April 2, 2020 Theory Working Group Call

Attendees: Will Pearse, Christy Rollinson, Jaime Ashander, Peter Adler, Mike Dietze, Jody Peters, Hassan Moustahfid, Amanda Gallinat

Agenda:

1. RCN virtual meeting update - There will be a time for all working groups to present 1-2 slides summarizing what they are working on. We have one more call on April 28 during which we will finalize a plan for this.
2. Manuscript updates and plans to move forward.
    a. Look at the Common Framework Slides [LINK REMOVED]
    b. For reference, the hypotheses are here [LINK REMOVED]

Notes:

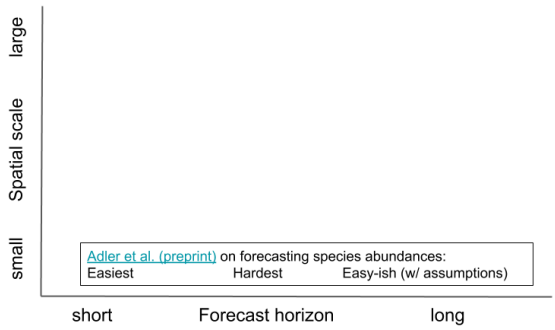
1. Is there a way EFI could help with covid-19?
    a. Guidance packs on how to coordinate on a management perspective. Will's colleague is doing this from his perspective on crisis handling.
    b. Could we help provide information on: How to assess if epidemiology model is working? How to update daily?
    c. Provide a web page where we link to existing forecast tournaments that are happening. There is one challenge linked to in Slack so far
    d. EFI Homepage - temporarily put coronavirus box with links to the competitions, modeling resources (might require time to create content)
    e. Send out tweet - we are going to keep a running list of forecasting related competitions related to covid. If anyone comes across any, ping us and we'll put them up.
    f. Put up list of members, states/countries they are in - so people can find people with forecasting expertise in specific locations.
    g. Where are people finding data to build models? Is it public? Mike think it is. There are a couple of sites that are compiling the info. WHO do daily reports which are processed in various ways. John Hopkins - has nice GitHub repo with clear sources.
    h. Post to Slack as well to see if anyone is interested in helping to compile the links/resources
    i. Want to make sure we are connecting people to good/vetted information.
    j. Hassan - look at correlation of temp/humidity to outbreak
    k. Converging on steps moving forward:
        i. Forecasting competitions
        ii. Link to members directory - here are people who are formally trained and think about forecasting a lot
        iii. Links to available data
        iv. Maybe something good for the Education group (or maybe social science) - blog post about what level of training do non-ecologists need in interpreting forecasts. This would be a good time for a blog to look at

how you interpret what comes out of a forecast model. What should inspire trust, what should you be wary of, probabilistic forecasts, what is included when error bars are shown, what is or is not included in error bars (have sources of uncertainty been not included)

v. EFI message - importance of collaborating. You don't have to be an epidemiologist but you should listen when you are out of your depth.
vi. Balancing the need for rigor with the need for speed. Be flexible in what you take for dogma, but balance that with staying in your lane of expertise.
vii. Include the broader concept of ethics of forecasts. Hobday 2019 paper - see Mike's post in Slack for citation and here is the link: https://academic.oup.com/icesjms/article-abstract/76/5/1244/5303214
viii. Think about having an EFI covid call

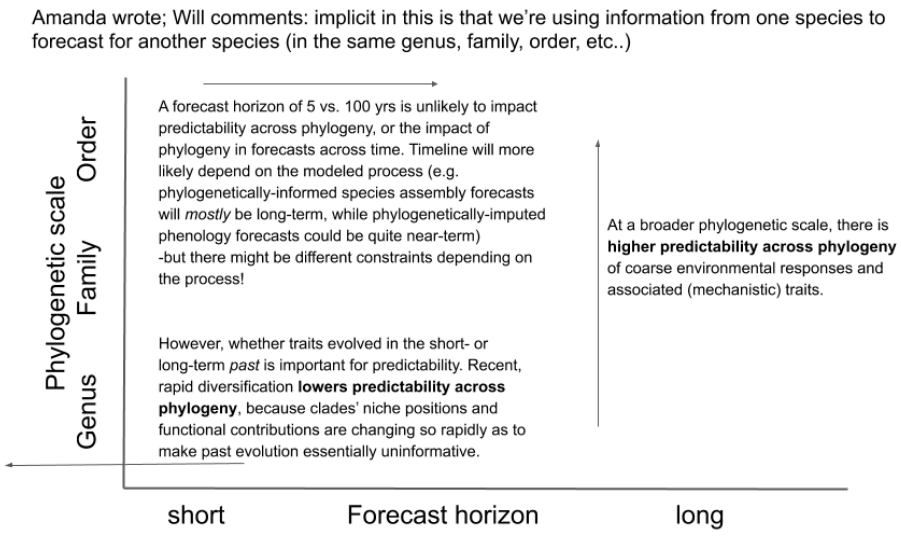
Theory Discussion

1. Prior to the March 10 call, Peter was having a hard time cleaning up the Hypotheses document. [LINK REMOVED] He had a hard time finding a common framework. So on the March 10 call we decided to try to use the common framework in the Google slides. [LINK REMOVED]
2. Common framework Idea is to have forecast horizon on x-axis.
3. Peters's example. Species abundance. If you study over time interannual variation is different if you study it in space and you get differences in forecasts depending on how you look at it. Peter was playing with tyo models that show that the time series work well. The space for time seem to work well for long horizons. With the intermediate time period neither do well. If you could figure out how to weight them, then you could get a better job at



a. Expanding up to the larger spatial scale you lose the gradient. As your spatial grain gets huge you average across conditions. There is an upper limit of how you can apply this approach. But he doesn't see any qualitative reason you can't scale up.

4. Amanda's slide:



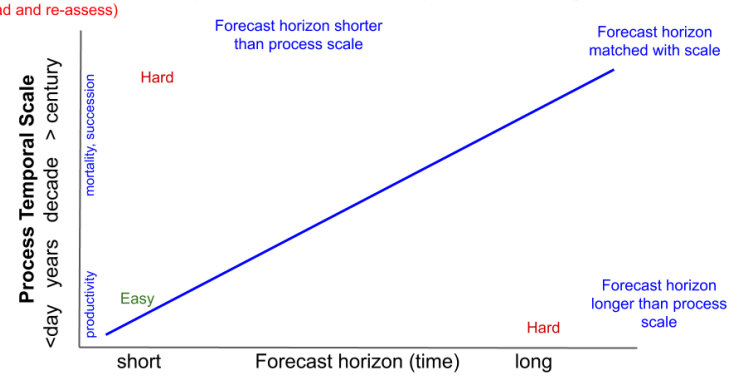
   a. Phylogenetic scale matters. If you are looking at coarse envi responses or associated traits, you will have better predictability at coarse phylo scale.
   b. Forecast horizon for incorporating phylogeny - this may not be the critical piece. Wouldn't expect phylogeny to change between a few hours and a few hundred years. But the evolutionary past in terms of timeline will matter a lot more. If you want to use past evolution to inform how we inform phylogeny then have lower predictability if we have seen rapid recent diversification. Past evolution then becomes less informative then traits that have evolved deeper in the past and deeper in time (conserved traits).
   c. As they discussed forecast horizon seems more clear. Phylogeny informs forecasts, but doesn't affect predictability over short evolutionary timeline. That will depend a lot more on the phylogeny process being informed.
   d. Whether phylogeny fits into the same framework, or if it is a tool that fits in with other frameworks presented in other slides.
   e. Perhaps phylogeny is like spatial scale interacts with level of organization
   f. From Mike's work with their fungi and bacterial analysis. Predictability is stronger as they move up phylogenetic scale. Fungal lineages vs bacterial lineages responses are different.
      i. In C flux forecast so much is driven by photosynthesis and that is incredibly conserved. You can rely on biochemistry because it is so conserved. C-4 came up, CAM came up. There isn't variability in how photosynthesis works. But if we move to a longer time scale are looking at demography and there may be much more variability there. Tradeoffs between things strongly phylogenetically constrained vs classical functional trade-offs.
      ii. In forest ecology - grow fast die yougn vs. grow slow live long. This maps well on some traits. But Josh's work shows the patterns matched so

much better on phylogeny than functional traits related to ecological niche.

g. Bacterial/fungi - is a good example of what Amanda shows in her slide.

5. Christy's Slides - go to slide 7 (skip two previous slides)

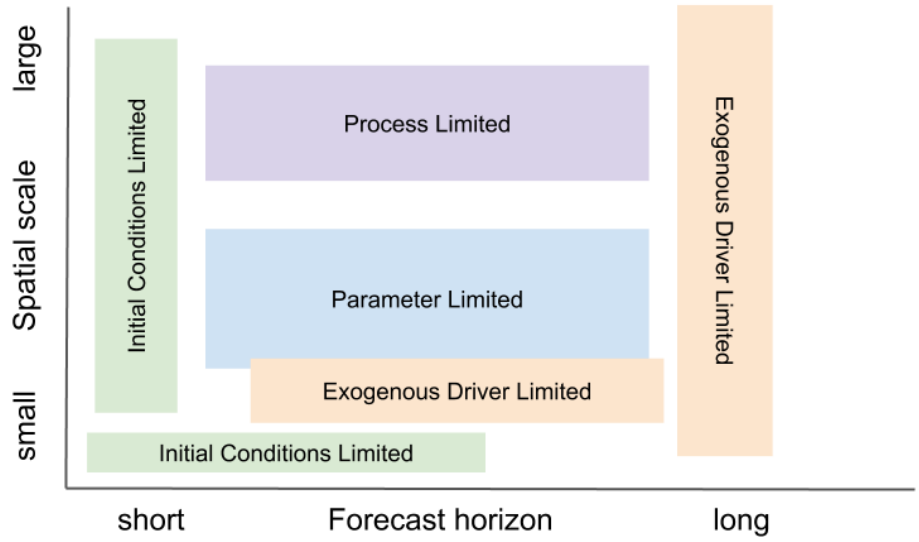
Rollinson Note: Are temporal scaling issues in forest modeling are separate from levels of organization or not. Can the temporal scale be independent of the forecast horizon? (I did this before seeing the Adler pre-print; will read and re-assess)



a. Struggled with some forecasting stuff because it depends on which process you are trying to forecast.
b. Slide 7 - the ability to forecast depends on how things are matched in scale. Easy to forecast fine scale, short time scale.
c. Or can get species ranges at broad scales at long time scales.
d. But when trying to mix and match is hard
e. Hard to predict what tree is going to die tomorrow. But over a couple of decades can predict those dynamics.
f. Forecast modeling perspective - easy to predict diurnal cycle, seasonal cycle (short time scales). But when thinking of how productivity changes over 100 years, it becomes hard because these other factors play different roles.
g. Thinking about mortality is the result of lots of cumulative processes that happen at short time scales.
h. How do short times scale processes occur over 100 years. Or when the long time scale process (mortality) is hard to predict on a short time scale.
i. Mike - want to predict community composition - tomorrow looks like today. The null model would be hard to beat. When you have a slow process it is easy to predict because nothing changes.
j. Jaime - stocks vs temporal variation in the drivers? Christy thinking about mortality of event.
k. Christy thinks it does matter if you are thinking stocks vs flows.

l. In figure 6 - Christy was trying this as well. Short forecasts depend on initial conditions. Long forecasts are hard due to driver limitation.

Rollinson: This is probably just me, but I get stuck on what the data/uncertainty limitations are for this. If you don't have good IC for a particular site, even your short-term forecasts can be really bad. And in general, there are better long-term drivers (e.g. meteorology) for large scales than site-specific.

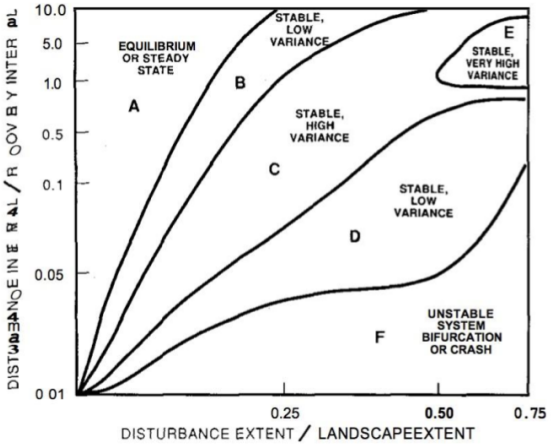


m. Mike thinks using slide 6 is really helpful. This shows the uncertainties that limit our ability to make forecasts.

n. Mike would like to come to a consensus on slide 6.

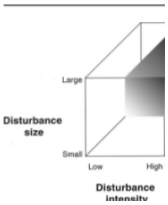
o. Thinking about mortality in slide 7 - Mike's prediction if a tree is alive now, he predicts that it will continue to be alive in the next 10 minutes, tomorrow, next year.

p. Mike thinks spatial scale could be different. Monica Turner's figure (Mike has it in his book) - has something analogous to what Christy has on slide 7. Diagonal predictability is easy, but corner cases are hard. Will this tree die vs this other tree is hard to predict, but as you move up in scale, you are averaging across stochasticity so it becomes easier.



Turner et al 1993 "A Revised concept of landscape equilibrium" Landscape ecology 8: 213-27

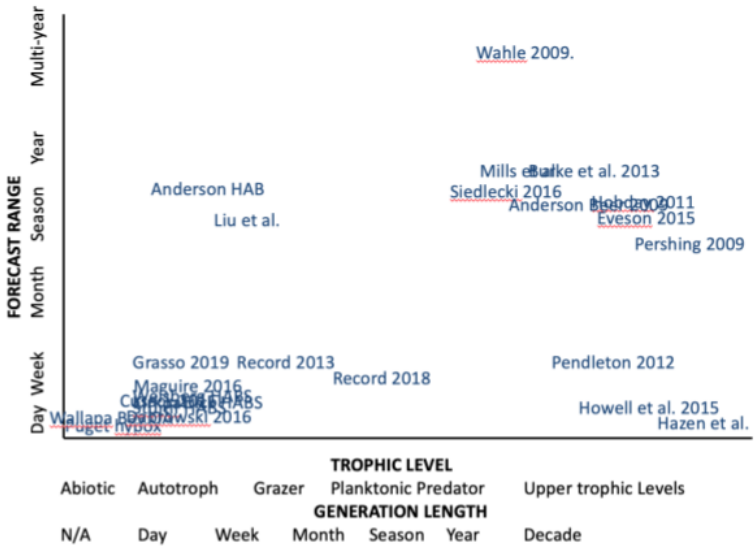
Other figures in that paper have examples of specific disturbance extends, grains, types, etc.



q. Slide 6 - process error is important. Split process error into 2 things. There may be some scales where it will be a limiting factor for many.

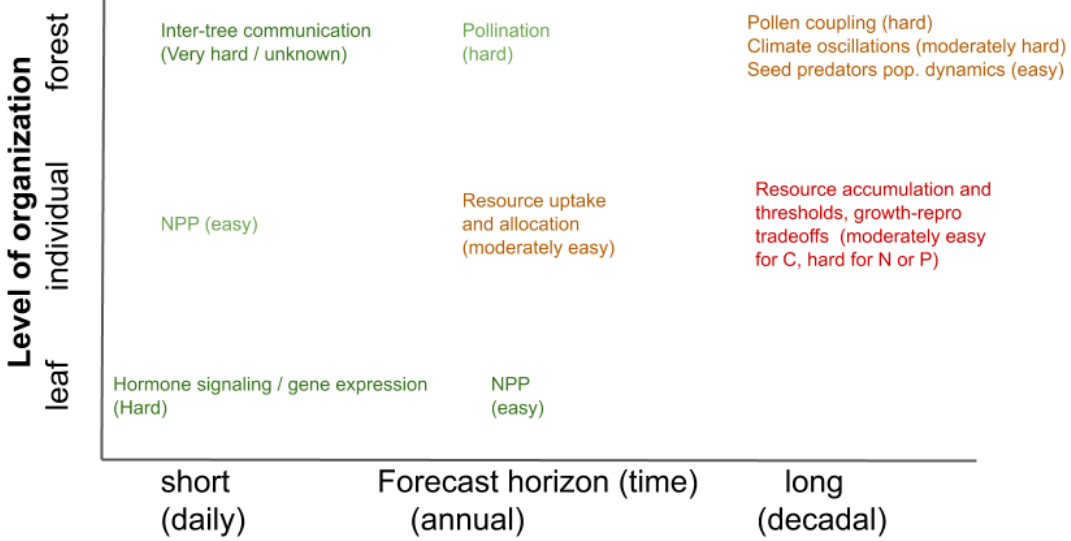
r. Will - scaling - we spatial extent vs grain. Spatial extent - doing a study across NA vs backyard. How far away are the measurement units
s. Grain - looking at assemblages of species. How big is the measurement unit.
t. Peter - trying to figure out the right spatial and temporal scales was important for meteorology forecasts. We haven't done this in our field yet, but could be important to deal with now.
u. Will said that Brian McGill has written about this.

6. Nick, Giorgio, Jono – Peter will follow up with them.

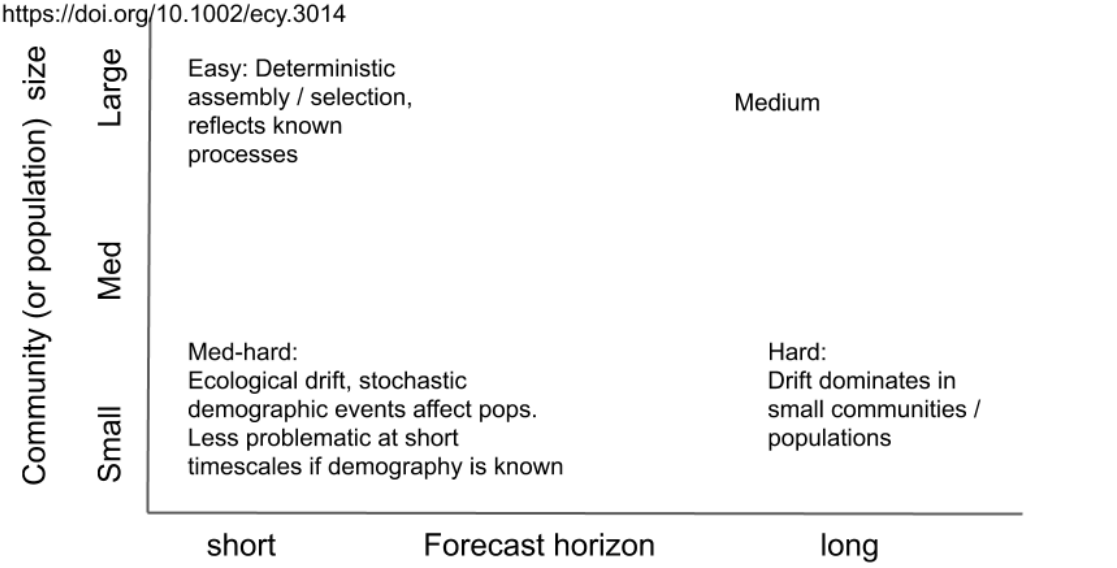


This is from a literature review I've been working on for marine ecological forecasts. Just from my notes-- I've just eyeballed the positions on this graph. Placing it here as food for thought. -Nick

G Vacchiano: variability and synchrony of seed production by woody plants
This entails forecasting different processes at different scales, as detailed in the graph
assumptions: good drivers for forecast horizon
Explanation and references for each level in
https://www.sciencedirect.com/science/article/pii/S0304380018300887

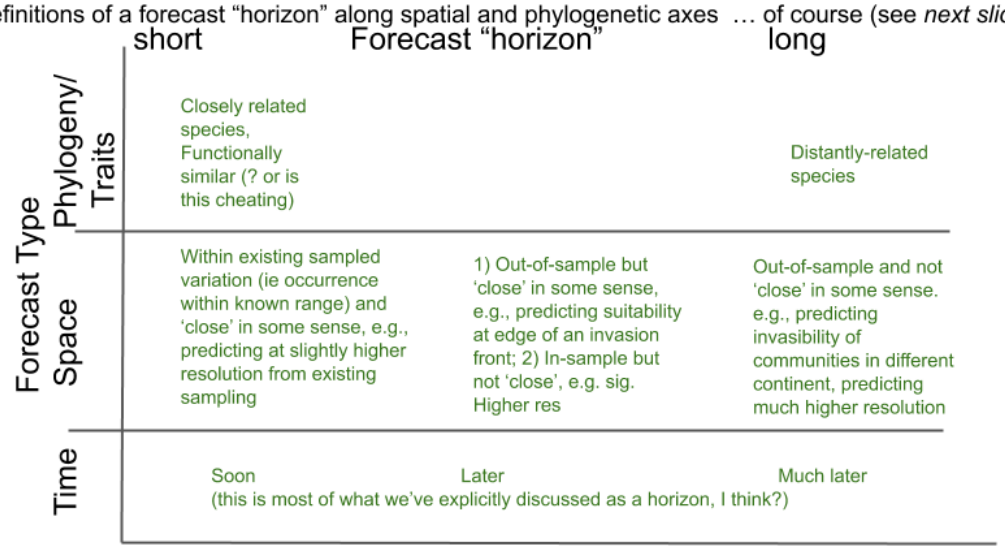


Jono Tonkin note: This is a bit left field but just an idea I've been thinking about based on a recent paper. Surely increasing drift increases the challenges associated with generating forecasts…
Paper: Community size can affect the signals of ecological drift and niche selection on biodiversity - https://doi.org/10.1002/ecy.3014



7. Jaime's slide –

Jaime A: Building off discussion of 'what equations would be we using what are the state vars and parameters and data' from last time and nice table made by Christy, here's some potentially distinct definitions of a forecast "horizon" along spatial and phylogenetic axes … of course (see *next slide*)



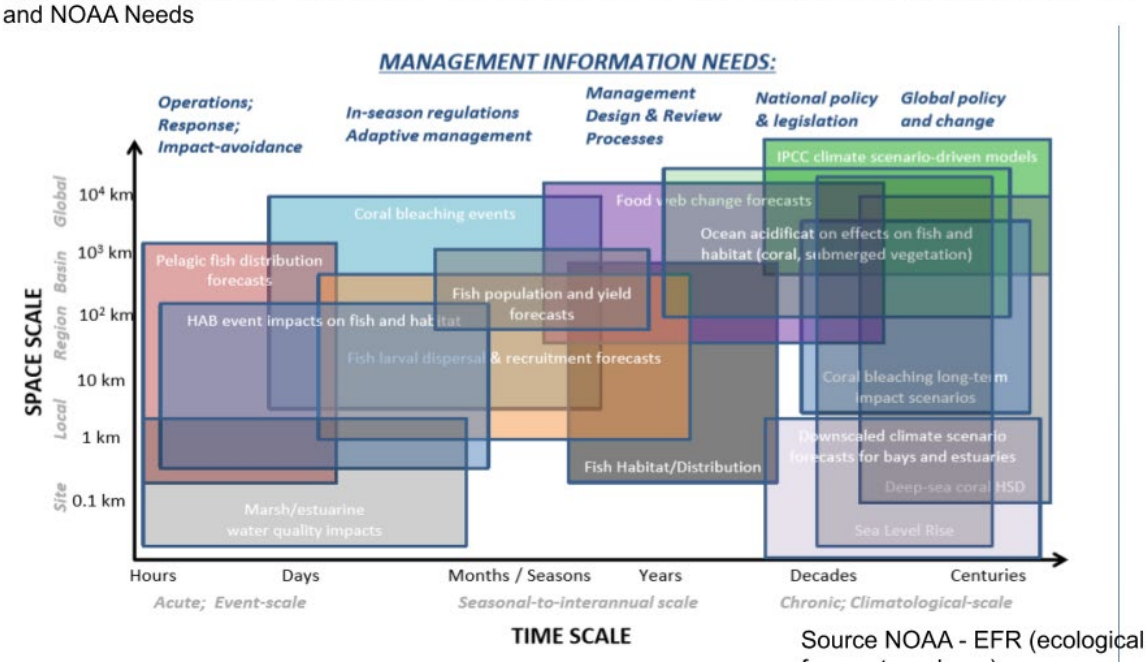
a. Jaime used the table Christy put in the Hypotheses document to brainstorm this Slide. Inherent in discussion around phylogeny predictability isn't always associated with time scale.
b. There can be forecast horizons that are not temporal.
c. Space/phylogeny separate from time. Usually we talk about the combination of them in this group. But being clear where the notions of predictability exist independent of time will be helpful for our own discussion and for communicating our findings.
d. Closely related species vs distantly related species was not included in Amanda's slide. But inherent in that slide it will always depend on whether we see phylogenetic signals in those traits. There will be higher predictability for closer related species.
e. Amanda will think about how to include that in her slide.
f. Jaime's slide – would work better as a table. The notion of horizon is often discussed in time. But concepts related to predictability outside of temporal context are somewhat analogous. With a short time scale the prediction is often close to the initial state, so good predictability. For space – if you try to forecast within a similar space, it will be easier to predict.
g. Jaime will try to draw what he means for the next call. It seems like it would be good to have it a 3 dimensional version of the figure if it is possible to make something that is compelling/easy to understand.
h. Amanda - Temporal Grain and extent is not the only grain and extent that is the dominant driver of uncertainty. When she and Will were thinking through the phylogeny example – it wasn't about how phylogeny interacts with time, but more about how phylogeny interacts with spatial extent and grain.

8. A big picture idea that Christy has taken away from the call is thinking about – what types of processes do vary with forecast horizon and which ones vary with spatial horizon. It would be good to try to pull this out from the figures/slides.

9. Peter – what is the homework before the next call.
    a. It seems that being explicit about the grain and extent is important for making the forecasts and for working interdisciplinarily. This is a key point to make!

10. Hassan's example – slide 15. From NOAA - everything they do has to focus on what stakeholders want to make management needs. At the top of the figure is the management needs.

Hassan added this messy figure: Wide Range of Space and time Scales , linked to different stakeholders and NOAA Needs



Source NOAA - EFR (ecological

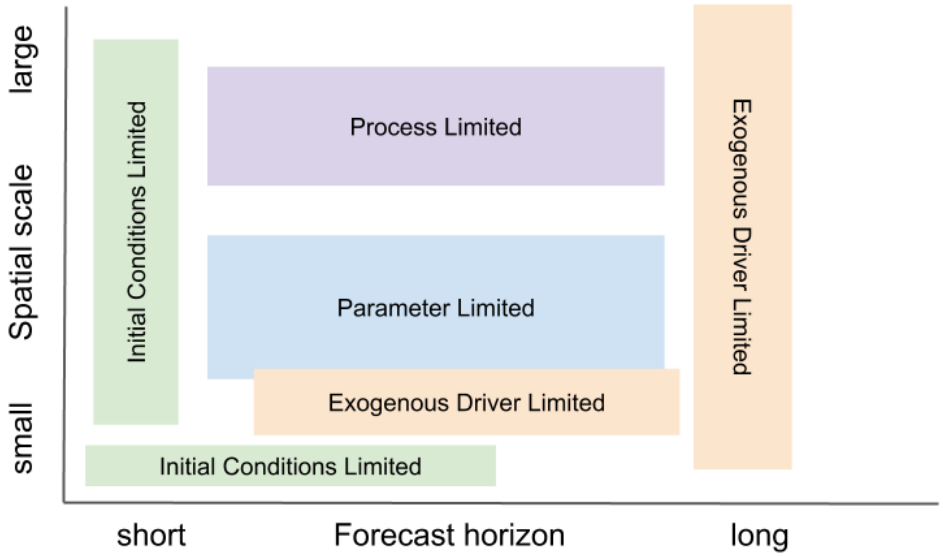
    a. Peter - If just looking at the biological responses. Could he color code them by the skill of forecast? The day and hours are more predictable. The longer time scale it is harder to forecast.
    b. The abiotic responses can be really well predicted at short and long scales. For predictions for animals it is harder to predict.

11. What do we do for next time?

1. **3-D figures.**
2. **Peter will reach out to Giorgio, Jono, and Nick to get more details about their slides**

3. **Have people try to take a stab thinking about Christy's slide**

   Rollinson: This is probably just me, but I get stuck on what the data/uncertainty limitations are for this. If you don't have good IC for a particular site, even your short-term forecasts can be really bad. And in general, there are better long-term drivers (e.g. meteorology) for large scales than site-specific.



4. Amanda's suggestion – we have produced some content and have heard everyone's expertise. Amanda is curious about what the paper each person would be most interested to read?
5. What are 1-2 points for a paper that each person would like to see come out of this?
6. Have each person think about what that would look like. Could be a way to latch on some ideas to funnel content into a central idea.
7. To hone that and focus/synthesize. What is the biggest thing you have learned? Or what is the biggest take home point you have gotten from these discussions. What are your lightbulb moments? What is something new we have learned from talking to other disciplines. Are there things we have talked about that have not been clearly communicated before in other papers?
8. **What are the top 3 things you have learned so far? What are the top 3 things you want to communicate to others?**