NGSS Alignment of EcoXPT

The EcoXPT activities are designed to align well with the Next Generation Science Standards (NGSS) in K-12 science education. The primary focus is on Cause and Effect and Systems and System Models; students explore data in patterns and then engage in experimentation to investigate whether relationships are correlational or causal. An important emphasis in data collection is on Measurement and Monitoring (Understanding what is happening in an ecosystem involves measurement and monitoring; We take measurements to help us gain precise information; We can monitor changes in our measurements to consider the behavior of the system at steady state and also to help us to detect possible changes "on the horizon"; We can use tools and various tests to monitor variables that we cannot see).

Cross-Cutting Concepts (CCC) at each Secondary School Grade Level in EcoXPT	
CCC: Cause and Effect	
Grade Level:	NGSS Understandings Explored by EcoXPT
Grades 6-8	-Classify relationships as correlational or causal; -Understand that correlation may not imply causation; -Cause and effect relationships may be used to predict phenomena in natural and designed systems; -Phenomena may have more than one cause; -Some cause and effect relationships may be described using probability
Grades 9-12	-Use empirical evidence to differentiate between instances of causation and correlation; -Make claims about specific causes and effects; -Cause and effect relationships can be suggested/predicted for complex natural and human designed systems, by examining what is known about smaller scale mechanisms within the system; -One can design systems to cause a desired effect; -Changes in systems may have various causes and may not have equal effects
CCC: Systems Thinking	
Grade Level:	NGSS Understandings Explored by EcoXPT
Grades 6-8	-Systems may interact with other systems; -Systems may have sub-systems and be a part of larger complex systems; -One can use models to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems; -Models are limited in that they only represent certain aspects of the system under study.
Grades 9-12	-Can investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. -Can use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. -Use models and simulations to predict the behavior of a system and can recognize that these predictions have limited precision and reliability due to the assumptions and approximations inherent in the models.

The table below sets out the Evidence and Data-Related Understanding Goals that are the focus of EcoXPT and indicates how they align with the Disciplinary Content and Science and Engineering Practices in the NGSS and aligned state standards.

EcoXPT Data-Related Understanding Goals:		NGSS Connections
EB1*	Good explanations typically involve a claim (what one hypothesizes), evidence (the data, patterns in the data, information about processes, expert explanations, supporting facts) and the reasoning (flow of logic, and invoke scientific principles) that explains the connection between the claim and the evidence. (As per the Claims, Evidence and Reasoning (CER) Model)	MS-LS1-5 MS-LS2-2 MS-LS1-6
EB2*	Many forms of evidence may be gathered and compared to assess a claim. Evidence be in the form of:	MS-LS1-5 MS-LS1-6

	• *Patterns in data*, which show how one variable changes (or not) in relation to other variables. (Patterns of correlation or co-occurrence *suggest* that there might be a causal relationship between two variables. But this is not always so; something more complicated might be going on. See more in the causality and systems thinking section) • *Expert explanations or testimony* can also be invoked as a form of evidence. One needs a way of assessing the trust-ability or veracity of expert evidence. Using other forms of evidence to corroborate it can be one way to evaluate it. • *Observations or perceptual data* that have been systematically collected and compared • Data generated through *systematic interventions in the system.*	MS-LS2-4 MS-LS2-2
EB3*	Information about *mechanisms*—how underlying processes in a system work – can support one's reasoning. Information about mechanisms can offer insights into how the system behaves. Examples: Well understood mechanisms (e.g., photosynthesis) can be used in reasoning to connect claims and evidence. Emerging or proposed mechanisms may be the subject of investigation in the form of claims (so beg to be supported by claims and evidence)	MS-PS3-2 MS-ESS2-1 MS-ESS2-6
EB4*	Scientists look for the best explanation based upon the evidence and revise their ideas as more evidence becomes available. Science is not about finding "one right answer."	MS-LS2-4
EB5*	Some forms of evidence are considered more trustworthy in scientific reasoning.	MS-LS2-4 MS-LS2-4 MS-LS1-6 MS-LS2-4
EB7	Evidence can be interpreted in more than one way. Taking time to think about evidence and how to collect and interpret it is very important.	
EB8	The community of scientists has a shared set of rules that are used to collect and evaluate evidence. This shared set of rules is also subject to change	

EcoXPT also includes a set of Understanding Goals related to what is called a "Body of Evidence (BOE) Approach":

1. It is not always possible or desirable to conduct an experiment.
2. In these cases, ecosystem scientists use an approach where they systematically look for lots of different types of evidence. (They call this a "Body of Evidence" approach.)
3. The more evidence that can be gathered in support of a claim, the more likely it is that that the claim will be accepted. The evidence should be from as many different and varied sources as possible.
4. In addition to trying to find out what makes something happen, scientists try to collect as much information as they can on how the cause and effect relationship varies—the range of possible outcomes. (For example, a variable might cause an outcome when it reaches a certain amount, but not at lesser amounts. It also might not cause more of an outcome as you keep adding more. Or it might be that the amount of outcome increases step-wise with the amount of the causal variable.)
5. Sometimes nature "conducts experiments" that scientists can interpret. They use these as natural opportunities to learn about what happens. This can be helpful in cases when an experiment is not possible or desirable.
6. Scientists talk about how much certainty they have in a set of findings.

EcoXPT also includes Disciplinary Content Understanding Goals and Key Concepts (not elaborated here but elaborated in our Teachers' Guide) related to Food Webs and Energy Transfer; Phosphates, Nitrates, and Eutrophication; Populations and Communities; Balance and Flux; Thinking about Spatial Scale and Action at a Distance; Matter Recycling; and Interactions between Biotic and Abiotic Worlds.