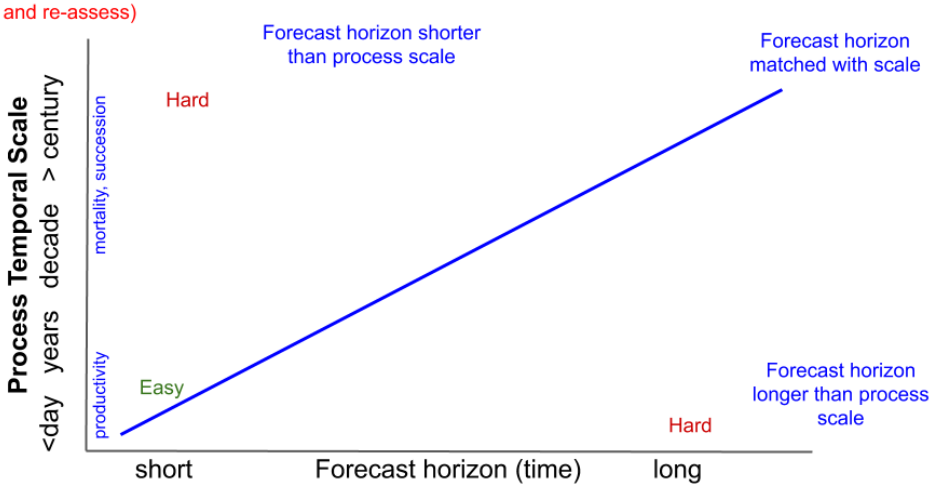
Old Material Referring to the Common Framework slides for reference especially for thinking about the RCN Forecasting Challenge examples:

a. Slide 8

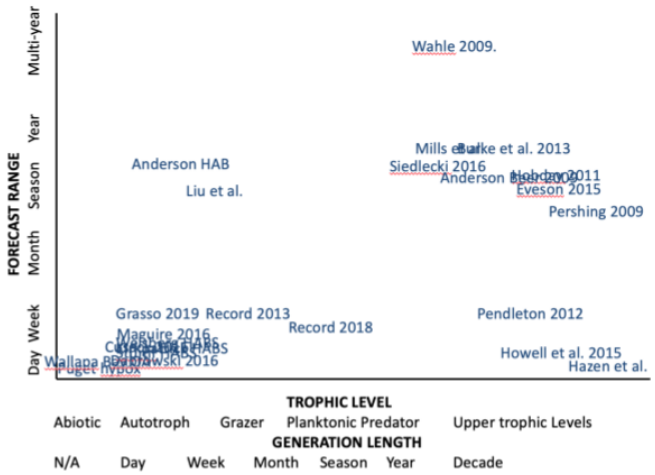


b. Slide 9

Rollinson Note: Are temporal scaling issues in forest modeling are separate from levels of organization or not. Can the temporal scale be independent of the forecast horizon? (I did this before seeing the Adler pre-print; will read and re-assess)



c. Slide 10



This is from a literature review I've been working on for marine ecological forecasts. Just from my notes-- I've just eyeballed the positions on this graph. Placing it here as food for thought. -Nick

d. Uncertainty components in forecasts

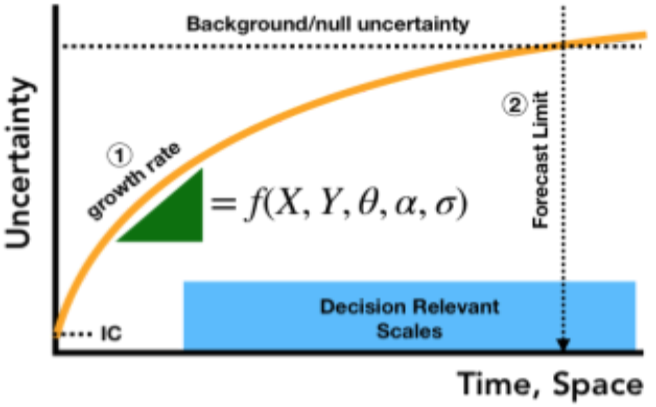


Figure 3: The predictability of a forecast is measured by the rate at which forecast uncertainty grows, in space or time, and the limit at which the forecast performs no better than chance. IC = initial conditions, X = exogenous drivers, Y = internal system state, θ = parameters, α = random effect variability, σ = process error.