

## August 5, 2025 Theory Working Group Call

Attendees: Bilgecan Sen, John Foster, Freya Olsson, Jon Borelli, Caleb Robbins, Abby Lewis, Jody Peters, Lindsay Campbell, Shubhi Sharma, Saeed Shafiei Sabet

Agenda:

1. Poll for September to December calls: <https://www.meetingbrew.com/ioey7h>
  - a. Make sure your time zone is selected. Click “respond”, enter your name, fill out your general availability, click “Done”
2. Update on the Predictability of Nature synthesis
  - a. A subset of the group met for two extended calls in July.
  - b. Updates on figure development and next steps
  - c. Asking figure 1 group to contribute 1-2 papers. Not asking for a literature survey. Asking for papers that were influential in their own work.
    - i. The table has a good number of papers so far. After getting more papers on the list will determine how to actually insert it in the manuscript - i.e., what form it will take.
    - ii. This table of papers, can also be useful for picking a few case studies to highlight the message from figure 2.
  - d. Figure 3 on future directions and outstanding questions, challenges, etc
    - i. There are lots of ideas about short comings that can be categorized under umbrella terms - still need to determine the umbrella terms and then incorporate that into a figure as way to organize
    - ii. First step - agree on the umbrella terms. Then send questionnaire - what are the challenges in your own research related to these umbrella terms
  - e. Deadline will be the end of September for feedback on papers and then will send out the questionnaire
  - f. The plan is not to convene another big meeting for 30-ish people like was held in July. But instead, find times for smaller groups to meet to discuss specific figures
  - g. Figure 1: 3 different things that affect predictability:
    - i. scale (larger scale temporally, spatially, taxonomically will be more predictable),
    - ii. horizon - the more into the future you predict the less correct you will be,
    - iii. novelty - predicting conditions you haven't predicted in the past
    - iv. There are other aspects that don't fit nicely into these 3 axes
      1. Species with more interactions are easier to predict
        - a. Could this be a novelty topic. If you are trying to predict a new edge presence/absence and you have no new

edge to predict on. Whereas if you have 30 edges to predict on a subset of new edges, this seems like a lower novelty situation

- b. Could go into scale - more aggregation. But still a bit of a stretch
2. Mixing regime in reservoir and trophic status - easier to predict a stratified reservoir vs a polymictic reservoir
3. How liberal to be to include in the 3 boxes or say this doesn't fit as it was originally conceived?
4. For horizon - includes stability of the system. Maybe the stable situations with more species interactions and more stratified systems are more stable
5. Think that makes stability has more of an mediating factor that is cross cutting.
6. Horizon, scale, and novelty can be determined by the agency of the researcher - hard decisions and data availability and not necessarily anything intrinsic to the study system.
  - a. Had a complexity box before which had include species interactions
7. Could mention the 3 axes and then mention the other aspects that affect predictability that do not fit nicely in the 3 axes
8. Does it make sense to have stability as a 4th axis that points to internal or external dynamics
9. Comparison of experimental model vs null model
10. Is there a place to bring in variability with extrinsic and intrinsic
11. Need to be clear in figure caption and text that the call outs are not fully comprehensive. Novelty is not only affecting parameters but also internal dynamics
12. The way stability is referred to may be external of the system or could go back to the internal dynamics of the system
13. Like that internal/external dynamics are split out. Nice that it isn't specified that stability isn't limited to one space
  - a. E.g., species interaction. Thinking of prediction in network space will be very different from forecasting in a river
  - b. Be open to terms having different meanings
  - c. Stability - is your system chaotic or not. If it is not stable, but is chaotic, then small differences can make big changes.
  - d. External dynamics have their own internal dynamics that can make them less stable and makes the predictive target less stable.

14. Whatever we put in for stability, want to agree on what is important for predictability research that we want to highlight in the figure.
    - a. Have some support from Mike's paper on what are stable vs unstable systems
  - v. Horizon, scale, and novelty (perhaps to a lesser degree) are choices made as a modeler for what/how to model
    1. They are characteristics of the problem. They are immutable if you approach it from the perspective that there is a problem you want to address using methods of predictability with methods that are set. Making changes to the horizon or scale in your methods may change the question you are able to answer.
    2. Things like data availability are not represented in horizon, scale, and novelty. Variability as well. Are there other things worth calling out as ways you can push the system to be more or less stable?
      - a. Can the entropy literature and information in the time series/system be the starting point.
      - b. Predictive ability - could be an umbrella term
    3. Can also put one example - to show a gradient of different relationships with predictability that you have. Then in the table, there can be a box of aspects that affect predictability - horizon, scale, novelty
  - vi. Newer version - think the focus is on the middle box that show the relationships and that the horizon, scale, novelty are the examples. Focus should be on what affects predictability (the middle box)
  - vii. Abby will play around with the figure to make the middle box the highlight/focus and the horizon, scale, novelty are the examples
  - h. Want to work on case studies for figure 2
    - i. Try to look at specific case studies for how they fit with the figure - could try to do it with some of Cayelan/Freya's work
    - ii. Maybe there isn't a single case study that works. Or maybe a longer term project/system could fit in.
    - iii. Would be surprised if there is one paper that fits all of these. But could imagine that there are systems with lots of research that combined informs our understanding of the system
    - iv. Want to consider the term to use for lumping the approximate intrinsic predictability together rather than calling them exploratory analyses, because we want them to be measured and reported
3. Other papers previously shared that Jody is including here for reference

- a. Discussed on 10-7-24 call. Nonlinear population dynamics -  
<https://www.nature.com/articles/s41559-019-1052-6>
  - i. See notes from the call here
- b. Discussed on 11-4-24 call. Basic principles of temporal dynamics
- c. The intrinsic predictability of ecological time series and its potential to guide forecasting; <https://esajournals.onlinelibrary.wiley.com/doi/10.1002/ecm.1359>
- d. Prediction in ecology: a first-principles framework;  
<https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/eap.1589>
- e. Fishing down the food web -  
<https://www.science.org/doi/10.1126/science.279.5352.860>
- f. Discussed on 1-14-25 call. Error metrics - the choice of error metrics can influence your overall conclusions. Ideas in this paper could feed into the synthesis and what metrics to use. Not relevant for forecasting specifically, but useful frameworks  
<https://www.sciencedirect.com/science/article/pii/S0304380023002922?via%3Dihub>
- g. EDM paper - <https://www.pnas.org/doi/pdf/10.1073/pnas.1417063112>
- h. Pennekamp paper with weighted permutation entropy:  
<https://esajournals.onlinelibrary.wiley.com/doi/10.1002/ecm.1359>
- i. Came up in the 11-4-24 call. Temporal ecology in the Anthropocene  
<https://onlinelibrary.wiley.com/doi/10.1111/ele.12353>
- j. Came up in the 11-4-24 call. Forecasting phytoplankton blooms  
<https://esajournals.onlinelibrary.wiley.com/doi/10.1002/fee.2376>
  - i. Here is the Supplemental Table with the specific example:  
<https://esajournals-onlinelibrary-wiley-com.libproxy.rpi.edu/action/downloadSupplement?doi=10.1002%2Ffee.2376&file=fee2376-sup-0003-TableS3.pdf>