Phenology

Why is thinking about phenology and seasonal change important?

Constructing knowledge about seasons and the earth's rhythms and patterns is something that culture communities across the earth have done since time immemorial. Engaging these cycles and rhythms has been central to how societies have developed specific nature-culture relations and the routine practices of human activity. Over time, scientists have come to call the study of seasonal impacts on plant and animal life cycles, including humans, Phenology! As the National Phenology Network (https://www.usanpn.org/) writes: "Phenology is nature's calendar—when cherry trees bloom, when a robin builds its nest and when leaves turn color in the fall." Learning more about phenology can help us think about complex socio-ecological systems and human relations with the natural world, and the decisions we make both every day and over time.

Learning in Places emphasizes phenology as the umbrella phenomena of interest because it is sufficiently complex to support robust and engaging investigations and many of the everyday wonderings and observations that people engage in are connected to Phenology. Further, because cultural communities across the earth have constructed rich knowledges of phenology that is relevant to them, it affords educators the ability to draw on these cultural and intellectual strengths. Studying phenology means observing and predicting the interplay of seasonal changes and life cycles, drawing upon disciplinary core ideas across the earth & space sciences and the life sciences, and engages cross-cutting concepts such as patterns and cause & effect (NRC, 2012). For example, learners can wonder about how earlier springtimes are affecting plant rhythms (earlier budding and blossoming of flowers, for example), which in turn is impacting animal rhythms (mismatched timing of hatching for feeding by insect larvae). In fact, many natural phenomena learned in science learning environments are reflected in the study of phenology, including daily sunlight, temperature variation, decomposition and soil quality, rainfall and the water cycle, behavioral changes (e.g. migrations, hibernation, nesting, leaf shedding, blooming), and more. However, studying these phenomena directly requires learners to move their studies outdoors and to engage in field-based science research in their communities.

In this framework, we emphasize 2 major dimensions related to phenology and seasonal change : 1) Phenology guides many rhythmic cycles on Earth that learners can directly and indirectly learn about through outdoor and indoor learning, and 2) Human-caused climate change is altering these cycles with impacts already being observed to global species and kinds. Engaging in high quality socio-ecological learning requires engagement with both. We emphasize these dimensions to help support educators in recognizing the range of relevant phenomena in children's wonderings and sensemaking and to help provide thematics to organize these ideas in learning environments.

How to use this framework

Learner Sense-Making: Use this framework to design learning activities that explicitly and purposefully ask learners to sense-make across one or more seasons using stories and knowledge from field observations, family knowledge and practice, and research. Ask learners to make connections between seasonal cycles and the abundance, types, and behaviors of species and kinds they observe.

Collaborative Practice: Use this framework to support field-based science practices that help learners think and investigate together how the seasons impact the natural world, including decisions made by humans.. These field-based practices include, but are not limited to, wondering, observation, collecting data, forming explanations and models with evidence, collaborative discussion and question asking, and engaging in collective deliberation.

Planning and Implementation: Use this framework to guide your planning and teaching. For example, how do your planned activities highlight the role of seasonal changes in place-based sense-making activities in your learning environment? What place-based explorations have you conducted (related to any outdoor space affiliated with your learning environment and neighborhood, the city in which your learning environment is located, the broader region in which your learning environment is situated) to prepare to support your learners' sense-making and deliberation throughout and across seasonal storylines?

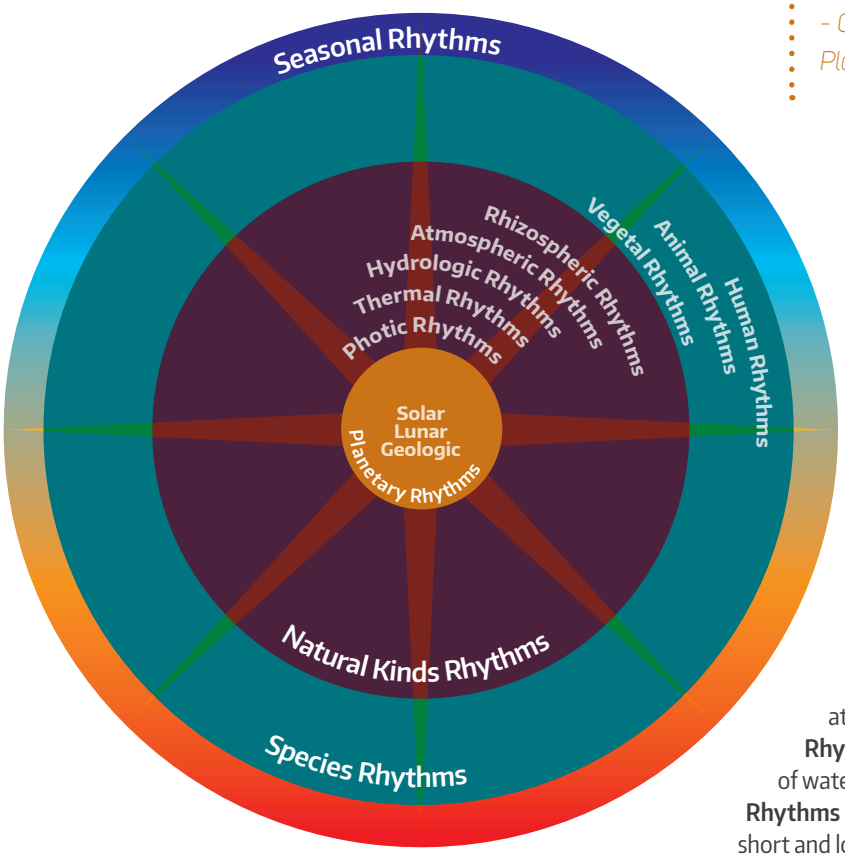
Co-Design and Assessment: Use this framework to engage families and other educators in thinking about phenology across settings in order to make sense of how seasonal cycles affect species and kinds at scale, and how families and educators make sense of these relationships based on their prior knowledge. Use this diversity of sensemaking around phenology and seasonal changes to create formative assessments and discussion opportunities that enable you to adapt instruction in ways that build on learners' knowledge and community ways of knowing.

Educator Reflection: Use this framework to reflect on your own knowledge, values, identities, and experiences in seasons, and the ways they shape your instruction and interaction with learners. Take time to ask yourself key reflective questions such as: What opportunities for seasonal connections are present in learner-sensemaking practices? What assumptions do you and learners hold about the seasons that may have been shaped by culture? How do these assumptions compare to your noticings and wonderings in the field? For each learning engagement, you can ask what went well and what you and learners can do differently next time and why.

Connections to expert thinking: Many experts across a range of disciplines engage with Phenology as well as policy makers. Our social systems are intimately tied to Phenological time. For example, our global and localized food production and distribution (i.e., gardening and agriculture) relies on understanding and predicting the interacting phenological cycles of species like plants, pollinators, humans, and herbivores as well as natural kinds such as amount of daylight, wind for seed dispersion, and more. Additionally, many experts are concerned that loss of key stone species—those organisms that support entire ecosystems—will negatively impact plant cross-fertilization and therefore food production for humans and more-than-humans. Bees in particular have become a "flagship" species that scientists, policymakers, and citizens across the globe work hard to raise awareness about declining population and potential impacts to socio-ecological systems. Our social systems, like transportation, energy, and health care all reflect phenology as well. Our transportation systems shift processes and planning depending upon the season. Our energy systems have predicative seasons of higher and lower use and store accordingly. And our health care systems predict need based on phenological calendars and know that human bodies tend to have particular responses and needs depending upon the season. There are many other ways phenology is relevant to social and ecological systems.

Phenology Wheel: Following 10 Cyclical Rhythms

The Phenology Wheel tool supports thinking across **10 cyclical rhythms** of the natural and social world. These provide a framework for supporting learner sense-making throughout seasons and life cycles. A key reason to engage learners in this thinking is that it will support them in understanding how species and kinds respond to changes in climate at different spatial and temporal scales. Learners should also reason across the seasons to understand how the impacts of unprecedented and unpredictable changes in one rhythm cause disruptions in another. Phenological asynchrony — mismatched seasonal timing — occurs when interacting species change the timing of their natural cycles at different rates due to changes in climate.



"Seasons control everything in the world"

- Grandfather of an elementary student in the Learning in Places project, sharing a Cantonese proverb

Seasonal Rhythms

Our planet has a 23.5 degree tilt that exposes its northern and southern hemispheres to varying intensities of solar radiation during its yearly revolution around the sun, resulting in varied experiences of seasonality. Circannual changes then determine qualities of shifts in the quality of circadian (daily cycles). This means that observations and data collection in local places will reflect the places and seasonality in which you live.

Planetary Rhythms

Planetary Rhythms control the patterns of seasonal cycles and their variance around the Earth at various time scales. **Solar Rhythms and Lunar Rhythms** control the daily and monthly movement of water on Earth through tidal fluctuations. **Geologic Rhythms** including tectonic and volcanic activity can impact short and long-term climate patterns on Earth.

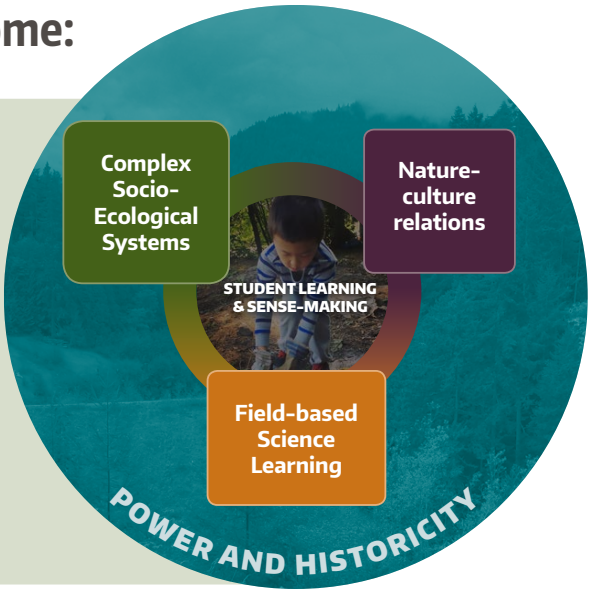
Natural Kinds Rhythms

Natural Kinds (e.g. water, wind, light, etc.) Rhythms are elemental cycles on Earth. **Photic Rhythms** are the daily and seasonal changes in visible light on Earth, which are called photoperiods. Annual and spatial variation of photoperiods guide most natural kinds and species rhythms, including **Thermal Rhythms** (the changes in temperature over time), **Hydrologic Rhythms** (the water cycle), **Atmospheric Rhythms** (local and global wind patterns that result from the uneven heating of Earth's surface, and **Rhizopheric Rhythms** (the daily surfacing and burrowing of microbes in the soil).

Species Rhythms

Species Rhythms are the biological responses to Seasonal, Planetary and Natural Kinds Rhythms on Earth. **Vegetal Rhythms** include the botanical (plant) and mycological (fungal) cycles daily cycles of photosynthesis and respiration as well as annual cycles of leaf emergence, blooming, fruit production, and dormancy. **Animal Rhythms** include humans and are the daily cycles of feeding, moving, and decomposing as well as annual cycles or migration, herniation and breeding. **Human Rhythms** are the social, cultural and technological practices that depend on and shape relations with and to local and global places, lands, and waters.

Connections to the Learning in Places Rhizome:



Complex Socio-Ecological Systems: Research has shown that the places in which people engage in learning about complex ecological phenomena shape sense-making and can support engagement with complex scientific phenomena in authentic and tangible ways. Socio-ecological systems refer to the interactions between human systems and ecological systems. The underlying premise is that humans are part of the natural world, and all of our systems (e.g. social, political, institutional) are always in relationship with ecological systems. Complex socio-ecological systems are simultaneously impacted by planetary, natural kinds, and species. Students must be supported in sense-making across multiple seasonal cycles and influences.

Nature-Culture Relations: The human practice of naming seasons depends on place. For example, those living in temperate zones in the Northern and Southern hemisphere experience changes in annual cycles — circannual rhythms — that are typically associated with four seasons (Spring, Summer, Autumn, Winter) or six seasons (Six Ecological Seasons: Prevernal, Vernal, Estival, Serotinal, Autumnal, Hibernal) that also align with natural phenomena and cultural traditions. Elsewhere there are fewer, longer seasons: summer and winter in the northern and southern polar regions or monsoon season and dry season in the tropical belt between the hemispheres. Western science and cultures have privileged the four-season model of circannual changes and many learners may assume that their own places follow these prototypical rhythms. Studying phenomena in the places that are important to learners and their families and communities can support learning about phenology.

Field-Based Science Learning: Research demonstrates that there is cultural variation in what we perceive and observe in outdoor learning environments, and this variation could serve as a resource for more equitable and expansive field-based science learning. This suggests that learning outdoors in places that matter for learners and their families, that is, in complex socio-ecological systems, may enhance reasoning and decision-making. Cultural variations in learners' experience of phenological dynamics also affords different sense-making strategies in regard to the ways one observes and makes sense outdoors. Anticipation of seasonal effects can inform investigatable questions and "Should We" questions.

Power and Historicity: Power is embedded in all relationships, and these relationships change over time. Power flows throughout the social and natural world. Many powerful forces in socio-ecological systems emerge from planetary motions—for example, the winds and rains, wildfires and frosts, lighting storms and floods, earthquakes and tidal waves. These forces carry the power to nourish and extinguish life.

These powerful forces return with daily and yearly regularities that plants and animals anticipate and respond to, and their own rhythmic cycles of thriving are tied intimately to this expectancy. Agriculture, one of the most ancient human rhythms, is intimately tied to the various traditions that observe and celebrate the synchronous alignments of planetary bodies, natural kinds, and species. With the rise of Global Time, powerful technological regimes such as the Green Revolution (the post-WWII industrialization, chemicalization, and homogenization of agriculture globally; also called the Third Agricultural Revolution) have disrupted multiple socio-ecological rhythms. These disruptions result in disproportionate impacts for subsistence communities and impoverished communities across the globe.

Suggested Citation

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