

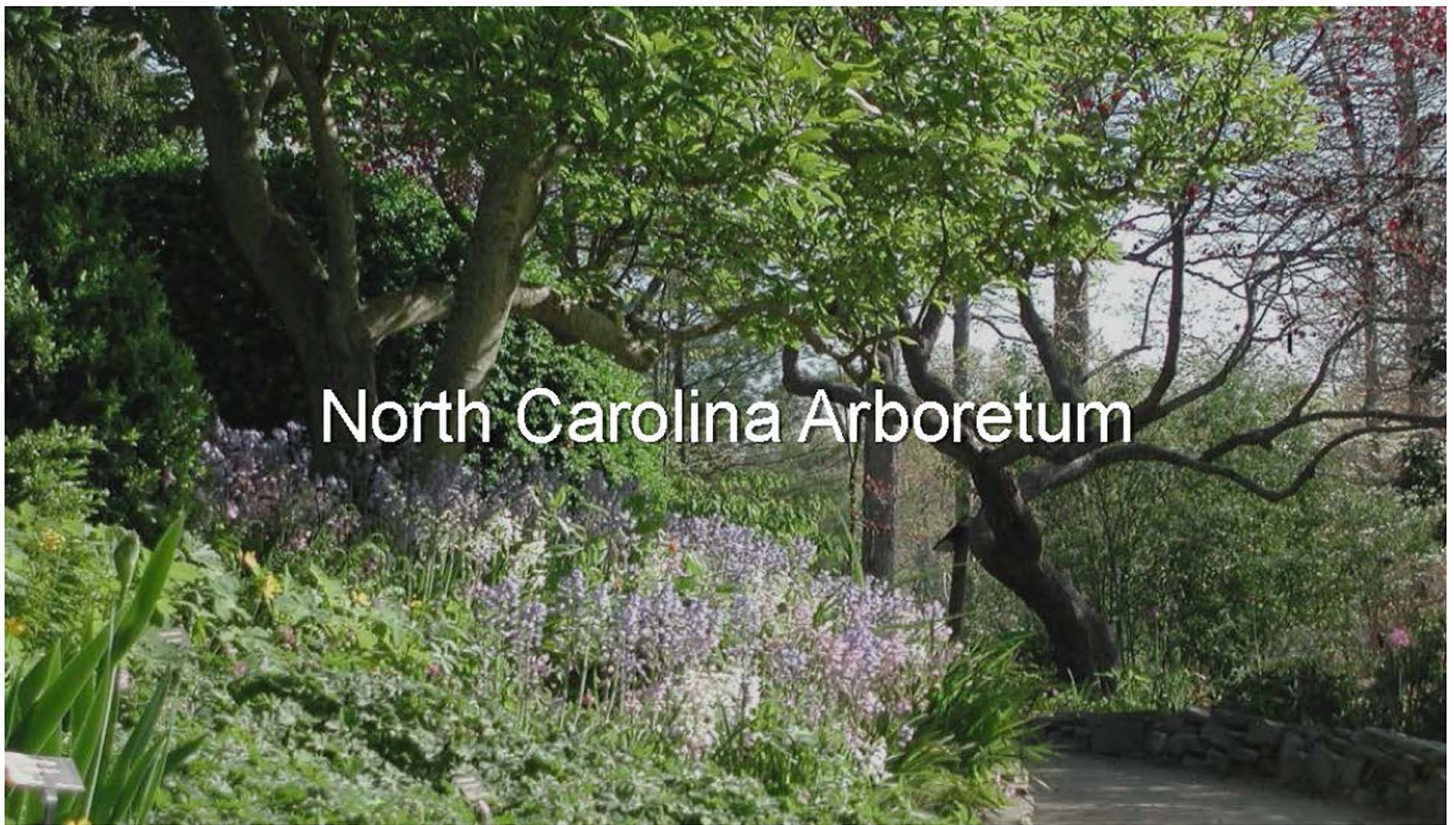
Garden Typologies: Arboreta

Molly Foote, Alex Leonard, Kinzer Hurt, Emily Slattberg



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Brooklyn Botanic Garden



North Carolina Arboretum

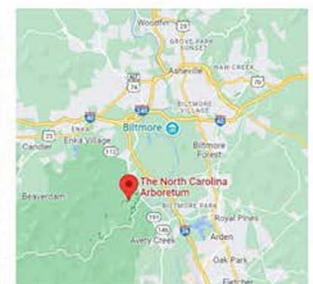
Location and Site

Location: Bent Creek
Experimental Forest in Pisgah
National Forest, NC

Size: 434 acres

Ecology: Southern Appalachian

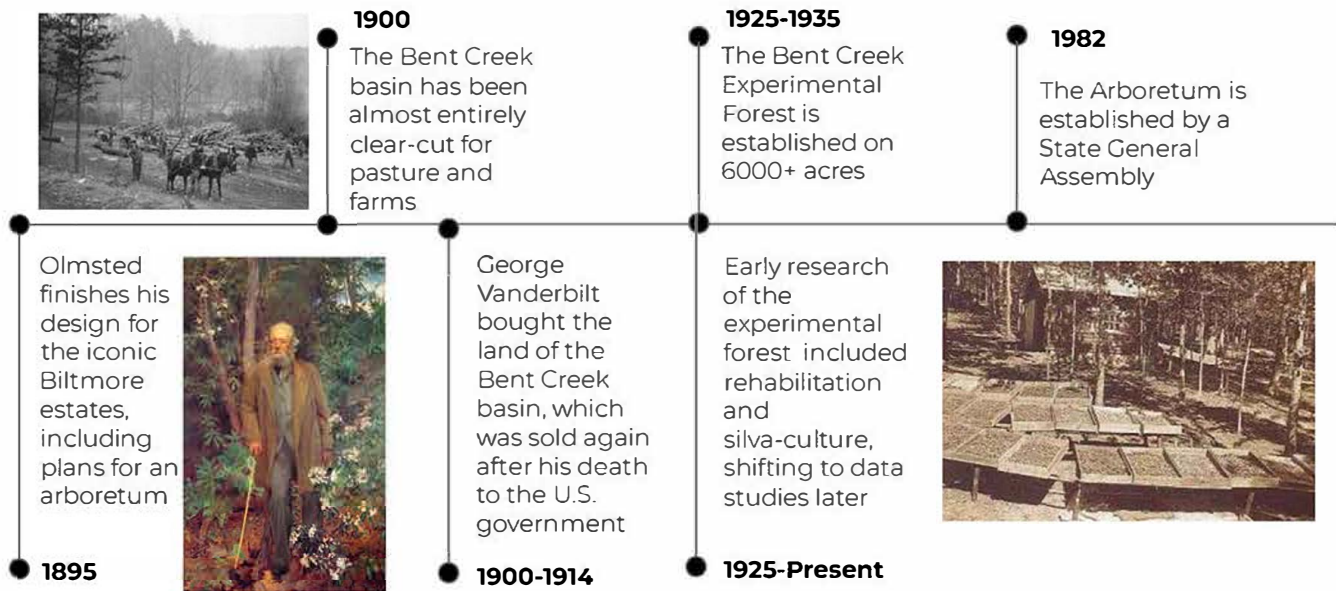
Nearby Attractions: Asheville,
Blue Ridge Parkway, Biltmore



Scenic Blue Ridge Ecology.
<https://www.romanticasheville.com/BlueRidgeParkway.htm>

NC Arboretum Visitor Map showing trails and gardens.
<https://www.ncarboretum.org/plan-a-visit/>

History



Mission

“...the Arboretum's mission, vision and values, and is closely aligned with Olmsted's four key design criteria: **environment, economics, aesthetics and social factors.**”

MISSION: “to advance our state's future by creatively connecting people, plants and places through education, design and economic development.”

VISION: “to redefine the Arboretum concept as central to education and place-based economic development.”

<https://www.ncarboretum.org/about-us/>

Features and Audience

- 65 acres of gardens
- 10+ miles of diverse trails
- Family-oriented activities
- Seasonal exhibits
- Educational experiences

PROGRAM: Conservation, Education, and Tourism

<https://www.ncarboretum.org/>

Garden Overview. <https://www.northcarolina.edu/news/>



Conservation

The North Carolina Botanical Garden practices conservation both through research and design.

- Seed banking and researching promote local biodiversity
- Energy conservation through sustainable building and landscape design reduces energy and water use



<https://www.ncarboretum.org/impact/conservation/>

<https://www.carolinacountry.com/carolina-gardens/a-colorful-roof-for-all-seasons>



Education



<https://www.ncarboretum.org/education-programs/>

Adult & Continuing Education Programs

Adult & Continuing Education Classes
Certificate Programs
The Curator's Journal

Professional Development

Continuing Education
OWL (Outdoor Wonders and Learning)

Youth & Family Programs

ecoEXPLORE
OAK Drop-off Program
Discovery Camp
Wee Naturalist
Birthday Parties
EXPLOREcorps High School Volunteer Program

School Programs

Field Trips
Project EXPLORE

Tourism

- Wedding and Event Venue
- Special Events
- Winter Lights
- Garden Collections
- Blue Ridge Heritage Trail

<https://blueridgeheritagetrail.com/explore-a-trail-of-heritage-treasures/>

<https://www.ncarboretum.org/>





Location and Site

Location: Madison, Wisconsin

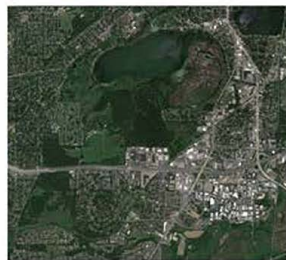
Size: 1200 acres

Ecology: Prairies, Forests, and Wetlands

Nearby Attractions: Wisconsin State Capitol, Olbrich Botanical Gardens, Henry Vilas Zoo, Museums

<https://www.visitmadison.com/>

<https://arboretum.wisc.edu/visit>



History

1911

John Nolen proposes a university arboretum in his report *Madison: A Model City*

1925-1927

Michael Olbrich, working to finance Madison's public parks promotes the idea for natural restoration, forest experimentation, and cultural protection



1935-1941

The Great Depression makes land easy to buy and workers easy to find, and the arboretum grows

Two square miles of derelict farmland — the Arboretum land at the time of acquisition
An aerial view from the southwest, about 1932. Note the Nelson barn, center right, the farm fields and woods, and the open wetland west of Lake Monona. The large tree along the drive just below and to the right of the center of the photograph was later named the Joseph W. Jackson oak in honor of the man who led the drive for land acquisition.



500 acres are acquired, and Aldo Leopold, research director, dedicates the arboretum to restoring the native ecology



The arboretum was the first to introduce and research 'ecological restoration', a theme which has continued in studies and restoration projects through now

1932-1934

1935-Present

Mission and Vision

MISSION: to "Conserve and restore Arboretum lands, advance restoration ecology, and foster the land ethic."

VISION: To educate and model "ecologically sustainable relationships between people and the land through integrative, innovative, and collaborative approaches in science, stewardship, education, and public engagement."



Visitor Center and Wisconsin Native Plant Garden

The visitor center provides space for a library, theater, event space, bookstore, and art gallery.

The native gardens are accessible and showcase ecological restoration, native plants, pollinators, sustainable stewardship, and plant care.

<https://arboretum.wisc.edu/visit/>



Longenecker Horticultural Gardens and Collections

Available to the public as well as researchers and educators, this extensive collection of landscape plants includes:

- Trees, shrubs, and vines
- 6000 specimens
- 2500 kinds of plants
- 100+ woody native species
- Renowned collections of lilacs, flowering crabapples, and other plant groups

<https://arboretum.wisc.edu/visit/gardens/>



Trails and Natural Areas

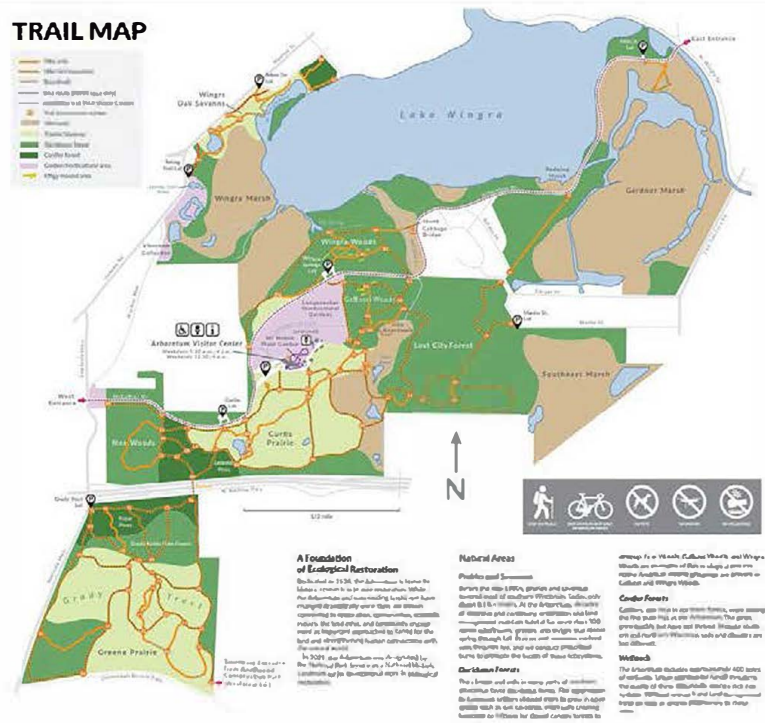
There are 17+ miles of trails available for hiking, birdwatching, tours, and snowshoeing/skiing. The trails are also on one of the most popular locations for running in Madison.

Trails weave through a diverse landscape of ecological areas, including:

- The world's oldest restored prairie (est. 1930s)
- Oak savannahs
- Oak and conifer forests
- Wetland sedge meadows

<https://greatruns.com/madison-wisconsin-uw-arboretum/>

<https://arboretum.wisc.edu/visit/>



Land Planning and Stewardship

Despite the long established ecological restoration of the site, the UW Arboretum continues the ongoing work of land management.

This includes everything from invasive species removal, controlled burns, protecting biodiversity of plants and animals, sedimentation, stormwater management, tree removal, and garden care.

<https://arboretum.wisc.edu/land-stewardship/>



Hampton Roads AREC

Agricultural Research and Extension Center

Hay field overlooking one of the many research greenhouses on site
<https://www.ares.vt.edu/arec/hampton-roads/about.html>



Mission and Goals

"The mission of the Hampton Roads AREC is to provide leadership in production and health of specialty crops, water management, and environmental sustainability through nationally-recognized **research and extension programs**. The HRAREC focuses on **ornamental, turf, fruit, and vegetable crops**, and water quality and management in agricultural and urban ecosystems."



Several on site fields of grapes, tomatoes, and various berries.
<https://www.ares.vt.edu/arec/eastern-virginia.html>

Location and Audience

One of many campuses around Virginia. Location determines the species typologies that are studied and expositioned.

Targets the local farming population in SE Virginia for sales, research, methods, and field trials.

Additionally open to the public, schools, universities, and garden groups.



Location maps and public groups on site
<https://www.arec.vaes.vt.edu/arec/hampton-roads/about.html>

Site Design and Elements



Main offices, labs, and visitors center that act as the entrance and parking lot.
<https://www.pubs.ext.vt.edu/AREC/AREC-75/AREC-75.html>

The original 1940's home that served as the first office for the site was renovated with the addition of new offices, labs, and service garages. The facilities act as an education center for guests and museum. The old home is now the on site residence of the director and possible housing for summer interns.



On site residence and
original 1940's office
[https://www.pubs.ext.
vt.edu/AREC/AREC-75
/AREC-75.html](https://www.pubs.ext.vt.edu/AREC/AREC-75/AREC-75.html)

History

Modern Visitors Center on the site

<https://www.arec.vaes.vt.edu/arec/hampton-roads/about.html>



1906

The Southern Produce Company asks the USDA for a research facility in Virginia for the purpose of studying growth of truck bed crops

The Southern Produce Company is abolished at the experiment is handed to Virginia Tech. Establishing the Hampton Roads AREC

1985

The Southern Produce Company buys roughly 60 acres to create the Virginia Truck Experiment Station, an extension of the USDA



Early photos of the first station

<https://www.arec.vaes.vt.edu/arec/hampton-roads/about.html>

1907



The AREC is renovated as a full extension of Virginia Tech and research facility dedicated to Southeast Virginia's agricultural community

2003

Non-Crop Demonstration and Study Gardens

- All American Trial Garden
 - A study of Eastern Coastal American Flowers
- Bayscape Garden and Buffer Zone Garden
 - Dedicated to the edge vegetation of coastal waterway
- The Enabling Garden
 - Demonstration that focuses on equal access to garden spaces
- Herb Garden
- Perennial Garden
- Rain Garden
 - Studies the effects of rain water runoff prevention in coastal areas
- Tidewater Arboretum
 - Focuses on the growth and health of tree species in urban spaces in the SE
- Utility Arboretum
 - Study of appropriate vegetation to support common utilities such as water lines, power cables, internet lines, etc



All American Trial Garden
<https://www.arec.vaes.vt.edu/arec/hampton-roads/gardens/trial-gardens.html>

User Experience and Review

The site is overall fairly bland from a user perspective. There are not many design aspects that fit the aesthetic needs of a public garden. The most beauty that can be seen on the site comes from fruit blooms and flowering.

The entire property is a mix of fields, greenhouses, soil pits, and open space. Roads and paths are gravel or dirt with no clear signage to direct visitors around the site. The minimal signs are mediocre and follow the similar style as VT's campus signs. It shows some related identity, but fits the vernacular of a research station rather than a garden.



Entrance signage and open sod fields

<https://whro.org/news/local-news/35423-hundreds-are-fighting-to-save-virginia-beach-agricultural-center-as-lawmakers-weigh-100-million-for-relocation>



The Hohhot National Arboretum

Entrance and major walk through the arboretum
Photo taken by A. Leonard, 2019

Mission

Though originally the Inner Mongolia Forestry Experiment Field, in 1956, it was rebranded as The Hohhot National Arboretum.

The overall role of the arboretum is to be a cultivating test nursery to collect and propagate tree and shrub species of Northern China.



Walkway through aspen trees
Photo taken by A. Leonard, 2019

Location

The arboretum is partnered with Inner Mongolia Agricultural University and located right within Hohhot, Inner Mongolia, China. The urban setting and proximity to buildings reflects similarities to Central Park, NYC.

The location of the park is perfect for walkability which is a major lifestyle for Urban China.



Aerial picture of the arboretum located within Hohhot

Audience

The Hohhot National Arboretum is an outreach experimental forest that works on urban greenspaces and repopulating forests in Northern China.

Public interaction is strictly walking. Most gardens are gated off, creating concrete and brick paths for visitors to follow.

There is a visitor center, gift shop, and heritage buildings, but no parking lot specific to the arboretum.

While this is a fully functioning garden, this park is open to the public and highly traveled.



The main entrance gate into the arboretum
Photo taken by A. Leonard, 2019

Changes Over Time

The original forest established in the 1880's was renamed in 1956. The next decade saw the arboretum cultivate over 150 species. Now, it has over 450 species that mix trees, shrubs, and flowering plants all native to Northern China.

The nursery portion of the forest provides trees of all species and sizes for commercial and residential use, along with the ability to study natural growth in a controlled environment.



One of many labeled trees and flowers protected in the
arboretum
Photo taken by A. Leonard, 2019

Design Elements

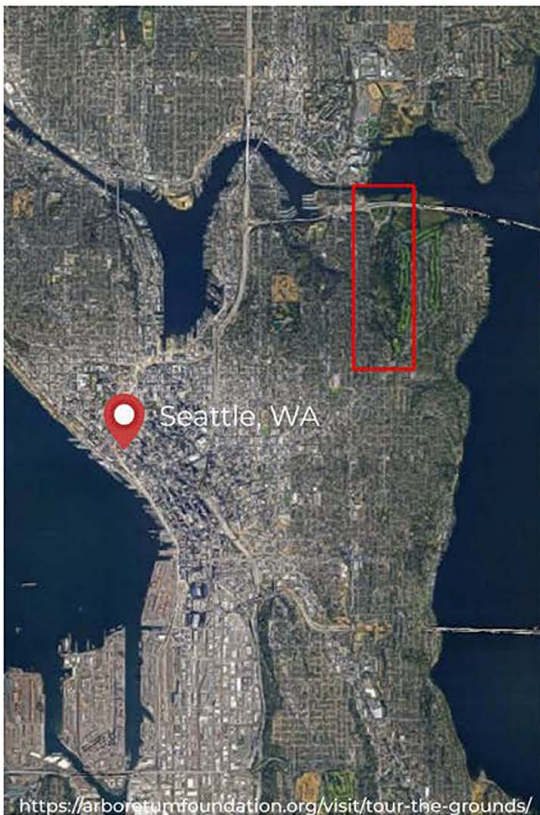
The most stand out feature is definitely the walkability. But the difference in walking paths is wildly attractive and gives each tree garden its own unique feel. The variety breaks up the nuance of the garden, and helps replicate some form of natural rock.

Especially within the major urban setting of Hohhot, an arboretum of this size and importance holds a strange yet significant identity to the community.



Path varieties within the arboretum





History

Pre-colonial

The land was first inhabited by the Coast Salish peoples



1900

230 acres of the site were purchased by the City of Seattle and turned into a park, used as a speedway, and as a sanitary landfill

1936

The Olmsted Brothers were hired to create a design for the Arboretum, and construction was carried out by the Works Progress Administration



The land was owned and logged by the Puget Mill Company. Old-growth timber from the site was shipped across the sound and milled

1880s

The Arboretum was officially established, as well as the Arboretum Foundation in the following year

1934



<https://arboretumfoundation.org/visit/history-of-the-arboretum/>

Mission & Vision

The Washington Park Arboretum is under the stewardship of the Arboretum Foundation

- Mission: "The Arboretum Foundation promotes, protects, and enhances the Washington Park Arboretum for current and future generations by strengthening and building a diverse and engaged community of donors, volunteers, and advocates."
- Vision: "The Arboretum is a highly treasured, widely used community asset and a horticultural, environmental, recreational, and cultural resource for the region."



Azalea Way

<https://arboretumfoundation.org/about-us/mission-vision/#~:text=MISSION%3A%20The%20Arboretum%20Foundation%20promotes,donors%2C%20volunteers%2C%20and%20advocates>

Features & Audience

As a free garden adjacent to several neighborhoods, the Washington Park Arboretum primarily attracts residents of Seattle.

The trails and facilities are managed by the City of Seattle, who owns the land, while maintenance is the responsibility of the University of Washington, who owns the plants.

Within the Arboretum are several miles of accessible trails and paved pathways, gardens with specific plant palettes, picnic areas, personal watercraft launch sites, and a visitors center.



<https://arboretumfoundation.org/visit/history-of-the-arboretum/>

<https://botanicgardens.uw.edu/about/planning-history/>

Japanese Garden



- Designed by Juki Iida, opened 1960
- It is one of the most highly-regarded and authentic Japanese gardens in North America
- It sees over 100,000 visitors annually, from 30 countries
- It is the only part of the Washington Park Arboretum with an entrance fee



<https://www.seattlejapanesearden.org/>



June 2021

Arboretum
Loop Trail

Picnic Shelter





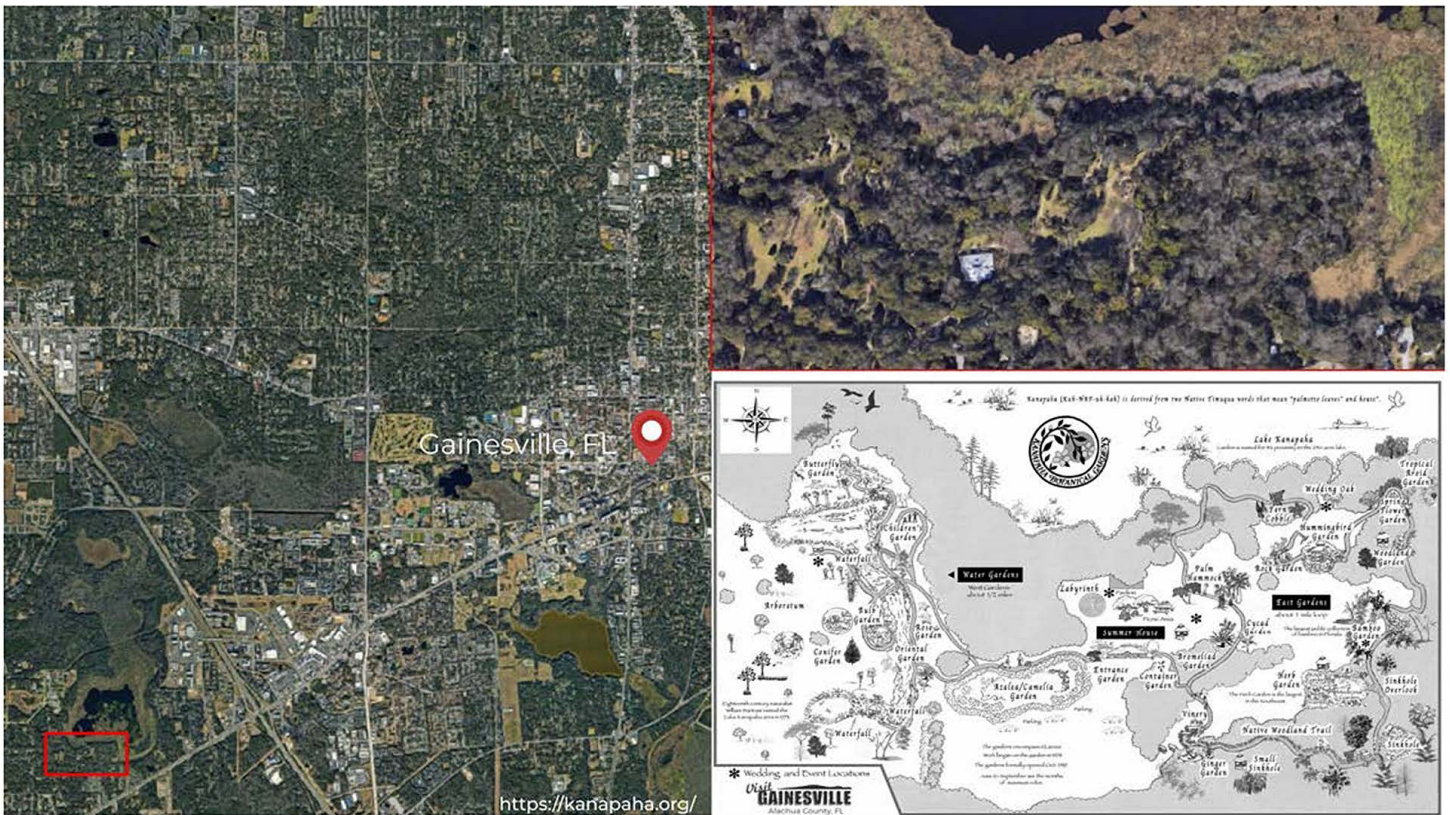
Lake Washington

SR 520 Overpass

June 2021



Kanapaha Botanical Gardens



History

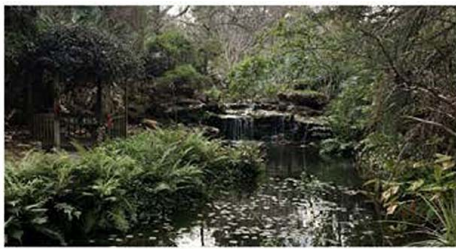
- The land was originally occupied by the Timucua peoples, who lived on Lake “Kanapaha”, meaning “palmetto leaf house”.
- Kanapaha Botanical Gardens were established in 1978 when the North Florida Botanical Society leased 33 acres about six miles southwest of the city of Gainesville, FL.
- In 1982, the Society added another 29 acres to the garden.
- Now at 68 acres, the property contains 24 specialty gardens themed after plant species, regions, activities, and people.



<https://www.gardendestinations.com/exploring-kanapaha-botanical-gardens/>

Mission

- The Gardens are operated by the North Florida Botanical Society, whose mission is to “establish, develop, and maintain a botanical garden as an educational and cultural facility.”
- Kanapaha continues to maintain several collections for primarily educational purposes



<https://www.guidestar.org/profile/59-1778454>

Features & Audience

- \$10 entrance fee
- The entire collection can be seen along 1.5 miles of paved, accessible trail
- Kanapaha hosts school groups, weddings, and festivals
- Besides the arboretum, sections include the largest public bamboo collection in Florida, the largest herb garden in the southeast, a children's garden, hummingbird garden, butterfly garden, rose garden, bulb garden, and rose garden
- Kanapaha is most well-known for its giant Victoria water lilies

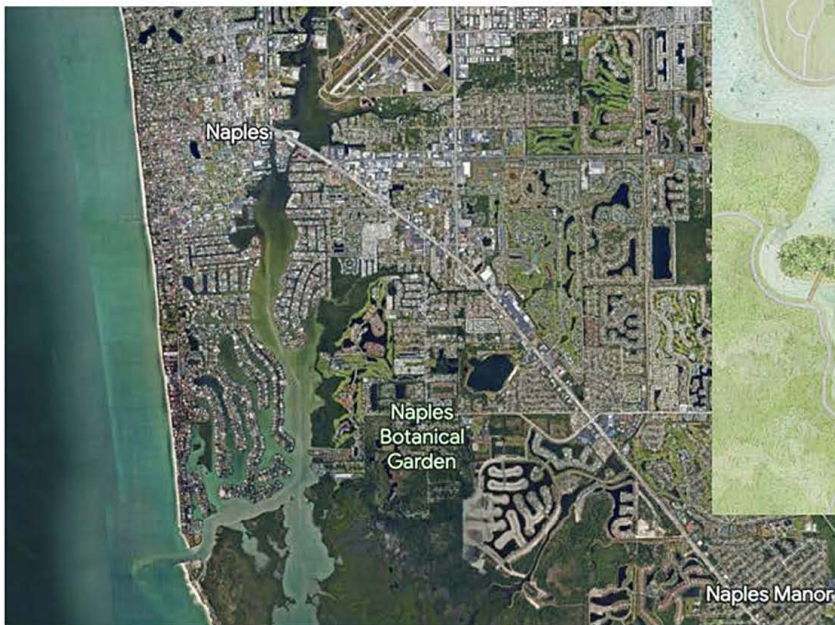


<https://kanapaha.org/>

<https://www.gardendestinations.com/exploring-kanapaha-botanical-gardens/>



Location



Mission

The Naples Botanical Garden Visitor Center aims to continue to preserve the surrounding environments, and to facilitate the visitor experience of the gardens.

The center, designed by Lake Flato, blurs the line between indoor and outdoor space, integrating both interior and exterior program space into the building, creating a connection with the surrounding nature.



<https://www.lakeflato.com/eco-conservation/naples-botanical-garden-visitor-center/?project=open>

Features & Audience

14,000 square-feet of ticketing space, retail, exhibit, event and cafe/dining, 16,000-square-feet of exterior space.

The Gardens themselves offer unique experiences, such as certain dog walking days and opportunities for teachers to bring students.

Today the Garden welcomes over 260,000 visitors per year to experience the themed gardens representing tropical flora.

With over 170 acres of property, the garden is a well known attraction for people of all ages.

<https://www.lakeflato.com/eco-conservation/naples-botanical-garden-visitor-center/?project=open>

<https://www.naplesgarden.org/visit/plan-your-visit/about-the-garden/>



Experience

The goal of the pedestrian experience is to move through the space while simultaneously feeling the importance of the natural environment surrounding the visitors center, and all of the botanical gardens.

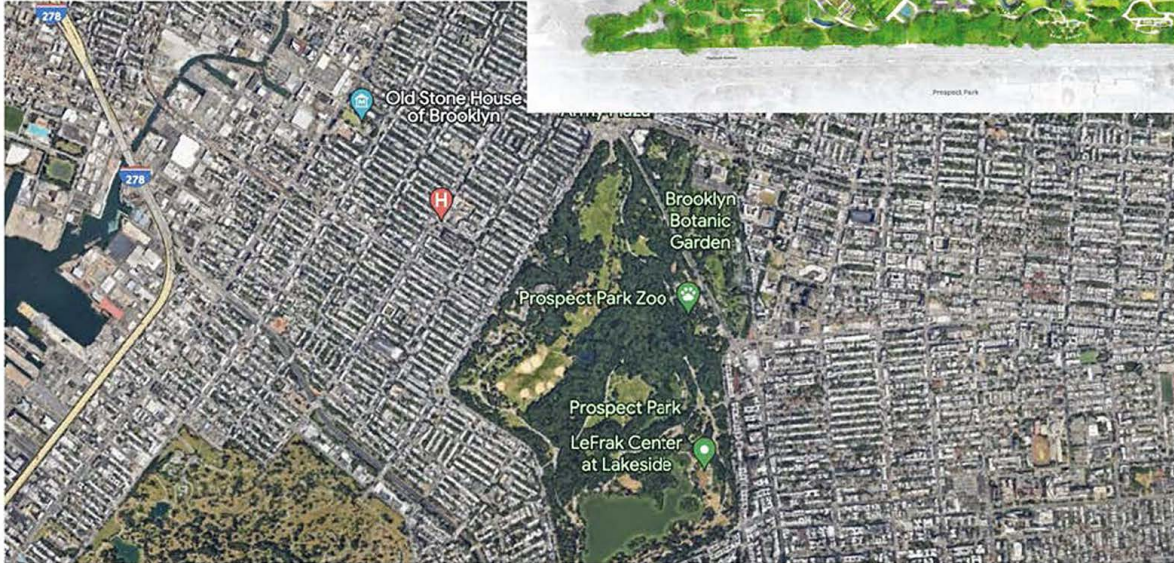
Outdoor wooden pavilions made of sinker cypress create even more of a connection between the built environment and the surrounding gardens.



<https://www.lakeflato.com/eco-conservation/naples-botanical-garden-visitor-center/?project=open>



Location

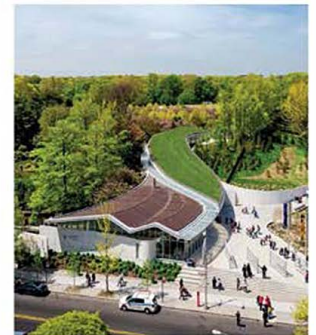
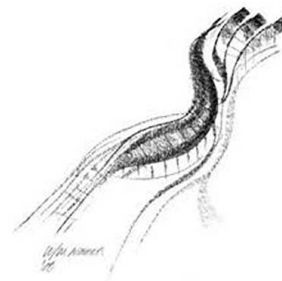


Mission

Being in a highly dense area of New York City, the Brooklyn Botanic Gardens, and Visitor Center aim to connect New York City residents to nature.

The space is meant to serve as an oasis for the surrounding New York residents, and has become a popular destination for people of all ages and backgrounds.

Designed by Weiss / Manfredi, the visitors center was a space designed to showcase urban innovation, sustainable design, as well as a space that would encourage visitors to pass through and into the gardens.



<https://www.weissmanfredi.com/projects/371-brooklyn-botanic-garden-visitor-center>

Features and Audience

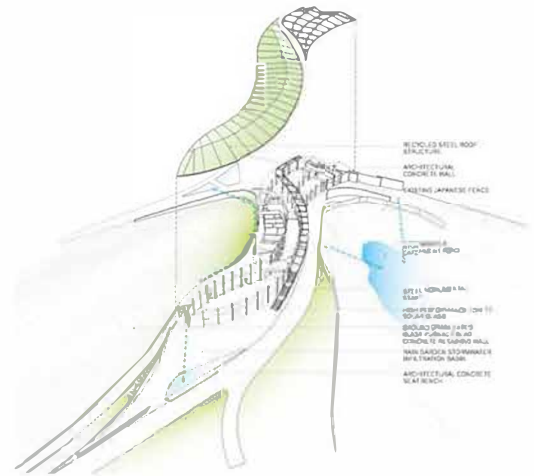
20,000 sqft program space includes admission booths, access to gardens, Gift Shop, and multimedia and gallery spaces.

The Visitor Center has earned LEED Gold certification for environmental sustainability.

The addition of a green roof limits the distraction from the surrounding gardens, and provides rainwater collection

The use of informational and interactive exhibits throughout the space draws in a younger audience to interact and enjoy nature

<https://www.archdaily.com/235079/brooklyn-botanic-garden-visitor-center-opens-to-the-public>



Experience

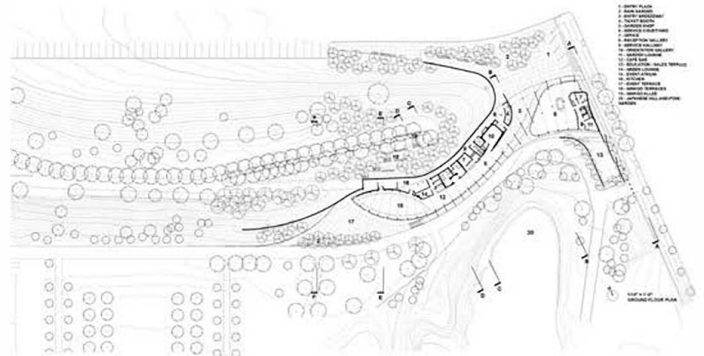
The building is a 480 foot curvilinear form that mimics the natural topography.

Passing through the building, there are opportunities to keep moving towards the gardens or to stop to and enjoy the different interior spaces along the way

The addition of interactive exhibits and maps makes it a welcoming and educational experience for all ages

After winding through the building, the end of the 480 foot journey leads you to the beginning of the botanical gardens

https://www.hbo.org/collections/gardens/visitor_center#~:text=Today%2C%20the%20Garden's%20mission%20to%20has%20evolved%20in%20that%20time.



REGIONAL RESEARCH: **Climate, Hydrology, and Geology**

MAKE

Molly Foote, Emily Slattberg,
Kinzer Hurt, Alex Leonard

Interdisciplinary Design and
Research | Fall 2023

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Current regional and local
climate data

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Estimated changes in local
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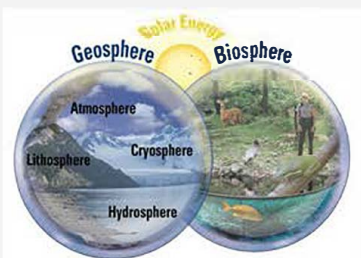
1

CLIMATE OVERVIEW

Definition, regional, local, and design considerations

What is climate?

- ❖ A long-term pattern of weather
- ❖ Determined by geosphere and biosphere conditions



GOES-17 Time-lapse - Storm spins up off Washington State 2022-06-14 - 2022-06-16



www.geographyrealm.com, www.youtube.com/watch?v=Ijx2FkLMlYc

Region

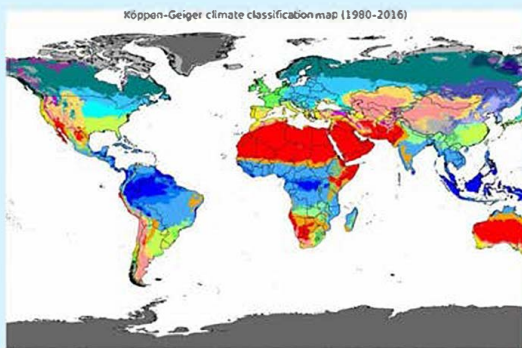
The Pacific Ocean, landforms such as the Cascades, glaciers, ocean and evergreen forests are a few examples of the diverse conditions which contribute to regional climate.



<https://textbooks.whatcom.edu/tiwahist/chapter/chapter-1/>

Climate Classified

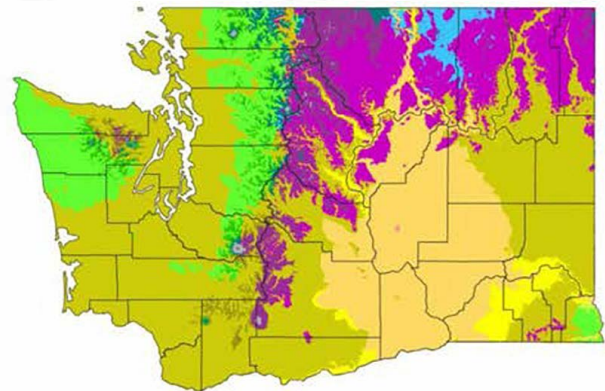
The Koppen Climate Classification system defines climate regions by vegetation, with five general categories: Tropical, Arid, Temperate, Continental, and Polar. Washington state displays subgroups of each category.



Source: Beck et al. Present and Future Köppen-Geiger climate classification maps at 2 km resolution. Scientific Data 9:100214, doi:10.1038/s41598-020-714-10081

<https://education.nationalgeographic.org/resource/koppen-climate-classification-system/>

Köppen Climate Types of Washington



Köppen Climate Type

BWk (Cold desert)	Dsa (Hot-summer mediterranean continental)
BSk (Cold semi-arid)	Dsb (Warm-summer mediterranean continental)
Csa (Hot-summer mediterranean)	Dsc (Dry-summer subarctic)
Csb (Warm-summer mediterranean)	Dfb (Warm-summer humid continental)
Cse (Cold-summer mediterranean)	Dfe (Subarctic)
Cfa (Humid subtropical)	ET (Tundra)
Cfb (Oceanic)	EF (Ice-cap)
Cfc (Subpolar oceanic)	

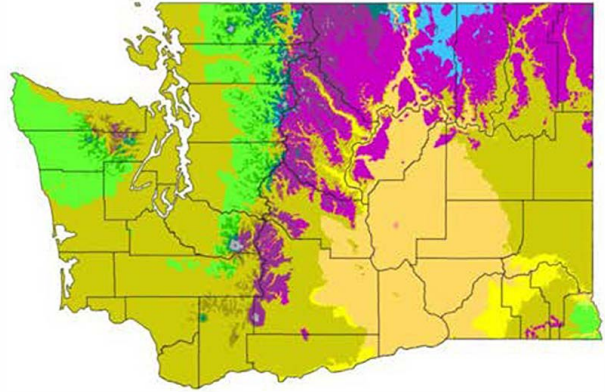
Data sources: 1991-2020 climate normals from PRISM Climate Group, Oregon State University, <https://prism.oregonstate.edu/>; Outline map from US Census Bureau

<https://geodiode.com/climate>

CSB warm summer mediterranean



Köppen Climate Types of Washington



CFB oceanic



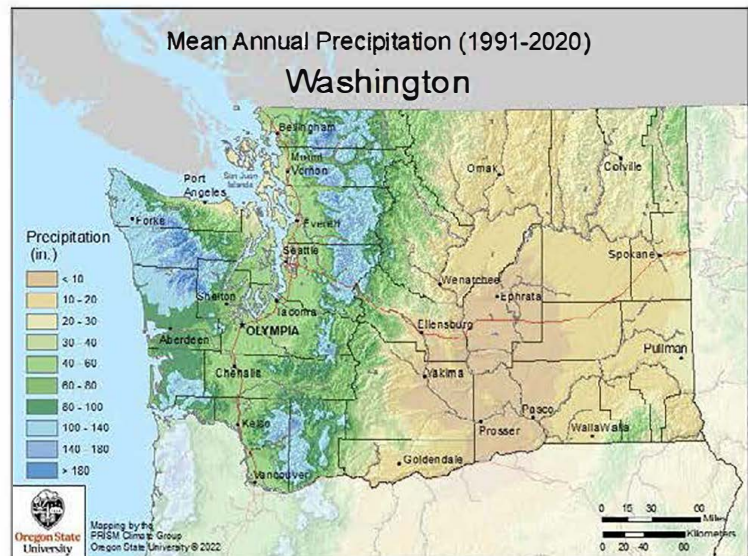
DSA-DFB mediterranean continental



Climate: Rain and Snow

In spring and summer, a clockwise rotational, high pressure cell brings in “comparatively dry, cool stable air” (wrcc.dri.edu)

As it comes inland, the air warms and dries further and generates a dry season during the transition between spring and summer.



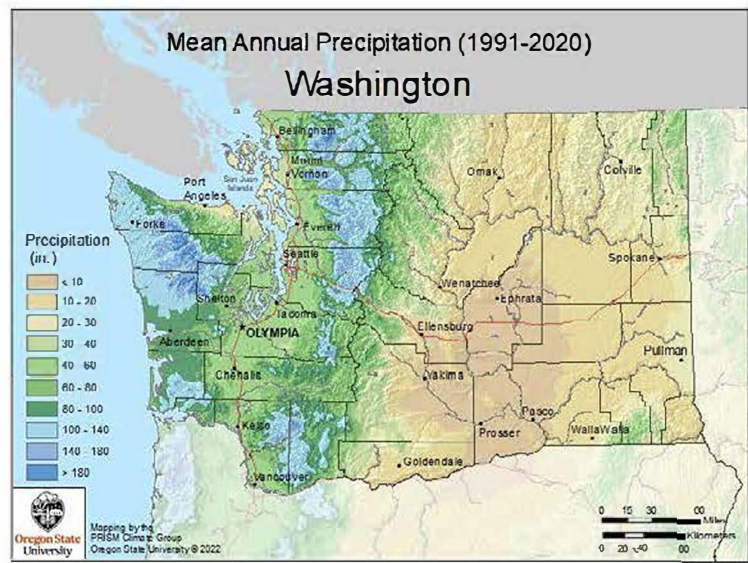
<https://prism.oregonstate.edu/>

Climate: Rain and Snow

In fall and winter, a counter-clockwise rotational, low pressure cell moves in to generate moist ocean winds, which generate a wet season inland.

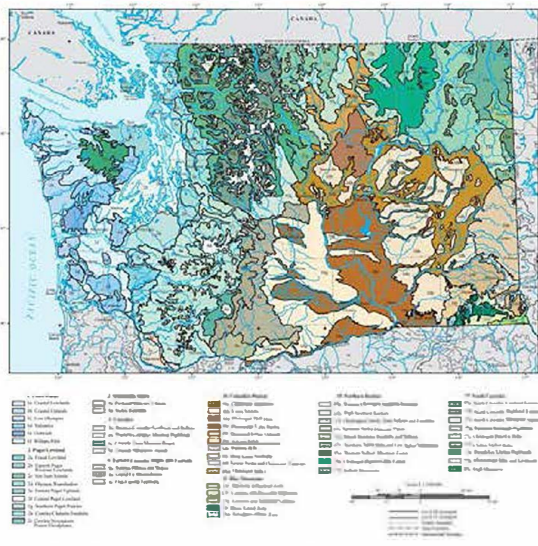
Winds moving eastward and down from the Cascades lose their moisture, creating lasting aridity in the eastern half of the state.

(wrcc.dri.edu)

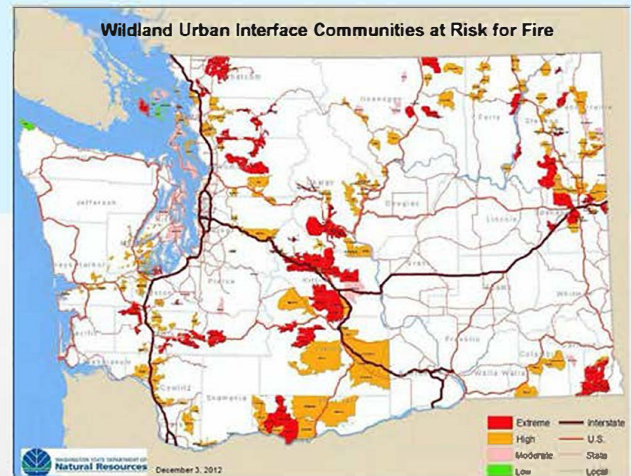
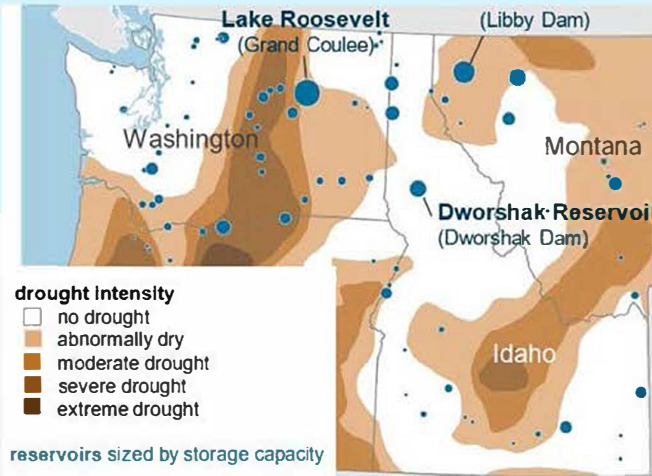


<https://prism.oregonstate.edu/>

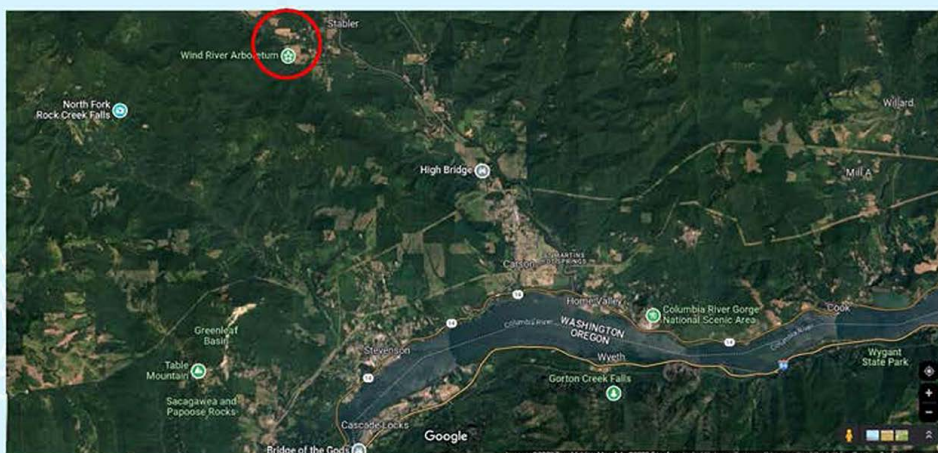
Climate Effects: Plant Hardiness and Ecoregions



Climate Effects: Droughts and Wildfire Risk



Local Weather Data



○ Historic Wind River

Nearest Town: Carson, WA

Koppen Climate
Classification: Csb, Warm
Summer Mediterranean

<https://www.weatherbase.com/>

Local Weather Data

Average Precipitation													Years on Record: 77
in.	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	99.7	16.9	12.6	11.5	6.1	3.6	2.4	0.7	1.3	3	8.4	15	18.4

Average Number of Days With Precipitation													Years on Record: 77
Days	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	142	18	15	16	12	10	8	4	4	7	13	16	19

Average Number of Days Above 90F/32C													Years on Record: 77
Days	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	15.7	---	---	---	---	0.6	2.3	5.7	5.4	1.7	---	---	---

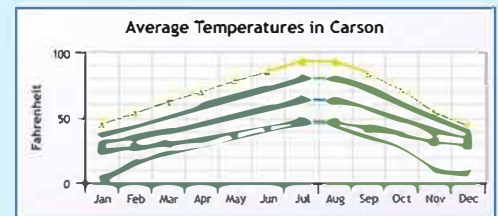
Average Number of Days Below 32F/0C													Years on Record: 77
Days	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	133.7	24.5	21.8	20.8	13.4	4.6	0.4	---	---	2	8	16.4	21.9

Average Snowfall													Years on Record: 77
in	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	84.9	38.1	17.8	7.3	0.7	---	---	---	---	---	---	3.4	17.6

Highest Recorded Temperature: 93.5 °F

Lowest Recorded Temperature: 2.9 °F

Average Range: 31°F - 64°F



<https://www.weatherbase.com/>

How does climate affect design?

- ❖ Planning for snow and rainy season
- ❖ Mitigating wildfire risks
- ❖ Visitor seasonality
- ❖ Plant communities and maintenance
- ❖ Sun exposure and solar power
- ❖ Seasonal recreation



University of Washington, Washington Park Arboretum

2

CLIMATE PROJECTIONS

Estimated changes in local and regional climate.

Location of Focus

- **Pacific Northwest**
 - Also referred to as Cascadia
 - Defined as the geographic area west of the Rocky Mountains and east of the Pacific ocean
 - US States associated with this area include Oregon, Washington, Idaho, Montana, Wyoming, and Alaska
-

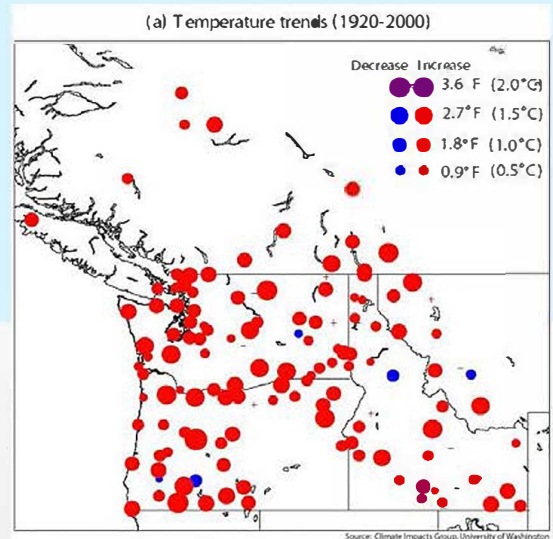


Map highlighting the Pacific Northwest. Drought.gov

<http://www.climate.gov/data-and-research/impacts/impacts-climate-change/impacts-mountain-west-forest-fire-drought-2012-2017-2022-winter-2018-2019-2020-2021-2022>

Current Observed Changes

- The Pacific Northwest has been experiencing steady warming
- The average annual temperature has risen almost 2 degrees fahrenheit since 1900
- Less summer precipitation and more winter precipitation
- Precipitation in the form of rainfall has increased during the winter months.
- Rising temperatures have reduced the overall snowpack leading to earlier spring snow melts



Climate Impacts Group, University of Washington.

<https://www.climateimpacts.washington.edu/northwest/impacts/climate-impacts-northwest-temperature-9-2014.html>

Projected Changes in Temperature

Variable	Projected Long-term Change								
Temperature									
<i>Annual</i>	Warming - Warming projected for <i>all</i> greenhouse gas scenarios; amount of warming depends on the amount of greenhouse gases emitted. - Projected change in Pacific Northwest^[1] average annual temperature for the 2050s (2041-2070),^[1] relative to the average for 1950-1999: <table> <tr> <td>Low emissions (RCP 4.5):</td><td>+4.3°F (range: 2.0 to 6.7°F)</td></tr> <tr> <td>High emissions (RCP 8.5):</td><td>+5.8°F (range 3.1 to 8.5°F)^[1]</td></tr> </table>	Low emissions (RCP 4.5):	+4.3°F (range: 2.0 to 6.7°F)	High emissions (RCP 8.5):	+5.8°F (range 3.1 to 8.5°F) ^[1]				
Low emissions (RCP 4.5):	+4.3°F (range: 2.0 to 6.7°F)								
High emissions (RCP 8.5):	+5.8°F (range 3.1 to 8.5°F) ^[1]								
<i>Seasonal</i>	Warming in all seasons for 2041-2070, relative to 1950-1999: <table> <tr> <td><i>Winter</i></td><td>Low emissions (RCP 4.5): +4.5°F (range: 1.6 to 7.2°F) High emissions (RCP 8.5): +5.8°F (range 2.3 to 9.2°F)</td></tr> <tr> <td><i>Spring</i></td><td>Low emissions (RCP 4.5): +4.3°F (range: 0.9 to 7.4°F) High emissions (RCP 8.5): +5.4°F (range 1.8 to 8.3°F)</td></tr> <tr> <td><i>Summer</i></td><td>Low emissions (RCP 4.5): +4.7°F (range: 2.3 to 7.4°F) High emissions (RCP 8.5): +6.5°F (range 3.4 to 9.4°F)</td></tr> <tr> <td><i>Fall</i></td><td>Low emissions (RCP 4.5): +4.0°F (range: 1.4 to 5.8°F) High emissions (RCP 8.5): +5.6°F (range 2.9 to 8.3°F)^[1]</td></tr> </table>	<i>Winter</i>	Low emissions (RCP 4.5): +4.5°F (range: 1.6 to 7.2°F) High emissions (RCP 8.5): +5.8°F (range 2.3 to 9.2°F)	<i>Spring</i>	Low emissions (RCP 4.5): +4.3°F (range: 0.9 to 7.4°F) High emissions (RCP 8.5): +5.4°F (range 1.8 to 8.3°F)	<i>Summer</i>	Low emissions (RCP 4.5): +4.7°F (range: 2.3 to 7.4°F) High emissions (RCP 8.5): +6.5°F (range 3.4 to 9.4°F)	<i>Fall</i>	Low emissions (RCP 4.5): +4.0°F (range: 1.4 to 5.8°F) High emissions (RCP 8.5): +5.6°F (range 2.9 to 8.3°F) ^[1]
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<i>Fall</i>	Low emissions (RCP 4.5): +4.0°F (range: 1.4 to 5.8°F) High emissions (RCP 8.5): +5.6°F (range 2.9 to 8.3°F) ^[1]								
<i>Geography of Change</i>	Overall, warming is expected to be fairly uniform across Washington State. However, there is slightly greater warming projected for the interior – east of the Cascade range.^[1]								

Study for the Climate Impacts Group

by College of the Environment, University of Washington
<https://civ.uw.edu/wp-content/uploads/sites/2/2020/12/university-climate-impacts-2011-ec5.pdf>

The Effects from Resulting Changes in Temperature

- Glaciers are predicted to vanish in Washington by 2070, impacting rising sea levels.
- According to a recent report by the National Research Council, sea level is expected to increase an additional 4 to 56 inches in Washington by 2100.
- Surface temperatures offshore of Washington are projected to rise by about 2°F by 2040, impacting habitats for native marine life.
- Warming temperatures and decreasing snowpack have heightened the risk of wildfires in the Washington area.
- As warming continues, local flora may experience lower productivity, increased vulnerability to pests, increased spread of invasive plants, and saltwater intrusion.



<https://www.nps.gov/articles/000/plants-climateimpact.htm>

Projected Changes in Precipitation

Variable	Projected Long-term Change
Precipitation	
<i>Annual</i>	Small changes ▪ Annual changes for all models are small relative to year-to-year variability. ▪ For all greenhouse gas scenarios, some models project wetter conditions while others project drier conditions. ▪ Projected change in annual Pacific Northwest precipitation for the 2050s (2041-2070,^[B] relative to 1950-1999): - Low emissions (RCP 4.5): -4.3 to +10.1% - High emissions (RCP 8.5): -4.7 to +13.5%^{[D][E]}
<i>Seasonal</i>	Projected changes vary seasonally. ▪ A majority of models project increases in winter, spring, and fall precipitation for the Pacific Northwest for mid-century, as well as decreasing summer precipitation. ▪ For all scenarios and seasons, some models project wetter conditions while others project drier conditions. ▪ Projected summer drying is more consistent among models. Some models project more than a 30% decrease in summer precipitation for the 2050s (2041-2070, relative to 1950-1999), although the average projected change for summer is notably smaller: -6 to -8% for a low (RCP 4.5) and high (RCP 8.5) greenhouse gas scenario, respectively.^[I]
<i>Geography of Change</i>	Changes in precipitation are expected to be different from place to place.

Study for the climate impacts group
by College of the Environment, University of Washington
<https://cse.uw.edu/wp-content/uploads/sites/2/2020/12/Novemberetalok2013sec5.pdf>

The Effects from Resulting Changes in Precipitation

- As rainfall decreases in the summer months the potential for drought increases.
- Idaho, Oregon, and Washington have experienced multiple droughts since 2000, and are projected to experience more drought with temperature increases.
- Predicted decrease in rainfall during the summer months creates an increased risk for wildfires.
- Heavy rainfall events are projected to become more severe by mid-century. The number of days with more than 1 inch of rain is projected to increase by between 7% and 13% by the 2050s



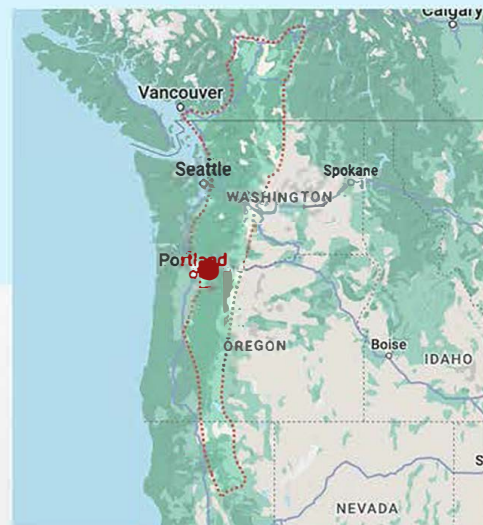
<https://civ.uw.edu/wp-content/uploads/sites/2/2020/12/snowmeltalsok2013sec5.pdf>

Connection to Wind River

The site is centrally located in line with the cascade mountains, creating potential to feel a harsher warming than other sections of the Pacific Northwest according to the study.

With projected decreases in snow pack, seasonal decreases in rainfall, and an increased risk of drought, there may be noticeable changes in water flow in and around the site.

Increases in heat can change potential plant species' ability to grow around the site.



Google map highlighting the boundary of the Cascade mountains

Why is understanding climate change important in designing for the future?

- Encourages us to design sustainably.
- Understand what the future human experience may look like and how to design with that in mind.
- It is important to understand the potential future challenges and setbacks that could influence the safety and effectiveness of your design.

3

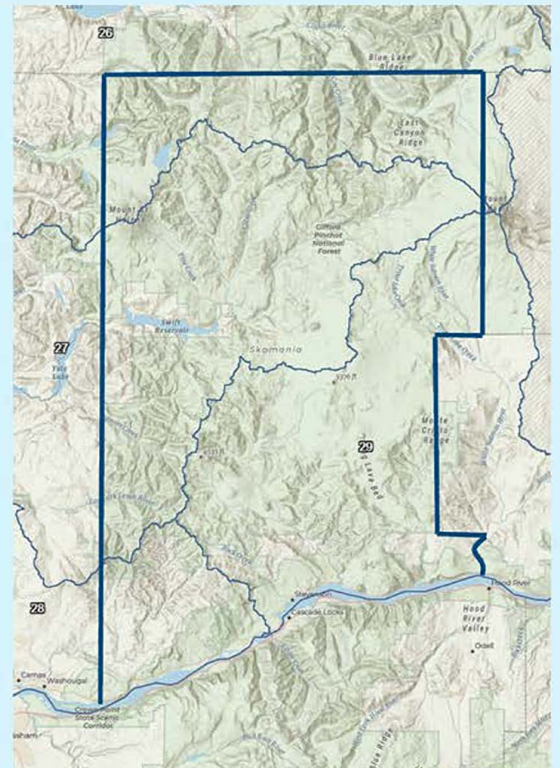
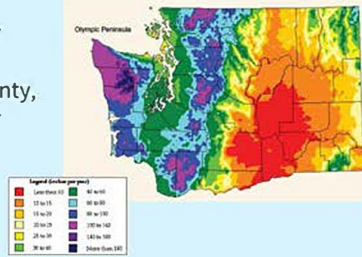
HYDROLOGY

Watersheds, water resources, water bodies

Watersheds

- ❖ Washington state contains 62 Water Resource Inventory Areas (WRIAs)
 - ❖ Our site is located in Skamania County, WA, which contains portions of four WRIAs:
 - Salmon-Washougal
 - Wind-White Salmon
 - Lewis
 - Cowlitz
 - ❖ The Wind River Arboretum is located in WRIA 29 (Wind/White Salmon)
 - ❖ All watersheds in Skamania County drain to the Columbia River, which empties into the Pacific Ocean
- 

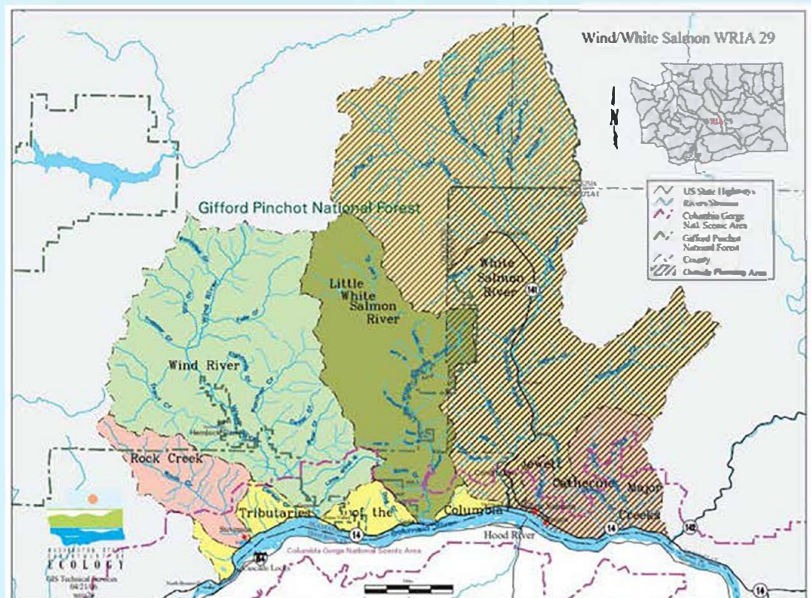
"Only 2.5% of water on Earth is freshwater; only 1.2% of that is on the surface."



<https://waecy.maps.arcgis.com/apps/webappviewer/index.html?id=996e6b21ae394cc3a3b63c6da0c3aa0a>

WRIA 29 (Wind-White Salmon)

- ❖ The Wind River watershed covers about 225 square miles
- ❖ The Wind River has an average flow of 433 cfs near Stabler
- ❖ The highest daily flow recorded in 2022 was 1,580 cfs (December 29)
- ❖ Major tributaries of the Wind River:
 - Dry Creek
 - Trout Creek
 - Panther Creek
 - Little Wind River

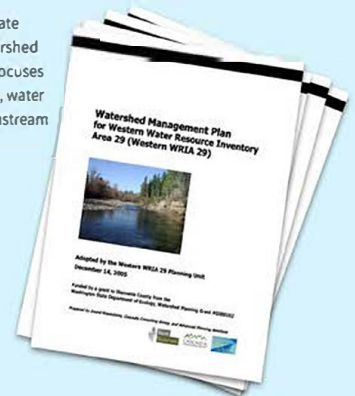


https://docs.wixstatic.com/ugd/810197_4af6b9b514d64ca0a70abc1308fcc949.pdf
<https://apps.ecology.wa.gov/continuousflowandwq/StationDetails?sta=29C100>

2005 Watershed Management Plan: Wind River

- ❖ Concerns:
 - Obstructions restricting fish passage
 - Invasive species, particularly Myriophyllum (milfoil plant)
 - Groundwater contaminated with fecal coliform
 - Severely increasing stream temperatures, to an extent dangerous to salmon and other fish (77°F), leading to placement on the EPA 303(d) list of impaired waterways
 - The watershed may not be able to support future water demands: "The [Skamania County Public Utility District] projects a need for a water reservation set in the Wind River sub-basin, of 4.45 cfs (2000 gallons per minute (gpm)) to meet the community's current and future needs"
 - Not enough data stations regarding streamflow and water quality
- ❖ Typical highest mean monthly flow is February, lowest mean monthly flow is September
- ❖ The Trout Creek Hill Basalt aquifer under Stabler/Wind River was primarily recharged by Trout Creek, Hemlock Lake (removed), and the USFS Nursery Site
- ❖ The Wind River sub-basin contains 181 miles of fish-bearing streams, 956 miles of non-fish-bearing/perennial/intermittent streams, and 293 acres of lakes and ponds
- ❖ Riparian function is generally good throughout the sub-basin

"In 1998, the Washington State Legislature passed the Watershed Management Act. This law focuses on addressing water quality, water quantity, fish habitat, and instream flow at the local level."



https://docs.wixstatic.com/ugd/810197_4af8b9b514d64ca0a70abc1306fcc949.pdf

Trout Creek

- ❖ Trout Creek flow ranges from 150-600 cfs
- ❖ Major tributaries of Trout Creek:
 - Crater Creek
 - East Fork
 - Layout Creek
 - Planting Creek
 - Martha Creek
- ❖ Important habitat for steelhead trout
- ❖ USFS Hemlock Dam removed in 2009



<https://woecy.maps.arcgis.com/apps/webappviewer/index.html?id=996e6b21ae394cc3a3b63c6da0c3aa0a>
<https://hydroreform.org/hydro-project/hemlock-dam/#:~:text=The%20dam%20ceased%20to%20provide,the%20removal%20of%20Hemlock%20Dam.>



1935-2009

<https://interfluve.com/2020/hemlock-dam-removal/>

4

GEOLOGY OVERVIEW

Regional and local geology: Soil Typology, Geological Record,
and Topography

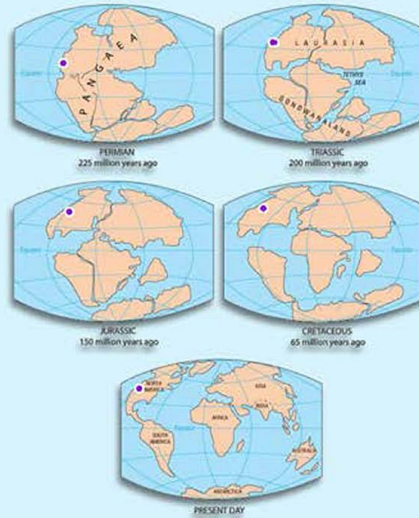
Geological History

The North American Plate was created from the Atlantic Coastal Ridge pushing new material west

At the same time, the Eurasian Plate is being pushed east by the same activity

The Pacific Plate, being older and thus more dense, is forced to submerge under the weight of two crustal plates

This subduction of the Pacific Plate creates what is known as the Ring of Fire



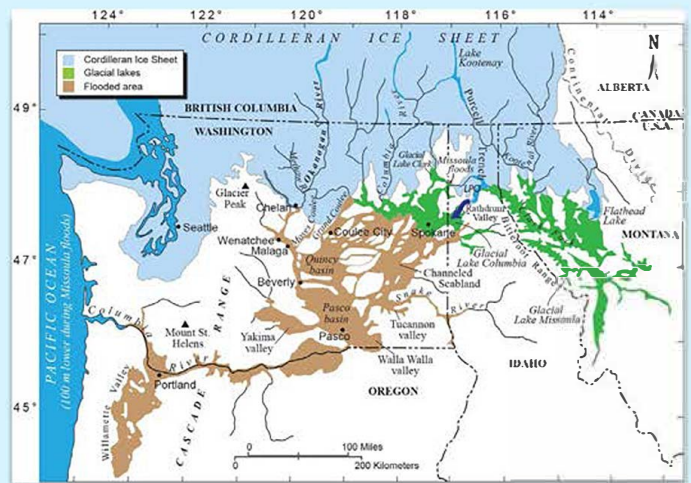
**Geological History of the
Cascades
USGS**

Ice Age

During the last Ice Age, 11,000 years ago, the Cordilleran Ice Sheet began melting, creating what would be the Columbia River

As the glacier receded, areas such as Portland, and much of the inner coastal region were very rich in deposited sediment from the glacial melt and floods

This glacial flooding mixed with volcanic eruptions caused the many fertile forested valleys along the length of the Cascades



**Cordilleran Ice Sheet and
Melting Map
NPS**

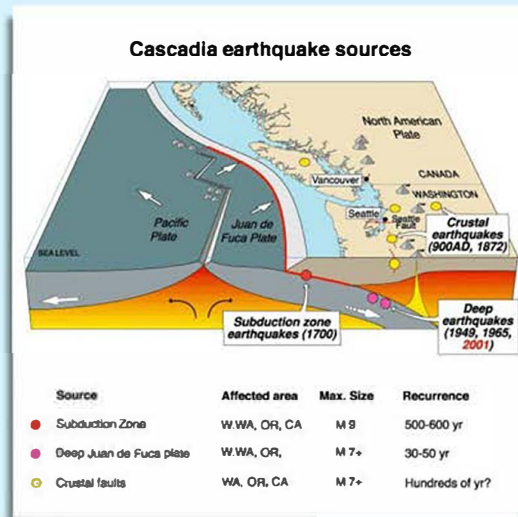
Earthquakes

Three main sources...

1. The scraping of the North American Plate over the Juan de Fuca Plate, creating a Subduction Zone
2. The melting of the Juan de Fuca Plate, creating deep earthquakes as the once solid plate turns viscous
3. Crystal Earthquakes are caused by the crushing of rock along the North American Plate, resulting in smaller more localized earthquakes

Resulting in...

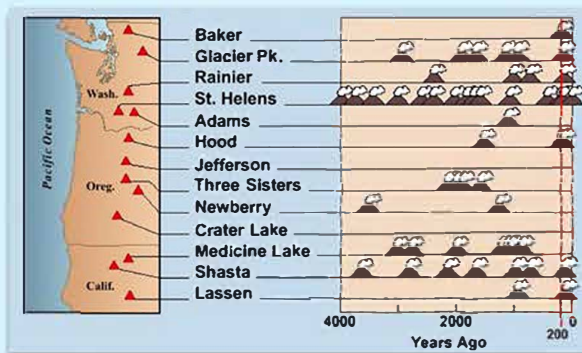
- Subduction Zone Earthquakes create Tsunamis
- Deep Earthquakes are prone to cause volcanoes
- Crystal Earthquakes are responsible for craters and surface cracks



Fault Map of the Pacific NW
Cascade Mountains
USGS

Volcanoes

- There are dozens of volcanoes that run the Cascade Mountains
- Most are technically active, but have little chance of eruption or are small enough to not cause panic
- The closest ones to our site is Mt. Hood and Mt. St. Helens



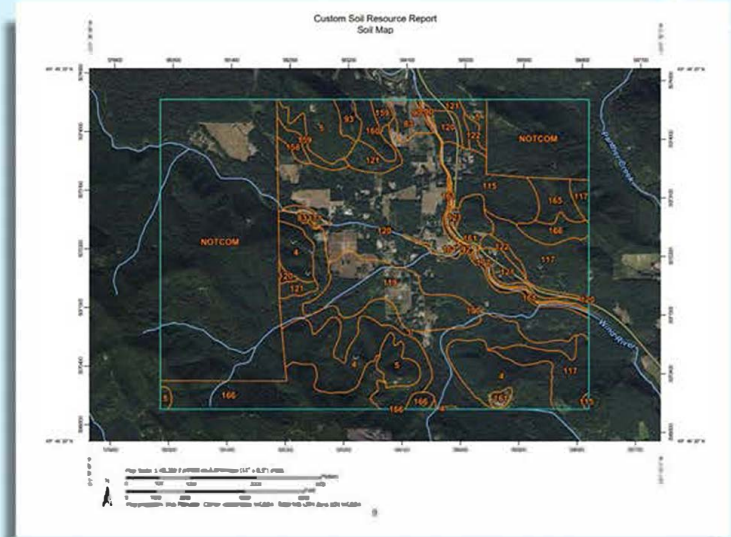
Volcanic Maps of the Cascades
NPS

Soil Typologies

The area is primarily loam, about 62% of the area

There is a mix between rocky loam and clay loam, there is less than 5% sand due to the distance from the coast

The soil is thick and dense, but there is only a short distance to the water table comparatively



Web Soil Survey Map
USDA

Rock Typologies

Heavily covered by volcanic rock, the Southern Cascades are made of old igneous rocks

Common rocks found here would be...



Andesite

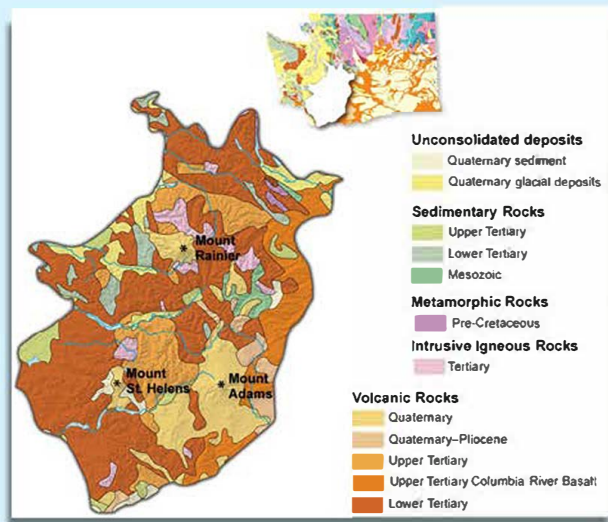


Dacite



Obsidian

Additional minerals found include quartz, rhyolite, and basalt



Rock and Mineral Typologies Map
WADNR



Research and Environmental Gardens

Jack Faulconer, Cate Williams, Hannah Durham

What is a Research/Environmental Garden?

A Research Garden is a garden that is designated for the study and research of plants. They can be a private organization or one that is open to the public. An Environmental Garden is one that uses gardening practices that cause no harm to the earth and its inhabitants while attempting to actually enhance it. These two are often combined to create a garden focused on the research and conservation of different types of plants, as well as educating the public about them.



Mission

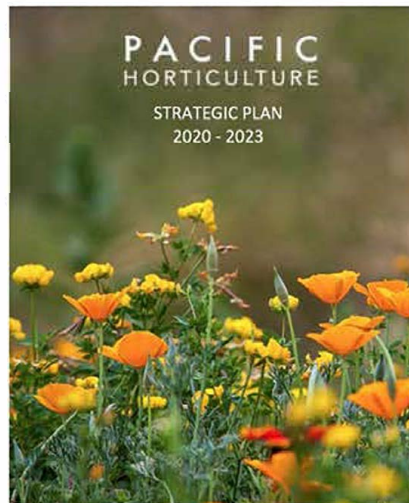
Their mission is to advocate for the garden and its power to enrich lives and heal the environment.

Reach/Focus

This organization is based in Berkeley, California. It is focused on the Pacific region of North America, and caters to gardeners in this area looking to learn more about the climate they live in.



-



-



Mission

The mission of the Lady Bird Johnson Wildflower Center is to increase the sustainable use and conservation of native wildflowers, plants, and landscapes.

History

- It was founded as the National Wildflower Research Center in 1982 by Lady Bird Johnson and Helen Hayes
- It was renamed the Lady Bird Johnson Wildflower Center in 1997
- It is now a part of the University of Texas at Austin

Architecture

The buildings on the site reflect the three main influences in Texas vernacular architecture-

1. Spanish Colonial
2. German Settler
3. Texas Rancher



Reach/Focus

- The center is located in Austin, Texas and has focused its garden on showcasing the native plants of the Central Texas hill country.
- While the gardens are focused only on plants native to Texas, the center offers a database of over 7,000 plant species that are native to North America.

Research Opportunities

- Arboretum with native Texan trees
- Pollinator garden
- Insectary
- Native grassland garden
- Long-term fire and land management research field



Garden Layout

The gardens are arranged around the central complex of buildings. There are paths that allow visitors to take “the scenic route” and paths that allow them to get to their destination quickly.



Mission

Connect with
environment

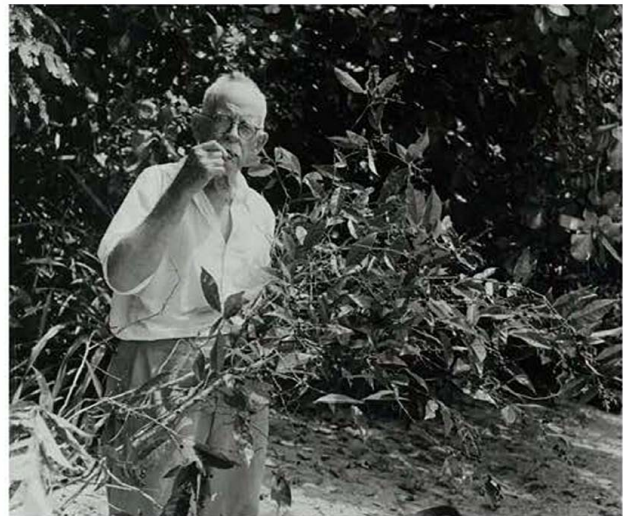
Connect with
nature

Promote
environmental
literacy



David Fairchild

- Botanist and plant explorer
- Travel for plants to bring to America
- Mangos, avocados, dates, nectarines
- Improve our diets and provide economic opportunities to farmers



Education

Concepts

- Tropical Biodiversity
- Exploration
- Plant, Animal Ecology
- South Florida Environments
- Plant Conservation

Fairchild Challenge

- School based education program on environmental engagement
- Interdisciplinary
- Teams respond to modern day environmental issues



Events

International Mango Festival

Most famous

Mango tasting

400 different varieties
on mango trees



Chocolate Festival

Chocolate foods and beverages

Cacao trees for purchase

Food of Gods



Orchids in Bloom Festival

Educational lectures

Plant walks

During october during peak
bloom times



Richard H. Simmons Rainforest

- Artificial tropical rainforest
- Clouds generated by fog machines to mimic natural environment
- Mix of plants from all over the world
- Only outdoor model in the US



Butterfly Conservatory

- Hundreds of butterflies that can be seen year round
- Walking paths
- Educational garden
- 40+ species rotated year round





Mission

Educate and inspire the public
while contributing to the
scientific knowledge about plants

Study and advancement of botany



Japanese Garden

Seiwa-en

14 acres with pools, rocks, and islands



Temperate House

5 regions dedicated to
Mediterranean Climate

Moorish Walled Garden

Bible Area

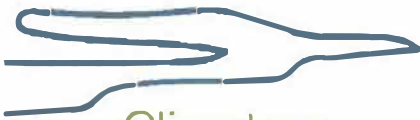
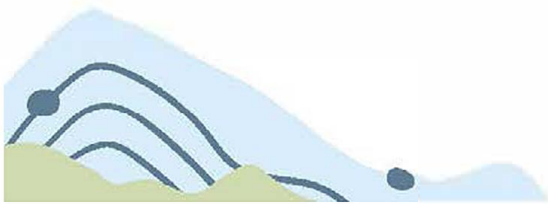
Riparian Plants

Madagascar



Climaltron

Tropical Control



Climaltron

- Most iconic feature of the garden
- Houses a rainforest
- Maintains a controlled tropical environment
- Serves to teach about importance of climate, rainforests, and ecosystems



Education

“ Promote botanical knowledge, environmental awareness, and sustainable gardening practices ”

- Leading center for botanical research
- Focus on plant systematics, ecology, conservation biology



Botany

International contributions to botany

Considered one of the oldest botanical institutions

Plant Collections

Research Programs

Herbarium

Education and Outreach

Science publications





Bernheim Arboretum + Research Forest

Founded by Isaac Wolfe Bernheim in 1929
Location: Clermont, Kentucky
Acreage: 16,137 acres



Mission:

“Since its founding, Bernheim has always been connecting people with nature. In that spirit, Bernheim’s vision is: Bernheim will be a nationally treasured leader in ecological stewardship that inspires the exploration of our deep connections with nature.”

AUDIENCE

"No matter your age or interest, there is a program, special event or festival for you."

- All ages welcome!
- Diversified activity and program in order to welcome everyone
- Field tours and group tours



OUTREACH

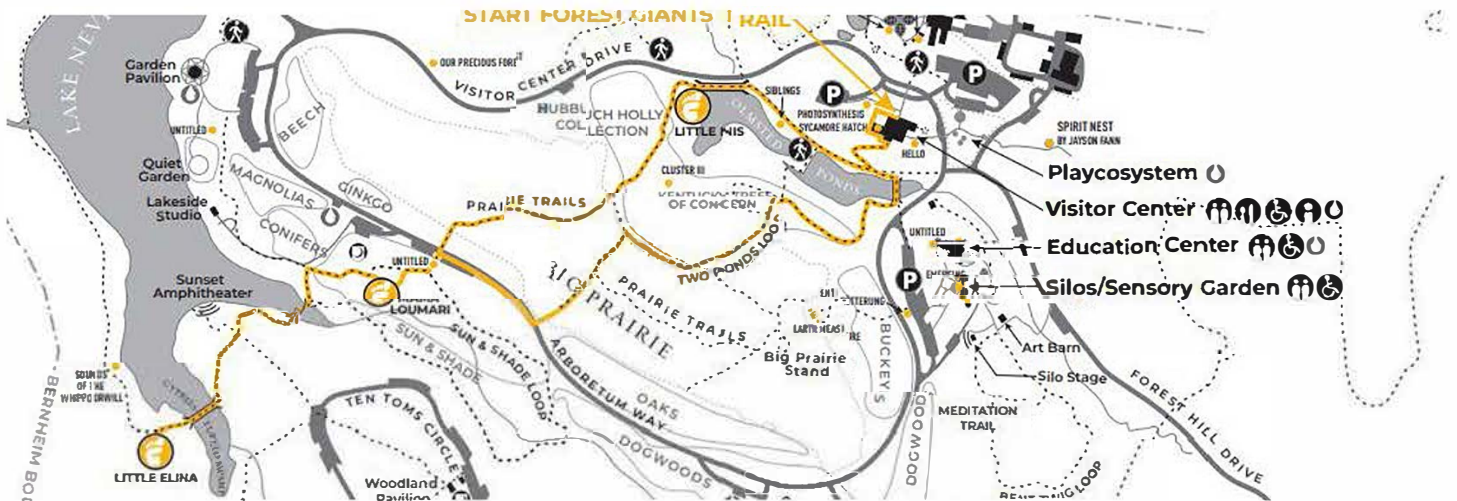
"Connect people with nature."

- Volunteer and donor opportunities
- Want volunteers to help them with their mission to "connect people with nature".
- You may volunteer to do trail work, gardening, reception desk work at their education center, youth programming, etc.



DESIGN + PROGRAM

Bernheim has several elements that promote and support their mission of connecting people with nature.



trails

Bernheim has 9 Arboretum trails, and 13 Natural Area trails.



The exhibit was completed in 2019 by Danish artist Thomas Dambo. Each of the giants was created using recycled materials, including wooden pallets, fallen trees, and discarded Louisville Slugger bats.



Designed by William McDonough + Partners, Bernheim has a LEED Platinum visitor's center. The architect designed this building to be part of the forest, and used recycled materials as well as incorporating green infrastructure on the roof.



Bernheim has their own children's play area which they call their "Playcosystem". This play area uses the idea of adventurous play to allow children access to nature in play.



The Bernheim edible garden includes dozens of beds for edible plants native to Kentucky, including heirloom tomatoes, snake squash and cotton. A pond for children to explore has been built, along with a small education shed.



Leon Levy Native Plant Preserve

Founded by Shelby White in 2003
Location: Eleuthera, Bahamas
Acreage: 30 acres



Mission:

"The Leon Levy Native Plant Preserve is a 30-acre botanical garden located in Eleuthera, The Bahamas. Managed by The Bahamas National Trust, it is a living part of Bahamian history and is the first and only national park on the island of Eleuthera...Shelby wanted to celebrate her husband's devotion to the island while contributing to a better future for all Eleutherans and founded The Preserve in 2003."

OUTREACH

“All we can do is try to leave a legacy of good works.” — Leon Levy

- The Leon Levy Foundation



- The Bahamas National Trust



Leon Levy Foundation:

“...an independent, non-profit foundation that endeavors to build on Leon’s vision, encouraging and supporting excellence in six broad areas: understanding the ancient world; arts and humanities; preservation of nature and gardens; brain research and science; human rights; and Jewish culture.”

[illegible]

An aerial photograph of a tropical atoll. A large, shallow lagoon with light blue water is the central feature, surrounded by a narrow strip of land. The land is covered with green vegetation and has a few small buildings. The water transitions from light blue in the lagoon to a deeper blue further out.



A stylized illustration of a landscape. On the left, a blue river flows from the top left towards the center. Below the river, there are green hills. In the center, there is a small, dark green, irregular shape. To the right, there is a small blue pond and a small green hill. The background is white with some light blue wavy lines at the top.



trails + features

The Leon Levy Plant Preserve has 13 trails, all with unique themes.



Mangrove Boardwalk + Wetlands

- Observe all four mangrove species found in The Bahamas. Amongst the plants' impressive root structures
- Wetland birds and other animals that depend on these ecosystems
 - A man-made waterfall was developed using natural Bahamian limestone with recirculated groundwater

Medicinal Trail

- Showcases plants used in medicine by Bahamians. Termed “bush medicine,” involves the brewing of the roots, bark, and leaves of particular plants and trees to make teas
- First brought to The Bahamas by African slaves in the 1700s
- Display beds on the medicinal trail are organized by ailment and the respective plants used to treat it



Endemic Display Beds

- Endemic plants are plant species that are native to a specific geographic region and are found nowhere else in the world. In the Endemic display beds
- These beds contain plants that have been collected by Dr Ethan Fried during his collections in the wild. Many of these species are considered threatened or endangered





Structures: Visitor Center

Spencer Addis

Craig Thomas Discovery and Visitor Center

- Opened in 2007
- Cost \$21 million for the first phase. Other phases are in the works.
- 22,000 square feet
- Closed from November 1-April 30



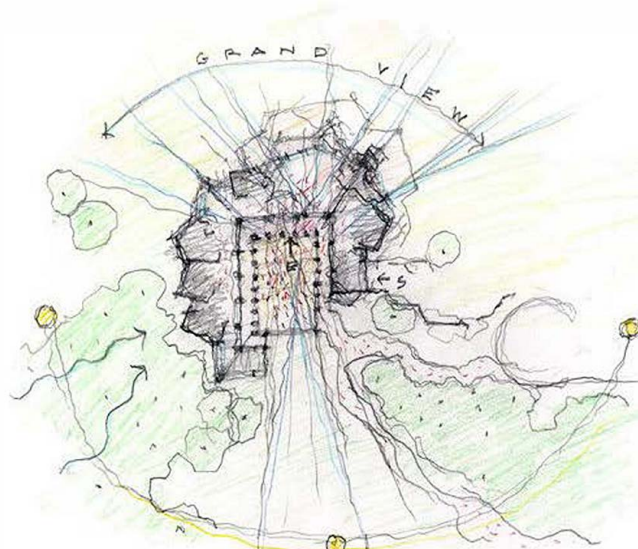
Guest Experience

- Offers themes of “place, people, preservation, mountaineering and Native American Indians encourage visitor to contemplate the past, present and future of this majestic place.”
- To support these themes the center has:
 - Interactive exhibits
 - Native American artifacts from the Vernon Collection
 - A large raised relief model of the park to demonstrate glacier movement and animal migration
 - A 24-minute park film that provides history and contents of the park
 - Tributes to Teton mountaineers
- Provides a shopping opportunity and restrooms.
- Guests can obtain trip planning info, backcountry permits, boating permits, trail info, weather forecasts, and ranger-led programs



The Architects

- Bohlin Cywinski Jackson
- Renowned for their design of institutional commercial and residential buildings, including Apple retail stores.
- Similar projects include the Liberty Bell Complex in Independence National Historic Park and Vermont Institute of Natural Science Raptor Center.
- Interactive Displays designed by: Ralph Appelbaum Associates
- 3 main themes for displays = people, place, protection.



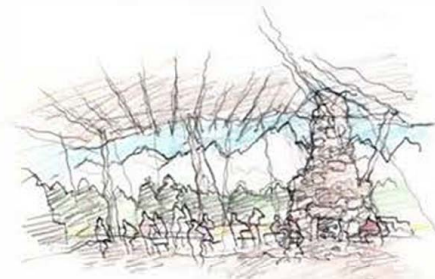
Design

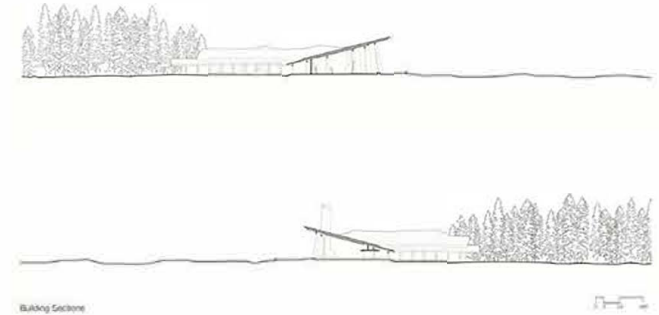
- The center is located between a sagebrush meadow and riparian forest along the Snake River
- Approaching the center, through a grove of trees, visitors are lead into a courtyard that "provides a calm and intimate place in the vast Wyoming landscape".
- The roof tilts up and away from the courtyard, "its jagged edges celebrating the peaks of the Teton Range beyond."
- Large full length glass windows show a beautiful view of the Tetons from the inside, and draws guests to the building from the outside.



Design

- Entering into the building from the courtyard, "visitors are drawn into the 'heart' of the building; a large gathering hall...with the magnificent view of the Teton Range as the backdrop."
- The focal point of the room is a large stone fireplace.
- Large columns mimics a forest, "while the ceiling rises up to reveal the jagged spires of the mountains"
- The center emulates the rustic architecture of traditional natural parks, while accomplishing a modern design.





Grand Teton National Park Foundation

- A private nonprofit organization
- Mission: "fund projects that enhance Grand Teton National Park's cultural, historic, and natural resources and to help other learn about and protect all that is special in the park"
- Initiate research, projects, and other improvements to help the visitors connect to the park.
- Widely recognized as one of the "strongest and most successful friends' groups to partner with the National Park Service.
- Raised over \$80 million for projects in the park



Mesa Verde National Park Visitor and Research Center

- Primary facility for orienting visitors to opportunities within the park
- \$14 million
- 7,400 sqft Visitor Information Center
- 16,300 sqft Curatorial Center
- LEED Platinum rating



Guest Experience

- “State-of-the-art research and storage facility for the park’s archives and museum collection of over 3 million objects”
- Exhibits are designed to help visitors plan their trip to the park and to “offer glimpses into the richness of Ancestral Puebloan culture and daily life”
- The exhibits highlight:
 - The history and modern descendants of the Pueblo people
 - The park’s research collection
 - The LEED building’s sustainability features
 - Original sculptures and art
- The bookstore features, books, trail guides, maps and merchandise



The Architects

- Ajc Architects
- Lead Architect: Derek Wilson
- Lead Landscape Architect: Lisa Benson with Landmark Design, Inc.
- The landscape surrounding the center reflects the park's mission by educating the public on the resources of the park and their "inter-connectivity"
- A mix of native and drought tolerant species were used to revegetate the site
- Concerns of fire danger were also addressed.



Design: Sustainability

- "The building demonstrates the use of energy efficiency, renewable energy, water conservation, recycling, and environmentally preferable materials. The curation facility incorporated special envelope and mechanical systems to preserve over 3 million artifacts."
- Renewable energy systems: capable of offsetting 95% of the building's energy requirements.
- These systems include:
 - Improved building envelope
 - Reduced lighting power requirements
 - Advanced lighting controls
 - High-efficiency HVAC system
 - Solar water heating
 - Hydroelectric power from a micro-hydro turbine
 - Photovoltaics.



The Mesa Verde Foundation

- Purchased land for the building site and donated it to the National Park Service
- Funded the architectural planning, but built with federal funding.
- Non-profit, philanthropic partner to Mesa Verde National Park
- Mission: "promote understanding and appreciation of Mesa Verde National Park and to develop financial and other resources to support the park in its mission of protecting its cultural, natural, aesthetic, and wilderness values."



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