Battelle Response to NEON STEAC Fall Meeting 2022 Advisory Report

According to its Bylaws, the STEAC is "primarily an advisory body to the NEON Project and will provide strategic advice to Battelle, the NEON Principal Investigator (PI), and NEON Project staff on the planning, construction, and operation of the NEON Project and other relevant programs." This response to the STEAC report from December 5th and 6th 2022 also combines the input of several members of the program team responsible for the execution of the NEON project. Battelle appreciates the thoughtful comments that the STEAC provided during this meeting and the formal recommendations in this Advisory Report. Following are our responses to the key recommendations.

STEAC Recommendations:

I. TOS Sampling - Long-Term Strategy and Communication Plan

We greatly appreciate the thoughtful discussions that the STEAC engaged in with us to help guide this difficult decision-making process and their support for the suspension of TOS sampling at five gradient sites in response to resource limitations. This suspension is no longer required, as NSF has secured some additional funding to enable NEON to move forward with TOS sampling across the five sites. NSF has been examining the impacts of inflation more broadly across all of its facilities, and due to the unprecedented impacts on the NEON mission to provide continuous and uninterrupted data collection and delivery to the community, it was deemed critical to address this shortfall in budget as it relates to the TOS sampling at the five gradient sites, as well as sample analysis, and completeness in data delivery from all Observatory sites. We are now replanning and working to ramp up recruitment across the five affected Domains to minimize TOS data gaps.

Regarding your suggestion that an ongoing strategy is needed, and this strategy must reflect community input – we wholeheartedly agree. We appreciate the suggestions to organize a community event to solicit input on the longer-term plan and to explore opportunities to engage with other networks to creatively identify mechanisms for increasing the efficiency of generating NEON data products. We will work with the STEAC to revise our work plan to address these recommendations.

We are also eager to incorporate technological advancements to increase the efficiency and/or efficacy of our sampling designs, as appropriate. NEON subject matter experts on staff follow these advancements and rely primarily on subject specific technical working group (TWG) advisory committees to provide the recommendations to change approaches when advancements warrant. We welcome input from the STEAC as opportunities come to their attention. NEON must balance its responsiveness to the emergence of novel techniques with the readiness of these novel techniques for deployment at the scale of NEON's operations. Frequently

these techniques are not yet tested and proven across this scale. We will continue to promote the Assignable Assets program as an opportunity in which the researchers and businesses can test new technologies at scale. NEON must also ensure that adopting new techniques does not compromise the NSF mission for the Observatory of generating standardized and comparable data products across space and time. That said, overwhelming community support would provide justification for Battelle to recommend such changes to the NSF. We look forward to continuing discussions with the STEAC and our other community advisors on ways to effectively strike this balance through time.

II. Community Empowerment

We appreciate the STEAC's participation in the brainstorming exercise and the suggestions to increase visibility of the community-generated resources, including NEON-related code, publications, and presentations. We will work with the STEAC to capture specific suggestions and revise our work plan as appropriate to address and implement their recommendations. We will also add a discussion of engagement metrics to a future STEAC meeting agenda.

III. Google Cloud Platform for NEON Users

The STEAC's recommendation to focus on platform-agnostic tools, to the extent possible, is helpful as we navigate this complex and evolving resource, particularly because cloud-native computing is a relatively under-used resource throughout the NEON user community. We will continue to work closely with ESIIL and the Ecological Forecasting Technical Working Group (TWG) to gain their guidance and expertise on the available platform-agnostic tools, and in their capacity as power users of NEON data and cloud-native approaches.

IV. ESIIL and NEON

We are very excited to work closely with ESIIL, and we are eager to leverage this partnership for mutual benefit. To date, we have been collaborating to promote the 2023 ESIIL Innovation Summit and to leverage the NEON Science staff to encourage a diverse suite of applicants with interest in NEON-related topics. We are planning to provide additional user support for Summit participants interested in using NEON resources.

V. Terrestrial Instrument System Optimizations

In accordance with the Soil Sensor TWG and STEAC recommendations, and pending NSF concurrence, we will plan to implement option 1, removing the deepest three

sensors in plots 2 and 4 at each site, during our upcoming soil sensor upgrade efforts.

We are grateful for the time and expertise these members of the community have provided to us in grappling with these costly and necessary upgrades.

VI. Meeting with NSF NEON Program Officer, Dr. Charlotte Roehm

We stand ready to collaborate with Dr. Roehm and other NSF colleagues to support the recommendations of the STEAC, as desired by the NSF.

VII. Algal Taxonomy Data Product Optimization Proposal

In accordance with the Algal Taxonomy TWG and STEAC recommendation, we will move forward with implementing the algae optimization 4-pronged proposal, pending NSF concurrence. We will also work with the TWG members to explore opportunities to advance alternative identification techniques for micro-algae, including metabarcoding and image analysis.

VIII. Phenology TWG

In accordance with the Plant Phenology and Diversity TWG and STEAC recommendation, we will move forward with implementing the TWG recommendation, i.e., continuing with full dynamic sampling (high frequency spring and fall) at the core site at each seasonal domain, while reducing frequency at gradient sites to 1x/wk and retaining 1x/2wk mid-season frequency where previously scheduled.

Regarding the recommendation to repeat the uncertainty modeling with a more random sampling interval (e.g., every 5-10 days), the modeling exercise did include this variability as it is inherent to the dataset. If bouts did not actually occur 7 days apart, we selected the next closest bout when we down sampled. Indeed, scheduled observation bouts are occasionally missed or cancelled for the reasons mentioned, resulting in extended sampling intervals. The protocol specifies that bout intervals for 1x/wk sampling be 6-9 days. An analysis of completed bouts for sites that have been scheduled for year-round (1x/wk) sampling (n=9 sites) for years indicates that domain teams are successfully meeting sampling intervals < 10 days 92% of the time (n=2876 bouts, 2013-present).

As the STEAC notes, the uncertainty modeling focused on capturing transition dates within sampling years rather than through time, in accordance with the Plant Phenology Science Design. For the data evaluated in the optimization analyses, 88%

of all site x year x species combinations in the down-sampled simulations of phase I sampling met the threshold of generating mean transition dates ±3 day SE specified in the science design to support phenological forcing models (Jeong et al. 2012[1]). The science design does not make specific recommendations based on multi-year trends but highlights that lower frequency sampling can detect significant change over the life of the Observatory based on Wolkovich et al.'s (2012[2]) suggestion that flowering transition dates may shift 5-6 days/°C. Analyses of change detection through time would be informative, of course, and we will continue working closely with the TWG to guide analyses moving forward.

The phased design to collect data initially on the phenology of dominant species and then transition to community phenology is central to the Science Design and was highlighted by the TWG as a priority to retain in optimization. We discussed not transitioning sites to the community phenology phase II to retain the higher replication given the proposal to reduce observation frequency. This option was rejected by the TWG. If desired, we are happy to organize further discussions between the STEAC and TWG members to reach a mutually agreeable path forward.

We appreciate the STEAC's creativity and openness to new technologies and methods to help NEON more efficiently meet its mission. The in-situ phenology observations currently complement tower mounted PhenoCams and enable scaling from the individual to landscape metrics at each site. We are hesitant to pursue the proposed, significant modification to the protocol at this time, given that there is currently no standardized, community-accepted protocol for translating image data to status-based phenological observations. Furthermore, this modification to our field procedure could jeopardize our alignment and ability to integrate with the USA National Phenology Network data, a key factor in our design that supports cross-network analyses. That said, we are monitoring promising technological advances in development in the community. Recent advances using UAV (drones) to collect images along a fixed path in unforested sites could support data collection during times when site access is restricted, and field teams cannot walk the transect. Prototyping these tools and approaches is out of scope for NEON but presents an exciting opportunity for external partners to develop standardized protocols for a UAV-supported in situ observation workflow.

[1] Jeong, S. J., Medvigy, D., Shevliakova, E., & Malyshev, S. (2012). Uncertainties in terrestrial carbon budgets related to spring phenology. *Journal of Geophysical Research: Biogeosciences*, 117(G1).

[2] Wolkovich, E. M., B. I. Cook, J. M. Allen, T. M. Crimmins, J. L. Betancourt, S. E. Travers, S. Pau, J. Regetz, T. J. Davies, and N. J. B. Kraft. (2012). Warming experiments underpredict plant phenological responses to climate change. *Nature*, 485:494–497.

IX. Recruiting

We appreciate the STEAC recommendations aimed at increasing the effectiveness of our recruiting efforts at reaching a diverse applicant pool. We will bring these recommendations to our recruitment support teams to consider how we might incorporate them into the current process and reporting system. These include paid job postings on MANRRS and SACNAS and expanding demographic data to include temporary seasonal positions and location-based reporting.

Regarding the STEAC concern regarding the competitiveness of total compensation for NEON's temporary positions (TFTs), we will bring this to the attention of Battelle recruitment to better understand the annual basis on which TFT salary is determined and how it aligns with comparable ecological field work positions in other networks.

We appreciate the acknowledgment of resource limitations to host interns and are exploring ways to engage REU and internship programs. In addition to the ongoing annual career panels we have hosted for intern programs (e.g., St. Edward's University i4 and ASU programs) since 2020, we are in conversations with partners to establish a cross-cohort virtual data skills training workshop and introduction to NEON presentations for distributed REU and internship programs in summer 2023.

X. Biorepository

The NEON Biorepository team thanks the STEAC for its recognition of the progress we have made towards shortening time to fulfillment of requests and our flexibility in response to researcher needs that vary widely in volume and specifications. In the future, NEON Biorepository services will represent a major component of the Biodiversity Knowledge Integration Service (BioKIC Services) recharge center currently being established at Arizona State University. As the scope, complexity, and number of requests continues to expand, administering requests through BioKIC Services will greatly streamline the process by which we communicate our available services and process the charges necessary to fulfill large or complicated requests in an analogous way to the NEON Assignable Assets program. Because timelines for additional NEON Biorepository expansion plans await the results of the NEON recompete, space limitations remain a serious concern, but we do not anticipate any disruption in our ability to receive samples over the next year. To increase visibility of NEON Biorepository collections, we plan to begin publishing datasets to the Environmental Data Initiative data portal within the next month. Once that is completed, we will be revamping our sample and data usage and citation and acknowledgement instruction on our website. These actions, along with more direct communication with users, should increase the citation rate for NEON Biorepository resources and promote further uptake. To facilitate targeted outreach in 2023,

members of our staff are planning to attend and strategically network at nine conferences that range from local to international in scope.