November 18, 2020 Theory Working Group Call

Attendees: Abby Lewis, Amanda Gallinat, Christy Rollinson, John Foster, Jaime Ashander, Jody Peters, Alex Young, Mike Dietze, Hassan Moustahfid, Daijiang Li

Agenda:

1. Draft Outline of Theory group manuscript
    a. This is based upon previous TG meetings and in particular the Forecasting Hypotheses document
        i. Thoughts on this structure for a theory-oriented forecasting manuscript?
    b. Link ecological concepts with forecasting concepts
        i. Amanda pictures a conceptual figure of a forecast overlaid with ecological theory and point to what can/cannot be tested with ecological theory
    c. Something else valuable to explore is the ability to identify what are the limits of predictability and sources of uncertainty. If we vary the scale how does that change the uncertainty.
    d. Goal - come to a consensus for 3 questions/hypotheses. Then put questions in slack and have more discussion
        i. Question 1: How does predictability relate to spatio-temporal variability
            1. This is the most well developed. The dominant scales idea
            2. Like organizing around the 2 figures.
            3. Question 2 seems like the converse of this first question (by the end of the discussion, we seemed to get to a place where the two questions were thought of differently - we will follow up with this on the Slack thread about these questions to make sure Questions 1 and 2 are articulated)
            4. Figure 2 with drivers/initial conditions seem the most fertile ground - if the broad pattern of our first question holds up, then if you do want to use a forecast you will be limited by these other things outside the process
            5.
        ii. Question 2: What factors limit predictability across scales
            1. Find an ecological question to set up the importance of uncertainty partitioning
            2. Partitioning uncertainty - if we can draw ecological examples to highlight what those different sources of uncertainty look like in an ecological context will be a good argument about what is unique in forecasting and has unique ecological value. A theory level understanding of partitioning the initial conditions to give us information about what has stronger predictability compared to other conditions
            3. Skill - how good we are doing.
                a. Theory of forecasting or the using forecasting to think about other ecological theory. Think this manuscript

b. What is the limit of the skill. Can we go from short to long-term forecasts? Not in terms of how good we are doing with the forecast
c. What are we saying by limit and by skill. Are we using these terms in the same way?
d. In Question 2: What factors limit predictability (skill) across scales? vs What factors control the forecast limit
    i. Limit of time scale and limit of strength
    ii. There is a limit of forecast on how far it can go and then there is skill - how good is the forecast
    iii. At this step focus on what factors limit predictability across scales. Then if we have some examples we can go into the factors that control the forecast limit

iii. Question 3: When does predictability in one context imply transferability to other contexts
    1. No hypothesis for this yet
        a. Hypothesis idea: Endogenous/Exogenous and initial conditions roughly match. Their role and importance in the forecast skill. MIght help to look at examples

e. If we can connect each of the questions/section to the ecological reality. What can forecasting can give us that other methods in ecology can't
    i. What is it about forecasting that helps us to understand predictability and spatial/temporal variability that we don't get from other ecology methods.
    ii. Linking process to spatio-temporal scale. Focus on process within forecasts
f. How to make this broader than predictability. Can we come up with a question that moves past predictability?
    i. Concepts of equilibria and linking through those
    ii. How organisms/populations integrate noise and their outcomes/fates. Ways to test those ideas.
        1. Forecasting assimilation could be a way to capture this. Would take some work to flesh out in this context
    iii. Could efforts to forecast identify convergent reasons on forecastability (e.g., insects have wings, bats have wings - but got them in different ways)
        1. When you are in an ecosystem are their important things that span across ecosystems but that would influence why forecasts work
        2. Comparative nature is not the only way. Forecasting puts strong emphasis on comparative approach to search for generalities which is often missing from ecological research (often get focused on theories within your own silo - but want to connect them)
        3. Example: Soil depth, tree canopy depth - is there a way to incorporate the understanding that taller forests no matter what

content you are on will have specific relationships and will have drivers that work similarly across continents.

4. Are highly structured communities in space (tree canopies, coral reefs) going to be more or less predictable then communities with simple physical structures.
    a. Think there are only certain ways life can work. There are more ways life can work in complex systems, compared to simple systems.
    b. Can you maintain a complex system? Gets back to classic theory papers. If you randomly assemble communities they are less stable. Diversity/productivity lit increases stability. This increase in stability probably goes along with an increase in predictability
    c. Depends on what you are trying to predict. Fates of individual populations

iv. From old Hypotheses document - had tried to get at some of these questions. Is theres something about levels of biological organization or phylogenetic scale that can help us understand predictability of systems.
    1. Took from that, that it is system dependent and depends on what you are trying to predict.
    2. Take away - instead of looking for traits of systems or ecological traits of systems
    3. For Question 3 trying to address this.
        a. Example: The role of initial conditions will depend on what observations are available
        b. Think about it in terms of a forecast, but limit it in terms of rule or options. Think about a set of ecological features/traits/systems (could be complexity - but have to define what we mean by complexity)
    4. Instead of ecology being a post stamp collection of examples. Use forecasting from one system and apply it to another system
    5. Connection between forecasting and ecology - going for more than a binary we reject the hypothesis or not. Go into it more than saying yes or no to the hypothesis.
    6. Using our model we can test the sensitivity of that model. If the new location/conditions have a different level of sensitivity. You can assess how different it is between systems/locations. This gives ecological knowledge and our limitations of ecological processes in other systems

v. Think about hypotheses of transferability couched in terms of each of the types of uncertainties.
    1. Simulations could be useful for this
    2. Variance partitioning and differences in hyper space - this is what forecasts can give

   g. Next steps
      i. People are on board with the 3 questions if we think about how to frame and applicability to general ecology and still much discussion about hypothesis for 3rd question.
      ii. Abby will post the 3 questions in slack and we can discuss each question in a thread until the next meeting
      iii. Question 2 vs Question 1 - would be good in the Slack conversation to make sure we have articulated the differences clearly

2. Finish discussing RCN NEON Forecasting Challenge Phenology example to continue to clarify what the questions are asking (see further info about using the Forecasting Challenge topics to explore ecological forecasting theory below in point 5). Do this in consideration of the forecasting vocab
   a. Work on final question about when people expect different uncertainties to dominate
   b. Want to think about the relevant time scale or the relevant scale of the predictors and the relevant scale of the process
   c. In phenology - the relevant temporal scale of the prediction. Predicting on the scale of days to weeks, but the scale of the process may actually be on 6 months into the past when the environmental control on the process is happening
   d. Question to discuss as a group - when does the uncertainty dominate?
      i. All uncertainties except for initial conditions. Drivers, parameters, random effects, process error. Look at this when we get to this point in the Tick example as well
      ii. Thinking about the importance of the genetic vs molecular clock. If we are using a state space model once we see leaf out does it take the same amount of time to leaf out or from leaf out to flower. This changes what type of uncertainty is dominating. It also influences the answer to the question of when the forecast is not doing better than chance.
         1. This is will be good to compare to when we get to the Tick example.
   e.

3. Tick Example - Didn't get to this on this call
   a. Before the next meeting everyone look at this and give an educated guess

4. Next steps for the Forecasting Vocab Terms - ideas are
   a. Summarize and put on the EFI website - once we get this box pulled together, want to get it on the website
   b. Box in Forecasting Definitions manuscript led by Anna and Gretchen
      i. Abby is working to compile the terms for a box in this manuscript
      ii. Forecast definition from Anna's manuscript:
         1. Based on 110 survey responses, and the norms and understanding of forecasters, we define a forecast as "an

estimate, and the associated uncertainty of that estimate, about an out-of-sample state of a system". We then place this definition within a nested framework of ecological forecasting to facilitate communication, improve environmental decision making, and encourage diverse involvement in the field.

iii. Forecast extent vs forecast horizon - something worth discussing
    1. Hassan hears from horizon than extent
    2. Abby hears extent more than horizon
    3. Bigger deal is getting horizon and limit sorted out
        a. Petchey paper used horizon opposite from the rest of the literature
        b. Horizon - how far we go
        c. Limit - when we are no longer predictability
        d. Extent - has spatial context
        e. Using extent to match with forecast grain. They come from the same literature. Use forecast horizon and forecast resolution and scale
            i. When talking about space - extent is how far out you go and grain is the pixel size
            ii. In time - horizon is how far out we go and
        f. Okay to have multiple terms if we match synonyms
        g. Spatial extent and temporal horizon are synonyms - tey are sensible because extent is used in space and is equivocal to
        h. Temporal grain and resolution synonyms
        i. Christy: We use "extent" for time to
        j. I like horizon because it's distance from where you are now; whereas I think about "extent" as more absolute
        k. e.g. horizon = 3 months; extent = Jan - March
        l. Need one person to read through the Standards doc - is that document using vocab consistent. If not, then resolve across the groups
            i. GitHub repo: https://github.com/eco4cast/EFIstandards
            ii. Standard text: https://bit.ly/2H0muAx (follow the link to v0.3 at the top)