THE NATIVE ORCHID CONFERENCE JOURNAL

SPECIAL 20TH ANNIVERSARY EDITION

VOLUME 19.1

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SPECIAL 20TH ANNIVERSARY EDITION
COMPILED BY RICK BURIAN
(*all photos by Rick Burian unless otherwise noted*)

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PREFACE: TWENTY YEARS & COUNTING

Many organizations (e.g. businesses, social clubs, youth athletic leagues, religious groups, political-action committees) trace their origins to a related predecessor entity from which they diverged. Although such divergence can be rancorous, more often than not it simply reflects alternative priorities, changing times or newfound objectives. Such was the case with the Native Orchid Conference. In 2002 a small group of like-minded individuals, led by David McAdoo and Mark Rose, diverged and created the NOC with a specific goal in mind … "to increase awareness of, and interest in, native orchids of the United States and Canada. Its mission is to promote and support the enjoyment of native orchids and the protection of orchid habitat through education, conservation and research." For twenty years that's exactly what the NOC has attempted to do.

In celebration of our twentieth anniversary, we are pleased to bring you this "Special Edition" of the NOC Journal. We pay tribute to David and Mark for their foresight and leadership. We also recognize the 112 Founding Members, those who are still active as well as those who have moved on or, in some cases, passed on. We are thankful for the Officers and Directors, past and present, who have led us to this point; especially previous presidents David McAdoo, Lorne Heshka, Mark Rose, Phil Oyerly and Ben Rostron. We acknowledge Hal Horwitz who led the effort to establish the Fred Case Grant Program which, in the ten years of its existence, has provided financial support to 15 students researching native orchids. Two pillars of this organization are the NOC Journal and our annual symposiums. We would not be who or what we are without the Journal. Special thanks go to our editors over the years; Bob Ferry, Jyotsna Sharma, Duane Erdmann and now Chelsea Kieffer. Neither would we be who or what we are without our annual symposiums. We thank the individuals who organized those spectacular events each year beginning in 2002 and continuing through 2019. In 2022 we will visit the Pacific Northwest.

We are indebted to Rick Burian who painstakingly assembled the material in this Anniversary Journal. Rick traces the entire history of the NOC through the lens of 18 symposiums as well as the lens of his always at-the-ready camera. He did not write a travelogue; there are no hotels, eateries, museums or historic sites mentioned. Neither did he prepare a field guide to native orchids. Rather, Rick painted a "picture of place" … twelve pictures of twelve places to be more precise. He accumulated details about those areas from the referenced sources, details which describe the geography, geology and hydrology of the bio-geographic regions we visited during our symposiums. (Several locales hosted us on multiple occasions). Those natural conditions obviously determine the flora (especially orchids) and fauna to be found in a region and are thus the reason we chose to visit. Rick's photos, as well as some from other members, highlight many of the things we encountered, especially the orchids. Amazingly, Rick includes photos of nearly half of North America's 200 plus native orchids.

For a more thorough description of those orchid species we recommend ***Go Orchids***, the website of the North American Orchid Conservation Center (NAOCC). NAOCC is a project of the Smithsonian Environmental Research Center with which we have enjoyed a close working relationship over the years.

For those who have attended one or more symposiums, this will be a nostalgic return to exciting days in the field, informative lectures and the extraordinary camaraderie that is born of our shared passion. For those who have yet to experience a NOC symposium, we hope this Journal will provide the incentive for you to join us next time.

-RES

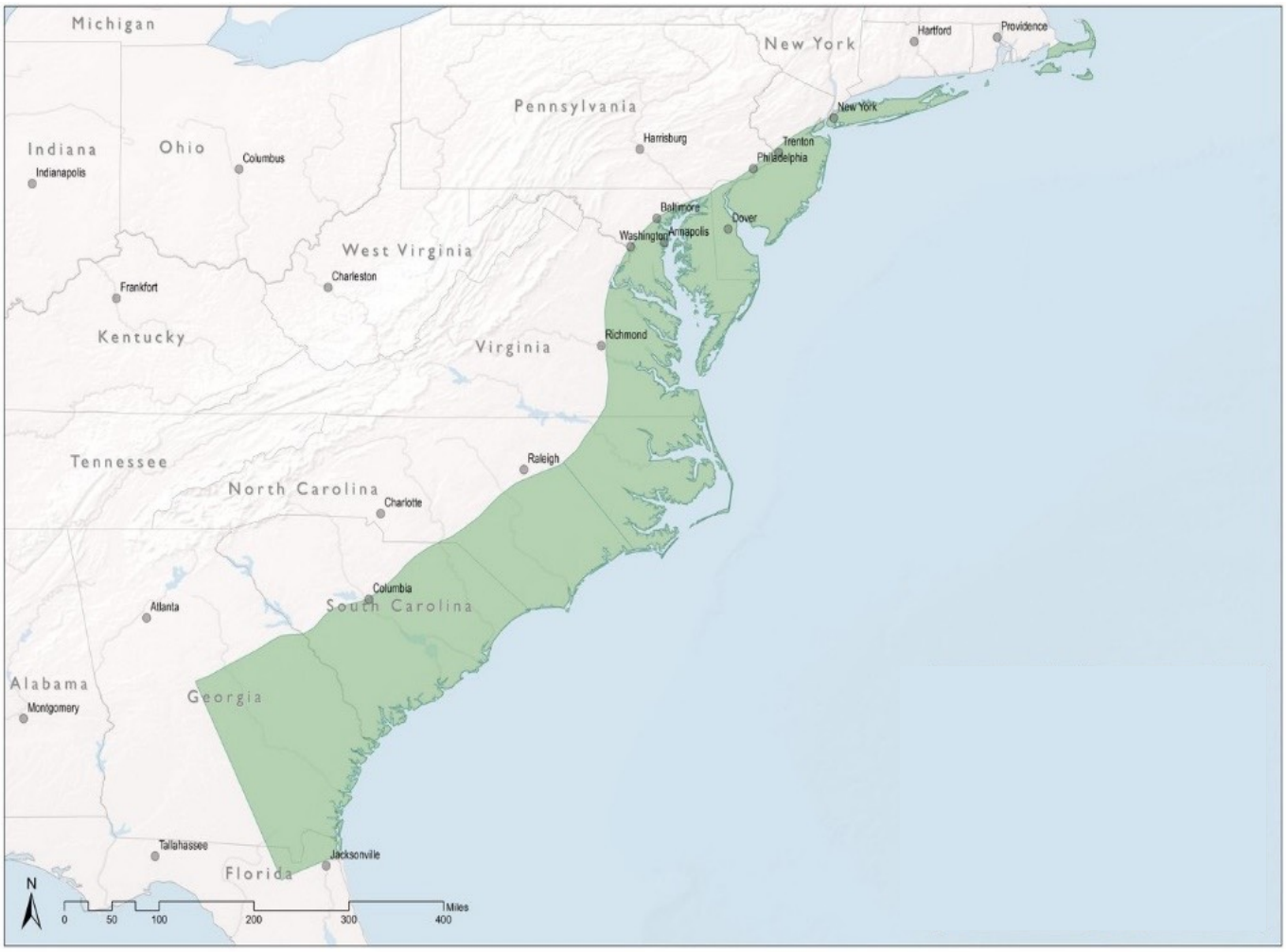
Native Orchid Conference founders, David McAdoo (left) and Mark Rose (right)

Greensboro, North Carolina	May, 2002	Wilmington, North Carolina	May, 2012
Hamilton, Ontario	June, 2003	Oroville, California	June, 2013
Conway, South Carolina	August, 2004	Itasca, Minnesota	July, 2014
Winnipeg, Manitoba	July, 2005	Gorham, New Hampshire	June, 2015
Ashland, Oregon	June, 2006	Tucson, Arizona	August, 2016
Miami, Florida	April, 2007	Scanterbury, Manitoba	June, 2017
Morgantown, West Virginia	July, 2008	Annapolis, Maryland	July, 2018
Green Bay, Wisconsin	June, 2009	Tobermory, Ontario	June, 2019
Edmonton, Alberta	June, 2010	Port Angeles, Washington	postponed 2020
Mt. Cuba Center, Delaware	July -August, 2011	Port Angeles, Washington	postponed 2021

In 2005 our fledgling organization was determined to be in need of an official LOGO. A contest was announced and in May of that year a winner was chosen from among several entries that had been submitted. Kathy Barton of Manville, Rhode Island created this emblem featuring Isotria verticillata. It has identified the NOC ever since.

THE COASTAL PLAIN OF THE CAROLINAS

(May 2002, August 2004, May 2012)



Map of the Southeastern US highlighting the Atlantic coastal plain ecoregion

The coastal regions of the eastern states from Georgia to New York all have a similar geography, starting with the Appalachian Mountains in the western interior, at elevations averaging about 3,000 feet. Just east of the Appalachian Mountains is the Piedmont region which typically ranges in elevation from 300 feet to 1,000 feet. Continuing eastward from these highlands is a "Fall Line" which serves as the transition into the Atlantic Coastal Plain. The Atlantic Coastal Plain gently slopes towards the Atlantic Ocean with few elevations higher than 300 feet.[1]

The coastal plain is South Carolina's largest ecoregion and makes up two-thirds of the state.[2] In North Carolina the coastal plain makes up 45% of the state. It varies from about 100 to 150 miles wide in these states.[3,4] The eastern coastal plain formed through the erosion of mountain ranges to the north and west, specifically the Blue Ridge, the Piedmont ranges, and the present Appalachian Mountains. In addition, the

sea rose and fell many times over millions of years, forming extensive deposits of off-shore limestone that is visible today at the surface in many areas of the coastal plain. Other unconsolidated sediments are found on the surface and at depth. These include sands, clays, and silt that eroded from the highlands and settled out onto the ocean floor. These sediments later were exposed as sea levels fell. Over time the sediments were eroded and redeposited repeatedly by rivers and estuaries, thus constructing the complex geomorphology of the coastal plain.[2]

Geographic features of the region include floodplains of the large rivers that traverse the area and near-pristine river bottomlands and swamps, estuaries, and other wetlands. The coastal plain is the only region in these states that contains Carolina bays, unique elliptical depressions that dot the region. The coastal plain also contains a unique area of karst topography. These caves and sinkholes formed over millions of years as acidic groundwater reacted with the Santee limestone of the area.[2]

Meadows and understory within the coastal coniferous forests. Photos by Richard Barmore

There are several habitat types found in the coastal plain. 1) Beaches and dunes can be found directly along the coast and barrier islands, which are seasonally flooded by high tides and storm surges. These areas usually stay moist due to salt spray and rainwater. 2) Dry Longleaf Pine (*Pinus palustris*) habitats (as opposed to wet longleaf pine habitats described later), range from very moist to well drained and are dominated by Longleaf Pine, an open mid-story and an understory of grasses and herbs where there are frequent fires. The mid-story can fill in with hardwood and shrubs that shade out native grasses if fires are absent or infrequent. 3) Dry coniferous woodlands occur throughout the coastal plain and consist of other pine species with mid-stories of dense shrubs and hardwood trees. 4) Early succession and scrub-shrub habitats are characterized by low woody vegetation and herbaceous plants and result from fires (natural and intentional), clear cutting, disking, pathogens, insect pests or large scale wind events. 5) Estuarine communities include salt and brackish marshes, mud and salt flats, and island communities. 6) Floodplain

forests include levee forests, Cypress-gum swamps, bottomland hardwoods, and alluvial floodplains along with sand and mud bars, beaver and mill ponds, and oxbow lakes. 7) Lakes and reservoirs include Carolina bays and peatland depressions and tend to be acidic and therefore have low productivity. 8) Mesic forests occur on moist portions of upland habitat that is protected from fires, or on north-facing slopes and on high sections of outer flood plains. Common canopy species include *Fagus grandifolia* (American Beech), *Liriodendron tulipifera* (Tulip Poplar), *Liquidambar styraciflua* (Sweetgum), *Carya cordiformis* (Bitternut Hickory), *Carya ovata* (Shagbark Hickory), *Ulmus americana* (American elm), *Juglans nigra* (Black Walnut), *Quercus alba* (White Oak), *Quercus michauxii* (Swamp Chestnut Oak) and *Quercus rubra* (Red Oak).[5]

Wetland habitats are a dominant feature of the coastal plain of the Carolinas. These are areas of soils saturated from surface or groundwater caused by a topography that prevents the land from draining completely. This results from terraces left along ancient shorelines or flat lying deposits on flood plains.[3] Habitats considered wetlands include 8) Peatland communities known as pocosins, have deep, acidic, sandy, peat soils. They can have Atlantic White Cedar forests or bay forests as well as pine woodlands. The soils are nutrient deficient. Other wetlands are known as 9) non-alluvial, meaning not deposited by running water such as stream beds and not having loose clay, silt, sand or gravel. These tend to be more nutrient-rich than pocosins but not as rich as floodplain wetlands. The wettest areas have *Taxodium distichum* (Bald Cypress), *Nyssa biflora* (Swamp Black Gum) and *Acer rubrum* (Red Maple). Less saturated non-alluvial wetlands commonly have *Quercus pagoda* (Cherrybark Oak), *Quercus imbricaria* (Laurel Oak), *Quercus michauxii* (Swamp Chestnut Oak), *Liriodendron tulipifera* (Tulip Poplar), *Liquidambar styraciflua* (Sweetgum), *Ulmus americana* (American Elm), and *Acer rubrum* (Red Maple). 10) Tidal swamp forests and wetlands occur along rivers and sounds where flooding is influenced by lunar or wind tides and freshwater input may heavily impact the salt content. Vegetation may range from Cypress-Gum swamps, characterized by *Nyssa biflora* (Swamp Black Gum), *Nyssa aquatica* (Water Tupelo), and *Taxodium distichum* (Bald Cypress), to freshwater marshes containing *Spartina cynosuroides* (Giant Cordgrass), *Cladium* spp. (Sawgrass), *Typha* spp. (Cattails), *Schoenoplectus americanus* (American Three Square Sedge), *Juncus roemerianus* (Black Needle Rush), *Carex* spp. (Spike-sedges), *Zizania aquatica* (Southern Wild Rice), *Sagittaria* spp. (Arrowhead), and *Thelypteris palustris* (Marsh Fern). There are also many smaller wetland communities such as vernal pools, Cypress savannas, small depression ponds, beaver ponds, interdune ponds and limesink depressions.[5]

Another important habitat is 11) wet pine savannas which are mineral wetlands subject to frequent burning under natural conditions. They include Pine Savannas, Sandhill Seeps, and Wet Pine Flatwoods communities. With fire, they are characterized by an open canopy dominated by Longleaf Pine or Pond Pine, an open mid-story, and an understory comprised of some mixture of *Aristida stricta* (Wiregrass), cane, herbs, and pocosin shrubs, depending on soil moisture and fire frequency. Herbaceous plant diversity

in these systems, particularly in Pine Savannas, is among the highest in temperate North America if burned on a consistent and frequent basis. When fire is suppressed, a dense shrub understory develops and herb diversity declines drastically. These pine communities are similar to dry Longleaf Pine communities in that they often grade into each other and can occur as mosaics on the landscape. They may also grade into dry Longleaf Pine communities, Pond Pine woodlands, and pocosins.[5]

Pinus palustris (Longleaf Pine) savanna with *Aristida stricta* (Wiregrass) understory
Photo by Jim Fowler

The NOC has visited areas near the South Carolina /North Carolina borders, in particular the Green Swamp. This is a Nature Conservancy managed preserve that contains some of the country's best remaining examples of Longleaf Pine (*Pinus palustris*) savannas.[6] Unfortunately, 98% of the original pine savannas were destroyed by early settlers and fire suppression over the years allowed pine savannas to be taken over by hardwoods and covered by non-native species.[7] The World Wildlife Fund has identified the Green Swamp as one of the top ten locations in North America because of the number of species of plants and animals it contains.[8]

Management of the 17,424 acre site began in 1977 with a donation from the Federal Paper Board and additional land has been added over the years. The open savannas have a diverse herb layer with many orchids and insectivorous plants. Almost 13,000 acres of the preserve, however, consist of a dense evergreen shrub bog (pocosin) dominated by *Ilex glabra* (Gallberry), *Cyrilla racemiflora* (Titi), and *Magnolia virginiana* (Sweetbay). The Green Swamp contains at least 14 different species of insectivorous plants, including extensive populations of *Dionaea muscipula* (Venus Flytrap), *Drosera* spp. (Sundew), *Pinguicula* spp. (Butterworts), *Utricularia* spp. (Bladderworts), and four species of *Sarracenia* spp. (Pitcher Plant). (There are 66 species of carnivorous plants in the US and North Carolina has 36 of those, while South Carolina has 25 species.) The preserve is also home to many rare animals, including *Alligator mississippiensis* (American Alligator), *Centronyx henslowii* (Henslow's Sparrow), *Peucaea aestivalis* (Bachman's Sparrow), *Picoides borealis* (Red-cockaded Woodpecker) and *Callophrys hesseli* (Hessel's Hairstreak Butterfly).[6] Eighteen species of orchids have been found at the preserve.[8]

The Nature Conservancy's many management activities at the Green Swamp include restoring pine plantations to Longleaf Pine savannas and controlled burning. Many of the plants in the Green Swamp benefit from periodic burning; the cones of pond pines burst and release seeds after being exposed to very high temperatures and wiregrass flowers vigorously after a fire. Longleaf Pine seeds need bare ground to germinate and plenty of sunlight to grow, typical traits of plants that evolved in a landscape with frequent fires. The grasses and sedges of the Green Swamp have roots that are protected from the hottest fires, as do the orchids and insectivorous plants. Fire knocks back shrubby vegetation so light can reach the forest floor, allowing these understory plant species to persist.[6]

New growth of Longleaf Pine after controlled forest fires.
Photo by Duane Erdmann

The climate of this part of the Carolinas is warm, temperate, and humid for much of the year. The elevation is close to sea level. Annual average temperature is 62.8 °F (17.1 °C). Monthly average temperatures are highest in July and August (high 92-93°F /33.3-33.9 °C to low 69-70°F /20.5-21.1°C) and lowest in January and February (high 59-63°F /15-17.2 °C and low 33-35°F /0.6-1.7 °C). Monthly precipitation amounts are highest in July and August when it rains about 12 days per month and lowest in April and November when it rains about 5 or 6 days per month. Annual rainfall is about 54 inches (1377 mm).

Asclepias lanceolata (Few-flowered Milkweed) [left] and *Rhexia petiolata* (Fringed Meadow-beauty) [right]
Photos by Jim Fowler

Drosera intermedia (Spoon-leaf Sundew) [left] and *Drosera capillaris* (Pink Sundew) [right]
Photos by Jim Fowler

Dionaea muscipula (Venus' Fly-traps) [left] and *Sarracenia minor* (Hooded Pitcher Plant) [right]
Photos by Jim Fowler

Habenaria repens
(Water Spider Orchid)

Platanthera blephariglottis
var. *conspicua*
(White Fringed Orchid)
Photo by Jim Fowler

Platanthera integra
(Yellow Fringeless Orchid)
Photos by Bob Sprague


Platanthera cristata
(Crested Orange Orchid)
Photo on left by Bob Sprague


Platanthera ciliaris
(Orange Fringed Orchid)
Photo on left by Bob Sprague

Spiranthes lacera
(Slender Ladies'-tresses)
Photo by Bob Sprague

Spiranthes cernua
(Nodding Ladies'-tresses)
Photo by Jim Fowler

Spiranthes longilabris
(Long Lipped Ladies'-tresses)
Photo by Jim Fowler

Goodyera pubescens
(Downy Rattlesnake Plantain)
Photo on left by Bob Sprague

Pogonia ophioglossoides
(Rose Pogonia)
Photo by Jim Fowler

Calopogon pallidus
(Pale Grass Pink)
Photo by Jim Fowler

Calopogon tuberosus
(Tuberous Grass Pink)
Photo by Jim Fowler

Isotria verticillata
(Large Whorled Pogonia)
Photo by Bob Sprague

Cleistesiopsis divaricata
(Rosebud Orchid)
Photo by Jim Fowler

Cleistesiopsis oricamporum
(Coastal Plain Pogonia)
Photo by Jim Fowler

Epidendrum magnoliae
(Green Fly Orchid)
Photo by Jim Fowler

Tipularia discolor
(Cranefly Orchid)

1) South Carolina Geology and Seismicity; SC Department of Transportation. 2019 https://www.scdot.org/business/pdf/geotech/Chapter%2011%20SC%20Geology%20and%20Seismicity.pdf
2) Coastal Plain of South Carolina https://www.scencyclopedia.org/sce/entries/coastal-plain/
3) North Carolina Coastal Plain: https://www.ncpedia.org/geography/region/coastal-plain/ncatlasrevisited
4) Geology of the Coastal Plain of South Carolina, C. Wyeth Cooke, US Dept. of the Interior, 1936; https://pubs.usgs.gov/bul/0867/report.pdf
5) Coastal Plain Habitats : https://www.ncwildlife.org/conserving/habitats/coast
6) The Green Swamp: https://www.nature.org/en-us/get-involved/how-to-help/places-we-protect/green-swamp-preserve/
7) Pine Savannas, Taylor Bodine: https://sites.google.com/site/thevenusflytrapuncw/coastal-and-barrier-island-ecosystem-factors/pine-savanna
8) Orchid habitat loss: https://www.orchidconservationcoalition.org/hl/greenswampnc.html

THE GREAT LAKES REGION

(June 2003, 2009 & 2019)

Maps showing the Great Lakes region. This article first covers the area near Green Bay, Wisconsin and the Upper Peninsula of Michigan (*) and then the eastern part of Lake Huron (Bruce Peninsula) in Ontario (*).

The Great Lakes region of North America is a bi-national Canadian–American region that includes portions of the eight U.S. states of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin as well as the Canadian province of Ontario.[1]

The geology of the Great Lakes basin consists of two fundamentally different successions of bedrock overlain by unconsolidated glacial clastic sediments. Bedrock in the more northern parts of the basin is composed of Precambrian metamorphosed igneous and sedimentary rocks. They formed during three major episodes between 3600 to 1000 million years ago with each followed by erosion for hundreds of millions of years. After a long period of erosion beginning about 500 million years ago ancient seas covered the Great

Lakes basin off and on and Phanerozoic sedimentary rocks began to be deposited. They consist largely of shale, limestone, and sandstone on top of the Precambrian bedrock. These rocks are thickest in the Lower Peninsula of Michigan where they fill the Michigan basin. The action of glaciers in the past one-million years removed this younger Phanerozoic bedrock to expose the Precambrian in the north. Upon retreat the glaciers left behind unconsolidated sediments that invariably buried much of the bedrock in the Great Lakes basin.[3]

During the last ice age, the mile-thick Laurentide ice sheet covered most of Canada and the northern contiguous United States. The massive weight and movement of this glacier gouged out the earth to form the lake basins. About 20,000 years ago, the climate warmed and the ice sheet retreated. Water from the melting glacier filled the basins, forming the Great Lakes. Approximately 3,000 years ago, the Great Lakes reached their present shapes and sizes. Today, the Great Lakes ecoregion contains a variety of habitats, including aquatic, forest, marsh, wetland, and dune ecosystems. Widely varying climate, soils, and topography support more than 3,500 species of plants and animals.[2]

The Great Lakes basin, as defined by watersheds that drain into the Great Lakes, includes about 85% of North America's and 20% of the world's surface fresh water, a total of about 5,500 cubic miles (23,000 cubic km) of water. The basin covers about 94,000 square miles (240,000 square km) and is home to about 10 % of the U.S. population and 30% of the Canadian population.[1] Lake Michigan is the only Great Lake entirely within the United States. The State of Michigan lies at the heart of the Great Lakes basin. Together the Great Lakes are the single largest surface fresh water body on Earth and have an important physical and cultural role in North America. There are more than 10,000 miles of shoreline that frame the Great Lakes and from west to east, the lakes span more than 750 miles.[7]

Its current climate is cold winters and warm summers and it is located in the southeastern and boreal climate regions. The Great Lakes act like heat sinks and keep the surrounding area a moderate temperature. As well, the lakes create a lot of moisture in the air.[4] In the winter, the Great Lakes Region experiences long nights and cold days. The northern hemisphere is tilted away from the Sun, incident solar energy is spread thin, and the sun rises and sets south of the equator. In the summer, the Great Lakes Region experiences short nights and warm days because the northern hemisphere is tilted toward the Sun so solar heating is more concentrated and efficient. Also, the Sun rises and sets north of the Equator between the summer solstice and autumnal equinox, lengthening hours of daylight. The lakes also act like giant humidifiers, increasing the moisture content of the air. In the winter, this moisture contributes to heavy snowfall known as "lake effect" snow.[5] As an example, Green Bay, Wisconsin on the western shores of Lake Michigan, has average January (the coldest month) temperatures varying between 22.6°F (-5.2°C) and 12.4°F (-10.9°C) and July (the warmest month) having an average high-temperature of 78.1°F (25.6°C) and an average low-temperature of 60.4°F (15.8°C). Annual rainfall here is 30 inches (considerably less than

the U.S. average of 38 inches). Of that, 25.2 inches fall as rain and the balance as snow (which equates to approximately 48 inches of snow). In contrast Chicago's coldest day in January averages a low of 22°F and high of 33°F and the warmest day in July has an average high of 83°F and low of 71°F. That city on the southern point of Lake Michigan annually gets 38 inches of rain (2.8 inches as snow = 28 inches) on average. Further east, on the shores of Lake Huron, Tobermory, Ontario has January average highs of 26°F (-3.3 °C) and lows of 13 °F (-10.5°C) while in July the average high is 73°F (22.8°C) and the average low is 56°F (13.3 °C). Rainfall is 62" annually with 13" of that as snow (130").

Before the European settlers arrived more than 400 years ago, the Great Lakes basin was made up of tallgrass prairies, oak savannas, woodlands and wetlands. Since then the region has lost much of its original landscape to agriculture, urban development and industry, such as logging. For example, approximately 65 percent of Illinois was originally tallgrass prairie; today, less than 0.01 percent of the original prairie remains. The Great Lakes region has also lost more than two-thirds of its natural wetlands to agriculture, urban uses, shoreline development, and recreation. In the mid-1800s, commercial logging became an important industry in the region. The earliest loggers harvested the easy to cut and abundant White Pine; the pine was much in demand for shipbuilding and construction. The trees were hundreds of years old and could not be replaced quickly; when the pines were gone, lumbermen had to utilize other species. Hardwoods, such as maple and oak, were then cut to make furniture, barrels and specialty products. Unfortunately, the forests of the region were often not reforested during this time of intense logging. And when the land was replanted, different types of trees were often used, altering the ecosystem of the area even more.[6]

Another influence on the flora in the region has been the introduction of non-native, or non-indigenous, plants. As the area became more populated, people began bringing plants and trees from other regions to plant in their yards and fields. Many of these non-native plants have no natural enemies to control their growth, therefore, they can out-compete native plants and eventually dominate a landscape. Diverse plant communities that once populated an area and supported a large animal community are often choked out by non-native plants, changing the ecosystem drastically.[8]

Many of the wildlife species that still call the region home exist in the remnants of those historic habitats, such as the Gray Wolf, Moose, and Beaver. Other mammals in the Great Lakes include the Canada Lynx, Elk, Black Bear, Little Brown Bat, River Otter, and Coyote. A variety of bird species also live in these habitat remnants. The Great Lakes region is important for many species of migratory and resident birds, particularly waterfowl, neotropical migrants, and birds that nest in colonies. The Great Lakes region provides important breeding, feeding, and resting areas for birds like the Bald Eagle, Northern Harrier, Common Loon, Double-crested Cormorant, Common Tern, Bobolink, Least Bittern, Common Merganser, Snowy Owl and the endangered Kirtland's Warbler.[6]

The Great Lakes are actually quite different from each other, and because of this variation, different numbers and varieties of fish and other aquatic wildlife can be found in each lake. There are more than 250 species of fishes found in the Great Lakes. Lake Superior, the largest of the lakes, is cold and deep. Lake Erie is one of the smallest of the Great Lakes and is relatively shallow and warm. Walleye, Yellow Perch, Lake Sturgeon, Brook Trout, Lake Whitefish, Muskellunge, and introduced salmon species are among the many kinds of fish in the Great Lakes. Some fish are undergoing restoration efforts, such as Lake Sturgeon and Lake Trout.[6]

The Great Lakes fauna have suffered greatly the effects of introduced (non-native) species during the past two hundred years. Non-native animal species such as Zebra Mussels, Quagga Mussels, Sea Lampreys, Alewives, Asian Carps, the Spiny Water Flea, and many others have greatly altered the Great Lakes ecosystem. Introduced species compete with native species for food and habitat. More than 180 non-native species have entered the Great Lakes since the latter part of the 19th century. Many of the introduced species have been transported into the Great Lakes in the ballast water of ships, but other species such as the Asian Carp, have invaded the lakes by swimming through the man-made channels and locks that now connect Lake Michigan to the Mississippi River.[7]

The Fumee Lake Natural Area in Michigan is often used by educators to aid in the study of ecology.

Fumee Lake Natural Area is an over 1800 acres natural wildlife area in the Upper Peninsula of Michigan. Fumee Lake and Little Fumee Lake provide a total of five miles of undeveloped shoreline and 507 acres of surface water surrounded by wetlands and forest. The area has historically been home to a number of rare or threatened species including the Bald Eagle, Common Loon, and seventeen species of orchids. Established in 1992, the reserve provides a number of non-motorized recreational opportunities for visitors.[9]



Polygala paucifolia (Fringed Polygala) [left] and *Arisaema triphyllum* (Jack-in-the-pulpit) [right] are some of the wildflowers found in the hemlock forests of the preserve.



Aquilegia canadensis (Columbine) [left], *Clintonia borealis* (Corn-lily) [center] and *Mitella nuda* (Naked Miterwort) [right] are also present.

Neottia cordata
(Heart Leaved Twayblade)

Corallorhiza striata
(Striped Coralroot)

Corallorhiza trifida
(Early Coralroot)

Platanthera hookeri
(Hooker's Bog Orchid)

Platanthera obtusata
(Blunt-leaved Bog Orchid)

Cypripedium parviflorum, var. *pubescens* [left] and var. *makasin* [right]
(Yellow Lady's-slipper)

Cypripedium acaule
(Pink Lady's-slipper)

Goodyera repens
(Dwarf Rattlesnake Plantain)

Carney Fen in Michigan is home to many rare species of plants and animals.

The Carney Fen is a high quality northern fen and rich conifer wetland within Escanaba River State Forest in Menominee County, Michigan. Fens are much less acidic in chemistry than a typical wetland or bog and are fed by groundwater and can support diverse landscapes of sedge meadows, rushes and wildflowers that combine to provide vital wildlife habitat. This area is home to the largest and most diverse population of orchids in the state, with at least two dozen species identified. Michigan's state wildflower, the Dwarf Lake Iris, has also been documented at the Carney Fen, and many species of wildlife, including Bobcat, Black Bear, deer, butterflies, raptors and songbirds, thrive in the fen's unique ecosystem.[11] The reserve was dedicated in 2009 after seven years of involvement by a group of volunteers as a recognized State Natural area. It provides the legal protection of 2,678 acres of pristine orchid habitat and an additional 320 acres set aside as a special conservation area.[12]

Sarracenia purpurea (Pitcher Plant) [left], *Drosera rotundifolia* (Round-leaved Sundew) [center] and *Castilleja coccinea* (Scarlet Indian Paintbrush) [right]

Arethusa bulbosa
(Dragon's-mouth)

Galearis rotundifolia
(Roundleaf Orchid)

Cypripedium arietinum
(Ram's Head Lady's-slipper)

Cypripedium reginae
(Showy Lady's-slipper)

The Menominee River is a dividing line between northern Wisconsin and western Michigan and here we found plants of *Spiranthes lucida* (Shining Ladies'-tresses) [right]. Unfortunately we were a week too early to enjoy the flowers.

The shores of Green Bay on Lake Michigan in Marinette County have wetlands which support many species of birds and flowers including *Iris versicolor* (Northern Blue Flag) [left] and *Iris lacustris* (Dwarf Lake Iris) [right]. The latter is endemic to the Great Lakes region.



Liparis loeselii
(Loesel's Wide Lipped Orchid)

The Bruce Peninsula is a peninsula in Ontario, Canada, that lies between Georgian Bay and the main basin of Lake Huron. The peninsula extends roughly northwestward from the rest of Southwestern Ontario, pointing towards Manitoulin Island, with which it forms the widest strait joining Georgian Bay to the rest of Lake Huron. The Bruce Peninsula contains part of the geological formation known as the Niagara Escarpment. In its southern Ontario portion, the Niagara Escarpment is a ridge of rock several hundred meters high in some locations, stretching 725 kilometers (450 mi) from Queenston on the Niagara River, to

Tobermory at the tip of the Bruce Peninsula. Today, in Ontario, the Escarpment contains more than 100 sites of geological significance, including some of the best exposures of rocks and fossils of the Silurian and Ordovician periods (405 to 500 million years old) to be found anywhere in the world. The Niagara Escarpment has origins dating to the Silurian age some 430 to 450 million years ago, a time when the area lay under a shallow warm sea. This sea lay in a depression of the Earth's crust, centered in what is now the lower peninsula of the State of Michigan. Known geologically as the Michigan Basin, the outer rim of this massive saucer-shaped feature governs the location of the Niagara Escarpment, which is shaped like a gigantic horseshoe. The Escarpment can be traced from near Rochester, New York, south of Lake Ontario to Hamilton, north to Tobermory on the Bruce Peninsula. It is covered by the waters of Lake Huron, re-appearing as Manitoulin Island, then across the Upper Peninsula of Michigan and down the west side of Lake Michigan into the State of Wisconsin. As occurs with present-day water bodies, such as Hudson Bay or the Gulf of Mexico, rivers flowing into this ancient sea carried sand, silt and clay to be deposited as thick layers of sediment. At the same time, lime-rich organic material from the abundant sea life was also accumulating. Over millions of years these materials became compressed into massive layers of sedimentary rocks and ancient reef structures now visible along the Escarpment. Some rock layers now consist of soft shales and sandstones while others are made up of dolomite (a rock similar to limestone which contains magnesium and is more durable). Today, fossil remains illustrating the various life forms can be found in many of the rocks as they are slowly exposed by the action of wind, water and ice.[13]



Tamiasciurus hudsonicus (American Red Squirrel) [left], *Meleagris gallopavo* (Wild Turkey) [center] and *Lithobates pipiens* (Northern Leopard Frog) [right]

The Bruce Peninsula is a key area for flora and fauna. Part of the Niagara Escarpment World Biosphere Reserve, the peninsula has the largest remaining area of forest and natural habitat in Southern Ontario and is home to some of the oldest trees in eastern North America. There are many varieties of wildlife on the Bruce Peninsula, such as the Northern Flying Squirrel, Black Bear, Chipmunk, Fisher, Long-eared Bats, Red Squirrel, Fox, Massasauga Rattlesnake, Red-shouldered Hawk, Barred Owl, Hermit Thrush, Black-throated Blue Warbler, Scarlet Tanager and Yellow-spotted Salamander. The Bruce Peninsula is located on a major northern migration route, so many species of birds, such as the Bald Eagle, have their wintering grounds here. The highest concentration of nesting birds can be found in the Bruce in May and June each year. About 20 species of warblers breed on "the Bruce," including the Black-throated Green, Yellow, Yellow-rumped, and Blackburnian Warblers and the ubiquitous American Redstart. Migrating hawks also follow the Niagara Escarpment.[13]

Nerodia sipedon (Common Watersnake) [left] and *Sistrurus catenatus* (Massasauga) [right]
Photos by Chelsea Kieffer

Singing Sands at Dorcas Bay is a good habitat for orchids.

Some of the rarest flowers and ferns in Ontario can be found growing on the Bruce Peninsula. For example: *Tetraneuris herbacea* var. *glabra* (Lakeside Daisy), Dwarf Lake Iris (*Iris lacustris*), and Northern Holly Fern (*Polystichum lonchitis*). Canada is home to roughly 77 orchid species. Ontario has about 61 kinds of orchids, and of these, 50 can be found in the Bruce Peninsula.[13] Many species seen in Wisconsin and Michigan were also seen here.

An alvar is a biological environment based on a limestone plain with thin or no soil and, as a result, sparse grassland vegetation. Often flooded in the spring, and affected by drought in midsummer, alvars support a distinctive group of prairie-like plants. Most alvars occur either in northern Europe or around the Great Lakes in North America. This stressed habitat supports a community of rare plants and animals. Lichen and mosses are common species. Trees and bushes are absent or severely stunted. Alvars comprise a small percentage of the Earth's ecosystems by land extent. Although some 120 exist in the Great Lakes region, in total there are only about 112 square kilometers (43 square miles) left across the entire Great Lakes basin, and many of these have been degraded by agriculture and other human uses. More than half of all remaining alvars occur in Ontario. Crevices in the limestone provide a distinctive habitat which is somewhat protected from grazing, and which may provide habitat for unusual ferns.

Asplenium viride (Green Spleenwort) [left] and
Tetraneuris herbacea var. *glabra* (Lakeside Daisy) [right] in an alvar.

Cystopteris fragilis (Fragile Fern) [left], *Dryopteris filix-mas* (Male Fern) [center] and *Asplenium scolopendrium* (Hart's-tongue Fern) [right]

Goodyera oblongifolia (Giant Rattlesnake Plantain)





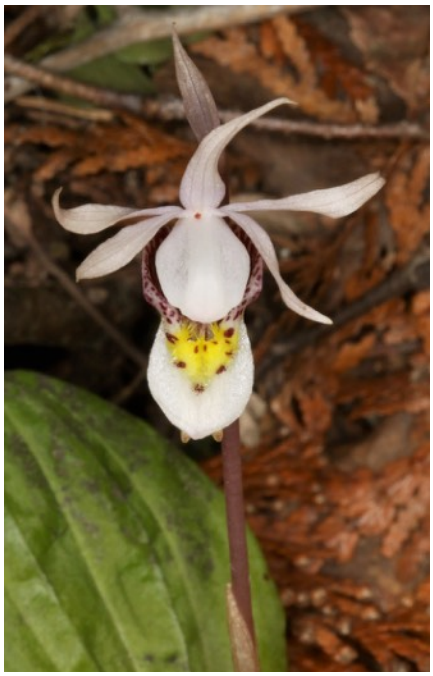
The variation among the extensive populations of *Cypripedium parviflorum* on the peninsula was incredible. In these photos both var. *pubescens* with lighter sepals and var. *makasin* with darker sepals are present.

Neottia ovata
(Egg-leaved Twayblade)
Introduced

The Oliphant Fen boardwalk allowed us access to
Platanthera dilatata
(Tall White Bog Orchid)

Flowerpot Island is an island in Georgian Bay, in the Canadian province of Ontario and is a part of Fathom Five National Marine Park. The island spans 2.1 kilometers (1.3 miles) from east to west, and 1.5 kilometers (0.93 miles) from north to south, and has a total area of 2 square kilometers (490 acres). It is 6.5 kilometers (4 miles) from Tobermory and only accessible by boat. The name of the island comes from two rock pillars on its eastern shore, which look like flower pots. A third flowerpot once stood, but tumbled in 1903. The Flowerpots are a type of sea stack, formed over many years as wind, rain, waves and ice hammered away at the cliff that once stood alongside the water's edge. The softer rock eroded more quickly, leaving the harder rock remaining in the shape of flowerpots with trees growing on top. Years ago there was some work to support the stacks and you can see some bricks and mortar but today the policy of the parks department is to let nature take its course so the pots will eventually fall though over time new ones will form.

Lampropeltis triangulum ssp. *triangulum* (Eastern Milksnake) and *Thamnophis sirtalis* (Eastern Garter Snake)
The large snake populations on the island have been attributed to isolation and resulting lack of predators.



Calypso bulbosa var. *americana*
(Fairy Slipper)

1) https://en.wikipedia.org/wiki/Great_Lakes_region
2) https://www.noaa.gov/education/resource-collections/freshwater/great-lakes-ecoregion
3) https://museum.mtu.edu/about-us/education-research/great-lakes-geology
4) https://museum.mtu.edu/sites/default/files/2019-11/AESMM_Web_Pub_1_Great_Lakes_Geology_0.pdf
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10) Go Orchids: https://goorchids.northamericanorchidcenter.org
11) Carney Fen, Michigan DNR: https://www.michigan.gov/dnr/
12) Native Orchid Conservation in Wisconsin and Michigan's Upper Peninsula https://www.orchidconservationcoalition.org/pr/friendsofcarneyfen.html
13) Bruce Peninsula: https://en.wikipedia.org/wiki/Bruce_Peninsula
14) Neottia ovata: https://en.wikipedia.org/wiki/Neottia_ovata

CANADIAN PRAIRIE OF MANITOBA

(July 2005 & 2017)

Maps showing the Province of Manitoba including a map of North America to show its relative location.[5] This article focuses on the area in the southeast of the province from the lower part of Lake Winnipeg to the U.S. border as outlined in red.

Manitoba is a province of Canada at the longitudinal center of the country. It is Canada's fifth-most populous province, with a population of 1,278,365. Manitoba covers 250,900 square miles (650,000 square kilometers) of widely varied landscape, from arctic tundra and the Hudson Bay coastline in the north to dense boreal forest, large freshwater lakes, and prairie grassland in the central and southern regions. Manitoba is bordered by the provinces of Ontario to the east and Saskatchewan to the west, the territories of Nunavut to the north, and Northwest Territories to the northwest, Hudson Bay to the northeast, and the U.S. states of North Dakota and Minnesota to the south. Manitoba's capital and largest city is Winnipeg with a population of 817,000, the seventh-most populous municipality in Canada.[1]

The geology of Manitoba starts with the oldest and most abundant rocks from the Precambrian era (rocks between 4.5 billion and 570 million years old). Precambrian rocks represent the initial formation of the earth's crust when lighter rock material was separating from denser mantle material deeper in the earth.

This upward separation of lighter rock material initially resulted in volcanic extrusions of basalt onto the sea floor as evidenced by some pillow lavas in various areas in Manitoba. The accumulation of basaltic material on the ocean floor resulted in the eventual rise above sea-level of volcanic islands. Subsequent subaerial (open air) erosion of these extrusive volcanic rocks resulted in the accumulation of greywackes (coarse grained sandstones derived from the erosion of the volcanic rocks) which were deposited on the flanks of the volcanoes.[3]

Manitoba's Paleozoic Era rocks (rocks between 570 and 245 million years old) were deposited as sediments (limestones, dolomites, shales, sandstones) on top of the Precambrian rocks between 570 and 235 million years ago. Paleozoic rocks overlie the Precambrian Shield in the Hudson Bay Lowlands and in southwestern Manitoba. These sedimentary rocks formed in topographically low areas of the crust known as sedimentary basins such as the Hudson Bay Basin in the northeast portion of the province and the Williston Basin in the southwest portion of the province.[3]

After the Paleozoic Era (about 235 million years ago) a major marine regression occurred that exposed the Paleozoic Era rocks to subaerial erosion. This resulted in the development of hills and valleys, sinkholes and caves in the limestone Paleozoic strata. Later during the Mesozoic Era (rocks between 245 and 65 million years old) a marine transgression episode deposited sandstones and shales over the Paleozoic strata. Marine vertebrate fossils of mosasaurs and plesiosaurs (marine reptiles) are found in the Mesozoic rocks of Manitoba. Occasional beds of volcanic ash (most likely from volcanic eruptions in Western North America) are found inter-bedded with the Mesozoic strata. Minor occurrences of Cenozoic Era rocks (rocks between 65 and 1.6 million years old) occur in the Turtle Mountain area of Manitoba. These sediments consist of sandy to silty shales.[3]

Broken Head Wetlands near Scanterbury [left] and
the Manitoba Tall Grass Prairie Preserve near Gardenton [right]

During the last 1.6 million years (the Pleistocene Epoch) almost all of Canada, including Manitoba had been subjected to repeated glacial advances and retreats. Glacial ice advances resulted in erosive scouring of the Precambrian, Paleozoic, Mesozoic and Cenozoic rocks. The eroded material picked-up by the ice was later deposited as till (a mixture of rock and mineral fragments scoured from rocks over which the glacial ice moved), outwash deposits (as water flowed from the melting glacier) and fine grained lake deposits (in pro-glacial lakes) as the glacial ice receded.[3]

Manitoba is part of what is called the Canadian prairie. This region in Western Canada includes the Canadian portion of the Great Plains and the Prairie Provinces, namely Alberta, Saskatchewan, and Manitoba. These provinces are partially covered by grasslands, plains, and lowlands, mostly in the southern regions. The northernmost reaches of the Canadian Prairies are less well known. They are marked by forests and more variable topography. Geographically, the Canadian prairies extend to northeastern British Columbia, but this province is not included in the political use of the term Canadian prairies. The Prairie starts from north of Edmonton and it covers the three provinces in a southward-slanting line east to the Manitoba-Minnesota border. The prairie is the most dominant land cover in Alberta and the least in Manitoba, since boreal forest covers a large area of Manitoba. Alberta has the most land classified as prairie, while Manitoba has the least, as the boreal forest begins more southerly in Manitoba than in Alberta. The southwestern Canadian prairies are semi-arid and highly prone to frequent and severe droughts. The eastern section of the Canadian prairies in Manitoba is well watered with several large lakes such as Lake Winnipeg and several large rivers. The area also gets reasonable amounts of precipitation.[2]

On average, 18 inches (454 mm) of precipitation falls on the prairies each year. Out of the three prairie provinces, Saskatchewan obtains the least amount of precipitation annually (15.5 inches/395 mm), with Manitoba receiving the most at 19.1 inches/ 486 mm. Most rainfall typically happens in the summer months such as June and July. With the high humidity of the prairies, tornadoes are likely to occur—marking central Saskatchewan and southern Manitoba high probability areas. Approximately 72% of tornadoes in Canada are seen across the prairies due to the capability of summer thunderstorm precipitation to mechanically mix with the air adjacent to the relatively flat surface of the region.[2]

Manitoba has an extreme continental climate. Temperatures and precipitation generally decrease from south to north and increase from east to west. Manitoba is far from the moderating influences of mountain ranges or large bodies of water. Because of the generally flat landscape, it is exposed to cold Arctic high-pressure air masses from the northwest during January and February. Temperatures can drop to −40 °F (−40 °C). In the summer, air masses sometimes come out of the Southern United States, as warm humid air is drawn northward from the Gulf of Mexico. Temperatures exceed 100 °F (38 °C) numerous times each summer. According to Environment Canada, Manitoba ranked first for clearest skies year round, and ranked second for clearest skies in the summer and for the sunniest province in the winter and spring.[1] Southern Manitoba

(including the city of Winnipeg), falls into the humid continental climate zone. This area is cold and windy in the winter and often has blizzards because of the open landscape. Summers are warm with a moderate length. This region is the most humid area in the prairie provinces, with moderate precipitation.

Three main grassland types occur in the Canadian prairies: Tallgrass prairie, mixed grass prairie, and Fescue prairie. Each has a unique geographic distribution and characteristic mix of plant species. All but a fraction of one percent of the Tallgrass prairie has been converted to cropland. What remains occurs on the 2,300 square miles (6,000 square kilometers) plain centered in the Red River Valley in south central Manitoba. Mixed prairie is more common and is part of the dry interior plains that extend from Canada south to the U.S. state of Texas.[2]

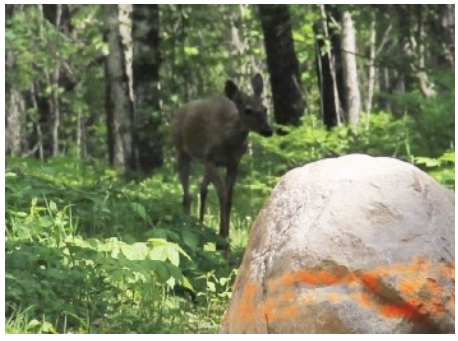
Manitoba natural communities may be grouped within five ecozones: boreal plains, prairie, taiga shield, boreal shield and Hudson plains. Three of these—taiga shield, boreal shield and Hudson plain—contain part of the Boreal forest of Canada which covers the province's eastern, southeastern, and northern reaches.[1]

Forests make up about 102,000 square miles (263,000 square kilometers), or 48 percent, of the province's land area. The forests consist of pines (Jack Pine, Red Pine, Eastern White Pine), spruces (White Spruce, Black Spruce), Balsam Fir, Tamarack (larch), poplars (Trembling Aspen, Balsam Poplar), birches (White Birch, Swamp Birch) and small pockets of Eastern White Cedar.[1]

Two sections of the province are not dominated by forest. The province's northeast corner bordering Hudson Bay is above the tree line and is considered tundra. The tallgrass prairie once dominated the south central and southeastern parts. Mixed grass prairie is found in the southwestern region.[1]

Animals found in Manitoba include Black Bear, Moose, White-tailed Deer, Elk, foxes, Lynx, Cougars, Coyotes, Wolves, Porcupines, and Beaver.[4] Manitoba is especially noted for its northern Polar Bear population.[1]





Chrysemys picta ssp. *belli* (Western Painted Turtle) [left], *Sylvilagus nuttallii* (Mountain Cottontail or Nuttall's Cottontail) [center] and *Odocoileus virginianus* (White-tailed Deer) [right]

Manitoba's bird diversity is enhanced by its position on two major migration routes, with 392 confirmed identified species; 287 of these nesting within the province. These include the Great Grey Owl, the province's official bird, and the endangered Peregrine Falcon. Manitoba's lakes host 18 species of game fish, particularly species of trout, Pike, and Goldeye, as well as many smaller fish.[1]

Lake Winnipeg is the eleventh largest freshwater lake on earth with a drainage area 40 times its surface, the greatest of any lake. It covers 9,465 square miles (24,514 square kilometers) and has an average depth of just 39 feet (12 meters). The lake's east side has pristine boreal forests and rivers while the west side has remote sandy beaches, large limestone cliffs and many bat caves in some areas. It is one of the largest reservoirs in the world. It suffers from many environmental issues such as an explosion in the population of algae, caused by excessive amounts of phosphorus seeping into the lake. The Global Nature Fund declared Lake Winnipeg as the "threatened lake of the year" in 2013.[6]

Mixed coniferous and hardwood forests in very sandy soil close to the lake.



Tragopogon pratensis (Yellow Goat's-beard) [left], *Lithospermum canescens* (Hoary Puccoon) [center] and a common tick from the forest [right]



Cypripedium acaule (Pink Lady's-slipper) [left], *Trientalis borealis* (Star flower) [top right] and *Clintonia borealis* (Corn-lily) with *Glaucopsyche lygdamus* (Silvery Blue Butterfly) [bottom right]

Blueberry Rock trail near Lac du Bonnet highlights a habitat along the edge of the Canadian Shield, an area of Precambrian igneous and metamorphic rock, the second oldest on earth.

Trillium cernuum (Nodding Trillium) [top left], *Corydalis sempervirens* (Pale Corydalis) [top right], *Aquilegia canadensis* (Wild Columbine) [bottom left] and *Cypripedium parviflorum* (Yellow Lady's-slipper) [bottom right]

The Brokenhead Wetlands are a topographically confined raised bog with some central ponds and marginal wet troughs (flarks) and a marginal fen. A fen is a kind of peatland characterized by a high water table with slow internal drainage by seepage down very gradual slopes. Brokenhead is a calcareous fen, which is distinguished primarily by a constant supply of groundwater high in calcium and magnesium carbonates and is rather rare in North America. This slow-moving groundwater is enriched by nutrients from upslope materials and thus fens are more mineral rich and less acidic than bogs. This land has been used for approximately 300 years by the Brokenhead Ojibway Nation and they continue to regard it as a place of spiritual and cultural importance and for collecting medicinal plants, berries, tea and cedar. Due to this significance, the provincial government, in cooperation with the Brokenhead Ojibway Nation declared the 3064 acre ecological reserve a protected area in 2005. With the additional involvement of Manitoba Model Forest and Native Orchid Conservation Inc., a plan was made to develop an interpretive trail. The province of Manitoba constructed the trail, floating boardwalk and other structures between 2013 and 2015 with the maintenance covered by an endowment set up by the Debwendon organization. The self-guiding nature trail is 0.85 miles (1.4 kilometers) long and passes through some rare White Cedar forest and over the fen on the floating walkways to prevent damage to the fragile environment. The wetlands are home to 28 of Manitoba's 37 native orchid species, eight species of carnivorous plants and 23 other rare plants.[7]

Brokenhead Wetland Ecological Reserve near Scanterbury near the southeast corner of Lake Winnipeg

Rhododendron groenlandicum (Labrador Tea) [left], *Polygala paucifolia* (Gaywings) [center] and *Linnea borealis* (Twinflower) [right]

Corallorhiza maculata
(Spotted Coralroot)
in spike

Corallorhiza striata
(Striped Coralroot)

Corallorhiza trifida
(Early Coralroot)

Arethusa bulbosa
(Dragon's Mouth)

Galearis rotundifolia
(Roundleaf Orchid)

Cypripedium reginae
(Showy Lady's-slipper)

Cypripedium parviflorum var. *makasin* (Small yellow Lady's-slipper) has smaller flowers than var. *pubescens*, dark maroon petals and a noticeable fragrance.

Coeloglossum viride
(Frog Orchid)

Platanthera orbiculata
(Round Leaved Orchid)

Cypripedium arietinum
(Ram's Head Lady's-slipper)

One of our two field trips took us on a drive south of Scanterbury for a couple of hours, skirting Winnipeg and then a bit east to near Woodridge where we then took a very dusty road through pine forest to a prime habitat for *Cypripedium acaule* (Pink Lady's-slipper).

Goodyera tesselata
(Checkered Rattlesnake Plantain)

Cypripedium arietinum
(Ram's Head Lady's-slipper)

Neottia cordata
(Heart Leaved Twayblade)

A very large specimen of *Coeloglossum viridis* (Frog Orchid) was found on the shoulder of the road in full sun.

We found several plants of *Galearis rotundifolia* (Roundleaf Orchid) in damp mossy ground in the shade of the forest. Nearby were plants of *Corallorhiza trifida* (Early Coralroot).

The Manitoba Tall Grass Prairie Preserve is one of the last remaining stands of Tallgrass prairie in Manitoba. The area is characterized by a mosaic of habitat types, including tallgrass prairie, aspen woodland, sedge meadow wetlands, riparian woodland, and oak savannah. Over 1,000 species depend on this diverse habitat and 16 species that are on provincial or national endangered species list reside within the area.

The ecological significance of the area that is now the preserve was only discovered in the late 1980s by botanists of the Manitoba Naturalist Society who were cataloging native plant species in the area. They discovered that a significant portion of the tallgrass prairie remained despite the belief it had been wiped out. There are just over 5,000 acres (20 square kilometers) that are protected in the preserve.[8]

The Tall Grass Prairie Preserve consists primarily of *Andropogon gerardi* (Big Bluestem or Turkey Foot, resembles the bird's foot), *Schizachyrium scoparium* (Little Bluestem), *Stipa spartea* (Porcupine Needlegrass), and *Sporobolus heterolepis* (Prairie Dropseed) grasses. One of the last known Canadian remnant population of the endangered Western Prairie Fringed Orchid (*Platanthera praeclara*) is within the preserve. It is the world's largest *Platanthera praeclara* population, containing over half the known population of the orchid.[8] Unfortunately it wasn't in bloom yet when we visited.



Sisyrinchium campestre (Prairie Blue-eyed Grass) [left], *Pedicularis lanceolata* (Swamp Lousewort) [center] and *Hypoxis hirsuta* (Yellow Stargrass) [right]


An incredible sight of a field of orange and yellow *Castelleja species* (Indian Paintbrush) had us stop for photographs and we found plenty of orchids just by the edge of the woods.

Platanthera hookeri (Hooker's Orchid) and *Cornus canadensis* (Bunchberry) [right] growing near each other.

Cypripedium arietinum (Ram's Head Lady's-slipper)
was growing in the grass, sometimes barely reaching 4 inches high.




Cypripedium candidum (Small White Lady's-slipper) and *Cypripedium parviflorum* [bottom right]
The Small White Lady's-slipper was the prime focus of our visit to the prairie and it didn't disappoint. The bright sun did make photography a little challenging. The flower pictured top right points to one of the reasons that this plant is rare: low pollination success. The small flower structure traps larger pollinators who can't escape so eat their way out of the flower without moving the pollinia. Invasive species also compete for the habitat adding to its decline.

The natural hybrid between *Cypripedium candidum* and *Cypripedium parviflorum* is called *Cypripedium* x *andrewsii.* We found a nice patch with many color forms in an otherwise unremarkable drainage ditch.

Pelecanus erythrorhynchos (American White Pelican) at sunset on Lake Winnipeg.

1) https://en.wikipedia.org/wiki/Manitoba
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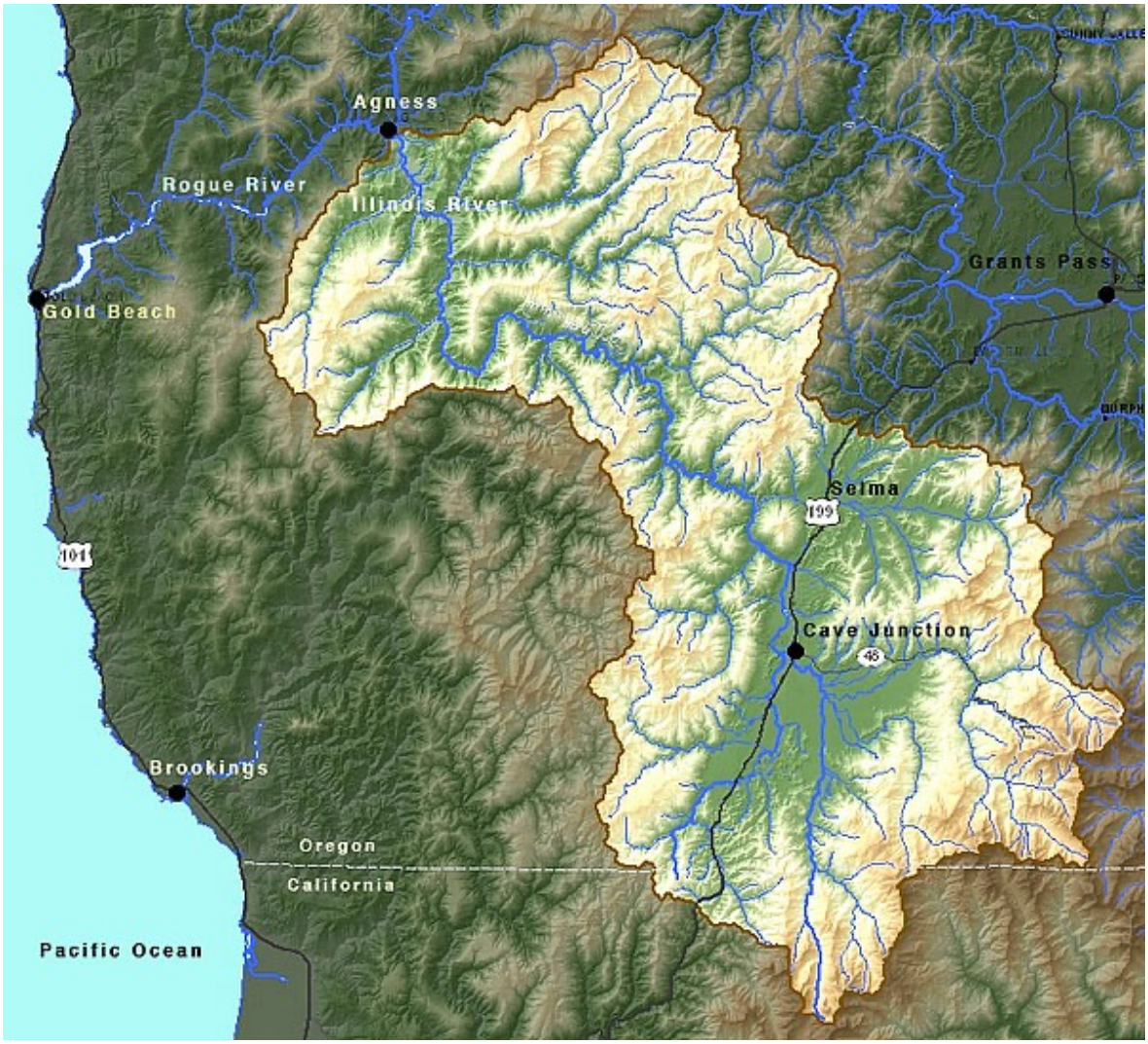
OREGON'S ILLINOIS RIVER VALLEY WILDERNESS

(June 2006)

The Illinois River is a tributary, about 56 miles (90 km) long, of the Rogue River in the U.S. state of Oregon. It drains part of the Klamath Mountains in northern California and southwestern Oregon. The river's main course begins at the confluence of its east and west forks near Cave Junction in southern Josephine County, Oregon. The main stem flows generally northwest in a winding course past Kerby and through the Siskiyou National Forest and Kalmiopsis Wilderness. It joins the Rogue River from the south at Agness on the Curry–Josephine county line and then stretches 27 miles (43 km) west where it empties into the Pacific Ocean at Gold Beach. The Illinois River got its name from three brothers who came from the Midwest to mine for gold along the river and nearby creeks. Most of the length of the river was designated as Wild and Scenic in 1984 and runs a treacherous course with nine class IV or higher rapids. Much of the river is far from roads and trails giving it the reputation as the most inaccessible river canyon in the lower 48 states. The Illinois River Basin is one of two rivers in the state of Oregon with strictly wild populations of Coho and Chinook salmon and Steelhead and Cutthroat Trout.[1] The highly forested river valley provides an outstanding convergence of geology, climate and antiquity to create incredible botanical and biological diversity. The area around the valley is home to the most varieties of rare and endemic plants in Oregon, some found nowhere else in the world. It is the northern limit of what is known as the California Floristic Province, a Mediterranean-type climate on the Pacific Coast with distinct flora that tolerates cool wet

winters and hot summer droughts similar to plants along the Mediterranean Sea. This large zone is home to over 3,000 species of plants of which 60% are endemic making it a biodiversity hotspot. The majority of the province is in California where it covers much of the state, with the Klamath Mountains bringing it into Oregon. Such a hotspot contains irreplaceable areas necessary for the existence of the specialized taxa but farming and urban spread are a major threat to its survival. Wildfires, strip mining, air pollution, soil contamination, global warming and off-trail vehicles all threaten the province.[4]



Illinois River Valley area

The Klamath Mountains have an extremely complex geology, with many different formations ranging in age from late Proterozoic (about 640 million years ago) through Oligocene (about 30 million years ago) as well as countless faults and other structures. The valley reflects the complexity of the mountains' geology with a variety of rock types that are primarily igneous, not volcanic, and formed very deep within the earth's surface. As the magma was uplifted it brought minerals and precious metals such as gold, silver,

lead and molybdenum to the surface. Other portions of the area began as sedimentary deposits from the oceans. They are a type of sandstone not made of quartz but rather of small stones. In addition there are areas of microcrystalline quartz or chert. Significant to this area are the layers of rock that crystalized as peridotite and then metamorphosed into serpentinite which is high in magnesium. Soils formed on these layers are poor in nutrients such as calcium and nitrogen and high in toxic heavy metals such as nickel and chromium.[2] Most plants cannot survive on serpentine soils, so vegetation is not abundant except for some specialists like *Darlingtonia californica* (California Pitcher Plant).

Magnesium rich rocks contribute to the harsh soils that limit plant life in the valley.

A tributary feeding into the Illinois River

The area supports a large variety of wildlife including *Odocoileus hemionus columbianus* (Black-tailed Mule Deer), *Cervus canadensis* (Elk), *Ursus americanus* (American Black Bear), *Puma concolor* (Cougar), *Lynx rufus* (Bobcat), *Lutra canadensis* (River Otter), *Mustela frenata* (Weasel), *Canis latrans* (Coyote), *Spilogale gracilis* and *Mephitis mephitis* (Skunk), *Vulpes vulpes* (Red Fox) and *Urocyon cinereoargenteu*s (Gray Fox) and *Taxidea taxus* ssp. *jeffersonii* (Northwestern American Badger). Numerous types of bats and rodents make this their home. More than 200 species of birds have been seen here including *Haliaeetus leucocephalus* (Bald) and *Aquila chrysaetos* (Golden) eagles, hawks, falcons, owls, ducks, woodpeckers, turkeys and song birds. Threatened species found here include *Martes pennanti* (the Pacific Fisher), *Strix occidentalis caurina* (Northern Spotted Owl) and *Plethodon elongatus* (the Del Norte) and *Plethodon stormi* (Siskiyou) salamanders.[5]

Sceloporus occidentalis
(Western Fence Lizard)

Odocoileus hemionus ssp. *columbianus*
(Black-tailed Deer)

The Illinois River Valley has a huge diversity of vegetation in part because three ecoregions meet in the Klamath Mountains: one which extends north to coastal Alaska, a second which stretches south to Baja California, and a third linked to the Cascades Range to the East. Also, variation in elevation, aspect [the direction that a slope faces], and lithology [the type of rock] add to the plant diversity. Over 1,400 different plant species have been counted in the Siskiyou National Forest, many occurring along the river. Tree species that dominate the area include *Pseudotsuga menziesii* (Douglas fir), *Pinus jeffreyi* (Jeffrey Pine), and *Arbutus menziesii* (Madrone), *Quercus chrysolepis* (Canyon Live Oak), *Pinus ponderosa* (Ponderosa pine) and *Calocedrus decurrens* (Incense Cedar) as well as endemics such as *Picea breweriana* (Brewer's Spruce) and *Quercus sadleriana* (Sadler Oak). There have been 28 species of conifers and over 200 species of woody plants documented here. At least 15 species of orchids are known from the area.

One of the most unique and significant floral sites in the valley is the Eight Dollar Mountain Botanical area which covers 2,867 acres. Likely named in the 1850s for a huge gold nugget worth eight dollars, the conical mountain is covered with peridotite and is 4,000 feet high. The elevation of the visitor areas and boardwalks around the fens is about 1,300 feet. It is listed in Oregon's Register of Natural Heritage Resources. The west half of the mountain is designated as a protected botanical area by the United States Forest Service. *Darlingtonia californica*, (California Pitcher Plant), a type of carnivorous plant, thrives in the serpentine fens in the reserve.

Fen with *Darlingtonia californica*
(California Pitcher Plant)

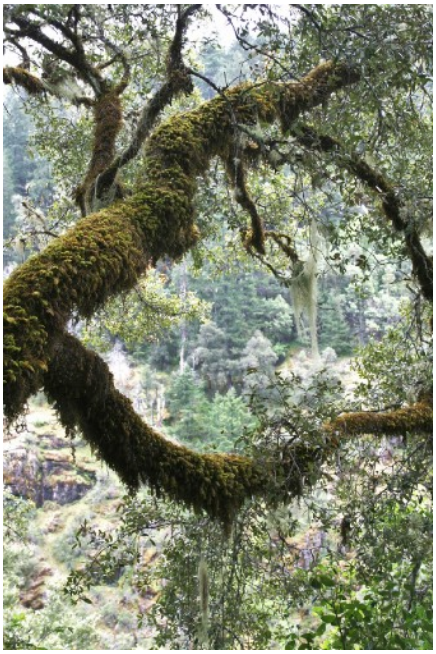
Calochortus elegans (Elegant Cat's Ear)

Wildflowers along Eight Dollar Mountain road include *Collinsia rattanii* (Sticky Blue-eyed Mary), *Mimulus guttatus* (Common Western Monkeyflower) and *Alium siskiyouense* (Siskiyou Onion)

Iris bracteata (Siskiyou Iris) [left], *Cirsium occidentale* (Snowy Thistle) [center] and S*edum oreganum* (Oregon Stonecrop) [right]

Boschniakia strobilacea (California Ground-cone) [left] and *Dicentra formosa* ssp. *oregona* (Oregon Bleeding Heart) [right]

Rhododendron occidentale (Western Azalea) and *Cornus nuttallii* (Pacific Dogwood)



Mosses, lichens and ferns occupy a niche on forest trees

The beautiful red peeling bark and tan trunk of *Arbutus menziesii* (Pacific Madrone)

A mountain stream

Trillium albidum (Giant White Wakerobin) and Ribes *lobbii* (Fuchsia-flowered Gooseberry)

Also found here are (*Platanthera sparsiflora* (Sparse-flowered Rein Orchid) and *Cypripedium californicum* (California Lady's-slipper). The Nature Conservancy maintains a 45-acre preserve on the east side of the mountain. The entire mountain ecosystem is managed cooperatively to protect this unique area. Hiking trails are very limited in the areas but roadside botanizing can be quite productive.[3,6]

Illinois River near Selma, Oregon. Good habitat for *Epipactis gigantea.*

Epipactis gigantea
(Stream Orchid)

Calypso bulbosa var. *occidentalis* (Fairy Slipper)

Goodyera oblongifolia (Giant Rattlesnake Plantain)

Cephalanthera austiniae (Phantom Orchid)

Corallorhiza maculata (Spotted Coralroot)

Platanthera sparsiflora
(Few-flowered Bog Orchid)

Platanthera unalascensis
(Short-spurred Rein Orchid)

Platanthera elegans
(Elegant Rein Orchid)

Platanthera stricta
(Slender Bog Orchid)

Cypripedium californicum
(California Lady's-slipper)

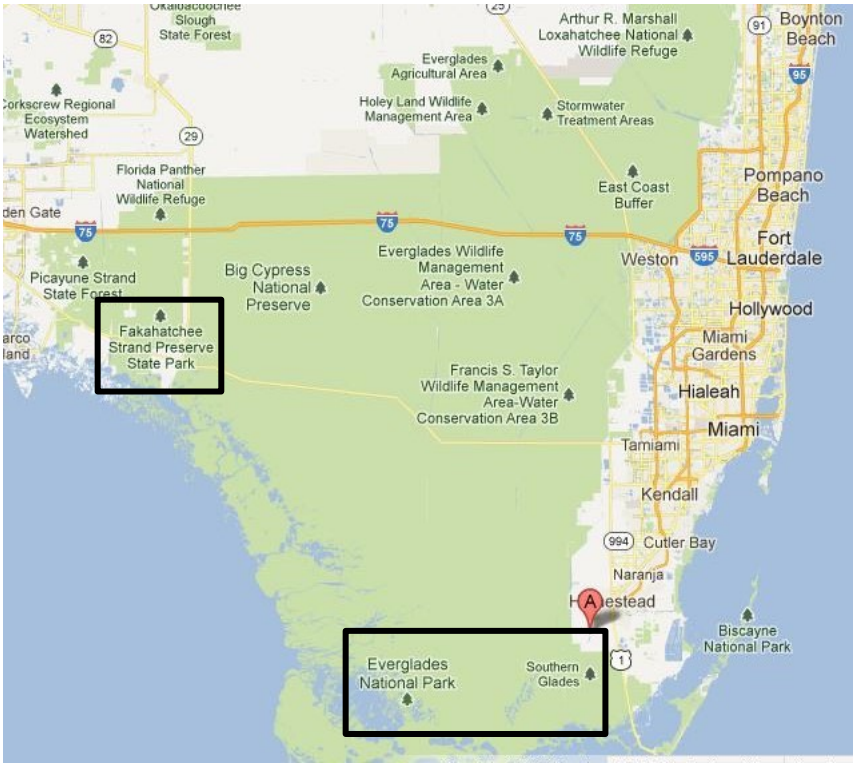
Cypripedium fasciculatum
(Clustered Lady's-slipper)

Cypripedium montanum
(Mountain Lady's-slipper)

Annual rainfall ranges from about 44" near Cave Junction and Eight Dollar Mountain to over 100" in the northwest basin. December is the wettest month while July gets close to no rain on average. Snowfall is only about 7 inches per year though much more falls in the higher elevations. It is sunny about 194 days of the year with summer highs around 90 °F. and winter lows close to 32 °F, making it relatively mild. The Illinois River base is at about 100 feet above sea level. Grayback Mountain, the highest peak in Josephine County, has an elevation of 7,048 feet. Attractions in the area include Oregon Caves National Monument, vineyards and wineries, museums such as the Smoke Jumper Base museum and the Siskiyou Field Institute which provides field-based nature study.

1) Illinois River; https://en.wikipedia.org/wiki/Illinois_River_(Oregon)
2) Illinois River geology: https://www.nwrafting.com/illinois-river/geology-along-the-illinois-river-kalmiopsis-wilderness
3) Eight Dollar Mountain, USFS; https://www.fs.fed.us/wildflowers/regions/Pacific_Northwest/EightDollar/index.shtml
4) California floristic province: https://en.wikipedia.org/wiki/California_Floristic_Province
5) Sisyiyou Wilderness: https://en.wikipedia.org/wiki/Siskiyou_Wilderness
6) Oregon Encyclopedia: https://www.oregonencyclopedia.org/articles/eight_dollar_mountain/#.YEVzOZuIaUk

THE FLORIDA EVERGLADES
(April 2007)



Cypress (*Taxodium distichum*) swamp with bromeliads [above].

Map of southern Florida [left] showing the extent of the Everglades. The two highlighted areas are featured in this article.

The Everglades is a unique natural region of tropical fresh water wetlands in the southern portion of Florida. It originally covered about 7,800 square miles, nearly 12% of the state, but now is thought to be about 3,100 square miles or 2 million acres in size. About ¾ of that is within the Everglades National Park. The system begins near Orlando in the center of the state with the Kissimmee River, a broad floodplain, which discharges into the vast but shallow Lake Okeechobee. The lake covers 730 square miles and has an average depth of 9 feet (2.8 meters). Water leaving the lake in the wet season forms a slow-moving river 60 miles (97 km) wide and over 100 miles (160 km) long, flowing southward across a limestone shelf to Florida Bay at the southern end of the state.[1] The "sheet flow" of water across the land makes this area unique in contrast to other wetlands that typically rely on waters originating from rivers and streams. The change in elevation is only 2 inches (5.1 cm) per mile so the flow is under 2 feet (0.6 meters) per minute or ½ mile per day.[5] The sheet flow travels so slowly that water is typically stored from one wet season to the next in the porous limestone substrate. The ebb and flow of water has shaped the land and every ecosystem in South Florida throughout the Everglades' estimated 5,000 years of existence.[1] Below the thin layer of soil and vegetation that we can see lies one of the most active substrates of carbonate sedimentation in the world. Primarily consisting of limestone, the bedrock geology of the Everglades has responded over time to the ongoing processes of weathering, erosion, compaction of organic sediments, unique hydrologic conditions, and episodes of sea-level rise and fall to produce the landscapes we see today.[6]

The climate of South Florida is located across the broad transition zone between subtropical and tropical climates. Like most regions with this climate type, there are two basic seasons – a "dry season" (winter) which runs from November through April, and a "wet season" (summer) which runs from May through October. About 70% of the annual rainfall in south Florida occurs in the wet season – often as brief but intense tropical downpours. The dry season sees little rainfall and dew points and humidity are often quite low. The dry season can be severe at times, as wildfires and water restrictions are often in place.

The annual range of temperatures in south Florida and the Everglades is rather small (less than 20 °F [11 °C]) – ranging from a monthly mean temperature of around 65 °F (18 °C) in January to 83 °F (28 °C) in July. High temperatures in the hot and wet season (summer) typically exceed 90 °F (32 °C) across inland south Florida (although coastal locations are cooled by winds from the Gulf of Mexico and the Atlantic Ocean), while high temperatures in the dry winter season average from 70 to 79 °F (21 to 26 °C). Frost and freeze is rare across south Florida and the Everglades; annually coastal cities like Miami and Naples report zero days with frost, although a few times each decade low temperatures may fall between 30 and 40 °F (−1 and 4 °C) across South Florida. The plant hardiness zones are 10a north with an average annual extreme minimum air temperature of 30 to 35 °F (−1 to +2 °C), and 10b south with an average annual extreme minimum air temperature of 35 to 40 °F (2 to 4 °C). Annual rainfall averages approximately 62 inches (160 cm), with the Eastern Coastal Ridge receiving the majority of precipitation and the area surrounding Lake Okeechobee receiving about 48 inches (120 cm). Unlike any other wetland system on

earth, the Everglades are sustained primarily by the atmosphere. Evapotranspiration – the sum of evaporation and plant transpiration from the Earth's land surface to atmosphere – associated with thunderstorms, is the key mechanism by which water leaves the region. During a year unaffected by drought, the rate may reach 40 inches (100 cm) a year. When droughts take place, the rate may peak at over 50 inches (130 cm), and exceed the amount of rainfall. As water leaves an area through evaporation from groundwater or from plant matter, activated primarily by solar energy, it is then moved by wind patterns to other areas that border or flow into the Everglades watershed system. Evapotranspiration is responsible for approximately 70–90 percent of water entering undeveloped wetland regions in the Everglades.[1]

Fire is an important element in the natural maintenance of the Everglades. The majority of fires are caused by lightning strikes from thunderstorms during the wet season. Their effects are largely superficial, and serve to foster specific plant growth: Sawgrass will burn above water, but the roots are preserved underneath. Fire in the Sawgrass marshes serves to keep out larger bushes and trees, and releases nutrients from decaying plant matter more efficiently than decomposition. Whereas in the wet season, dead plant matter and the tips of grasses and trees are burned, in the dry season the fire may be fed by organic peat and burn deeply, destroying root systems. Fires are confined by existing water and rainfall. It takes approximately 225 years for one foot of peat to develop.[1]

Cladium jamaicense, known as Sawgrass for the sharp teeth along the blades, is a type of sedge that grows through much of the Everglades. It can reach heights of 9 feet. Much of it has been cleared for growing sugar cane over the years.

Several ecosystems are present in the Everglades, and boundaries between them are subtle or absent. The primary feature of the Everglades is the Sawgrass marsh. The iconic water and Sawgrass combination in the shallow river 100 miles (160 km) long and 60 miles (97 km) wide that spans from Lake Okeechobee to Florida Bay is often referred to as the "true Everglades" or just "the Glades." Sawgrass thrives in the slowly moving water, but may die in unusually deep floods if oxygen is unable to reach its roots. It is particularly vulnerable immediately after a fire. Sloughs, or free-flowing channels of water, develop in between Sawgrass prairies. Sloughs are about 3 feet (0.91 m) deeper than Sawgrass marshes, and may stay flooded for at least 11 months out of the year and sometimes multiple years in a row. Aquatic animals such as turtles, alligators, snakes, and fish thrive in sloughs; they usually feed on aquatic invertebrates. Submerged and floating plants grow here, such as *Utricularia* (Bladderwort), Nymphaeaceae (Waterlily), and *Nuphar lutea* (Spatterdock). Wet prairies, called marl prairies, are slightly elevated like Sawgrass marshes, but with greater plant diversity. The surface is covered in water only three to seven months of the year, and the water is, on average, shallow at only 4 inches (10 cm) deep. When flooded, the marl prairies can support a variety of water plants.[1]

A young hardwood hammock with various species of trees.

Small islands of trees growing on land raised between 1 foot (0.30 m) and 3 feet (0.91 m) above sloughs and prairies are called tropical hardwood hammocks. They may range from one (4,000 m2) to ten acres (40,000 m2) in area, and appear in freshwater sloughs, Sawgrass prairies, or pineland. Hammocks are slightly elevated on limestone plateaus risen several inches above the surrounding peat, or they may grow

on land that has been unharmed by deep peat fires. Hardwood hammocks exhibit a mixture of subtropical and hardwood trees, such as *Quercus virginiana* (Southern Live Oak), *Bursera simaruba* (Gumbo Limbo), *Roystonea* (Royal Palm), and *Dipholis salicifolia* (Bustic), that grow in very dense clumps. Near the base, sharp *Serenoa repens* (Saw Palmetto) flourish, making the hammocks very difficult for people to penetrate, though small mammals, reptiles and amphibians find these islands an ideal habitat. Water in sloughs flows around the islands, creating moats. Although some ecosystems are maintained and promoted by fire, hammocks may take decades or centuries to recover. The moats around the hammocks protect the trees. The trees are limited in height by weather factors such as frost, lightning, and wind; the majority of trees in hammocks grow no higher than 55 feet (16.9 meters).[1]

Typical pine and palmetto forest, some of the driest parts of the Everglades.

Some of the driest land in the Everglades is the pineland (also called pine rockland) ecosystem, located in the highest part of the Everglades with little to no hydroperiod. Some floors, however, may have flooded solution holes or puddles for a few months at a time. The most significant feature of the pineland is the single species of *Pinus elliottii* (South Florida Slash Pine). Pineland communities require fire to maintain them, and the trees have several adaptations that simultaneously promote and resist fire. The sandy floor of the pine forest is covered with dry pine needles that are highly flammable. South Florida Slash Pines are insulated by their bark to protect them from heat. Fire eliminates competing vegetation on the forest floor and opens pine cones to germinate seeds. A period without significant fire can turn pineland into a

hardwood hammock as larger trees overtake the slash pines. The understory shrubs in pine rocklands are the fire-resistant *Serenoa repens* (Saw Palmetto), *Sabal palmetto* (Cabbage Palm), and *Tetrazygia bicolor* (West Indian Lilac). The most diverse group of plants in the pine community are the herbs, of which there are two dozen species. These plants contain tubers and other mechanisms that allow them to sprout quickly after being charred.[1]

Taxodium distichum (Bald Cypress) are adapted to grow in flooded areas.

Cypress swamps can be found throughout the Everglades but the main concentration is called the Big Cypress swamp which covers 1,200 square miles (3,108 square kilometers). Cypresses are deciduous conifers that are uniquely adapted to thrive in flooded conditions, with buttressed trunks and root projections called “knees” that protrude out of the water. Bald cypress trees grow in formations with the tallest and thickest trunks in the center, rooted in the deepest peat. As the peat thins out, cypresses grow smaller and thinner, giving the small forest the appearance of a dome from the outside. They also grow in strands, slightly elevated on a ridge of limestone bordered on either side by sloughs. Other hardwood trees can be found in cypress domes, such as *Acer rubrum* (Red Maple), Persea *palustris* (Swamp Bay), and *Fraxinus caroliniana* (Pop Ash). If cypresses are removed, the hardwoods take over, and the ecosystem is re-categorized as a mixed swamp forest. Most of the Big Cypress sits atop a bedrock covered by a thinner layer of limestone. The limestone underneath the Big Cypress contains quartz, which creates sandy soil that

hosts a variety of vegetation different from what is found in other areas of the Everglades. The basin for the Big Cypress receives on average 55 inches (140 cm) of water in the wet season.

Where the Everglades meets the ocean is brackish water of mangroves and coastal prairie, primarily of Saw grass. There are three species of trees that are considered mangroves: *Rhizophora mangle* (Red), *Avicennia germinans* (Black), and *Laguncularia racemosa* (White), although all are from different families. All grow in oxygen-poor soil, can survive drastic water level changes, and are tolerant of salt, brackish, and fresh water. All three mangrove species are integral to coastline protection during severe storms. All three types of trees absorb the energy of waves and storm surges. Everglades' mangroves also serve as nurseries for crustaceans and fish, and rookeries for birds.[1]

Platalea ajaja (Roseate Spoonbill) [left], *Porphyrio martinicus* (Purple Gallinule) [center] and *Mycteria americana* (Wood Stork) [right]

Anhinga anhinga (Anhinga) [left], *Ardea alba* (Great Egret) [center] and *Ardea herodias* (Great Blue Heron) [right]

Everglades National Park protects the southern twenty percent of the original Everglades in Florida. The park, at 2,350 square miles, is the largest tropical wilderness in the United States, and the largest wilderness of any kind east of the Mississippi River. A state park, founded in 1916, was the first area dedicated to preserving the area. The area was proposed as a national park soon after but the official dedication was not until 1947. An average of one million people visit the park each year. Everglades is the third-largest national park in the contiguous United States after Death Valley and Yellowstone. UNESCO declared the

Everglades & Dry Tortugas Biosphere Reserve in 1976, and listed the park as a World Heritage Site in 1979, while the Ramsar Convention included the park on its list of Wetlands of International Importance in 1987. Everglades is one of only three locations in the world to appear on all three lists.[1]

Most national parks preserve unique geographic features; Everglades National Park was the first created to protect a fragile ecosystem. The park is the most significant breeding ground for tropical wading birds in North America and contains the largest mangrove ecosystem in the Western Hemisphere. Thirty-six threatened or protected species inhabit the park, including *Puma concolor coryi* (Florida Panther), *Crocodylus acutus* (American Crocodile), and *Trichechus manatus* (West Indian Manatee), along with 350 species of birds, 300 species of fresh and saltwater fish, 40 species of mammals, and 50 species of reptiles. The majority of South Florida's fresh water, which is stored in the Biscayne Aquifer, is recharged in the park. Thirty-six federally protected animals live in the park, some of which face grave threats to their survival.[1]

Alligator mississippiensis, the American Alligator, sometimes referred to colloquially as a Gator or Common Alligator, is a large crocodilian reptile native to the Southeastern United States, with a small population in Mexico. Adult male American alligators measure 11.2 to 15.1 ft. (3.4 to 4.6 m) in length, and can weigh up to 999 lb. (453 kg). Females are smaller, measuring 8.5 to 9.8 ft. (2.6-3 m.) in length. American Alligators are apex predators and consume fish, amphibians, reptiles, birds, and mammals. Hatchlings feed mostly on invertebrates. They play an important role as ecosystem engineers in wetland ecosystems through the creation of alligator holes, which provide both wet and dry habitats for other organisms. Historically, hunting had decimated their population, and the American Alligator was listed as an endangered species by the Endangered Species Act of 1973. Subsequent conservation efforts have allowed their numbers to increase and the species was removed from endangered status in 1987. The species is the official state reptile of three states: Florida, Louisiana, and Mississippi.[1]

Less than 50 percent of the Everglades which existed prior to drainage attempts in the late 1800's and early 1900's remains intact today. Populations of wading birds dwindled 90 percent from their original numbers between the 1940's and 2000's. The diversion of water to South Florida's still-growing metropolitan areas is the Everglades number one threat. In the 1950's and 1960's, 1,400 miles (2,300 km) of canals and levees, 150 gates and spillways, and 16 pumping stations were constructed to direct water toward cities and away from the Everglades. Low levels of water leave fish vulnerable to reptiles and birds, and as Sawgrass dries it can burn or die off, which in turn kills apple snails and other animals that wading birds feed upon. There have been some attempts at protection and restoration including the Everglades National Park Protection and Expansion Act of 1989 and the Comprehensive Everglades Restoration Plan in 2000 but both have had limited positive effects.[1]

The Everglades continue to be threatened by human encroachment including increased farming, housing, commerce and pollution. Climate warming with drought and rising sea levels is a big concern. Approximately 26 percent of all fish, reptiles, birds, and mammal species in South Florida are exotic—more than in any other part of the U.S.—and the region hosts one of the highest numbers of exotic plant species in the world. Many of these exotic species bring in diseases that are harmful to native flora and fauna. With no natural predators or controls, many of these become invasive and compete with native species. Examples include *Python bivittatus* (Burmese Pythons), *Python sebae* (African Rock Pythons), Eunectes notaeus (Yellow Anacondas), *Osteopilus septentrionalis* (Cuban Tree Frogs) and *Clarias batrachus* (Walking Catfish). Introduced invasive and damaging plants include *Melaleuca quinquenervia*, (the Melaleuca tree), *Schinus terebinthifolius* (Brazillian Pepper) and *Lygodium microphyllum* (Old World Climbing Fern). The US spends $500 million annually on control of invasive species yet most areas remain infested.[1] If you have never been to the Everglades maybe you should go before it has to go on life support.

Cyrtopodium punctatum
(Cigar Orchid)
Photo on right by Hal Horwitz

Trichocentrum undulatum
(Spotted Mule Eared Orchid)

Encyclia tampensis
(Florida Butterfly Orchid)
Photo by Hal Horwitz

Calopogon tuberosus
(Tuberous Grass Pink)

Prosthechea boothiana
(Florida Dollar Orchid)

Oeceoclades maculata
(African Spotted Orchid)

Vanilla barbellata
(Worm Vine)

Prosthechea cochleata
(Clamshell Orchid)

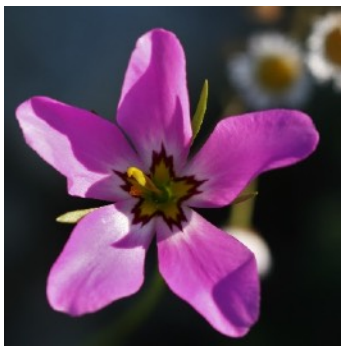
Various hardwood species grow in the wet Fakahatchee Strand

Fakahatchee Strand State Preserve is located in the Fakahatchee Strand, a linear thread, or strand, of forested swamp in Big Cypress, a section of the Florida Everglades off SR 29. The Big Cypress Swamp of southwest Florida is basically a flat, gently sloping limestone plain. The Fakahatchee Strand is the major drainage slough of southwestern Big Cypress Swamp and the largest and most unusual of the strands. Although logging, drainage and other human actions have had a serious impact on the swamp, it is still one of the state's most unusual natural features.[3] The preserve is the largest state park in Florida and is home to a variety of plant and animal species that can be found nowhere else in the continental United States.[2] The Fakahatchee Strand is approximately 20 miles (32 km) long and three to five miles (4.8-8 km) wide. The flow of water through it is essential to its continued health and that of the estuaries to the south of it.[3] The natural values of the strand may be greater than those of any area of comparable size in the state of Florida. It contains the largest stand of native royal palms and largest concentration and variety of orchids in North America, as well as other species of plants that are extremely rare. It is the home of the rare *Dendrophylax lindenii* (Ghost Orchid). The unusual wildlife of the Fakahatchee Strand includes some threatened or endangered species. *Puma concolor coryi* (the Florida Panther), *Mycteria americana* (Wood Stork), *Ursus americanus floridanus* (Florida Black Bear), *Sciurus niger avicennia* (Mangrove Fox Squirrel) and *Neovison vison evergladensis* (the Everglades Mink) have all been documented within the preserve area.[3]

The park also is home to *Odocoileus virginianus clavium* (White-tailed Deer), *Procyon lotor* (Raccoon), *Didelphis virginiana* (Opossum), *Buteo lineatus* (Red-shouldered Hawk), *Meleagris gallopavo* (Wild Turkey), owl, vulture, *Alligator mississippiensis* (Alligator), duck, *Antigone canadensis* (Sandhill Crane), *Platalea ajaja* (Roseate Spoonbill), *Haliaeetus leucocephalus* (Bald Eagle), and *Pandion haliaetus* (Osprey).[1]

Tropical vegetation in the woodlands include ferns and *Tillandsia* sp. (Bromeliads) [right]

An adult *Romalea microptera* (Eastern Lubber Grasshopper) [left]
is harmless to humans, and in fact it's only rarely a pest of concern to plants and
Agkistrodon conanti (Florida Cottonmouth) [right]


Cephalanthus occidentalis (Button Bush) [left], *Sabatia stellaris* (Sea Pink) [center] and *Rhynchospora latifolia* (White Top Sedge) [right]

Lontra canadensis (North American River Otter or Common Otter) is a semiaquatic mammal endemic to the North American continent found in and along its waterways and coasts. An adult North American river otter can weigh between 11.0 and 30.9 lbs. (5.0 and 14 kg.). The river otter is protected and insulated by a thick, water-repellent coat of fur. A member of the weasel family, these otters are equally versatile in the water and on land. It establishes a burrow close to the water's edge in river, lake, swamp, coastal shoreline, tidal flat, or estuary ecosystems. Fish is a favored food among the otters, but they also consume various amphibians and mollusks and crustaceans. The range of the North American river otter has been significantly reduced by habitat loss, beginning with the European colonization of North America. Common otters are very susceptible to the effects of environmental pollution, which is a likely factor in the continued decline of their numbers.[7]

Ionopsis utricularioides
Delicate Ionopsis

Vanilla phaeantha
Leafy Vanilla

Dendrophylax lindenii
Ghost Orchid
Photo on right by Hal Horwitz

Epidendrum amphistomum
Dingy Flowered Star Orchid

Oncidium ensatum
Dancing Lady
Photo by David McAdoo

Malaxis spicata
Florida Adder's Mouth
Photo by David McAdoo

Eltroplectris calcarata
Spurred Neottia
Photo by David McAdoo

Cyclopogon cranichoides
Speckled Ladies'-tresses
Photo by David McAdoo

Bletia purpurea
Pine Pink
Photo by David McAdoo

Sacoila lanceolata
Leafless Beaked Orchid
Photo by Hal Horwitz

Eulophia alta
Wild Coco
Photo by Hal Horwitz

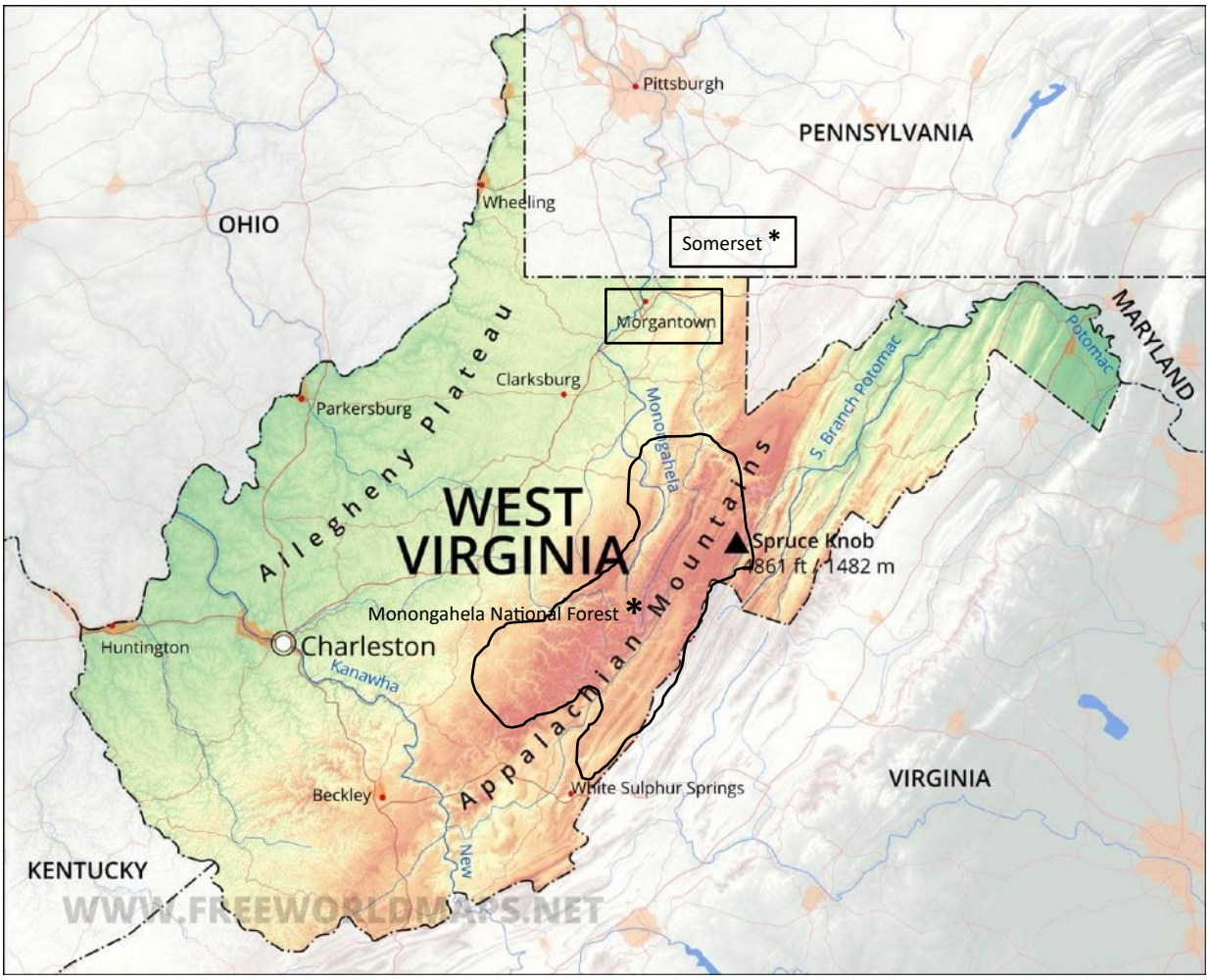
1) https://en.wikipedia.org/wiki/Everglades; https://en.wikipedia.org/wiki/Everglades_National_Park
2) Florida state parks https://www.floridastateparks.org/parks-and-trails/fakahatchee-strand-preserve-state-park
3) Absolute Florida http://www.abfla.com/parks/FakahatcheeStrand/fakahatchee.html
4) National Park Service https://www.nps.gov/ever/index.htm
5) Florida museums https://www.floridamuseum.ufl.edu/southflorida/regions/everglades/
6) Geology of the Everglades https://www.arcgis.com/apps/MapJournal/index.html?
7) River Otter: https://en.wikipedia.org/wiki/North_American_river_otter

THE ALLEGHENY MOUNTAINS

(July 2008)

A valley in the Allegheny Mountains, part of the Appalachian Mountain range

Maps showing the general area of the Appalachian and Allegheny Mountains[1]



Morgantown and Monongahela National Forest highlighted on map of West Virginia.[2]
The area highlighted in southwest Pennsylvania is also discussed in this article

The Allegheny Mountain Range is part of the vast Appalachian Mountain Range of the Eastern United States and Canada. The Appalachian Mountains span across five geologic provinces (as defined by the USGS) with the Alleghenies being in the Appalachian Basin. The others are the Blue Ridge Mountains, the Piedmont Province, the Adirondack Province, and the New England Province. This 1,075 mile (1730 km) long and 310 mile (499 km) wide basin contains Paleozoic sedimentary rocks of Early Cambrian through Early Permian age. It crosses from the top of New York into Pennsylvania, eastern Ohio, West Virginia, western Maryland, eastern Kentucky, western Virginia, eastern Tennessee, northwestern Georgia, and northeastern Alabama. The Appalachian Basin is one of the most important coal producing regions in the US and one of the biggest in the world. In 2019, West Virginia was the second-largest coal producer in the nation, after Wyoming, and accounted for 13% of U.S. total coal production. The Appalachian Basin has also had a long history of oil and gas production starting with the discovery of oil in 1859 in the Drake Well, Venango County, Pennsylvania.[3]

The Alleghenies comprise the rugged western-central portion of the Appalachians. This barrier range has a northeast–southwest orientation and runs for about 400 miles (640 km) from north-central Pennsylvania, through western Maryland and eastern West Virginia, to southwestern Virginia. From west to east, at their widest, they are about 100 miles (160 km). They rise to approximately 4,862 feet (1,482 m) in northeastern West Virginia at Spruce Knob on Spruce Mountain. In the east, they are dominated by a high, steep escarpment known as the Allegheny Front. In the west, they slope down into the closely associated Allegheny Plateau, which extends into Ohio and Kentucky. The unofficial northern end of the range is the Susquehanna River valley and the southern limits is the New River valley. The mountains to the south of the Alleghenies—the Appalachians in westernmost Virginia, eastern Kentucky, and eastern Tennessee—are the Cumberlands.[3]

The Appalachians first formed roughly 480 million years ago during the Ordovician Period. They once reached elevations similar to those of the Alps and the Rocky Mountains before experiencing natural erosion. The bedrock of the Alleghenies is mostly sandstone and metamorphosed sandstone, quartzite, which is extremely resistant to weathering. Prominent beds of resistant conglomerate can be found in some areas, such as the Dolly Sods. When it weathers, it leaves behind a pure white quartzite gravel. The rock layers of the Alleghenies were formed during the Appalachian orogeny. Because of intense freeze-thaw cycles in the higher Alleghenies, there is little native bedrock exposed in most areas. The ground surface usually rests on a massive jumble of sandstone rocks, with air space between them that are gradually moving down-slope. The crest of the Allegheny Front is an exception, where high bluffs are often exposed.[4]

The largest part of the Allegheny Mountains run from the southwest through the northeast of West Virginia. They create a rain shadow causing the western part of the state to receive more precipitation than the eastern panhandle, but the mountains receive the most. Annual precipitation there is 53.8 inches (137 cm) with May through July the wettest months. The average annual temperature in the Allegheny Mountains is 49.4 F (9.4°C).[4] In Morgantown, a middle elevation city, the January daily mean temperature is 31°F (−0.4 °C) with occasional sub-0 °F (−18 °C) readings. Summers are hot and humid with a July daily mean temperature of 73.2 °F (22.9 °C) and 12 days of 90 °F (32 °C)+ highs annually. Average precipitation is 42 inches (107 cm) of rain.[11]

The southern third of the Allegheny Mountains lies in the Monongahela National Forest, one of three in West Virginia. This National Forest covers about 2,650 square miles (6,863 square kilometers) or 1,700,000 acres, 11% of the state. George Washington and Jefferson National Forests also form part of the Alleghenies.

Headwaters of six major river systems are located within Monongahela National Forest: Monongahela, Potomac, Greenbrier, Elk, Tygart, and Gauley. Twelve rivers are currently under study for possible inclusion in the National Wild and Scenic Rivers System.[10]

The High Alleghenies are noted for their forests of *Picea rubens* (Red Spruce), *Abies balsamea* (Balsam Fir) and *Sorbus americana* (Mountain Ash), trees typically found much farther north. Hardwood forests also include *Betula alleghaniensis* (Yellow Birch), *Acer saccharum* and *rubrum* (Sugar and Red Maple), *Tsuga canadensis* (Eastern Hemlock), and *Prunus serotina* (Black Cherry). *Fagus grandifolia* (American Beech), pine and hickory can also be found. The forests of the entire region are now almost all second- or third-growth forests, the original trees having been removed in the late 19th and (in West Virginia) early 20th centuries.

Certain isolated areas in the High Alleghenies are well known for their open expanses of sphagnum bogs and heath shrubs (e.g., Dolly Sods, Cranberry Glades). Many plant communities are indeed similar to those of sea-level eastern Canada. But the ecosystems within the Alleghenies are remarkably varied. In recent decades, the many stages of ecologic succession throughout the area have made the region one of enduring interest to botanists.[5]

The larger megafauna which once inhabited the High Alleghenies—*Cervus canadensis* (Elk), *Bison bison* (Bison), *Puma concolor* (Mountain Lion)—were all exterminated during the 19th century. They survived longer in this area, however, than in other parts of the eastern United States. Mammals in the Allegheny region today include *Odocoileus virginianus* (White-tail Deer), *Tamias striatus* (Chipmunk), *Procyon lotor* (Raccoon), skunk, *Marmota monax* (Groundhog), *Didelphis virginiana* (Opossum), weasel, field mouse, flying squirrel, *Sylvilagus obscurus* (Cottontail Rabbit), *Urocyon cinereoargenteus* (Gray Fox), *Vulpes vulpes* (Red Fox), *Sciurus carolinensis* (Gray Squirrel), *Tamiasciurus hudsonicus* (Red Squirrel) and a cave bat. *Felis rufus* (Bobcat), *Lepus americanus* (Snowshoe Hare), *Sus scrofa* (Wild Boar) and *Ursus americanus* (Black Bear) and *Canis latrans* (Coyote) are also found in the forests and parks of the Alleghenies. *Neovison vison* (Mink) and *Castor canadensis* (Beaver) are much less often seen.

These mountains and plateau have over 20 species of reptiles represented as lizard, skink, turtle and snake. Over 230 species of birds have been found in Monongahela National Forest alone. The water habitats of the Alleghenies hold 24 families of fish. Amphibian species number about 21, among them *Cryptobranchus alleganiensis alleganiensis* (Eastern Hellbender), lungless salamanders, and various toads and frogs. The Alleghenies provide habitat for about 54 species of common invertebrates.[5]



Notophthalmus viridescens (Eastern Newt) [left], *Terrapene carolina* ssp. *carolina* (Eastern Box Turtle) [center] and *Nymphalis antiopa* (Mourning Cloak Butterfly) [right]


Typical forest habitat in the Monongahela National Forest in east-central West Virginia



Rosa carolina (Carolina or Pasture Rose) [left], *Monarda didyma* (Scarlet Bee Balm) [center] and *Asclepias syriaca* (Common Milkweed) [right]

Corallorhiza maculata
(Spotted Coralroot)

Corallorhiza bentleyi
(Bentley's Coralroot)

Aplectrum hyemale
(Putty Root)
Photo on right by Duane Erdmann

Platanthera orbiculata
(Round Leaved Orchid)

Goodyera repens (Dwarf Rattlesnake Plantain)
This dwarf orchid is rare on the east coast and disappearing from West Virginia forests due to infestations of the alien bug *Adelges tsugae* (Hemlock Woolly Adelgid) which destroys the hemlock tree habitat.

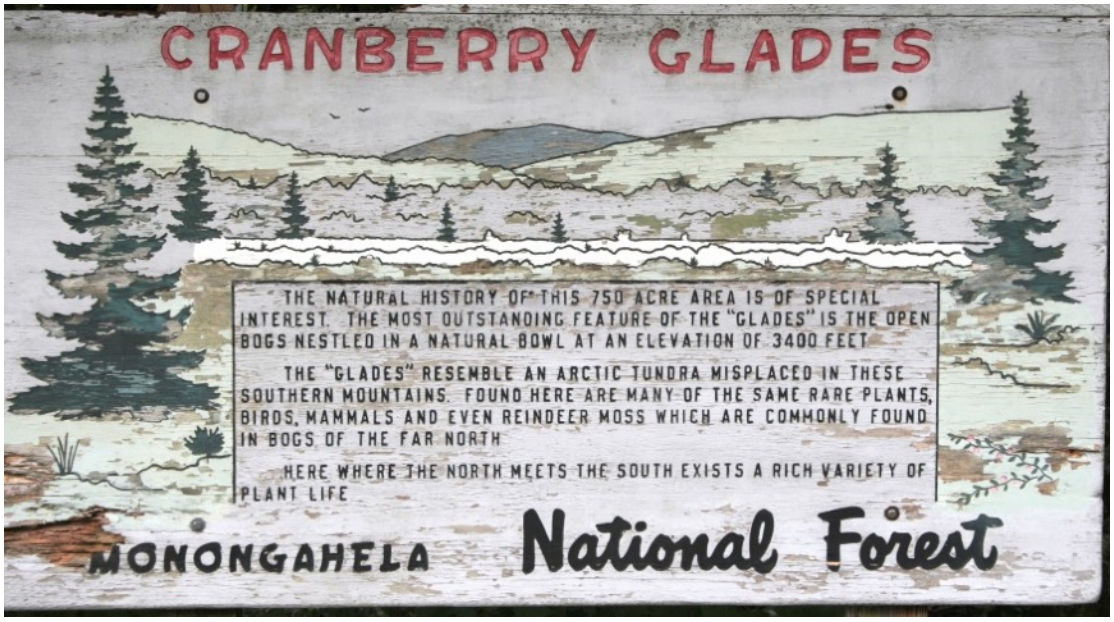
Goodyera pubescens
(Downy Rattlesnake Plantain)



Platanthera shriveri
(Shriver's Frilly Orchid)



Platanthera x keenanii
(hybrid between *Platanthera lacera* and *Platanthera grandiflora*)



Parts of the Alleghenies, in particular a section of the Monongahela National Forest, have open areas called glades. Dating back over 12,000 years, at the end of the last ice age, the tundra in this area was replaced by a forest of conifer-northern hardwood. The glaciation formed a basin with easily eroding rocks but at the lower end was more resistant rock which allowed for a low gradient in the valley. Limestone in the surrounding rocks influenced the chemistry of the area and over the last 10,000 years or so the depression filled with calcium rich marl (wet prairies) covered with a layer up to 10 feet (3 meters) thick of decaying plant material called peat. Low levels of oxygen and cold temperatures make it more difficult for fungi and bacteria to decompose dead plants quickly. Because decomposition happens so slowly, the soil and water in these so called bogs is very acidic. This environment has a spongy composition and a unique flora and allows for the open character of glades. The largest areas of bogs in West Virginia is protected by a 750 acre (3 square kilometers) reserve known as Cranberry Glades Botanical Area. The elevation here is about 3,300 feet (1,000 meters) and there are 4 separate glades within the reserve. The water from the Glades drains to form the headwaters of the Cranberry River. Many of the plants found in these glades resemble those in the northern region of North America. They are descendants of seeds that took root over ten thousand years ago before the last glacial retreat. Several species ended their migration here, and the Cranberry Glades are now the southern-most point in North America where some of these life forms are found. Among these are two unusual species of carnivorous plants that thrive in the area: *Sarracenia purpurea* (Purple Pitcher Plant) and *Drosera rotundifolia* (Round-leaved Sundew). They evolved carnivorous habits because of the scarce root food in the spongy soil. Two very rare boreal plants, *Andromeda polifolia* (Bog Rosemary) and *Menyanthes trifoliata* (Buckbean), also live here. Much of the area provides a home for many species of mosses. These include a cover of Sphagnum Moss, Bird-wheat Moss, bog moss and reindeer lichen. Hummocks of these plants reach a height of 3 feet (0.91 m). Over top of these grow prostrate cranberry vines that bloom nice pink flowers in the summer and a bunch of fruits in late September. The surrounding

forests in the flood plain include *Picea rubens* (Red Spruce), *Tsuga canadensis* (Canadian Hemlock), *Betula alleghaniensis* (Yellow Birch) and *Acer rubrum* (Red Maple) while the upland forests add *Fagus grandifolia* (American Beech), *Acer saccharum* (Sugar Maple), *Prunus serotina* (Black Cherry), *Fraxinus americana* (White Ash), *Tilia americana* (American Basswood), *Aesculus flava* (Yellow Buckeye), *Betula lenta* (Black Birch), *Magnolia fraseri* (Frasier Magnolia) and *Quercus rubra* (Northern Red Oak). Many shrubs inhabit the glades with *Alnus incana* (Speckled Alder) dominant along the fringes of open glades and streams. Herbs with primarily northern distributions occur here and for many, including *Corallorhiza trifida* (Northern Coralroot), this is the most southern location in the U.S. This is also the most southern breeding grounds for many birds common in the northern U.S. such as *Catharus ustulatus* (Swainson's Thrush) and *Catharus guttatus* (Hermit Thrush). [6,9]

Like many of the adjoining areas high in the Alleghenies, Cranberry Glades are known for frequent weather changes. Generally speaking, the area is cool and wet, comparable to the climates of New England and Canada. This can be explained by the biome which this area is set in, the Temperate Deciduous Forest. Biomes are defined by common flora and fauna types and by certain types of consistent weather patterns. Higher mountains surround the Glades form a bowl, draining their cool air downhill to the Glades. Due to the high elevation, the potential for frost exists year-round at Cranberry Glades. Still, the average summer high is roughly 74 °F -82 °F (23 °C- 28 °C). Mid-winter temperatures record as low as −26 °F (−32 °C), and the area often sees heavy snow.[6,9]



Sarracenia purpurea (Purple Pitcher Plant) [left and center] is a carnivorous plant that obtains most of its nutrition from insects and small invertebrates that drown in the fluid filled modified leaves or pitchers. It is a cold climate plant that is found throughout Canada, the Great Lakes and along the eastern seaboard. *Drosera rotundifolia* (Round-leaved Sundew) [right], is a carnivorous species of flowering plant that grows in bogs, marshes and fens. One of the most widespread sundew species, it has a circumboreal distribution, being found in all of northern Europe, much of Siberia, large parts of northern North America, Korea and Japan but is also found as far south as California, Mississippi and Alabama in the United States of America and in New Guinea. It passively traps insects in the sticky droplets on its leaves and the enzymes in the secretions dissolve the prey and allows the plant to extract nutrients and ammonia that the plant uses instead of nitrogen that other plants obtain from soil.[12]

Platanthera ciliaris
(Orange Fringed Orchid)

Pogonia ophioglossoides
(Rose Pogonia)

Calopogon tuberosus
(Tuberous Grass Pink)

Platanthera flava
(Northern Tubercled Bog Orchid)

Neottia smallii
(Kidney Leaf Twayblade)

The southwestern portion of Pennsylvania on the border with West Virginia is the upper limit of the Allegheny Mountain range. Elevations near Fayette and Somerset Counties range from a low of 741 feet (226 meters) in the east to a high of 3,213 feet (979 meters) at Mt. Davis, the highest point in the state. Snow fall at the higher elevations average over 150 inches (288 cm) of snow annually making it the one of the snowiest inhabited areas in the U.S. At lower levels the snow fall is about 25 inches (65 cm). Total precipitation is about 44 inches (111 cm). The warm-summer humid climate has average monthly temperatures in January of 24.5 °F (-4.2 °C) and 67.1 °F (19.5 °C) in July.[7,8]

With its geologic history similar to that described for east central West Virginia, peat bogs are scattered throughout the counties. Much of those areas are within privately owned forest so a big threat is logging with the removal of forest canopy and increased sediment loading in the streams which degrades the peat wetlands. In addition there are areas of late successional forest typical of the Allegheny Mountains.[7,8]

Monotropa uniflora [left], (Indian Pipe) and
Dendrolycopodium hickeyi (Pennsylvania Clubmoss) [right]

Central City Bog [left] and Crumb Bog [right} in Somerset County are examples of peat bogs in open glades

Malaxis unifolia
(Green Adder's Mouth)

Spiranthes lacera var. *lacera*
(Slender Ladies'-tresses)

Platanthera clavellata
(Club Spur Orchid)


The forest at Mountain Fellowship in Fayette County [left] is next to Markleysburg Bog [right]



Ferncliff Peninsula Natural Area within Ohiopyle State Park is a unique habitat with many rare and unusual plants for the region. The peninsula is created by a meander in the Youghiogheny River which flows north into Pennsylvania from West Virginia and Maryland carrying seeds from that region. The warmer microclimate inside the river gorge allows these plants to survive. *Rhododendron maximum* (Rosebay Rhododendron) is a standout in the forest.[12]

Platanthera peramoena
(Purple Fringeless Orchid)

Lobelia cardinalis
(Cardinal Flower)

Lillium superbum
(Turk's Cap Lily)

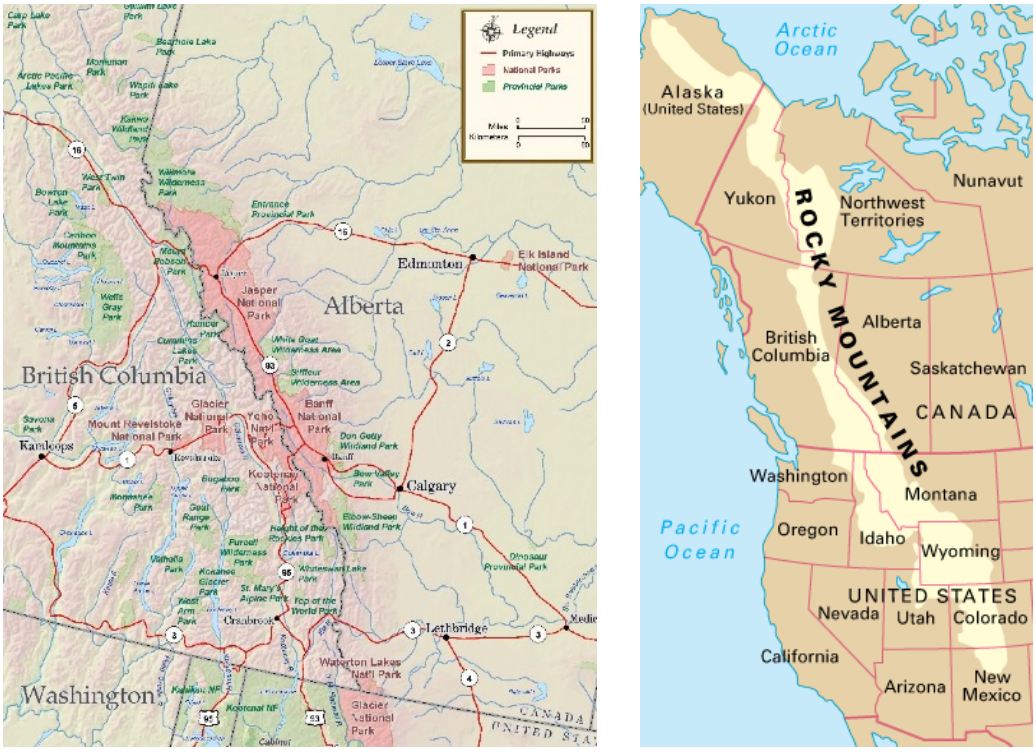
Fossil trees

1) Encyclopedia Britannica maps
2) Free World Maps www.freeworldmaps.com
3) https://en.wikipedia.org/wiki/Appalachian_Mountains
4) https://en.wikipedia.org/wiki/Allegheny_Mountains
5) West Virginia: the Mountain state; Marshall University https://www.marshall.edu/herp/pages/aboutwv.htm
6) Cranberry Glades Botanical Area, US Forest Service; https://www.fs.usda.gov
7) Somerset County, Pennsylvania: Wikipedia https://en.wikipedia.org/wiki/Somerset_County,_Pennsylvania
8) Peatlands; Western Pennsylvania Conservancy https://waterlandlife.org/wildlife-pnhp/special-places-2/peatlands/
9) Cranberry Glades; Wikipedia: https://en.wikipedia.org/wiki/Cranberry_Glades
10) https://en.wikipedia.org/wiki/Monongahela_National_Forest
11) Morgantown, WV: https://en.wikipedia.org/wiki/Morgantown,_West_Virginia
12) https://en.wikipedia.org

THE CANADIAN ROCKIES: ALBERTA

(June 2010)

View of the Canadian Rockies from the Icefields Parkway in Alberta



Maps showing the mountain range between the provinces of British Columbia and Alberta

Views of Jasper and Banff National Parks in Alberta

The Canadian Rockies are the easternmost part of the Canadian Cordillera, the collective name for the mountains of Western Canada. They form part of the American Cordillera, an essentially continuous sequence of mountain ranges that runs all the way from Alaska to the very tip of South America. The Cordillera, in turn, is the eastern part of the Pacific Ring of Fire that runs all the way around the Pacific Ocean. This section of the Rockies comprise both the Alberta Rockies and the British Columbia Rockies in the Canadian segment of the North American Rocky Mountains. They are the eastern part of a system of multiple ranges of mountains which runs from the Prairies to the Pacific Coast. The Canadian Rockies mountain system comprises the southeastern part of this system, lying between the Interior Plains of Alberta and northeastern British Columbia on the east to the Rocky Mountain Trench of British Columbia on the west. The southern end borders Idaho and Montana of the United States. Contrary to popular misconception, the Rockies do not extend north into Yukon or Alaska, or west into central British Columbia. North of the Liard River, the Mackenzie Mountains, which are a distinct mountain range, form a portion of the border between the Yukon and the Northwest Territories. The mountain ranges to the west of the Rocky Mountain Trench in southern British Columbia are called the Columbia Mountains, and are not

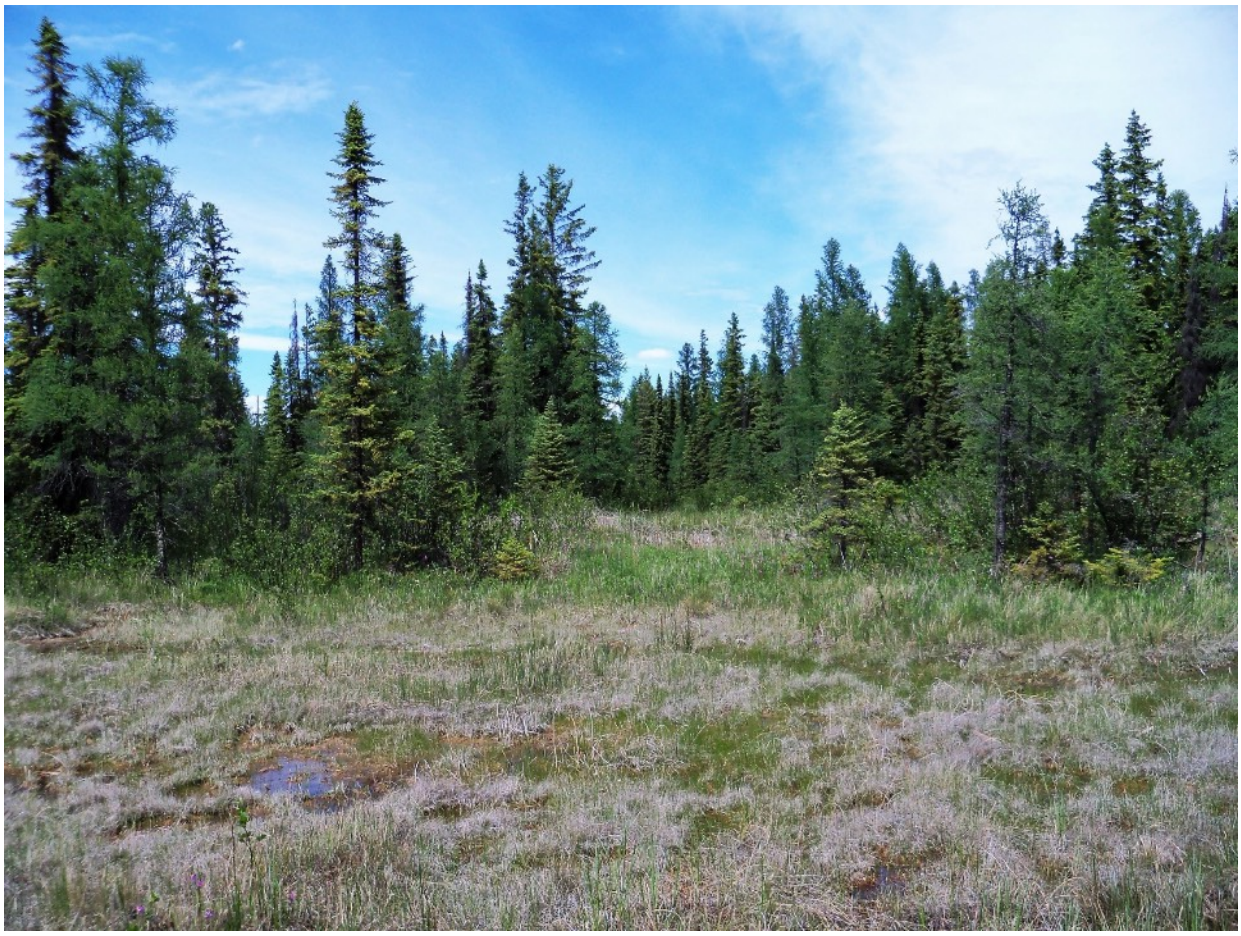
considered to be part of the Rockies by Canadian geologists. The Canadian Rockies have numerous high peaks and ranges, such as Mount Robson (12,972 ft. /3,954 m) and Mount Columbia (12,293 ft. / 3,747 m.).[1]

The rocky cores of the mountain ranges are, in most places, formed of pieces of continental crust that are over one billion years old. In the south, an older mountain range was formed 300 million years ago, then eroded away. The rocks of that older range were reformed into the Rocky Mountains. The Rocky Mountains took shape during an intense period of plate tectonic activity that resulted in much of the rugged landscape of the western North America. The Laramide orogeny, about 80–55 million years ago, was the last of the three episodes and was responsible for raising the Rocky Mountains. Subsequent erosion by glaciers has created the current form of the mountains. The rocks in the Rocky Mountains were formed before the mountains were raised by tectonic forces. The oldest rock is Precambrian metamorphic rock that forms the core of the North American continent. There is also Precambrian sedimentary argillite, dating back to 1.7 billion years ago. During the Paleozoic, western North America lay underneath a shallow sea, which deposited many kilometers of limestone and dolomite. Immediately after the Laramide orogeny, the Rockies were like Tibet: a high plateau, probably 20,000 ft. (6,000 meters) above sea level. In the last 60 million years, erosion stripped away the high rocks, revealing the ancestral rocks beneath, and forming the current landscape of the Rockies. Periods of glaciation occurred from the Pleistocene Epoch (1.8 million–70,000 years ago) to the Holocene Epoch (fewer than 11,000 years ago). The ice ages left their mark on the Rockies, forming extensive glacial landforms, such as U-shaped valleys and cirques. All of the geological processes have left differing complex sets of rocks exposed at the surface depending on which area of the cordillera one is studying.[1]

The Canadian Rockies are noted for being the source of several major river systems, and also for the many rivers within the range itself. The Rockies form the divide between the Pacific Ocean drainage on the west and that of Hudson Bay and the Arctic Ocean on the east. Of the range's rivers, only the Peace River penetrates the range. Notable rivers originating in the Canadian Rockies include the Fraser, Columbia, North Saskatchewan, Bow and Athabasca Rivers.[1]

The Canadian Rockies are quite different in appearance and geology from the American Rockies to the south of them. The Canadian Rockies are composed of layered sedimentary rock such as limestone and shale, whereas the American Rockies are made mostly of metamorphic and igneous rock such as gneiss and granite. The Canadian Rockies are overall more jagged than the American Rockies, because the Canadian Rockies have been more heavily glaciated, resulting in sharply pointed mountains separated by wide, U-shaped valleys gouged by glaciers, whereas the American Rockies are overall more rounded, with river-carved V-shaped valleys between them. The Canadian Rockies are cooler and wetter, giving them moister soil, bigger rivers, and more glaciers. The tree line is much lower in the Canadian Rockies than in the

American Rockies.[1] All of this influences the flora and fauna of the regions allowing for significant differences between sections of the ranges. Much of the Canadian range is protected by national and provincial parks, several of which collectively comprise a World Heritage Site.[1]



Low elevation forest

The Canadian Rockies experience a highland climate, characterized by warm summer days with long hours of sunshine, and cold, crisp winters when snow covers the ground from November to March. The coldest months are December and January when temperatures can plummet to well below freezing, exacerbated by the wind chill factor. Hikers in the summer months should note that May and June are the wettest time of year, and that even in summer weather conditions can be changeable and unpredictable.[3]

More than any other factor, prevailing moisture-laden westerlies blowing across British Columbia from the Pacific Ocean dictate Canadian Rockies weather. The cold heights of the mountain peaks wring the winds dry, making for clear, sunny skies in southern Alberta; Calgary gets up to 350 hours of sunshine in June alone–good news, unless you're a farmer. Elevation and, to a lesser degree, latitude are two other factors affecting the climate within the mountain ecosystem. Elevations vary from 2,600 feet (800 meters) above

sea level at Radium Hot Springs to 4,920 feet (1500 meters) at Lake Louise to 12,970 feet (3954 meters) at the summit of Mount Robson. Calgary, on the edge of the Rockies is at 3,557 feet (1084 m) and Edmonton is at 2,116 feet (651 meters). As a general rule, temperatures fall 9°F (5°C) for every 3,280 feet (1,000 meters) of elevation gained. Another interesting phenomenon occurring in the Canadian Rockies is the temperature inversion, in which a layer of warm air sits on top of a cold air mass. During these inversions, high- and low-country roles are reversed; prairie residents can be shivering and bundling up, while their mountain fellows are sunning themselves in short sleeves.[3]

Summer in the mountains is short, but the days are long. With up to 17 hours of daylight around the summer solstice of June 21, this is an ideal time for travel and camping out. The months on either side of summer are ideal for touring, especially September, when rainfall is minimal. Winter is cold, but the skiing and snowboarding are fantastic. January is usually the coldest month, when Banff's average temperature is about 5 °F (-15 °C) though extended spells of -22°F (-30°C) are not uncommon anywhere in the mountains and temperatures occasionally drop below -40°C. The coldest temperature recorded was -62°F (-52°C) in Lake Louise on January 25, 1950. Severe cold weather is often accompanied by sunshine; the cold is a dry cold, unlike the damp cold experienced in coastal regions. Cold temperatures and snow can be expected through mid-March. July is the hottest month, with Banff, Jasper, and Canmore's average daytime temperature topping out above 73°F (23°C) and Radium Hot Springs and Golden enjoying average daytime highs of 84°F (29°C) and 81°F (27°C), respectively. On hot days, the temperature can hit 86°F (30°C) along lower elevation valleys. Again, because of the dryness of the air, these temperatures are more bearable here than in coastal regions experiencing the same temperatures.[3]

Days of precipitation in the region range from about 120-160. Rainfall in Jasper is only about 16 inches (40.6 cm) per year while Banff gets about 22 inches (56 cm). Waterton Lakes can get over 43 inches (109 cm) annually. Snow fall makes up about 1/3 to ½ of the annual precipitation with parts of Jasper seeing 50-70 inches (127-178 cm) of snow and Banff getting 75 inches (190 cm) (equal to 7.5 inches/19 cm of rain). Lake Louise, near Banff, gets 110 inches (279 cm) of snow each winter and Waterton Lakes gets 190 inches (483 cm).[2]

Botanists divide the Canadian Rockies into three distinct vegetation zones (also called biomes): montane, subalpine, and alpine. The boundaries of these zones are determined by several factors, the most important being altitude. Latitude and exposure are also factors, but less so. Typically, within any 4,920 feet (1,500 meters) of elevation change, you'll pass through each of the three zones.[3]

The foothills, along with most major valleys below an elevation of about 4,920 feet (1,500 meters), are primarily cloaked in montane forest. *Populus tremuloides* (Aspen), *Populus balsamifera* subsp. *balsamifera* (Balsam Poplar), and *Picea glauca* (White Spruce) thrive here. *Pinus contorta* var. *latifolia* (Lodgepole

Pine) is the first species to emerge after fire. On dry, south-facing slopes, *Pseudotsuga menziesii* var. *glauca* (Rocky Mountain Douglas-fir) is the climax species. Where sunlight penetrates the forest, such as along riverbanks, flowers like lady's slipper, Indian paintbrush, and saxifrage are common. Large tracts of fescue grassland are common at lower elevations. The montane forest holds the greatest diversity of life of any vegetation zone and is prime winter habitat for larger mammals. But this is the habitat where most development occurs and therefore is often much changed from its natural state.[3]

Subalpine forests occur where temperatures are lower and precipitation higher than in the montane. In the Canadian Rockies, this is generally 4,920 to 7,220 feet (1,500-2,200 meters) above sea level. The upper limit of the subalpine zone is the tree line. Approximately half the flora of the mountains falls within this zone. The climax species are *Picea engelmannii* (Engelmann Spruce) and *Abies lasiocarpa* (Subalpine Fir) (recognized by its spire-like crown), although extensive forests of *Pinus contorta* var. *latifolia* (Lodgepole Pine) occur in areas that have been scorched by fire in the last 100 years. Before Lodgepole Pines take root in fire-ravished areas, fireweed blankets the scorched earth. At higher elevations, stands of *Larix lyallii* (Larch) are seen. Larches are deciduous conifers–unlike those of other evergreens, their needles turn a golden-orange color each fall, producing a magnificent display for photographers.[3]

The alpine zone extends from the tree line to mountain summits. The upper limit of tree growth in the Canadian Rockies varies between 5,900 to 7,900 feet (1,800-2,400 meters) above sea level, dropping progressively to the north until it meets the treeless tundra of the Arctic. Vegetation at these high altitudes occurs only where soil has been deposited. Large areas of alpine meadows burst with color for a short period each summer as *Dryas octopetala* (Mountain Avens), *Myosotis asiatica* (Alpine Forget-me-not), *Erythronium montanum* (Avalanche Lily), *Silene acaulis* (Moss Campion), lupines and a variety of heathers bloom.[3]

Perisoreus canadensis (Canada or Gray jay, Camp Robber, or Whisky Jack) [left], is a passerine bird of the family Corvidae. It is found in boreal forests of North America north to the tree line, and in the Rocky Mountains subalpine zone south to New Mexico and Arizona.
Nucifraga columbiana (Clark's Nutcracker) [right], is a passerine bird in the family Corvidae, native to the mountains of western North America. The Clark's Nutcracker is an omnivore but subsists mainly on pine nuts, burying seeds in the ground in the summer and then retrieving them in the winter by memory.[1]

Ursus americanus (American Black Bear) [left], is a medium-sized bear native to North America. It is the continent's smallest and most widely distributed bear species. American Black Bears are omnivores, with their diets varying greatly depending on season and location. They typically live in largely forested areas but will leave forests in search of food. They are sometimes attracted to human communities because of the immediate availability of food. The American black bear is the world's most common bear species. Despite the name, some subspecies can be brown or even blond in coloration. *Marmota caligata* (the Hoary Marmot) [right], inhabits the mountains of northwest North America. Its name refers to its silver-grey fur on its shoulders. Hoary marmots live near the tree line on slopes with grasses and forbs to eat and rocky areas for cover. It is the largest North American ground squirrel and has a high pitched whistling sound used to alert others.[1]


Lithobates sylvaticus (Wood Frog) [left] and *Papilio canadensis* (Canadian Tiger Swallowtail) [right]


Oreamnos americanus (Mountain goat) [left], is a hoofed mammal endemic to North America. A subalpine to alpine species, it is a sure-footed climber commonly seen on cliffs and ice. *Ovis canadensis* (Bighorn sheep) [right], is a species of sheep native to North America. It is named for its large horns. A pair of horns might weigh up to 30 lbs. (14 kg). The sheep typically weigh up to 315 lbs. (143 kg).[1]


Cervus canadensis (Elk or Wapiti) [left], is one of the largest species within the deer family, and one of the largest terrestrial mammals in North America, as well as Central and Northeast Asia. Males stand almost 5 feet (1.5 meters) at the shoulders and weigh over 700 pounds (318 kilograms). *Odocoileus virginianus* (White-tailed Deer) [right] is a medium-sized deer native to North America, Central America, Ecuador, and South America as far south as Peru and Bolivia. A second species of deer, the Mule Deer (*Odocoileus hemionus*), is also common in the Rockies.[1]



Mertensia paniculata (Tall Bluebell) [left], *Mitella nuda* (Naked Bishop's Cap or Naked Miterwort) [center] and *Primula pauciflora* (Few-flowered or Pretty Shooting Star) [right]



Pinguicula vulgaris (Hairy Butterwort) [left], *Viola macloskeyi* (Small White Violet) [center] and *Anemone occidentalis* (Western Pasqueflower) [right]



Clematis occidentalis (Western Blue Virginsbower) [left], *Caltha palustris* (Marsh Marigold) [center] and *Cornus canadensis* (Bunchberry) [right]


Cypripedium parviflorum
(Yellow Lady's-slipper)


Mid-level elevation forests

Corallorhiza trifida
(Early Coralroot)

Neottia cordata
(Heart-leaved Twayblade)

Platanthera obtusata
(Blunt Leaved Bog Orchid)





Hundreds of plants of *Galearis rotundifolia* (Roundleaf Orchid) near the Athabasca River

Cypripedium passerinum
(Sparrow's Egg Lady's-slipper)

Snow is not uncommon even at mid-elevations in summer

Malaxis monophyllos
(White Adder's Mouth)

Neottia borealis
(Northern Twayblade)

Platanthera aquilonis
(North Wind Bog Orchid)

Coeloglossum viridis
(Frog Orchid)

Calypso bulbosa var. *americana*
(Fairy Slipper)

Roche Ronde, Jasper National Park

1) Wikipedia https://en.wikipedia.org/wiki/Canadian_Rockies

2) Current results weather and science facts: https://www.currentresults.com/Weather/Canada/Rocky-Mountains/temperature-snow-precipitation-averages.php

3) Canadian Rockies.com: https://thecanadianrockies.com

THE MIDDLE ATLANTIC STATES

(July-August 2011 & July 2018)

The central eastern section of the United States is usually referred to as the Middle Atlantic or Mid-Atlantic region and consists of five to seven states with Virginia and West Virginia only sometimes in that definition. And some sources leave out New York and/or add Ohio. This artificial grouping may have more to do with socio-economic factors than natural affinities such as geology or flora and fauna.[1] For this article I will use the boundary as shown in the above map[2] to limit the scope though there is still a wide range of topography, geology and climate, for example, within this large portion of the country.

The Mid-Atlantic region covers 4 principal physiographic regions oriented along a northeast-southwest axis.[5] They form a mosaic of mineral ridges, shale valleys, glacial and impact craters, sand dunes, tidal estuaries and river systems.[3] On the eastern edge, there is the relatively flat Coastal Plain, composed mostly of sedimentary rock and extending inland from the oceans and estuaries. This zone traverses all of Delaware and parts of New Jersey, Maryland, Virginia, and North Carolina. The Piedmont is the foothills

region covering the eastern, lower portion of the Appalachian mountain range. This area is composed mostly of metamorphic and igneous rock, and covers north-central New Jersey, southeastern Pennsylvania and the central portions of Maryland, Virginia and North Carolina. The Ridge and Valley zone contains primarily sedimentary rocks and exhibits folded terrain with a series of parallel, eroded mountains of equal height. This strip of land extends from the northwest corner of New Jersey to the south-west, passing through Pennsylvania, Maryland and Virginia. The Appalachian Plateau is a complex swath of land extending from the New York portion of the Middle Atlantic through north-central and western Pennsylvania, the western edge of Maryland and most of West Virginia. This region is composed of rolling hills in places and relatively flat sedimentary rock in others, dissected throughout by meandering waterways.[5]

The temperatures and rainfall of the region varies considerably depending on elevation, latitude and proximity to the ocean. Mountainous areas have very cold winters and mild summers while coastal areas tend to be milder throughout the year. The plains have hot and humid summers and cold winters. Rainfall in the Appalachians can be higher but the annual average for most of the states is about 40-50 inches (102-127 cm) which is slightly above the average for the United States.

Flora and fauna also vary depending on the environment. The forests of the Piedmont area include hardwood species such as various *Quercus* (oaks), *Carya* (hickories), *Ace*r (maples), *Fraxinus* (ash), *Ulmus* (elm), *Prunus* (cherry), *Juglans* (walnut), *Betula* (birch), *Platanus occidentalis* (sycamore), and *Fagus* (beech). Coniferous species include *Pinus strobus* (Eastern White Pine), *Pinus rigida* (Pitch Pine), *Juniperus virginiana* (Eastern Red Cedar), and *Tsuga canadensis* (Eastern Hemlock).[4] Wetland forests are dense with shrubs, ferns, *Quercus bicolor* (Swamp Oak), *Salix* (willow), *Castanea* (chestnut), *Fraxinus pennsylvanica* (Geen Ash), *Acer rubrum* (Red Maple), and *Nyssa sylvatica* (Black Gum) trees growing in standing water that does not drain. Mid-Atlantic mainland beaches are characterized by dunes and extensive wetlands, marshes and swamps. *Odocoileus virginianus* (White-tailed Deer), squirrels, *Vulpes vulpes* (Red) and *Urocyon cinereoargenteus* (Gray) Foxes, *Procyon lotor (*Raccoon), *Didelphis virginiana* (Opossum), *Spilogale putorius* (Eastern Spotted) and *Mephitis mephitis* (Striped) Skunks, *Anas platyrhynchos* (mallard), *Aix sponsa* (Wood Duck), *Corvus brachyrhynchos* (crow), and *Chelydra serpentina* (Snapping Turtle) are common in the wetland forests while inland forests have White-tailed Deer, *Tamias striatus* (Chipmunk), *Procyon lotor* (Raccoon), skunks, *Marmota monax* (Groundhog), *Didelphis virginiana* (Opossum), weasel, field mice, flying squirrels, *Sylvilagus floridanus* (Cottontail Rabbit), Gray Fox, Red Fox, *Sciurus carolinensis* (Gray Squirrel), *Tamiasciurus hudsonicus* (Red Squirrel) and many amphibians and reptiles.[3]


Pine Barrens habitats

One unique environment in the Mid-Atlantic region is the Pine Barrens, best exemplified by the New Jersey Pine Barrens, or Pinelands, the largest remaining example of the Atlantic coastal Pine Barrens ecosystem which stretches across more than seven counties of New Jersey. Two other large, contiguous examples of this ecosystem remain: the Long Island Central Pine Barrens, and the Massachusetts Coastal Pine Barrens. Historically there were large *Pinus rigida* (Pitch Pine) forests in Rhode Island, Maine and central New York. The name Pine Barrens refers to the area's sandy, acidic, nutrient-poor soil. Although European settlers could not cultivate their familiar crops there, the unique ecology of the Pine Barrens supports a diverse spectrum of plant life, including orchids and carnivorous plants. The area is also notable for its populations of rare pygmy Pitch Pines (same species but dwarfed to under 4 feet (1.2 meters) by frequent fires) and other plant species that depend on the frequent fires of the Pine Barrens to reproduce. The sand that composes much of the area's soil is referred to by the locals as sugar sand.[6]

Over millions of years, the rising and falling of the coastline deposited minerals underground, culminating with the end of the last ice age about 12,000 years ago, when plants and trees began growing in what is now New Jersey.[6]

The New Jersey Pinelands National Reserve contains approximately 1,100,000 acres (4,500 km2) of land, and occupies 22% of New Jersey's land area. They are in the transition zone between humid subtropical and humid continental climates. They however have a microclimate that allows for a shorter frost-free season, and colder nighttime temperatures compared to most of New Jersey. Because of sandy soil and very little development, clear and calm nights can get much colder in the Pine Barrens than in the surrounding areas. On an average night, a 6 to 8 °F (3.3 to 4.4 °C) difference is commonly seen, but the change can be as much as 10 °F (5.6 °C).

The Pine Barrens receives annual snowfall, varying from 15 to 21 inches (380 to 530 mm) throughout the Pinelands (the northern pinelands receive the most snowfall, on average). Summers are typically hot and humid, and winters are typically cold, and fall/spring are milder transition seasons. Frost can be seen in fall, spring, and winter. In the Pine Barrens, frost occurs earlier in the fall and later in the spring than the surrounding areas due to the sandy soil. The average annual precipitation in the Pinelands is from 42 to 46 inches (1,100 to 1,200 mm), but year-to-year precipitation varies greatly. Thunderstorms are frequent in the warmer months, along with strong winds and heavy rains from these storms.[6]

The Pine Barrens are home to at least 850 species of plants, of which 92 are considered threatened and endangered. Several species of orchids, including *Cypripedium acaule* (Pink Lady's-slipper), are native to the Pine Barrens.

The forest communities are strongly influenced by fire, varying from dwarf or pygmy pine forests less than 4 feet (120 cm) tall where fires are frequent, to pine forests, to oak forests where fires are rare. Dark swamps of *Chamaecyparis thyoides* (Atlantic White Cedar) grow along the waterways.[6] The understory of the forests is made up of shrubs such as *Quercus ilicifolia* (Scrub Oak), *Kalmia latifolia* (Mountain Laurel) *Vaccinium angustifolium* (Lowbush Blueberry), *Hudsonia ericoides* (Pine Barrens Heather), and *Comptonia peregrina* (Sweet-fern). The ground cover consists of low-lying plants such as lichens, mosses, ferns, annual and perennial wildflowers, and sub-shrubs like *Arctostaphylos uva-ursi* (Bearberry), *Gaultheria procumbens* (Teaberry), and *Hudsonia* (Goldenheathers).[7] In the cedar swamps one finds *Vaccinium corymbosum* (Highbush Blueberry), *Magnolia virginiana* (Swamp Magnolia), *Betula populifolia* (Gray Birch), *Rhododendron viscosum* (Swamp Azalea) *Sarracenia* (Pitcher Plants), *Drosera* (sundews), several species of orchids, various wildflowers, as well as grasses, sedges, and rushes. A great many of the Pinelands animals use cedar swamps for breeding, feeding, nesting, and resting. Some of our rarest flora and fauna have safe harbors in these communities.[7]

Schizea pusilla (Curly-grass Fern) with *Drosera rotundifolia* (Round-leaved Sundew) [left], *Drosera filiformis* (Thread-leaved Sundew) [center] and *Sphagnum sp*. [right], one of 44 species of sphagnum moss found in the Pine Barrens

Polygala cruciata (Cross-leaved Milkwort) [left] and *Sarracenia purpurea* (Pitcher Plant) [center and right]

In addition there are Savannas or Wet Meadows. They vary greatly in size and species make-up, but are recognized by the lack of trees, and abundance of herbaceous plants, grasses, sedges, and rushes. This is another hotspot for rare plants, some of them of worldwide significance. They include globally rare species such as *Juncus caesariensis* (New Jersey Rush), *Narthecium ossifragum* (Bog Asphodel), and several of the Beaked-rushes including *Rhynchospora*.[7]



Pinus rigida (Pitch Pine) needles and cone [left and center] and *Quercus velutina* (Black Oak) [right]

Forest fires play an important role in regulating the growth of plants in the Pine Barrens. Frequent light fires tend to reduce the amount of undergrowth and promote the growth of mature trees. Forest fires have contributed to the dominance of Pitch Pine in the Pine Barrens. They can resist and recover quickly from fire by resprouting directly through their bark (something very unusual for pines). Their serotinous (late in developing) pine cones open only after having been heated by a fire. The prevalence of forest fires allows the Pitch Pines to dominate over oaks, which by comparison are usually killed outright by a moderate or intense fire. High air temperatures and dry plant undergrowth contribute to the intensity of the fire. While severe fires are uncommon, severe fires at fairly frequent intervals can eliminate species that do not bear seed at an early age. Frequent killing fires keep an area covered with small sprouts.[6]


Lithobates sphenocephalus (Southern Leopard Frog) [left] and
Sceloporus undulatus ssp. *hyacinthinus* (Northern Fence Lizard) [right]

The Pine Barrens is home to at least 39 species of mammals, over 300 species of birds, 59 reptile and amphibian species, and 91 fish species. At least 43 species are considered threatened and endangered by the New Jersey Division of Fish and Wildlife, including the rare *Crotalus horridus* (Eastern Timber Rattlesnake) and *Haliaeetus leucocephalus* (Bald Eagle). The threatened tree frog, *Hyla andersonii* (Pine Barrens Tree Frog), has a population here, as well as *Ursus americanus* (American Black Bear) and *Lynx rufus* (Bobcat).[6]

Platanthera integra
(Yellow Fringeless Orchid)

Platanthera blephariglottis
(White Fringed Orchid)

Platanthera clavellata
(Little Spur Bog Orchid)

Iron Hill Park near Wilmington, Delaware was one place where we found
Tipularia discolor (Cranefly Orchid)

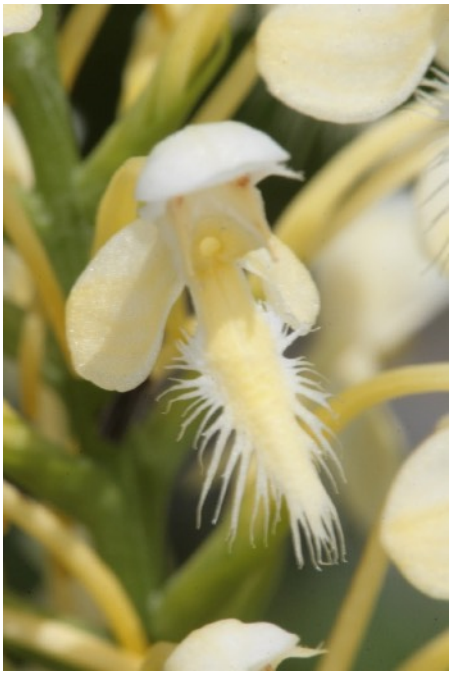

Gentiana linearis (Narrow Leaved Gentian) [left] and *Lygodium palmatum* (Climbing Fern) [right]


Hazleton, Pennsylvania is about 48 miles (77 km.) northwest of Allentown in the east central part of the state. It is located in Pennsylvania's ridge and valley section on a plateau named Spring Mountain which is in the divide between the Delaware and Susquehanna River watersheds. At 1,886 feet (575 meters) above sea level, it is the highest incorporated city in Pennsylvania.[8] Outside of the town is an industrial park by some wetlands. Here there are several species of orchids that conservationists are trying to protect.

Calopogon tuberosus
(Tuberous Grass Pink Orchid)

Platanthera blephariglottis
(White Fringed Orchid)

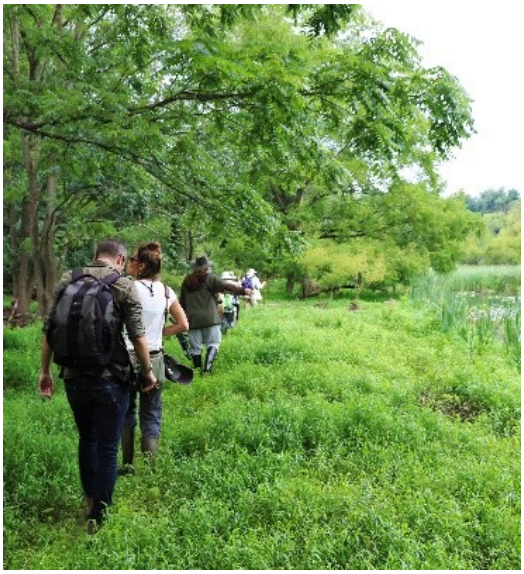
Platanthera ciliaris
(Orange Fringed Orchid)



The natural hybrid of *Platanthera blephariglottis* and *Platanthera ciliaris* is called *Platanthera* x *bicolor*. Here are several different plants of that cross.

Maryland is somewhat divided by the Chesapeake Bay. Western Maryland is mountainous with valleys and it is forested by oaks and other hardwoods [*Fagus* (beech), *Betula* (birch), and *Acer* (maple)]. The Piedmont area of central Maryland is broad, rolling upland with several deep gorges cut by rivers. It is dominated by *Quercus* (oak), *Liriodendron tulipifera* (Yellow Poplar), *Fraxinus* (ash), and some *Pinus* species (pine). The Coastal plain and Eastern shore is less populated and much of the original forest has been cleared. *Taxodium* (cypress) and *Pinus* (pines) and a few *Quercus* (oaks) are the main trees. Because of its coastal and low-lying geography, the region is vulnerable to extreme weather events like hurricanes and larger environmental issues like climate change.[9]

For field trips, on one day we headed northwest of Annapolis for sites west of Baltimore (red asterisks*). On the other day we crossed the Chesapeake Bay to the Delmarva Peninsula which is made of Maryland's and Virginia's Eastern Shore and all of Delaware. We visited a few areas in the upper western and middle sections of the peninsula (blue asterisks*).



West of Baltimore near Ellicott City we stopped at the 77 acre Meadowbrook Park.

Platanthera peramoena
(Purple Fringeless Orchid)

Gambrill State Park is a public recreation area located on Catoctin Mountain near the city of Frederick, about 53 miles west of Baltimore.

Monotropa uniflora (Indian Pipe) [left], *Monotropa hypopitys* (Pinesap or Dutchman's Pipe) [center] and *Prunella vulgaris* (Self Heal) [right]. Fascinating fungi (below)

Galearis spectabilis
(Showy Orchis)
Photo by Bob Sprague

Goodyera pubescens
(Downy Rattlesnake Plantain)

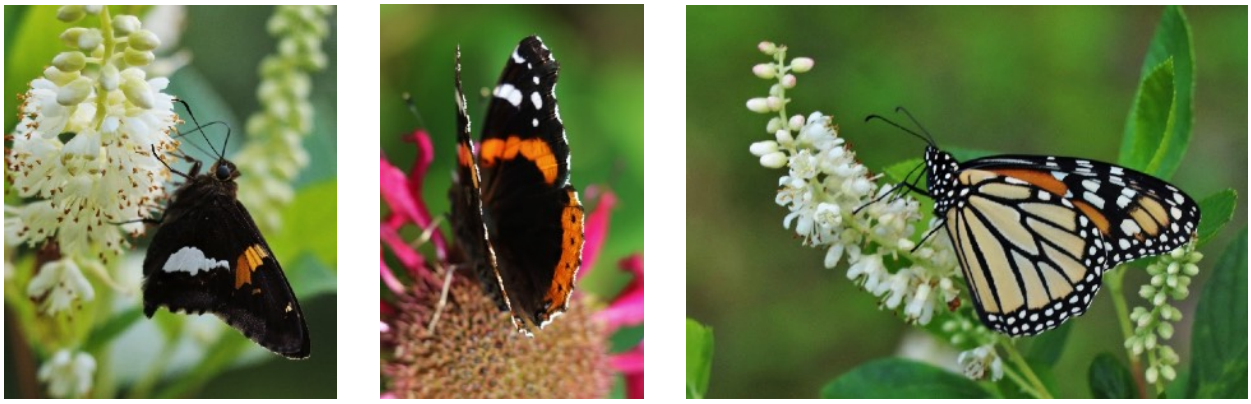
Platanthera ciliaris
(Orange Fringed Orchid)

Pine and oak forests on the Delmarva Peninsula near Pocomoke are home to a reserve protected by The Nature Conservancy

Rhexia virginica (Virginia Meadow Beauty) [left], *Rhexia mariana* (Maryland Meadow Beauty) [center left], *Polygala lutea* (Orange Milkwort) [center right] and *Xyris deforma* (Bog Yellow-eyed Grass) [right]

The natural hybrid of *Platanthera cristata* [left] with *Platanthera blephariglottis* [center] is called *Platanthera x canbyi* [right]

Adkins Arboretum is a 400-acre native garden and arboretum located within Tuckahoe State Park in Ridgely. The Arboretum grounds contain five miles of paths through meadows and native plant gardens and a "living collection" of more than 600 species of native shrubs, trees, wildflowers and grasses, used to promote land stewardship practices in the Chesapeake Bay region.[10]



Epargyreus clarus (Silver Spotted Skipper) [left], *Vanessa atalanta* (Red Admiral) [center] and *Danaus plexippus* (Monarch Butterfly) [right]

Male *Papilio glaucus* (Eastern Tiger Swallowtail) [left], female [center] and *Eurytides marcellus* (Zebra Swallowtail) [right]

Opheodrys aestivus (Rough Green Snake) [left] and a recently emerged male *Actias luna* (Luna Moth) [right]

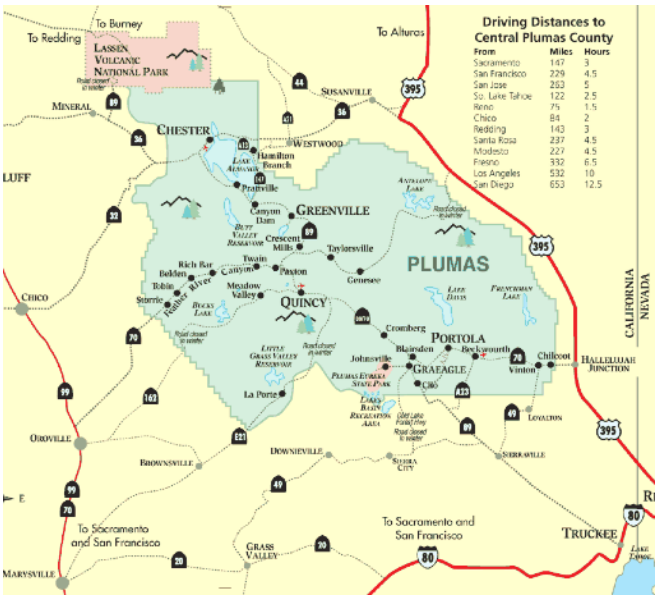


By Pocomoke State Park we found many plants of *Platanthera clavellata* (Little Spur Bog Orchid) on small hummocks in very wet forest


1) https://en.wikipedia.org/wiki/Mid-Atlantic_(United_States)
2) maps.com
3) Martin, P. What Are the Three Landform Regions of the Middle Atlantic States? 2017 https://sciencing.com/three-regions-middle-atlantic-states-8250156.html
4) National Park Service: https://www.nps.gov/dewa.
5) Polsky, Colin, et al, The Mid-Atlantic Region and its climate: past, present, and future, 2000; https://www.int-res.com/articles/cr/14/c014p161.pdf
6) NJ Pine Barrens : https://en.wikipedia.org/wiki/Pine_Barrens_(New_Jersey)
7) Pinelands Alliance: https://pinelandsalliance.org/learn-about-the-pinelands/ecosystem/habitats
8) Hazleton, Pennsylvania: https://en.wikipedia.org/wiki/Hazleton,_Pennsylvania
9) Maryland: https://www.britannica.com/place/Maryland-state/Climate
10) Adkins Arboretum: https://en.wikipedia.org/wiki/Adkins_Arboretum

THE PLUMAS NATIONAL FOREST OF THE NORTHERN SIERRA NEVADA MOUNTAINS OF CALIFORNIA

(June 2013)



The Sierra Nevada is a mountain range in the Western United States, between the Central Valley of California and the Great Basin. Its name is from the Spanish for Snowy Mountain. The vast majority of the range lies in the state of California, although the Carson Range spur lies primarily in Nevada. The Sierra Nevada is part of the American Cordillera, an almost continuous chain of mountain ranges that forms the western "backbone" of the Americas. The Sierra runs 400 miles (640 km) north-south and is approximately 70 miles (110 km) across east-west. Notable Sierra features include General Sherman, the largest tree in the world by volume; Lake Tahoe, the largest alpine lake in North America; Mount Whitney at 14,505 feet (4,421 m), the highest point in the contiguous United States; and Yosemite Valley sculpted by glaciers from one-hundred-million-year-old granite, containing high waterfalls. The Sierra is home to three national parks, twenty wilderness areas, and two national monuments. These areas include Yosemite, Sequoia, and Kings Canyon National Parks; and Devils Postpile National Monument.[1]

More than one hundred million years ago during the Nevadan orogeny, granite formed deep underground. The range started to uplift four million years ago, and erosion by glaciers exposed the granite and formed the light-colored mountains and cliffs that make up the range. The uplift caused a wide range of elevations and climates in the Sierra Nevada, which are reflected by the presence of five life zones (areas with similar plant and animal communities). Uplift continues due to faulting caused by tectonic forces, creating spectacular fault block escarpments along the eastern edge of the southern Sierra. West-to-east, the Sierra Nevada's elevation increases gradually from 500 feet (150 m) in the Central Valley to more than 14,000 feet (4,300 m) atop the highest peaks of its crest 50–75 miles (80–121 km) to the east. The height of the mountains in the Sierra Nevada increases gradually from north to south. Between Fredonyer Pass and Lake Tahoe, the peaks range from 5,000 feet (1,500 m) to more than 9,000 feet (2,700 m). The crest near Lake Tahoe is roughly 9,000 feet (2,700 m) high, with several peaks approaching the height of Freel Peak (10,881 ft or 3,317 m). Farther south, the highest peak in Yosemite National Park is Mount Lyell (13,120 ft or 3,999 m). The Sierra rises to almost 14,000 feet (4,300 m) with Mount Humphreys near Bishop, California. Finally, near Lone Pine, Mount Whitney is at 14,505 feet (4,421 m), the highest point in the contiguous United States.[1]

The climate of the Sierra Nevada is influenced by the Mediterranean climate of California. During the fall, winter and spring, precipitation in the Sierra ranges from 20 to 80 in (510 to 2,030 mm) where it occurs mostly as snow above 6,000 feet (1,800 m). Precipitation is highest on the central and northern portions of the western slope between 5,000 and 8,000 feet (1,500 and 2,400 m) elevation, due to orographic lift. Above 8,000 feet (2,400 m), precipitation diminishes on the western slope up to the crest, since most of the precipitation has been wrung out at lower elevations. Most parts of the range east of the crest are in a rain shadow, and receive less than 25 inches of precipitation per year. While most summer days are dry, afternoon thunderstorms are common, particularly during the North American Monsoon in mid and late summer. Some of these summer thunderstorms drop over an inch of rain in a short period, and the lightning

can start fires. Summer high temperatures average 42–90 °F (6–32 °C). Winters are comparatively mild, and the temperature is usually only just low enough to sustain a heavy snowpack. The growing season lasts 20 to 230 days, strongly dependent on elevation. The highest elevations of the Sierra have an alpine climate. Precipitation varies substantially from year to year. It is not uncommon for some years to receive precipitation totals far above or below normal.[1]

The ecology of the Sierra Nevada is diverse and complex. The combination of climate, topography, moisture, and soils influences the distribution of ecological communities across an elevation gradient from 500 to 14,500 feet (200 to 4,400 m). Biotic zones range from scrub and chaparral communities at lower elevations, to subalpine forests and alpine meadows at the higher elevations. The western and eastern Sierra Nevada have substantially different species of plants and animals, because the east lies in the rain shadow of the crest. The plants and animals in the east are thus adapted to much drier conditions.[1]

Plumas National Forest- Little Grass Valley Reservoir

The Plumas National Forest occupies 1,146,000 acres of scenic mountain lands in the northern terminus of the Sierra Nevada. This is just south of where the granitic bedrock of the Sierra Nevada dives below the southern extent of Cenozoic igneous surface rock from the Cascade Mountain range.[1] The Forest was named after its primary watershed, the Rio de las Plumas, or Feather River.[2] The Plumas is a transition Forest ranging from the Sierra Nevada Mountains in the south to the Cascades in the north, the Sacramento Valley uplands in the west to the Great Basin high desert in the east.[3] Plumas National Forest was established in 1905 by President Theodore Roosevelt and has been managed by the Forest Service ever since.[4] The forest is also subdivided into three Ranger Districts, the Beckwourth Ranger District, the Feather River Ranger District and the Mt. Hough Ranger District, with local management in Blairsden, Oroville, and Quincy, respectively.

The Forest has been used by humans for at least 8,000 years. It is homeland of the Mountain and Konkow tribes. Washoe and Piute also live along the Forest's current eastern boundaries. The ruggedness of the area discouraged exploration until the Gold Rush. Spanish exploration in the early 1800's was limited to the Sacramento Valley. The Hudson Bay Fur Company, however, had entered the Plumas Region by the early 1830's. Gold miners spread into the area by 1850. Although native tribes had known about the Sierra's lowest pass for centuries, James Beckwourth, an African American mountain man, did not formally "discover" it until 1851. Immigrants and miners soon began moving through the pass and into the area. Gold camps and towns sprang up almost overnight as miners searched for that elusive metal.[5] The Western Pacific Railroad through the Feather River Canyon was completed in 1909. Lumber from the Plumas forests was shipped by railroad nation-wide. The Feather River Highway (State Route 70, now a national forest scenic byway) was completed in 1937.

Today the forest provides diverse recreation opportunities and includes 414 lakes and ponds, 5,811 miles of rivers and streams, 23,777 acres of wilderness, 115 miles of Wild and Scenic Rivers, 636 meadows, 53 developed campgrounds and 8 developed picnic areas.[6] Feather Falls Scenic Area includes Feather Falls, the sixth highest waterfall in the United States. The Pacific Crest Trail that reaches from Mexico to Canada extends across the Plumas National Forest crossing two major canyons, the North Fork of the Feather River and the Middle Fork of the Feather River. Over 357,000 people visit the forest annually. There are 42 active grazing allotments on the Plumas National Forest with 24 local ranch families running 7,500 cattle pair and 1,000 sheep.[6] Timber sales are currently used to thin the forests that are overcrowded due to fire suppression and lately to also remove trees that burned in the recent wildfires.

Of great importance is the role the forest plays in providing water to much of California, in particular the arid southern parts of the state including Los Angeles. The California State Water Project (SWP) collects water from rivers in Northern California and redistributes it to the water-scarce but populous cities through a network of aqueducts, pumping stations and power plants. It was developed in 1960 and is now one of the largest public water and power utilities in the world. The Feather River, a tributary of the Sacramento River, provides the primary watershed for the State Water Project. Runoff from the Feather River headwaters is captured in Antelope, Frenchman, and Davis reservoirs, which impound tributaries of the North and Middle forks of the Feather River. Water released from the Upper Feather River system flows into Lake Oroville, which is formed by the Oroville Dam several miles above the city of Oroville. At 770 feet (230 m), Oroville is the tallest dam in the United States; by volume it is the largest dam in California. From Oroville, a regulated water flow travels down the Feather and Sacramento Rivers to the Sacramento-San Joaquin River Delta. The vast majority of the SWP water is drawn through the Delta's complex estuary system into the Clifton Court Forebay, located northwest of Tracy on the southern end of the Delta. Here, the Harvey O. Banks Pumping Plant lifts water 224 feet (68 m) into the California Aqueduct. The aqueduct then reaches A.D. Edmonston Pumping Plant, which lifts the water 1,926 feet (587 m) over the Tehachpi

Mountains that separate the San Joaquin Valley from Southern California. Together, Pyramid and Castaic Lakes form the primary storage for West Branch water delivered to Southern California. Water is supplied to municipalities in Los Angeles and Ventura counties. Through Lake Perris, the Metropolitan Water District of Southern California receives a large portion of its water from the SWP. Water is also supplied to the San Diego Aqueduct through a connection from Perris to Lake Skinner, further south. In total there are 21 dams, 5 power plants and more than 700 miles (1,100 km) of canals, pipelines and tunnels.[7] About 2.6 million acre-feet of water per year or 849 billion gallons come from the Plumas which is enough for 6.4 million households or enough drinking water for all of the state's population for 72 years![6]

The Plumas has been a logging epicenter starting with the gold rush so there is almost no accessible virgin timberland remaining. About 10% of the forest is classified as old growth with the timber being mainly found in the inaccessible steep canyons. Here at mid to higher elevations are primarily *Pseudotsuga menziesii var. menziesii* (Douglas-fir), *Pinus ponderosa* (two subspecies of Ponderosa Pine), Abies *concolor* (White Fir), *Pinus jeffreyi* (Jeffrey Pine), *Abies magnifica* (Red Fir), *Pinus contorta ssp murryana* (Sierra Lodgepole Pine), *Calocedrus decurrens* (Incense Cedar) and *Pinus lambertiana* (Sugar Pine).[11] Lower elevations on the edge of the forest have some oak woodland. Montane chaparral is found interspersed with the conifer species.[1]

A floral survey from 2005 and updated in 2012 documented just over 2,000 species of plants in the national forest and surrounding county. That is about 1/3 of the total number of native plant varieties found in the state while the area studied covers just 2% of the state![9] Some noteworthy species include *Sidalcea gigantea* (Giant Checkerbloom), *Botrychium simplex* (Little Grape Fern), *Clarkia mildrediae ssp. lutescens* (Golden-anthered Clarkia), *Drosera rotundifolia* (Round-leaved Sundew), *Erigeron lassenianus var. deficiens* (Rayless Lassen Daisy) and *Viola tomentosa* (Wooly Violet).[10] At least twenty species of orchids have been reported in the Plumas. NOC symposium participants visited Caribou Road in the Feather River Canyon and Genessee Valley east of Tayorsville. Meadow Valley, Snake Lake and Butterfly Valley were also visited near Quincy by NOC participants.

The Sierra Nevada is home to a wide variety of animals including *Ursus americanus* (Black Bear), *Bassariscus astutus* (Ringtailed Cat), *Canis latrans* (Coyote), *Sciurus griseus* (Gray Squirrel), *Lynx rufus* (Bobcat), *Odocoileus hemionus californicus* (California Mule Deer), *Spilogale gracilis* (Spotted Skunk) and *Mephitis mephitis* (Striped Skunk), *Otospermophilus beecheyi* (California Ground Squirrel), *Junco hyemalis* (Dark-eyed Junco), *Poecile gambeli* (Mountain Chickadee), *Catharus guttatus* (Hermit Thrush) and *Dendragapus obscurus* (Dusky Grouse).[1] The Plumas specifically hosts some threatened, endangered and sensitive species including *Rana aurora draytonii* (California Red-legged Frog), *Rana sierra* (Sierra Nevada Yellow-legged Frog), *Canis lupus* (Gray Wolf),[6] *Actinemys marmorata* (Northwestern Pond Turtle), *Strix occidentalis occidentalis* (California Spotted Owl), *Strix nebulosa* (Great Grey Owl) *Martes caurina* (Pacific Marten), *Pekania pennanti pacifica* (Pacific Fisher), *Gulo gulo* ssp. *luteus* (California Wolverine), *Antrozous pallidus* (Pallid Bat), and *Empidonax trailii* ssp. *brewsteri* (Willow Fly-catcher).[8]

Rana aurora ssp. *draytonii* (California Red-legged Frog) [left] and *Taricha sierrae* (Sierra Newt) [right]
Photos by Chelsea Kieffer

Actinemys marmorata (Northwestern Pond Turtle) [left] and
Crotalus oreganus ssp. *oreganus* (Northern Pacific Rattlesnake) [right]
Photos by Chelsea Kieffer

Strix occidentalis ssp. *occidentalis* (California Spotted Owl) [left] and
Tracks of *Puma concolor* (Mountain Lion) [right]
Photos by Chelsea Kieffer

[Left] Caribou Road follows the north fork of the Feather River from Highway 70 up to the Caribou Powerhouse and Butt Valley Reservoir. Water from Lake Almanor flows from Butt Valley Reservoir to the Caribou Powerhouse then down the north fork of the Feather River. Several campgrounds are along the Caribou Road including Gansner Bar, North Fork, and Queen Lily. *Lilium pardalinum* (Leopard Lily) [right] A hillside seep along Caribou Road [below]

Epipactis gigantea
(Stream Orchid)

Cypripedium californicum
(California Lady's-slipper)

Edwin Hosselkus of Genessee, New York came to this valley in 1862 and named it Genessee. He built a general store/post office, granary, creamery and blacksmith shop. The store in Genessee Valley was built in 1880 along the 1873 wagon road as a stage coach stop and is still standing today. In the forest of Genessee Valley grows the saprophytic *Sarcodes sanguinea* (Snow Plant).

Pleuricospora fimbriolata (Fringed Pinesap), a myco-heterotrophic herb [left] and *Viola lobata* (Pine Violet) [right]


Corallorhiza striata
(Striped Coralroot)
Photos by Jim Fowler


Meadow Valley, on the stage coach road from Oroville to Quincy, was a thriving community that supported goldminers back in the mid-1800s.



Cornus nuttallii (Mountain Dogwood) [left], *Pedicularis densiflora* (Warrior's Plume) [center] and *Maianthemum racemosum* (Western False Solomon's Seal) [right]

Corallorhiza maculata
(Spotted Coralroot)

Cypripedium montanum
(Mountain Lady's-slipper)

Cypripedium fasciculatum
(Clustered Lady's-slipper)

Snake Lake is located west of Quincy in the Meadow Valley area off the Bucks Lake Road, the old stage coach road from Oroville to Quincy. A campground with 17 campsites for all campers and 8 sites with corrals for equestrian campers is located along the lakeside.

Cephalanthera austiniae
(Phantom Orchid)

Butterfly Valley is named for its resemblance to a butterfly shape as seem from the top of ridges in the area. Butterfly Valley and the surrounding area have been developed since the early 1850's for many uses. Mining operations and the old mining town of Butterfly Valley occupied the area initially. After the mineral values were mined out and the town of Butterfly Valley was abandoned, grazing and logging operations were prominent in the area. Since the cessation of logging operations about 1950, the area was used primarily for grazing until designated as a botanical area in 1976. The Butterfly Valley Botanical Area was designated as a protected area due to its outstanding abundance and diversity of plant life present. Butterfly Valley has long been recognized a botanical treasure. Rebecca Merit Austin first made botanical collections in the area from 1873-1878. Walter and Irja Knight and John Thomas Howell wrote a manuscript in 1970 titled "A Vegetation Survey of the Butterfly Valley Botanical Area" after four years of field survey work. Jim Battagin updated their work in 1997 and published the "Flora of Butterfly Valley Botanical Area and the Butterfly Creek Watershed." Photo on right by Harold Carlson.

Narthecium californicum (California Bog Asphodel) [left], *Camassia leichtlinii* ssp. *suksdorfii* (Camas Lily) [center] and *Xerophyllum tenax* (Beargrass) [right]

The Butterfly Valley Botanical Area is a home of *Darlingtonia californica* (California Pitcher Plant). The California Pitcher Plant is a rare and unusual insect eating plant that only grows in scattered wet soggy areas from southern Oregon down through northern California to just north of Lake Tahoe. *Darlingtonia* has a unique leaf adaptation that allows it to capture and dissolves insects to gather nutrients for the plant. The long snakelike leaf has an opening under the top of the leaf with small sun-lit windows that attract flies, bees and other insects into the tube. The waxy smoothness of the upper portions of the chamber provides the next step in the one-way trip to the waiting doom below. The downward pointing hairs on the inside of the lower leaf tube force the insects downward toward the bottom of the pitcher where the insects are dissolved and absorbed as nutrients for the plant. In addition to the California Pitcher Plant, three other species of insectivorous plants (Common and Lesser Bladderwort and Round-leaved Sundew) are found in the Butterfly Valley area.

Drosera rotundifolia (Round-leaved Sundew) [left] and *Rhododendron occidentale* (Western Azalea) [right]

Platanthera sparsiflora
(Sparsely Flowered Bog Orchid)
Photo by Jim Fowler

Platanthera dilatata
(White Bog Orchid)

Neottia convallarioides
(Broad-leaved Twayblade)

Photos by Linnea Hanson unless otherwise noted.

1) https://en.wikipedia.org/wiki/Sierra_Nevada
2) https://en.wikipedia.org/wiki/Plumas_National_Forest
3) https://www.csustan.edu/sites/default/files/Career/offcampus/documents/MulPos-PlumNatiFore.pdf
4) http://www.exploreplumascounty.com/recreation/national-forest.htm
5) https://www.nationalforests.org/our-forests/find-a-forest/plumas
6) https://www.fs.fed.us/emc/economics/documents/at-a-glance/benefits-to-people/pacificsw/BTP-Plumas.pdf
7) https://en.wikipedia.org/wiki/California_State_Water_Project
8) Plumas National ForestWildlife & Aquatic SpeciesSmall Project Form17-20 https://www.fs.usda.gov/nfs/11558/www/nepa/106916_FSPLT3_3993088.pdf
9) Clifton, Glenn; Plumas Flora, May, 2005
10) Plumas National Forest, Feather River Ranger District, Grass Flat Hazardous Fuels Reduction and Forest Health Restoration Project https://www.fs.usda.gov/nfs/11558/www/nepa/80580_FSPLT2_264249.pdf
11) https://ucjeps.berkeley.edu/eflora/

NORTHWESTERN MINNESOTA
(July 2014)

Map of Minnesota[1] with conference location marked by * and Map of North America highlighting Minnesota.

Minnesota is the second northernmost U.S. state (after Alaska) and northernmost contiguous state, as the isolated Northwest Angle in Lake of the Woods county is the only part of the 48 contiguous states north of the 49th parallel. The state is part of the U.S. region known as the Upper Midwest and part of North America's Great Lakes Region. It shares a Lake Superior water border with Michigan and a land and water border with Wisconsin to the east. Iowa is to the south, North Dakota and South Dakota are to the west, and the Canadian provinces of Ontario and Manitoba are to the north. With 86,943 square miles (225,180 square kilometers), or approximately 2.25% of the United States, Minnesota is the 12th-largest state.[2]

Minnesota has some of the earth's oldest rocks, gneisses that are about 3.6 billion years old (80% as old as the planet). About 2.7 billion years ago basaltic lava poured out of cracks in the floor of the primordial ocean; the remains of this volcanic rock formed the Canadian Shield in northeast Minnesota. The roots of these volcanic mountains and the action of Precambrian seas formed the Iron Range of northern Minnesota. Since a period of volcanism 1.1 billion years ago, Minnesota's geological activity has been more subdued, with no volcanism or mountain formation, but with repeated incursions of the sea, which left behind multiple strata of sedimentary rock.

In more recent times, massive ice sheets at least one kilometer thick ravaged the state's landscape and sculpted its terrain. The Wisconsin glaciation left 12,000 years ago. These glaciers covered all of Minnesota except the far southeast, an area characterized by steep hills and streams that cut into the bedrock. Much of the remainder of the state has fifty feet (15 m) or more of glacial till left behind as the last glaciers retreated. Gigantic Lake Agassiz formed in the northwest 13,000 years ago. Its flat bed now is the fertile Red River valley, and its outflow, glacial River Warren, carved the valley of the Minnesota River and the Upper Mississippi downstream from Fort Snelling. Minnesota is geologically quiet today; it experiences earthquakes infrequently, most of them minor.[2]

The diversified scenery of Minnesota is due to the location of the state in the approximate center of the continent. Situated midway between the Atlantic and Pacific oceans, Hudson Bay and the Gulf of Mexico, the state has within its boundaries three principal divides in the watersheds of North America. Minnesota lacks the rugged topography and high elevations found in most continental divides. Its highest elevation, 2,300 feet on the Mesabi Range, is in close proximity to its lowest, the surface of Lake Superior, at 602 feet above the sea. The general surface of the state slopes from the north-central portion near Itasca Park, in four directions toward its distant and opposite corners.[3] Notwithstanding dramatic local differences in elevation, much of the state is a gently rolling peneplain, a more or less level land surface produced by erosion over a long period, undisturbed by crustal movement.[2]

The state's nickname "Land of 10,000 Lakes" is appropriate, as there are 11,842 Minnesota lakes over 10 acres (436,000 square feet) in size. Minnesota's portion of Lake Superior is the largest at 962,700 acres (3,896 square kilometers) and deepest [at 1,290 feet (390 meters)] body of water in the state. Minnesota has 6,564 natural rivers and streams that cumulatively flow for 69,000 miles (111,000 kilometers). The Mississippi River begins its journey from its headwaters at Lake Itasca and crosses the Iowa border 680 miles (1,090 kilometers) downstream. It is joined by the Minnesota River at Fort Snelling, by the St. Croix River near Hastings, by the Chippewa River at Wabasha, and by many smaller streams. The Red River drains the northwest part of the state northward toward Canada's Hudson Bay. Approximately 10.6 million acres (16,600 square miles/ 43,000 square kilometers) of wetlands are within Minnesota's borders, the most of any state outside Alaska.[2]

Minnesota has four ecological provinces: prairie parkland, in the southwestern and western parts of the state; the eastern broadleaf forest (Big Woods) in the southeast, extending in a narrowing strip to the state's northwestern part, where it transitions into tallgrass aspen parkland; and the northern Laurentian mixed forest, a transitional forest between the northern boreal forest and the broadleaf forests to the south. These northern forests are a vast wilderness of pine and spruce trees mixed with patchy stands of birch and poplar.[2]

Much of Minnesota's northern forest has undergone logging, leaving only a few patches of old growth forest today in areas such as in the Chippewa National Forest and the Superior National Forest, where the Boundary Waters Canoe Area Wilderness has some 400,000 acres (625 square miles/ 1618 square kilometers) of unlogged land. Although logging continues, regrowth and replanting keep about a third of the state forested. Nearly all Minnesota's prairies and oak savannas have been fragmented by farming, grazing, logging, and suburban development.[2]

While loss of habitat has affected native animals such as *Martes americana* (Pine Marten), *Cervus canadensis* (Elk), *Rangifer tarandus caribou* (Woodland Caribou), and *Bison bison* (Bison), others like *Odocoileus virginianus* (White-tailed Deer) and *Lynx rufus* (Bobcat) thrive. Minnesota has the nation's largest population of *Canis lupus lycaon* (Timber Wolf) outside Alaska, and supports healthy populations of *Ursus americanus* (Black Bear), *Alces alces* (Moose), and gophers. Located on the Mississippi Flyway, Minnesota hosts migratory waterfowl such as geese and ducks, and game birds such as grouse, pheasants, and turkeys. It is home to birds of prey, including the largest number of breeding pairs of *Haliaeetus leucocephalus* (Bald Eagle) in the lower 48 states as of 2007. Hawk Ridge is one of the premier bird watching sites in North America. The lakes teem with sport fish such as Walleye, bass, Muskellunge, and Northern Pike, and Brook, Brown, and Rainbow Trout populate streams in the southeast and northeast.[2]

Minnesota experiences temperature extremes characteristic of its continental climate, with cold winters and hot summers. The lowest temperature recorded was −60 °F (−51 °C) at Tower on February 2, 1996, and the highest was 114 °F (46 °C) at Moorhead on July 6, 1936. Meteorological events include rain, snow, blizzards, thunderstorms, hail, derechos, tornadoes, and high-velocity straight-line winds. The growing season varies from 90 days in the far northeast to 160 days in southeast Minnesota near the Mississippi River, and average temperatures range from 37 to 49 °F (3 to 9 °C). Average summer dew points range from about 58 °F (14 °C) in the south to about 48 °F (9 °C) in the north. Average annual precipitation ranges from 19 to 35 inches (48 to 89 cm), and droughts occur every 10 to 50 years.[2]

Minnesota has 72 state parks and recreation areas, 58 state forests covering about four million acres (6,178 square miles/ 16,000 square kilometers), and numerous state wildlife preserves, all managed by the Minnesota Department of Natural Resources. Minnesota's first state park, Itasca State Park in the Northwestern quadrant, was established in 1891, and is the source of the Mississippi River and was the site of the NOC symposium in 2014. There are over 100 lakes in the park including Lake Itasca.[2]

Northwestern Minnesota is a vast plain in the bed of Glacial Lake Agassiz. This plain extends north and northwest from the Big Stone Moraine, beyond Minnesota's borders into Canada and North Dakota. In the northeast, the Glacial Lake Agassiz plain transitions into the forests of the Arrowhead. The region includes the lowland portions of the Red River watershed and the western half of the Rainy River watershed within

the state, at approximately the level of Lake Agassiz's Herman Beach. In ecological terms, it includes the Northern Minnesota Peatlands of the Laurentian Mixed Forest, the Tallgrass Aspen Parklands, and the Red River Valley Section of the Prairie Parklands.[6]

Lake Itasca, in Itasca State Park, is a small glacial lake, approximately 1.8 square miles (4.7 square kilometers; 1,200 acres) in area. It has an average depth of 20 to 35 feet (6.1 to 10.7 meters) and is 1,475 feet (450 meters) above sea level. The Lake Itasca region claims a unique location, not only at the headwaters of the Mississippi River and amidst 25% of the old growth forest of Minnesota, but also at the juncture of the three great habitats of North America: the Great Plains, the Deciduous Forest of the south, and the Coniferous Forest of the north. Remnants of all three may be observed in the park.[4] Itasca is notable for its bogs—wetlands that preserve plant material as peat. Bogs support a variety of rare flora, including fungi, mosses, lichens, orchids and insectivorous plants such as pitcher plant and sundews.[5] At marginally higher elevations within these wetlands are areas of *Picea mariana* (Black Spruce), *Larix laricina* (Tamarack), and other water-tolerant species.[6] All of these factors contribute to a wide variety of orchid species, making this an ideal venue for our symposium.

Itasca State Park: Lake Itasca [left] and wooded forest in the park [right]
Itasca State Park was established in 1891 and is Minnesota's oldest state park. The park was created to preserve remnant stands of virgin pine and to protect the basin around the Mississippi River source. Today, the park has more than 32,000 acres and over 100 lakes. You can walk across the mighty Mississippi as it starts its journey to the Gulf of Mexico.

Douglas Lodge [left] and cabins [right]. Photos by Jim Fowler

The historic Douglas Lodge was built in 1903 to 1905 in the heart of Itasca State Park. It contains guest rooms, meeting rooms, a full service restaurant and fireplace lobby. A variety of other lodging facilities is available including log cabins, four-plex units and the historic East Station cabin.

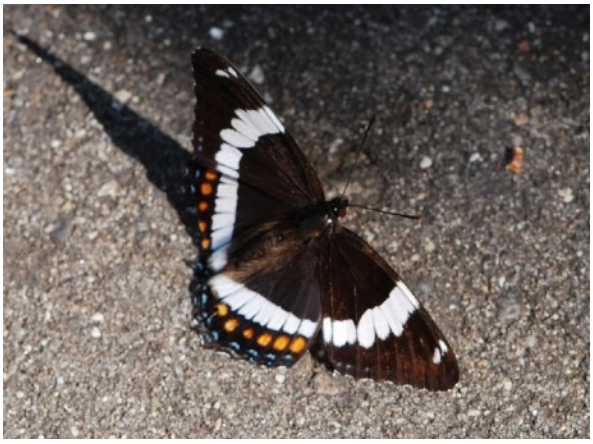
Jacob V. Browser Visitor Center [left] and Mary Gibbs Mississippi Headwater Center [right]

Participants in the 2014 Native Orchid Conference symposium utilized the lodging facilities at Itasca State Park and in the surrounding towns. The Symposia talks were held at the Jacob V. Browser Visitor Center. The Wilderness Drive provided an overall view of the surrounding area. Participants spent time at stops along the drive including the Civilian Conservation Corp (CCC) Forestry Demonstration Trail and the Large White Pine. The Mary Gibbs Mississippi Headwater Center was also visited by many of the participants.


Goodyera tesselata
(Checkered Rattlesnake Plantain)
Photos by Jim Fowler



Achillea multifolium (Common Yarrow) [left], *Asclepias syriaca* (Common Milkweed) [center] and *Campanula rotundifolia* (Small Bluebell) [right]

Silene latifolia ssp. *alba* (White Campion) [left] and *Limenitis arthemis* (White Admiral Butterfly) [right]

The start of the Mississippi River. Center and right photos by Jim Fowler

Only two miles northwest of Lake Itasca and the storied headwaters of the Mississippi, the Iron Springs Bog Scientific and Natural Area has its own distinctions. Generations of students from the nearby University of Minnesota Itasca Biological Station have spent time along Sucker Creek and its nameless tributary here, conducting research and using this SNA as a field study site.

Technically speaking, Iron Springs Bog has no bog. Red and Jack Pine occupy the drier ridge tops and upland slopes. Boreal forest occupies lower slopes, with Balsam Fir, White Spruce, Paper Birch and Trembling Aspen. Bordering the creeks is a conifer swamp forest: a wetland type more typically dominated by White Cedar, but here by Black Spruce.

The interesting twist is that this conifer swamp forest is situated on a seepage slope associated with a gravel moraine rather than in a depression. Mineral-rich groundwater comes to the surface in upwellings and springs along this seepage slope. For plants, this water contains the macro-nutrients calcium and magnesium as well as iron, a micro-nutrient needed in small but essential amounts to produce chlorophyll. Orange pools—the telltale sign of iron—dot the carpet of moss.

The existence of this "groundwater-influenced sloping forested peatland" with its distinctive flora not typical of conifer swamp forests, led to designation of this site as an SNA.

The varying water chemistry across the site has led to an interesting assembly of plant species including the carnivorous pitcher plant and Round-leaved Sundew, and a diversity of orchids. Among the rare, state-listed species that flourish here are *Agrostis hyemalis* (Winter Bentgrass), *Malaxis paludosa* (Bog Adder's mouth) and *Cypripedium arietinum* (Ram’s Head Lady’s-slipper).

Hammarbya paludosa
(Bog Adder's Mouth)
Photo by Jim Fowler

Malaxis monophyllos
(White Adder's Mouth)
Photo by Jim Fowler

Malaxis unifolia
(Green Adder's Mouth)
Photo by Jim Fowler

Platanthera huronensis
(Lake Huron Bog Green Orchid)
Photo by Jim Fowler

Platanthera dilatata
(White Bog Orchid)
Photo by Jim Fowler

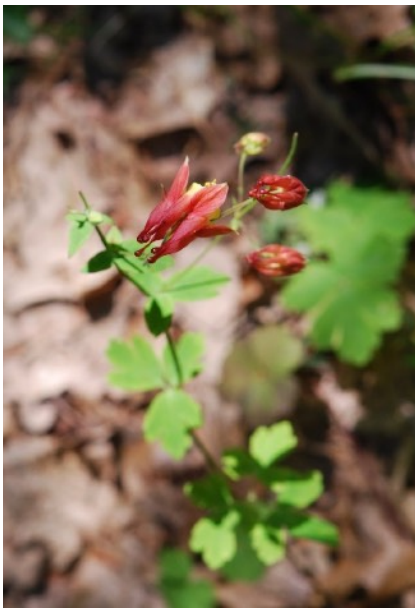
Platanthera orbiculata
(Round Leaved Orchid)
Photo by Jim Fowler

Neottia cordata
(Heart Leaved Twayblade)
Photo by Jim Fowler

Cypripedium reginae
(Showy Lady's-slipper)

Pyrola asarifolia
(Pink Pyrola)

Actaea rubra (Baneberry) [left], *Anemone Canadensis* (Canada Windflower) [center]
and *Sarracenia purpurea* (Purple Pitcher Plant) [right]



Pennington Bog Scientific and Natural Area is located off of the Lady Slipper Scenic Byway, near Bemidji. A major effort was undertaken with the help of local organizations and community volunteers to salvage, store and re-plant lady's-slipper orchids growing naturally along the roadway during a multi-phase road construction project. Included in this project was the creation of a parking lot with a small boardwalk overlooking a variety of orchids salvaged during the road construction. Photo [left] by Chelsea Kieffer. Pennington Bog is located within lowland coniferous forest on the Chippewa National Forest. It can be characterized as a northern cedar swamp community. Peaty, mucky soils have formed on the near-level terrain, in the ground moraine that was deposited by the retreating Des Moines lobe of the late Wisconsin glaciation. The water table is at or near the surface throughout the bog with Sucker Creek that bisects the site as it flows from Kitchi Lake to Popple Lake. Sphagnum moss, insectivorous pitcher plants and many orchid species are found beneath a canopy of White Cedar, Balsam Fir, and Black Spruce. *Aquilegia canadensis* (Columbine) [right] was found growing in the bog area.

Pennington Bog and boardwalk

Goodyera repens
(Dwarf Rattlesnake Plantain)
Photos by Jim Fowler

Calopogon tuberosus
(Tuberous Grass Pink)

Platanthera aquilonis
(North Wind Bog Orchid)
Photo by Jim Fowler

Liparis loeselii
(Loesel's Wide Lipped Twayblade)
Photo by Jim Fowler

Corallorhiza trifida
(Early Coralroot)
Photo by Jim Fowler

The Native Orchid Conference visited the prairie habitat in northwestern Minnesota to see *Platanthera praeclara* (Western Prairie Fringed Orchid) [right]. After a seedling has a green leaf it take six years before the first flowers are produced. This species is known to live for about 25 years. Currently a count is kept of all the known plants across the range of this species due to its rarity. Only the flowering plants have been consistently counted since the non-flowering plants are hard to find in the prairie. Approximately one percent of Minnesota's original tallgrass prairie remains with most being tilled by early European settlers for agriculture. Northwestern Minnesota prairie types range from dry to wet. Minnesota's wildflowers, both in the prairie and in other parts of the state, are lovely to look at but please leave them in the ground for all to enjoy.

Prairie wildflowers seen in the northwestern prairie include *Lilium philadelphicum* (Prairie Lily) [left], *Dalea purpureum* (Purple Prairie Clover) [center left], *Rubdeckia hirta* (Black-eyed Susan) [center right] and *Stachys palustris* (Hedge Nettle) [right]

Platanthera psycodes
(Small Purple Fringed Orchid)

Potentilla sp.
(Cinquefoil)

Asclepias incarnata (Swamp Milkweed) [left], *Solidago juncea* (Early Goldenrod) [center] and *Asclepias tuberosa* (Butterflyweed) [right]



Monarda fistulosa (Wild Bergamot) [left], *Lilium superbum* (Turk's Cap Lily) [center] and *Veronicastrum virginicum* (Culver's Root) [right]

Impatiens capensis (Jewelweed)

Photos by Linnea Hanson unless otherwise noted.

1) www.FreeWorldMaps.net

2) https://en.wikipedia.org/wiki/Minnesota

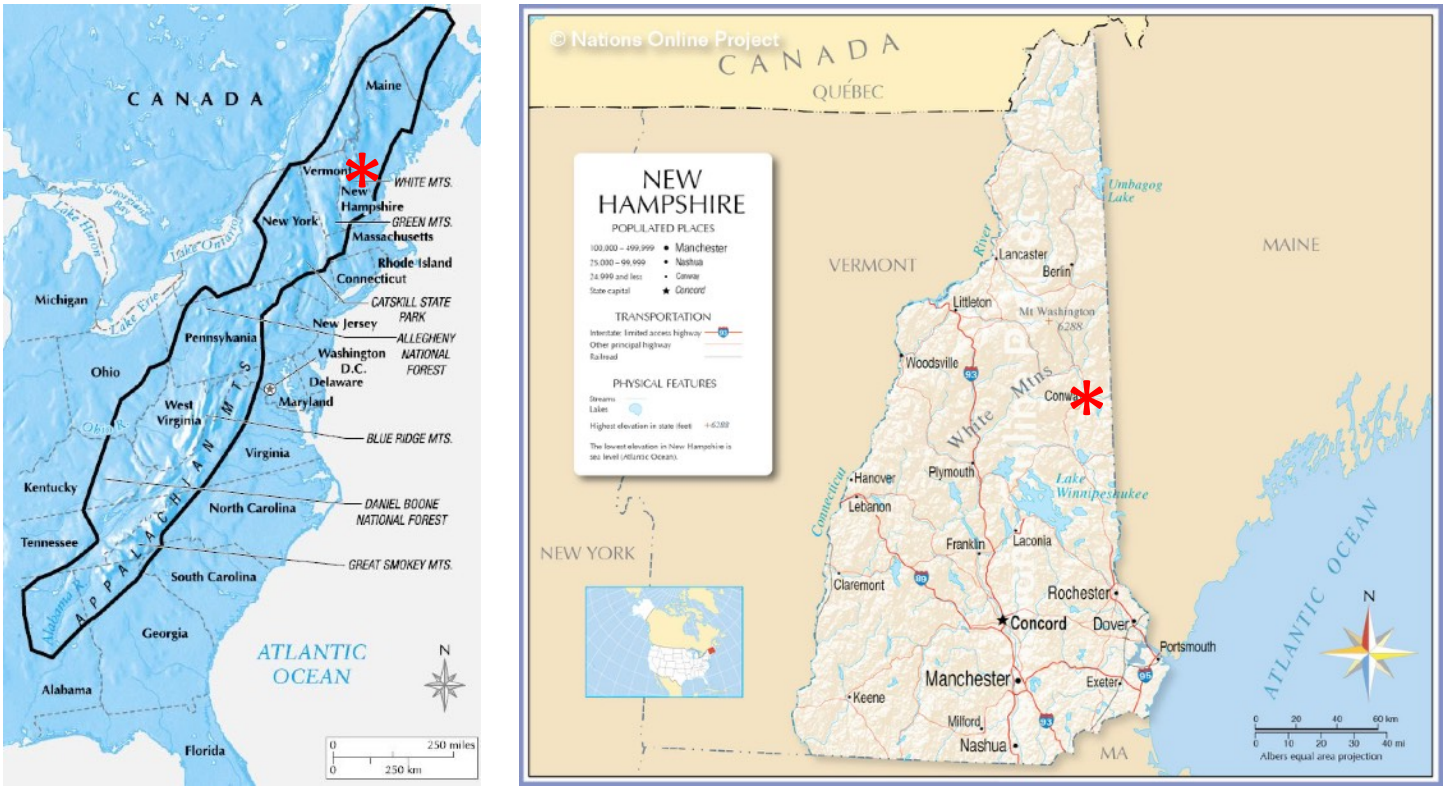
3) http://roadmarker.geosocmn.org/content/geology-minnesota-lake-itasca

4) https://en.wikipedia.org/wiki/Lake_Itasca

5) https://cbs.umn.edu/itasca/about/geological-history

6) https://en.wikipedia.org/wiki/Geology_of_Minnesota

THE WHITE MOUNTAINS OF NEW HAMPSHIRE
(June 2015)



Maps showing the extent of the Appalachian Mountains and New Hampshire with the White Mountains indicated (*)[1,2]

The White Mountains are an 87 mile (140 km) long mountain range covering about a quarter of the state of New Hampshire and a small portion of western Maine. They are part of the northern Appalachian Mountains and the most rugged mountains in New England. Most of the area is public land, including the White Mountain National Forest and a number of state parks. Its most famous mountain is 6,288-foot (1,917 m) Mount Washington, which is the highest peak in the Northeastern U.S. and for 76 years held the record for fastest surface wind gust in the world (231 miles per hour (372 km/h) in 1934). Mount Washington is part of a line of summits, the Presidential Range, that are named after U.S. presidents and other prominent Americans. The White Mountains also include the Franconia Range, Sandwich Range, Carter-Moriah Range and Kinsman Range in New Hampshire, and the Mahoosuc Range straddling the border between it and Maine. In all, there are 48 peaks within New Hampshire as well as one (Old Speck Mountain) in Maine over 4,000 feet (1,200 m), known as the four-thousand footers.[3] The northeastern edge of the mountains is marked by the Ammonoosuc and Androscoggin river valleys.[4]

A view of the White Mountains. Photo by Duane Erdmann

The White Mountains are a physiographic section of the larger New England province, which in turn is part of the larger Appalachian physiographic division. The magma intrusions forming the White Mountains today were created 124 to 100 million years ago as the North American Plate moved westward over the New England hotspot. Widespread evidence of glaciation may be seen in the U-shaped form of various notches, or mountain passes. Glacial cirques form the heads of Tuckerman Ravine on Mt. Washington. Glacial striations are visible at numerous locations in the range.[3] The Connecticut River that separates New Hampshire and Vermont is the junction of two tectonic plates.

New Hampshire has a humid continental climate with warm, humid summers and cold, snowy winters. The climate varies between hot summers in the south to cold summers and subarctic winters in the north - the Atlantic Ocean influences the weather in the southeastern part of New Hampshire, while mountain ranges hold sway in the north. Summers have average daytime highs in the 70°F (21.1°C) to 85°F (29.4°C) range at the peak of July and are warm and humid. Winters have average lows in the -4°F (-20°C) to 15°F (-9.4°C) range in January and are cold, icy and snowy. The northern wilderness regularly drops below 0°F (-17.8°C) during the winter. Nashua recorded New Hampshire's highest temperature of 106°F (41.1°C) on July 4, 1911, while Mount Washington recorded the lowest temperature of -47°F (-43.9°C) on January 29, 1934.[5] In Conway (near the NOC venue) temperatures average a high of 27 °F (-2.8°C) and a low of 8 °F (-13.3°C) in January and a high of 81°F (27.2°C) and a low of 57°F (13.9°C) in July.

Spring and summers produce moderate rain and are prone to thunderstorms. Snowstorms are frequent during the winter. Strong arctic winds sweep through the Canadian plains and reach unabated to the northern frontiers of New Hampshire. The northern mountain ranges protect the southern part of the state from the cold fronts, and the Atlantic Ocean regulates temperatures in the southeast. New Hampshire averages an annual rainfall of 40" (1016 mm) with significant variations in the White Mountains range and northern highlands. Rain is evenly distributed throughout the year. Snowfall is heavy during the winter and accumulates 60" (1524 mm) to 100" (2540 mm) statewide with a higher range in the mountains. Conway gets about 50” (1270 mm) of rain annually and 77” (1956 mm) of snow.[5]

New Hampshire is prone to wildfires, thunderstorms, hurricanes, and tornadoes in late spring and summer. Cyclones that originate in the Atlantic Ocean affect the state, and at least two tornadoes every year mark their presence in the state.[5]

The White Mountains are home to wildlife species including *Haliaeetus leucocephalus* (Bald Eagle), *Procyon lotor* (Raccoon), *Castor canadensis* (Beaver), *Odocoileus virginianus* (White-tailed Deer), (*Alces alces* (Moose), *Ursus americanus* (Black Bear), *Canis latrans* (Coyote), *Falco peregrinus* (Peregrine Falcon), *Lynx canadensis* (Canadian Lynx), *Lontra canadensis* (River Otter), *Lynx rufus* (Bobcat), *Urocyon cinereoargenteus* and *Vulpes vulpes* (Gray and Red Foxes), *Pekania pennanti* (Fisher), *Neovison vison* (Mink) and *Erethizon dorsatum* (Porcupine).[6] The White Mountains draw birders in search of over 200 species including *Falcipennis canadensis* (Spruce Grouse), *Picoides arcticus* (Black-backed Woodpecker), *Poecile hudsonicus* (Boreal Chickadee), *Catharus bicknelli* (Bicknell’s Thrush) as well as warblers, flycatchers, crossbills and grosbeak.[8]

Some of the symposium attendees went moose-watching. Here a male and female Moose (*Alces alces*), the largest member of the deer family. Photos by Duane Erdmann

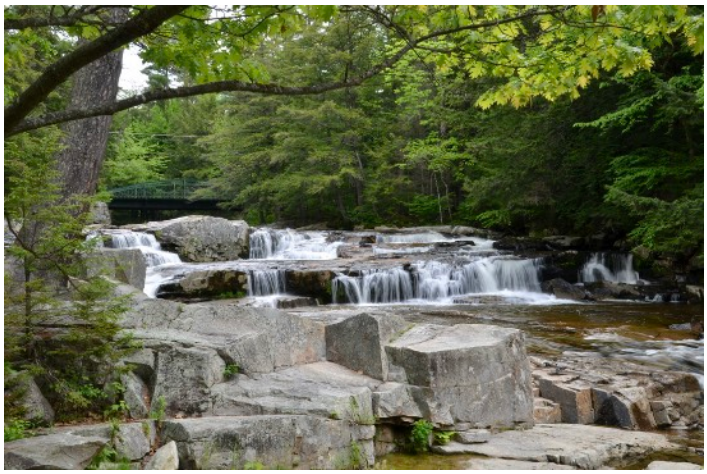
Coniferous forests are found in the White Mountain regions and the northern parts of New England Uplands, primarily the middle interior of Maine and northwards and especially in areas between 4,265 feet (1300 meters) and 2,953 feet (900 meters) elevation. The coniferous forest goes by many names, including: Boreal forest, Fir-spruce forest, the North Woods, and the Taiga. It is noted in New England for its "harsh" conditions such as cold, subarctic temperatures, a short growing period, sandy-gravely acidic soil, and a high rate of leeching of nutrients out of the soil.[7]

Representative forest of the White Mountains. Photos by Duane Erdmann

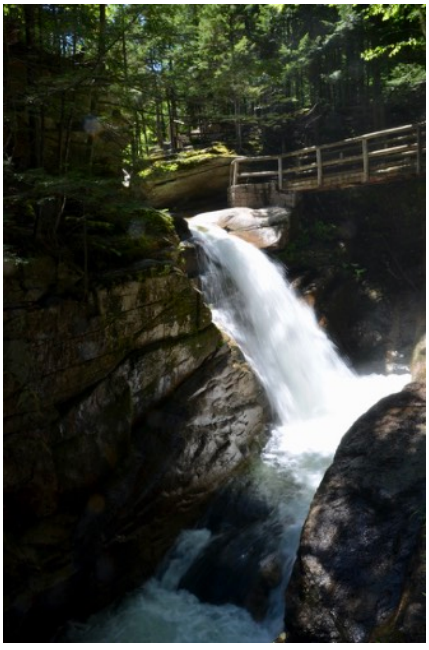
The dominant canopy species of this area include *Pinus resinosa* (Red Pine), *Abies balsamea* (Balsam Fir), *Betula papyrifera* (Paper Birch), *Picea rubens* (Red Spruce), which northwards, is replaced by *Picea glauca* (White Spruce). Also present are *Pinus banksiana* (Jack Pine) and *Pinus strobus* (White Pine) which is found in areas of richer soil in the lower elevations of this forest. The presence of *Betula papyrifera*, a successional species, is often an indication of past disturbances such as fire or logging in the forest. Typical woody understory and shrub layer species include *Acer pensylvanicum* (Moosewood), *Vaccinium angustifolium* (Low Bush Blueberry) and other heath species, especially the genera *Gaylussacia* and *Vaccinium*. Woody plants of the ground cover layer include *Gaultheria procumbens* (American Wintergreen) and *Mitchella repens* (Partridge Berry). Common wildflowers include *Trientalis borealis* (Star Flower), *Clintonia borealis* (Bluebead Lily), *Tiarella cordifolia* (Foam Flower), *Cornus canadensis* (Bunchberry), *Linnaea borealis* (Twinflower), *Dalibarda repens* (Dewdrops), *Aralia nudicaulis* (Wild Sarsaparilla), and *Maianthemum canadense* (Canada Mayflower). Trilliums, and lady slippers (genus *Cypripedium*) are also common showy wildflowers. The herbaceous layer also includes many mosses, lichens, and ferns. *Pteridium aquilinum* (Bracken Fern) is often particularly abundant in these communities.[7]

Clintonia borealis (Bluebead Lily). Photos by Jim Fowler

Aralia nudicaulis (Sarsaparilla) [left], *Rhododendron canadense* (Canada Rosebay) [top right] and *Cornus canadensis*, (Bunchberry) [bottom right]. Photos by Jim Fowler



Papilio canadensis (Canadian Tiger Swallowtail) [left] and a waterfall along the Kancamagus Highway [right] Photos by Chelsea Kieffer



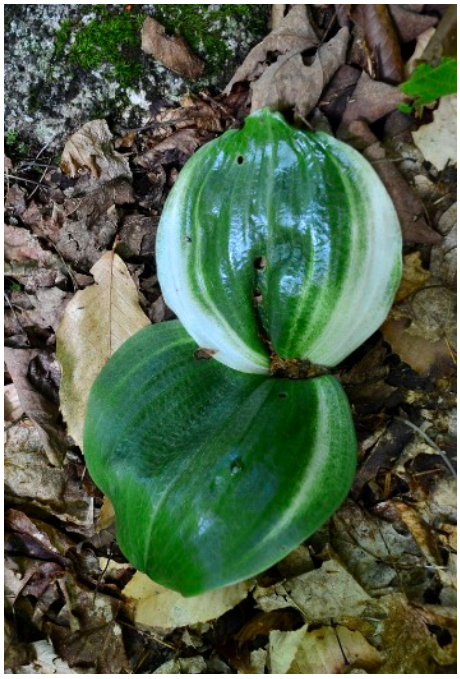
There are many recreational opportunities in the area and beautiful places to explore. Sabbaday Falls [left] and Madison Boulder, a glacial erratic [right]. During the glacial period over 25,000 years ago a great ice sheet more than a mile thick moved over the area. The mass of ice was powerful enough to move both large and small boulders. As the ice sheet retreated, these boulders were left behind. Madison Boulder is one of the largest glacial erratics in the world. It is 87 feet long, 23 feet wide and 37 feet high. Its estimated weight is 4,662 tons. Photos by Chelsea Kieffer

Corallorhiza trifida
(Early Coralroot)
Photo by Jim Fowler

Isotria medeoloides
(Small Whorled Pogonia)
Photo by Jim Fowler

Coeloglossum viridis
(Frog Orchid)
Photo by Duane Erdmann

Cypripedium parviflorum
(Yellow Lady's-slipper)
Photo by Chelsea Kieffer



Platanthera orbiculata
(Round Leaved Orchid)
Photo by Chelsea Kieffer

This area had exceptional colonies of the *Cypripedium acaule* (Pink Lady's-slipper) ranging from the typical pink ones to the white form. Photos by Jim Fowler

An optional field trip during the symposium was to see the alpine gardens atop Mt. Washington. Mt. Washington, at 6,288 feet in elevation, is the highest peak in the northeastern United States. To get to the summit one can hike, take the cog railway, or drive the auto road. Photos by Chelsea Kieffer

Before the auto road was built in 1861, tourists could only access the summit by foot or on horseback. Tourism grew in the mid-1800's and The Tip-Top House was built in 1853. The Tip-Top House served as an overnight hostel for visitors and in 1877 it became the first printing office for *Among the Clouds* newspaper. More development occurred at the summit, but most of the buildings were destroyed by fires. The current Tip-Top House [right] was restored in 1978.[9] The original stage office was built in 1908 and served as the first home of the Mount Washington Observatory from 1932 to 1937. In a great storm on April 12, 1934 the crews instruments measured a wind velocity of 231 miles per hour, the highest wind ever observed by man! The building was replaced in 1976 [left]. Photos by Chelsea Kieffer

Rhododendron lapponicum (Lapland Azalea) [left], *Kalmia procumbens* (Alpine Azalea) [center] and *Diapensia lapponica* (Lapland Pincushion Plant) [right]. Photos by Chelsea Kieffer

An optional pre-symposium field trip was held in Manchester, NH where we toured the gardens and greenhouses of Dr. George Newman, a pathologist and horticulturist. Photos by Chelsea Kieffer

The group carpooled to take a tour of Ponemah Bog Wildlife Sanctuary with Dr. George Newman [top right]. The sanctuary features a three-acre pond surrounded by a floating sphagnum mat and encircled by upland oak-pine woods. *Cypripedium acaule* (Pink Lady's-slipper) [top left], cranberry and sundews line the boardwalk [bottom left] and *Sarracenia purpurea* (Purple Pitcher Plant) [bottom right]. Photos by Chelsea Kieffer

An optional post-symposium field trip to a hardwood forest in central Vermont

Platanthera hookeri
(Hooker's Bog Orchid)
Photo by Duane Erdmann

Goodyera pubescens
(Downy Rattlesnake Plantain)
Photo by Chelsea Kieffer

Galearis spectabilis
(Showy Orchis)
Photo by Chelsea Kieffer

1) Map of New England: Encyclopedia Britannica
2) Map of New Hampshire: https://www.nationsonline.org/oneworld/map/USA/new_hampshire_map.htm
3) https://en.wikipedia.org/wiki/White_Mountains_(New_Hampshire)
4) https://www.britannica.com/place/White-Mountains-Maine-New-Hampshire
5) https://www.weather-us.com/en/new-hampshire-usa-climate
6) White Mountain National Forest: https://en.wikipedia.org/wiki/White_Mountain_National_Forest
7) New England-Acadian forests: https://en.wikipedia.org/wiki/New_England%E2%80%93Acadian_forests
8) White Mountain birdwatching: https://twinmountain.org/bird-watching/
9) https://www.nhstateparks.org/getmedia/8c627b69-1a70-4aef-947c-45fd3a7536a6/MountWashingtonStatePark_TipTopHouse_2010.pdf

SOUTHERN ARIZONA'S SKY ISLANDS:
SANTA CATALINA AND CHIRACAHUA MOUNTAINS
(August 2016)

Thimble Peak (5,323 feet/1,622 meters elevation) in the Santa Catalina Mountains north of Tucson, AZ.

Map of Arizona showing the two mountain ranges visited.

After the Ice Age, between 20,000 and 10,000 years ago, the American Southwest region was subjected to increasing atmospheric warming. The plains and valleys among the wooded mountainous areas became deserts and the peaks became isolated. Now called Sky Islands, these high altitude forests differ greatly from the surrounding environment and are unique.[4] As the elevation changes, so do the surrounding ecosystems. With increasing altitude there are decreasing temperatures. The higher up you go, the less breathable oxygen there is in the air. Conditions often vary from the bottom of these ranges to the top.[5] At the lower elevations the climate often has hot summers and mild winters. Near the higher elevations there are more mild summers and frigid winters. When it is raining at the lower elevations it could be snowing higher up. Precipitation closer to the surrounding desert is low, about 15 inches per year, while higher up it is significantly greater. The higher elevation creates different weather conditions from the lower valleys.[1] There are 27 of these sky islands in the United States and seven in Arizona.[6] These seven are part of the Madrean sky islands, the most studied of this phenomenon in the world. This group is located in the U.S. states of Arizona and New Mexico and the Mexican states of Sonora and Chihuahua. The mountains form links in a chain connecting the southern Colorado Plateau and the northern terminus of the Sierra Madre Occidental which are located at the intersection of the ecosystems of the Sonoran and Chihuahuan Deserts and the Rocky and Sierra Madre Mountains. Temperate and tropical zones meet here.[4] Because of these factors there is extraordinary biodiversity and more species of mammals, birds, reptiles, ants and bees found here than in any other place in the country.[2] The flora is equally diverse. When one speaks of world biomes, these areas have several. A biome is a large area of plant and animal groups that are adapted to a specific environment. Climate and geology play an important role in the description of these zones. In the Arizona sky islands one can see desert, grasslands, deciduous forest, coniferous forest and chaparral.[1] One description for the Madrean sky islands defines them as mountains that rise 3,000 feet or higher in elevation, have oak woodland habitat and are isolated from surrounding ranges by lower elevation grassland or desert. In addition, some habitats are characterized by pine (particularly *Pinus ponderosa*, Ponderosa pine) forests or spruce-fir-aspen forests.[5] This area is unique too in its mix of floralistic affinities, meaning that plants of the lower elevations have ties to the desert and mountains of the south while the flora of the higher elevations are more characteristic of our northern latitudes.[4]

Some sky islands can serve as a refuge for boreal species stranded by warming climates since the last glacial period. In other cases localized populations can move towards speciation and often these become endemic to the sky islands. A few examples of such species are *Yucca* × *schottii* (Mountain or Schott's Yucca), *Tamiasciurus hudsonicus grahamensis* (Mt. Graham Red Squirrel), *Pyrgulopsis thompsoni* (Huachuca Springsnail), *Plethodon neomexicanus* (Jemenez Mountains Salamander),[4] *Trogon elegans* (Elegant Trogon), *Rhynchopsitta pachyrhyncha* (Thick-billed Parrot) and *Antrostomus ridgwayi* (Buff-collared Nightjar).[2]

Altitudinal migration (moving from one elevation to another and back) can be seen in the sky islands. Interestingly, the sky islands can act not only as barriers to biological dispersal but also a path to migration and extending of ranges north or south. Unfortunately, these isolated places can also lead to the demise of a species due to being vulnerable to forces of extinction.[4]

The Catalina Mountains are one of Arizona's sky islands and are located just to the north/northeast of Tucson. The range provides a picturesque view from the city and a perfect background to the Tucson skyline. The Santa Catalina Reserve was created in 1902 to remove the land from public domain. In 1908, it was combined with two other nearby national forests (Dragoon and Santa Rita) to create the present Coronado National Forest.[7] The highest point in the Catalinas is Mount Lemmon at an elevation of 9,157 feet (2,791 m) above sea level. The village of Summerhaven on Mount Lemmon serves as a popular summer retreat from the heat of Arizona's lower deserts. Mount Lemmon Ski Valley is also notable as it is the southernmost ski destination in the United States. Mount Lemmon is named after Sara Lemmon, a plant collector and the first white woman to ascend the peak in 1881. It is one of the few peaks in the U.S. named after a woman.

Geologically, the basement rock of this part of Arizona is 1.65 billion years old. The formation of the Santa Catalina Mountains from these deeply buried rocks began about 35 million years ago when molten magma was pushed upward through the Catalina fault. A second period of extension began about 15 million years ago and broke the crustal rocks of western North America into blocks, separated by new, more steeply dipping faults. In southern Arizona, some of these crustal blocks were further uplifted to form mountain ranges such as the Santa Catalinas. The mountains contain sedimentary, igneous and metamorphic rocks. Millions of years of erosion, weathering and other forces have shaped the mountains into what we see today.[8]




The road from Tucson to Mt. Lemmon and the Catalina Mountains takes you through parts of Saguaro National Monument in the Sonoran Desert where many varieties of cacti can be seen including the park's namesake, the *Carnegiea gigantea* (Giant Saguaro). The remarkable 30 mile long Mt. Lemmon Highway (General Hitchcock Highway) took 8,000 federal prisoners 18 years to construct and was opened in 1948. It was officially designated as the Sky Island Scenic Byway in 1995 due to its exceptional vistas and landscapes. It starts at 2,200 feet (677 meters) elevation and ends at the summit of Mt. Lemmon, a gain of almost 7,000 feet (2,154 meters). One passes through the ecological equivalent of traveling from Mexico to Northern Canada with a rainfall gradient of 17 inches (43 cm) annually in Tucson to 29 inches (74 cm) at the top. Mt. Lemmon gets about 65 inches (165 cm) of snowfall annually making up about 6.5 inches (16.5 cm) of the total annual precipitation.

Gopherus morafkai (Sonoran Desert Tortoise) [left] can live to 40 years of age. A desert tortoise may spend up to 95 percent of its life in shelters, only emerging to feed, bask and breed when the weather allows, mostly during the monsoon season, typically July – October. In fact, it will get most of its food for the entire year during this period. It eats the leaves, stems and flowers of many species of desert plants. *Moneilema gigas* (Cactus Longhorn Beetle) [right], is a large, flightless, black beetle native to the Sonoran desert at elevations below 5,000.' The front wings are fused forming a single, hardened shell. It normally feeds on chollas and prickly pear cacti, and is known to feed on saguaro seedlings. Larvae bore into cactus roots and stems, sometimes killing more susceptible individuals. Adults also feed on the surface of cacti. The beetles are most active during mid or late summer - the adults typically emerging during the summer monsoon season.

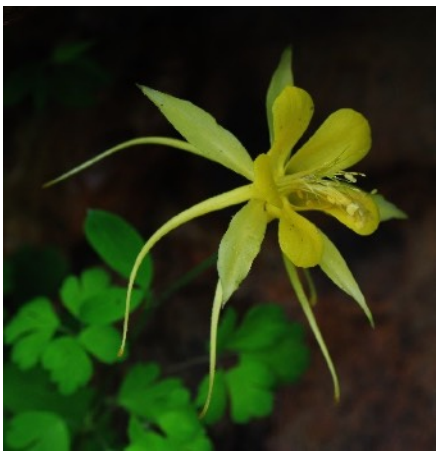
Cylindropuntia fulgida (Jumping, Hanging Chain or Chain Fruit Cholla) is a tree-like cactus that can grow to 13 feet (4 meters) tall. As the spiny sections detach easily, an animal stepping nearby on the soft soil can make the plant lean in that direction causing parts to fall, giving the appearance that the plant is jumping. Sharp spines allow the stems to attach to the animal and are carried and dropped where a new plant will grow.

Typical pine forest at the mid to upper elevations of the mountains.

The leaves of the orchid *Schiedeela arizonica* (Fallen Ladies'-tresses) [left] emerge in the summer, well after the flowers have finished blooming in May. It has small tubular white to rose to tan flowers on 4-10 inches (10.6-25.4 cm) tall stems. It prefers shaded forests at elevations of 6,500-9,300 feet (2,000-2,862 meters). Tall *Pteridium aquilinum* (Bracken Fern) cover the forest floor where we found a couple of orchid species [right].


Malaxis soulei (Mountain Malaxis or Rat-tailed Adder's Mouth) is found in southern Arizona and parts of Texas as well as into Mexico and Central America at 6,000-9,000 feet (2,000-2,769 meters) elevation. Plant height is from 4-11" (10-28 cm) tall. Spikes can have up to 150 tiny green flowers.


Platanthera limosa (Thurber's Bog Orchid) is widely distributed in Mexico but found only in Arizona and New Mexico in the U.S. The robust plants can reach heights of over 4 feet (1.2 meters) tall with up to 200 long spurred yellow-green flowers.




Aquilegia chrysantha (Golden Columbine) [left] and *Lupinus palmeri* (Palmer Lupine) [right]



Mimulus cardinalis (Red Monkeyflower) [left], *Penstemon barbatus* (Bearded Penstemon) [center] and *Castilleja austromontana* (Rincon Mountain Indian Paintbrush) [right]


Geranium caespitosum (Cranesbill) [left] and *Ipomopsis tennuituba* (Longtube Ipomopsis) [right]

The Chiricahua Mountains in the far south eastern corner of Arizona is also one of the sky islands. Typical grasslands are seen at the base of the range.

Another of the sky island groups is found 120 miles (193 km) southeast of Tucson close to the New Mexico border. The Chiricahua Mountains are the largest of Arizona's Sky Island mountain ranges and the second highest. The main crest of the mountain range resembles rolling hills atop a narrow high plateau rather than distinct mountain peaks. This relatively flat area is bounded on the east and west by steep slopes and sharply dissected canyons. *Picea engelmanii* (Engelmann Spruce) reaches its southernmost limit in North America in this mountain range. The vegetation at upper elevations is dominated by *Pinus ponderosa* (Ponderosa Pine), *Pseudotsuga menziesii* subsp. *glauca* (Douglas-fir), and *Abies concolor* subsp. *concolor* (White Fir). The highest point is Chiricahua Peak at 9,759 feet (2,975 meters). Elevation change from the base is 5,259 feet (1603 meters).[9] The Chiricahua Wilderness is home to a fascinating diversity of both plant and animal life, as well as some of the Southwest's most spectacular geology. This 87,700-acre (137 square miles/355 square km) wilderness covers much of the upper slopes and inner canyons of the mountain range. The Chiricahua National Monument features a wonderland of rock spires eroded from layers of ash deposited by the Turkey Creek Volcanic eruption 27 million years ago.

By far the most noticeable natural features in the monument are the rhyolite rock pinnacles for which the park was created to protect. Rising sometimes hundreds of feet into the air, many of these pinnacles are balancing on a small base. Though incredibly stable, they seem ready to topple over at any time.






Sceloporus jarrovii (Mountain Spiny Lizard) [left] is native to the area. It is distinguished by the black collar and it is about 8" long. *Sylvilagus audubonii* (Desert Cottontail Rabbit) [right] are well-suited to the arid climate in southern Arizona. They differ from other cottontails by their large ears. In addition to rabbits, the region is home to *Tayassu tajacu* (Javalina), *Nasua nasua* (Coatimundi), *Urocyon cinereoargenteus* (Gray Fox), *Odocoileus virginianus* ssp. *couesi* (Arizona White-tailed Deer), all four species of North American skunks, *Lynx rufus* (Bobcat) *Ursus americanus* (Black Bear), *Dasypus novemcinctus* (Armadillo), mice, bats, squirrels, *Procyon lotor* (Raccoon) and *Canis latrans* (Coyote). The Chiricahua Mountains were also historically the home of *Panthera onca* (Jaguar), North America's largest cat, and *Leopardus pardalis* (Ocelot). There are records of 375 species of birds sighted in the Chiricahuas.

An important natural feature found in the park, and integral to the presence of flora and fauna and the magnificent rock spires, is water. The freezing and thawing of water has helped in the creation of the "wonderland of rocks," slowly eroding the rhyolite tuff rock over thousands and thousands of years.[1]

Malaxis brachystachys (Huachuca Mountain Adder's-mouth Orchid) is primarily a Mexican species but has been found in two counties of southern Arizona. Plants are 3-15 inches (7.6-38 cm) tall with many tiny yellow-green flowers arranged in a circular inflorescence. The rainy weather added challenges for photographers.



Malaxis abieticola (Arizona or Fir-loving Adder's-mouth Orchid) is found, as its name implies, beneath fir trees (genus *Abies*) at 8,000-9,000 feet (2,438-2,743 meters) elevation in Arizona, though also in New Mexico and Mexico. Up to 40 tiny narrow green flowers, facing in all directions, can be along the 3-9 inch (7.6-23 cm) stem that is clasped by the singular leaf.



Malaxis porphyrea (Purple Adder's-mouth Orchid or Cochise Adder's-mouth—after the county in Arizona where it is found) is limited to only Arizona and New Mexico in the U.S. and northern Mexico. It prefers moist pine or oak forests or damp grassy meadows and can grow to 12 inches (35 cm) tall with over 100 small purple flowers with triangular lips.



Commelina dianthifolia (Spiderwort) [left], *Thalictrum fendleri* (Fendler's Meadow Rue) [center] and *Monarda citriodora* var. *austromontana* (Lemon Bee Balm) [right]



Mirabilis albida (Tufted Four o'clock) [left], *Delphinium wootoni* (Wooton's Delphinium) [center] and *Salvia microphylla* (Mountain Sage) [right]


Glandularia bipinnatifida (Mexican or Dakota Mock Vervain) [left] and
Potentilla thurberi (Thurber's Cinquefoil) [right]


Geranium richardsonii (Richardson's Geranium) [left] and *Verbesina encelioides* (Crownbeard) [right]


Plectocephalus americanus (American Basketflower) [left] and
Achillea millefolium var. *lanulosa* (Yarrow) [right]

The summer monsoons can bring flash flooding to roads in the open ranges causing hazardous driving. Arizona has “stupid driver laws” that make you pay any costs incurred from a rescue when common sense should have prevailed. Sometimes you can wait for the water levels to subside making it safe to cross or you can turn around and drive many miles out of your way to get to where you are going.

The NOC symposium in Arizona was held in 2016 and was coordinated by the late Ron Coleman to whom we owe sincere gratitude for all that he did to advance the study of native orchids.

1) National Park Service website https://www.nps.gov
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