Interpreting Ecological Calendars for the Public Through Exhibits, Art, and Education

Sonja M. Skelly1,2, Sarah Fiorello1, Jay Potter3, Werner Sun4, and Siobhan Hull1

1Cornell Botanic Gardens, Cornell University, Ithaca, NY, USA, 2School of Integrative Plant Sciences, Horticulture Section, Cornell University, Ithaca, NY, USA, 3Wilson Synchrotron Laboratory, Cornell University, Ithaca, NY, USA

Abstract

This article describes the process educators at Cornell Botanic Gardens undertook to interpret the Ecological Calendar research project for public audiences. An ecological calendar is a way of keeping track of seasonal changes in a habitat. Many communities use and have used such calendars to coordinate their subsistence activities based on these seasonal events. Using interpretive and design planning processes, educators developed an exhibition in the Gardens’ welcome center to help the visiting public understand what ecological calendars are, how they are used by communities most impacted by climate change, and their great potential for use by people around the world to adapt to increasing uncertainty associated with changes such as the increase in extreme weather events. To further help the public understand ecological calendars, two artists were invited to create art installations as part of the whole exhibition based on the research and knowledge from participating communities. Finally, project team members worked with educators to develop an environmental education activity that could be used at the Gardens and in primary and secondary schools to educate students about the value of ecological calendars and how to create them. The team was invited to submit a summary of their exhibition development process to this journal, as part of this special issue and to describe the process they took to communicate the ecological calendar research to a public audience. The process, which included an interdisciplinary team of scientists, Indigenous community members, artists, and educators’ emphasized co-creation and the benefits of including multiple voices and viewpoints. It also describes interpretation—a purposeful approach to communication that facilitates meaning and understanding—and offers an example of how this discipline can be used by the scientific community to help convey their work to public audiences.

Plain Language Summary

This article describes the process educators at Cornell Botanic Gardens undertook to interpret the Ecological Calendar research project for public audiences. Interpretation is a communication process that reveals meanings and relationships through direct experience with objects, artifacts, sites, and landscapes. Using interpretive and design planning processes, educators developed an exhibition to help the visiting public understand what ecological calendars are, how they are used by communities most impacted by climate change, and their potential for use by people around the world to adapt to increasing uncertainty associated with climate change. The exhibition included a photographic narrative; glass case exhibits comprised of objects, photos, and narratives; and displays of ecological calendars. To further public understanding of the ecological calendars, two artists were invited to create art installations to provide a different interpretive perspective. Finally, research team members worked with educators to develop an education activity that could be used at the Gardens and in primary and secondary schools to educate students about the value of ecological calendars, how to create and use them. An evaluation of the exhibition showed that respondents understood what ecological calendars are, why communities were participating in the research project and the benefits of developing ecological calendars.

1. Introduction

A public garden is an organization, open to the public, that curates a collection of plants and uses that collection to further its mission. The mission of many public gardens includes the cultivation and display of a wide range of plants—its collection—to address some purpose such as education, conservation, or aesthetic display (Rakow, 2011). Often referred to as living museums, public gardens also curate exhibits and education programs in support of its mission. Cornell Botanic Gardens’ mission is to inspire people—through cultivation, conservation, and education—to understand, appreciate, and nurture plants and the cultures they sustain. Advancing this mission works toward the Gardens’ vision: a world in which the interdependence of biological and cultural diversity is respected, sustained, and celebrated. This vision and mission was a key reason staff at the Gardens
partnered with the ecological calendars and climate adaptation project (ECCAP). Using interpretive displays, photographic narratives, art, and environmental education Gardens staff collaborated with the ECCAP research team to express to a public audience the ways in which Indigenous and rural communities around the world are adapting to disruptions caused by the climate crisis.

The exhibition “Ecological Calendars: Finding Hope in the Face of Climate Change” interpreted the research project that investigated how climate-driven shifts in ecological patterns, such as first snowfall or the emergence of specific plants, adversely affect agropastoralists who rely on these patterns for timing subsistence tasks.

The exhibition included interpretive displays providing an overview of the research project, a photographic narrative of the people and landscapes involved, prints of ecological calendars developed at each research site and two commissioned pieces of art that provided alternative ways of visualizing and understanding the ECCAP research.

The exhibition was installed prior to a three-day conference, “Rhythms of the Land: Indigenous Knowledge, Science and Thriving Together in a Changing Climate,” which gathered more than 50 scholars and community members from Afghanistan, Tajikistan, Kyrgyzstan, Xinjiang, the Standing Rock Sioux Nation; and from the Oneida Lake region of New York state who were involved in the ECCAP on Indigenous Peoples Day, 11 October 2021. The exhibition was available to public from October 2021 to March 2022.

Through interpretive exhibits, photographic narratives, art, and environmental education the aim was to help visitors learn about the ECCAP and how ecological calendars can build adaptive capacity in the face of climate change.

2. Developing the Exhibition

The Gardens’ exhibit team comprised of the executive director, director of education, interpretation coordinator, and graphic designer who worked collaboratively with the ECCAP team comprised of K.-A. Kassam and graduate students who conducted the ECCAP research. To achieve the goal of the exhibition, the exhibit team followed a formal interpretive planning process in close collaboration with the ECCAP team. Interpretation is “a purposeful approach to communication that facilitates meaningful, relevant, and inclusive experiences that deepen understanding, broaden perspectives, and inspire engagement with the world around us” (National Association for Interpretation, 2021). To achieve this goal, interpretation must provoke the interest of the audience, relate to the audience, and have a main idea or theme unifying the whole story (Veverka, 2011).

To develop the exhibition, the exhibit team followed the National Association for Interpretation’s guidelines for interpretive planning (Brochu et al., 2003). These guidelines outline a process of taking an inventory of interpretive parameters and opportunities, profiling audience characteristics, establishing interpretive goals and objectives, developing the message framework and narratives that align with goals and objectives and the audience’s motivations, developing interpretive media and conducting evaluation.

Each step in the process began with in-person meetings with the ECCAP team to facilitate understanding, especially with respect to indigenous knowledge, to generate and discuss ideas for outcomes, and to gather necessary items needed for the exhibition. Progress was shared with all participants, with all feedback incorporated into the interpretive planning document or resolved before progressing to the next step.

2.1. Inventory of Interpretative Parameters and Opportunities

When identifying the most appropriate interpretive elements to include in an exhibition, it is important to assess any known limitations or opportunities, referred to more generally as parameters. The exhibition space provided several opportunities for display, including a gallery wall, five glass cases, an adjacent large space for people to comfortably view large panels, and a high ceiling for suspending art. These parameters drove the decision to include an overview of the research project using interpretive panels and objects within the glass cases, a photographic narrative that included a series of images of the communities and landscapes participating in ECCAP on the gallery wall, large prints of each community’s ecological calendar in the adjacent large space, and two commissioned pieces of art—one placed within the glass cases and one suspended from the high ceiling.
2.2. Profiling Audience Characteristics

The audiences for this exhibition included the participants in the “Rhythms of the Land” conference and two of the Gardens’ key audiences—visitors to the Gardens and Cornell University students. For visitors and student audiences, profiles of each audience were considered along with the implications of these audiences’ characteristics for interpretation.

In 2017, the Tompkins County Visitors Bureau ranked the Gardens as the most visited cultural organization in the County. The characteristics of these visitors include: a majority come from New York and nearby states; they visit as a leisure activity with some interest in plants, gardens, and/or to spend time in nature; and have graduate or undergraduate education (Jones, 2017).

Characteristics of Cornell students who visit the botanic gardens include: they are often brought to the Gardens by their families, professors, and/or other program; they are likely to use technology and social media; many visit as part of a class; they are most likely to visit areas with close proximity to main campus; and they often visit when the University is in session.

These characteristics have implications for how interpretation and exhibitions are developed. For example, interest in understanding the Gardens’ connections to Cornell University was one characteristic of visitors. Therefore,
Primary theme: Ecological calendars enable communities to increase self-resilience and anticipate and adapt to climate change for the ultimate purpose of securing food and livelihoods.

Subtheme 1: The Ecological Calendar Project was initiated as a response to the threat imposed by climate change on traditional farming communities whose food systems and livelihoods were disrupted.

Supporting Stories:
1. Communities who have contributed the least to human-caused climate change are facing its earliest and harshest consequences.
2. The communities that were part of the Ecological Calendars project were agropastoralists in ecologically-sensitive environments in the Pamir Mountains, which span Afghanistan, China, Kyrgyzstan, and Tajikistan.
3. These communities once relied on environmental observations to successfully grow and raise their own food, but were challenged with changing weather patterns as well as the loss of transgenerational knowledge resulting from disturbances in the passing on of traditional knowledge systems.
4. Scientists with a diversity of expertise from several countries along with a wide cross-section of local knowledge holders came together to revitalize and enhance ecological calendars as a tool to adapt their farming practices in the face of climate variability.

Subtheme 2: Ecological calendars apply existing knowledge systems to anticipate and adapt to changing weather conditions to enhance and secure food systems and livelihoods of threatened communities.

Supporting Stories:
1. Ecological calendars integrate indigenous knowledge and scientific data to most accurately anticipate climate variability.
2. A collaboration between many people with different experiences, including scientists and local knowledge holders, and an integration of existing knowledge systems was imperative to the success of the Ecological Calendars Project and is essential to address the impacts of climate change at local scales.
   i. Ecological calendars were generated by community meetings involving a diversity of local knowledge holders sharing their knowledge of seasonal events that inform their agricultural practices. All knowledge was aggregated to generate a seasonal round, which were combined with climate and weather data to produce ecological calendars that were tested in each community.
3. People around the world have traditionally developed and applied a variety of ways to keep track of environmental observations, including ecological calendars, which connect physical and biological events with the timing of sociocultural activities and their interactions with natural resources, and are constantly adjusted in response to ecological and cultural changes.
   i. One example includes the “Calendars of the Human Body” used by agropastoralists of the Pamir Mountains.
4. Ecological calendars include seasonal events, both abiotic and biotic, which builds in flexibility to synchronize a community’s livelihood activities with their ecosystem to account for climate trends and increasing variability.
5. Communities that rely on tracking environmental observations acknowledge that everything has been and will always be connected to everything else in nature.

Subtheme 3: Ecological Calendars can be used to help a diversity of communities around the world continue to thrive and preserve their livelihood in the face of climate change.

Supporting Stories:
1. Revitalization and development of new ecological calendars is a promising, innovative approach for climate adaptation anywhere in the world.
2. The people who participated in the Ecological Calendars Project gathered at Cornell University to identify actions to broaden the impact beyond the communities that participated and imagine its potential to positively address climate change challenges on a global scale.
highlighting that the ECCAP team was based at Cornell and involved researchers with connections to the Gardens' was important for the interpretive outcomes. Both visitors and students were interested in engaging in the interpretive experience. This is a key reason the exhibition was comprised of multiple elements in multiple spaces, allowing groups to gather to experience the exhibition. Although both audiences had high levels of education, the exhibit team determined that a variety of elements was needed to convey the complexities of the ECCAP research. These elements included the use of captivating images, intriguing cultural objects, kinetic art, and instructions on how to explore the exhibition.

Furthermore, close attention was paid to how best to articulate and convey Indigenous knowledge. In the same way that the ECCAP research team relied on community knowledge to develop the ecological calendars, the exhibit team relied on the ECCAP research team to help contextualize exhibition's content. This reliance meant the exhibit team needed to learn how to share Indigenous knowledge and the meanings and context of each community's observations as it related to the calendar while determining how to relate it to audiences visiting the exhibition.

Based on prior experience working with members of Cornell University's American Indian and Indigenous Studies Program on interpretive exhibit, the exhibit team appreciated the importance of listening to Indigenous people and respectfully approaching content development in ways that accurately represented their viewpoints. Providing feedback opportunities for the ECCAP team at each step in the process was vital to the exhibit team. Having the ECCAP and the exhibit teams co-create the exhibition's goals, objectives, themes, and materials in an iterative manner was paramount in making sure that the Indigenous knowledge shared in the exhibition was honored and appropriately conveyed.

2.3. Establishing Goals and Objectives

An initial step in the interpretive planning process is to establish a goal and measurable objectives to identify what the audience should understand, feel, or want to do after engaging with the exhibit. Identifying one overarching goal ensures that only content which will work to achieve that goal is included. Establishing measurable objectives further defines the goal by adding specificity and measures by which to evaluate whether the goal was achieved. The goal and objectives for the interpretive exhibit elements are outlined in Table 2.

2.4. Developing the Message Framework and Narratives

Once the exhibit goal was defined, the team established a “message framework” for the purposes of ensuring that all supporting information worked to communicate the main interpretive theme. A set of subthemes, or supporting messages, was developed to further organize the exhibit content. A message framework, that focuses only on the information needed to achieve the exhibit goal, increases audience comprehension because information is organized within a thematic structure (Thorndyke, 1977). The message framework for this exhibit was built around the primary theme that ecological calendars

Figure 1. First exhibit display case providing overview of the ecological calendars and climate adaptation project.
enable communities to increase self-resilience and anticipate and adapt to climate change for the ultimate purpose of securing food and livelihoods. This theme and the supporting subthemes and stories are outlined in Table 2.

2.5. Developing Interpretive Media

Upon the establishment of the message framework, the exhibit team wrote text, gathered images, designed, fabricated, and installed all components of the displays in glass cases and in the photographic narrative gallery. For the glass cases, images of the participating communities and a variety of colorful textiles and other cultural artifacts, used by people living in the project areas, were displayed along with interpretive content. An Indigenous-inspired color palette was created as part of the exhibit branding and cohesively implemented throughout the entire exhibition. The unique tones of: Sakwapu (native corn variety); Curcurbita (native squash variety); Azul (sky); Terra Cotta (earthenware); Weathered Stone; Weave; Buffalo Hide; and Deep Turquoise comprised this palette and were used throughout the exhibition.

2.5.1. Glass Cases Display

When visitors first enter the Botanic Gardens’ welcome center they immediately face a set of three glass cases. The content of the first case was designed to orient visitors to the overall exhibition: indicating where they could see learn the context of the research project in the remaining glass cases, view the photographic narrative gallery, and explore the ecological calendars and accompanying art (Figures 1–4).

2.5.2. Photographic Narrative

The teams determined that a curated selection of images taken by ECCAP researchers of the participating community members and their environments would support the goal and objectives of the exhibit. Images were selected based on their ability, with a short amount of narrative text, to be representative of all participating communities and to significantly support the message framework (Figure 5). The ECCAP team drafted the accompanying narratives and the exhibit team edited them for brevity and readability by visitors.

2.5.3. Ecological Calendar Display

Along with the interpretive displays in the glass cases and photographic narrative, 14 ecological calendars developed for each site (Sary Mogul, Kyrgyzstan; Savnob and Roshorv, Tajikistan; Oneida Lake Watershed, United States; Standing Rock Sioux Nation, United States) were displayed in an accompanying gallery space. For each calendar, an interpretive panel with information about the community, its location, and instructions for use was displayed. These calendars, created by the ECCAP research team, were printed at a scale that allowed for ease of readability, mounted on foam core for durability (Figure 6).

2.6. Conducting Evaluation

The exhibit team evaluated the success of the exhibition by administering a written survey in October and November 2021. Data were collected by providing a one-page survey to visitors after they had engaged with the exhibition. All 42 respondents were university students who visited the Botanic Gardens to attend a class and had no prior knowledge of the Ecological Calendars Project. The exhibit team planned to survey additional visitors to its welcome center, but due to the university's COVID-19 restrictions regarding campus visitation, these additional evaluations could not be completed.
Survey results indicated that most of the exhibitions' objectives were achieved. Respondents' answers clearly indicated that most understood why the communities were participating in the research project and the benefits of developing an ecological calendar. When asked “What challenges are the communities that were part of this project facing due to climate change?” 25 respondents indicated in their own words that changes in climate disrupted their livelihoods. The remaining respondents showed partial understanding by indicating that communities were observing changes in weather patterns. When asked “What is the purpose of developing an ecological calendar?” 33 respondents indicated in their own words that the calendars were used to anticipate and adapt to changing weather conditions in order to enhance and secure their livelihoods. All but one respondent indicated they were aware that ecological calendars were not a new idea.

In response to a question assessing the objective that most people will “recognize that a collaboration between many people with different experiences, including scientists and local knowledge holders, and an integration of the existing knowledge systems was imperative to the success of the Ecological Calendars Project,” half of the respondents included scientists and local community members in their responses, while 17 referred to just the local communities involved and two responses only mentioned researchers.

To assess how visitors understood the impact of the Ecological Calendars Project beyond the participating communities, the question was posed, “How do you think the ecological calendars project could positively address climate change challenges on a local scale?” Twenty-two respondents indicated that the project would increase awareness of specific changes within the communities, while 19 indicated that the calendars would allow communities to identify the changes and adjust their livelihood activities in response. An additional question asked how the project could address climate change on a global scale which resulted in respondents providing a variety of answers. Eighteen people described how the calendars could provide for an accumulation of global knowledge on the change of climate and weather patterns, four people thought it could be a way to inform policies or encourage political activism, seven envisioned an increase in awareness of climate change happening globally, four indicated an increase in awareness of the negative effects of climate change on Indigenous ways of life, and the remaining four responses described other impacts.

A final question assessed whether people will be motivated to more closely observe the seasonal cycles that take place in their own habitat. Using a five-point Likert scale (Likert, 1967), people were asked how likely they were to create an ecological calendar with seasonal events where they lived. Fourteen respondents were neutral, 13 were unlikely, eight likely, and four very unlikely to create an ecological calendar with seasonal events where they lived. These responses indicate that most people did not have an interest in creating an ecological calendar. This is likely due to all respondents being college students who are focused on their academic endeavors and are not currently living where they spent most of their lives.

A hallmark of successful interpretation is that it is provocative—it provokes curiosity, a desire to learn more, to ask questions, and engage deeper with the topic being interpreted. Given the complexity of the ECCAP, the teams agreed art was a creative way of provoking curiosity that would complement the exhibition. Author Jeanette Winterson wrote an essay reflecting on the ability of art to provoke:

“What art does is to coax us away from the mechanical and toward the miraculous. The so-called uselessness of art is a clue to its transforming power. Art is not part of the machine. Art asks us to think differently, see
differently, hear differently, and ultimately to act differently, which is why art has moral force. Ruskin was right, though for the wrong reasons, when he talked about art as a moral force. Art is not about good behavior, when did you last see a miracle behave well? Art makes us better people because it asks for our full humanity, and humanity is, or should be, the polar opposite of the merely mechanical. We are not part of the machine either, but we have forgotten that. Art is memory—which is quite different [from] history. Art asks that we remember who we are, and usually that asking has to come as provocation—which is why art breaks the rules and the taboos, and at the same time is a moral force.” (Popova, 2014).

This viewpoint describes why incorporating art as an interpretive tool is important: it provides an opportunity for an audience to think differently, see differently, hear differently, and ultimately to act differently. Two pieces of art were commissioned as part of the exhibition: a kinetic mobile and an Indigenous artist’s sculpture.

### 3.1. Kinetic Mobile Art

Traditionally, exhibitions featured at the Nevin Welcome Center include two dimensional interpretive panels with artifacts mounted in the glass case displays and two-dimensional photographs in the gallery wall space as described above. For the ECCAP installation, in addition to fully utilizing these spaces, it was agreed that a novel approach involving three-dimensional sculpture would connect the two display areas and give visitors the opportunity to think, see, and possibly act differently.

A central mechanism connected to many exposed points that constantly move and change, swing and shift, rise and fall, much like the data recorded from the ECCAP research team. The speed of the movement was carefully reviewed during the design process. Volume of airflow from entryways, and air vents as well as from people passing underneath were all tested to find the ideal placement. The intended movement being a slow, meditative motion that compels the viewer to look upwards and to engage as new configurations reveal themselves. The indigenous-inspired color palate was also incorporated into the mobile as colored thread connecting the armature. This furthered the connection between the art and the rest of the exhibition.

Interpreting climate science through this unique mobile art installation hints at the complexities and the challenge surrounding data collection and interpretation. Our perception changes when looking through different lenses—in this case through artistic interpretation. Ultimately, the artwork allows viewers to physically and emotionally connect to and interact with a moving expression of the findings.

The three-piece mobile (Figures 7 and 8) was created by Ithaca, New York-based artist Werner Sun and represents the multiple elements of the natural world, held in a delicate gravitational balance by their mutual connections.

#### 3.1.1. Werner Sun’s Artist’s Statement

*Keeping Time With Changing Seasons* is a kinetic installation created for the Ecological Calendars exhibition. As an artist with a scientific background, I conceived of this piece not as a literal depiction of ecological calendars, but, rather, as an expression of the dynamic, creative research process that produces them. In my work in general, I explore the interplay between pattern and complexity by folding two-dimensional photographic prints into three-dimensional geometric forms that act as a metaphor for the practice of science—the shaping of real-world observations into concise (often mathematical) descriptions. For the Ecological Calendars installation, I augment these paper engineering techniques by incorporating my photographic sculptures into a group of suspended mobiles that float through the air in response to their environment.
The source material for my installation comes primarily from photographs taken by the Kassam Research Group to document the people and places that they visited during their research. I also include drawings made by Anna Ullmann, one of the researchers. These images accompany a rich data set of measurements and received knowledge that the research team painstakingly collected, organized, and distilled into their ecological calendars.

When the Kassam Research Group described their work to me, I recognized their process as one of exploration and improvisation, pursued without a firm, preconceived notion of the expected outcome. To evoke this prolonged state of uncertainty that characterizes scientific work, I situated the Kassam Research Group's photographs and drawings among contrasting non-representational elements provided by blank drafting film, blocks of color gradients, and enlarged fragments of photographs embellished with geometric line drawings. These
layers of abstraction serve as a backdrop or negative space for the concrete imagery of plants, animals, people, and dwellings in the source material. In this way, the photographs and drawings are seen as emerging from a featureless visual landscape, much as scientific understandings slowly coalesce during the course of a research project.

To create the three mobiles in the installation, I fold ed digital prints of all these images into polyhedral sculptures, grouped them into cloud-like clusters, and attached them together with wire armatures. Each mobile was assembled from the bottom up with a nested series of connections and then supported from a single point at the top. This recursive branching structure allows the mobiles to rotate organically when pushed by air currents, changing shape with gentle movements that are transmitted from one part of a mobile to another.

The complexity of climate science often hampers our efforts to communicate its findings effectively. Keeping Time With Changing Seasons is an example of an artwork that can aid in this communication by presenting multiple points of entry into the subject. Not only does it refer specifically to ecological calendars, but it also calls to mind the inquisitive, sense-making mindset of scientists in general. The constant motion of the mobiles mirrors the open-ended nature of scientific research, and the couplings among their individual elements can serve as a simplified demonstration of the deep interconnectedness found in natural ecosystems. Thus, art enables viewers to engage with science by offering a physical embodiment of quantitative knowledge that they can experience in a visceral, non-verbal way.

3.2. Indigenous Artist’s Sculpture

In addition to the mobile art installation the ECCAP team commissioned art from Indigenous artist Natani Notah whose art practice explores contemporary Native American identity through the lens of Diné womanhood. Notah’s sculpture Grounded included Native beadwork, leather, and fiber (Figure 9).

3.2.1. Natani Notah’s Artist’s Description

The sculpture was created using a mixture of globally sourced fabrics, seed beads, metal, driftwood, and other natural materials to highlight the importance of interconnectivity. In addition to using conceptually relevant materials, I focused on including beadwork, sewing, and carving to spark
conversations about the role of the human hand in causing and responding to climate change.

In my art practice I tend to combine both natural and synthetic materials to serve as a metaphor for coexistence. What that means to me is that one entity cannot exist without the other. Through this sculpture commission I was interested in speaking to the role of the human hand in responding to climate change. All the materials for the sculpture have been ethically sourced or collected over time. Once combined they form an abstracted representation of an ecological calendar. Through color, shape, and repetition, the sculpture's design is intended to mimic patterns in nature including symmetries and spirals that are visible in the overall structure as well as the detailed application of beadwork.

4. Primary and Secondary Environmental Education Activity on Ecological Calendars

One of the Gardens' strategic goals in achieving its vision and mission is to nurture the unique and personal connection people have to plants. One way of achieve this is by cultivating the next generation of “biocultural guardians”; namely young activists who appreciate the relationship between biological and cultural diversity. Educators at the Gardens, using the message framework for the exhibition, developed an environmental education activity designed to be used by teachers and students in grades three through eight. To ensure that the important lesson of building community resilience in the face of climate change was accessible to school-aged children, an activity was developed to facilitate their interaction with the exhibition. The goal of the activity was for students to gain an understanding of how to read ecological calendars, to reflect on the purpose of ecological calendars, and to apply what they learned by creating an ecological calendar of their own.

Given the dense amount of information present in the ecological calendars, it was important to first identify the key takeaway of the exhibition. It was determined that students should be able to explain how ecological calendars can help a community track and respond to changes in the climate. To do so, students first needed to understand several key concepts. For instance, students needed to recognize the basic organization of the ecological calendars, the link between climate events and human activities, and the differences that exist between communities. A series of questions was developed that progressed as students moved through the exhibition. Early questions asked them to identify how many sections an ecological calendar is divided into and locate certain symbols, while later questions asked them to explain how different communities respond to seasonal changes and articulate the role of ecological calendars in responding to climate change.

Educators wanted students to not only understand the structure and purpose of ecological calendars, but to apply the concepts to their own community. To encourage such reflection, an activity was included that asked students produce their own ecological calendar (Figures 10 and 11). A series of questions were provided to prompt their thinking, asking students to identify both when an event occurs and what the event signals to them, with the first snow of the year as one example. By encouraging students to consider the personal and community implications of seasonal events, the activity demonstrated the universal benefit of ecological calendars.

The activities were designed for students in grades three through eight and to be easily adapted to accommodate the needs of younger or older students. For instance, younger children might benefit from having the questions posed in a discussion format, while older students might prefer to concentrate on designing their own ecological calendar.
The Gardens' educators planned to deliver and evaluate the activity with visiting students in the fall of 2021 and early spring 2022, however due to the University’s visitor restrictions (due to COVID-19) these visits did not occur. One high school class did visit just before restrictions were implemented and educators used the activity guide with them. The students were highly engaged in the exhibition and were able to answer the activity's questions by engaging with the exhibition and ecological calendar display. They were also able to create personalized ecological calendars, with many remarking that they had not previously reflected on seasonal cues and found the exhibition to be revelatory.

5. Conclusions

Education has been a major focus of public gardens since their earliest days when physic gardens were established to teach about the medicinal qualities of plants. Most present-day gardens have education programs that focus on plant conservation and the importance of plants to human well being (Skelly, 2016). At Cornell Botanic Gardens, education is a key pillar by which it works toward its mission of inspiring people to understand, appreciate, and nurture plants and the cultures they sustain. Collaborating with the ECCAP team provided the Gardens with the opportunity to support research conserving plants and the cultures sustained by them as well as educating its key audiences—visitors and Cornell students—about the research and its implications for participating communities and to the broader public.

By using a co-creative collaboration process, the ECCAP and exhibit teams conceived of, developed, and implemented an exhibition that centered around a goal of having visitors understand and appreciate that the ECCAP revitalized ecological calendars and developed new ones with different communities and villages in order to re-establish links between environments and human activities and how such calendars can build adaptive capacity in the face of climate change. The exhibition consisted of interpretive displays, a photographic narrative, a

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**Figure 10.** Page 1 of the ecological calendar environmental education activity for primary and secondary school students in grades three through eight.
display of 14 ecological calendars created by the ECCAP researchers and communities, and two commissioned art installations. An additional component—an environmental education activity for students in primary and secondary schools—was developed as a way to help a younger generation understand ecological calendars and their significance in recognizing the impact climate change is having to indigenous livelihoods and ways of adapting to such changes.

Though limited in scope, initial evaluations of the exhibition and the educational activity indicated that the teams met most of their goal and objectives. The incorporation of art into the exhibition was important as a way to engage people through different and thought provoking media as well as a way to bring scientific research forward in a beautiful and meditative capacity.

For both the ECCAP and exhibit teams the importance of honoring and respecting the depth and breadth of Indigenous knowledge was at the heart of this project. The diverse, nuanced, context and culturally specific knowledge that emerged through the ECCAP was at the forefront of the minds of the teams' participants as they progressed through the interpretive planning process. Since interpretation theory promotes the presentation of a whole concept without its oversimplification, the teams sought a thorough understanding of the Indigenous knowledge before developing, designing, and implementing the exhibition. The ECCAP team was especially skilled at keeping the Indigenous perspective in focus which allowed the exhibit team to proceed without first-hand interaction with the communities participating in the ECCAP.

Interpretive panels, the ecological calendars, the photographic narrative panels, and the art on the web at cornellbotanicgardens.org/explore/exhibits/ecological-calendars-finding-hope-in-the-face-of-climate-change/.

**Conflict of Interest**

The authors declare no conflicts of interest relevant to this study.
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Data Availability Statement
No data were collected for this project.

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