EXPLORING PERCEPTIONS OF SEASONAL CALENDARS IN A TIME OF ENVIRONMENTAL CHANGE

Eleni Bellas
Alexander Hayden
Roe Hendrick
Anne Lapsley

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Exploring Perceptions of Seasonal Calendars in a Time of Environmental Change

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By:
Eleni Bellas
Alexander Hayden
Roe Hendrick
Anne Lapsley

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Report Submitted to:

Kerstie van Zandvoort
Dr. Paul Schneider
CALENDARS Project: Massey University

Dr. Scott Bremer
CALENDARS Project: University of Bergen

Dr. Yunus Telliel and Dr. Shana Lessing
Worcester Polytechnic Institute

ABSTRACT

As climate change alters the environment, changes to the seasons people use to describe the world are forcing calendars out of sync with natural events. Our work, a pilot for the CALENDARS Project, explored viticulturists' seasonal perceptions. We developed an online calendar tool and used it in interviews with viticulturists in New Zealand and North America, finding that their seasonal perceptions are changing significantly. Our findings demonstrate the feasibility of our methods and tools for the longer-term parent project.

EXECUTIVE SUMMARY

INTRODUCTION

As climate change progresses, traditional calendar seasons deviate from the seasons we actually experience. There is a dearth of data regarding how perceived seasons and traditional calendar seasons differ from each other, and how this variation affects different groups of people. As climate change causes seasons to vary from their documented benchmarks, many activities associated with an occupation or a sense of place are no longer synchronized with the local climate. While seasonal variation is more visible in regions that have experienced physical indicators and impacts—melting ice, late rainfall, larger fires—it may still be present in areas where the climate shifts are more subtle.

The goal of this project is to document individuals' experiences and perceptions of seasons and the calendars they use. We gathered information using interviews and an interactive tool, which allowed participants to describe the seasons they experience. This allowed us to compare how people in different institutions engage with calendar systems and gain insights into how climate change challenges their natural patterns.

METHODOLOGY

We conducted open-ended conversational interviews (via Zoom) with viticulturists and other members of the winegrowing and winemaking industry to build an understanding of their perception of seasons, seasonal variations, and their experience with calendars. In order to see possible cultural connections to seasons, we decided to look at two regions in different parts of the world: North America, primarily in New England, and New Zealand. We used the information from interviews in conjunction with data from the calendar tool to create visualizations that depict the seasonal experiences of viticulturists in New Zealand and New England.

We created an online calendar tool (see Appendix D), inspired by the one created by our sponsors in New Zealand (see Appendix C). This offered interviewees the opportunity to express their unique experience with seasons. We designed the tool to incorporate some aspects of a conventional calendar to orient the participant, while still allowing it to be unstructured to eliminate potential biases. The design of the tool was such that a participant can fill in important dates, time periods, and seasonal markers aligned with the participant's perceptions, with little influence from arbitrarily important calendar dates. We encouraged the participants to be more cognizant of their own relationship to seasons and seasonal rhythms as they filled in the tool.

FINDINGS & OBSERVATIONS

We conducted interviews with fifteen viticulturists and winemakers from New Zealand and New England, all of them from different locations, backgrounds, and vineyards. These interviews offered

insight into the year of a winegrower, the seasons they experience within each year, and how the seasons and climate where they work have changed over time.

The responses we received suggest that viticulturists generally agree on two overarching seasons that are determined by the grape life cycle: a growing season and a dormant season. However, we saw variation between the sub-seasons they observed, the indicators they relied on to delineate the seasons, and the prevailing conditions they experienced during all seasons.

Figure 1. A general timeline of events of a viticulturist's year based on calendar tools and interviews. It depicts two overarching seasons.

Most of the interviewees stated that their year was best described by two predominant seasons, growing season and maintenance season, as seen in Figure 1. These are defined by the growth and maturation of the grapes during the warmer growing season and the vines remaining dormant during the colder maintenance season. During the growing season, the grapes must be tended to—activities during this time include watering, monitoring, pesticide application, disease prevention, and some pruning—which are completed to ensure that the grapes develop to the best flavor before harvest. After harvest is complete, the vines must be pruned and maintained during their dormancy. Winemaking is a priority during this time; however, maintenance of equipment and structures occur in tandem. The order of tasks within each season varies by vineyard—either by preference of the managers or the local climate—but these same tasks must be completed everywhere and the phases the vines experience are nearly universal.

In both regions, people felt that choosing a "start" and "end" of the year failed to address its naturally cyclic nature. Most individuals described the year as rolling and continuous, characterized by the absence of an off-season, making it difficult to define a start or end date. When urged to provide an answer, many interviewees concluded that the transition from harvest to pruning was the most drastic transition of the year. This is because their routine changes significantly between attending to the maturing grapes in the growing season, and maintaining equipment and making wine in the maintenance season, as seen in Figure 2.

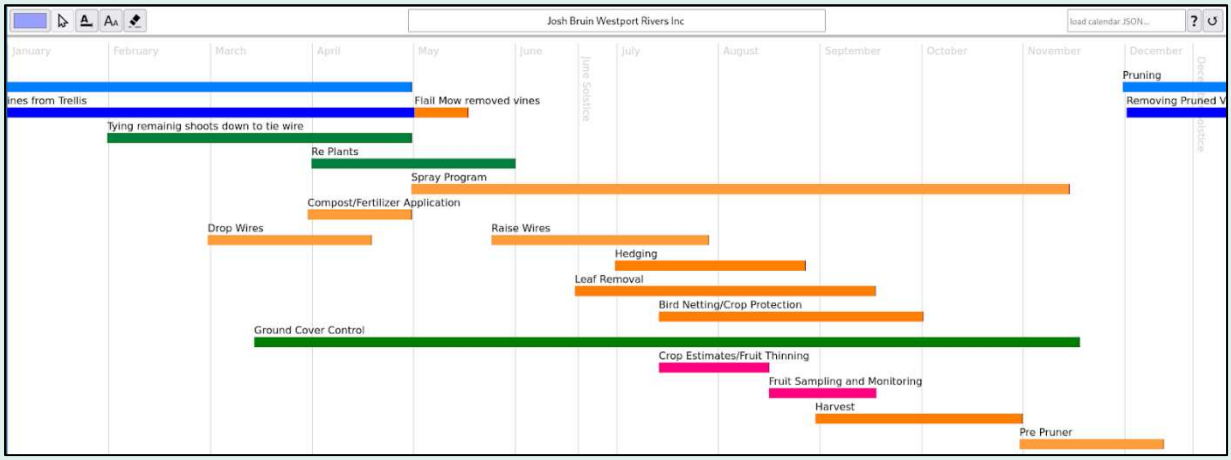

Figure 2. Visualization of the transition between preharvest and postharvest occurring in November at Westport Rivers Vineyard and Winery.

While individuals' answers and timelines of events varied, it was clear that their years and perceptions are predominantly shaped by their crops. As we spoke to viticulturists and winemakers, it became evident that their perceptions of seasons were largely dependent on the natural seasonality of vineyard maintenance. For this reason, calendars have little influence over viticulturists' perceptions of seasons; instead of using established dates, they observe their crops to delineate between seasons. Events throughout the year, such as pruning, bud burst, bloom, and harvest, serve as key seasonal indicators. Some viticulturists perceive the beginning of spring as when they first notice sap flowing, or that winter starts when it becomes time to prune (Nico Kimberly, personal communication, February 3, 2022). Because the year-round nature of winegrowing necessitates constant interaction with the vineyard, it in turn imparts an influence on the viticulturists' understanding of seasons outside their profession. It is doubtless that these individuals observe other seasons, and some mentioned additional seasons in their responses, but they focused on vineyard-related seasons during the interviews.

Many people with long-term experience in vineyards reported that they have witnessed an increase in weather variability and unpredictability as climate change has progressed. As the weather becomes more variable, viticulturists are forced to change their practices to ensure they can still produce wine. The dramatic effect climate change has on winegrowing is because grapes, like all plants, reflect the status of the ecosystem in which they are growing (Jeff Sinnott, personal communication, January 30, 2022). For example, the warming climate accelerates the grape growing process, as there are more viable growing days when the mean temperature is higher. In Hawke's Bay, New Zealand, the fruit has been ripening three or four days earlier every year for the past ten years. In Marlborough, NZ, harvest is beginning this year a month earlier than it did twenty years ago (Jeff Sinnott, personal communication, January 30, 2022). New Zealand's overall harvesting season used to last about six weeks nationally, but it has since decreased to only three or four weeks in length (Ed Massey, personal communication, January 31, 2022).

RECOMMENDATIONS

Although it may not be feasible in all cases, we recommend conducting interviews in person, as this improves communication with the interviewee and gives them a better understanding of the project. The conceptual nature of the CALENDARS research is difficult to grasp, requiring exceptional communication during interviews. Meeting candidates in person allows for more nuanced communication and gives both parties a better understanding of the other.

Researchers should also aim to conduct the majority of their interviews during the off-season of their institution of interest. Because viticulturists are most busy in the spring, summer, and early fall, winter is the best time to contact them. The longer the study has to conduct interviews, the easier it is to meet with interviewees at a time convenient to them. A longer timeframe also gives the interviewee time to reflect and update their response and provides opportunity to follow up with interviewees during different parts of the year.

We highly recommend that future researchers utilize and improve the calendar tool, as our use of the tool demonstrated that it is effective enough to be used for future projects related to calendar perceptions. Because the calendar tool is web-based, it can be used remotely from any location, and it requires minimal instruction to use. Therefore, it can easily be used to collect data from a large sample. If others end up using the tool, we recommend exploring a variety of methods for analyzing and visualizing the responses collected. We only scratched the surface of what can be done; other analyses could include comparing responses across cultures, changing how the year is presented, exploring the colors participants used, or mapping the responses onto different representations of the year.

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CHAPTER 1: INTRODUCTION

As globalization brings the world closer together, the importance of scheduling and calendars in society is becoming more apparent. This reliance on calendars, in conjunction with the influence of weather and seasons, begs further understanding of how well calendars actually reflect our perception of seasons and the world around us. With climate change altering the environment, the world described by these calendars—most of which were created before the onset of climate change or were imposed by colonizing groups—deviates from the seasons we actually experience.

There is a general lack of understanding about how people relate to calendars, especially how those relationships are altered by climate change. In addition, there is a dearth of data regarding how perceived seasons and traditional calendar seasons differ from each other, and how this variation affects different groups of people. As climate change causes seasons to deviate from their traditional and documented benchmarks, many activities are no longer synchronized with the local climate. While seasonal variation is more visible in regions that have experienced physical indicators and impacts—melting ice, late rainfall, larger fires—it may still be present in areas where climate shifts are more subtle.

Seasonal calendars include specific dates that mark the transition between the four hallmark seasons. However, calendars do not always convey the seasons that people perceive; people understand many events separate from calendar dates as indicators for the transitions between seasons. These indicators vary between individuals; they may be objective, like the first frost of the year, or subjective, like the time to take out a winter jacket. For example, much of the imagery surrounding the Christmas season is related to snow and winter, but for many parts of the world, Christmas falls in the middle of summer. Moreover, winter imagery is still prevalent in places where Christmas occurs during the local summer.

Although the "new year" starts on an arbitrary day in the Gregorian calendar, for many people there is no significant transition in January. For example, for school children the year may "begin" on the first day of school in September, but for tax accountants the year begins at the start of tax season in late January. In a time of climate change, differences in the perception of seasons raise new questions:

How does environmental change alter our experiences? For instance, would individuals living in New England still want pumpkin-flavored foods if October feels like August? In understanding our personal relationships with seasons, we will hopefully gain a better understanding of seasonal variability.

The goal of this project is to document individuals' experiences and perceptions of seasons and the calendars they use. We gathered information about these findings using interviews and an interactive tool which allowed participants to describe the seasons they experience. This allowed us to compare how people in different institutions engage with calendar systems, and elucidate how climate change challenges their natural patterns. To accomplish our goal, we identified three objectives. Using the wine industry as a case study, we drew from viticulturists' experiences regarding their perceptions of seasons and climate change, documented and mapped their seasonal rhythms, and evaluated the extent of seasonal variation in relation to their calendars. Our findings contributed to the global CALENDARS Project.

CHAPTER 2: LITERATURE REVIEW

This chapter provides an overview of existing research pertaining to how climate change interacts with local perceptions of seasonal calendars. We describe calendar systems in greater depth and present research about how seasons influence environmental and cultural frameworks. We also describe the role of the institution we worked with, the winegrowing/winemaking industry, and we conclude with several case studies that offer insights into how our research study was structured and executed.

THE CALENDARS PROJECT: PARTNERS IN CROSS-CULTURAL PERCEPTIONS

The CALENDARS Project is an international, cross-cultural study researching the relationship between institutions and their seasonal calendars within the context of social and environmental change. The project began in Norway at the University of Bergen in 2019 with a partnering research team on the Coromandel Peninsula in New Zealand. Their research is focused on understanding and examining how representations of seasons differ between groups, and how these representations are able to adapt in a time of environmental change. The goal of their research is to understand the relationship between humans and the seasonal calendars they define, potentially providing further insights into our relationship with time. The topic engages with cultural frameworks, social practices, and alternative knowledge, including how traditional knowledge may be used or lost. The project team suggests that climate change might be undermining the representations of seasons that we use to understand "seasonal rhythms," yearly environmental cycles that influence our actions (*CALENDARS Project*, n.d.). The CALENDARS Project team argues that as long as institutions are living according to outdated and inaccurate ideas of seasons, they are not adapting to the changing seasons they actually face (*CALENDARS Project*, n.d.). Their principal research question is as follows: "What seasonal representations are shaping the different institutions in our society, and how do these ideas of seasons help (or hinder) these institutions to successfully adapt to seasonal change?" (*CALENDARS Project*, n.d.).

The project was awarded a European Research Council (ERC) grant. The CALENDARS Project aims to build an understanding of how institutions and their seasonal representations interact,

and determine how well these representations will help institutions adapt to seasonal variation (*CALENDARS Project*, n.d.). To accomplish this goal, the project is broken down into three distinct phases. Phase one will compare how seasonal representations shape different institutions and examine how those institutions in turn shape their own seasonal representations. Phase two aims to study the institutions' seasonal representations and appraise its quality for successful adaptation in different institutions. Phase three intends to study "facilitators and barriers" to adoption of new representations, using the research gained in previous phases with the help of locals to create alternative seasonal representations (*CALENDARS Project*, n.d.). Research is ongoing, as the project is funded until 2024.

VITICULTURE AND ITS RELATION TO SEASONS

The impact of seasonal variation differs between institutions. We elected to focus on the effects of climate change on seasons in the wine industry. Because the grapes used to produce wine are extremely sensitive to small variations in weather conditions, we conjectured that concentrating on the wine industry could unearth interesting perspectives on seasonal variation. Changes in temperature, water status, and light intensity can have profound consequences on viticulture (Leeuwen & Darriet, 2016). For this reason, climate change has been causing a significant shift in suitable areas for viticulture. Over time, wine-growing regions have adopted specific varieties of grapes based on their respective climates. (van Leeuwen et al., 2019). This study also noted that with the rise in temperature and greater prevalence of droughts, varieties historically found in certain locations are not ripening in the ideal ripening window, which can lead to lower quality grapes and wine. Conversely, research also shows that in some locations, varieties that could not previously be grown may now ripen in the optimal window for harvest (van Leeuwen et al., 2019). In addition, increasing drought produces lower yields, but better-quality red wines (van Leeuwen et al., 2019) Thus, climate change produces both positive and negative effects on viticulture.

Regardless of the nature of its effect on viticulture, the influence of climate change and seasonal variability is irrefutable. For this reason, we expected viticulturists and those intertwined with the wine industry to be exceptionally cognizant of minute seasonal variation. With climate change

having a particularly strong influence on viticulture and wine production, those responsible for ensuring both the quality and quantity of wine produced must be especially perceptive to changing environmental conditions. We purposefully selected the wine industry to research because of the intimacy those involved have with changing seasonal rhythms.

The viticultural year is the same anywhere grapes are grown and consists of five key events of grape development: bud break, flowering, veraison, harvest, and dormancy. Bud break, also known as bud burst, is when the vines wake from their winter dormancy and begin to produce buds. Flowering, or bloom, is when the shoots begin to grow from the vine. Veraison, the “onset of ripening” in French, is when the grapes transition from green to their final color. Harvest occurs once the sugar and pH level in the grapes reach ideal conditions; once they are cut from the vine, all sugar and aromatic development stops. Following harvest, the vines are pruned back and the cold temperatures lead to the vine entering a dormant state until bud break restarts the cycle.

SEASONAL BENCHMARKS AND SEASONAL CHANGE

Many calendars mark December 21st (sometimes the 20th or 22nd) as a solstice, the shortest or longest day of the year depending on the hemisphere. In many cultures, that date is generally regarded as the start of a season, despite indicators of seasonal transitions occurring in a wide range of dates around it. For example, in many locations in the Northern hemisphere, snow is common more than a month preceding the winter solstice. The conventional ideas of seasons represent them as a linear timeline where one season slowly transitions into the next. However, there are many seasons that are more discrete, like a "rainy season" (marked by the presence or absence of monsoons) or "fire season" (marked by the presence of wildfires). A study conducted in the southeastern United States about the fire season (or in less severe years, the "dry season") found a significant change in the dry season between now and previous decades. Researchers observed that longer periods of dry weather gave rise to an increased likelihood of wildfire ignitions and more severe fires (Fill et al., 2019). Because the fire season is easily observed by monitoring dry weather and presence of fires, it is easy to distinguish how fire seasons have changed on a yearly basis, providing a documented example of seasonal variation.

Although rain and fire are easily measured, many other seasonal indicators are a relatively arbitrary way for humans to classify time based on their perceptions of the world around them. Most people in a particular region can agree on roughly the climate they experience, but not the seasons they perceive in that climate. There is extensive academic literature that attempts to quantify the borders of seasons, with varying success. This approach to find seasonal borders has been applied to studying concepts like energy use and how behavior varies between seasons (Wang et al., 2015).

The standard practice of dividing a year into four seasons places the transition between seasons at the solstices and equinoxes. Seasons divided this way are easily calculated with astronomical models, but they cannot reflect the seasonal cycles experienced at local scales. Even when the location experiences four seasons per year, local variations still cause these to deviate from the global model (Joussaume & Braconnot, 1997). Instead, much research into seasons at specific locations is done with respect to local weather patterns. This is difficult because of the natural variation in patterns from year to year, therefore most researchers use methods which involve averaging temperatures over time and grouping them with temperature thresholds. Some methods involve more complicated statistical analyses of these weather measurements in an attempt to get more consistent results (Cannon, 2005; Wang et al., 2015).

These studies can produce results meaningful to climate researchers and some anthropologists, but they overlook the more human aspect of seasons and seasonality. Because seasons are based on human perception and interpretation, it is important to understand the local experiences on which these are based. Without getting perspectives from those living through the seasons, each season is simplified to easily measurable metrics. As a result, they do not reflect cultural events, values, or changes that cannot be observed by traditional weather monitoring techniques. This anthropological approach is more difficult because it requires building relationships with locals; however, pursuing this research produces information that is invaluable in determining the meaning of seasons and their effect on those living through them.

HISTORICAL CALENDARS AND SEASONS

To understand connections between the environment and calendars, we can refer to Neolithic age artifacts that show primitive measures of seasons. Timekeeping has always been dependent on events in the environment, whether astronomical or seasonal in nature. Early calendars often featured ways to measure the Sun's position in the sky, such as the Gold Lozenge from Bush Barrow that featured holes marking the height of the sun in both winter and summer. These holes were presumably meant to help create solar calendars by noting the angle of the sun on particular days (MacKie, 2009). Another example is the Nebra "Sky Disc" from present-day Eastern Germany that features arcs, which represent the positions of the sun in midsummer and midwinter (MacKie, 2009). These calendars show how early calendar systems were dependent on the movement of the Sun for keeping time, tying the calendars directly to astronomical seasons.

In Norway, one of the research sites used by the CALENDARS Project, the traditional calendar measure is the Primstav, a physical representation of their yearly calendar. The Primstav is a flat, sword-shaped, wooden stick that splits the year into two halves; the summer months are marked on one side and winter months on the other. A notch is cut into the wood for each day in the calendar year (see Figure 1).

Figure 1. A primstav (Norwegian calendar stick) (Dahlmann, n.d.).

The oldest primstav found has been dated back to the mid-1400s (Dahlmann, n.d.). The Norwegians used the calendar to keep track of dates to perform certain actions dictated by the natural world. In addition, other symbols marking special events and holidays are carved into the calendar. Instead of referencing an event using the year it occurred (i.e. an even happened in 1965), when using a primstav, events are referenced in respect to a previous important event (i.e. an event happened two summers after the President was assassinated) (Dahlmann, n.d.). The first almanac was released in 1644, after which almanacs slowly replaced primstavs until Norwegians adopted the Gregorian calendar that was used elsewhere in Europe.

Today, the Gregorian calendar is the global standard; it is an extension of the earlier Julian calendar, established by Julius Caesar in the 40s BCE. The Julian calendar consists of 12-month years, with every fourth year being a "leap year" and containing one extra day (*Julian Calendar*, n.d.). Because each year is not precisely 365.25 days, a leap day every four years was not enough to prevent the calendar from drifting over time. The Gregorian calendar removed this drift. Proclaimed by Pope Gregory XIII in 1582, it is the same as the Julian—just with several leap days removed—and it all but eliminated the calendar's drift (EB Editors, n.d.). Great Britain did not adopt the Gregorian calendar until the 1600s, an adjustment which required removing days from a year (Ridpath, 2018). Aside from creating confusion, it would be relatively easy to shift the calendar in use now to align January 1st with the winter solstice. In an astronomical sense, the Gregorian calendar is rather arbitrary, although colonialism did ensure that it became the standard calendar used internationally (Case, 1955).

Before colonists brought calendars from Europe, Indigenous groups in the Americas used their own systems for measuring the passage of time. Some cultures, such as the Mayans in Central and South America, divided years into the equivalent of "months," albeit with names and lengths completely unlike the Julian (Sundstrom & DeBoer, 2012). Other systems were either lost to time or did not require grouping days. Despite variances between groups, most used celestial markers to measure the passage of time, with many going so far as to build structures that aligned with the sun on the solstices and other astronomical events. One group in North America used the star cluster Pleiades to mark the start of frost season (Anton, 2014). While not "calendars" in the sense of the Julian calendar, these systems nonetheless provided useful timing information and seasonal indicators to the people using them.

CULTURAL PERCEPTIONS OF SEASONALITY IN A TIME OF CLIMATE CHANGE

The known consequences of climate change effects, such as unpredictable weather patterns, seasons changing, severe storms, and sea level changes, are altering the way people live and work around the globe. At the same time, we use calendars that are fixed to a long heritage of practices and traditions connected to specific months, despite these months having little bearing on astronomical or seasonal

events. Especially among occupations that rely on seasonal patterns for their livelihood, climate change has altered centuries of land-based knowledge and expertise. In one study of farmers' perceptions of weather forecasting in Zambia, Kenya, and Jamaica, the majority of farmers stated that they believe weather is becoming harder to predict, and many do not use professional forecasts (Guido et al., 2021). Climate change and its disruption of weather patterns is challenging the accuracy of calendars and possibly changing how we perceive seasonal benchmarks.

There is substantial evidence that climate change is altering seasons around the world. One study across Africa on the timing of the rainy season showed that parts of the continent are experiencing the rainy season 5-10 days later than usual, with some up to 12 days late. Many areas are also experiencing shorter wet seasons with less rainfall (Dunning et al., 2018). These shifts in seasons highlight how drastically climate conditions are changing seasons. Another study from Benin showed similar results of shifting rainy seasons and the impact it had on maize farmers. They found that farmers are forced to begin land preparations earlier to be prepared for the possibility of the rainy season arriving sooner (Yegbemey et al., 2014). This underscores how changing precipitation severely impacts traditional seasonal tasks and how local farming must change in order to maintain crop yields. Harvesting seasons are also changing with climate change; studies in some locations have found that increased temperatures lead to changes in the yield of crops (Yang et al., 2021). Similarly, viticulture has seen noticeable changes in growing timelines; one study showed that "In Alsace (France), over a 70-year timespan, budbreak has advanced by 10 days, flowering by 23 days, véraison by 39 days, and harvest by 25 days" (van Leeuwen et al., 2019). Many different cultures and industries across the world have observed these shifts in seasons. Changes in yields can lead to food insecurity, one of many side effects of climate change with serious repercussions.

Beyond cultural identities, there are other groups whose livelihoods or geographies bring them in close connection with the landscape. They experience greater effects of environmental change, which decrease the usefulness of long-upheld calendars. Communities who closely interact with their environment are more likely to both notice and be affected by changing environmental conditions, even subtle ones. Some professions that hold these ties include farmers, beekeepers, fishers, and

hunters; all of whom rely on seasonal rhythms to be successful in their occupation. Communities relying on the ocean and tidal patterns may find their seasonal calendars altered by sea level rise. Because of environmental change, calendars that these people previously relied on have become unreliable for scheduling tasks tied to their occupations. Peak times for harvest may shift, migratory patterns of animals change, and seasonal indicators occur at abnormal times. An inability to utilize the predictive power of calendars that have historically been accurate can have profound effects on those who depend on it, their livelihoods, and others that depend on their work.

RELEVANT CASE STUDIES

In our preliminary research, we uncovered three case studies that are relevant to the work of the CALENDARS Project, all of which demonstrate the complexity of this type of study. The first case study described here examines local perceptions of the environment in Bangladesh, where climate change has eliminated two of the six local seasons. The second case study documented farmers' perceptions of weather forecasting in Zambia, Kenya, and Jamaica. Although not focused on seasons, this study examines regional perceptions and relationship to their climate and environment. The third study researches changes to rice planting seasons in Vietnam. These studies possess a similar goal to our project: understanding people's relationship and thoughts about seasons and climate.

CASE STUDY 1: SIX OR FOUR SEASONS? PERCEPTIONS OF CLIMATIC CHANGES AND COOPERATIVE ATTITUDES TOWARD FLOOD PROTECTION IN BANGLADESH

Researchers from the International University of Japan were seeking to compare residents' observations of climate change with data from climate research and relate this to a "willingness to pay" metric. This study took place in Bangladesh, a country predominantly comprised of low-lying areas and floodplains, making the region extremely susceptible to flooding and sea level rise (Islam & 小谷, 浩示, 2013).

Data collection for this study consisted of a written survey which was administered to 1,011 participants, mainly heads-of-household, around Dhaka. The majority of respondents stated that they had noticed changes to the local climate, especially a trend toward a four-season year instead of the 6-

season year that Bangladesh historically experienced. On top of this, the researchers found that those who observed the problem were more supportive ("willing to pay") of flood-mitigation projects in the region. Locals' observations, where they observed climate change effects, generally matched those of climate researchers and meteorological data of the time (Islam & 小谷,浩示, 2013).

This research is valuable because it explores perceptions of climate change impacts that have not been as clearly investigated in the past. However, by focusing on quantitative climate data instead of experienced seasons, this study does not offer much insight into the human relationship with calendars. A survey, while effective at garnering large quantities of responses, offers little opportunity for nuance in the answers; individual's relationships with the climate and calendar are ignored. Furthermore, by conducting a door-to-door survey that mainly interacted with male heads-of-household, the researchers did not collect information from a large subset of the population, leaving a significant number of perspectives unexplored (Islam, & 小谷,浩示, 2013).

CASE STUDY 2: PERCEIVED LINKS BETWEEN CLIMATE CHANGE AND WEATHER FORECAST ACCURACY: NEW BARRIERS TO TOOLS FOR AGRICULTURAL DECISION-MAKING

Another case study in Zambia, Kenya, and Jamaica investigated small farmers' trust in weather forecasts. The researchers sought to show changing perceptions of weather forecasting. These changes are due to climate change rendering traditional farming calendars inaccurate (Guido et al., 2021).

Figure 2 shows survey responses of farmers who did and did not use weather forecasts, comparing farmer's perceptions of the accuracy of weather forecasting (Guido et al., 2021). This shows a link between the perceived accuracy of weather prediction and farmers' use of weather forecasts. Farmers will be less likely to use a forecast they perceive as less accurate, illustrating how perceptions of weather forecasts impact their usage. The study concluded that the use of weather forecasting tools is low, and that the farmers acknowledge increasing unpredictability of the weather.

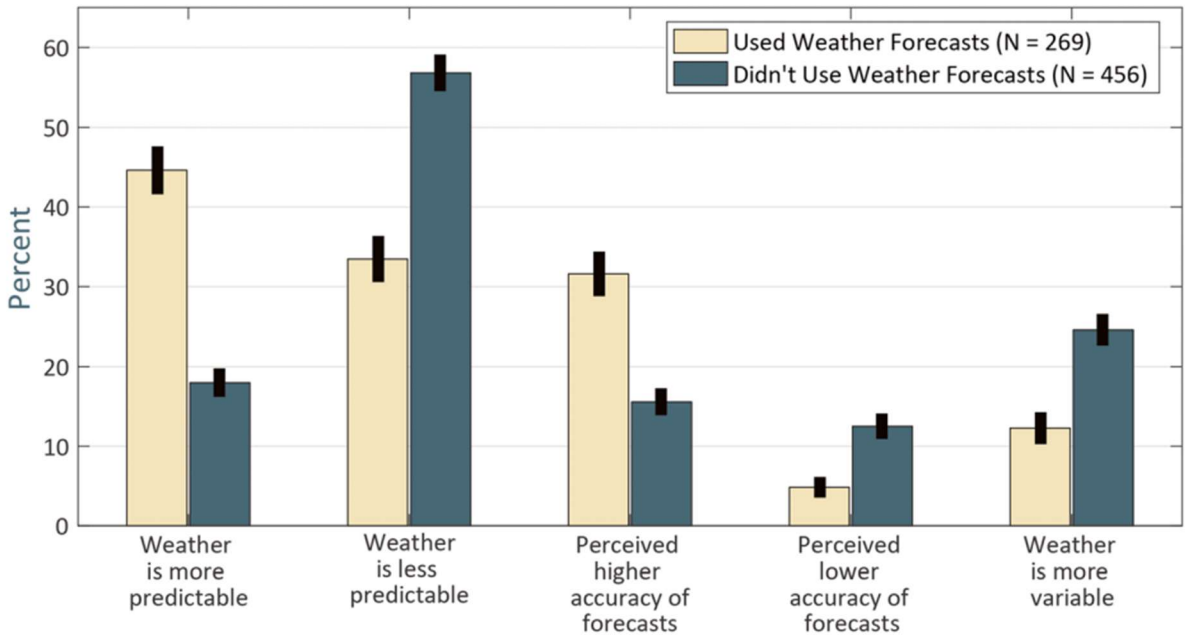

Figure 2. The perception of accuracy of weather forecasting and weather predictability among farmers based on whether or not the participant used weather forecasts (Guido et al., 2021).

This project is relevant to the CALENDARS Project because it is doing similar work with a different focus. While the CALENDARS Project focuses on perception of seasonal calendars, this study is focused on perception of weather forecasting in a time of climate change. Both studies investigate changes to personal perceptions, but this study concentrates on the perception of weather rather than that of seasons.

CASE STUDY 3: SHIFTING CROP PLANTING CALENDAR AS A CLIMATE CHANGE ADAPTATION SOLUTION FOR RICE CULTIVATION REGION IN THE LONG XUYEN QUADRILATERAL OF VIETNAM

Finally, a study conducted in Vietnam researched how to maximize yield of rice when the cultivation season is altered due to climate change. The objective of this study was to determine the best time for broadcasting (planting) rice crops in order to mitigate climate change impacts (Truong An, 2020). These researchers used FAO-AquaCrop, a crop modeling software, to mimic the rice crop yields utilizing different crop broadcasting calendars (Truong An, 2020).

The results of the model showed that delaying the cultivation process by 7 to 14 days in both the winter-spring and the summer-autumn cropping seasons would increase crop yield by 6.2% and

5.3%, respectively. The study concluded with a recommendation of shifting the cultivation season to better align with the seasons impacted by climate change to maximize harvests.

This study directly relates to the CALENDARS Project as it examines the effects of changing seasons on a particular industry, in this case rice farming. The rice industry could optimize its crop planting in response to the reduced yield caused by climate change. Following the same planting calendar each year will decrease the industry's production, but by understanding how the seasons are changing, this industry (and others) can better adapt in kind.

SUMMARY

As climate change continues to alter our seasonal rhythms, there is a potential mismatch between environmental conditions and their depictions in traditional calendars. We learned that some of the disconnect stems from the use of colonial calendars in inappropriate locations. In other cases, we found evidence that seasons may be inconsistent with customary calendar time by as much as two or more weeks. This creates a gap in traditional practices and cultural expectations and how we experience certain times of the year. The importance of the CALENDARS Project has become more evident through reading these sources; changing climate and fluctuating seasons are beginning to alter communities in a variety of ways. We can also see the impact of location on experiences of seasons and perceptions of seasonal variation, which we took into consideration while conducting our research. Finally, it is clear that this project aligns with the UN Sustainable Development Goal number 13: climate action. As such, this research is encouraging reflection on how climate change influences people's everyday lives.

CHAPTER 3: METHODOLOGY

The goal of this project is to document individuals' experiences and perceptions of seasons through calendars. We used a calendar tool to record individuals' perceived seasons, seasonal indicators, and experiences. Gathering this data from different sources allowed us to compare perceptions across different cultures, offering insights into how climate change alters people's relationships with natural seasonal patterns. To accomplish our goal, we identified three objectives:

1. Understand the experiences of viticulturists and their perceptions of seasons and climate change in New England and New Zealand
2. Document and map seasonal rhythms
3. Evaluate the extent of seasonal variation in relation to calendars

OBJECTIVE 1: UNDERSTAND THE EXPERIENCES OF VITICULTURISTS AGAINST THEIR PERCEPTIONS OF SEASONS AND CLIMATE CHANGE

To build an understanding of viticulturists' perceptions and experiences, we elected to conduct conversation-style interviews with individual viticulturists. To identify people willing to participate in interviews, we reached out to a large number of professionals in the wine industry. We wanted to see possible cultural connections to seasons so we decided to look in two different parts of the world, New England (and the surrounding area) and New Zealand. We identified these professionals with two methods: researching and contacting vineyards, and through a chain of contacts from our acquaintances at the WPI New Zealand project center. In addition, we utilized snowball sampling by asking our contacts to identify other individuals in the wine industry who they thought would be good candidates to interview. These processes provided a variety of participants with various roles and levels of experience in the field of viticulture.

We conducted open-ended conversational interviews with participants to build an understanding of their perception of seasons, seasonal variations, climate change, and their experience with calendars. Although we asked for only fifteen minutes from each interviewee to encourage responses, most interviews lasted upwards of thirty minutes, and longer could have yielded still more information. We prepared an informal interview guide with the goal of inspiring a conversation about

the individual's personal relationship with seasons (see Appendix A). These questions are open-ended in the hope that they will spur the respondent to think deeply about their relationship with the calendars they use and the seasons they experience. We chose questions that covered what we felt were the most important topics and used these to guide our interviews. These conversations helped us to see different individuals' perspectives on seasons which we compared among participants. Since this project was conducted during the COVID-19 pandemic, interviews with all participants were completed remotely via Zoom video calls. In order to study and revisit the information gleaned from interviews, we documented each conversation and recorded the Zoom exchanges when given oral consent.

OBJECTIVE 2: DOCUMENT AND MAP SEASONAL RHYTHMS

We created an online calendar tool (see Appendix D), inspired by the one created by our sponsors in New Zealand (see Appendix C). The online calendar tool offered interviewees the opportunity to express their unique experiences with seasons. We designed the tool to incorporate some aspects of a Gregorian calendar to help orient the participant, but included as few as possible to limit potential biases. The design of the tool was such that a participant can fill in important dates, time periods, and seasonal markers such that they align with the participant's perception. We designed this tool prior to the interview phase of the project, allowing us to use it in all of the interviews we conducted.

The calendar tool was designed to be accessible remotely or in person by delivering it via a website we created. On the website, there is an outline of the conventional twelve calendar months and indications of when the solstices occur. Although it is not circular, the user can scroll the calendar sideways. As the user continues scrolling, they will come back to where they started, creating the cyclical nature of the calendar tool that we wanted to include. When the user clicks on an area of the calendar, a text box appears in which they are able to create a season or place an event on the calendar. After they enter this information, they are able to click and drag a bar that appears below to indicate the duration of that particular season or event. In addition, there is a color picker that allows the user to differentiate between seasons or events using any color of their choosing. After the participant completes the calendar tool to their satisfaction, they click a button that says "submit," uploading their

calendar tool to a database. We collected no personal information. We were also able to calculate the approximate length of each season that they entered for data processing purposes.

At the end of each conversation, we explained the concept of the calendar tool to the participant. Then, we instructed them to fill it out based on their perceptions after the conclusion of the interview. Through the conversation beforehand, we inspired the participants to be more cognizant of their own relationship to seasons and seasonal rhythms. The participant could use examples from the conversations we had during the interview to complete their calendar tool, and the preceding conversation should have helped them think about seasons in a more open way.

OBJECTIVE 3: EVALUATE THE EXTENT OF SEASONAL VARIATION ACROSS CALENDARS

We concluded our project by analyzing the data we collected and producing relevant visualizations. The analysis provided further insight into how climate and seasonal change impacts individuals' perceptions of calendars. By studying viticulturists' experience of seasonal variation, the impact of climate change on their work and personal lives, and how they relate to seasons, we were able to evaluate some of the effects of climate change on viticulturists' livelihoods.

We compared the results from the calendar tool using metrics such as the number of seasonal cues, timing of cues, number of seasons, and lengths of seasons. We manually coded responses from the interviews and the calendar tool, and the calendar responses were compiled and subsequently analyzed in tandem with the interview responses. We also developed techniques for visualizing the response data for the purposes of data analysis and presentation.

CHAPTER 4: FINDINGS & OBSERVATIONS

We conducted interviews with fifteen viticulturists and winemakers from New Zealand and the New England, all of them from slightly different locations, backgrounds, and vineyards. These interviews offered insight into the year of a winegrower, the seasons they experience within each year, and how the seasons and climate where they work have changed over time. In this section, we compare different viticulturists' responses to our questions, the seasons they perceive, and other data we gleaned from speaking with these experts.

Figure 3. Approximate locations of each viticulturist we interviewed

In addition, we piloted the calendar tool with our WPI peers to gain further insight into the tool's effectiveness and our peers' seasonal perceptions.

VITICULTURISTS' SEASONS

Our main objective was exploring and understanding the perceptions and experiences of seasons in viticulture. The responses we received suggest that viticulturists generally agree on two overarching seasons that are determined by the grape life cycle: a growing season and a dormant season. However, we saw variation between the sub-seasons they observed, the indicators they relied on to delineate the seasons, and the prevailing conditions they experienced during all seasons.

Figure 4. A general timeline of events of a viticulturist's year based on calendar tools and interviews. It depicts two overarching seasons.

Most of the interviewees stated that their year was best described by two predominant seasons, growing season and maintenance season, as seen in Figure 4. These are defined by the growth and

maturation of the grapes during the warmer growing season and the vines remaining dormant during the colder maintenance season. During the growing season, the grapes must be tended to—activities during this time include watering, monitoring, pesticide application, disease prevention, and some pruning—which are completed to ensure that the grapes develop to the best flavor before harvest. After harvest is complete, the vines must be pruned and maintained during their dormancy. Winemaking is a priority during this time; however, maintenance of equipment and structures occur in tandem. The order of tasks within each season varies by vineyard—either by preference of the managers or the local climate—but these same tasks must be completed everywhere and the phases the vines experience are nearly universal.

In both regions, people felt that choosing a "start" and "end" of the year failed to address its naturally cyclic nature. Most individuals described the year as rolling and continuous, characterized by the absence of an off-season, making it difficult to define a start or end date. When urged to provide an answer, many interviewees concluded that the transition from harvest to pruning was the most drastic transition of the year. This is because their routine changes significantly between attending to the maturing grapes in the growing season, and maintaining equipment and making wine in the maintenance season, as seen in Figure 5.

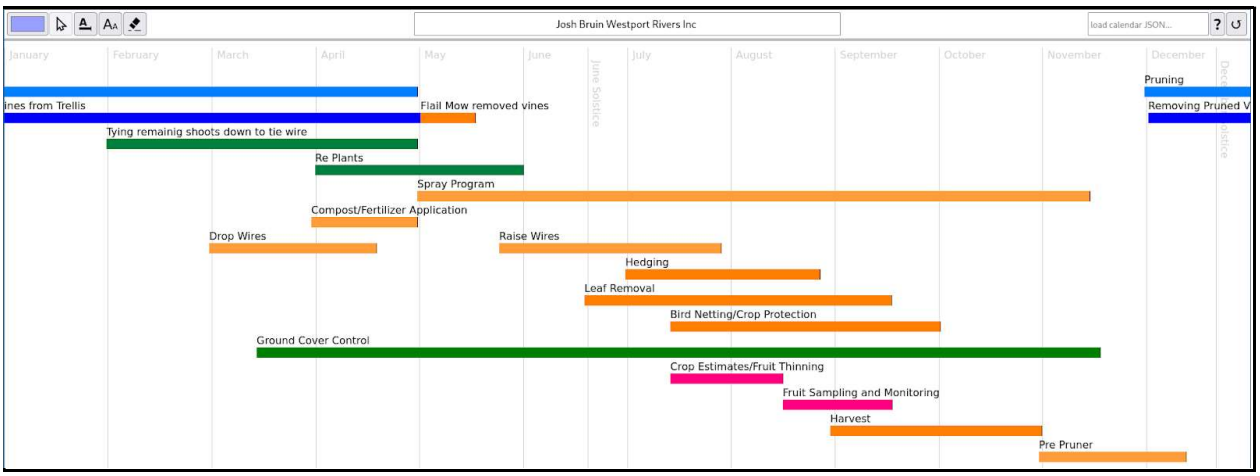

Figure 5. Visualization of the transition between preharvest and postharvest occurring in November at Westport Rivers Vineyard and Winery.

While individuals' answers and timelines of events varied, it was clear that their years and perceptions are predominantly shaped by their crops. As we spoke to viticulturists and winemakers, it became evident that their perceptions of seasons were largely dependent on the natural seasonality of vineyard maintenance. For this reason, calendars have little influence over viticulturists' perceptions of seasons; instead of using established dates, they observe their crops to delineate between seasons. Events throughout the year, such as pruning, bud burst, bloom, and harvest, serve as key seasonal indicators. Some viticulturists perceive the beginning of spring as when they first notice sap flowing, or that winter starts when it becomes time to prune (Nico Kimberly, personal communication, February 3, 2022). Because the year-round nature of winegrowing necessitates constant interaction with the vineyard, it in turn imparts an influence on the viticulturists' understanding of seasons outside their profession. It is doubtless that these individuals observe other seasons, and some mentioned additional seasons in their responses, but they focused on vineyard-related seasons during the interviews.

Viticulturists in the New England area described a variety of seasonal benchmarks throughout the year. In conjunction with the universal growing/dormant seasons, growers described a spring characterized by temperature variations, and a long fall with warm days and cool nights that encourage grape ripening. Different areas of New England receive different amounts of snow during various periods in the year, making the "snowy season" dependent on location (Figure 6). One interviewee even described the quintessential New England "syrup season," where they tap maple trees in the area surrounding their vineyard.

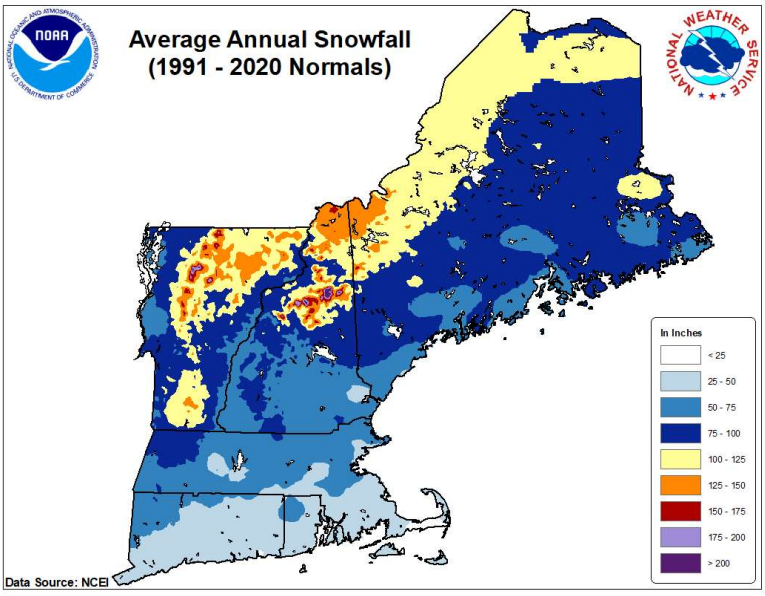

Figure 6. Average annual snowfall totals 1991-2020 across New England (National Centers for Environmental Information - National Oceanic and Atmospheric Administration).

The viticulturists we interviewed in New Zealand generally agreed that beside the growing and dormant seasons, the country experiences roughly four seasons, much like New England. However, these seasons are less distinct from each other than in other regions; winter only *tends* to be cooler and summer *tends* to be warmer, but spring can sometimes be identified by prevailing winds (James Bowskill, personal communication, January 27, 2022).

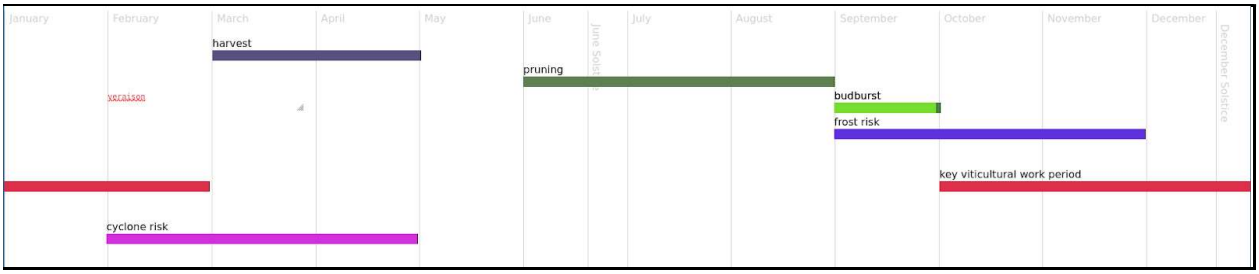

Figure 7. Calendar from the general manager of sustainability at New Zealand Wine Growers, depicting the cyclone season from February to May.

New Zealand also experiences a "cyclone season" (as seen in Figure 7), the time of year when the country can experience tropical cyclones. Many viticulturists we interviewed expressed concerns regarding the cyclone season. Because it coincides with the final ripening of the grapes, severe weather can destroy the entire crop. To combat this, vineyards may elect to harvest their grapes ahead of anticipated cyclones arriving to ensure they do not lose their crop (Jess Wilson, personal communication, February 3, 2022). Because the winter months are generally warmer in New Zealand than in New England, several New Zealand viticulturists prune throughout the winter, unlike in New England where some vineyards need to pause pruning due to inclement weather.

CALENDAR TOOL

The calendar tool we developed presented the opportunity to visualize seasonal perceptions our interviewees verbally described. Some tool responses even included further reflection from the respondent after the interview. These visualizations offered further insight into individuals' responses, which allowed us to quickly grasp individual's seasons. For example, one United States respondent included "Black Fly" and "Maple Syrup" seasons, seen in Figure 8. Although they mentioned these during the interview, entering them in the calendar tool offered the opportunity to collect additional

information regarding these unique seasons—they both occur in New England "spring"—with syrup season spanning the duration of March, and Black Fly season spanning from the beginning of May until halfway through June.

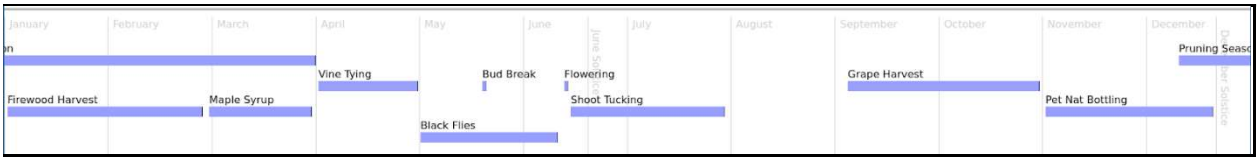

Figure 8. This calendar from a viticulturist shows Black Fly season and Maple Syrup season.

The graphical representation of each viticulturist's year allowed us to compare them side-by-side, offering unique visualizations of the data that would be impossible with only interviews. All the viticulturists we interviewed described a pruning season and harvest season, both essential stages in grape growing. Based on the tool responses, we were able to construct graphs illustrating the times in which these seasons generally occur. In New Zealand, pruning occurs around July, but extends into the surrounding months. In the United States, there is much more variation of when pruning occurs and how long it lasts (this is most likely due to differing climates within the region we studied).

Figure 9. Instances of "pruning" on the calendar tool responses, overlaid. The thickness of the green bar represents the frequency of tools that described the indicated period as "pruning season." Note the two separate groups of responses: These correspond to the two regions.

Figure 10. Instances of "harvest" on the calendar tool responses, overlaid. The thickness of the gold bar represents the frequency of tools that described the indicated period as "harvest season." Note the two separate groups of responses: These correspond to the two regions.

Conversely, "harvest season" for the respondents showed little variation within each region, stretching for around two months in most cases. The New England and New Zealand vineyards we consulted seem to harvest approximately six months apart from one another. The single response that stretches from September through January came from a respondent who described a "harvest & winemaking" season; they perceive the two actions as so intertwined that they do not define them as separate seasons.

We were also able to aggregate the responses to acquire a view of how the whole group's perceptions vary over the course of a year. The graphs below show the tool responses from each region: the height of the graph at each point represents the number of seasons respondents labeled at that time. The colors were chosen by respondents when marking the seasons. New England viticulturists described the most seasons in April, July and August, and fewer in the colder months. We received fewer responses from the New Zealand viticulturists— resulting in a lower maximum amplitude—but they follow a similar trend, with more labeled seasons in the warmer months than the colder months.

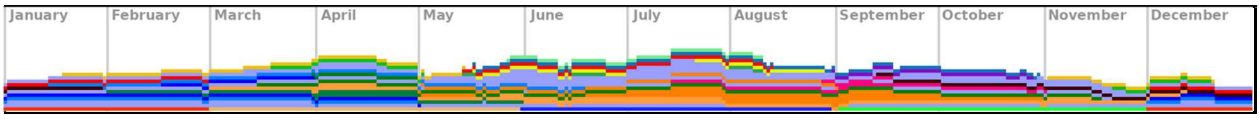

Figure 11. Compiled calendar responses from New England viticulturists. Height represents the number of seasons labeled in that time period.

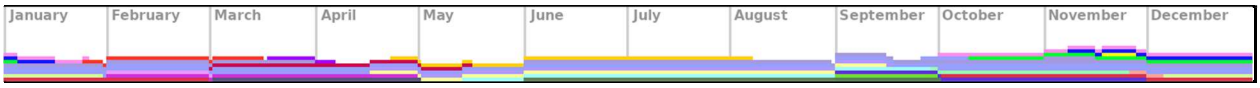

Figure 12. Compiled calendar responses from New Zealand viticulturists. Height represents the number of seasons labeled in that time period.

SEASONS IN THE CONTEXT OF CLIMATE CHANGE

The status of grape vines throughout the year is tied to the climate where they grow. Events such as bud burst are almost chiefly dependent on the average air temperature, and the speed that grapes mature is related to the temperature and the sunlight the vines receive. As climate change alters when these events occur, viticulturists' perceptions of the seasons change in concert. For example, if bud burst usually marks the beginning of spring, and it occurs two weeks earlier than it did 10 years prior, then the viticulturist might perceive the start of spring to occur two weeks earlier than it had 10 years before.

Gauging the extent of climate change in New England can be difficult because of the area's naturally chaotic weather. Although climate change certainly impacts New England, many winemakers and viticulturists we interviewed felt it was difficult to discern a difference between New England weather (which is naturally variable and unpredictable), and climate change induced variations. Despite this, many agreed that in recent years there has been a warmer and more gradual transition of summer into autumn—a welcomed change for some winemakers. Warm and mild autumn seasons are favorable for grape growing and allow wines to develop more complex flavors (John Nunes, personal communication, January 25, 2022). However, warmer weather can also be detrimental to vineyards because it creates a more suitable environment for disease. Moreover, viticulturists generally agreed that winters are becoming more mild. Despite this, they also acknowledged that occasionally New England winters are harsher than historical extremes, adding yet another possibility that they must plan for. Furthermore, the changing climate may also affect the migratory patterns of certain birds that are known to eat grapes, which can alter the number of grapes being lost to birds (John Nunes, personal communication, January 25, 2022).

Many people with long-term experience in vineyards reported that they have witnessed an increase in weather variability and unpredictability as climate change has progressed. As the weather

becomes more variable, viticulturists are forced to change their practices to ensure they can still produce wine. A few viticulturists in New England referenced planting hardier varieties of grapes to better withstand harsh winters, while other individuals opt to protect their grapes from the cold weather. Because the vines are very sensitive, summers that are too mild, dry, or wet may have devastating impacts on the grape harvest. For example, particularly wet seasons can cause more diseases to spread throughout the vines. This is especially dangerous during the pruning season because severe weather of any variety can easily damage a large portion of a vineyard's crop. These types of events have always plagued farmers, but there is widespread agreement among the growers with whom we spoke that these events are becoming more common.

Grapes, like all plants, reflect the status of the environment in which they are growing (Jeff Sinnott, personal communication, January 30, 2022). For example, the warming climate accelerates the grape growing process, as there are more viable growing days when the mean temperature is higher. In Hawke's Bay, New Zealand, the fruit has been ripening three or four days earlier every year for the past ten years. This year, in Marlborough, NZ, harvest is beginning a month earlier than it did twenty years ago (Jeff Sinnott, personal communication, January 30, 2022). These changes demonstrate the impact environmental change has on seasons and seasonal perception.

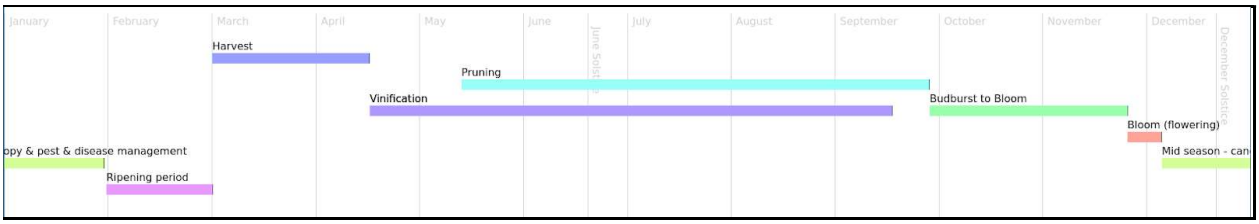

Figure 13. Harvest beginning in early March this year is an entire month earlier than 20 years ago.

The New Zealand viticulturists we interviewed were in agreement that summers are becoming hotter and dryer, and the risk of a spring frost destroying the crop is increasing. Vineyards that previously did not have frost management infrastructure because it was unnecessary, are now investing in frost fans to protect their grapes (Jess Wilson, personal communication, February 3, 2022). During the harvest season in New Zealand, the risk of tropical cyclones is at its highest. To mitigate the risk, one vineyard redesigned its entire receiving area so the harvested grapes can be collected and stored as

quickly as possible in the event of an incoming cyclone (Jess Wilson, personal communication, February 3, 2022).

Moreover, nearly everyone we interviewed felt that the frequency of extreme weather events has been increasing, and that the climate has become much more variable overall. Many United States and New Zealand vineyards also reported both harvest occurring earlier and the growing season becoming shorter. New Zealand's overall harvesting season used to be about six weeks nationally, but it has decreased to three or four weeks (Ed Massey, personal communication, January 31, 2022). Both regions expressed concerns about late frosts, which have the potential to kill a crop as it comes out of dormancy.

Many vineyards are attempting to mitigate the effects of irregular frosts by implementing new practices, such as utilizing fans. In places with more extreme cold, geotextiles are used to cover the vines in the winter after they have been pruned and aren't removed until the risk of frost has subsided in the spring.

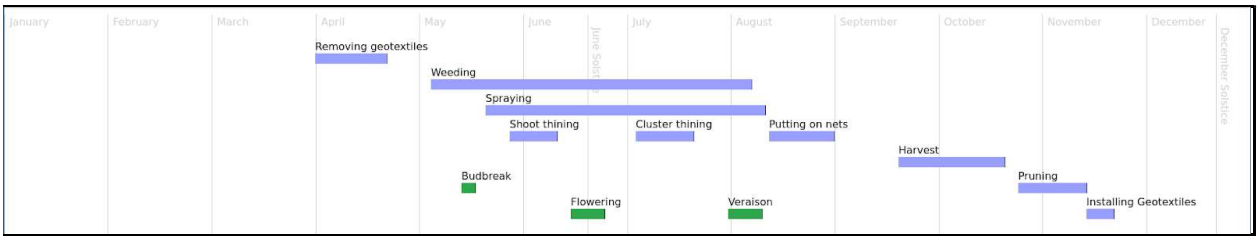

Figure 14. Geotextiles cover the vines starting in mid-November until they are removed in April. Almost no activity can take place in the vineyard during this time.

In places that are experiencing unprecedented hot and dry spells, many vineyards have been installing previously unnecessary irrigation systems and/or retention ponds. While the changing climate may force smaller vineyards to start planting new varieties that are better suited for their new climate, such as hybrids, larger vineyards may take a different approach. In one case, research is ongoing to selectively breed and force mutations in the Sauvignon Blanc grape variety so they are able to continue producing the same variety while planting hardier grape vines (Jeff Sinnott, personal communication, January 30, 2022). Moreover, disruption of the historically documented climate may be altering the flavor of the wine. For this reason, some vineyards may elect to mix other varieties into

their Sauvignon Blanc to retain a similar flavor profile, as only 85% must come from the variety a wine is labeled as (Neill Culley, personal communication, February 1, 2022).

ADDITIONAL FINDINGS

SUSTAINABILITY

Sustainability was a common theme across almost all of the interviews we conducted. Although viticulturists' specific sustainable practices differed, there were many common goals, such as limiting tractor passes through the vineyard. A common way to achieve this is allowing livestock to graze through the vineyard in the winter months (Bart Arnst, personal communication, February 8, 2022). Some vineyards in the New England area are beginning to adopt this practice from New Zealand. By integrating grazing animals like sheep, vineyards reap the benefits of less tractor passes for mowing, less soil compaction, nutrient cycling with natural fertilizer, and aeration (Ethan Joseph, personal communication, January 27, 2022).

The viticulturists' widespread focus on increasing sustainability practices illustrates their recognition and understanding of the impacts of environmental change. Many individuals are employing these techniques in response to the seasonal change they are observing. We can deduce that because they are taking initiatives to address climate change, they feel that it can and will have lasting impacts on their industry and the world as a whole.

Figure 15. Word cloud illustrating the most commonly used words during interviews.

Figure 15 creates a visual representation of the concepts that were most prevalent during interviews. The size of each word corresponds to how frequently it was used

over the course of the interviews. The inclusion of words such as “risk,” “extreme,” and “change,” are indicative of the emphasis that was placed on these topics throughout the interview. These words provide further insight into the most important topics regarding impacts of environmental change on seasons. It is evident that these individuals are perceiving more extreme seasons that impose a risk on their vineyards, and they are taking action to mitigate these risks.

CALENDARS

It was clear through their responses that viticulturists do not depend on any established calendar system to plan future actions. By following natural indicators from the grapes, they are able to stay perfectly in tune with the needs of their crops without any outside inputs. However, all of the viticulturists we talked to still used the Gregorian calendar in a role more akin to timekeeping. Because the Gregorian calendar is the global calendar standard, our respondents still use it for communicating dates, describing the timing of recurring seasons, and dictating business relations. They also document seasonal information in Gregorian dates, which allows them to compare events across years and track changes in the grapes' rhythms over longer periods of time.

WPI STUDENTS' CALENDAR TOOL RESPONSES

As we developed and refined the calendar tool, we asked a group of our peers to provide responses. Our goal was to test the usability of the website and to obtain more unique responses; we prompted respondents to include as many seasons outside of the "traditional" four as they could. Unsurprisingly, this provided us with a huge variety of responses. Some people had an overarching theme to their year, like the calendar in Figure 16, that is mainly focused on running, while others compared seasons between locations important to them, as seen in Figure 17. These responses depict how people use the calendar tool without an accompanying interview, and the tremendous variety of the responses is promising for the tool’s ability to generate and depict useful information.

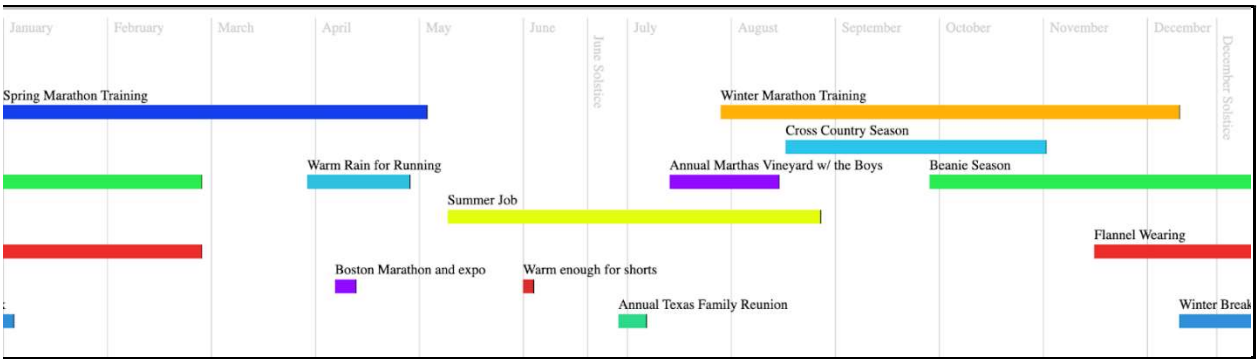

Figure 16. A calendar tool response heavily focused on running.

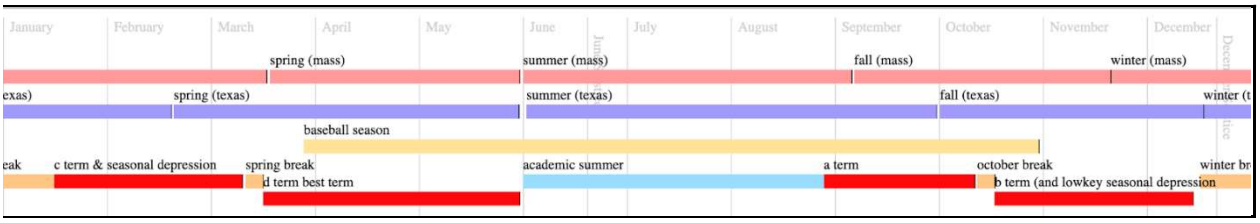

Figure 17. A calendar tool response differentiating between seasons at home in Texas and at school in Massachusetts.

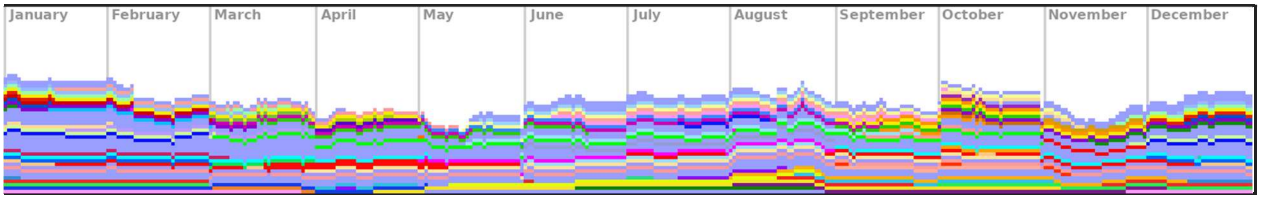

Figure 18. Compiled calendar responses from our peers. Height represents the number of seasons labeled in that time period.

Figure 18 shows the number of seasons represented across all of the calendar tool responses from our peer test group. This group identified the most seasons in January and October, and the least in early May. Aside from the "spooky season" that spans October, there is little consistency between the lengths or labels of seasons between different respondents. This is likely a result of the respondents' differing backgrounds and our asking them to be as creative as possible. The quantitative nature of the tool responses allows us to deduce more patterns within the responses, while it also begs more questions. One observation of interest is that the majority of seasonal borders in the responses also lie on the transition between two months: Are Gregorian months so ingrained in the respondents' minds

that they fit their perceived seasons to them? Or did we accidentally prompt this behavior by labeling the months? Both the individual responses and their aggregation offer a significant amount of information from perspectives with no relationship with vineyards.

CHAPTER 5: RECOMMENDATIONS

In this chapter we provide insights and suggestions for others conducting similar research in the future. In doing so, we reflect on our experiences and highlight the processes we used, how our tools can be reused, and additional methods we thought of but did not execute.

SUGGESTIONS FOR FUTURE RESEARCHERS

Although it is not always feasible, we recommend conducting interviews in person, as this improves communication with the interviewee and gives them a better understanding of the project. The conceptual nature of the CALENDARS research is complex, necessitating clear communication between parties during interviews. Meeting candidates in person allows for more nuanced communication and gives both parties a better understanding of the other. Conducting online interviews may also introduce the possibility of technical difficulties, as well as making nonverbal cues more difficult to read, further compromising connections with participants. A more engaging discussion with the participants also increases the likelihood they will be willing to share their colleague's contacts, enabling snowball sampling.

Researchers executing similar research should budget a significant period of time (ideally at least one year) for the project, allowing them to comfortably work around participants' schedules. More time allows researchers to reach out to more potential interviewees and accommodate their schedules. Researchers should also aim to conduct the majority of their interviews during the off-season of their institution of interest. Because viticulturists are most busy in the spring, summer, and early fall, winter is the best time to contact them; the longer the study has to conduct interviews, the easier it is to meet with interviewees at a time convenient for them. A longer timeframe also gives the interviewee time to reflect and update their response and provides the opportunity to follow up with interviewees during different parts of the year. Methods of maintaining contact include follow up interviews, regular check-ins, or a calendar tool meant to be revisited as the year progresses.

Future research could also benefit from longer interviews utilizing more direct questions. The planned length of an interview influences its overall structure, including the level of detail in participants' responses, as longer interviews provide the opportunity to discuss topics in greater depth.

A longer interview would allow researchers to place more emphasis on seasonal experiences outside the four conventional seasons. This type of abstract concept may require more discussion before the participant fully understands it; longer discussion should provide better information to the interviewer. Complex concepts would benefit from more direct questions, as discussions may never naturally drift to more abstract topics.

FUTURE OF THE CALENDAR TOOL

We highly recommend that future researchers utilize and improve the calendar tool, as our use of the tool demonstrated that it is effective enough to be used for future projects related to calendar perceptions. Because the calendar tool is web-based, it can be used remotely from any location, and it requires minimal instruction to use. Therefore, it can easily be used to collect data from a large sample. In addition, it could be used to collect initial data from an interviewee prior to meeting with them. This initial data may be compared to a physical calendar tool that the participant completes over the course of a year, enabling researchers to draw a comparison between the interviewee's instantaneous perception of the year and their experience living through it.

The tool is open source, giving anyone the ability to both use and modify it as they wish. Researchers with different needs could change the user interface and types of data recorded. Future researchers may consider adding other features to the tool, such as the ability to sketch or upload images, enhancing the types of data that can be collected. Although there is other surveying software available that could be adopted for use in calendar research, we recommend the in-house tool, as this allowed us to tailor it to represent information precisely how we wanted. We also continued to revise the tool and how we used it throughout the duration of the project, as in-house development allowed for easier continual improvement.

If others end up using the tool, we recommend exploring a variety of methods for analyzing and visualizing the responses collected. The tool offers data in a concrete form that is more conducive to visualization and larger-scale data processing. We only scratched the surface of what can be done; other analyses could include comparing responses across cultures, changing how the year is presented,

exploring the colors participants used, or mapping the responses onto different representations of the year. More time and thought will elucidate further patterns and information.

CHAPTER 6: CONCLUSION

Our research confirms that at least some perceptions of seasons are changing. Beyond collecting data, the project is designed to encourage people to reflect upon concepts, such as seasons, they would normally ignore. Accordingly, this project also provided evidence of changing seasons clashing with traditional calendars, as substantiated by significant shifts in harvest seasons. People who care about these institutions but do not see the changes within their own lives are offered a new perspective on the issue. In addition, by sharing our research with our participants, we are also increasing awareness of seasonal variation within the winemaking industry. In this way, our research offered introspection to both viticulturists who we worked with and others outside the industry who were unaware of the aspects we researched.

This research acted as a pilot project for the larger-scale CALENDARS Project and attempted to establish ways to accomplish a similar goal within a shorter timeline. As well as conducting the first CALENDARS Project research in North America, our project used strategies and processes that the larger scale project has not, such as the online calendar tool we developed, which could be of value to their research going forward. As the CALENDARS Project continues toward its goal, we hope its researchers can apply some of our experience and tools to their research as seasonal change continues.

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APPENDIX A. SAMPLE INTERVIEW QUESTIONS

I) Background Questions

· What is your role at your vineyard?

· How long have you been in this job/profession?

· What drew you to viticulture?

· How long have you lived here?

II) Overview impressions of a calendar year

· What does a typical year look like for you?

· When does the year start/finish?

· How would you describe your year to a visitor from outside your area and profession?

III) Seasons & Seasonal frameworks

· How do seasons fit into the year for you? When do they occur? (What season are we in now?)

· What are the different seasons associated with in terms of key markers, events and routines/rituals?

· What is the seasonal calendar of the viticulture industry?

IV) Seasonal practices and adapting to change

· How does your job change between seasons? What are the key timings of the transitions?

· Have there been any changes to the nature and/or timing of seasons resulting from climate change?

· What has been the response/changes within the industry or on a smaller scale – if any?

· What do you see as key issues for the future of the viticulture industry?

V) Calendar tool

APPENDIX B. THE NEW ZEALAND CALENDARS PROJECT CALENDAR TEMPLATE

APPENDIX C. CONSENT SCRIPT FOR ZOOM INTERVIEWS

[Prior to starting the recording]

“We are a group of students from Worcester Polytechnic Institute (WPI) in the United States. We are conducting interviews to learn more about experiences and perceptions of climate change. Your participation is voluntary. Do we have your consent to record video and audio of this interview? Your consent can be revoked at any point.”

[Start recording]

[State the interview number and date.]

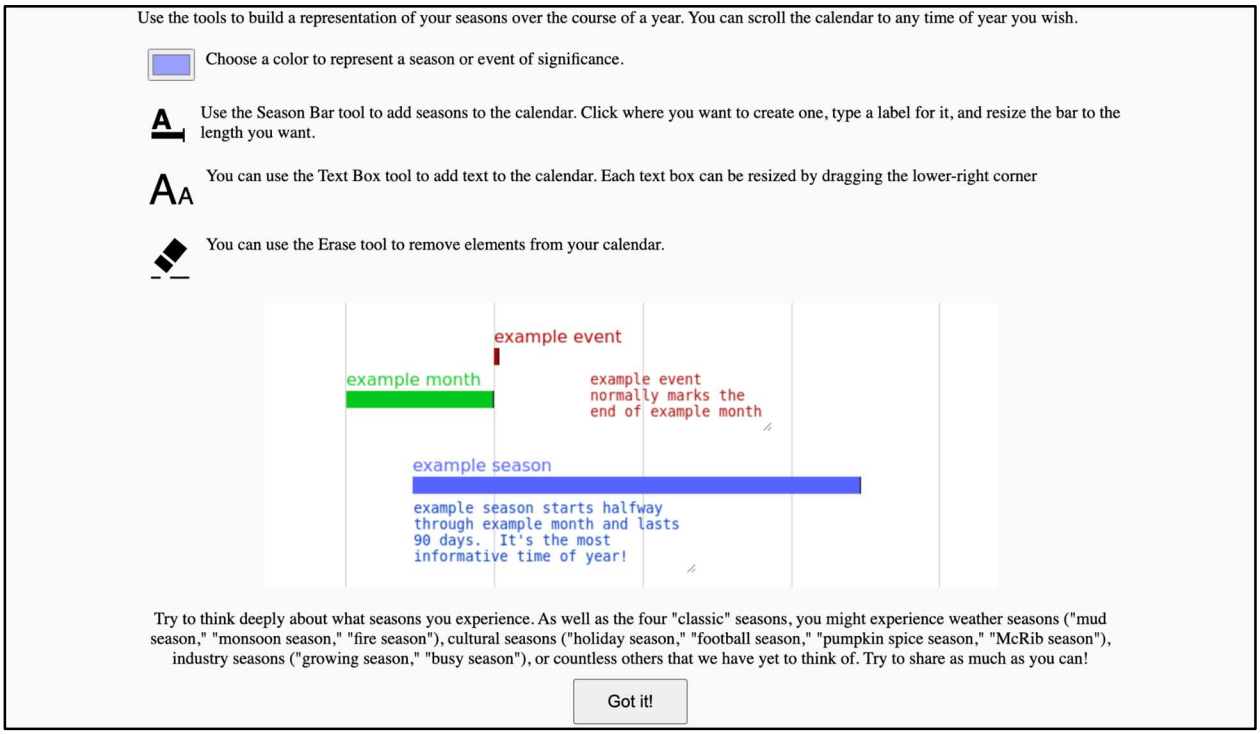
"Thank you for having this conversation with us, [address the participant]. To confirm, we have your consent to record this conversation and include its contents in our report which will be publicly available. Correct?"

[Wait for their response.]

"Thank you. Remember that you are free to revoke your consent at any time."

[Begin asking interview questions.].

APPENDIX D. CALENDAR TOOL

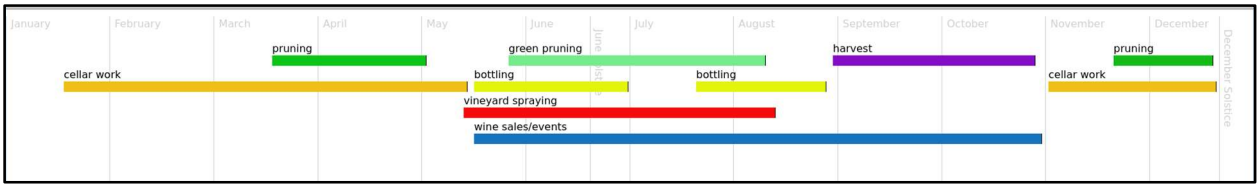


The finalized instructions we used to prompt our participants, which were adapted throughout the process.

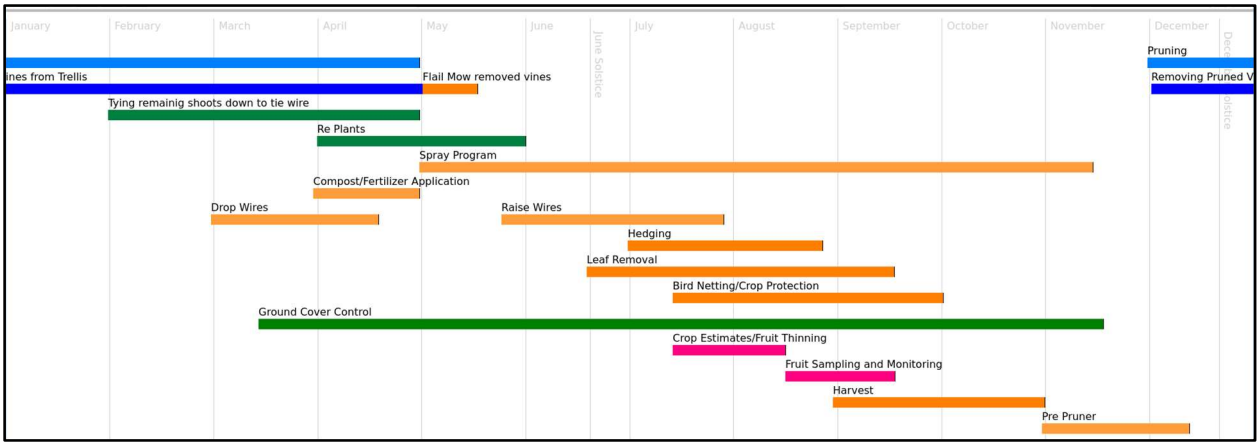
A blank calendar tool

APPENDIX E. CALENDAR TOOL RESPONSES (VITICULTURISTS)

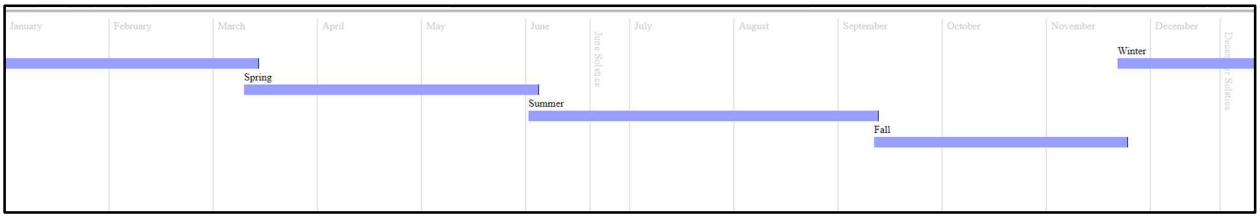
NORTHEASTERN NORTH AMERICA RESPONSES:



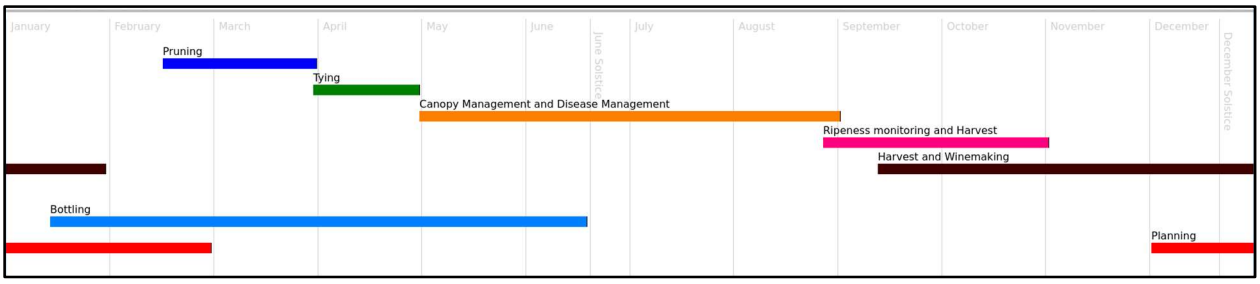
Snow Farm Vineyard, South Hero Vermont, USA



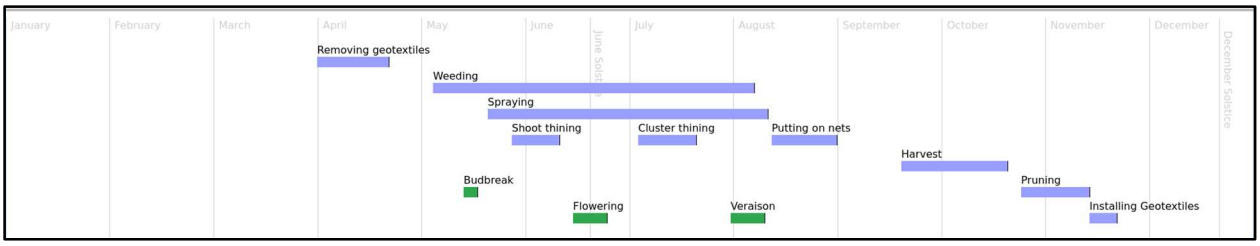
Westport Rivers Inc, Westport Massachusetts, USA



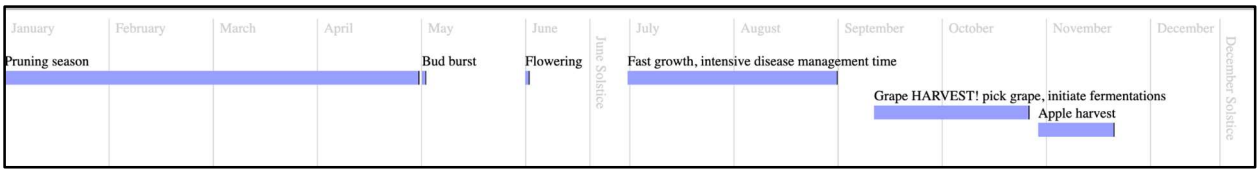
Shelburne Vineyards, Shelburne Vermont, USA



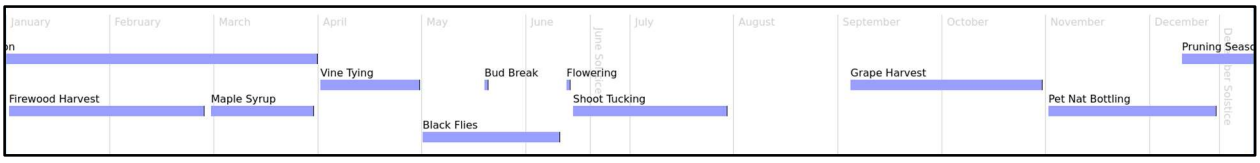
Silver Thread Vineyard, Lodi New York, USA



Domaine du Nival, Les Maskoutains Québec, Canada

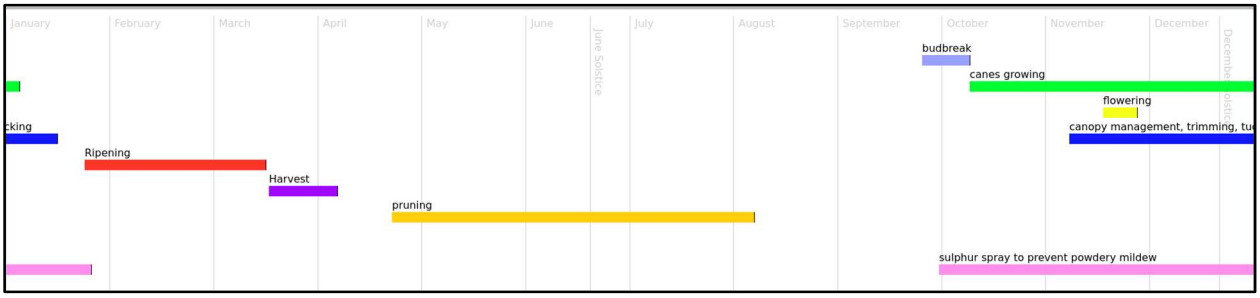


NOK Vino, Concord New Hampshire, USA

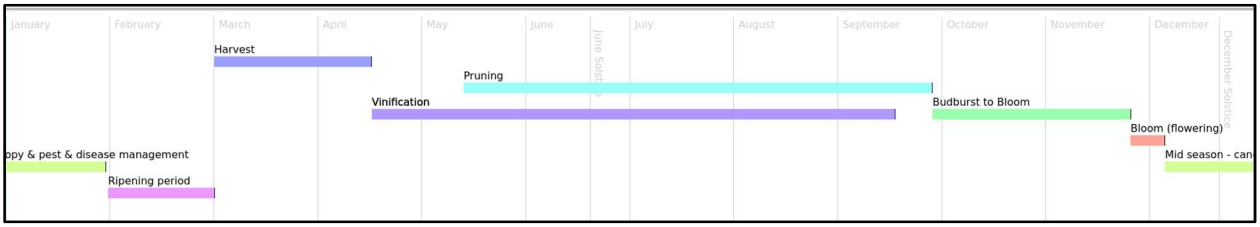


Oyster River Winegrowers, Warren Maine, USA

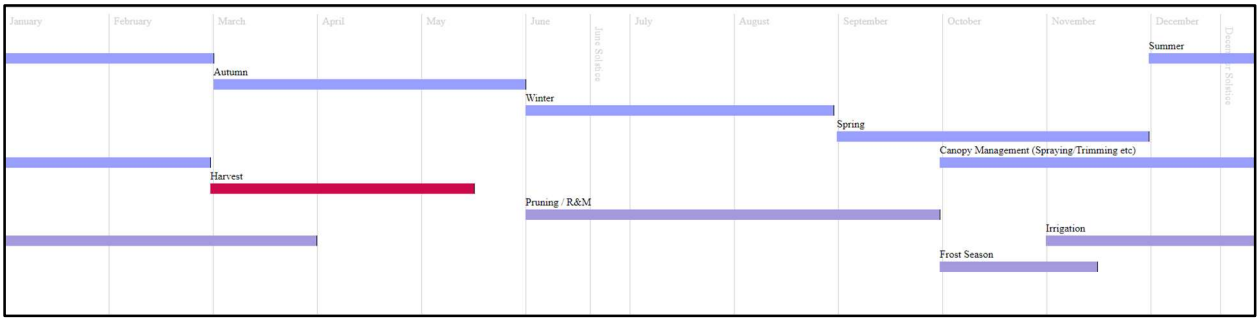
NEW ZEALAND SOUTH ISLAND RESPONSES:



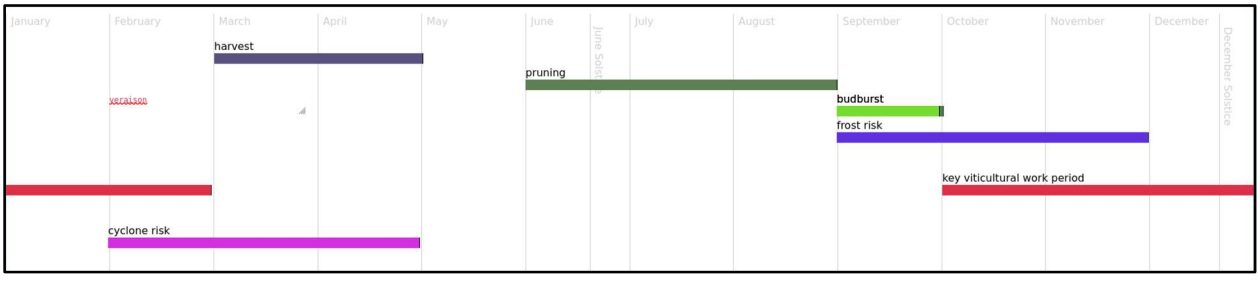
Maori Point Wines, Central Otago, New Zealand



Ostler Wines, Kurow, New Zealand

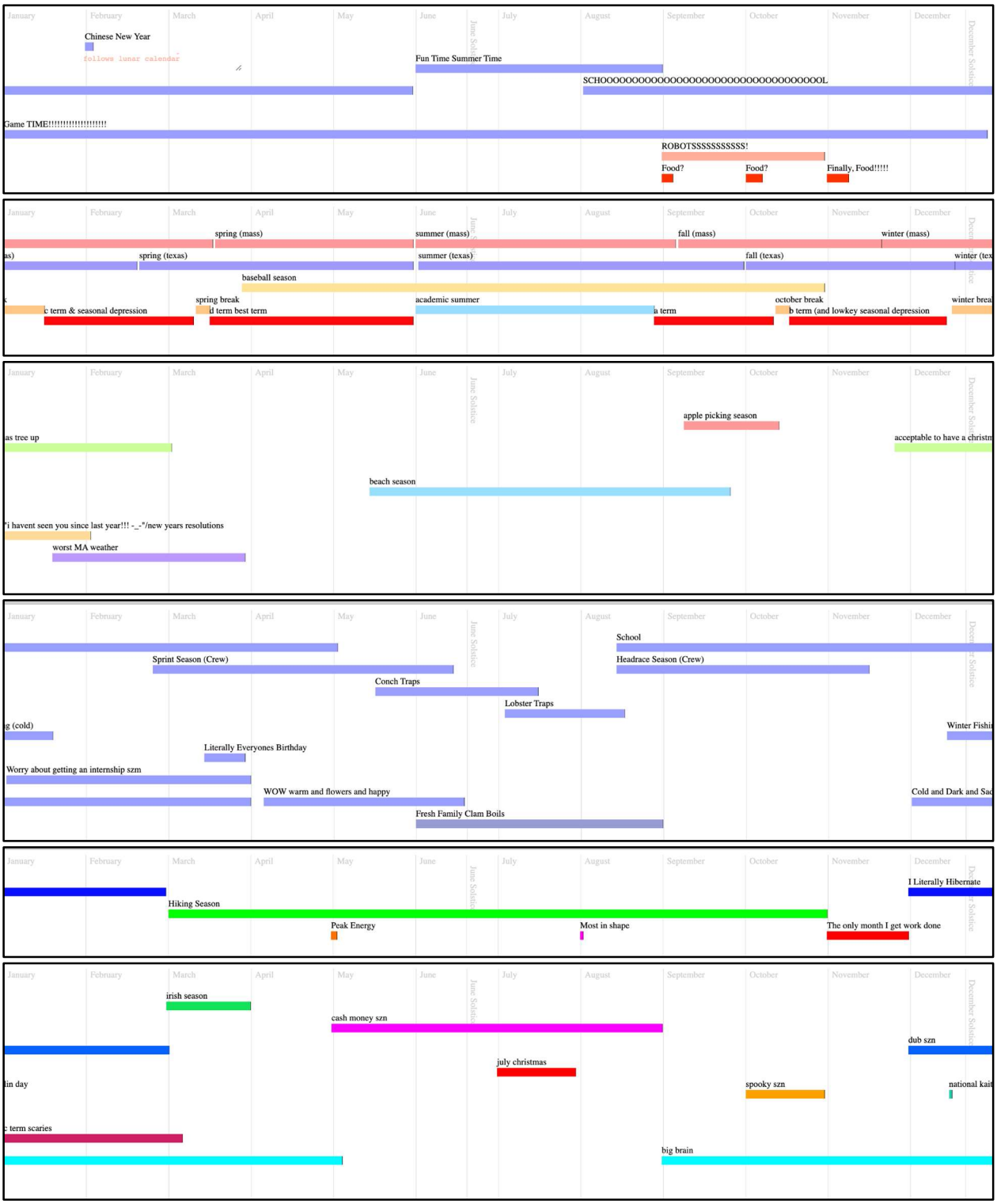


Framingham Wines, Renwick, New Zealand

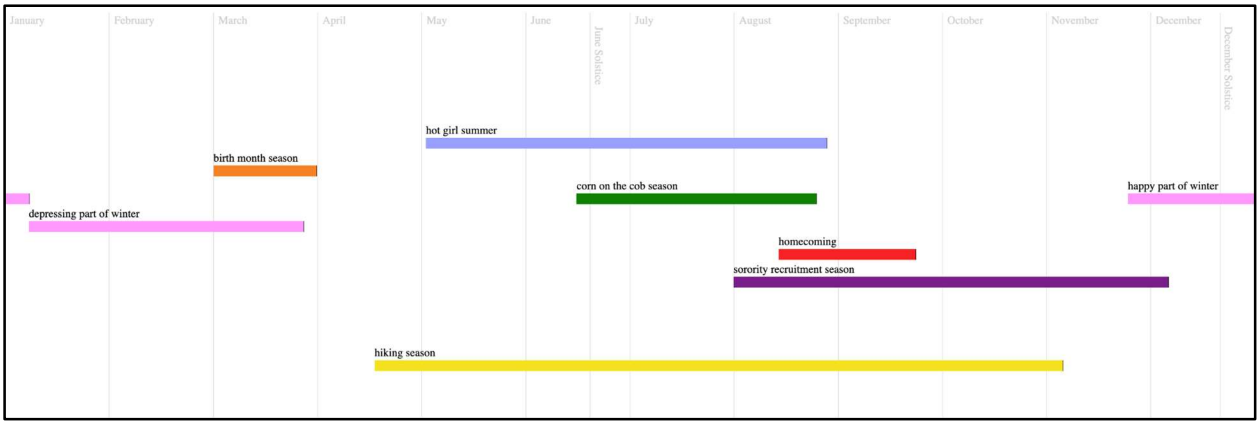


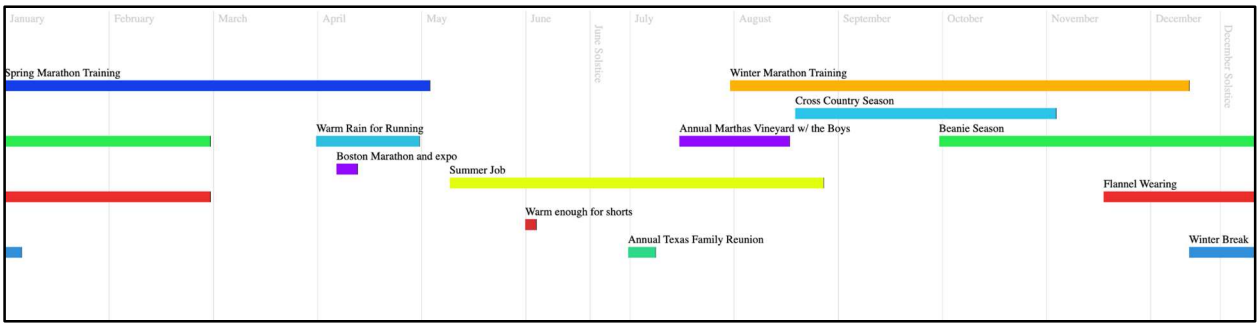
General Sustainability Manager of New Zealand Winegrowers, Marlborough, New Zealand

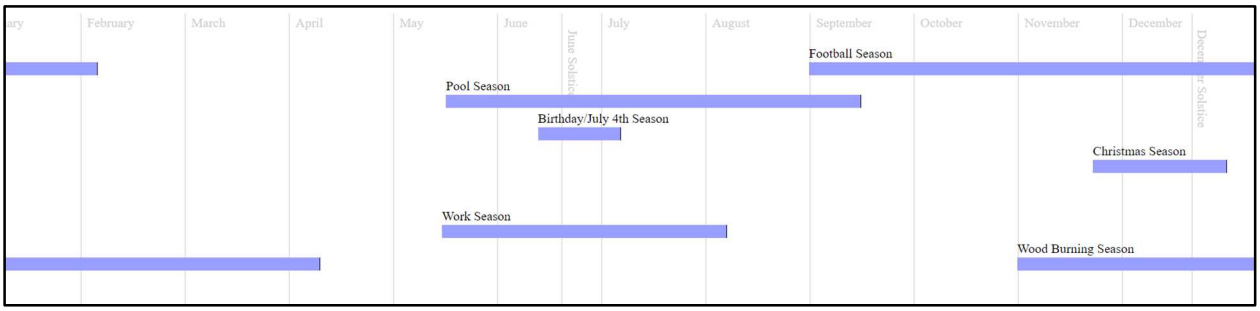
APPENDIX F. CALENDAR TOOL RESPONSES (WPI PEERS)

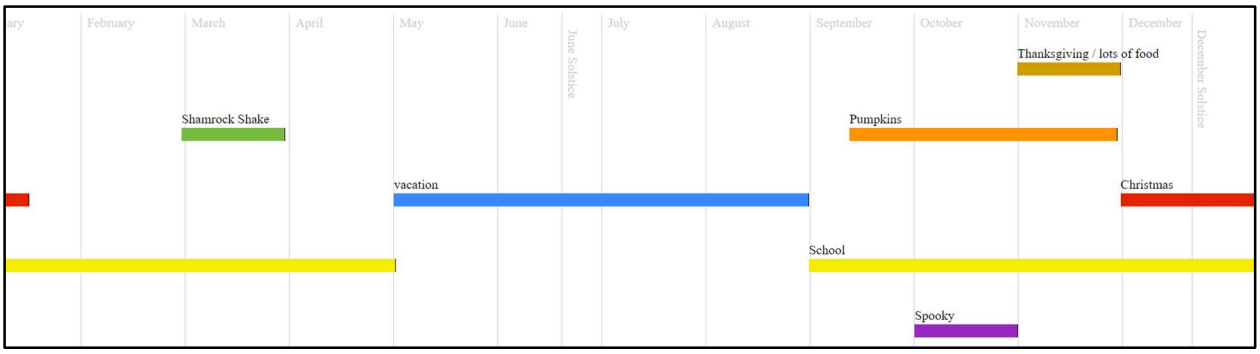


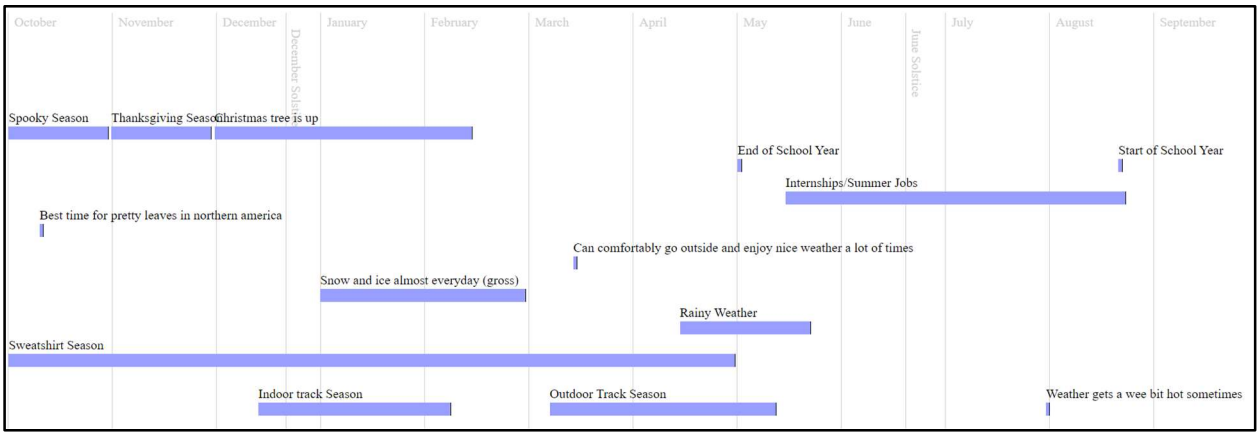

January
February
March
April
May
June
June Solstice
July
August
September
October
November
December
December Solstice
my birthday
valentines day
st pattys day
baseball opening day
warm
4th of july
its too hot
back to school
halloween
thanksgiving
xmas

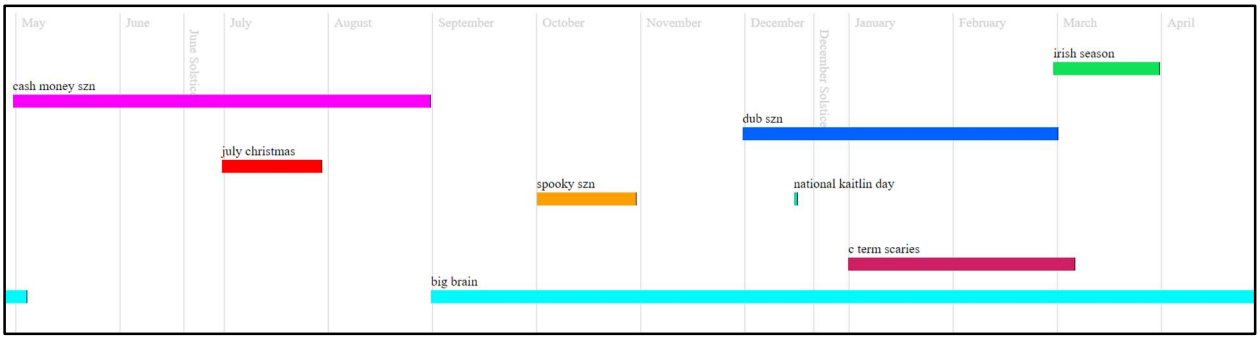

January
February
March
April
May
June
June Solstice
July
August
September
October
November
December
December Solstice
hot girl summer
birth month season
corn on the cob season
happy part of winter
depressing part of winter
homecoming
sorority recruitment season
hiking season

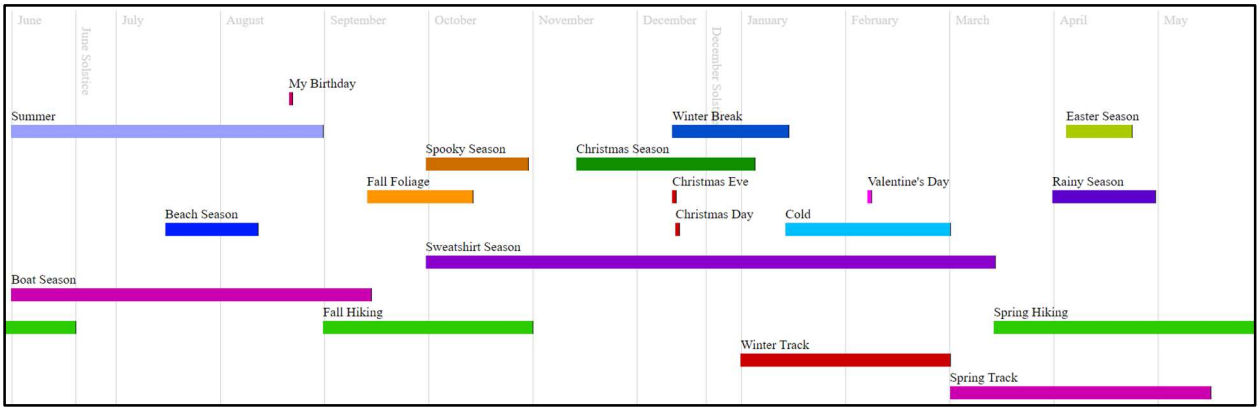

January
February
March
April
May
June
June Solstice
July
August
September
October
November
December
December Solstice
Spring Marathon Training
Winter Marathon Training
Cross Country Season
Warm Rain for Running
Annual Marthas Vineyard w/ the Boys
Beanie Season
Boston Marathon and expo
Summer Job
Flannel Wearing
Warm enough for shorts
Annual Texas Family Reunion
Winter Break


February
March
April
May
June
June Solstice
July
August
September
October
November
December
Football Season
Pool Season
Birthday/July 4th Season
Christmas Season
Work Season
Wood Burning Season


ary
February
March
April
May
June
June Solstice
July
August
September
October
November
December
December Solstice
Thanksgiving / lots of food
Shamrock Shake
Pumpkins
vacation
Christmas
School
Spooky


October
November
December
December Solstice
January
February
March
April
May
June
June Solstice
July
August
September
Spooky Season
Thanksgiving Season
Christmas tree is up
End of School Year
Start of School Year
Internships/Summer Jobs
Best time for pretty leaves in northern america
Can comfortably go outside and enjoy nice weather a lot of times
Snow and ice almost everyday (gross)
Rainy Weather
Sweatshirt Season
Indoor track Season
Outdoor Track Season
Weather gets a wee bit hot sometimes


May
June
June Solstice
July
August
September
October
November
December
December Solstice
January
February
March
April
irish season
cash money szn
dub szn
july christmas
spooky szn
national kaitlin day
c term scaries
big brain


June
June Solstice
July
August
September
October
November
December
December Solstice
January
February
March
April
May
My Birthday
Summer
Winter Break
Easter Season
Spooky Season
Christmas Season
Fall Foliage
Christmas Eve
Valentine's Day
Rainy Season
Beach Season
Christmas Day
Cold
Sweatshirt Season
Boat Season
Fall Hiking
Spring Hiking
Winter Track
Spring Track