



# NEON Ecological Forecasting Technical Working Group

## *2020 Annual Report*



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National Ecological Observatory Network (NEON) is a project sponsored by the National Science Foundation and proudly operated by Battelle.

## Introduction

Since its inception, NEON has relied on expertise within the science, education, and engineering communities to advise on key areas impacting the design, construction, and maintenance of the observatory with the goal to optimize its operation. Currently, two types of external advisory bodies support staff and leadership in making key decisions that guide all of NEON's activities: the Science, Technology & Education Advisory Committee (STEAC) and Technical Working Groups (TWGs). Both bodies are comprised of experts nominated to serve in these roles who are selected by NEON staff following a rigorous selection process.

NEON currently relies upon input from 22 TWGs. These groups play an important role by providing input to NEON's data collection and processing methods and ensuring that NEON infrastructure, data, and programs are a valuable community resource. Working groups are participatory and advisory; they are often tasked with providing input on issues that have scientific, educational, engineering, or operational implications.

This document includes a summary of activities, recommendations, and NEON's response to those recommendations for the Ecological Forecasting TWG during the 2020 funding year (November 2019-October 2020).

The Ecological Forecasting Technical Working Group provides recommendations to NEON on how to best support ecological forecasting. This may include facilitating community discussions around forecasting needs, providing guidance for data product development, and identifying opportunities for NEON to engage with the forecasting community through workshops, educational materials, and code/data product development.

## Q1 – November 2019-January 2020

### Summary of Activities

The Ecological Forecasting TWG kicked off with an introductory meeting on 19 December 2019. We reviewed the charter, logistics of meetings, and collaboration for coming year. The charter was approved. During the second meeting, held 14 January 2020, the TWG discussed forecasting interests in the group and interests that are known about from the community. This group felt that there should be a high priority on finding a place to run code that pulls NOAA GEFS 21-member ensemble data clipped to NEON sites (could be a subset), and store in a centralized place. The code is written; it and the output data need a place to live. This may close to a Tier 2 community code project. The TWG agreed to write a one-pager describing needs for this work. The TWG also confirmed that they would like to leverage the Ecological Forecasting Initiative Research Coordination Network (EFI RCN) to better define community needs from NEON data.

### TWG Recommendations

No recommendations were made at these initial meetings.

### NEON Response

N/A

## Q2 – February 2020-April 2020

### Summary of Activities

The Ecological Forecasting TWG held three meetings in Q2, one each in February, March, and April. Over the course of these meetings, NEON staff stood up an instance of a TWG member's Global Ensemble Forecast System (GEFS) code on a NEON server, ran it, and produced some introductory outputs. The group also created a spreadsheet to try to figure out which L0' data products would be the most useful to the group as streaming data products (future). The difficulties of archiving forecasts were discussed; even at the Environmental Data Initiative (EDI) it is a challenge, as a DOI is placed on each forecast and is expensive to generate and maintain. In April, we discussed the impacts of COVID-19 on both NEON and academic field operations, with the note that NEON could provide graduate students/postdocs with data needed to complete their work while they can't access the field.

### TWG Recommendations

The Ecological Forecasting TWG made the following recommendations:

1. Try out the existing GEFS code and run for at least a subset of NEON sites, in time for the Research Coordination Network (RCN).
2. Discuss with EDI the potential for better storage of forecasts built on NEON data.

### NEON Response

1. This has been done for a single slice of time for all 81 NEON sites. The resulting data is several hundred MB for a 16-day window. Storage is an issue for NEON, despite the clear advantages of hosting such data. Computation bandwidth is also an issue, and we recommend running this code on CyVerse.
2. We have had a preliminary conversation about hosting NEON-based forecasts at EDI, who also acknowledge this is very difficult to do properly and is costly.

## Q3 – May 2020-July 2020

### Summary of Activities

This TWG did not meet during Q3 though many of us participated in the Ecological Forecasting Initiative Research Coordination Network (EFI-NEON RCN) meeting in May and follow-up meetings.

### TWG Recommendations

N/A

### NEON Response

N/A

## Q4 – August 2020-October 2020

### Summary of Activities

A primary goal of this TWG is to liaise with the Ecological Forecasting Initiative Research Coordination Network (EFI-RCN). The EFI-RCN is coordinating a NEON Ecological Forecast Challenge that will run its first round January-December 2021, with the goal of the Challenge occurring multiple times in future years. Teams from around the world with varying levels of expertise in using NEON data will forecast ecological variables derived from NEON datasets for the Challenge. Currently, there are five themes: Aquatics (focused on forecasting water temperature and dissolved oxygen monthly at Lake Barco and the Flint River), Terrestrial fluxes (focused on forecasting net ecosystem exchange, latent heat, and soil moisture at four flux tower sites), Beetle communities (focused on forecasting beetle community abundance and species richness at all terrestrial NEON sites), Tick populations (focused on *Amblyomma americanum* and *Ixodes scapularis* nymphal tick abundance at seven NEON sites), and Plant phenology (forecasts of plant greenness at seven deciduous broadleaf forest NEON sites, as measured by Phenocams)..

### TWG Recommendations

#### Recommendation 1: Expedite instrumented data access for selected NEON data products

To best support the ecological forecasts that will be developed as part of the EFI-RCN Challenge, we propose expedited data access for specific NEON data products that are needed to make near-term forecasts on the daily and weekly scale. The current month-long data latency of NEON data products prevents the generation of forecasts of future ecological conditions, so the 2021 Forecast Challenge is focused on hindcasts (forecasts of historical conditions). To support future Forecast Challenges as well as the NEON forecasting community as a whole, having access to specific level 0' data products on the day to week scale would enable members of the ecological community to be able to generate actual forecasts of future conditions, as well as update models on a much more rapid time scale. These data products would be for a limited number of sensor variables that the Challenge teams need for forecast development, model drivers, and forecast validation.

#### Recommendation 2: Expedite processing of eddy-covariance data at selected NEON sites

To best support the ecological forecasts that will be developed as part of the EFI-RCN Challenge, we propose expedited processing of eddy-covariance data at selected NEON sites. These sites would be prioritized for processing so the monthly eddy-covariance bundle (Bundled data products - eddy covariance) is available through the API within 2 weeks at the end of the month or sooner. The EFI-RCN Challenge would greatly benefit from more predictable availability of the eddy-covariance data for designing the timing of the Challenge submissions.

#### Recommendation 3: NEON Staff Support for NEON Forecasting Challenge

To best support this actively growing community of forecasters using NEON data, we propose appointing a NEON staff person (or persons) to be available to field questions specific to NEON data for each of the five Challenge focal themes (Aquatics, Beetle communities, Terrestrial fluxes, Tick populations, and Plant Phenology). Specifically, we request having an individual NEON employee identified and available as a direct contact person for questions from both the design teams and participant teams that will submit forecasts to the Challenge. While resources exist online from NEON and community members for downloading and cleaning data, there will undoubtedly be usability

challenges for team members unfamiliar with the new data products they are working with. As the EFI-RCN's NEON Ecological Forecast Challenge is a catalyst for increasing the number of NEON users within the research community, having a designated NEON staff member (or members) available for troubleshooting lowers the barrier of entry for team members new to using NEON data.

Recommendation 4: NEON should endorse CyVerse and the EFI-RCN Cyberinfrastructure Working Group's efforts in automating the collection of NOAA GEFS forecasts for NEON sites

Many ecological forecasts at NEON sites require forecasts of future meteorological conditions specific for a site. The NOAA Global Ensemble Forecasting System (GEFS) produces weather forecasts 4 times per day, up to 35 days in the future. Similarly, the NOAA Climate Forecasting System (CFS) produces weather forecasts 4 times per day up to 9 months in the future. However, the NOAA GEFS and CFS output are globally gridded products that require extraction for each individual NEON site. The extraction of these meteorological forecasts requires continual downloading and processing, which is extremely computationally intensive and may be challenging for the average ecologist to manage on their individual computers. Consequently, we propose endorsing the development of a partnership with CyVerse (via the EFI-RCN) to provide the computational resources needed for both 1) extracting NOAA forecasts at all NEON sites and 2) providing storage for saving these forecasts for use in subsequent ecological forecasting analyses.

Recommendation 5: NEON should provide an FAQ for common questions from the Ecological Forecasting Community

Working with data specifically for the purpose of ecological forecasting is a different endeavor than using similar data in typical ecological research. To date, the ecological forecasting community has asked questions about topics such as which data products are best suited for forecasting, expected data latency, best practices for programmatically and frequently pulling data to incorporate into scheduled code runs, and best practices for archiving workflows and their outputs. A section of the existing FAQ that is specifically dedicated to ecological forecasting questions would assist forecasters new to working with NEON data and reduce the redundancy of questions submitted through NEON's service portal. The TWG will explore FAQ forum options during fall 2020.

## NEON Response

Recommendations are still being considered at this time.