SAKURA STORYTELLERS: CHERRY BLOSSOMS AS INDICATORS OF CHANGE IN MORE-THAN-HUMAN ENVIRONMENTS

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abstract: Flowering cherry trees, members of the family of plants which also includes plums, apricots, and peaches, have been revered around the world for centuries. Wherever they are found, flowering cherries have been cultivated for the beauty of their blossoms as well as the utility of their flowers, fruits, bark, and leaves in food, medicine, and other cultural practices. Cherry blossoms hold a variety of important meanings and symbolic associations in different cultures, with historical ramifications that reach across time and space as well as across the boundaries of humans and nature: they take bloom in war, in love, in disaster, in healing, and in vivid color behind anime heroines. My interest in cherry blossoms lies at the confluence of plant ecology, environmental history, and climate science, where cherry blossoms play a revelatory role as indicators of environmental transformation. In this study, I seek to understand how flowering cherry trees reflect ecological processes like climate change and species introduction as well as shifts in the social, cultural, and political relations of the more-than-human environments in which they are embedded.

This study begins with the question of how flowering cherry trees shift their phenology in response to climate change in their native and non-native ranges; it ends with a story and a suggestion. While cherry blossoms have demonstrated their power as indicators of climate, it is unknown whether and how this response is altered when introduced to new geographic areas, and flowering cherry trees have taken multiple paths across oceans to new continents. As climate-sensitive species that have been introduced all over the globe and have also been incredibly well-recorded, flowering cherries offer a unique look at the intersection of two prominent environmental issues, and so I began to investigate whether cherry blossom flowering can indicate human-caused shifts in geographic range as well as human-caused shifts in climate. What I found was that cherry blossoms are much more implicated in the problems of human societies than through changes in range and climate alone.

Well before weather stations, written histories, and modern science, people have understood their environments, cultures, and selves through the cyclical life and death of cherry blossoms, looking to them as holders of spirits with wisdom to share. I try to learn from this practice by paying attention to cherry blossoms wherever they appear, moving between fields and disciplines and watching out for where threads of connection take transient bloom, weaving stories in the hopes of similarly making sense of this world. What emerges from understanding cherry blossoms as ecological, environmental, social, cultural, political, racial, and spiritual entities with capacity for observation and response is a porous interweaving of people and flowering trees in reciprocal interaction, shaping each other's worlds in new ways over time and space. Acknowledging the power of these trees to mold our worlds and to teach us about ourselves is not so far removed from the view of cherry blossoms as the seat of the gods.

I cultivate flowering cherries as storytellers of tension and transformation in three realms: of physical environments, climates, and ecosystems; of cultures, identities, and selves; of war, violence, and the collisions of worlds. Their timing tells of heated conflict in more-than-human entanglements; their fragrance traces across oceans and continents, along roads and waterways, through minds and bodies; their color reveals death and destruction buried at the roots. Opening our minds to what sounds beneath the rustling of leaves and the whistle of the wind, we listen for the language of blossoms.

A NOTE ON NAMES

The ecological study I conducted considers four species commonly described as "cherry trees" or "flowering cherries": *Prunus* × *yedoensis* (*Cerasus* × *yedoensis*), commonly known as somei-yoshino (**ソメイヨシノ / 染井吉野**) or Yoshino cherry; *Prunus jamasakura* (*Prunus serrulata, Cerasus*

serrulata, Prunus leveilleana), known as yamazakura (やまざくら / 山桜) in Japan and as Japanese flowering cherry, hill cherry, or even oriental cherry in other parts of its introduced range; *Prunus serotina*, called black cherry, rum cherry, or mountain black cherry in English but first referred to with many different names in the languages of North American indigenous peoples (see figure 1); and *Prunus avium*, common names wild cherry, sweet cherry, gean, or mazzard. *Sakura* (さくら/ 桜) refers broadly to flowering cherries in Japan, and I will use that term to refer to the two East Asian species *Prunus x yedoensis* and *Prunus jamasakura* or to cherry blossoms as they appear symbolically in Japanese culture. While *Prunus serotina* and *Prunus avium* do not hold the same intensity of cultural significance and popularity for cultivation as these East Asian flowering cherries and are not usually thought of when people refer to cherry blossoms, they are also species that have been of great importance for their ornamental beauty as well as for food and medicine.

I would also like to acknowledge that there is some debate as to the origins of *Prunus x yedoensis*, with implications in the colonial history of Korea. This widespread variety was thought to have been developed through hybridization in Japan and brought to Korea during the Japanese colonial period (1910-1945), resulting in the cherry trees around Korea today. However, after claims that these cherry blossoms were actually of Korean origin, further genetic analyses were conducted to differentiate the origins of the popular Somei-yoshino cultivar *P. x yedoensis* and the wild *P. yedoensis* var. *nudiflora* naturally occurring on Jeju Island, Korea. Molecular evidence has been found to demonstrate the hybrid origin of wild *P. yedoensis* on Jeju Island, but studies remain inconclusive and hesitant about the controversial origin of the Somei-yoshino variety *P. x yedoensis* relative to this

native Korean species.[1] I will use *P. × yedoensis* to refer to the contested variety, making considerations in my analysis for the disputes over origin.

The use of the Linnaean taxonomic system should also be called into question. It is difficult to apply any of the common species concepts to members of the genus *Prunus*, which are morphologically similar, have undergone a great deal of hybridization through both human and nonhuman means, and include various increasingly ambiguous levels of classification into subspecies and varieties. Furthermore, blindly naming plants in line with Western categories of taxonomy runs the risk of erasing other ways of understanding the lives and lineages of plants, as seen in the naming of *P. serotina* for its different parts and forms. In the interest of specificity in the realm of Western science, I will use the Latin names of these tree species in reference to my ecological analysis and refer to the trees by their common names elsewhere.

[1] Myong-Suk Cho et al., "Molecular and Morphological Data Reveal Hybrid Origin of Wild Prunus Yedoensis (Rosaceae) from Jeju Island, Korea: Implications for the Origin of the Flowering Cherry," *American Journal of Botany* 101, no. 11 (2014).

Tahltan: ***teʔkaʔjeʔ jije, tehkaje jije*** (S) 'frog berries'
Kaska: ***det'oos jijé'***
Dakelh (Stuart/Trembleur Lake): ***nalgus*** ("cherry"); ***chənatch'əl*** ("cherry tree")
Dakelh (Saik'uz): ***dəlgusmai*** prob. 'crunchy berries' (fruit or tree);
dəlgusmaichən (tree) (also Cherry, bitter: *P. emarginata* – Saik'uz, but this may be a misidentication)
Tsilhqot'in: ***nelguns, melguns***; poss from ***guns*** 'crunchy sound' [?]
Gitxsan: ***haluuts'ooq'***, ***haluuts'oq***, ***m'iits'ooq, eluuts'ooq, tsooq' (mii ts'ooqxʷ)*** (fruit);
sgan'eluuts'ooq (tree) (check *P. pensylvanica, P. emarginata*); ***eluuts'ook'*** (W. Gitxsan), ***ts'ook'*** "makes your mouth smooth so nothing can slip on it" ('Ksan, People of 1980) (E. Gitxsan) (prob. choke cherry – *P. virginiana*)
Haisla: ***hʔum'adus t'ism*** ("big stone") (*P. emarginata*?)
Halkomelem, Upriver: ***ɬəxʷɬə́xʷ*** 'spit out many times' (see also *P. emarginata, P. pensylvanica*) (cognate with Interior Salish)
Stl'atl'imx (Pemberton): ***zəlkʷúʔ; "xlo.xlóx"*** ("Lower Lillooet" – Newcombe 1903) (fruit); ***zəlkʷúʔ-az'*** (plant, tree)
Stl'atl'imx (Fraser River): ***zəlkʷúʔ***; (fruit); ***zəlkʷúʔ-az'*** (plant, tree)
Nlaka'pamux: ***zəlkʷúʔ*** (fruit); ***zəlkʷuʔ-élp*** (tree); ***stəptep-úseʔ*** 'dark berry' (dark variety); ***tsiqʷ-úseʔ, stsəqʷtsiqʷ-úseʔ*** 'red berry' (red variety)
Secwepemc: fruit: ***tkʷlóseʔ*** (W, E) (fruit); ***tkʷlosəʔəlp*** (bush/tree) (cf. Proto-Salish ***kʷəl*** 'green, yellow' – Kuipers 2002)
Okanagan: ***lexʷɬáxʷ*** (fruit); ***lexʷɬxʷílp*** (bush/tree); ***sk'eluʔsálq*** 'old spring salmon fruit' (red variety); ***steplxiyálnexʷ*** 'covered away from the sun' (dark variety); ***nts'ew'ts'ag'w-wísxn*** (cf. ***ts'agʷ*** 'tasteless') (small, dark red variety)
Snchítsu'umshtsn: ***ɬáxʷ-ɬəxʷ***
Spokan: ***ɬxʷɬóxʷ*** (red and black varieties); ***st'xálq*** (a sweet variety – red)
Selish: ***ɬxʷɬó*** (apparently unanalyzable) (fruit), ***ɬxʷɬxʷálkʷ*** (tree) (also domesticated cherries)
Kalispel: ***ɬoxʷɬóxʷ***
Nez Perce: ***tímssiway***
Sahaptin: ***tmísh*** (fruit); ***tmish-aash, tmáashu*** (tree)
Ktunaxa: ***ʔakiʔɬmak'*** 'pit' (berries), ***ʔakiʔɬmak'-wuʔk*** (bush/tree)

FIGURE 1. NATIVE NAMES FOR PLANTS RELATED TO BLACK CHERRY.
FROM NANCY TURNER, "APPENDIX 2B. NAMES OF NATIVE PLANT SPECIES IN INDIGENOUS LANGUAGES OF NORTHWESTERN NORTH AMERICA," IN *ANCIENT PATHWAYS, ANCESTRAL KNOWLEDGE: ETHNOBOTANY AND ECOLOGICAL WISDOM OF INDIGENOUS PEOPLES OF NORTHWESTERN NORTH AMERICA* (MCGILL-QUEEN'S PRESS-MQUP, 2014).

CHERRY BLOSSOMS AS INDICATORS OF CLIMATE + ENVIRONMENT

My scientific study of cherry blossoms began with the intersection of species introduction, phenology, and climate change, a point of coalescence among environmental issues which *Prunus* species straddle. Flowering cherry trees have traveled across the world and passed between civilizations, moving through global networks alongside humans, becoming a part of new ecosystems and societies, and forming new biotic and abiotic interactions, all while humans alter their surrounding environments at an intensifying pace. Cherry blossom flowering is one of the most widely recognizable phenological events, as I've found when defining phenology—the study of

cyclical and seasonal phenomena in an organism's life history—to those outside the field. For this reason, cherry blossoms have made the news in recent years as erratic shifts in their flowering season, likely in response to climate change-induced temperature variability, thwart tourists in the hunt for falling pink petals.

Cherry blossoms have taken off as a topic of discussion within the study of climate change in the last several decades, with this observation that their extravagant flowering season has become earlier over time with increasing global temperatures. Variability due to climate change has even triggered flowering in the autumn: in 2018, "confused" sakura across Japan flowered in October, the result of unusually warm temperatures combined with strong typhoons that caused trees to lose leaves and to release less hormones that typically prevent blooming.[2] These trees are just a few of many befuddled organisms found to shift the timing of their life histories in response to anthropogenic environmental change, as scientists have demonstrated phenological climate adaptations in a variety of plants, birds, insects, reptiles, and mammals.[3] As a well-known and visually obvious phenological event, cherry blossom flowering is now commonly invoked as an indicator of climate change.[4]

There are many possible approaches to flowering cherry trees as indicators of environment, as plant phenology has been found to respond to various aspects of their physical surroundings, including temperature, light, altitude, and soil conditions.[5] My study looks in particular at the full

[2] Jerica Deck, "Confused by Climate Change, Japan's Famous Cherry Blossoms Bloom Six Months Early," https://www.globalcitizen.org/en/content/cherry-blossoms-climate/.
[3] D. B. Roy and T. H. Sparks, "Phenology of British Butterflies and Climate Change," *Global Change Biology* 6, no. 4 (2000); Peter A. Cotton, "Avian Migration Phenology and Global Climate Change," *Proceedings of the National Academy of Sciences* 100, no. 21 (2003); Jessica R. K. Forrest, "Complex Responses of Insect Phenology to Climate Change," *Current Opinion in Insect Science* 17 (2016); Stan Boutin and Jeffrey E. Lane, "Climate Change and Mammals: Evolutionary Versus Plastic Responses," *Evolutionary Applications* 7, no. 1 (2014); Forrest, "Complex Responses of Insect Phenology to Climate Change."
[4] "Community Connection: Cherry Blossom Bloom Dates in Washington, D.C.," United States Environmental Protection Agency.
[5] Leonor Patrícia Cerdeira Morellato et al., "Linking Plant Phenology to Conservation Biology," *Biological Conservation* 195 (2016).

flowering phenology of four species of cherry trees and their responses to temperature and precipitation averaged over the winter months prior to blooming. Though scientists have studied certain *Prunus* species in depth for their responses to climatic cues in specific sites, so far their phenology has not been studied on a global scale taking into account both native and introduced range. Through a comparison of climate responses at the continental level, I aim to develop an understanding of cherry blossom flowering as indicative of change in both climate and region.

BACKGROUND: ROOTS

The four species that I chose to analyze are the most well-recorded in the genus *Prunus* due to their commonness, ease of identification, and cultural value, and they also represent several different routes of species introduction. *P. × yedoensis* and *P. jamasakura* are the famous flowering cherries native to East Asia, while *P. serotina* is native to the Americas and *P. avium* to Europe and the Mediterranean region. *P. × yedoensis*, *P. avium*, and *P. jamasakura* have all been introduced to North America, while *P. serotina* and *P. jamasakura* have been introduced to Europe.

These four species also capture some of the variation in discourse around introduced species, in that *P. serotina* and *P. avium* are listed as invasive species in Europe and North America, respectively. Both species were initially brought across the Atlantic as ornamentals and have escaped cultivation, persisting in the wild without human aid or even requiring management.[6] They are now noted for their detrimental effects on native forests, forming monoculture stands that displace native species and hosting parasites.[7] The two Asian flowering cherries, on the other hand, do not typically

[6] "Prunus Serotina (Black Cherry)," Centre for Agriculture and Bioscience International; "Sweet Cherry - *Prunus Avium* (L.) L. ," Center for Invasive Species and Ecosystem Health.
[7] Mathilde Poyet et al., "Invasive Host for Invasive Pest: When the Asiatic Cherry Fly (Drosophila Suzukii) Meets the American Black Cherry (Prunus Serotina) in Europe," *Agricultural and forest entomology* 16, no. 3 (2014); Raf Aerts et al.,

escape cultivation and form naturalized populations. In places where they are non-native, these species are not considered harmful or tagged as invasive and are instead cherished for their ornamental beauty in gardens and urban spaces.

TABLE 1. FOUR FLOWERING CHERRY SPECIES

species	common names	origin	introduction	# observations
avium	wild cherry, sweet cherry, gean, mazzard	Europe, Anatolia, Maghreb, Western Asia	North America*	12511
jamasakura	yamazakura, Japanese cherry, hill cherry, mountain cherry, oriental cherry	East Asia (Japan)	North America, Europe	404
serotina	black cherry, rum cherry, mountain black cherry	North America, Mexico	Europe*	965
yedoensis	somei-yoshino, Yoshino cherry	East Asia (Japan)	North America	5580

Notes: I look to these four species in my study of how cherry blossom flowering responds to climate change. These species, all considered flowering cherry trees that have been introduced to other regions of the world, are some of the most well-documented in the genus Prunus. I found extensive records for these species across their native and non-native ranges from 13 sources, described in Table 2 below. * = noted for ecological impact in non-native habitat.

P. x yedoensis, *P. jamasakura*, *P. serotina*, and *P. avium* have each been found to shift their flowering phenology in response to climate change at particular sites. In line with the trends described in other plant species, these trees typically shift to earlier flowering times with increases in temperature. These advancements are correlated with the average temperature or accumulated warm days preceding flowering, conditions thought to trigger flowering in conjunction with other environmental factors like frost and sunlight. The impact of precipitation on flowering phenology has been less clear, with significance and magnitude of effect varying by region.[8]

P. x yedoensis, as a popular ornamental with strong cultural and economic significance, is studied extensively with respect to climate. In 1990, Omoto and Aono found evidence that these

"Invasion by the Alien Tree Prunus Serotina Alters Ecosystem Functions in a Temperate Deciduous Forest," *Frontiers in plant science* 8 (2017); "The Cherry Blossoms Have Arrived! Some Good, Some Bad.," Maryland Invasive Species Council.
[8] Sang-Don Lee, "Global Warming Leading to Phenological Responses in the Process of Urbanization, South Korea," *Sustainability* 9, no. 12 (2017).

trees advance their bloom dates with urban warming.[9] Another study by Kai et al in 1993 measured this advancement at 2.5-4 days/ºC.[10] In 2014, Korean scientists similarly found advancements in cherry blossom flowering time correlated with increases in temperature; in this case, uneven advancements resulted in a shrinking gap between forsythia and cherry blossom flowering time, with negative impacts on economic and communal aspects of Korea's seasonal landscape.[11] The climate responses of *P. × yedoensis* have also been documented in the U.S., with peak bloom of cherry blossoms in the Tidal Basin predicted to advance 5 days by 2050 and 10 days by 2080.[12]

P. jamasakura, while less widespread than other sakura varieties, has been blooming in Kyoto alongside human societies for centuries. Using imperial court records, poetry, and newspaper clippings referencing the breathtaking flowers or celebrations of *hanami*, the practice of cherry blossom viewing that continues into the present, Japanese scientists were able to pinpoint the bloom dates of *P. jamasakura* dating back to the 9th century. This dataset represents the longest and most complete phenological record in existence. Aono and Kazui found various fluctuations in full bloom corresponding to major periods of climate variation, and they also determined that flowering was progressively earlier after approximately 1830. Temperature reconstructions aided by this phenological dataset indicated that the cherry trees are now experiencing warmer conditions than at any time in the last 1200 years. As a result, average full flowering day in the period from 1971-2000 was 7 days earlier than the average of all records before.[13]

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[9] Yukio Omoto and Yasuyuki Aono, "Estimation of Change in Blooming Dates of Cherry Flower by Urban Warming," *Journal of Agricultural Meteorology* 46, no. 3 (1990).
[10] Keiko Kai et al., "Potential Effects on the Phenological Observation of Plants by Global Warming in Japan," ibid.48, no. 5 (1993).
[11] Ho-Seung Lee, Jin-Hee Kim, and Jin I Yun, "Recent Trends in Blooming Dates of Spring Flowers and the Observed Disturbance in 2014," *Korean Journal of Agricultural and Forest Meteorology* 16, no. 4 (2014).
[12] Uran Chung et al., "Predicting the Timing of Cherry Blossoms in Washington, Dc and Mid-Atlantic States in Response to Climate Change," *PLoS One* 6, no. 11 (2011).
[13] Yasuyuki Aono and Keiko Kazui, "Phenological Data Series of Cherry Tree Flowering in Kyoto, Japan, and Its Application to Reconstruction of Springtime Temperatures since the 9th Century," *International Journal of Climatology: A Journal of the Royal Meteorological Society* 28, no. 7 (2008); Yasuyuki Aono, "Cherry Blossom Phenological Data since the

Scientists at the Cherry Tree Preservation Forest at the Tama Forest Science Garden near Mt. Takao studied both *P. x yedoensis* and *P. jamasakura*. They found that these cherry trees flowered 5.5 days earlier over a 25-year period, in conjunction with February and March temperature increases, with an advancement of 3-5 days per ºC.[14] In similar studies, Allen et al. found that cherry blossom taxa will flower on average 30 days earlier by 2100, with 2-6 days greater uncertainty.[15]

P. avium is also a species of interest in various phenological studies, as it is widely cultivated in Europe and is therefore relatively well-recorded. Chmielewski et al. discovered that *P. avium* is flowering progressively earlier in urban areas compared to rural areas, with an average forcing of 11 days earlier in warmer urban climates.[16] Another study, using *P. avium* as one of four representative species, found an advancement in growing season of 8 days over the last 30 years, or 7 days for every 1ºC warming in early spring temperatures (February–April).[17]

P. serotina is the least studied of the four species, as its phenology has not been recorded over time for any alternative cultural or economic purpose. However, Laura Brenskelle et al. conducted a study of *P. serotina* phenology using data extracted from preserved herbarium specimens dating back to 1873, showing that the trees have steadily advanced flowering time over the years, with the effect varying by latitude.[18]

Seventeenth Century for Edo (Tokyo), Japan, and Their Application to Estimation of March Temperatures," *International Journal of Biometeorology* 59, no. 4 (2015).

[14] Abraham J Miller-Rushing et al., "Impact of Global Warming on a Group of Related Species and Their Hybrids: Cherry Tree (Rosaceae) Flowering at Mt. Takao, Japan," *American Journal of Botany* 94, no. 9 (2007).

[15] Jenica M. Allen et al., "Modeling Daily Flowering Probabilities: Expected Impact of Climate Change on Japanese Cherry Phenology," *Global Change Biology* 20, no. 4 (2014).

[16] Frank-M Chmielewski and Thomas Rötzer, "Response of Tree Phenology to Climate Change across Europe," *Agricultural and Forest Meteorology* 108, no. 2 (2001).

[17] Thomas Roetzer et al., "Phenology in Central Europe–Differences and Trends of Spring Phenophases in Urban and Rural Areas," *International journal of biometeorology* 44, no. 2 (2000).

[18] Laura Brenskelle et al., "Integrating Herbarium Specimen Observations into Global Phenology Data Systems," *Applications in Plant Sciences* 7, no. 3 (2019).

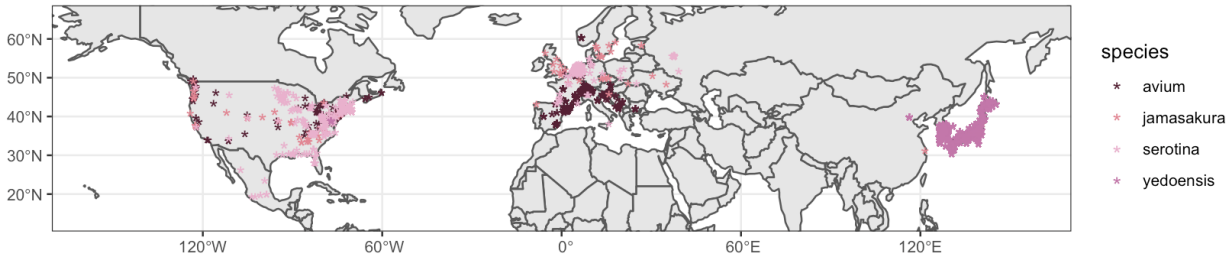

FIGURE 2. MAP OF CHERRY BLOSSOM FLOWERING OBSERVATION SITES

METHODS: TRUNK

My research takes a relatively novel approach to studying phenology, in that it combines formal scientific data, community science observations, and historical and archival resources in order to achieve a wide spatial and temporal scale. Studies of phenology are often constrained by lack of long-term data, with the value of phenological records only coming into scientific recognition towards the end of the 20th century, and this attempt to study species across their native and non-native range also constitutes a spatial challenge. However, because of the immense cultural significance and economic value of their flowering and fruiting, *Prunus* species are relatively well-documented in the places where they appear, with government agencies like meteorological associations and parks services maintaining records of their phenology. Furthermore, as seen in the work of Aono and Kazui, there are several forms of flowering data other than formal phenological records that have been thoroughly collected over time and space for these species. This includes mentions or depictions of blooming in poetry and other artwork as well as preserved specimens in the herbaria of museums and botanical gardens and photographs of plants taken by community observers.

While the use of these sources can pose problems in terms of data aggregation, *Prunus* species have several characteristics that lend themselves to this methodology. Firstly, *Prunus* species

exhibit showy phenophases that are easily identifiable and distinguishable from one another, with vivid flowers and fleshy fruits, making them easy to score even when photographed from afar or preserved on paper over time. The obviousness of their reproductive stages also makes it more likely for photos or specimens to be taken during flowering or fruiting, as opposed to other plants that might be well-documented when vegetative. *Prunus* species have relatively short phenophases, particularly the Japanese flowering cherries famous for their ephemerality, which reduces possible data discrepancies resulting from scoring the beginning of a phenophase versus the end.

In order to represent global patterns in *Prunus* flowering phenology with respect to climate, I looked for any type of data that contained information on the time, location, species, and phenophase of an observed flowering cherry tree. Miller-Rushing et al demonstrated in their 2006 study that field observations, herbarium specimens, and photographs of plants with a visible phenophase can be successfully combined to determine patterns of phenological change in response to climate;[19] taking this as a precedent, I collected flowering data on four *Prunus* species from 13 different sources, including phenological databases, community science platforms, government agency records, and herbarium archives (Table 2). I also incorporated data collected for previous phenological studies, some from the researchers' physical observations and some taken from herbaria or historical art and records. This mix of sources allowed me to cover the wide geographical spread of these four species' native and non-native ranges, as shown in figure 2.

TABLE 2. LIST OF PHENOLOGICAL DATA SOURCES

source name/description	database type	# observations	species	continent	scoring
Aono et al. (2008, 2010)	historical records	111	jamasakura	E Asia	prescored

[19] Abraham J Miller-Rushing et al., "Photographs and Herbarium Specimens as Tools to Document Phenological Changes in Response to Global Warming," *American Journal of Botany* 93, no. 11 (2006).

Budburst	phenology	155	avium, yedoensis, serotina	N America	prescored
Brenskelle et al. (2019)	herbaria	83	serotina	N America	prescored
Global Biodiversity Information Facility (GBIF)	observations, community	500	avium, jamasakura, serotina	N America, Europe	unscored
iNaturalist	community	87	avium, serotina	N America, Europe	unscored
Japanese Meteorological Association	government agency	5456	yedoensis	E Asia	prescored
Korean Meteorological Association	government agency	1890	yedoensis	E Asia	prescored
Mid-Atlantic Herbaria Consortium	herbaria	93	avium	N America	unscored
Pan-European Phenology Database (PEP725)	phenology	590	avium	Europe	prescored
US National Park Service	government agency	179	jamasakura, yedoensis	N America	prescored
USA National Phenology Network (USA-NPN)	phenology	546	jamasakura, serotina, yedoensis	N America	prescored
Wang et al. (2017)	phenology	23	yedoensis	E Asia	prescored
Wenden et al. (2017)	phenology	725	avium	Europe	prescored

Notes: 13 online sources with phenology data on flowering cherry trees. I include the type of study or database originally collecting the data, the number of full flowering specimens or observations, the species and regions represented, and whether the data already included phenological classifications. Any datasets that were not already scored were scored by me. After standardizing phenophases across data sources, the final dataset was subset by phenophase to include only full flowering (70% blossoms open).

For datasets that were pre-scored for phenology, I used the descriptions of the classifications in order to adjust them into a standardized phenology scale that would allow me to combine data across sources. I applied that phenology scheme to score community science photos and herbarium specimens. Any observation that did not contain geographic coordinates, a full date, and clear phenological information was removed. I also omitted community science observations that were not research grade, a qualification that indicates consensus on the plant's identity at a species level. Finally, I subset the data to focus on full flowering phenology or peak bloom, here defined as when 70% or more of the blossoms are open.

I then used the geographic coordinates and dates associated with each observation to match them to climate data, namely average monthly temperature and average monthly total precipitation. The climate dataset that I chose for this study is CRU TS4.04, a global gridded time-series of high-resolution monthly climate data. These variables were calculated using daily or sub-daily data collected by national meteorological services and cover the period 1901-2019 on a 0.5ºx0.5º grid. For both average temperature and precipitation, I calculated the average over the months December–March in order to capture the winter climatic conditions prior to onset of flowering for each observation, based on previous findings that cherry blossoms were responsive to temperature in this period.

In order to analyze phenological response to climate, I used the lme4 package in R 4.0.2 to create linear mixed-effect models across all four species for both average winter temperature and average winter precipitation.[20] My final model explains variation in full flowering day of year based on the species, the continent where the observation occurred, and the average winter climate at the site, as well as the interaction between those effects. I included site as a random effect, in order to account for other unknown environmental differences in the locations where this data was collected as well as the different methods of phenological capture used across sites. The final model structure is as follows: DOY ~ species * continent * TAVG_winter + species * continent * PAVG_winter + (1 | site).

[20] R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria; Martin Maechler Douglas Bates, Ben Bolker, Steve Walker, "Fitting Linear Mixed-Effects Models Using Lme4," *Journal of Statistical Software* 67, no. 1 (2015).

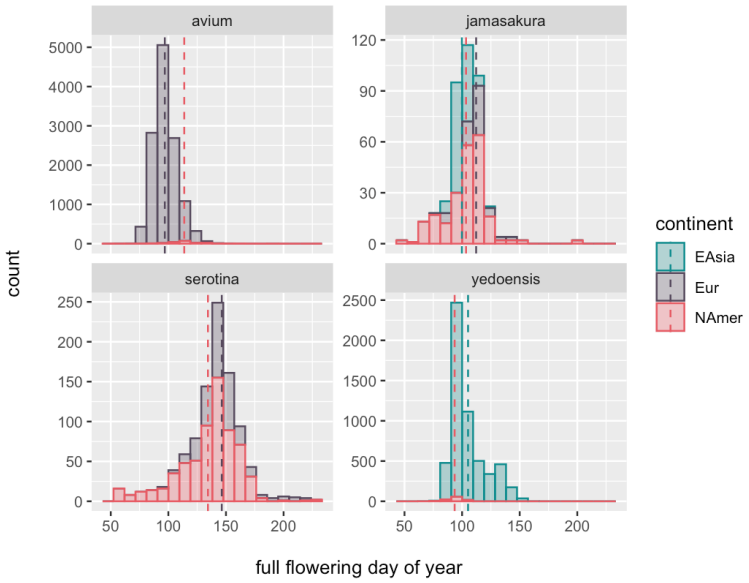

FIGURE 3: MEANS AND DISTRIBUTIONS FOR FULL FLOWERING DAY

DOTTED LINES INDICATE LEAST SQUARES MEANS. FULL FLOWERING OCCURRED IN EARLY TO MID APRIL FOR ALL SPECIES EXCEPT P. SEROTINA, WHICH FLOWERED IN LATE APRIL TO MAY. FOR ALL SPECIES EXCEPT P. X YEDOENSIS, FULL FLOWERING OCCURRED EARLIER IN THE TREES' NATIVE RANGE COMPARED TO NON-NATIVE RANGE.

I summarized this model with the emmeans package to calculate the mean full flowering day for each species on each continent, using least squares means to account for the unbalanced sample sizes in these groups. I also isolated trends by species and continent for the relationship between full flowering day and both winter climate variables and produced figures depicting the means and slopes of climate responses using the emmeans and ggplot2 packages.[21]

TABLE 3. MODEL OUTPUT: PRUNUS FULL FLOWERING PHENOLOGY

predictors	estimate	SE	t-stat.	*P*
full flowering DOY				
(Intercept)	132.42	13.54	9.78	**<0.001**
TAVG_winter	–3.17	0.58	–5.50	**<0.001**

[21] Emmeans: Estimated Marginal Means, Aka Least-Squares Means; Hadley Wickham, *"Ggplot2: Elegant Graphics for Data Analysis"* (New York: Springer-Verlag, 2016).

PAVG_winter	–0.23	0.005	–4.69	**<0.001**
continent (Eur)	–19.52	13.58	–1.44	0.151
continent (NAmer)	–7.59	13.38	–0.57	0.571
species (J)	–26.48	13.70	–1.93	**0.053**
species (S)	6.79	2.31	2.94	**0.003**
species (Y)	–19.61	13.50	–1.45	0.147
TAVG : continent (Eur)	0.18	0.58	0.30	0.762
TAVG : continent (NAmer)	–0.18	0.54	–0.33	0.745
TAVG : species (J)	1.26	0.74	1.69	0.090
TAVG : species (S)	0.84	0.23	3.68	**<0.001**
TAVG : species (Y)	0.63	0.57	1.11	0.267
continent (Eur) : species (J)	34.29	13.96	2.46	**0.014**
continent (NAmer) : species (J)	16.90	13.79	1.23	0.221
continent (Eur) : species (S)	27.26	4.25	6.42	**<0.001**
continent (Eur) : PAVG_winter	0.29	0.005	5.79	**<0.001**
continent (NAmer) : PAVG_winter	0.10	0.004	2.319	**0.020**
species (J) : PAVG_winter	0.16	0.006	2.771	**0.006**
species (S) : PAVG_winter	0.15	0.003	4.400	**<0.001**
species (Y) : PAVG_winter	0.18	0.005	3.559	**<0.001**
TAVG_winter : continent (Eur) : species (J)	–0.55	20.74	2.763	**0.006**
TAVG_winter : continent (NAmer) : species (J)	–0.77	20.43	1.86	0.063
TAVG_winter : continent (Eur) : species (S)	2.33	6.84	6.66	**<0.001**
continent (Eur) : species (J) : PAVG_winter	–0.19	0.007	–2.787	**0.005**
continent (NAmer) : species (J) : PAVG_winter	–0.18	0.006	–3.123	**0.002**
continent (Eur) : species (S) : PAVG_winter	–0.20	0.005	–4.331	**<0.001**
N observations	21256			
R^2_m	0.448			
R^2_c	0.884			

Notes: SE, standard error; TAVG_winter, average winter temperature (Dec-Mar); PAVG_winter, average winter precipitation (Dec-Mar); $R^2_{m/c}$, marginal and conditional R^2. Results are from a mixed effect model with species, continent, and climate as fixed effects and site as a random effect. Bolded p-values represent significant effects at α=0.05.

RESULTS: BRANCHES

My model revealed significant effects of species, continent, and climate on the full flowering day of cherry trees, as well as significant interactions between these effects. Based on the values of marginal and

condition R^2, fixed effects alone (species, continent, and average winter temperature and precipitation) explain 44% of the variation while the inclusion of random effects (site) explains another 44% (Table 3).

TABLE 4. FLOWERING TRENDS: TEMPERATURE

species	continent	TAVG_winter trend (days/°C)	SE	lower CL	upper CL	*P*
avium	Europe	–3.01	0.0634	–3.132	–2.883	**<0.001**
avium	North America	–3.57	0.1939	–3.946	–3.186	**<0.001**
jamasakura	East Asia	–1.92	0.4674	–2.835	–1.003	<0.001
jamasakura	Europe	–2.29	0.3530	–2.980	–1.597	<0.001
jamasakura	North America	–2.87	0.2579	–3.381	–2.369	<0.001
serotina	Europe	0.17	0.1370	–0.0984	0.439	0.2142
serotina	North America	–2.45	0.1248	–2.698	–2.208	**<0.001**
yedoensis	East Asia	–2.54	0.0821	–2.702	–2.380	**<0.001**
yedoensis	North America	–2.72	0.5374	–3.771	–1.664	**<0.001**

Notes: SE, standard error; CL, confidence limits, TAVG_winter, average winter temperature prior to flowering (Dec-Mar). Full flowering day advanced in response to temperature for all 4 flowering cherry species across their native and non-native range except for P. serotina, which did not have a significant relationship with temperature in its non-native range in Europe. Bolded p-values indicate significant effects at α=0.05.

In this model of all four species across their global range, there were significant differences in mean full flowering day by species based on continent. *P. avium* flowered on average 13 days earlier in Europe (April 6) than in its nonnative range in North America (April 19); *P. jamasakura* reached full flower earliest in its native range in East Asia (April 6), 7 days earlier than in North America (April 13) and 13 days earlier than in Europe (April 19). *P. serotina* had the most dramatic difference in full flowering day across its range, a full 28 days later in Europe (May 27) relative to its native range in North America (April 29).

The model revealed an overall effect of temperature on full flowering day, with multiple significant interactions between temperature, species, and continent. According to the trends analysis, average winter temperature had a significant negative effect on full flowering day for every species on every continent except *P. serotina* in Europe, where the direction of the temperature effect was inconclusive. The magnitude of the advancement in full flowering day varied from -1.9 days/°C, for *P. jamasakura* in East Asia, to -3.6 days/°C, in the case of *P. avium* in North America.

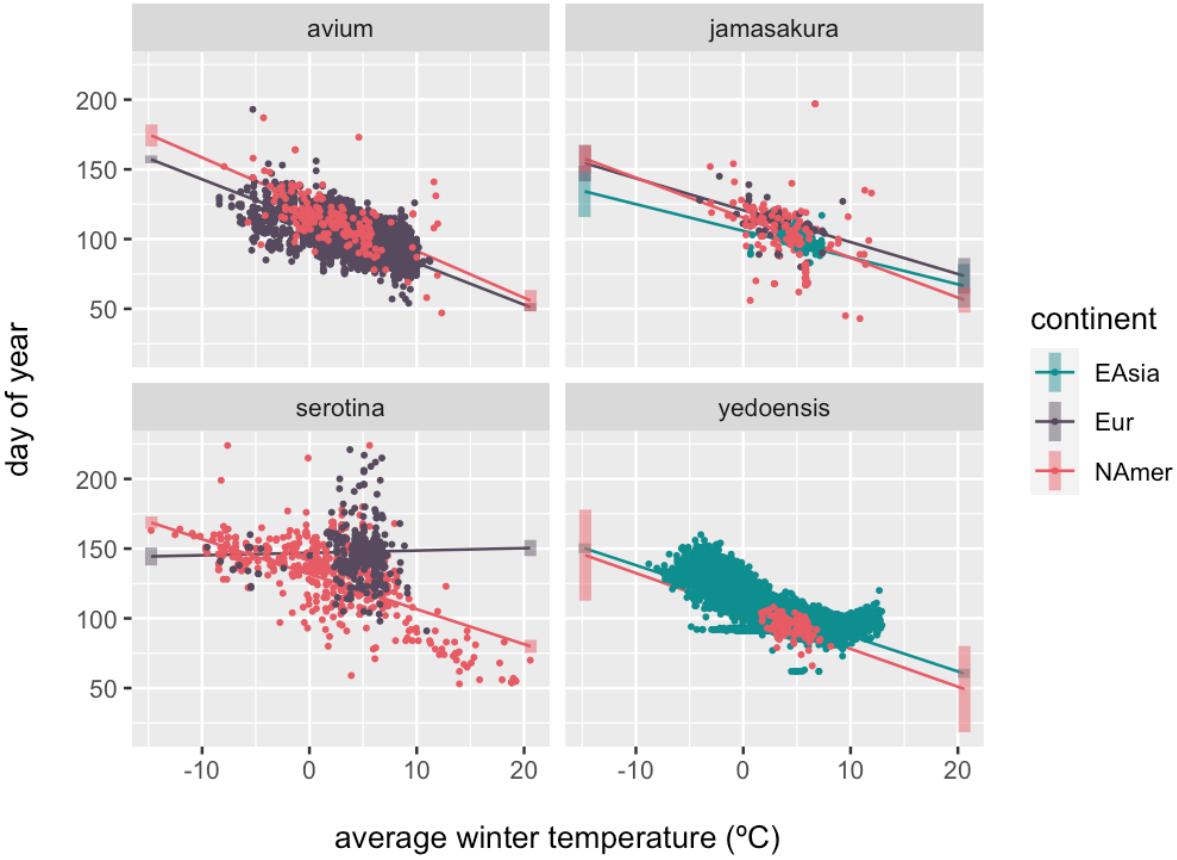

FIGURE 4. FLOWERING RESPONSE TO TEMPERATURE

RESPONSE OF FULL FLOWERING DAY TO AVERAGE WINTER TEMPERATURE (DEC-MAR) FOR 4 SPECIES OF FLOWERING CHERRIES BY CONTINENT. SLOPES IN DAYS/°C. ERROR BARS REPRESENT CONFIDENCE INTERVALS FOR THE MIXED MODEL PREDICTIONS.

My analysis also demonstrated continental differences in the relationship between phenology and temperature for each species. *P. avium* displayed significantly different behavior across its range,

with a greater advancement in full flowering day per ºC in its nonnative range in North America (-3.6 days/ºC, 95% CI [-3.9, -3.2]) compared to Europe (-3.0 days/ºC, 95% CI [-3.1, -2.9]). *P. serotina* also had distinct differences in phenological response to climate between its native and nonnative range. In the species' native range in North America, there was a significant advancement in full flowering day with increased winter temperature (-2.5 days/ºC, 95% CI[-2.7, -2.2]), while there was no significant effect of winter temperature on phenology when introduced to Europe. Both *P. jamasakura* and *P. x yedoensis* had no significant range differences in the effect of average winter temperature on full flowering day, with both species undergoing an advancement of 1 to 3 days/ºC increase (combined 95% CIs [-3.4, -1.0] and [-3.8, -1.7], respectively).

TABLE 5. FLOWERING TRENDS: PRECIPITATION

species	continent	PAVG_winter trend (days/mm)	SE	lower CL	upper CL	*P*
avium	Europe	0.05517	0.00349	0.0483	0.0620	**<0.001**
avium	North America	–0.14676	0.02690	–0.1995	–0.0940	**<0.001**
jamasakura	East Asia	–0.07422	0.4674	–0.1305	–0.0180	**0.0097**
jamasakura	Europe	0.02056	0.03867	–0.0552	0.0964	0.5949
jamasakura	North America	–0.15077	0.02444	–0.1987	–0.1029	**<0.001**
serotina	Europe	0.00733	0.02986	–0.0512	0.0659	0.8062
serotina	North America	0.01433	0.02058	–0.0260	0.0547	0.4863
yedoensis	East Asia	–0.07134	0.00584	–0.0828	–0.0599	**<0.001**
yedoensis	North America	0.03858	0.04064	–0.0411	0.1182	0.3425

Notes: SE, standard error; CL, confidence limits; PAVG_winter, average winter precipitation (Dec-Mar, monthly total). Full flowering day had a significant response to precipitation for all species of flowering cherries except P. serotina. The two East Asian flowering cherries, P. jamasakura and P. x yedoensis, both flowered earlier in response to increased precipitation in their native ranges, but P. x yedoensis did not respond to precipitation when introduced to North America while P. jamasakura had a more negative response in North America and no response in Europe. P. avium flowered earlier in response to increasing precipitation in North America but later in its native range in Europe. Bolded p-values indicate significant effects at α=0.05.

Average winter precipitation also had an overall effect on full flowering day, again modulated by species and continent. *P. avium* had a positive relationship with winter precipitation in its native

range of Europe (0.055 days/mm increase in total monthly precipitation, 95% CL [0.048, 0.062]) but a negative relationship in North America (-0.15 days/mm, 95% CL [-0.20, -0.094]). *P. x yedoensis* also exhibited differences in precipitation response across its range, flowering earlier with increased winter precipitation in East Asia (-0.071 days/mm, 95% CL [-0.083, -0.060]), but with no conclusive response in North America. *P. jamasakura* had significant differences in precipitation response in that the species responded negatively in East Asia (-0.074 days/mm, 95% CL [-0.13, -0.018]) and in its non-native range in North America (-0.15 days/mm, 95% CL [-0.20, -0.10]) but did not respond to precipitation in Europe; furthermore, the negative responses in East Asia and North America did not significantly differ. *P. serotina* did not have a significant response to average winter precipitation in either part of its range.

Seeing that *Prunus x yedoensis* was listed as native to Japan specifically rather than East Asia, as the variety was said to be first developed there, I also created a preliminary model of full flowering day based on country and average winter temperature for that species. This model by country revealed that the negative temperature response of *P. x yedoensis* full flowering day was significantly smaller in Korea (-1.7 days/ºC, 95% CL [-1.8, -1.6]) compared to the other East Asian countries (-4.7 days/ºC in China, 95% CL [-7.4, -2.0], and -3.3 days/ºC in Japan, 95% CL [-3.3, -3.2]).

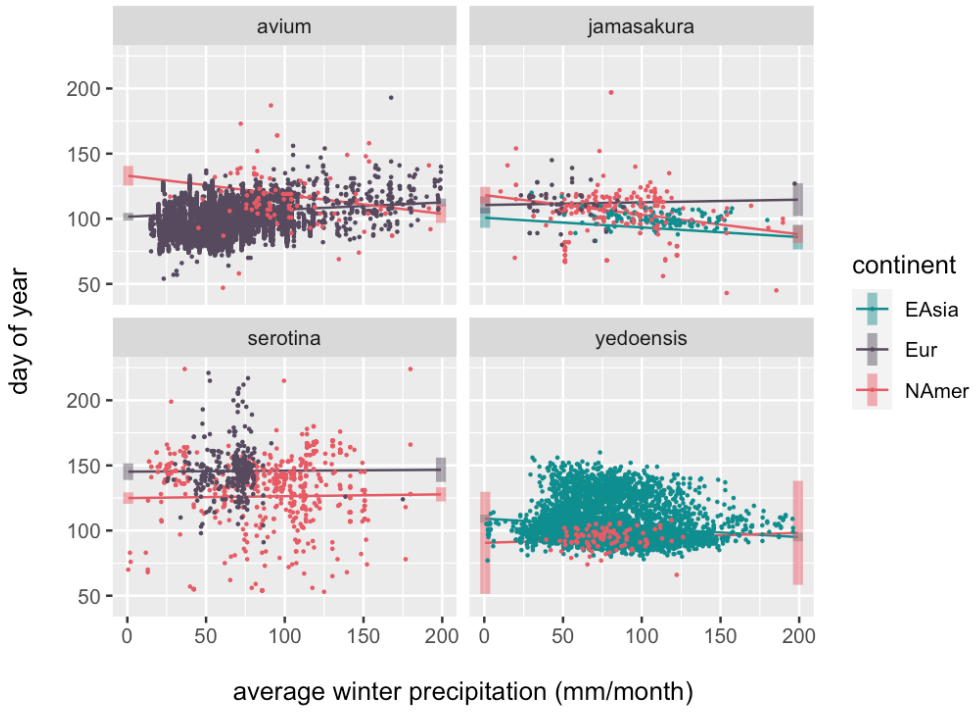

FIGURE 5. FLOWERING RESPONSE TO PRECIPITATION

RESPONSE OF FULL FLOWERING DAY TO AVERAGE WINTER PRECIPITATION (DEC-MAR) FOR 4 SPECIES OF FLOWERING CHERRIES BY CONTINENT. SLOPES IN DAYS/MM. ERROR BARS REPRESENT CONFIDENCE INTERVALS FOR THE MODEL PREDICTIONS.

DISCUSSION: STEM(S)

The results of the linear mixed-effect model demonstrate that *Prunus* species differ both in their phenology and in their phenological responses to climate when introduced to different regions of the world. With other site-level factors like soil and altitude accounted for as a random effect, *P. avium*, *P. serotina*, and *P. jamasakura* all reached full flower substantially later in their non-native range compared to their native range, with differences of 5 days up to an entire month. This suggests that *Prunus* species shift to later flowering phenology outside of their native range regardless of the continent where they occur.

In order to further interpret these results, I ran pairwise contrasts in full flowering day between species cooccurring on the same continent. I found that in both Europe and North America, *P. avium*, *P. jamasakura*, and *P. serotina* all differ significantly from one another in full flowering day; in other words, they fill different phenological niches when they exist in the same region and potentially compete for pollinators. The fact that each of these species shifts its phenology when transplanted to a new part of the world in conjunction with the fact that they maintain different phenological niches despite these shifts suggests that they act in order to avoid competition as closely related species.

Though climate change is projected to act unevenly across the surface of the earth, with smaller-scale variation highly dependent on regional factors, my discussion of phenological responses to climate change here will consider a general increase in temperatures as well as an increase in precipitation. While an overall projected increase in temperature is widely accepted within climate science, expected patterns of precipitation are not as well understood. My decision to analyze *Prunus* phenology with respect to an increase in precipitation is based on the CMIP5 RCP8.5 model for total precipitation, in which almost all of the geographic area in my study is projected to experience an increase by 2100.[22]

The trends in full flowering day relative to average winter temperature and average winter precipitation reveal differences in climate sensitivity by species and continent. Based on my model, flowering cherry species are accelerating their flowering phenology by as much as 3.5 days/ºC. To put these patterns into perspective, from 1970 to 2020, average winter temperature in Washington, D.C. rose 2.9ºC, and the area is expected to experience a further 4.2º increase in winter low

[22] International Monetary Fund, "Figure 3.5. Temperature and Precipitation Projections under the Rcp 8.5 Scenario," (2017).

temperatures between 2000 and 2050.[23] For a phenological sensitivity of -3.5 days/ºC, this climatic change would correspond to a two-week advancement in full flowering day. With a projected shift of that magnitude, it is unclear whether these tree species will face other ecological or physiological restraints posed by the earlier timing, relative to frost dates as well as the life cycles of pollinators.

P. avium had differential responses to both temperature and precipitation in its native vs. non-native range. Increasing temperature resulted in a significant advancement in full flowering day in both regions for this species, though the magnitude of the effect was greater in its non-native range in North America than in Europe. This larger shift could be attributed to the fact that *P. avium* flowers later in North America to begin with, and therefore has to make greater adjustments to compensate for increasing temperatures due to climate change. *P. avium* also had differences in the direction of its precipitation response based on continent, with a positive response in its native range and a negative response in its non-native range.

P. serotina also exhibited differences in temperature response between its native and non-native range, with a substantial advancement in full flowering phenology in its native range of North America but with no significant response when introduced to Europe. It may be that because *P. serotina* in Europe flowers so late, its full flowering phenology is sensitive not to winter temperature but to temperature in the later spring months closer to the time of full flowering. This species was also unique in that it showed no significant response to average winter precipitation. Further analysis is required to determine which climate variables best explain full flowering of *P. serotina* outside its native range.

P. jamasakura had a relatively uniform negative response to average winter temperature across its range, but its response to average winter precipitation differed by continent. While this

[23] Ian Livingston, Freedman, Andrew, "Climate Change Is Warming Winters in Dc," The Washington Post, https://www.washingtonpost.com/weather/2020/12/03/washington-warming-winters-snow/.

species advances its full flowering day with increased precipitation in both its native range in East Asia and North America, there was no significant relationship between flowering phenology and precipitation when introduced to Europe. Similarly, *P. x yedoensis* also had a negative response to average precipitation in its native range in East Asia, with an inconclusive relationship to precipitation when introduced to North America.

Interestingly, the two species that showed differences in temperature response between their native and non-native range are also the species that are naturalized and listed as "invasive species," while the two cultivated ornamental species did not differ in their responses to temperature. This suggests that *Prunus* species can moderate their phenological responses to climate change in order to gain an advantage over competitors in novel ecosystems. The ability to dramatically shift phenology in response to climatic variation could facilitate species introduction by allowing non-native plants to take advantage of different phenological niches than co-occurring competitors.

As the precipitation changes resulting from climate change as well as the effects of precipitation on phenology are highly variable and as yet misunderstood, discussion of these responses in cherry blossoms is even further limited to speculation. One observation from these results is that the two East Asian species not known to form naturalized, unassisted populations responded to precipitation in their native range but not their non-native range. It is possible that the species maintained by humans do not need to shift relative to precipitation despite introduction to new environments, because they have assistance in competing for survival and propagation and may not require that advantage.

Upon further investigation of the differences in *P. x yedoensis* flowering response across its range, I learned of the conflict around its origin and introduction to other parts of East Asia mentioned above, as well as the findings in support of the cultivated Japanese variety and the wild

Korean variety arising from multiple independent hybridizations.[24] Assuming that the flowering cherries observed by the Korean Meteorological Association were the Korean *P. yedoensis* var. *nudiflora* and that those trees are distinct from the Japanese cultivar *P. ×yedoensis* that was gifted to the United States, these genetic distinctions could explain some of the difference in phenological response to winter temperature. Likewise, these phenological differences may lend support to the independent origin of the Korean species. However, as the two varieties coexist in South Korea due to planting during Japanese colonization, it is unknown which hybridization the observed trees arose from.

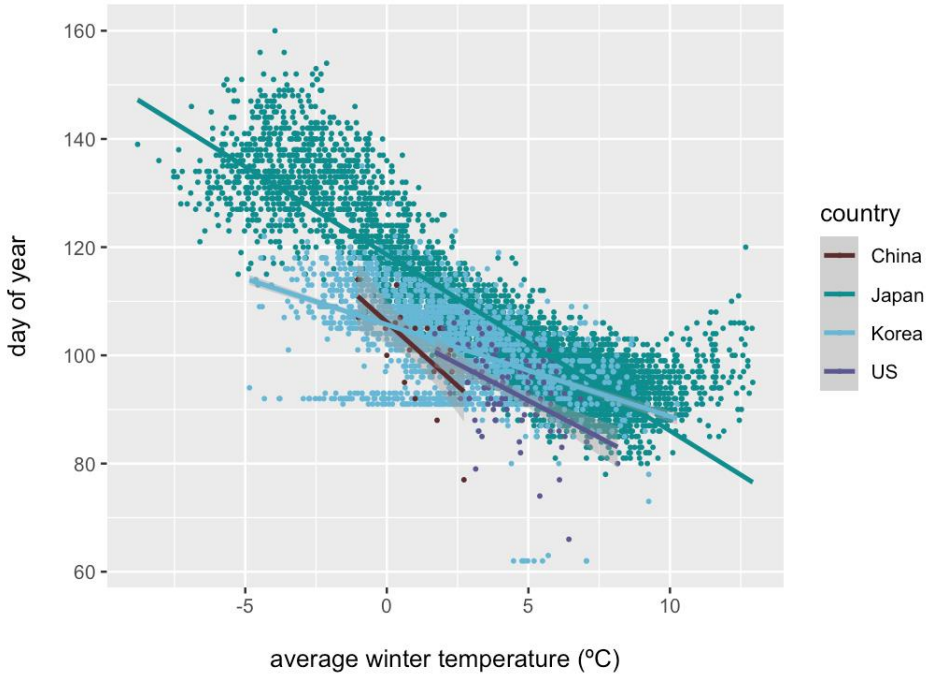

FIGURE 6. P. X YEDOENSIS OR P. YEDOENSIS?
TEMPERATURE RESPONSE OF CHERRY BLOSSOM FULL FLOWERING DAY IN KOREA, BY COUNTRY. DIFFERENCES IN RESPONSE IN KOREA RELATIVE TO OTHER COUNTRIES MAY REFLECT INDEPENDENT ORIGIN OF KOREAN CHERRY BLOSSOMS, P. YEDOENSIS VAR. NUDIFLORA.

[24] Cho et al., "Molecular and Morphological Data Reveal Hybrid Origin of Wild Prunus Yedoensis (Rosaceae) from Jeju Island, Korea: Implications for the Origin of the Flowering Cherry."

Issues with this analysis include the use of gridded climate data, which takes averages of available data in order to provide even information over time and space, but which involves the loss of fine-scale variation in the environmental features of sites. Matching phenological observations with these derived estimations of temperature and precipitation rather than known environmental conditions at the sites may obscure actual trends in the responses of flowering to climate variables. While much more precise meteorological data is available for some of the sites where cherry blossoms have been observed, gridded climate timeseries allowed me to incorporate sources like herbaria and community observation platforms which are not directly affiliated with government climate monitoring. However, it would be useful in the future to pinpoint and analyze specific sites within this dataset where climate data is available at a high spatiotemporal resolution, to compare across range at a smaller scale with more specific meteorological information and comparable sample sizes.

While photographs of plants and herbarium specimens have been used in previous studies of plant phenology, these methods are not without issue. As observations only require two positive identifications to be considered "research grade" on observational networks like iNaturalist, there is possibility for the inclusion of misidentified trees. Phenological classification could also be warped by scoring bias, in that my visual judgement of phenological phases may not match with that of the unknown people who recorded flowering in the past. Furthermore, herbarium specimens can be discolored or poorly preserved, complicating determinations of phenophase through digital records.

I would also like to note that in several cases, species as observed did not experience the same diversity of climatic conditions in their native and non-native ranges, which hinders comparison. For example, *P. serotina* existed within a much broader range of temperature and precipitation conditions in North America than in Europe, making it more difficult to determine and compare patterns of response in this species' non-native range. This may be due to continental

differences in environmental variation, but it is possible that *P. serotina* has so far been unable to naturalize in all conditions where it can typically survive, suggesting that other aspects of the ecosystem constrain its ability to realize its full fundamental niche. It could also be a side effect of the lack of data on non-native species, as I found that national organizations have not collected long-term phenological information on introduced plants. With increasing support for the importance of phenological data to studies of ecology and climate change, I hope to see more and more growth in these databases of plant information.

The results of these statistical analyses may provide more questions than answers, and without detailed data on the exact environmental conditions of the trees at these sites it is impossible to determine the specific mechanisms through which these differences in full flowering phenology are manifesting. These patterns are just a few of many that have been found regarding the flowering of cherry blossoms in response to environmental factors. However, the unique, extensive dataset of geotagged phenology records produced in this study provides a strong basis to which additional environmental information can easily be added to better explain variation, and it opens the door to many possibilities for future research. Analysis with respect to other climate variables, including more specific measures of temperature like heating degree-days or unstudied variables like sunlight and altitude, would be useful in elucidating the exact climate sensitivities of these species. Another possibility would be to subset the data and focus on comparing sites of similar representative sizes and environments between native and non-native range for each species. Data of the same type for other *Prunus* species are also available, offering opportunities for further investigation of phenology across the genus.

Cherry trees are involved in a multitude of ecosystems with various levels of human involvement, from the heart of old-growth forests to the parks and gardens that dot urban spaces, engaging in relationships of competition, facilitation, co-production, and symbiosis with other

organisms. In addition to their long and convoluted relationships with humans, cherry trees are embedded in complex interactions with bees, birds, small mammals, and other creatures that act as pollinators, herbivores, seed dispersers, or parasites. As such, shifts in flowering cherry phenology are highly relevant for conservation planning, as plant phenology has been shown to play a crucial role in terrestrial carbon balance, agricultural zoning, atmospheric feedback with vegetation, plant competition, pest and disease control, and pollen forecasting.[25] Furthermore, plants and animals in a given area have often been found to respond differently to temperature change, altering patterns of pollination and herbivory.[26] This web of relationships is further complicated when organisms are brought into new encounters and interactions through introduction by humans.

The sakura native to Japan are especially prominent throughout Japanese history and have come to represent Japanese culture and identity as a whole. *Hanami*, the springtime viewing and celebration of cherry blossoms, has been practiced in Japan for centuries and has spread all over the world along with the cherry trees themselves. This ritual is a total cultural phenomenon in Japan, gathering people of all ages under the falling petals for eating, drinking, music, poetry, and another festivities. Because of this rich cultural significance, flowering cherry trees also represent an enormous economic resource on top of their horticultural value. An estimated 63 million people travel to Japan or within Japan every year to see the sakura, with nearly 10 million coming from outside the country, driving a boost of $2.7 billion for local economies.[27] In the United States, the National Cherry Blossom Festival attracts about 1.5 million visitors annually and generates up to $160 million for the city of Washington, D.C., while over a dozen other U.S. cities have cherry

[25] Morellato et al., "Linking Plant Phenology to Conservation Biology."
[26] Susanne S. Renner and Constantin M. Zohner, "Climate Change and Phenological Mismatch in Trophic Interactions among Plants, Insects, and Vertebrates," *Annual Review of Ecology, Evolution, and Systematics* 49, no. 1 (2018).
[27] Chloe Whiteaker, Katanuma, Marika, and Murray, Paul, "The Big Business of Japan's Cherry Blossoms," Bloomberg, https://www.bloomberg.com/graphics/2019-cherry-blossoms/.

blossoms and festivals of their own.[28] A study of how Japanese residents understand global climate change and its relationship to cherry blossom flowering revealed that many were concerned about the economic impacts, as some businesses rely heavily on the income from *hanami* and sakura tourism;[29] shifts of the magnitude described in my analysis could have major implications for local economies dependent on cherry blossom season in both Japan and other parts of the world where the festivals have become important seasonal events.

[28] Horus Alas, "National Cherry Blossom Festival Generates over $100 Million for Dc," Capital News Service, https://cnsmaryland.org/2019/05/01/national-cherry-blossom-festival-generates-over-100-million-for-dc/.
[29] Ryo Sakurai et al., "Culture and Climate Change: Japanese Cherry Blossom Festivals and Stakeholders' Knowledge and Attitudes About Global Climate Change," *Biological Conservation* 144, no. 1 (2011).

Other ornamental flowering cherry trees, like the black cherry and sweet cherry varieties that I analyzed in this study, do not boast the same intense popularity as a cultural symbol and tourist attraction but still hold both cultural and economic significance. Black cherry (*Prunus serotina*) has been used by North and Central American Indigenous peoples for centuries, in food, medicine, alcohol, and woodworking. It later became an important source of timber and is highly valued for furniture, paneling, crafts, toys, and other woodwork that requires strength and a smooth finish.[30] Wild cherry or sweet cherry (*Prunus avium*), native to Europe and the Mediterranean, is one of the main ancestors of the many varieties of cultivated cherries grown across the world, and it is thought to have been a human food item since the Bronze Age. Sweet cherry wood is also valued for woodworking, while other parts of the plant were historically used for medicines and dyes.[31] As such, the flowering phenology of both of these species has massive implications for cultural practices and economies.

Even at sites where flowering has been recorded over long periods of time and where fine-scale meteorological data is available, it seems that scientists struggle to pinpoint the exact climate cues that control bloom. Perhaps it is fitting that cherry blossoms as symbols of transience elude capture even after decades of observation. While analyses like mine above may not point to specific processes underlying the phenology of flowering cherry trees, they represent observations of significant trends in Prunus phenology that, at the very least, suggest possibilities of mechanisms. Because of the importance of cherry blossoms for cultural practices as well as for economic activity, changes in the flowering phenology of cherry trees due to climate change and introduction to new regions can be expected to have major consequences well beyond the realm of ecology; I present this phenological analysis with respect to climate as one way of paying attention to the responses of

[30] Guy Nesom, "Plant Guide: Black Cherry," (United States Department of Agriculture, Natural Resources Conservation Service).
[31] E. Welk, de Rigo, D., Caudullo, G., "Prunus Avium in Europe: Distribution, Habitat, Usage and Threats," in *European Atlas of Forest Tree Species*, ed. J. San-Miguel-Ayanz, de Rigo, D., Caudullo, G., Houston Durrant, T., Mauri, A. (2016).

cherry blossoms, and I look beyond the fields of biology, ecology, and botany for other ways of doing so.

Given that cherry trees are so deeply embedded in human societies, it follows that the study of these species in the context of anthropogenic environmental problems should engage with their interconnections with humans. In this light, beginning to untangle the responses of cherry blossoms and their role as indicators requires an approach that considers these trees within an entangled web of human and nonhuman agents that together produce a multispecies environment. A view of the relationship between humans and cherry blossoms as reciprocal and mutually responsive offers a broader understanding of the impacts of environmental change. Human societies arguably adjust their phenology in response to climate through cherry blossoms too, altering the cyclical rhythms of the fiscal year and the work week to travel, gather, eat, and court in time with the appearance of pink buds and petals.

ETHNOBOTANY: BUDS

Studies of cherry blossoms in the context of climate are not just a recent venture brought about by phenology records and concerns of climate change, as others have looked to human responses to cherry blossom responses in order to understand history. In 1969, for example, geographer Takeo Yamamoto analyzed the work of 12th century Japanese poet Saigyo and found that the early appearance of cherry blossoms served as a marker of the Little Climatic Optimum, a period of warming that significantly advanced full bloom relative to modern flowering times.[32] Descriptions of bloom were also used to pinpoint the poet's location at the time of his death. Even

[32] Takeo Yamamoto, "Some Climatological Considerations About a Poem on Cherry Blossoms Composed by Saigyo," *Journal of Geography (Chigaku Zasshi)* 78, no. 4 (1969).

earlier, in 1955, H. Arakawa was able to determine climatic patterns from bloom records in Kyoto. Even without the long-term meteorological data that would later make these relationships between flowering and climate more explicit, as in the recent work of Yasuyuke Aono mentioned above, Arakawa linked late blooming to solar cold periods and noted trends of earlier blooming in the last few centuries.[33]

Scientists have also considered the responses of cherry blossoms to other aspects of their physical environment, including light irradiation. The Yoshino flowering cherry is known to often produce only white flowers when grown indoors, but this light response has not proven to be straightforward. Studies of Yoshino flower coloration found that the blossoms had variable responses to different spectrums of light, increasing pigment production in response to blue light wavelengths alone and to red light only in the presence of blue light, revealing a complex system of sensory input and response through which the plant reacts to its environment and expresses its requirements.[34]

Moving beyond the norms of physical environment, botanists like Suzanne Simard have shown that plants exhibit extraordinary sensory, cognitive, and communicative abilities to a level similar or perhaps more extensive than humans and other animals; plants display the same five senses as humans as well as the ability to measure soil humidity, to detect distant water, to sense gravity, to measure gradients in air and soil, and more. They also reveal capacity for memory, learning, and behavior without a nervous system, complicating the conventional conceptions of

[33] H Arakawa, "Twelve Centuries of Blooming Dates of the Cherry Blossoms at the City of Kyoto and Its Own Vicinity," *Geofisica pura e applicata* 30, no. 1 (1955).
[34] S. An et al., "Effects of Blue and Red Light Irradiations on Flower Colouration in Cherry Blossom (Prunus × Yedoensis 'Somei-Yoshino')," *Scientia Horticulturae* 263 (2020).

sentience and species hierarchy that color the natural sciences. These advancements in plant science highlight the vitality of plants and the expansiveness of their action.[35]

Looking to other fields of study reveals a shared understanding of flowering cherries as active and responsive agents in their environments. Studies of industry and environment draw on this nature, looking to cherry blossoms as teachers of sustainability. For example, chemist and advocate of sustainable industry Michael Braungart argues that cherry trees appear to be inefficient by industrial standards because of the perceived "waste" of the large and short-lived bloom, but that they actually demonstrate waste-free living because of how they actively interplay with the soil, pollinators, the next generation of trees, and human hearts.[36]

An analysis of cherry trees in architecture and landscape design demonstrates the role of cherry trees in human place-making, both physically and metaphorically. Sakura are commonly found marking the entrances of temples and other sacred places in Japan, and around the world they are used to commemorate the dead and to signify places of spiritual passage. Widespread planting along roadsides and rivers can lead to the formation of canopies and sakura tunnels that enclose *hanami* patrons and draw them down its length. Cherry trees also serve indexical roles in the placement of features like windows or mirrors and can make up the physical structure of buildings, as in the "patient gardener" project where flowering cherries grow into a house over several decades.[37]

The affective powers of cherry blossoms are evident in the ways that they elicit behavior in creatures around them through sight and smell. The vivid coloration of the flowers is a clear visual

[35] Suzanne W Simard, "Mycorrhizal Networks Facilitate Tree Communication, Learning, and Memory," in *Memory and Learning in Plants* (Springer, 2018).
[36] Michael Braungart, "The Wisdom of the Cherry Tree," *International Commerce Review* 7, no. 2 (2007). Not that I agree with the idea of trying to make capitalist industrial systems sustainable, because they are by definition run on the exploitation of oppressed bodies, communities, and earth systems, but the point stands that people with many different outlooks on the environment see flowering cherry trees as teachers of the cycling of life and death.
[37] Fredrik Aspling, Jinyi Wang, and Oskar Juhlin, "Plant-Computer Interaction, Beauty and Dissemination" (paper presented at the Proceedings of the Third International Conference on Animal-Computer Interaction, 2016).

cue for attracting birds and insects, ensuring the interchange of food for pollination and other services that animals can provide like pruning and parasite control.[38] A behavioral study of Luehdorfia japonica, a species of butterfly endemic to Japan, found that the scent compounds released by *P. x yedoensis* not only alerted the pollinating insect to the plant's presence but also stimulated foraging behavior.[39] It has also been found that other *Prunus* species, including *P. avium*, produce different levels of floral chemical signals to attract either specific pollinator species or a broad range of species, and that they alter the balance of visual and chemical signaling depending on vegetation density and other features of the environment.[40] These processes demonstrate the ability of cherry trees to sense their surroundings, to adjust their physical and biochemical expression accordingly, and to induce particular responses in other organisms with which they have important relationships.

The many poetic references to the breathtaking color and alluring fragrance of falling cherry blossoms as well as the crowds of people drawn in by the springtime bloom suggest that humans are similarly affected by the sight, smell, and temporality of cherry trees. These sentiments are echoed in the work of theorists of plant-human interaction, who give agency and affective power to trees in various ways and consider their roles in shaping society. Jones and Cloke's Actor-Network Theory ascribes agency to trees through their routine actions and processes of growth and reproduction, their transformative self-seeding, their purposive action through structural growth plans, and their capacity to engender affective and emotional responses in other beings. Furthermore, Michael Pollan has suggested that plant species like the apple, the tulip, cannabis, and the potato successfully spread and multiply by biochemically satisfying certain human desires and enticing humans to do their work

[38] "The Birds, the Bees, and the Flowering Cherry Trees," National Park Service, U.S. Department of the Interior, https://www.nps.gov/articles/birds-and-cherry-blossom-trees.htm.
[39] Hisashi Omura et al., "The Role of Floral Scent of the Cherry Tree, Prunus Yedoensis, in the Foraging Behavior of Luehdorfia Japonica (Lepidoptera: Papilionidae)," *Applied entomology and zoology* 34, no. 3 (1999).
[40] Ashraf M. El-Sayed et al., "Scents in Orchards: Floral Volatiles of Four Stone Fruit Crops and Their Attractiveness to Pollinators," *Chemoecology* 28, no. 2 (2018).

for them. Building on this body of work, Aspling et al. suggest that cherry blossoms, like tulips, enact their agency to spread by playing along with human desires, emotions, and aesthetic values.[41]

FIGURE 7. 桜坂 SAKURAZAKA: A CHERRY-LINED SLOPE
SOURCE: PABLO PADIERNA, "PHILOSOPHER'S PATH DREAM," KYOTO, FLICKR (2012).

Aspling et al. noted distinctive behaviors brought about by cherry blossoms in their ethnographic observation of cherry blossom viewing in Stockholm, Sweden, finding that many slowed down to inspect the buds or flowers, engaged with the blossoms through touching and smelling, and photographed them with an intensity described as "visual worship" in "an almost ritualized manner."[42] Tourism studies also suggest that cherry blossoms as a vivid visual marker of seasonal change elicit certain behaviors among humans, including the desire to get close to the trees

[41] Aspling, Wang, and Juhlin, "Plant-Computer Interaction, Beauty and Dissemination."
[42] Ibid.

and to capture their transience through photographs and other imagery.[43] Tokyo urbanites described the urge to photograph sakura not as an attempt to take the most beautiful photos but only to take photos oneself, in order to "keep" the experience of true seeing which is so distinct from viewing sakura in the newspaper or online.[44]

This impulse mirrors the seasonal consciousness and the sentiment of *mono no aware*, a melancholy arising from the experience of evanescence which similarly elicited centuries of poetry, painting, cultivating, and other forms of cherry blossom capture in ancient and medieval Japan. Like so many birds and insects, humans are drawn in by the rich color and fragrance of the ephemeral blossoms and compelled to consume, reproduce, and disperse, through a petal in a cup of sake or tea, an image stitched into a kimono, or a cutting taken and planted on the other side of the world.

While it may be impossible to scientifically prove that this is a strategy for propagation among wild cherries, relying on enamored humans to help them spread and overcome the wasteful pulses of flowers and fruits that result in so few new trees, cultivated varieties like *P. ×yedoensis* have been selected to produce very little fruit and as such have greater dependence on humans for propagation and survival. As cherry blossoms became inseparable parts of human cultures and societies, humans too became integral to the lives and spaces—the nature-cultures, the niches, the more-than-human environments—of flowering cherry trees.

In sociologist Tamito Yoshida's framework for understanding all natural beings through a common structure of resource processing systems, the climate responsiveness of cherry blossoms is seen as analogous to the way humans process a range of cultural, social, and environmental

[43] Sarani Pitor Pakan, "Can the 'Other' Frame Back in Tourism Studies? Experimenting to Respond in an Asymmetrical Dialogue," *Tourism Review*, no. 16 (2019).
[44] Lucy Walker et al., *Tsunami & the Cherry Blossom* (United States: Supply & Demand Integrated, 2011).

information.[45] Bringing this framework into conversation with an ethnobotanical multispecies view, one that complicates the boundaries between human culture and nature, it follows that cherry trees are also engaged in this web of cultural and social relations. Cherry blossoms respond to environments in which humans are inextricably implicated, and humans respond to the signs, symbols, norms, and values in which cherry blossoms are implicated; both humans and cherry blossoms act in response to shifts in the intersecting niches that they occupy.

Humans have been compelled to spread cherry blossoms around the world, to fill urban spaces with them, and to record them in so many ways for centuries, and as a result, the environments that cherries inhabit are intricately connected to human place-making and cultural transformation. The physical distribution and even the genetic structure of cherry blossoms are linked with the ways that humans have altered the landscape over time, enabling these species to serve as a lens into the societies in which they are embedded. Cherry blossom flowering is able to act as an indicator of urban warming, for example, because its cultural significance and extensive cultivation for greening and development projects made the trees so common in urban spaces.[46] As an interdisciplinary, intersectional approach to ethnobotany reveals, cherry trees respond to and elicit response in much more than just their physical environment of climate and plant-pollinator interactions, branching into the spheres of the social and cultural that Western science reserves for humanity.

Scholars like Val Plumwood and Donna Haraway have argued that environmental problems like climate change arise out of exploitative power dynamics based on rigid dualisms between humans and nature, matched by the parallel dualisms of culture and nature, civilized and primitive,

[45] As described by Koichi Hasegawa, "Information and Resource Processing Paradigm," *The Blackwell Encyclopedia of Sociology* (2007).
[46] Yukitaka Ohashi et al., "The Phenology of Cherry Blossom (Prunus Yedoensis "Somei-Yoshino") and the Geographic Features Contributing to Its Flowering," *International Journal of Biometeorology* 56, no. 5 (2012).

modern and backwards, white and black, masculine and feminine.[47] As such, climate change and species introduction cannot be viewed in isolation for their impacts on "natural" entities like ecosystems, as these issues are shaped and borne of the same systems of oppression that prevail in human society. And as urban trees so beloved by humans, cherry blossoms are especially subject to rifts and shifts in these social structures. With their incorporation into human societies around the world, cherry trees are uniquely situated to reflect the systems of difference and power that govern relationships among humans and between humans and the environment, the same systems that produce disruptions like climate change. Haraway invites us to commit ourselves to ongoingness in reconfigured relationships with multispecies kin, thinking-with other organisms like the cherry trees that have lived alongside us for centuries.[48] If climate change has been systematically produced by the oppression of the dualistic other — the realm of the natural, the ethnic, and the feminine — then looking to cherry blossoms as indicators of climate change requires looking through the entangled worlds of the ecological, sociocultural, and geopolitical.

When one considers cherry blossoms not as an isolated species nor as part of an isolated ecosystem but as intricately embedded in systems of interrelation among soil, water, plants, animals, and human societies, their potential power as indicators extends from climate to more-than-human environment: the question of what cherry blossoms tell us about climate in different parts of their range becomes a question of what cherry blossoms tell us about more-than-human environments in different parts of their range. Wherever they appear, cherry blossoms point to tension and transformation in the power structures that have historically produced environmental damage and systemic oppression through the enforcement of these dualisms related to race, gender, and

[47] Val Plumwood, *Feminism and the Mastery of Nature* (Routledge, 2002); Donna Haraway, "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century," *Technology and Values: Essential Readings* (2009).
[48] Donna J Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Duke University Press, 2016).

humanity. Paying attention to cherry blossoms reveals shifts in climate, in culture, in political power, in racial relations, in gender roles, and even in the physiological balance of the body.

Agustín Fuentes offers the route of integrated multispecies anthropology developed as a mode of naturalcultural criticism in order to describe "mutual ecologies," the interweaving of structural and social ecologies that govern the physical and biotic as well as the political, historical, and cultural landscape. He argues that studying the way humans and other organisms coproduce and co-construct niches through ecological, behavioral, and physiological processes can help us to understand how humans have acted as agents of environmental change, resisting the easy narratives of the Anthropocene. Fuentes also draws on Haraway in invoking the space of ethnoprimatology, in which "ethno" indicates a rejection of epistemological boundaries and the inclusion of social, economic, and political contexts at the center of inquiry, incorporating traditional models of ecological data collection with ethnographic practice and sociostructural analyses.[49] I follow his lead in ethnoprimatology with a foray into what I will call "ethnobotany," not just as a botanical practice that diverges from universalized Western scientific knowledge but one that understands humans and plants as deeply intertwined in a process of co-creating nature. Starting from the knowledge offered by traditional plant ecology lens, I will expand outwards into a broad ethnobotanical analysis that considers the deeply entangled histories of humans and cherry blossoms.

I draw inspiration from Robin Wall Kimmerer, Alexis Pauline Gumbs, Julie Cruikshank, Anna Tsing, and Bathsheba Demuth, who have shown me how much there is to be discovered when we try to understand a species through every available way of knowing the world, including those that grant species agency and response-ability.[50] Faced with a hotpot of science, archives,

[49] Agustín Fuentes, "Naturalcultural Encounters in Bali: Monkeys, Temples, Tourists, and Ethnoprimatology," *Cultural Anthropology* 25, no. 4 (2010).
[50] Robin Wall Kimmerer, *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants* (Milkweed Editions, 2013); A.P. Gumbs and adrienne maree brown, *Undrowned: Black Feminist Lessons from Marine Mammals* (AK Press, 2020); Julie Cruikshank, *Do Glaciers Listen?: Local Knowledge, Colonial Encounters, and Social Imagination* (ubc Press,

social critique, and oral history, these women take what they can find and mash it together, take it apart and put it back together, turn it on its head, read between its lines, and somehow manage to weave through the muck threads of incredible meaning. I believe that they do this by giving other species unlikely voices, by paying attention to radical forms of response, by letting nonhumans lead them down paths of storytelling where humans tend not to venture. Everywhere you look, across the boundaries imposed on time, space, and society, sakura appear to do much more than just react to those variables that are measurable with the tools of capital-S Science. They reflect life, death, and transformation; they house gods, souls, and memory; they inspire hope, upheaval, and action.

Though this view of cherry blossoms does not come easily from the understandings of plants or the environment engender by Western settler colonial science, it appears through the bridging of fields and the breaking of disciplinary boundaries. Working across dualisms allows cherry blossoms to reveal similar pushes and pulls of dichotomy in the fabric of society throughout history. Respect for the agency, responsiveness, and interconnectedness of cherry blossoms is something that flows naturally from the practices of those who first revered them as spirits and deities. They watched closely enough to know without meteorological equipment that the blossoms were telling them something about climate, and their understandings of the tether between cherry blossoms and the constantly transforming forces of life and death have permeated time and space. Through relationships of respect and reciprocity, ancient peoples were able to make sense of their world through cherry blossoms.

Sano Tōemon XVI, a 16th-generation cherry master or "keeper of the sakura" outside of Kyoto, says that "everyone sees sakura differently depending on how they are feeling. If you are

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2007); Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton University Press, 2015); Bathsheba Demuth, *Floating Coast: An Environmental History of the Bering Strait* (WW Norton & Company, 2019).

feeling peaceful, you will see them as peaceful. If you are irritated, you will see them as irritating. Cherry is the tree that will sympathize with you."[51] It is not just our ability to relate to the cherry blossom but its ability to relate back that allows the tree to reflect and draw out the intricate cycles and transformations that surround it. Taking cherry trees as responsive agents in their environments opens new windows of analysis into the entangled roots and branches of nature-cultures.

[51] Walker et al., *Tsunami & the Cherry Blossom*.

CHERRY BLOSSOMS AS INDICATORS OF CULTURE + COSMOLOGY

Trees have been understood for their spiritual nature all over the world for centuries. They have offered shelter, food, medicine, tools, and fuel over centuries of civilization, and conceptions of trees as the living representation of life trace back to the Neolithic era. They are also frequently associated with knowledge and wisdom, as in the Tree of Knowledge or the Tree of Life. This is further evidenced by the derivations of the words for these concepts in the Germanic languages, Anglo-Saxon *witan* (mind, consciousness) and *witiga* (wisdom), English "wits" and "witch," and the German *witz* (wits, jokes), all of which stem from the root *vid* meaning wood or forest.[52]

Sacred trees differ by ancient culture, cedar in Sumer, plane trees in Persia, the World Tree in Siberia, but they each appear as a source of knowledge, healing, and connection with the divine. Even early timber harvesting was treated not as extraction but as an interchange mediated through spirituality, with inscriptions on the tomb of treasurer to the Egyptian Pharaoh Thutmosis III 3,500 years ago revealing that trees were taken only with permission gained through offerings.[53] Humans and trees thrived in relationships of respect and reciprocity where both were understood as parts of a larger web of interconnected life, and on every continent flowering cherry trees have offered people insight into the cycles of life, death, and rebirth.

[52] Fred Hageneder and Lizzie Harper, *Living Wisdom of Trees : A Guide to the Natural History, Symbolism and Healing Power of Trees* (2020).
[53] Ibid.

TEACHER AND HEALER

Black cherry has been an incredibly bountiful resource for humans, used for food, medicine, and woodworking in many American Indigenous nations. The Cherokee, Delaware, Iroquois, Chippewa, Mohegan, Micmac, Menominee, Ojibwa, Penobscot, Potawatomi, Malecite, Mahuna, Rappahannock, and Shinnecock peoples all used black cherry in their traditional remedies. Decoctions of the bark are used to draw out fever and chills as well as to remedy headaches and lung inflammation, and the bark also serves as a disinfectant, burn salve, and wound poultice. Root bark in particular can treat sores and ulcers and act as a blood purifier. Fruits were widely used to treat cough and diarrhea, and in Mohegan medicine liquid from the fruit for a year was given as a treatment for dysentery.[54] Extracts from black cherry also commonly appear in Mexican traditional medicine, used to treat hypertension and heart disease by promoting vasorelaxation.[55]

Black cherry fruits were also a food source, eaten fresh, dried, made into jam, or fermented into wine or whisky. In tension with the ephemerality associated with the flowers, the Delaware and Iroquois turned black cherry fruits into dried cakes that could be stored for the future. The Mahuna ate berries mainly to quench thirst. As such, black cherry exists at the narrow line between medicine and poison, nutrient and intoxicant, its bark and berries beneficial when fresh or properly fermented but just as easily a toxic killer when allowed to go stale.[56]

The use of the native cherry for multiple cultural functions in conjunction with spiritual beliefs about trees points to a reverence for cherries and an appreciation of their reciprocal relationship with humans. The Cherokee, for example, moderate their many uses of black cherry

[54] Daniel Moerman, "A Database of Foods, Drugs, Dyes and Fibers of Native American Peoples, Derived from Plants," (Native American Ethnobotany Database, 2003).
[55] César Ibarra-Alvarado et al., "Vasorelaxant Constituents of the Leaves of Prunus Serotina "Capulín"," *Rev. Latinoam. Quim* 37 (2009).
[56] Moerman, "A Database of Foods, Drugs, Dyes and Fibers of Native American Peoples, Derived from Plants."

through dutiful respect for the tree.[57] The contributions of black cherry and other trees are honored in the Cherokee story "The Trees Are Alive" told by Edna Chekelelee, where she suggests that we pray for the trees because they're alive, because they give us shelter and clean air so that we might "make it," and because they, like life and water, came from god.[58]

In addition to being one of the commonly cultivated table cherries, wild cherry is an important plant in the ancient medicine of the Mediterranean region, including Turkey and Bosnia and Herzegovina. In this area, cherry stems were traditionally dried or prepared as tea for use as a diuretic, promoting kidney function and helping to clear stones from the kidney and bladder. Sweet cherry stems and fruits both exhibit strong anti-oxidative, anti-bacterial, and anti-inflammatory properties, and the fruits have been found to alleviate arthritis and pain related to gout and to reduce the proliferation of human colorectal cancer cells.[59] Grave sites in southeast Europe dating back to the Mesolithic era were found to contain Cornelian cherry fruit stones, suggesting a similar early association with life and death for cherries in this part of the world.[60]

The Matsumura cherry blossom *P. yedoensis* native to Jeju Island also appears in Korean folk medicine. The bark of this tree has traditionally been used to treat a range of ailments, including asthma, measles, cough, urticaria, pruritis, and dermatitis. Recent studies have also determined that the bark has a vasorelaxant effect and that it can be used to promote healing of scald wounds by drawing out inflammation and promoting tissue regeneration.[61] *P. serrulata* is also used in Korean

[57] Ibid.
[58] Barbara R. Duncan and Davey Arch, *Living Stories of the Cherokee* (Chapel Hill: The University of North Carolina Press, 1998), Book, 128-29.
[59] Zahida Ademović et al., "Phenolic Compounds, Antioxidant and Antimicrobial Properties of the Wild Cherry (Prunus Avium L.) Stem," *Acta Periodica Technologica*, no. 48 (2017); Erdem Yeşilada et al., "Traditional Medicine in Turkey Iv. Folk Medicine in the Mediterranean Subdivision," *Journal of ethnopharmacology* 39, no. 1 (1993).
[60] Dragana Filipović et al., "Gathered Fruits as Grave Goods? Cornelian Cherry Remains from a Mesolithic Grave at the Site of Vlasac, Danube Gorges, South-East Europe," *Quaternary International* 541 (2020).
[61] YQ Zhang et al., "The Anti-Inflammatory Effect of Cherry Blossom Extract (Prunus Yedoensis) Used in Soothing Skincare Product," *International journal of cosmetic science* 36, no. 6 (2014); Jin-Ho Lee et al., "Wound Healing Effects of Prunus Yedoensis Matsumura Bark in Scalded Rats," *Evidence-Based Complementary and Alternative Medicine* 2017 (2017).

herbal medicine, the bark and stems used to treat allergic diseases according to the Donguibogam medicine book of the Joseon dynasty.[62] The fruits appear as treatment for heart failure, dropsy, mastitis, and emmenagogue and have high antioxidant and antiviral activity, such that they are suggested for the prevention of cancer and heart disease. A mixture of *P. yedoensis*, *P. serrulata*, and *P. sargentii* (Sargent's hill cherry) was taken as a detoxifier, relaxant, and cough remedy.[63]

Broadly speaking, flowering cherries in early cultures were used benignly as a nutrient and resource but also to react within the body at places of tension caused by inflammation, disease, damage, contamination, and transformation.[64] While the products of flowering cherry trees can be everyday foods, they also act medicinally where the regular cycles of organ systems like lungs and skin are disrupted. Across three continents, cherry trees and their offerings to humans were treated with spiritual reverence, understood as markers of the cycles of life and death at the level of cells and organs as well as in multispecies relationships, the ongoing shifts in the balance of forces that produce living bodies in interconnection. In the many societies where they appear, these trees impart healing as well as wisdom about the turning of the universe.

Cherry blossoms also enter the realm of the body in Japanese culture, but sakura have historically been used ceremonially rather than for strictly functional or medicinal purposes. Cherry flowers and leaves instead serve as inedible garnishes, symbolic markers of the cultural practices for

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[62] Min-Jong Kim et al., "Prunus Serrulata Var. Spontanea Inhibits Mast Cell Activation and Mast Cell-Mediated Anaphylaxis," *Journal of ethnopharmacology* 250 (2020).
[63] Hong-Sun Yook et al., "Antioxidative and Antiviral Properties of Flowering Cherry Fruits (Prunus Serrulata L. Var. Spontanea)," *The American journal of Chinese medicine* 38, no. 05 (2010).
[64] Today, cherry blossom extract itself still serves as an antibacterial in medicines and cosmetics and also provides the phytoconstituents for a "green" process of synthesizing silver and gold nanoparticles, which are powerful antibacterial agents used in medicine. See P Velmurugan et al., "Crystallization of Silver Metal by Extract of Prunus× Yedoensis Matsumura Blossoms and Its Potential Characterization," *Journal of Industrial and Engineering Chemistry* 31 (2015); Priyanka Singh et al., "In Vitro Anti-Inflammatory Activity of Spherical Silver Nanoparticles and Monodisperse Hexagonal Gold Nanoparticles by Fruit Extract of Prunus Serrulata: A Green Synthetic Approach," *Artificial cells, nanomedicine, and biotechnology* 46, no. 8 (2018).

which the food is being prepared, as in the festival of *hanami* celebrated with cherry petals floating in sake and sweet pink *sakuramochi* filled with red bean and wrapped in a cherry leaf.[65]

Sakura as it appears in Japanese culture also permeates the body, but many would say that it permeates being in profound ways beyond the physical, woven into earth and ancestry. The words of Motoori Norinaga, a poet of the Edo period (1603-1868), point to centuries of cultural development that position sakura as the essence of identity native to the island of Japan:

> Should someone ask,
>
> 'What is the soul Of Yamato, our ancient land?'
>
> It is the scent of mountain cherry blossoms
>
> In the morning sun. [66]

SEAT OF SPIRITS

Sakura have been revered in Japan for centuries, and the first rituals in their honor developed well before recorded history. These practices arose from a worldview that took the boundaries between humans, nature, and the spirit world as open and ever-changing, through the animistic Shinto tradition of worshipping *kami* (gods or spirits) held in nonhuman beings. As described by Charles Shirō Inouye, "the barriers between human and divine beings were porous,

[65] Robert W Pemberton, "Japanese Food as Art and Symbol: Evidence from Inedible Leaf Garnishes," *Petits Propos Culinaires* 63 (1999).
[66] Charles Shiro Inouye, *Evanescence and Form : An Introduction to Japanese Culture* (New York, N.Y.: Palgrave Macmillan, 2008), 140.

even to the point that the supernatural world *was* the natural world. In Japan, a tree, a waterfall, a rock can be a god (*kami*). This was true anciently. It remains true today."[67]

Trees held particular wisdom and spiritual importance in Shintoism, inhabited by tree spirits called *kodama* who gave them personality. Trees were believed to have emotions and would scream or groan when cut. As such, premodern Japanese people regarded trees with reverence and caution, placing sacred ropes or *shimenawa* around certain trees to warn off others who might cut them down and anger the spirit.[68]

In ancient Japan, rice was the most sacred plant, the representation of agrarian life and energy and the house of the soul. Japanese myth-histories pinpoint cherry blossoms as the symbolic equivalent of the rice plant, symbolizing life energy. In the *Kojiki*, one of the earliest written mythologies of Japan dating back to A.D. 712, the Sun Goddess Amaterasu sends her grandson Ninigi-no-Mikoto to transform the land into a country with stalks of rice grown from heavenly seed, and this grandson marries the female deity *Konohana-no-Sakuya-Bime* (A Blossom on a Tree); this grandson's choice of wife results in his life being short like the blossoms, and for this same reason emperors, and humans in general, do not live long.[69] The association of cherry blossoms with transience would continue throughout Japanese cultural sensibility into the present.

These myth-histories, the earliest written records of Japan, drew on traditional beliefs but standardized them into one official agrarian cosmology that became the foundation for Japan's symbolic politics. The codified association of rice with cherry blossoms came largely from practices of mountain worship (*sangaku shinkō*), centered around the belief that the Mountain Deity (*Yama-no-Kami*) is the most powerful of the Japanese pantheon and that the mountains are therefore the most

[67] Ibid.
[68] Glenn Moore, Atherton, Cassandra, "Eternal Forests: The Veneration of Old Trees in Japan," *Arnoldia*, May 18, 2020 2020.
[69] Emiko Ohnuki-Tierney, "Cherry Blossoms and Their Viewing," *The culture of Japan as seen through its leisure* (1998).

sacred space. As cherry blossoms in ancient Japan were exclusively *yamazakura* (*Prunus jamasakura*), the mountain cherries that preceded cultivation of new hybrid varieties, cherry blossoms were thought of as the home of the Mountain Deity. Some scholars believe that *sakura* is formed from the words *sa* (deity) and *kura* (seat), referring to the Deity of Rice Paddies (*Ta-no-kami*) that was born each spring when the Mountain Deity descended to the rice paddies on the petals of cherry blossoms in order to look after agricultural production.[70]

Various agrarian practices associated with mountain worship tie cherry blossoms to rice production and agricultural prosperity through the climate. These early Japanese peoples looked to snow in the early spring as well as the blooming of flowers, particularly mountain cherry blossoms, as forecasts for the fall rice crop. Petals falling prematurely were considered inauspicious for the fall growing season, and rituals of prayer were performed for long-lasting bloom. These practices ultimately developed into the flower festival *hana-e-shiki* or *chinkasai*, held at temples and shrines by the 8th century and intended to expel evil spirits causing epidemics through the power of the "flowers of rice plants." Through their godly residents cherry blossoms were intrinsically linked to annual seasonal cycles, as a marker of the end of winter and the beginning of spring but also as an indicator of upcoming conditions in the late summer and fall, an understanding of flowering as both a spiritual and environmental process.[71] Climatic change could be known and understood by observing changes in the flowering of these cherry trees, just as is done today.

The mountain is also considered the abode of the dead, with a common folk belief that a dead person goes to the mountains to rest and after thirty-three years joins the collective of identity of the ancestors, in unity with the Deity of the Mountain and the Deity of Rice Paddies. Cherry trees, especially weeping cherry trees, are thought to be a conduit between the world of the living and the

[70] *Flowers That Kill: Communicative Opacity in Political Spaces* (Stanford University Press, 2015).
[71] *Kamikaze, Cherry Blossoms, and Nationalisms: The Militarization of Aesthetics in Japanese History* (University of Chicago Press, 2010).

dead, with spirits and dead souls taking shelter in them and traveling from sky to earth and back again through their roots, trunk, and branches. In oral tradition from Shinano, Nagano Prefecture, it is said that a ghost appeared where a cherry tree marked the entrance to the world after death, telling the people that those who saw the cherry blossoms in life would be spared torture and granted a successful transition into an ancestral spirit. Understandings of climate and living in harmony with the land in ancient Japan were grounded in observations of cherry blossom flowering and a conception of these trees as responsive spiritual entities that hold the gods as well as the dead.[72]

Inouye points out that Japan is a land geologically defined by transformation, an island chain produced from the movement of tectonic plates over a volcanic hotspot, whose people must be attuned to the shifting of the earth that can shake homes to the ground or bring waves the size of mountains crashing to shore.[73] These reminders of constant change are built into the very earth on which the earliest islanders settled. Inouye's analysis suggests that cherry blossoms as a marker of seasonal cycles serve as a way of understanding the intense transformation and transience that characterize Japan's grounded reality. The annual bloom, consistent even if ephemeral, provide a tempo for aligning with the rhythms of the seasons among broader forces of geological and environmental change.

Interestingly, Japan's geological transformation is also intricately linked with sakura in that sakura literally appear in the strata: blossom-shaped mineral formations called *sakura ishi*, formed from intergrowth of cordierite-indialite into mica pseudomorphs and sometimes colored pink with hematite, are found only in central Japan. *Sakura ishi* appear in particular around the Kyoto region, where cherry blossoms have been revered for centuries, as well as in mountainous areas that also serve as the sites of *O-bon*, the Buddhist festival of the dead. These crystal formations are fragile and

[72] Ibid., 37.
[73] Inouye, *Evanescence and Form : An Introduction to Japanese Culture*.

require processes for preservation, much like their namesake. Though *sakura ishi* occur as part of a much longer-term process, the geological cycling that defines the land's physical form and basis rather than the seasonal climatic variation that produces sakura bloom, both emerge as markers of cyclical transformation related to powerful earthly forces.[74]

FIGURE 8. EVENING GLOW AT KOGANEI BORDER, UTAGAWA HIROSHIGE
WOODBLOCK PRINT DEPICTING TIES BETWEEN THE SACRED MOUNTAIN, GROWING OF RICE, PRACTICES OF HONORING SAKURA, AND THE CLIMATE. 1797-1858

INSCRIPTION: POEM BY TAIHAIDO DONSHO
THE GLOW OF SUNSET AT THE END OF A CLOUDY SPRING DAY
FORETELLS TOMORROW'S WEATHER IN KOGANEI,
WHERE CHERRY BLOSSOMS ARE IN FULL BLOOM.

SOURCE: METROPOLITAN MUSEUM ONLINE COLLECTION

Cherry blossom viewing, *hanami*, thus originated as a religious ritual under cherry trees in the sacred mountains in honor of the spirits that descend with the falling blossoms and the spiraling

[74] John Rakovan, Masao Kitamura, and Osamu Tamada, "Sakura Ishi (Cherry Blossom Stones): Mica Pseudomorphs of Complex Cordierite-Indialite Intergrowths from Kameoka, Kyoto Prefecture, Japan," *Rocks & Minerals* 81, no. 4 (2006).

cycles of life and death that they bring with them. The drinking of *sake* that still accompanies this ritual today is said to be derived from the sacred rite of humans and the deity sharing wine made from the deity's body. Likewise, the singing, dancing, art-making, and feasting that are still common in modern hanami derive from rituals once practiced in honor of the gods housed by these plants.[75]

This agrarian cosmology was not maintained but rather incorporated into the culture of the imperial elite, which had already begun to foreground the aesthetics of cherry blossoms as a sign of cultural refinement, political power, and wealth. While commoners continued to enjoy cherry blossom viewing over the centuries, with wide-ranging celebrations and festivals, it was not until the Edo period (1603-1868) that the people of Tokyo began to establish a well-documented hanami tradition distinct from elite practices. Even with these divergent paths of development in the practice of hanami, however, the rituals practiced today speak to an understanding of cherry blossoms as sacred, spiritual entities that bloom in relation to both the climate and the actions of humans around them.

Though patrons of hanami today do not necessarily act with explicit religious purpose, sakura viewing maintains its role as a way of appealing to the gods for good fortune. For example, modern Japanese students look to sakura as symbols of good luck on examinations, using expressions like "the sakura have bloomed" and the "sakura have fallen" to refer to passing or failing and exchanging cherry blossom-themed trinkets for good luck in place of visiting shrines or giving shrine charms.[76] The rural practice of planting cherry trees in cemeteries for the souls of the dead also continues in urban settings in Japan and around the world. In this sense, sakura continue to inform people's understandings of god and universe today.

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[75] Ohnuki-Tierney, "Cherry Blossoms and Their Viewing."
[76] Moeko Okada, "Wordplay as a Selling Strategy in Advertisements and Sales Promotion," in *Language and Humour in the Media*, ed. Jan Chovanec and Isabel Ermida (Cambridge Scholars Publishing, 2012).

Experiential understandings of the relationship between cherry blossoms and climate also persist into the present. For centuries, worshippers at temples and shrines around the mountain town of Yoshino have observed how trees flowered at different times during the spring due to subtle, site-level differences in climate.[77] Furthermore, there persists a Japanese superstition that lighter flower color is related to a long winter, indicating a sense for the response of cherry blossoms to low light without technical knowledge of the relationship between light irradiation and flower coloration.[78]

The view of sakura as alive, divine, and responsive has not faded from belief. In the words of Sano Tōemon, whose family has raised cherry trees for over 300 years: "It's like raising children. You think about them all the time, but you have to let them do what they want. You take care of them when they get sick. The trees here are still young kids. They listen to me because they're still young. When they get a few hundred years older, a god will inhabit them, and they'll each have their own unique atmosphere and identity."[79]

In this light, no interaction between humans and cherry blossoms can be seen as a simple extraction of value, as these relationships are based in reciprocal spiritual interchange. An analysis of ecosystem services may fail to capture the joy, healing, interconnectedness, and good fortune provided by these trees, and a discussion of their climate responses may fail to capture the many other human alterations of their environments that flowering cherries sense and reflect. Cherry blossoms with unique identities are cherry blossoms that watch, perhaps with interest or other emotion (teenage angst, even?), as history enfolds them and unfolds around them. They watch from the green spaces and waterways that cut through the clean lines of humanity, roots and branches

[77] Naoko Abe, *The Sakura Obsession: The Incredible Story of the Plant Hunter Who Saved Japan's Cherry Blossoms* (Vintage, 2019).
[78] Yoririn, "17 Interesting Japanese Superstitions," Tsunagu Japan.
[79] Walker et al., *Tsunami & the Cherry Blossom*.

reaching across the boundaries of nature to dip into bloody more-than-human stories, and they tell those tales in the pink stain of their petals against the sky.

YAMATO SOUL

Other species closely related to flowering cherries also hold important cultural significance, and this ultimately led to the intensified role of sakura in Japanese society in particular. The plum blossom, *Prunus mume*, was revered in ancient China long before the Japanese began to worship sakura. Due to Chinese colonial influence, plum blossoms were widely appreciated by the early Japanese upper class, featuring more heavily than cherry blossoms in poetry and other artwork of the 4th and 5th centuries.[80] Peach trees, *Prunus persica*, were also prominent in Chinese culture, and they are said to represent spring, vitality, and relationships much like sakura. However, in Hong Kong peach blossoms also serve as a symbol of distinction from Chinese political rule, in claiming difference from Chinese reverence for the plum blossom.[81]

Likewise, sakura developed into a symbol of Japanese culture and national identity partially as an attempt on the part of Japanese aristocrats to distinguish themselves from the Chinese elite. The plum blossom viewing practice of the Chinese upper class ultimately became fused with Japanese agrarian custom honoring sakura and celebrating the coming of spring, bringing about the rise of *hanami*. The first Japanese imperial viewing of cherry blossoms occurred in 813, honoring a cherry tree in front of the palace that had replaced a plum tree originally planted there. Despite continuing Chinese influence on Japanese elite culture, including adoration for Chinese characters

[80] Ohnuki-Tierney, *Kamikaze, Cherry Blossoms, and Nationalisms: The Militarization of Aesthetics in Japanese History*, 53.
[81] Yin-lun Chan, "On the Symbolism of Plants in the Context of Hong Kong," *Yuanlin/Planting Futures* 15 (2015): 18.

and rituals, cherry blossoms were harnessed as a symbol to differentiate Japanese painting, poetry, and pomp from that of the powerful mainland civilization.[82]

The transition of sakura from a site of spiritual connection into a cultural symbol can be traced through the heavily codified poetry of the Japanese high court in the Heian period (794-1195).[83] As *hanami* became more and more alienated from rural life and the agrarian rituals at the root of the practice, entrenched in elite ceremony and art, conceptions of sakura diverged from understandings of evanescence and seasonality through experience with the landscape and instead developed through poetic codes relating the blossoms to spring and Japanese identity. These strict associations in art were ultimately translated and recoded into a chronometric understanding of sakura's cyclicality that matched the mobility, urbanization, and eventually industrialization of the masses.[84] *Hanami* also came to signify social structure, with each social group practicing its own distinct version of the ritual.[85]

Sakura were widely planted beginning in ancient times for their beauty but also for the practical purpose of strengthening riverbanks. There was a widespread belief that the leaves and petals had antitoxic properties, which led to their planting along rivers and aqueducts.[86] Even in places where they provided no other notable ecosystem services, sakura were planted by obligation in public spaces across Japan in order to instill national pride.[87] During the Edo period (1603-1868), when the shogunate required regional lords to reside in Edo every other year, officials brought over

[82] Ohnuki-Tierney, *Kamikaze, Cherry Blossoms, and Nationalisms: The Militarization of Aesthetics in Japanese History*, 33-34.
[83] Inouye, *Evanescence and Form : An Introduction to Japanese Culture*.
[84] Kati Lindström, "From Experiential to Chronometric Seasonality–the Establishment of Seasons as a National Symbol in Modern Japan," in *Seasonal Landscapes* (Springer, 2007), 225.
[85] Ohnuki-Tierney, "Cherry Blossoms and Their Viewing."
[86] *Kamikaze, Cherry Blossoms, and Nationalisms: The Militarization of Aesthetics in Japanese History*, 55.
[87] Lindström, "From Experiential to Chronometric Seasonality–the Establishment of Seasons as a National Symbol in Modern Japan," 223. Lindström highlights that the popular Somei-yoshino variety was particularly useless when not blooming, as it is bred to produce minimal fruit and does not offer substantial shade.

200 varieties of cherry trees from their own regions of Japan, transforming Edo—and therefore Japan—into the land of cherry blossoms.[88]

Bashō, a prominent poet during this era, featured both plum blossoms and cherry blossoms heavily in his work. Bashō was particularly interested in the bitterness and nostalgia invoked by life's transience, and he was highly attuned to seasonal cycles in nature. He pointed to the lateness of cherry blossom bloom as a sign of the tardiness of spring, which he connected to other cues like the thaw, bush-warblers, and plum blossoms. His work speaks to the cultural sensibility regarding seasonality and the importance of cherry blossoms in understanding climate at that time.[89]

Other poetry from this time invokes cherry blossoms as the quintessential representation of *mono no aware*, the sentiment of deep emotional movement by the sadness of passing things said to be core to Japanese identity. Here too the cherry blossom appears to highlight possibilities of transformation and duality: while invoking melancholy through their transient bloom, the intense beauty of the falling blossoms provides a moment for transformation into joy and pleasure. The cherry blossom thus developed as "the aesthetics of the sullied and the weak," beautiful in a "self-pitying yet assertive way," a living representation of the bittersweet truth of constant change.[90]

Throughout the Japanese feudal age (1185-1600), in the four centuries before the Edo period, bushidō served as the moral code for samurai behavior and lifestyle. Though these guidelines for the way of the warriors developed in the medieval period, it was not until fusion with Confucian ethics in the Edo period that the term bushidō was coined. The concept was further transformed in the early Meiji period that followed (1868-1912), creating a new tradition which established bushidō not as the soul of just Japanese warriors, but as the soul of all Japanese. These reimaginings also firmly established cherry blossoms as the symbol of the Japanese soul embodied in bushidō and

[88] Ohnuki-Tierney, *Kamikaze, Cherry Blossoms, and Nationalisms: The Militarization of Aesthetics in Japanese History*, 55.
[89] Koji Kawamoto, "The Use and Disuse of Tradition in Bashō's Haiku and Imagist Poetry," *Poetics Today* (1999): 714-15.
[90] Inouye, *Evanescence and Form : An Introduction to Japanese Culture*, 82.

transformed notions of loyalty to one's master into loyalty to the emperor. These adaptations to understandings of the warrior's way were part of an insidious shift in the meaning of cherry blossoms, from a symbol of Japanese cultural nationalism to one of political nationalism acted out in the sacrifice of soldiers for the emperor.[91]

In her book *Kamikaze, Cherry Blossoms, and Nationalisms: The Militarization of Aesthetics in Japanese History*, Emiko Ohnuki-Tierney describes the use of the cherry blossom as a motivating symbol for Japanese pilots who flew to their violent sacrificial deaths in the Second World War, known as *tokubetsu kōgekitai* (Special Attack Forces) or *tokkōtai* in Japan and as *kamikaze* ("divine wind") outside of Japan. Sakura were directly associated with these suicide missions as vehicles of motivation and aestheticization, in the use of the symbol in propaganda, uniforms, the design of the planes, and even the names of tokkōtai pilot corps. She argues that through its polysemy, sakura confounded the mismatch between the pilots' thoughts and the state's ideologies, moving the pilots to sacrifice through a combination of naturalization, aestheticization, and misrecognition.

The construction of the Yasukuni Shrine served as a moment in which cherry blossoms pivoted towards militarization. Intended by Meiji oligarchs to console the souls of the dead who fought for the Meiji Restoration, the Shrine featured cherry blossoms meant to offer their beauty as comfort. However, the shrine was also under the control of the rising military, and ultimately became a place for enshrining the souls of those loyal to the emperor: the histories published by the shrine directly linked the image of falling cherry petals to those sacrificing themselves for the emperor. In reflection of this association, a very popular song was later composed portraying naval cadets as scattering like falling cherry blossoms, reborn as the flowers blooming for the emperor's viewing at Yasukuni Shrine.[92]

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[91] Ohnuki-Tierney, *Kamikaze, Cherry Blossoms, and Nationalisms: The Militarization of Aesthetics in Japanese History*, 116-18.
[92] Ibid., 107-09.

Besides the representative symbology of Yasukuni Shrine, cherry blossoms appeared in militaristic development throughout the early Meiji period. Beginning in 1870, the cherry blossom featured centrally in military insignia on uniforms and weapons, and badges of honor began to use cherry blossoms as the main motif. As such, blooming cherry blossoms came to represent the might of soldiers, while military songs referenced the cherry blossoms on the collars of soldiers and suggested that they would fall in battle like cherry blossom petals. The military aestheticized soldiers' deaths by frequently employing this metaphor, using the term *sange* ("to scatter like flowers") in official statements and popularizing it to the point that soldiers began to refer to their own deaths in this way. Though the term came from a practice of scattering flower petals in honor of Buddhas, a ritual closer to the earliest understandings of sakura, it was ultimately transformed in support of mass death and sacrifice.[93]

The military construction of blooming cherry blossoms consisted of a reversal of the ancient cosmological conception. In the agrarian model, it was the Deity of the Mountains that descended to earth from the cherry trees and gave the gift of self to humans, who grew rice and gave seeds in return in the autumn; in the Yasukuni Shrine model, humans fell to earth for the emperor (a living deity) as cherry blossom petals and ascended to become divine cherry blossoms. Ohnuki-Tierney stresses that the shifts in meaning and emphasis put in place by the military state were not taken as odd or drastic changes because of the rich field of symbolism in which cherry blossoms already existed, and because the vital physicality of blooming cherry blossoms was ascribed to soldiers both living and at rebirth, even if this was predicated by their sacrificial fall.[94]

The Meiji military state capitalized on the newly transformed symbolic association between cherry blossoms and warriors, bolstering the connection by systematically planting cherry trees in

[93] Ibid., 110-12.
[94] Ibid., 120-21.

castle compounds viewed as vestiges of the feudal period and inviting people to view them there. This was a major departure from the tradition of planting pines in symbolic spaces, to the point that some former warriors protested the planting and the use of the castles for recreation. Cherries were also planted to commemorate significant nationalistic events, like victory over Russia, the birth of the crown prince, and the establishment of a military unit. In the words of Sano Tōemon, cherry blossoms "marched with the military."[95]

The military deployment of cherry blossom symbology in support of death and sacrifice was most obvious in the aestheticization of the tokkōtai operation. All nine squadrons of the first *shinpū* (God's wind) tokkōtai were named in reference to cherry blossoms, including *Yamazakura-tai* (mountain cherry blossom corps) and *Yoshino-tai* (Yoshino cherry blossom corps). Cherry blossoms were also chosen as the exclusive visual symbol for tokkōtai: the plane itself was called *ōka*, another pronunciation for sakura, and was painted with a single cherry blossom against a white background. The explosives were referred to as *sakura-dan*, or the cherry blossom bomb.[96]

This strategy of aestheticization was ultimately so successful that the pilots themselves took up the imagery in attempts to come to terms with their fate. Many fastened branches of cherry blossoms to their uniforms or helmets before taking off on fatal missions, and those seeing them off often waved sakura branches in farewell (figure 9). In letters to loved ones, tokkōtai pilots commonly referred to their own imminent deaths as the falling of cherry petals and called on the power of the cherry blossom's bloom and fragrance for good luck and legacy. While their writings assigned complex and differential meanings to cherry blossoms based on their feelings and experiences, some dying happily for the emperor and others straining against the weight of this

[95] Ibid., 121-22.
[96] Ibid., 164-66.

sacrifice, pilots of different backgrounds and political ideologies were united in their use of the cherry blossom image to discuss their own deaths or the deaths of other soldiers.[97]

FIGURE 9. SCHOOLGIRLS WAVE SAKURA BRANCHES AT A DEPARTING TOKKŌTAI PILOT APRIL 12, 1945. SOURCE: HATSUHO NAITO, "MEMOIR OF A KAMIKAZE SQUADRON SURVIVOR: HOW THE THUNDER GODS PREPARED FOR SUICIDE," AIR & SPACE MAGAZINE (1991).

However, in the accounts of the survivors, it appears that few soldiers and survivors went on to consider cherry blossoms as the souls of fallen friends and family. Where the analogy between the soldier and the cherry blossom succeeded, the vision of fallen warriors reborn as cherry blossoms did not bloom as intended. Sakura existed at the fissure between the militaristic ideology that co-opted their symbolism and the values of soldiers whose identification with the blossoms enabled their sacrifice.[98]

Ohnuki-Tierney's discussion of the tokkōtai operation highlights that cherry blossoms do not stand for isolated categories of meaning, and instead represent concepts embedded in the

[97] Ibid., 166, 88-89, 241.
[98] Ibid., 184-85, 278.

relationships between men and women and between life, death, and rebirth. As a multilayered, polysemic entity existing at these places of interconnection, sakura indicate not bounded structures in human societies but the boundaries themselves as they undergo shifts and transformations. In the divine wind of war, walls and ceilings of sakura are whipped into a vortex of pink petals, filling the air with that soft mingling of red and white until it's all you can see, blurring the lines between tree and ground and sky until they flutter down and leave only empty branches.

On October 28, 1944, Petty Officer 1st Class Isao Matsuo took off from an airfield in Manila in a dive bomber loaded with a 500-kg explosive. He was 23 years old, the same age that I am now, the same age that my parents were when they took off from an airfield in Manila to come to the United States. The night before Isao Matsuo's death in a kamikaze attack, he wrote two poems in a letter to his parents, one tanka and one haiku:[99]

Dear Father and Mother,

I go as a shield for the Emperor

Soaring through the skies of the southern seas

Cherry blossoms glisten

As they open

And fall

[99] Mamoru Kitagawa, *Ā Kamikaze Tokkōtai: Kaerazaru Seishun No Isho Shū (Ah, Kamikaze Special Attack Corps: Collected Last Letters of Youth That Would Not Return)* (Tōkyō: Nihon Bungeisha, 1970).

CHERRY BLOSSOMS AS INDICATORS OF GEOPOLITICS + SOCIETY

The 19th and 20th centuries brought massive globalization, and with it unprecedented forms of war, transnational movement, environmental change, and cultural interchange. These worldwide forces brought sakura into new and distinct encounters with humans, deeply entangled relationships which reflect underlying shifts in social structures, geopolitical systems, and multicultural relations. As humans moved around the world across oceans and borders, bringing their civilizations with them on the rolling wheels of empire or in scraps of culture hand-carried by immigrants, they also brought cherry blossoms. These flowering cherry trees traveled along the same paths as humans and watched histories unfold from all over the globe.

SPREADING FRAGRANCE

While sakura developed as a symbol of Japanese identity and both cultural and political nationalism within Japan, the flower was also making itself known around the world as an emblem of the Japanese nation. Concurrent with Meiji period militarization and the co-opting of sakura symbolism as the sacrifices of soldiers, sakura also served as indicators of colonial rule through Japan's military expansion. Sakura appeared as a notable marker of colonialism in 1895, when Japan celebrated its first successful war of expansion against China under the blooming cherry trees in Ueno Park, Tokyo. This period saw the development of cherry blossoms into a symbol of empire

through the powerful fragrance of sakura, invoked as a force moving and spreading over conquered lands.[100]

In addition to their visual presence on Japanese military uniforms during battles of occupation, the trees were planted as a way of establishing colonial power in the aftermath. In newly colonized Asian countries, officials would go out of their way to find native cherry trees or planted seedlings brought from Japan, marking the land as a space intended for the people and customs of the Japanese Empire. In Qingdao, Shandong Province, China, which was occupied by Japan in 1914, cherry blossoms as well as black pine were widely planted through the hills in the region as ornamentals signifying Japanese rule. After Japan's defeat in the Second World War, many of the cherry blossoms were cut down and replaced with Chinese cedar as a reclamation of land and power, though the black pine did not receive this same treatment and is still widely used in Qingdao. The selective destruction of cherry blossoms as a symbol of Japanese imperial power points to their distinctive significance as reflectors of social relations.[101]

In South Korea, cherry trees planted by the Japanese have also been destroyed to commemorate liberation from colonial rule. In 1996 there was great debate in the general election about replacing cherry trees in the Seoul national cemetery with the rose of Sharon, the Korean national flower. Many Koreans take up the rose of Sharon in opposition to sakura, in that it "blooms continuously like the Koreans, unlike cherry blossoms and the Japanese who are strong but whose strength does not last." [102]

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[100] Inouye, *Evanescence and Form : An Introduction to Japanese Culture*, 118.
[101] Benyan Jiang and Masaki Fujikawa, "The Plantation of Black Pine and Cherry Blossom in Qingdao before Wwii," *Journal of the Japanese Institute of Landscape Architecture* (2014).
[102] Hai Gyoung Kim, "A Study on Interpreting People's Enjoyment under Cherry Blossom in Modern Times," *Journal of the Korean Institute of Traditional Landscape Architecture* 29, no. 4 (2011): 124; Ohnuki-Tierney, *Kamikaze, Cherry Blossoms, and Nationalisms: The Militarization of Aesthetics in Japanese History*, 122-23.

Contestations of culture continue to bloom with cherry blossoms. In 1942, the Korean-American Council released a statement claiming that the famous Yoshino cherry tree came from Korea rather than Japan, a battle of naming and origin which continues to play out through genetic analysis into the present.[103] The assertion of Korea's land-based connections to cherry trees serves as a reclamation of power from the Japanese colonial oppressor, redefining identification with the altered landscape and relying on cherry blossoms to reflect new changes to structural relations.

Despite these heated cultural associations, cherry blossom viewing is still a popular practice in Korea today. While this may appear in contrast to the anti-colonial sentiments expressed through the tree's symbolism, Hai Gyoung Kim argues that cherry blossom viewing in Korea developed as a space of accessible enjoyment and consumption that ran counter to Japanese colonial influence, disrupting the stratifications of leisure culture based on class and ethnicity imposed during Japanese rule.[104] As the center of an agrarian ritual turned elite ceremony, cherry blossoms appear through communal resistance and hegemonic power alike.

GROWING PEACE

Sakura also spread globally in ways unrelated to war and colonialism, widely admired for their breathtaking ornamental beauty and desired by visitors to Japan from all over the world. One path through which sakura made their way out of Japan was as a peace offering from the Japanese government or people. The father of Sano Tōemon, for example, prepared 100,000 seedlings for the monk Ōtani Kōzui as he endeavored to plant cherry trees along the Siberian railroad in a gesture of friendship among Japan, Russia, China, Korea, and the rest of the world. Cherry blossoms are also a

[103] Gayle Brandow Samuels, *Enduring Roots: Encounters with Trees, History, and the American Landscape* (Rutgers University Press, 2005), 75; Cho et al., "Molecular and Morphological Data Reveal Hybrid Origin of Wild Prunus Yedoensis (Rosaceae) from Jeju Island, Korea: Implications for the Origin of the Flowering Cherry."
[104] Kim, "A Study on Interpreting People's Enjoyment under Cherry Blossom in Modern Times."

common gift from Japan to other nations, with seedlings sent to Bulgaria, France, Iran, Germany, and Austria in commemoration of national events and celebrations.[105]

The offering of cherry trees to other countries originated with the gift of several thousand trees from Japan to the United States, the famous cherry blossoms that line the Tidal Basin in Washington, D.C. today. However, sakura first came to the United States through the passions of plant-lovers rather than as a political gift, brought over and personally grown by a plant explorer and USDA official, and the idea to plant them at the Tidal Basin came from women who had witnessed their beauty in Japan.[106] While this gift was largely presented as an apolitical gesture grounded in shared appreciation for the beauty of the blossoms, paying close attention to the details of how sakura arrived in the United States reveals the social and political processes that underlay the transaction.

The first shipment of sakura from the Japanese government arrived in the United States in 1909 and was immediately considered indicative of a larger ecological concern, namely that of species invasion. Much like other flowering cherries that have now been labeled "invasive" for their ability to host pests and parasites, these two thousand ornamental cherry trees were reported to be infested with crown gall, root gall, two kinds of scale, a new species of borer, and several other insects thought to be dangerous. The acting chief of the Bureau of Entomology of the U.S. Department of Agriculture recommended that the entire shipment be destroyed as soon as possible, and several weeks later the trees were reduced to ashes. Though this issue is often cast as an awkward technical blunder in cultural diplomacy, Philip J. Pauly argues that this was a political decision grounded in ongoing USDA controversy over the introduction of valuable "plant immigrants" versus the exclusion of undesirable "alien crop enemies." He describes the flood of

[105] Ohnuki-Tierney, *Kamikaze, Cherry Blossoms, and Nationalisms: The Militarization of Aesthetics in Japanese History*, 123.
[106] "History of the Cherry Trees," National Park Service.

imported plant stocks from American explorers and tropical colonies, and the growing fear in response that international contact and interchange would bring foreign pests and parasites into the country, putting native biota and American agriculture at risk.[107]

The disputes brought to light by cherry blossoms were inextricably linked to views and policies regarding "foreign" and "native" humans; politicians were similarly concerned about the damage human immigrants might cause to white American life. For example, legislation requiring plant imports to undergo quarantine came just a year before the 1882 Chinese Exclusion Act, intended to protect "native" Californian workers from Chinese laborers and from the possibility of Chinese populations establishing permanently in North America.[108]

The arrival of cherry blossoms in the United States as plant immigrants was also inherently connected to immigration of Japanese people in particular. The years leading up to the gift of cherry blossom were characterized by intense anti-Japanese rhetoric and sentiment, including the segregation of East Asian students in San Francisco in 1906 and the so-called Gentleman's Agreement in 1907-1908 which informally restricted Japanese immigration. The 1909 gift of cherry trees was a diplomatic act intended to smooth relations between Japan and the United States regarding immigration, the incorporation of quintessential Japanese horticulture into the landscape of Washington as symbolic recompense for America's disrespect and exclusionary demand. The 1924 Immigration Act, which banned all Asian immigration and set a quota of 165,000 for countries outside the Western Hemisphere, was in place and effective even as Americans began to commemorate the gift from Japan and celebrate the annual cherry blossom festival.[109]

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[107] Philip J. Pauly, "The Beauty and Menace of the Japanese Cherry Trees: Conflicting Visions of American Ecological Independence," *Isis* 87, no. 1 (1996): 51-54.
[108] Ibid. Controversy over the classification of non-native/invasive species continues today, as do controversies over immigration. Sakura stories suggest that ecological nativism in the United States cannot be disentangled from political nativism sparked by racism and xenophobia: we must learn to take care in how we discuss our nonhuman familiars.
[109] Ibid., 70-72.

In the mid 1930's, cherry blossoms appeared at the center of a controversy over plans for the new Jefferson Memorial, which would involve the destruction of several hundred of the famous cherry trees. An editorial written in the *Washington Post* in 1937, entitled "No Decent Respect," described the hypothetical removal of the trees as "wanton destruction" and "sheer vandalism" as well as a "flagrantly gratuitous insult to the Japanese people." The editorial went on to conclude that "to uproot these … trees is to kill them."[110] Considering that these trees first came to the United States as transplants, uprooted from their original soil, this sentiment suggests that Americans at the time had come to see Japanese cherry trees in the U.S. as holding a life force beyond the technicalities of survival; uprooting cherry trees was an act of symbolic death, a disruption in the relationships of respect and reciprocity between Americans and the trees as well as Americans and Japanese.

Cherry blossoms continued to act as symbolic "plant immigrants" with the start of the Second World War. Waves of anti-Japanese and general anti-Asian sentiment that had already been building for decades took off with Japan's surprise attack on Pearl Harbor in December 1941 and the U.S.'s subsequent declaration of war against Japan. 3 days after the attack, vandals cut down cherry trees on the west side of the Tidal Basin, including some of the original 1912 gifts. One tree was marked "To Hell with the Japanese."[111] The uprooting of cherry trees years prior would be mirrored by the uprooting of people from their homes and livelihoods, with the forced relocation and incarceration of over 120,000 Japanese Americans in internment camps from 1942 to 1945.

The Cherry Blossom Festival was not held that spring of 1942 and was not celebrated again until 1948. Many insisted that Japanese cherry trees be referred to as "Oriental cherry trees" in order

[110] Victoria S Tietze Larson, "Memorializing Jefferson: Imperial Designs and the Battle of the Cherry Blossoms," *International journal of the classical tradition* 22, no. 3 (2015): 320-21.
[111] "The Vandalization of the Cherry Trees in 1941," National Park Service, U.S. Department of the Interior, https://www.nps.gov/articles/the-vandalization-of-the-cherry-trees-in-1941.htm.

to avoid the association with a war enemy. Others spoke out in support of the vandalism, with letters coming into the National Capital Parks commission demanding that the trees be torn up and burned or at least replaced with trees of an American variety.[112]

Cherry blossoms of the Tidal Basin were a reflection of anti-Japanese sentiment and global tension before and during the war, and in its aftermath they again served as indicators of the political moment. In 1952, Japan looked to restore the famous cherry tree grove in Adachi Ward, which grew along the Arakawa River near Tokyo and had fallen into decline due to war. As these trees had provided the parent stock for the gift to Washington, the U.S. was asked for help in maintaining the grove, and the National Park Service sent back budwood from descendants of the trees in Adachi Ward to help replenish the original trees. This cycle of reciprocity enabled by the power of the cherry blossoms to propagate anew through ancestry and transplantation acted in parallel with the cycle of generosity and hopeful friendship between two nations.[113]

In 1954, cherry blossoms were again used as a focal point of peace among nations, with the dedication of matching stone lanterns among the cherry trees in D.C.'s Tidal Basin and in Tokyo's Ueno Park. These gifts were intended to commemorate the 100th anniversary of the United States and Japan's first Treaty of Peace, Amity and Commerce, and were followed by a stone Japanese Pagoda in 1958 from the Mayor of Yokohama as well as another gift of 3,800 trees in 1965. In 1982, the cycle of restoration and preservation continued when the rerouting of a river in Japan flooded a grove of Yoshino cherry trees, and Japanese horticulturists were permitted to take cuttings from the Tidal Basin to replace the destroyed trees. Cherry trees also served to bind the U.S. and Japan in

[112] Joseph Stromberg, "After Pearl Harbor, Vandals Cut Down Four of Dc's Japanese Cherry Trees," Smithsonian Magazine.
[113] "History of the Cherry Trees".

watershed conservation efforts, with the establishment of a Sister River agreement in 1996 for collaboration on the management and protection of the Potomac and Arakawa Rivers.[114]

SNAPPED BRANCHES

Just as the cancellation of the Cherry Blossom Festival during the Second World War spoke of anti-Japanese sentiment and the sacrifice of recreation for war effort, the restarting of this celebration after the war pointed to new attempts at peace and friendship. In Washington, D.C. as well as in places like San Francisco and Hawai'i with large Japanese-American populations, the Cherry Blossom Festival came to be seen as a critical bridge between the U.S. and Japan as well as between Americans and Japanese-Americans.

However, while sakura are commonly recognizable as an emblem of the Japanese nation, its many meanings have not necessarily translated well into Western contexts. In one cringeworthy example, the 2003 Hollywood blockbuster *The Last Samurai* filled its sets with cherry blossoms in an attempt at cultural authenticity. While visually impactful, the film distorted sakura's crucial temporal qualities by having them flower for the duration of the movie's events rather than in the spectacular fleeting bloom for which they are known in reality.[115]

The same distancing of symbolism from experiential knowledge through practice seems to hold true not just for non-Japanese foreigners but for the cultural identification of Japanese immigrants overseas. For example, I searched the compilation *Sakura in the Land of the Maple Leaf: Japanese Cultural Traditions in Canada*, looking for potential details about cherry blossom festivals or other ways that Japanese-Canadian immigrants appreciate sakura; it soon became clear that the book contained no descriptions of cultural practices involving cherry blossoms besides a brief mention of

[114] Ibid.
[115] Inouye, *Evanescence and Form : An Introduction to Japanese Culture*, 10.

the folk song *Sakura Sakura* and how it invokes connection to the homeland.[116] Their appearance in the title combined with their absence in the ethnographic content of the book highlight the departure of sakura's cultural symbolism from actual cultural practice. More often than not, sakura outside of Japan seem to underscore an alienation both from Japanese culture and from the host country's culture produced by the constraints of immigration, assimilation, and both overt and underlying racism. In the examples I bring forward, sakura appear as symbols of an essentialized Japanese identity at odds with the actual forces of cultural production at play, acting as indicators of tension in the encounters and interchange produced by globalization and transnational movement.

While intended to emulate *hanami* practiced across Japan, cherry blossom festivals in other parts of the world lack the symbolism born of a long history of agrarian worship and viewing rituals and instead tend to focus on celebrating Japanese culture. For example, celebrations in the United Kingdom and Australia include origami workshops, calligraphy, bonsai exhibitions, martial arts, and tea ceremonies, while the event in Germany features modern Japanese media like movies and manga. Cherry blossom festivals in the United States often present themes of Japanese culture incorporated into American elements like parades and pageants, again with little focus on traditional practices like gathering to view or eat and drink under the trees. The event in Macon, Georgia even features a fashion show, a formal ball, and home tours.[117] The transformation of *hanami* practices and meaning when taken overseas points to different relationships between humans and cherry blossoms that come of different conceptions of nature.

American cherry blossom festivals ultimately reflect a detachment of Japanese-American immigrants from the homeland and a need to establish cultural identity in a way legible to the

[116] Carlo Caldarola et al., *Sakura in the Land of the Maple Leaf : Japanese Cultural Traditions in Canada* (2007), 71. Note that cherry blossom bloom has begun to be celebrated in Canada since the publication of this book; 2007 was the first year of the Vancouver Cherry Blossom Festival, which continues to be held annually at Queen Elizabeth Park with a Cherry Jam concert, a Japan Fair, a Big Picnic emulating hanami, a gala, and a bike ride.
[117] Emi Moriuchi and Michael Basil, "The Sustainability of Ohanami Cherry Blossom Festivals as a Cultural Icon," *Sustainability* 11, no. 6 (2019): 12.

American public, i.e. through an exotified and stereotype-driven falsehood. Ohnuki-Tierney describes the festival in Hawai'i as a call to "stage something called Japanese culture," an event deliberately named in English (Cherry Blossom Festival rather than Sakura Matsuri) and featuring a Miss America-style pageant in which Japanese-American girls were invited to perform themselves as Americans. She also points out that the airlifting of sakura petals from Japan for the event was the first time most of the local Japanese Americans had ever seen the flowers, and that the pageant prize of a trip to Japan was, for many Cherry Blossom Queens, their first and only experience of the homeland. In this way, cherry blossoms came to represent the divide between the US-born and US-oriented nisei generation and the older issei generation with lived experience in the homeland, as well as the divide between the nisei and the American population into which they were expected to assimilate.[118]

Cherry blossoms also reveal a point of disconnect in cultural interchange in the attempt to translate practices of sakura viewing into other cultural contexts. One example of this incongruence is a case study of a foreign language learner staying with a Japanese host family, in which the foreign student could not understand the association between viewing sakura and drinking sake that the host mother took as unconscious or universal knowledge. Confrontation with cherry blossoms forced the Japanese host mother to reflect on her deep-seeded understanding of *hanami*, where the drinking of sake is a ritual process with roots in ancestral tradition and with generations of practice harkening back to agrarian ceremonies, in conflict with the foreigner's conception of cherry blossom viewing as a merely aesthetic or emotional experience.[119]

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[118] Christine Reiko Yano, *Crowning the Nice Girl Gender, Ethnicity, and Culture in Hawaii's Cherry Blossom Festival* (Honolulu: University of Hawai'i Press, 2006), 90-92.
[119] Margaret A DuFon and Eton Churchill, *Language Learners in Study Abroad Contexts*, vol. 15 (Multilingual Matters, 2006), 133-36.

An analysis of Japanese community forums and blogs related to hanami found an overarching belief that sakura can be maintained and properly enjoyed through respect. Courtesy and good manners extended to sakura, as to other humans and living things, were considered the proper way to appreciate them, especially in accordance with the ancient belief that they hold the presence of gods. Moriuchi and Basil, however, found that overseas celebrations of cherry blossoms were less focused on finding and admiring the trees themselves and more concerned with symbolic events related to spring or Japanese culture.[120] Perhaps it is because of this shift away from reverence and politeness and towards commodity that the National Park Service is struggling to protect the Tidal Basin's cherry trees and other natural resources from long-term degradation by festivalgoers, and that some of the trees are cracking from climbing and other rough treatment.[121] Or, as the frustrated arborists of Reddit would suggest, perhaps it is that the trees are poorly cared for to begin with, suffering from rot and disease and therefore unable to handle the normal strains of climbing and playing.[122] The old aunties of Miharu, Fukushima remember playing on the thousand-year-old sakura in their childhood, and are sure that it will grow strong for hundreds of years after they die.[123] It seems that playing with the sakura is permissible, but only with the prerequisite of respect and care, practices that come from ancient connotations often lost in translation — or transplantation.

Even where cherry trees themselves do not appear, cherry blossoms appear as a signifier of the Japanese nation and culture detached from the lived experiences of Japanese people. In another example of multicultural celebration, cherry blossoms were employed as a signifier of Japanese

[120] Moriuchi and Basil, "The Sustainability of Ohanami Cherry Blossom Festivals as a Cultural Icon," 12-14.
[121] Minkyung Park et al., "An Analysis of Service Provision and Visitor Impacts Using Participant Observation and Photographic Documentation: The National Cherry Blossom Festival," *Event Management* 14, no. 2 (2010); Willard West, "This Is Why You Shouldn't Climb Cherry Blossom Trees " *NBC Washington* (2020), https://www.nbcwashington.com/news/local/this-is-why-you-shouldnt-climb-cherry-blossom-trees/2248759/.
[122] "Cherry Blossom Tree in Dc Destroyed after Someone Climbed It.," Reddit, https://www.reddit.com/r/trashy/comments/fmhmvb/cherry_blossom_tree_in_dc_destroyed_after_someone/. I hadn't realized there was a community of angry arborists, but I'm grateful for them as translators of sakura stories. Without them, you might never know how D.C.'s cherry trees are neglected and mistreated.
[123] Walker et al., *Tsunami & the Cherry Blossom*.

culture in the festival of diversity held in Stockholm, Sweden. While fake sakura branches and sakura designs served as a marker of difference in the public-facing performance, an ethnographic analysis revealed that these distinctions held little weight backstage, where rigid ethnic boundaries gave way to an intermingling of Swedish-speaking people of many indeterminate ethnicities. Even more telling is the way in which multicultural unity was enacted for the event, where the representatives of different cultures joined together to dance first to Swedish fiddle tunes and then to American jazz, signaling an understanding of Japanese identity not through the cultural identification of the Japanese population itself but through a generalized symbolism tailored to the multiculturalism of a broadly Western audience.[124]

As symbols of war and nation, life and death, rebirth and renewal, and several forms of identity, cherry blossoms appear in their relationships with humans at points of tension and transformation in human societies, indicating moments of conflict as well as moments of healing and collaboration within more-than-human networks. The trees that "sympathize with you," they reflect love and respect as much as they do the splintered realities of racism, discrimination, and hateful destruction.

It is not surprising, then, that the recent rise in violence towards Asian-Americans—a result of xenophobic rhetoric around the COVID-19 pandemic, capitalizing on decades of anti-Asian sentiment—has been marked by vandalism of cherry trees. I write just a week after the brutal murders of 6 Asian-American women[125] by a white man in the Georgia massage parlor shooting, and after a slew of public attacks on elderly Asian-Americans around the country. In January 2021, flowering cherries in front of the Japanese Culture and Community Center of Northern California

[124] Owe Ronström, "Orchestrating and Controlling the Foreign: The Festival of Diversity in Stockholm City Hall," *Journal of folklore research* 30, no. 1 (1993): 77-80.
[125] Xiaojie Tan, Daoyou Feng, Soon Chung Park, Hyun Grant, Suncha Kim, and Yong Ae Yue. Say their names.

were shorn down to their trunks, sakura that had been planted in commemoration of a visit by the Japanese emperor and empress after the establishment of Japantown. The vandals returned over the course of three nights to violently snap off every branch of the 15-foot trees, including limbs that were over three feet thick. It was reported that other cherry trees were similarly vandalized the year before.[126]

FIGURE 10. CHERRY TREE VANDALISM, DECEMBER 1941 AND JANUARY 2021
TIDAL BASIN PARK, WASHINGTON, D.C. + JAPANTOWN, SAN FRANCISCO

SOURCE: "AFTER PEARL HARBOR, VANDALS CUT DOWN FOUR OF DC'S JAPANESE CHERRY TREES," SMITHSONIAN MAGAZINE (2014); "CHERRY BLOSSOM TREES VANDALIZED IN SAN FRANCISCO'S JAPANTOWN," NY TIMES (2021)

SAKURA (THEY/THEM)

Sakura are remarkably mutable with respect to gender symbolism: they have come to represent women, men, women dressed as men, queer men, warriors, soldiers, young girls, old women, mothers, and geishas. Some of these associations are particular to varieties of sakura, such

[126] Allyson Waller, "Cherry Blossom Trees Vandalized in San Francisco's Japantown," *The New York Times* (2021), https://www.nytimes.com/2021/01/08/us/japantown-cherry-blossom-trees.html. Also note this story from 2015, in which four full-grown flowering cherry trees were painstakingly hacked down overnight at Cannon Hill Park in Birmingham, UK, an incident passed off as "mindless" vandalism: "Cannon Hill Park Cherry Trees Attacked in Act of Vandalism," *BBC News* (2015), https://www.bbc.com/news/uk-england-birmingham-32629055.

as the *ubazakura* who are likened to old women because their blossoms come out when they have no leaves (or no teeth, as both are called *ha*).[127] However, sakura in general seem to exist at points of tension in gender construction, where common ideals of masculinity and femininity are troubled and where selves and identities comes in multitudes.

Cherry blossoms signify transformations in reproductive power and gender in their very existence through interaction with humans. Varieties like *P. x yedoensis* are the products of deliberate hybridization among trees of other species, trees come to life through careful human control over reproduction. Flowering cherries have also been found to reflect climatic change through sexual abnormality: orchards growing the non-native sweet cherry in California observed notable cases of flowers growing pistils ("female" reproductive organs) at the tips of filaments where they were supposed to develop anthers ("male" reproductive organs), resulting in doubled fruits, an effect that was attributed to high summer temperatures in hot interior valleys.[128] The use of black cherry bark and roots for ailments specific to women and childbearing in the Cherokee, Delaware, and Iroquois nations also suggests an association with femininity, reproduction, and the cycling of life.[129] On the level of the tree's physiology as well as that of the human body, cherry blossoms serve as indicators of forces experienced through womanhood.

Cherry blossoms in pre-modern Japan were also taken as markers of femininity and reproduction. The agricultural significance of sakura in Japanese agrarian cosmology extended naturally to an interpretation as a symbol of fertility and beauty, and through these characteristics,

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[127] Ohnuki-Tierney, "Cherry Blossoms and Their Viewing," 226. In 1904, Greek-Irish writer Lafcadio Hearn published a collection of retellings of Japanese folk tales, including a story about the ubazakura. In his version, the ubazakura blooms out of season on the anniversary of the death of a devoted milk nurse who gave her soul for the child she cared for. Note that *uba* (姥, old woman) is distinct from *uba* (乳母, wet nurse). A pun or a mistranslation?

[128] G. L. Philp, "Abnormality in Sweet Cherry Blossoms and Fruit," *Botanical Gazette* 94, no. 4 (1933): 815, 19-920.

[129] Moerman, "A Database of Foods, Drugs, Dyes and Fibers of Native American Peoples, Derived from Plants."

femininity. In ancient Japan, production and reproduction were figured as part of the same cycle, through *musubi* (reproduction *musu* and growth by the sun *hi*) or the making of a knot to encapsulate a soul. This equation of female reproductive power with rice production, linked to sakura through the Mountain Deity of Rice Paddies who descended from the trees, led to the development of cherry blossoms as a symbol of women.[130]

Poems in the *Manyõshū*, a collection from the 4th to 8th centuries, focused on cherry blossoms as representations of beauty and femininity, particularly in the context of love. According to records from the 8th century, when *hanami* was already well-established among both common folk and the elite, cherry blossom bloom was marked by the exchange of poems and dancing for courtship. Through this association, along with practices like the wearing of cherry branches on one's head to invite the favor of the gods in romance, sakura came to represent love and marriage. Tea brewed from the petals, sometimes salted, is called *sakura-yu* and is commonly served at weddings and engagements. As singing, dancing, and music were religious rituals in ancient Japan, these practices are thought to have stemmed from spring rites during which women and men climbed the sacred mountain to feast, drink, dance, compose poetry, and make love.[131]

While the blossoms represented feminine beauty, they also represented the emotions and sexualities of both men and women, leaving them open to interpretation through masculinity. Cherry blossom viewing was considered a highly cultured practice, and composing poetry in their praise was a way for aristocrats and upper-class warriors of the feudal era to demonstrate refinement and political power.[132] As discussed above, sakura also developed as an emblem of the way of the warrior or *bushidō* starting in the Heian period (794-1185), as suggested by the common expression "cherry blossoms among flowers and warriors among people." But while the military later deployed

[130] Ohnuki-Tierney, *Kamikaze, Cherry Blossoms, and Nationalisms: The Militarization of Aesthetics in Japanese History*, 32.
[131] Ibid., 32-33.
[132] Ibid., 34.

this association to capitalize on sakura as a sign of masculine bravery and heroism, it simultaneously drew on associations with reproduction to envision the rebirth of fallen soldiers as blooming cherry trees.

This disruption of gender enacted through cherry blossoms also developed during the Heian period through early cherry blossom festivals, where cross-dressing and the wearing of masks were popular for both men and women. Moreover, cherry blossoms were a common trope to describe young men called *chigo*, practitioners at powerful temples who underwent a temporary change of gender and simulated the lifestyle of court women for several years at a time. These temple boys were often partners for older homosexual monks, a relationship in which the *chigo* acted as a "flower of truth" (*hottsusho*) to draw out the monk's latent sexuality represented by "fire in the abyss" (*mumyū no hi*). Here sakura acted very directly as an indicator of shifts in dichotomies related to gender and sexuality.[133]

[133] Ibid., 44-45, 48.

FIGURE 11. THE SPIRIT OF THE KOMACHI CHERRY TREE, TSUKIOKA YOSHITOSHI 8TH IN THE WOODBLOCK PRINT SERIES *NEW FORMS OF THIRTY-SIX GHOSTS*. THE SPIRIT OF SAKURA APPEARS AS AN ENCHANTING COURTESAN TO KEEP THE LORD FROM CUTTING DOWN THE TREE.

Noh and kabuki plays of the later Edo period (1600-1868) also invoked sakura to depict alternative imaginations, including gender nonconformity. Cherry blossom motifs were emblematic of *shirabyōshi*, female dancer-entertainers in kabuki who dressed as men, kabuki actors being otherwise male. Sakura were also the quintessential symbol of geisha's quarters seen in kabuki and woodblock printing, where geisha and their attendants resided, a sexually subversive space existing in antithesis to the norms of gender and sexuality imposed by mainstream society. Notably, geisha could be men or women, though it would become known as a feminine practice, and all of the geisha represented in kabuki plays were played by male actors. Despite these many subversions of

gender, sakura still readily lent themselves to masculinity in kabuki through male characters, appearing in the stage techniques of male dancers like *rakka* (falling flower petals) and *hana-no-ame* (flower rains).[134]

TRANSPLANTING TREES

If the association of cherry blossoms with gender was already troubled, it was only further distorted by the addition of a racial element when the trees were transplanted across the globe. Transplantation of sakura to new parts of the world whittled down their rich body of meanings around transience and transformation into simple spring symbolism, and likewise, their heavily nuanced interconnections with gender were reduced to stereotypes of femininity. The particular ways in which sakura have left Japan and appeared elsewhere have produced distinct relationships between foreigners and cherry blossoms characterized by an association with exotified femininity. Cherry blossoms highlight not only new constructions of race and ethnicity but also strain in gender relations where women are faced by the constraints of heteropatriarchal norms and expectations.

The arrival and sustained life of sakura in the United States was contingent on the efforts of women to make themselves heard in an all-male political climate, well before white women received the right to vote. The first to suggest that cherry blossoms be planted on the Potomac waterfront was Eliza Ruhamah Scidmore, a writer and diplomat who encountered Japanese cherry trees on her world travels. Her proposal to the U.S. Army Superintendent of the Office of Public Buildings and Grounds in 1885, and to every subsequent superintendent over the next 24 years, was ignored entirely.[135] Pink flowers may have meant bravery to a samurai, but not to a soldier of the U.S. Army.

[134] Ibid., 35-36, 48-51.
[135] "History of the Cherry Trees".

It was not until plant explorer Dr. David Fairchild imported Japanese cherry trees and grew them on his own property in Chevy Chase—an option not available to Scidmore, who of course could not so easily control land—that fulfilling her dream became possible. Scidmore worked to raise money in order to buy trees from Fairchild, intending to donate them to the city to see her dream fulfilled. She wrote about her plans to the new First Lady Helen Herron Taft, who finally took up the project officially and responded with further ideas about the location and aesthetics of planting.[136]

With the blessing of the First Lady, the idea of planting cherry blossoms in the Tidal Basin quickly gained support and new meaning. A Japanese chemist visiting Washington who heard of the idea suggested that more trees be donated to fill the area, with the gift given in the name of the City of Tokyo, and several days later Mrs. Taft accepted two thousand more trees from Tokyo mayor Yukio Ozaki.[137] What began as an aesthetic venture would become an important political exchange, with women taking an unusually active role in mediation.

After the ecological mishaps with cherry tree shipments discussed above, the monumental planting finally took place. Helen Taft and the Viscountess Chinda, wife of the Japanese Ambassador, planted two Yoshino cherry trees on the northern bank of the Tidal Basin. The symbolic gift from Japan to the United States was recognized with a return gesture, the first lady's presentation of a bouquet of "American Beauty" roses to the Viscountess.[138] This simple ceremony among women adjacent to power, witnessed by only a few, would mirror the quiet Gentleman's Agreement that looked to accept Japanese cherry trees as a balm for rejecting Japanese migrant workers — a gift of innocent Japanese femininity to staunch the flood of Japanese male laborers that seemed to threaten white American jobs and livelihoods.

[136] Ibid.
[137] Ibid.
[138] Ibid.

Even after two decades, several more rounds of planting, and the beginnings of the annual spring festivals, cherry blossoms in the Tidal Basin were not safe from removal for the political ends of men in power. The 1938 "Battle of the Cherry Blossoms" staged over the Jefferson Memorial marked another bubbling up of tensions among politicians and women of relative status who were invested in the trees. When the National Park Service revealed in a press release that the construction of the memorial would involve 600 trees in the Tidal Basin, the most powerful resistance came from coalitions of women led by Eleanor "Cissy" Patterson, the owner of the two daily newspapers the Times and the Herald who was highly critical of FDR's policies. Patterson published several articles against the memorial project, organized almost a hundred women to deliver a petition to the White House while chanting Joyce Kilmer's poem "Trees," and when ignored, gathered over 150 women to stop the work the next day.[139]

The defining moment of resistance was the demonstration at the Tidal Basin, during which these women wrestled shovels away from Civilian Conservation Corps workers and chained themselves as well as a U.S. Park Police sergeant to the cherry trees. These women of the "Cherry Tree Rebellion," whether they acted out of democratic or merely aesthetic values, stood up against the destruction of plant immigrants which had come to represent both the legitimacy of Japanese presence in the United States and that of women in contributing to government decisions. Their newly held rights enabled them to take part in the ideological battle of individual democratic liberty versus patriarchal authoritarianism sparked by the controversy around the monument's design and siting.

Police were deputized in order to move protesting women away from the trees and the workmen transplanting them, though violence on both sides was treated with derision and sarcasm.

[139] "The Cherry Tree Rebellion," National Park Service, U.S. Department of the Interior, https://www.nps.gov/articles/the-cherry-tree-rebellion.htm.

In fact, President Roosevelt himself commented that the protest was a "flimflam game" and that women attacking the workmen transplanting Japanese cherry trees "may be transplanted themselves," speaking to a view of women, nature, and ethnic others as dispensable objects that could rightfully be moved and acted upon by white men who dealt with more important business. Roosevelt ordered the work to be completed under cover of darkness later that night, to avoid further disturbance.[140] The light-hearted, humorous text of the newspaper coverage is haunted by the corresponding photographs of women chaining themselves to cherry trees, just years after the protests for white women's suffrage and just years before Japanese-Americans would be interned en masse based on ethnicity alone.

Cherry blossoms in America were thus firmly tied to racialized ideas of femininity before and after arrival, their planting and protection off-handedly relegated to the realm of women—the realm of the other, where nature and immigrants could reside—despite their political weight and cultural impact. Sakura came to the U.S. through the persistence of women who chose to use their precarious status and power to bring its blossoms across the ocean regardless of the dismissal of men in authority. The challenges in maintaining their continued existence and celebration speak to heteropatriarchal constructions of gender as well as to larger issues of visibility and representation, or political existence, in the United States. Even with their place in the Tidal Basin secured, cherry blossoms would continue to highlight gendered tensions in the confluence of cultural interchange and international geopolitics.

[140] Larson, "Memorializing Jefferson: Imperial Designs and the Battle of the Cherry Blossoms."

The centrality of femininity to cherry blossom festivals in America points to the prominence of these ties. Thousands gathered to watch in 1937 as Sakiko Saito, daughter of the Japanese ambassador, was crowned the first "Queen of the Cherry Blossoms" by the Commissioner of the District of Columbia, just two years after the first Cherry Blossom Festival in America (figure 12). In 1940, after the Cherry Tree Rebellion and just a year and a half before the U.S. would declare war on Japan, the Cherry Blossom pageant was incorporated into the D.C. festival. After World War II, the Cherry Blossom Festival would continue, with Cherry Blossom Princesses now chosen from each state of the union and a Queen selected from among them.[141]

Dorothea Wender goes as far as to argue that the naming and parading of cherry blossom princesses in D.C.'s spring festival represent a bloody ritual of virgin sacrifice, in honor of George Washington as an agricultural deity through his association with the cherry tree of his youth.[142] This take on cherry blossoms as part of the "Myth of Washington" insinuates that cherry blossoms in America were not wholly alienated from the connotations of death and transience as well as new life and innocence that they hold in Japan, and that they fulfilled a role as the cultural sacrifice of immigrant women to an ideation of the American Dream.

The gift of "American Beauty" given in return for sakura during the early years of Asian exclusion in the U.S. suggests that acceptance of Japanese-Americans was contingent on their ability to fit into a certain American standard for Asian beauty and grace, on their ability to make sakura parallel the rose. Those roses might as well have been called "Model Minority." Especially in the aftermath of the Second World War, as Japanese-American communities worked through the trauma of internment, celebrations of Japanese culture through cherry blossoms were colored by the need to enact loyalty to the American nation and values even while displaying difference as an ethnic

[141] "History of the Cherry Trees".
[142] Dorothea Wender, "The Myth of Washington," *Arion: A Journal of Humanities and the Classics* 3, no. 1 (1976).

other. This staging of cultural identity was inherently gendered, played out through the grooming of young Japanese-American women training to become Cherry Blossom Queens.

FIGURE 12. CHERRY BLOSSOM QUEENS, JAPANESE AND AMERICAN
LEFT: MASAKO SAITO, SAKIKO SAITO, + BARBARA CALDWELL, 1937.
RIGHT: RISAKO TAKENAKA + MARGARET O'MEARA, 2018.

SOURCES: "HISTORY OF THE CHERRY TREES," NATIONAL PARK SERVICE; "U.S. CHERRY BLOSSOM QUEEN MARGARET O'MEARA TO SERVE AS GOODWILL AMBASSADOR TO JAPAN," VIRGINIA TECH NEWS (2018).

The Cherry Blossom Festivals celebrated around the country, in DC as well as in ethnic enclaves like San Francisco and Honolulu, came to serve not only as a stereotyped performance of Japanese culture for the benefit of white audiences but also as an acting out of expectations for Japanese-American women. The event was viewed as a bridge between countries, and by extension the Cherry Blossom Queens served as a bridge between Japanese-Americans and the Japanese. They were expected to do so by acting out traditionally feminine expectations like "charm, beauty, voice, and tone" as well as a generalized "ability to represent American life… a melting pot of races."[143]

[143] Yano, *Crowning the Nice Girl Gender, Ethnicity, and Culture in Hawaii's Cherry Blossom Festival*, 90. Note that cherry blossom pageants across the U.S. differ in their requirements for the ethnic background of contestants, and only a few require

Contestants for the Honolulu Cherry Blossom Festival, called "Cherry Sisters," were initially selected from debutante balls such that the exotic young women could be posed as local debutantes able to fit into the white standard for a nuclear family and modern life. Contestants over the years would continue to come from middle-class, elite-educated families who represented proper assimilation as the model minority. Cherry Sisters were intended to work towards the Japanese ideal of the "nice girl" (*ojōsan*), but in reality were trained in supposedly pan-ethnic traits that would be desirable to a panel of racially unbiased judges.[144] The performance of the festival and pageant worked to retrofit Japanese culture into broader norms of behavior imposed onto Asian-Americans, paying homage to emblems of perceived multiculturalism while ensuring assimilation into American norms, values, and lifestyles. The exotified women of the American cherry blossom pageant act out a version of Japanese identity through physical and symbolic interaction with sakura, and in doing so reflect the gendered tensions in Japanese-American cultural identification.

Cherry blossoms continue to hold connotations of exotified femininity in foreign spaces beyond the context of these festivals. Sakura is a name for both women and men in Japan, but it is more common among women and more commonly viewed as a feminine name abroad. With the global popularization of Japanese media through the internet, most of my peers would know "sakura" as the pink-haired ninja in *Naruto* or the young, innocent title character of *Cardcaptor Sakura*, and their frequent pink presence floating in the background of scenes symbolizing love, beauty, and nature link the blossoms to femininity for most Western audiences. As Japanese anime grows in popularity around the world, so does its power as a method of cross-cultural communication, lending non-Japanese audiences thematic understandings of sakura through imagery and

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that the girls be Japanese-American. The Cherry Blossom Queen for the National Cherry Blossom Festival in D.C. does not have to be Japanese. See Yano, chapter 5, for discussion of debates over blood quantum in the Honolulu festival.

[144] Ibid., 74-77, 200, 35.

association.[145] The stories that sakura tell on an international level are subject to these particular modes of representation, with as much possibility for loss of meaning in translation as in the subtitled dialogue.

Fashion brands have also been found to use cherry blossoms to represent a certain kind of cute Japanese femininity, part of a cycle of renewal to maintain the appearance of scarcity and exclusivity in which multiculturalism periodically makes an appearance.[146] Kumiko Sato suggests that the Japanese conception of cuteness, *kawaii*, can be seen in parallel with *mono no aware* in that both invoke a kind of pity, pity for things loved and protected alongside pity for things passing.[147] Cherry blossoms capture both senses of vulnerability and fragility, but the emphasis on their cuteness rather than their tragedy — as in the manga-inspired smiley faces of the flowers in Louis Vuitton and Takashi Murakami's "Cherry Blossom" collection — points to a construction of sakura in Western contexts traced through the gendered deprivation of power and independence inherent to *kawaii* rather than a nuanced meaning including *mono no aware*.

The use of cherry blossoms in association with "mail order bride" services also points to the perversion of the symbol into one of an exotified Asian female stereotype. One online matchmaking agency called Cherry Blossoms played on this stereotype to attract mostly U.S.-based men seeking partners from China, the Philippines, Thailand, and Vietnam.[148] The fact that this list does not include Japan further highlights the distancing of cherry blossoms from their distinctly Japanese connotations in the context of Asian othering and exotification.

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[145] Shinobu Price, "Cartoons from Another Planet: Japanese Animation as Cross-Cultural Communication," *The Journal of American Culture* 24, no. 1-2 (2001).
[146] Anita Radón, "Luxury Brand Exclusivity Strategies-an Illustration of a Cultural Collaboration," *Journal of Business Administration Research* 1, no. 1 (2012): 108-10.
[147] Kumiko Sato, "A Postwar Cultural History of Cuteness in Japan," *Education about Asia* 14, no. 2 (2009): 38.
[148] Nicole Constable, "A Tale of Two Marriages: International Matchmaking and Gendered Mobility," *Cross-border marriages: Gender and mobility in transnational Asia* (2005): 171-72.

As described by Ohnuki-Tierney, "cherry blossoms constituted the invention and performance of "Japan" in postwar Hawai'i and beyond, replacing memories of Pearl Harbor with that of beauty queens."[149] At least in some contexts, it would seem that sakura have been employed to perform not just Japan but Asia for the benefit of the Western world, presenting a feminized, multicultural, and safely assimilated (transplanted) subject that can survive and bloom even after decades of anti-Asian racism, exclusion, and violence.

[149] Yano, *Crowning the Nice Girl Gender, Ethnicity, and Culture in Hawaii's Cherry Blossom Festival*, 92.

Flowering cherry trees display an incredible ability to capture duality and contradiction in the folds of naturecultures, threading through their histories with humans and bringing to the fore moments of strain in dichotomies of humans and nature, masculine and feminine, and life and death. These forces work at all levels of life, from the permeable more-than-human environment of the human body to the rich entanglements that make natural-cultural civilizations: cherry blossoms around the world appear at places of tension and stress held in the body, heart, mind, and spirit just as they do on the scale of community and society. They act not just as indicators and reflectors of conflict but as healers, with physiological, mental, and spiritual powers of regeneration and transformation.

As discussed above, the bittersweet products of flowering cherry trees were commonly used in ancient cultures around the world to treat conditions of inflammation and other disturbances to bodily systems as well as for food, liquor, and craft. In this way, the trees play a role in marking the disruption of cycles as well as their restoration. In matters of the heart and spirit as well as the body, cherry blossoms are associated with both unrest and healing.

A well-known Japanese phrase expresses that "the flower turns people's blood crazy," and performing arts and literature often invoke the scattered petals to represent the loss of self and the mind. This scattering expressed through sakura, a dissolution of spirit into multiplicity and nothingness, often appears as the result of shifts in the balance of life and death surrounding an individual. The famous noh play *Cherry Blossom River* features a mother trying to scoop sakura petals out of a stream, seeing her daughter floating to pieces on the water and trying desperately not to lose

her; another popular kabuki play uses cherry blossoms to aestheticize madness as a man's soul departs from his body at the death of his lover.[150]

Madness as expressed through sakura is inherently tied to a spiritual understanding of these trees. During the medieval era, *kuru'u* meant "to go insane" as well as "to dance," and dancing was seen as an act of communication with the gods.[151] This kind of insanity might then be interpreted as a spiritual closeness with the gods present in nature, and a resultant distance from normative human society, facilitated through cherry blossoms. I cannot help but feel that truly contending with the histories of pain and violence that sakura have seen would drive anyone mad in that way, spirit wrenched away from mind and body to escape the trauma and loss of a cruel human world.

Despite their transient flowering, sakura repeat the cycle of blooming consistently and dependably over time and can survive much longer than humans: in this way, they exemplify longevity and health as well as insanity and brevity of life. Elders in the community surrounding the 1000-year old *takizakura* (waterfall cherry) in Miharu, Fukushima Prefecture, connect sakura to resilience and long life with the belief that many nearby live to old age because of the tree and its positive spiritual effects. They stress that their hearts are bright because the sakura is strong, and that it will be there long after they're gone.[152]

Cherry blossoms have long served as a way for humans to attune themselves with seasonal cycles and shifts in climate and environment, both planetary and anthropogenic, bridging social and political time with a natural and spiritual temporality. Links between affective state and seasonality, reinforced by ritual and lived cultural experience like the appreciation of sakura, can have impacts at the biochemical level and produce neurophysiological effects that manifest as seasonal affective

[150] Ohnuki-Tierney, *Flowers That Kill: Communicative Opacity in Political Spaces*, 30-31.
[151] Ibid.
[152] Walker et al., *Tsunami & the Cherry Blossom.*

disorder.[153] Cherry blossoms have been found to reduce depression and anger and increase vigor, invoking a mood state characterized as soft, warm, familiar, and full, even more so than other popular spring flowers like forsythia, rosebay, apricot, and magnolia.[154] On both a spiritual and physiological level, cherry blossom bloom is a marker of *mono no aware* as well as a powerful healing balm against that melancholy.

In this light, cherry blossoms are a cruel reminder of reality as well as a model of resilience for the inhabitants of a land that periodically undergoes violent upheaval and transformation on a social, political, ecological, and geological level. They bloom, in tension as always, in the environmental disasters that come of the transforming more-than-human earth of Japan. The Great East Japan Earthquake, tsunami, and nuclear meltdown, from which 20,000 people are now dead and thousands more missing, came just weeks before the cherry blossom season. The sakura flowered that spring in the aftermath of a rifting and shifting that shook the island and all of its entangled inhabitants, a transformation that rippled and poured through earth, bodies, ecosystems, and civilizations alike. The sakura flower in Tōhoku as I write, ten years in the wake of the devastating wave.

In the aftermath of the 2011 disaster, organized festivals like the Tokyo Sakura Matsuri were canceled, and signs placed around urban areas urged people to refrain from hanami and to be mindful of the victims. Though the drinking and other activities usually associated with hanami were largely forgone that spring, many still went out to simply look at the sakura. Rather than a celebration, sakura viewing was a meditation on suffering and a mode of peaceful healing for those affected by the earthquake and tsunami.[155] Many new cherry trees have been planted in Fukushima

[153] Simon Harrison, "Emotional Climates: Ritual, Seasonality and Affective Disorders," *Journal of the Royal Anthropological Institute* 10, no. 3 (2004): 583-84, 89, 98.
[154] Hyun-Ju Jo and Gye-Sook Hong, "Visio-Psychological Effect of Spring Flowers Blossoms on University Students," *Journal of Environmental Science International* 25, no. 8 (2016).
[155] Walker et al., *Tsunami & the Cherry Blossom*.

in memory of those who died, as part of a movement to rebuild neighborhoods that crumbled or were washed away.[156]

The direct accounts of survivors are also revealing in regard to the healing power of cherry blossoms, as seen in the documentary *The Tsunami and the Cherry Blossom*. The sudden intensity of the wave and its ravaging, dislocating, dismembering effects left survivors in fear and disbelief; many said that the tsunami was bigger than anticipated and that this fact would haunt the living and the dead. Yet survivors of the tsunami expressed calmness in the aftermath because of the knowledge that the sakura were coming, and they looked with hope to the fact that the cherry trees survived to bloom again. "Plants are stronger than humans," said one survivor, "They don't give up even after drowning in seawater." Another pointed out that not everyone the joyful display of the sakura in contrast to their suffering, saying that "some people resent the blossoms for looking so relaxed. When I see sakura, I see hope. I look at them and know that they'll bloom no matter what."[157]

The mayor of Hirosaki, a town on the edge of the Fukushima Daichii nuclear disaster zone whose sakura tourism season was lost to the disaster, echoed this sentiment with his confidence in cherry trees' ability to bloom every year despite any catastrophe. He looked to sakura as a sign of resilience, commenting that "like the trees, we will also recover." In Miharu, another town in the exclusion zone, visitors still flocked to see the thousand-year-old weeping cherry. One mother of four spoke to the healing strength of the blossoms, noting that she otherwise kept the children playing inside but that viewing the sakura outweighed concerns of radiation.[158]

Others likened sakura to Japanese people in that they are individually small and hard to see but are at their best all together, and though short-lived can provide great strength; following the

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[156] Abe, *The Sakura Obsession: The Incredible Story of the Plant Hunter Who Saved Japan's Cherry Blossoms*, 303.
[157] Walker et al., *Tsunami & the Cherry Blossom*.
[158] Hiroko Tabuchi, "Japan's Cherry Blossoms Bloom, but Nuclear Fears Keep Tourists Away," *The New York Times* (2011), https://www.nytimes.com/2011/04/26/world/asia/26blossom.html.

lead of sakura made for community resilience in the face of adversity. By maintaining a "metronome of life" for those displaced, dispossessed, and in mourning, sakura's ephemeral but dependable bloom was a lifeline in the tidal wave that swept away homes and families. One young woman, who watched from a hillside as townspeople and hopeful rescuers alike were washed away, said of a cherry tree flowering at the same spot: "They blossom as they watch over this town. They saw the tsunami, they see everything. I want to tell the blossoms, 'Keep watching us. We'll revive.'"[159] Her words make clear that sakura hold healing power not just because of their beauty and symbolic presence, but because of their active role in demonstrating the ongoingness of life and in watching over us in times of catastrophe.

"Nature has a terrible destructive power. And nature also has a positive creative power. Beauty and terror always exist in nature, but we forget the terror. We used to have a better relationship with nature. But now we are living in a world of modern convenience. If something bad happens unexpectedly, we panic."[160]

For Sano Tōemon XVI, sakura are a reminder of the balance of universal forces from which humans have become alienated. His words invite us to find healing by disturbing the boundaries between humans and nature, reattuning ourselves to the forces and cycles revealed by the cherry blossom, and finding resilience through multispecies relationships when our connection to the earth is shifted and shaken—by tectonic activity, by industry, by a rapidly changing climate, by the imposition of extraction-based norms and values onto a land that *cycles* and does not *produce*, by cruel and violent imbalance.

[159] Walker et al., *Tsunami & the Cherry Blossom*.
[160] Ibid.

The 16th keeper of the sakura also reminds us that once a tree is indwelt by its own kami, it can then be entered by the spirits of the dead. When we remember that these trees are divine, we allow the memory of the dead to flow through them, and we give voice to the histories that sakura and their spirits have seen.

I offer three stories to think with:

The first is the Japanese folktale *Hanasaka-jiisan* (花咲か爺さん), which tells of an old couple, their dearly beloved dog Shiro, and their wicked neighbor who mistreated the dog. When Shiro led the old couple to gold buried beneath a tree, the greedy neighbor tried to borrow him in order to do the same but found only a refuse heap, or in some versions, bones. The neighbor killed Shiro on the spot and even admitted as much to the old man, who was too kind to even reproach him for his wickedness. The old man learned that Shiro was buried under that tree, and he asked for the tree in remembrance, cutting it down and carefully carving it to make a mortar. When he and his wife pounded rice in the mortar for a ritual celebration in memory of Shiro, the cakes grew to five times the original amount and tasted better than anything else. Of course, when the neighbor borrowed the mortar and tried to use it, only a horrid-smelling substance came out, and he burned it

to ashes. The old man, upon discovering this, asked to keep the ashes and carried them home in a basket, where he scattered some on the trees in his garden. Although it was autumn and the trees had already shed their leaves, they burst into bloom at the touch of the ashes. Later, the old man was sought by a *daimyo* (lord) who asked him to bring a dead cherry tree in his garden back into blossom, and he was rewarded for his success with precious items and the name *Hanasaka-jijii*, or "the old man who makes the trees blossom." The old man's (very predictable) neighbor, jealous of his good fortune, stole the remaining ashes. He was imprisoned as an impostor when he failed to repeat the trick, instead scattering ashes into the daimyo's eyes.[161]

Next, from Motojirō Kajii's short story *Sakura no ki no shita ni wa* (**櫻の樹の下には**, Under the Cherry Blossoms): "There lie cadavers buried under the cherry blossoms! This is a truth you must accept. For how else could the flowers of the cherry tree be so magnificent in their bloom? … The cadavers of horses, the cadavers of dogs and cats, and it seems, the cadavers of human beings too. Rotting cadavers, crawling with maggots, reeking of a most intolerable stench, all the while seeping a liquid so pure and clear. The cherry tree, as if it were the rapacious octopus, extends its roots outward to grasp. Like the feeding tentacles of the sea anemone, its roots enfold to partake of that liquid. What could form such a petal? What was behind the creation of such a stamen? I had envisioned it in dreamlike detail: The roots had gathered silently, matter-of-factly, to siphon that pure, clear liquid into its vascular system."[162]

And finally, in the work of all-female Japanese manga collective CLAMP, the sakurazukamori (桜塚護, cherry blossom burial mound guardian) is a mysterious and powerful

[161] Yei Theodora Ozaki, "The Story of the Old Man Who Made Withered Trees to Flower," in *Japanese Fairy Tales, Lit2Go Edition* (1908). A daimyo is a lord of the Japanese feudal era.
[162] Motojirō Kajii and Bonnie Huie, "Under the Cherry Blossoms," The Brooklyn Rail. Kajii lived from 1901-1932 and spent much of his life in Osaka, a rapidly industrializing city with a high rate of tuberculosis. He died from TB at age 31.

assassin who feeds his victim's bodies, blood, and souls to the sacred sakura. Cherry blossoms, once pure white, bloom pink and out of season with the blood of each new body laid to rest beneath the tree's roots.[163] CLAMP's characters cross dimensions, and the sakurazukamori of Tokyo Babylon and X/1999 also appears in Tsubasa: Reservoir Chronicle, a world where the blossoms frequently flutter and where Sakura is a girl whose power transcends worlds through spirit and memory. In the chapter "Parting Beneath the Cherry Trees," Seishirō Sakurazuka waits in a torrent of falling petals for Sakura's protectors, whom he fights and "kills" before using his powers to merge their virtual reality with the real world—one of many real worlds in that universe, as in our own.[164]

With these three stories, sakura captured my attention and demanded that I ask how blossoms might respond to more than just climate variables. I saw the beautiful trees we supposedly bend and breed to our will and wondered what bodies, blood, and souls they might take in return for that power, as we, like Hanasaka-jiisan's close-minded neighbor, act out the motions of ritual offering without remembering the meaning. With ash in my eyes, I wake into this world and try to let sakura show me life and death with their bloom.

Perhaps it's too far-fetched to wonder about the truth in these stories, to imagine that these authors saw the same hungry ghosts in sakura for a reason, to fantasize that cherry blossoms bloom in memory of lost souls and changing worlds. Perhaps it's too unscientific to think that the trees which have been thought to hold spirits for centuries, which capture the cycle of life and death in splendid beauty with each turn of the earth, might have some kind of response to the death and transformation that appear as they live and breathe alongside us. Perhaps it's too unconventional to

163 "Sakurazukamori," Suburban Senshi Wiki, https://whatis.suburbansenshi.com/index.php/Sakurazukamori.
164 CLAMP and Anthony Gerard, *Tsubasa: Reservoir Chronicle, Volume 7* (New York, NY: Del Rey/Ballantine Books, 2005). Sakura is the title character in CLAMP's other work mentioned above, *Cardcaptor Sakura*, where she is tasked with collecting mystical cards made of Eastern and Western magic and imbued with the power and personality of elemental forces.

suggest that the understandings of sakura that these stories engender—as watchful, reactive, and even judgmental—are just as useful for exploring their relationship to climate change as statistical analyses of their measurable responses.

And yet the fact remains that in fiction and nonfiction, sakura appear most prominently in war and upheaval, in contact and conflict, in the messy world of love and sex and gender, in environmental disaster. And yet the fact remains that Kajii's dark story from a time of illness and unrest, of intense shifts in the balance of life and death, is one of the most commonly quoted literary works when discussing cherry blossoms, even in the United States where the flowers have lost their connotations of transience in favor of spring renewal. And yet the fact remains that stories say sakura bloom out of season when fed dead bodies, and science says sakura bloom out of season when a civilization fueled by death warms the earth.

FIGURE 13. SAKURA BLOOMING BY THE SIDEWALK IN LATE OCTOBER 2020
TSUKUBA, IBARAKI PREFECTURE, JAPAN
FROM PERSONAL CORRESPONDENCE WITH DR. MIKIKO KAINUMA.

Whether you believe in sakura as spirits or not, they are deeply entangled with human lives and histories, and they serve as a powerful lens into the processes that have shaped civilization through a changing climate. When we grant them the agency to observe and react as many have for centuries, understanding them as beings that both impact and are impacted by human lives, we allow cherry trees to tell more-than-human stories through entanglement and interconnection. They have watched over humans through war and disaster, taken potent offerings of love and hate, and given back powers both light and dark in their spectacular bloom, forever shifting in time, space, and meaning. Cherry blossoms have histories of life, death, and transformation held in the hearts of their wood and the souls of their blossoms.

Maybe cherry trees are sentient and smart enough to understand heating-degree days, and maybe they just don't care. Maybe they have more pressing things to pay attention to, because humans dragged them down the sacred mountain and into wars, tsunamis, climate change, beauty pageants, and sci-fi/fantasy comics. Maybe we can learn something if we start paying attention too.

BIBLIOGRAPHY

Abe, Naoko. *The Sakura Obsession: The Incredible Story of the Plant Hunter Who Saved Japan's Cherry Blossoms.* Vintage, 2019.

Ademović, Zahida, Snježana Hodžić, Zarka Halilić-Zahirović, Darja Husejnagić, Jasna Džananović, Broza Šarić-Kundalić, and Jasmin Suljagić. "Phenolic Compounds, Antioxidant and Antimicrobial Properties of the Wild Cherry (Prunus Avium L.) Stem." *Acta Periodica Technologica*, no. 48 (2017): 1-13.

Aerts, Raf, Michael Ewald, Manuel Nicolas, Jérôme Piat, Sandra Skowronek, Jonathan Lenoir, Tarek Hattab, *et al.* "Invasion by the Alien Tree Prunus Serotina Alters Ecosystem Functions in a Temperate Deciduous Forest." *Frontiers in plant science* 8 (2017): 179.

Alas, Horus. "National Cherry Blossom Festival Generates over $100 Million for Dc." Capital News Service, https://cnsmaryland.org/2019/05/01/national-cherry-blossom-festival-generates-over-100-million-for-dc/.

Allen, Jenica M., Maria A. Terres, Toshio Katsuki, Kojiro Iwamoto, Hiromi Kobori, Hiroyoshi Higuchi, Richard B. Primack, *et al.* "Modeling Daily Flowering Probabilities: Expected Impact of Climate Change on Japanese Cherry Phenology." *Global Change Biology* 20, no. 4 (2014): 1251-63.

An, S., O. Arakawa, N. Tanaka, S. Zhang, and M. Kobayashi. "Effects of Blue and Red Light Irradiations on Flower Colouration in Cherry Blossom (Prunus × Yedoensis 'Somei-Yoshino')." *Scientia Horticulturae* 263 (2020/03/15/ 2020): 109093.

Aono, Yasuyuki. "Cherry Blossom Phenological Data since the Seventeenth Century for Edo (Tokyo), Japan, and Their Application to Estimation of March Temperatures." *International Journal of Biometeorology* 59, no. 4 (2015/04/01 2015): 427-34.

Aono, Yasuyuki, and Keiko Kazui. "Phenological Data Series of Cherry Tree Flowering in Kyoto, Japan, and Its Application to Reconstruction of Springtime Temperatures since the 9th Century." *International Journal of Climatology: A Journal of the Royal Meteorological Society* 28, no. 7 (2008): 905-14.

Arakawa, H. "Twelve Centuries of Blooming Dates of the Cherry Blossoms at the City of Kyoto and Its Own Vicinity." *Geofisica pura e applicata* 30, no. 1 (1955): 147-50.

Aspling, Fredrik, Jinyi Wang, and Oskar Juhlin. "Plant-Computer Interaction, Beauty and Dissemination." Paper presented at the Proceedings of the Third International Conference on Animal-Computer Interaction, 2016.

"The Birds, the Bees, and the Flowering Cherry Trees." National Park Service, U.S. Department of the Interior, https://www.nps.gov/articles/birds-and-cherry-blossom-trees.htm.

Boutin, Stan, and Jeffrey E. Lane. "Climate Change and Mammals: Evolutionary Versus Plastic Responses." *Evolutionary Applications* 7, no. 1 (2014): 29-41.

Braungart, Michael. "The Wisdom of the Cherry Tree." *International Commerce Review* 7, no. 2 (2007): 152-56.

Brenskelle, Laura, Brian J Stucky, John Deck, Ramona Walls, and Rob P Guralnick. "Integrating Herbarium Specimen Observations into Global Phenology Data Systems." *Applications in Plant Sciences* 7, no. 3 (2019): e01231.

Caldarola, Carlo, Mitsuru Shinpo, K. Victor Ujimoto, Ban Seng Hoe, and civilisations MusÈe canadien des. *Sakura in the Land of the Maple Leaf : Japanese Cultural Traditions in Canada.* [in Texte en anglais avec un rÈsumÈ en franÁais.] 2007.

"Cannon Hill Park Cherry Trees Attacked in Act of Vandalism." *BBC News* (2015). Published electronically May 7, 2015. https://www.bbc.com/news/uk-england-birmingham-32629055.

Chan, Yin-lun. "On the Symbolism of Plants in the Context of Hong Kong." *Yuanlin/Planting Futures* 15 (2015): 22.

"Cherry Blossom Tree in Dc Destroyed after Someone Climbed It.". Reddit, https://www.reddit.com/r/trashy/comments/fmhmvb/cherry_blossom_tree_in_dc_destroyed_after_someone/.

"The Cherry Blossoms Have Arrived! Some Good, Some Bad.". Maryland Invasive Species Council.

"The Cherry Tree Rebellion." National Park Service, U.S. Department of the Interior, https://www.nps.gov/articles/the-cherry-tree-rebellion.htm.
Chmielewski, Frank-M, and Thomas Rötzer. "Response of Tree Phenology to Climate Change across Europe." *Agricultural and Forest Meteorology* 108, no. 2 (2001): 101-12.
Cho, Myong-Suk, Chan-Soo Kim, Seon-Hee Kim, Ted Oh Kim, Kyoung-In Heo, Jumin Jun, and Seung-Chul Kim. "Molecular and Morphological Data Reveal Hybrid Origin of Wild Prunus Yedoensis (Rosaceae) from Jeju Island, Korea: Implications for the Origin of the Flowering Cherry." *American Journal of Botany* 101, no. 11 (2014): 1976-86.
Chung, Uran, Liz Mack, Jin I Yun, and Soo-Hyung Kim. "Predicting the Timing of Cherry Blossoms in Washington, Dc and Mid-Atlantic States in Response to Climate Change." *PLoS One* 6, no. 11 (2011): e27439.
CLAMP, and Anthony Gerard. *Tsubasa: Reservoir Chronicle, Volume 7*. [in English] New York, NY: Del Rey/Ballantine Books, 2005.
"Community Connection: Cherry Blossom Bloom Dates in Washington, D.C.". United States Environmental Protection Agency.
Constable, Nicole. "A Tale of Two Marriages: International Matchmaking and Gendered Mobility." *Cross-border marriages: Gender and mobility in transnational Asia* (2005): 166-86.
Cotton, Peter A. "Avian Migration Phenology and Global Climate Change." *Proceedings of the National Academy of Sciences* 100, no. 21 (2003): 12219-22.
Cruikshank, Julie. *Do Glaciers Listen?: Local Knowledge, Colonial Encounters, and Social Imagination.* ubc Press, 2007.
Deck, Jerica. "Confused by Climate Change, Japan's Famous Cherry Blossoms Bloom Six Months Early." https://www.globalcitizen.org/en/content/cherry-blossoms-climate/.
Demuth, Bathsheba. *Floating Coast: An Environmental History of the Bering Strait.* WW Norton & Company, 2019.
Douglas Bates, Martin Maechler, Ben Bolker, Steve Walker. "Fitting Linear Mixed-Effects Models Using Lme4." *Journal of Statistical Software* 67, no. 1 (2015): 1-48.
DuFon, Margaret A, and Eton Churchill. *Language Learners in Study Abroad Contexts.* Vol. 15: Multilingual Matters, 2006.
Duncan, Barbara R., and Davey Arch. *Living Stories of the Cherokee.* [in English] Chapel Hill: The University of North Carolina Press, 1998. Book.
El-Sayed, Ashraf M., Andrew Sporle, Kate Colhoun, Jess Furlong, Robyn White, and David M. Suckling. "Scents in Orchards: Floral Volatiles of Four Stone Fruit Crops and Their Attractiveness to Pollinators." *Chemoecology* 28, no. 2 (2018/04/01 2018): 39-49.
Filipović, Dragana, Milica Fotirić Akšić, Dragana Dabić Zagorac, and Maja Natić. "Gathered Fruits as Grave Goods? Cornelian Cherry Remains from a Mesolithic Grave at the Site of Vlasac, Danube Gorges, South-East Europe." *Quaternary International* 541 (2020): 130-40.
Forrest, Jessica R. K. "Complex Responses of Insect Phenology to Climate Change." *Current Opinion in Insect Science* 17 (2016/10/01/ 2016): 49-54.
Fuentes, Agustín. "Naturalcultural Encounters in Bali: Monkeys, Temples, Tourists, and Ethnoprimatology." *Cultural Anthropology* 25, no. 4 (2010): 600-24.
Fund, International Monetary. "Figure 3.5. Temperature and Precipitation Projections under the Rcp 8.5 Scenario." 2017.
Gumbs, A.P., and adrienne maree brown. *Undrowned: Black Feminist Lessons from Marine Mammals.* AK Press, 2020.
Hageneder, Fred, and Lizzie Harper. *Living Wisdom of Trees : A Guide to the Natural History, Symbolism and Healing Power of Trees.* [in English] 2020.
Haraway, Donna. "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century." *Technology and Values: Essential Readings* (2009): 225-46.
Haraway, Donna J. *Staying with the Trouble: Making Kin in the Chthulucene.* Duke University Press, 2016.
Harrison, Simon. "Emotional Climates: Ritual, Seasonality and Affective Disorders." *Journal of the Royal Anthropological Institute* 10, no. 3 (2004): 583-602.
Hasegawa, Koichi. "Information and Resource Processing Paradigm." *The Blackwell Encyclopedia of Sociology* (2007): 1-2.

"History of the Cherry Trees." National Park Service.
Ibarra-Alvarado, César, Alejandra Rojas, Francisco Luna, J Isela Rojas, Blanca Rivero-Cruz, and J Fausto Rivero-Cruz. "Vasorelaxant Constituents of the Leaves of Prunus Serotina "Capulín"." *Rev. Latinoam. Quim* 37 (2009): 164-73.
Inouye, Charles Shiro. *Evanescence and Form : An Introduction to Japanese Culture.* [in English] New York, N.Y.: Palgrave Macmillan, 2008.
Jiang, Benyan, and Masaki Fujikawa. "The Plantation of Black Pine and Cherry Blossom in Qingdao before Wwii." *Journal of the Japanese Institute of Landscape Architecture* (2014).
Jo, Hyun-Ju, and Gye-Sook Hong. "Visio-Psychological Effect of Spring Flowers Blossoms on University Students." *Journal of Environmental Science International* 25, no. 8 (2016): 1097-105.
Kai, Keiko, Mikiko Kainuma, Naomi Murakoshi, and Kenji Omasa. "Potential Effects on the Phenological Observation of Plants by Global Warming in Japan." *Journal of Agricultural Meteorology* 48, no. 5 (1993): 771-74.
Kajii, Motojirō, and Bonnie Huie. "Under the Cherry Blossoms." The Brooklyn Rail.
Kawamoto, Koji. "The Use and Disuse of Tradition in Bashō's Haiku and Imagist Poetry." *Poetics Today* (1999): 709-21.
Kim, Hai Gyoung. "A Study on Interpreting People's Enjoyment under Cherry Blossom in Modern Times." *Journal of the Korean Institute of Traditional Landscape Architecture* 29, no. 4 (2011): 124-36.
Kim, Min-Jong, Young-Ae Choi, Soyoung Lee, Jin Kyeong Choi, Yeon-Yong Kim, Eun-Nam Kim, Gil-Saeng Jeong, *et al.* "Prunus Serrulata Var. Spontanea Inhibits Mast Cell Activation and Mast Cell-Mediated Anaphylaxis." *Journal of ethnopharmacology* 250 (2020): 112484.
Kimmerer, Robin Wall. *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants.* Milkweed Editions, 2013.
Kitagawa, Mamoru. *A Kamikaze Tokkōtai: Kaerazaru Seishun No Isho Shū (Ah, Kamikaze Special Attack Corps: Collected Last Letters of Youth That Would Not Return).* Tōkyō: Nihon Bungeisha, 1970.
Larson, Victoria S Tietze. "Memorializing Jefferson: Imperial Designs and the Battle of the Cherry Blossoms." *International journal of the classical tradition* 22, no. 3 (2015): 304-40.
Lee, Ho-Seung, Jin-Hee Kim, and Jin I Yun. "Recent Trends in Blooming Dates of Spring Flowers and the Observed Disturbance in 2014." *Korean Journal of Agricultural and Forest Meteorology* 16, no. 4 (2014): 396-402.
Lee, Jin-Ho, Kyungjin Lee, Mi-Hwa Lee, Bumjung Kim, Khanita Suman Chinannai, Heseung Hur, Inhye Ham, and Ho-Young Choi. "Wound Healing Effects of Prunus Yedoensis Matsumura Bark in Scalded Rats." *Evidence-Based Complementary and Alternative Medicine* 2017 (2017).
Lee, Sang-Don. "Global Warming Leading to Phenological Responses in the Process of Urbanization, South Korea." *Sustainability* 9, no. 12 (2017): 2203.
Emmeans: Estimated Marginal Means, Aka Least-Squares Means.
Lindström, Kati. "From Experiential to Chronometric Seasonality–the Establishment of Seasons as a National Symbol in Modern Japan." In *Seasonal Landscapes*, 215-29: Springer, 2007.
Livingston, Ian, Freedman, Andrew. "Climate Change Is Warming Winters in Dc." The Washington Post, https://www.washingtonpost.com/weather/2020/12/03/washington-warming-winters-snow/.
Miller-Rushing, Abraham J, Toshio Katsuki, Richard B Primack, Yukio Ishii, Sang Don Lee, and Hiroyoshi Higuchi. "Impact of Global Warming on a Group of Related Species and Their Hybrids: Cherry Tree (Rosaceae) Flowering at Mt. Takao, Japan." *American Journal of Botany* 94, no. 9 (2007): 1470-78.
Miller-Rushing, Abraham J, Richard B Primack, Daniel Primack, and Sharda Mukunda. "Photographs and Herbarium Specimens as Tools to Document Phenological Changes in Response to Global Warming." *American Journal of Botany* 93, no. 11 (2006): 1667-74.
Moerman, Daniel. "A Database of Foods, Drugs, Dyes and Fibers of Native American Peoples, Derived from Plants." Native American Ethnobotany Database, 2003.
Moore, Glenn, Atherton, Cassandra. "Eternal Forests: The Veneration of Old Trees in Japan." *Arnoldia*, May 18, 2020 2020.

Morellato, Leonor Patrícia Cerdeira, Bruna Alberton, Swanni T. Alvarado, Bruno Borges, Elise Buisson, Maria Gabriela G. Camargo, Leonardo F. Cancian*, et al.* "Linking Plant Phenology to Conservation Biology." *Biological Conservation* 195 (2016/03/01/ 2016): 60-72.

Moriuchi, Emi, and Michael Basil. "The Sustainability of Ohanami Cherry Blossom Festivals as a Cultural Icon." *Sustainability* 11, no. 6 (2019): 1820.

Nesom, Guy. "Plant Guide: Black Cherry." United States Department of Agriculture, Natural Resources Conservation Service.

Ohashi, Yukitaka, Hiroshi Kawakami, Yoshinori Shigeta, Hiroshi Ikeda, and Nobuko Yamamoto. "The Phenology of Cherry Blossom (Prunus Yedoensis "Somei-Yoshino") and the Geographic Features Contributing to Its Flowering." *International Journal of Biometeorology* 56, no. 5 (2012/09/01 2012): 903-14.

Ohnuki-Tierney, Emiko. "Cherry Blossoms and Their Viewing." *The culture of Japan as seen through its leisure* (1998): 213-37.

———. *Flowers That Kill: Communicative Opacity in Political Spaces*. Stanford University Press, 2015.

———. *Kamikaze, Cherry Blossoms, and Nationalisms: The Militarization of Aesthetics in Japanese History*. University of Chicago Press, 2010.

Okada, Moeko. "Wordplay as a Selling Strategy in Advertisements and Sales Promotion." In *Language and Humour in the Media*, edited by Jan Chovanec and Isabel Ermida: Cambridge Scholars Publishing, 2012.

Omoto, Yukio, and Yasuyuki Aono. "Estimation of Change in Blooming Dates of Cherry Flower by Urban Warming." *Journal of Agricultural Meteorology* 46, no. 3 (1990): 123-29.

Omura, Hisashi, Keiichi Honda, Ayami Nakagawa, and Nanao Hayashi. "The Role of Floral Scent of the Cherry Tree, Prunus Yedoensis, in the Foraging Behavior of Luehdorfia Japonica (Lepidoptera: Papilionidae)." *Applied entomology and zoology* 34, no. 3 (1999): 309-13.

Ozaki, Yei Theodora. "The Story of the Old Man Who Made Withered Trees to Flower." In *Japanese Fairy Tales, Lit2Go Edition*, 1908.

Pakan, Sarani Pitor. "Can the 'Other' Frame Back in Tourism Studies? Experimenting to Respond in an Asymmetrical Dialogue." *Tourism Review*, no. 16 (2019).

Park, Minkyung, Margaret J Daniels, Russell Brayley, and Laurlyn K Harmon. "An Analysis of Service Provision and Visitor Impacts Using Participant Observation and Photographic Documentation: The National Cherry Blossom Festival." *Event Management* 14, no. 2 (2010): 167-82.

Pauly, Philip J. "The Beauty and Menace of the Japanese Cherry Trees: Conflicting Visions of American Ecological Independence." *Isis* 87, no. 1 (1996): 51-73.

Pemberton, Robert W. "Japanese Food as Art and Symbol: Evidence from Inedible Leaf Garnishes." *Petits Propos Culinaires* 63 (1999): 37-49.

Philp, G. L. "Abnormality in Sweet Cherry Blossoms and Fruit." *Botanical Gazette* 94, no. 4 (1933): 815-20.

Plumwood, Val. *Feminism and the Mastery of Nature*. Routledge, 2002.

Poyet, Mathilde, Patrice Eslin, Marie Héraude, Vincent Le Roux, Geneviève Prévost, Patricia Gibert, and Olivier Chabrerie. "Invasive Host for Invasive Pest: When the Asiatic Cherry Fly (Drosophila Suzukii) Meets the American Black Cherry (Prunus Serotina) in Europe." *Agricultural and forest entomology* 16, no. 3 (2014): 251-59.

Price, Shinobu. "Cartoons from Another Planet: Japanese Animation as Cross-Cultural Communication." *The Journal of American Culture* 24, no. 1-2 (2001): 153-69.

"Prunus Serotina (Black Cherry)." Centre for Agriculture and Bioscience International.

Radón, Anita. "Luxury Brand Exclusivity Strategies-an Illustration of a Cultural Collaboration." *Journal of Business Administration Research* 1, no. 1 (2012): 106.

Rakovan, John, Masao Kitamura, and Osamu Tamada. "Sakura Ishi (Cherry Blossom Stones): Mica Pseudomorphs of Complex Cordierite-Indialite Intergrowths from Kameoka, Kyoto Prefecture, Japan." *Rocks & Minerals* 81, no. 4 (2006): 284-92.

Renner, Susanne S., and Constantin M. Zohner. "Climate Change and Phenological Mismatch in Trophic Interactions among Plants, Insects, and Vertebrates." *Annual Review of Ecology, Evolution, and Systematics* 49, no. 1 (2018): 165-82.

Roetzer, Thomas, Markus Wittenzeller, Hans Haeckel, and Jiri Nekovar. "Phenology in Central Europe–Differences and Trends of Spring Phenophases in Urban and Rural Areas." *International journal of biometeorology* 44, no. 2 (2000): 60-66.

Ronström, Owe. "Orchestrating and Controlling the Foreign: The Festival of Diversity in Stockholm City Hall." *Journal of folklore research* 30, no. 1 (1993): 75-83.

Roy, D. B., and T. H. Sparks. "Phenology of British Butterflies and Climate Change." *Global Change Biology* 6, no. 4 (2000): 407-16.

Sakurai, Ryo, Susan K Jacobson, Hiromi Kobori, Richard Primack, Kohei Oka, Naoya Komatsu, and Ryo Machida. "Culture and Climate Change: Japanese Cherry Blossom Festivals and Stakeholders' Knowledge and Attitudes About Global Climate Change." *Biological Conservation* 144, no. 1 (2011): 654-58.

"Sakurazukamori." Suburban Senshi Wiki, https://whatis.suburbansenshi.com/index.php/Sakurazukamori.

Samuels, Gayle Brandow. *Enduring Roots: Encounters with Trees, History, and the American Landscape.* Rutgers University Press, 2005.

Sato, Kumiko. "A Postwar Cultural History of Cuteness in Japan." *Education about Asia* 14, no. 2 (2009): 38-42.

Simard, Suzanne W. "Mycorrhizal Networks Facilitate Tree Communication, Learning, and Memory." In *Memory and Learning in Plants*, 191-213: Springer, 2018.

Singh, Priyanka, Sungeun Ahn, Jong-Pyo Kang, Soshnikova Veronika, Yue Huo, Hina Singh, Mohan Chokkaligam*, et al.* "In Vitro Anti-Inflammatory Activity of Spherical Silver Nanoparticles and Monodisperse Hexagonal Gold Nanoparticles by Fruit Extract of Prunus Serrulata: A Green Synthetic Approach." *Artificial cells, nanomedicine, and biotechnology* 46, no. 8 (2018): 2022-32.

Stromberg, Joseph. "After Pearl Harbor, Vandals Cut Down Four of Dc's Japanese Cherry Trees." Smithsonian Magazine.

"Sweet Cherry - *Prunus Avium* (L.) L. ." Center for Invasive Species and Ecosystem Health.

Tabuchi, Hiroko. "Japan's Cherry Blossoms Bloom, but Nuclear Fears Keep Tourists Away." *The New York Times* (2011). Published electronically April 25, 2011. https://www.nytimes.com/2011/04/26/world/asia/26blossom.html.

R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Tsing, Anna Lowenhaupt. *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins.* Princeton University Press, 2015.

Turner, Nancy. "Appendix 2b. Names of Native Plant Species in Indigenous Languages of Northwestern North America." In *Ancient Pathways, Ancestral Knowledge: Ethnobotany and Ecological Wisdom of Indigenous Peoples of Northwestern North America*: McGill-Queen's Press-MQUP, 2014.

"The Vandalization of the Cherry Trees in 1941." National Park Service, U.S. Department of the Interior, https://www.nps.gov/articles/the-vandalization-of-the-cherry-trees-in-1941.htm.

Velmurugan, P, S Sivakumar, YC Song, and SH Jang. "Crystallization of Silver Metal by Extract of Prunus× Yedoensis Matsumura Blossoms and Its Potential Characterization." *Journal of Industrial and Engineering Chemistry* 31 (2015): 39-42.

Walker, Lucy, Aaron Phillips, Supply, and Integrated Demand. *Tsunami & the Cherry Blossom*. United States: Supply & Demand Integrated, 2011.

Waller, Allyson. "Cherry Blossom Trees Vandalized in San Francisco's Japantown." *The New York Times* (2021). Published electronically January 8, 2021. https://www.nytimes.com/2021/01/08/us/japantown-cherry-blossom-trees.html.

Welk, E., de Rigo, D., Caudullo, G. "Prunus Avium in Europe: Distribution, Habitat, Usage and Threats." In *European Atlas of Forest Tree Species*, edited by J. San-Miguel-Ayanz, de Rigo, D., Caudullo, G., Houston Durrant, T., Mauri, A., 2016.

Wender, Dorothea. "The Myth of Washington." *Arion: A Journal of Humanities and the Classics* 3, no. 1 (1976): 71-78.

West, Willard. "This Is Why You Shouldn't Climb Cherry Blossom Trees " *NBC Washington* (2020). Published electronically March 20, 2020. https://www.nbcwashington.com/news/local/this-is-why-you-shouldnt-climb-cherry-blossom-trees/2248759/.

Whiteaker, Chloe, Katanuma, Marika, and Murray, Paul. "The Big Business of Japan's Cherry Blossoms." Bloomberg, https://www.bloomberg.com/graphics/2019-cherry-blossoms/.

Wickham, Hadley. *"Ggplot2: Elegant Graphics for Data Analysis"*. New York: Springer-Verlag, 2016.

Yamamoto, Takeo. "Some Climatological Considerations About a Poem on Cherry Blossoms Composed by Saigyo." *Journal of Geography (Chigaku Zasshi)* 78, no. 4 (1969): 271-81.

Yano, Christine Reiko. *Crowning the Nice Girl Gender, Ethnicity, and Culture in Hawaii's Cherry Blossom Festival.* [in English] Honolulu: University of Hawai'i Press, 2006.

Yeşilada, Erdem, Gisho Honda, Ekrem Sezik, Mamoru Tabata, Katsumi Goto, and Yasumasa Ikeshiro. "Traditional Medicine in Turkey Iv. Folk Medicine in the Mediterranean Subdivision." *Journal of ethnopharmacology* 39, no. 1 (1993): 31-38.

Yook, Hong-Sun, Kyoung-Hee Kim, Jung-Eun Park, and Hyun-Jin Shin. "Antioxidative and Antiviral Properties of Flowering Cherry Fruits (Prunus Serrulata L. Var. Spontanea)." *The American journal of Chinese medicine* 38, no. 05 (2010): 937-48.

Yoririn. "17 Interesting Japanese Superstitions." Tsunagu Japan.

Zhang, YQ, L Guan, ZY Zhong, M Chang, DK Zhang, H Li, and W Lai. "The Anti-Inflammatory Effect of Cherry Blossom Extract (Prunus Yedoensis) Used in Soothing Skincare Product." *International journal of cosmetic science* 36, no. 6 (2014): 527-30.