

Final Report to the Virginia Wine Board for FY16


August 12, 2016

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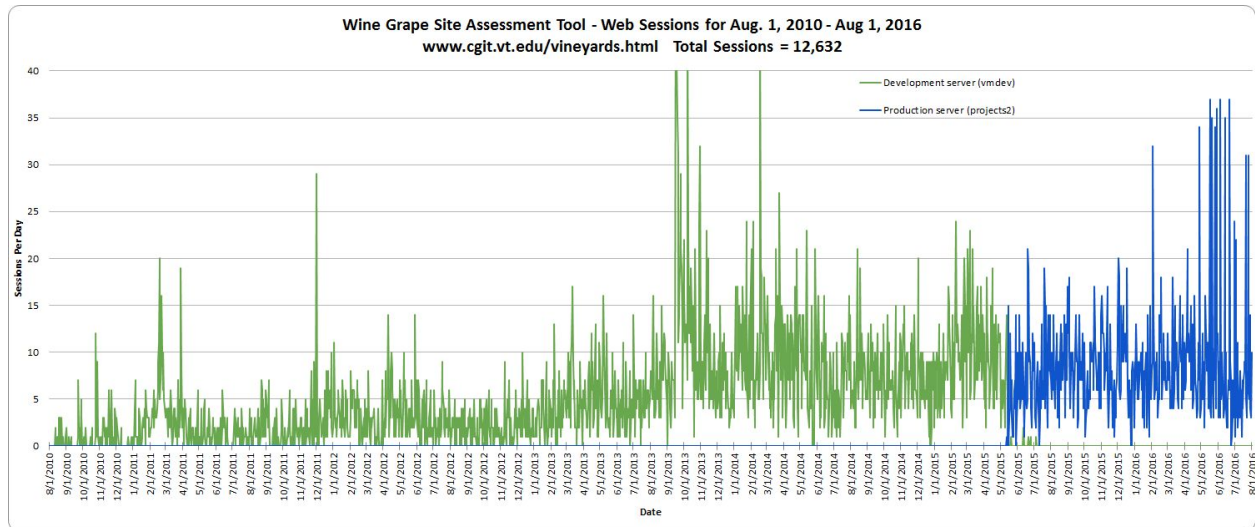
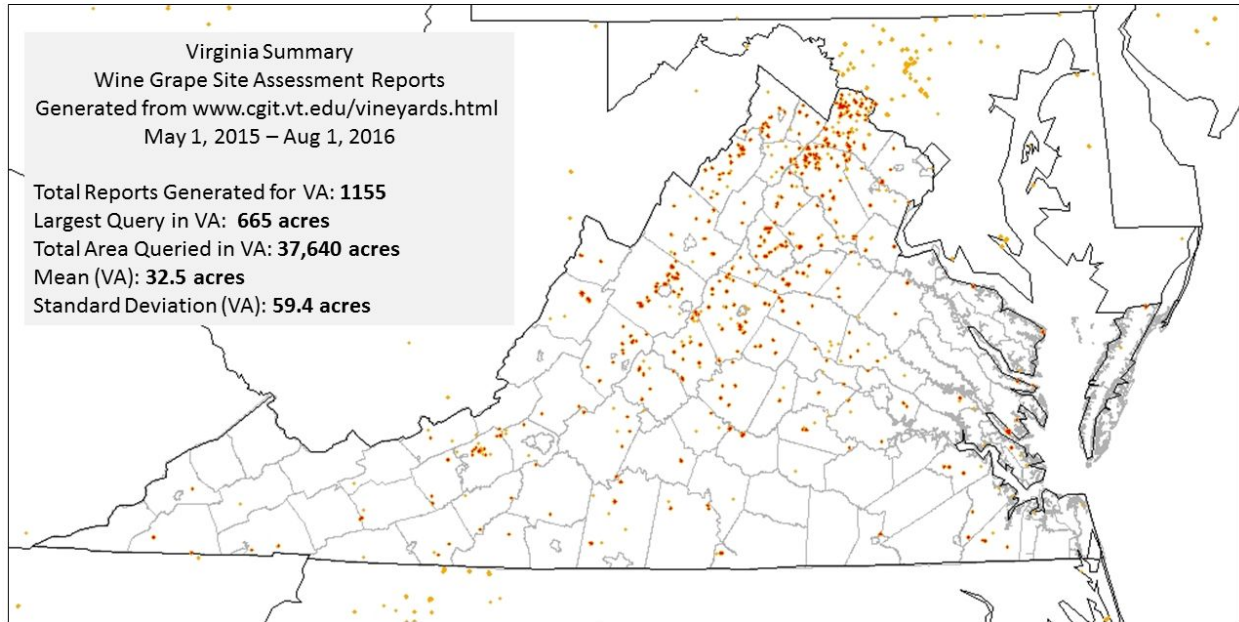
The full project scope is completed at this time, with the following major deliverables:

1. Review of Virginia Grape and Wine Policy (attached).
2. Report of Land Use Regulations to Consider When Purchasing Property for a Vineyard (attached)
3. Generated a substantial number of site assessment reports for Virginia stakeholders. A Summary of Wine Grape Site Assessment Reports Generated from www.cgis.vt.edu/vineyards.html from May 1, 2015 – Aug 1, 2016 (See Map and graph below)
 - a. Total Reports Generated for VA: 1155
 - b. Largest Query in VA: 665 acres
 - c. Total Area Queried in VA: 37,640 acres
 - d. Mean (VA): 32.5 acres
 - e. Standard Deviation (VA): 59.4 acres
4. Major updates to the web interface at www.cgis.vt.edu/vineyards.html
 - a. This website is also used for the USDA eastern US grape and wine project, and will be rebranded to feature Virginia on the web site with the current FY17 project funded by the Virginia Wine Board. A new URL will be made available for the Eastern US interface, and while both sites will use the same computational infrastructure (back end), the Virginia data and models will continue to be improved whereas the Eastern US data will largely be static until further funding can be secured.
 - b. Unified naming and ordering of values and report sections
 - c. QAQC to ensure reported values are correct
 - d. Added NLCD map to the appendix
 - e. Removed soil suitability rankings
 - f. Updated graphs and tables
 - g. Stabilized code to handle errors properly
 - h. improved image resolution in reports
 - i. New climate data layers (DayMet) utilized in map books and to be incorporated into the web portal in Sept 2016.

5. The statewide geospatial data layers have been processed with a collection of map books currently (Sept 2016) being reviewed by selected stakeholders in Virginia and USDA. The draft Virginia map book collection includes over 1620 individual pages at statewide, AVA, region, and county levels covering soils, geology, topography, and climate. The draft PDFs (482 MB) are available at https://drive.google.com/file/d/0B4FQhIFVAo_TcDd0LUJNMXhHbkk/view?usp=sharing and a web page is being developed for the public release of the PDF map books as smaller downloadable sets for a county, region, AVA or statewide. CGIT is also preparing an interactive viewer for this collection as part of the FY17 project. Examples from the map book deliverable are included below. The Virginia Wine Marketing Office is considering use and modification of these data layers and graphics for new marketing efforts in FY17.
6. CGIT has conducted formal phone interview process in Fall 2015 (7 completed) related to the research and development of on-line resources on behalf of the grape and wine industry in Virginia. Stakeholders and interviewees include researchers, commercial growers, distributors, merchants, government employees, consultants, or consumers in the grape and wine industry and as a potential user and beneficiary of the web portal. We focused on data and data privacy issues, but also prompted stakeholders with a series of open ended questions about what on-line resources would be of greatest benefit to them? The results have been summarized and was utilized to inform the current FY17 phase of development proposed for the Virginia Vineyards Portal.
7. Real-time Weather and Grape Disease Risk Models. In addition to the accomplishments listed above, the Virginia Wine Board should be aware of a new capability at CGIT for hourly weather modeling and grape disease risk models for Virginia. CGIT now has four grape disease models running (off-line) on an hourly basis including Powdery Mildew, Phomopsis, Blackrot, and Bunch Rot. A prototype web interface was developed in Fall 2015, and CGIT shared a preview of the outputs with Tony Wolf and Mizuho Nita on Sept 30, 2015. The development of real-time data sources and actionable information will continue in the FY17 project by launching a Real-Time Weather, Growing Season Weather and Grape Disease Risk service as a component of the Virginia Vineyard Portal, a research and outreach platform for Vineyard Site Assessment, Geodesign, and Management. A zip file has been placed on Google Drive containing the outputs of models for the week of Sept 23, 2015 - Sept 30, 2015, which include a couple of days of good weather before the rain sets in over Virginia and disease models show increased risk.

- a.  **VA Weather and Grape Disease Risk 093015 VTCGIT...**
https://drive.google.com/a/vt.edu/file/d/0B4FQhIFVAo_TZzFSWjRkTjNYdTQ/view?usp=drive_web
- b. Unzip the files to a local directory, then open the HTML file in a web browser (Chrome or Firefox recommended however it should display in IE and other web browsers). Note this is a beta test, with feedback and collaboration required to validate and improve the model outputs for Virginia as we move forward. Inside the ZIP file, you will find:
 - i. `_README VA Weather and Grape Disease Model Description 093015 Sforza.pdf`
 - ii. `_VIEW_Virginia Grape Weather and Disease Risk.html`
 - iii. 25 webm files, which are movies of the model outputs that will play in any web browser, or viewed using the HTML file listed above.

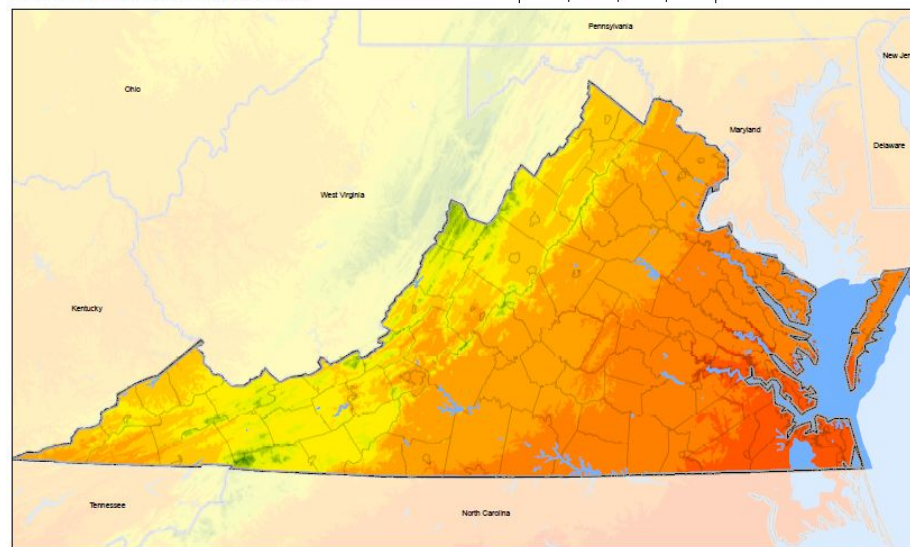
Web metrics for the Virginia Vineyards Portal



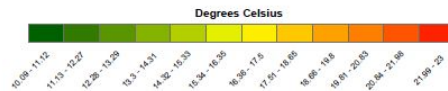
Samples from Map Book Collection (full collection draft is available at https://drive.google.com/file/d/0B4FQhIFVAo_TcDd0LUJNMXhHbkk/view?usp=sharing)

Virginia Statewide

Mean Growing Season Temperature (C)



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, Daymet, VGIN



www.cgl.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/

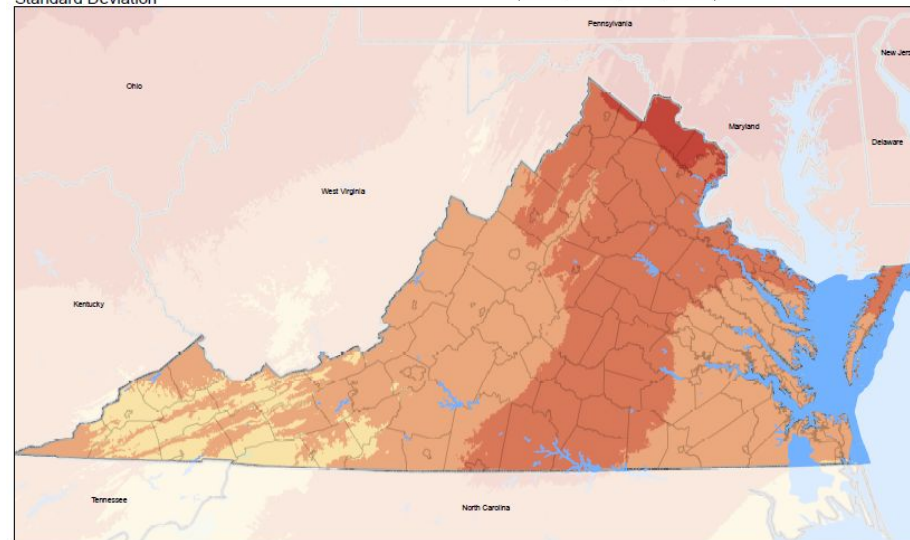
Thomson, P.E., M.M. Thomson, B.W. Meyer, Y. Wu, R. Deaneke, and N. Wilhelms. 2016. Daymet Daily Surface Weather Data on a 1-km Grid for North America, Version 3. ORNL DAAC, Oak Ridge, Tennessee, USA. Accessed February 17, 2016. Time period: 1980-01-01 to 2014-12-31. <http://dx.doi.org/10.3334/ORNLDAAC/1328>

The Mean Growing Season temperature is the average temperature occurring from April through October. Daymet monthly averages of Tmax and Tmin from the years 1980 to 2014 were used to calculate the 35 year normal of average growing season temperature.

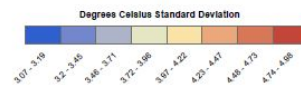
State Boundaries
Waterbodies
County Boundaries

Virginia Statewide

Mean Growing Season Temperature (C)
Standard Deviation



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, Daymet, VGIN



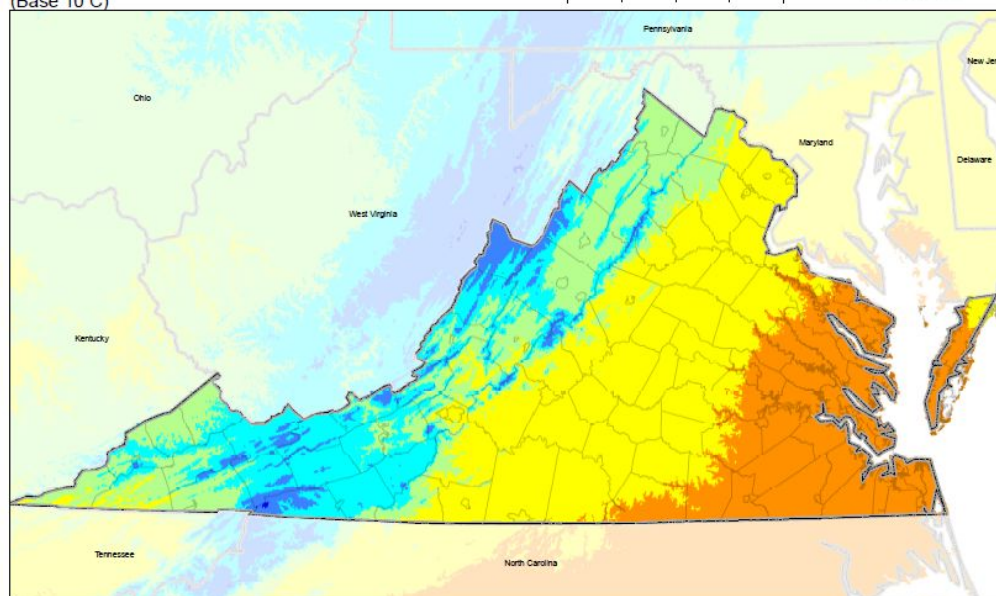
www.cgl.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/

Thomson, P.E., M.M. Thomson, B.W. Meyer, Y. Wu, R. Deaneke, and N. Wilhelms. 2016. Daymet Daily Surface Weather Data on a 1-km Grid for North America, Version 3. ORNL DAAC, Oak Ridge, Tennessee, USA. Accessed February 17, 2016. Time period: 1980-01-01 to 2014-12-31. <http://dx.doi.org/10.3334/ORNLDAAC/1328>

The Mean Growing Season temperature is the average temperature occurring from April through October. Daymet monthly averages of Tmax and Tmin from the years 1980 to 2014 were used to calculate the 35 year normal of average growing season temperature. Displayed is the standard deviation of the the average growing season temperatures across all 35 years.

State Boundaries
Waterbodies
County Boundaries

Virginia Statewide Growing Season Growing Degree Days (Base 10 C)



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, Daymet, VGIN

Growing Degree Day Accumulation (Celsius)



State Boundaries
County Boundaries

www.cglit.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/

Thornhill, P.E., M.M. Thornton, B.W. Meyer, Y. Wu, H. Dawkins, and N. Vothwehr, 2016. Daymet Daily Surface Weather Data on a 1-km Grid for North America, Version 3.0 (2016). Oak Ridge, Tennessee, USA. Accessed February 17, 2016. Time period: 1980-01-01 to 2014-12-31. <http://dx.doi.org/10.3334/ORNL/DAAC/1328>

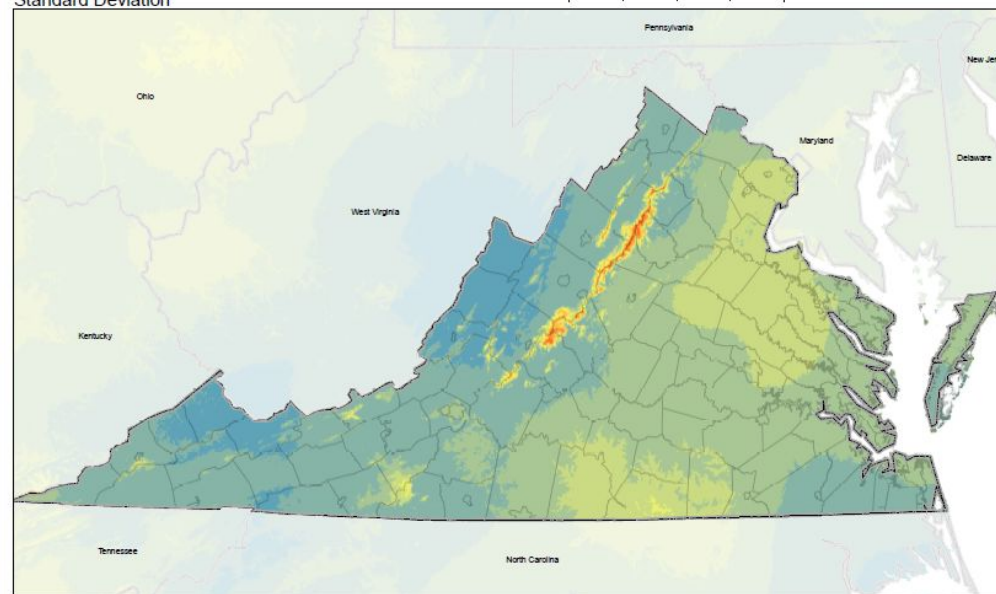


Growing Degree Days (GDD), also known as a Thermal Clock, is one of the oldest environmental parameters used to qualify plant growth, being first used by Réaumur in 1735 for wheat. Daymet Daily Surface data from 1980 to 2014 was used to calculate season GDD's using Base temperature 10 C for the time period from April 1 to October 31. Reported is the average of accumulated GDD's during the Growing Season (April to October) from 1980 to 2014.

Amerine and Winkler's GDD Climate Categories

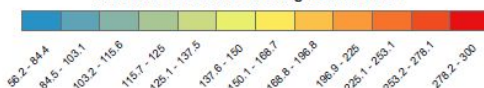
Too Cold: < 850
I: 850 - 1389
II: 1390 - 1667
III: 1668 - 1944
IV: 1945 - 2222
V: 2223 - 2700
Too Hot: > 2700

Virginia Statewide Growing Season Growing Degree Days (Base 10 C) Standard Deviation



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, Daymet, VEDP, VGIN, EORI

Standard Deviation of Growing Season GDDs



www.cglit.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/

Thornhill, P.E., M.M. Thornton, B.W. Meyer, Y. Wu, H. Dawkins, and N. Vothwehr, 2016. Daymet Daily Surface Weather Data on a 1-km Grid for North America, Version 3.0 (2016). Oak Ridge, Tennessee, USA. Accessed February 17, 2016. Time period: 1980-01-01 to 2014-12-31. <http://dx.doi.org/10.3334/ORNL/DAAC/1328>



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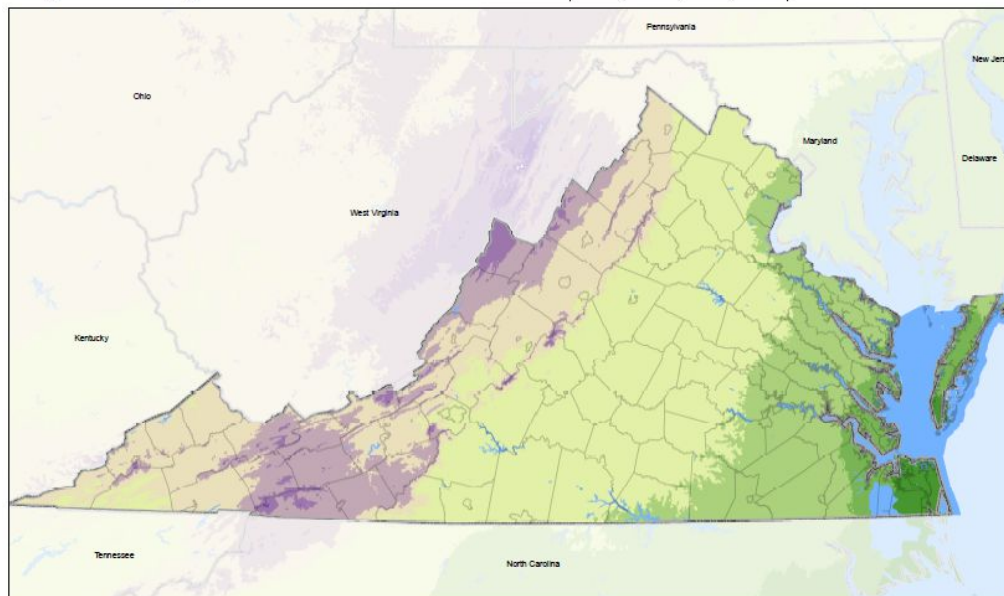
State Boundaries
County Boundaries

Virginia Statewide Length of Growing Season Above 0 C

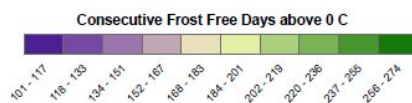
0 50 100 Miles



VirginiaTech



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, Daymet, VGIN



www.cgit.vt.edu/vineyards

www.virginiawine.org/industry/wine-board/

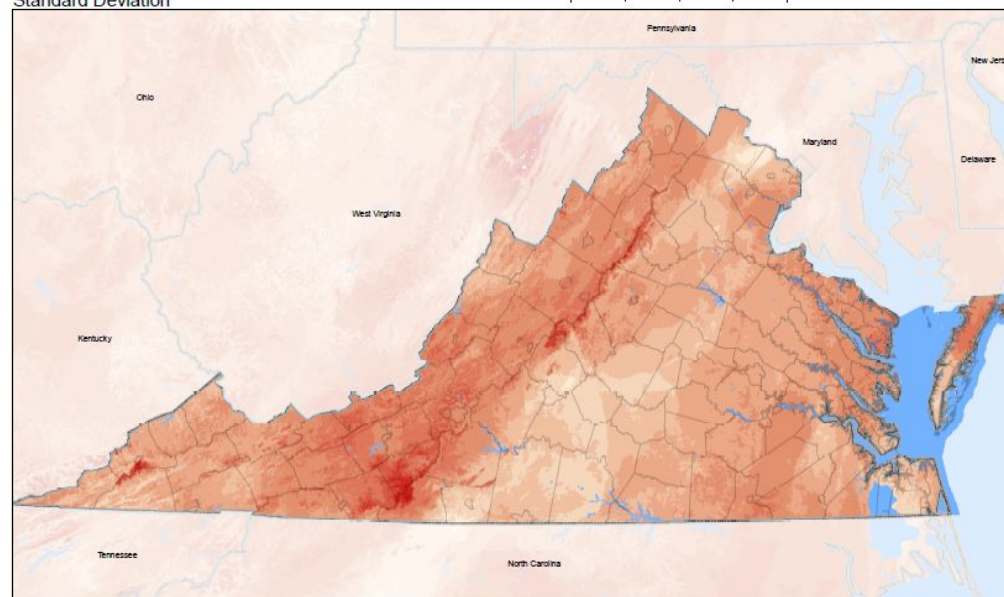
The Frost Free Period counts the number of consecutive days with minimum temperature above 0 C (32 F) occurring between the last spring frost and the first fall frost. Daymet Daily Surface Temperature data from 1980 through 2015 were used to calculate Growing Season Lengths for each year. Reported is the 36 year average of Frost Free Period (in number of days) from 1980 to 2015.

Virginia Statewide Length of Growing Season Above 0 C Standard Deviation

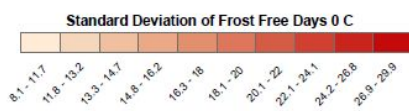
0 50 100 Miles



VirginiaTech



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, Daymet, VGIN



www.cgit.vt.edu/vineyards

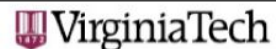
www.virginiawine.org/industry/wine-board/

The Frost Free Period counts the number of consecutive days with minimum temperature above 0 C (32 F) occurring between the last spring frost and the first fall frost. Daymet Daily Surface Temperature data from 1980 through 2015 were used to calculate the length of Growing Season for each year. Displayed are the Standard Deviations of the annual Frost Free Days (Length of Growing Season) above 0 C.

- State Boundaries
- Waterbodies
- County Boundaries

Thomson, P.E., M.M. Thomson, B.W. Meyer, Y. Wu, F. Deneke, and N. Vilhauer. 2016. Daymet: Daily Surface Weather Data on a 1-km Grid for North America. Version 3.0.0.0. CGIAR, Oak Ridge, Tennessee, USA. Accessed February 17, 2016. Time period: 1980-01-01 to 2014-12-31. <http://dx.doi.org/10.3334/ORNLDAAC/1328>

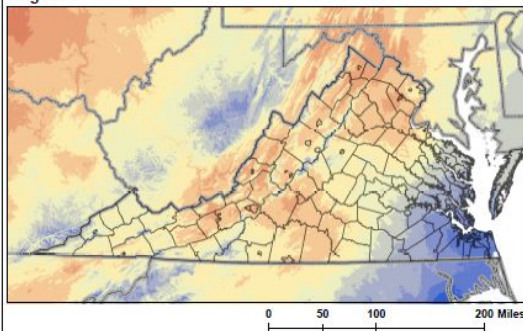
Ripening Period Rainfall: August through October Monthly Averages



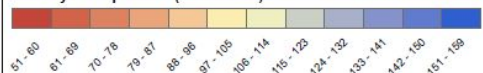
Displayed are the 35 year averages of monthly precipitation for August, September, and October (millimeters). Calculations were performed on monthly summaries from Daymet of total monthly precipitation from the years 1980 through 2014.



August



Monthly Precipitation (millimeters) 25.4 mm = 1 inch



County Boundaries
State Boundaries

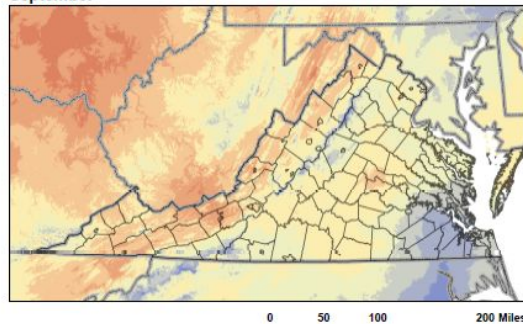
Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, Daymet, VGIN

www.cci.vt.edu/vineyards

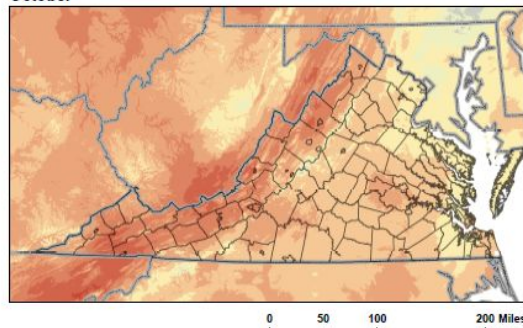
www.virginiawine.org/industry/wine-board/

Thomson, P.E., M.M. Thomson, B.W. Meyer, Y. Wei, R. Dwyer, and N. Williams. 2016. Daymet Daily Surface Weather Data on a 1-km Grid for North America. Version 3.0. ORNL DAAC, Oak Ridge, Tennessee, USA. Accessed February 17, 2016. Time period: 1980-01-01 to 2014-12-31. <http://dx.doi.org/10.3334/ORNL/DAAC/1328>

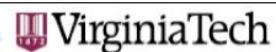
September



October



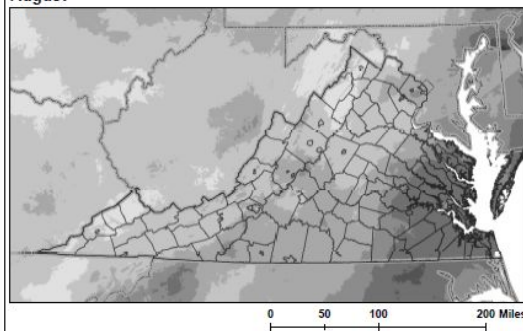
Ripening Period Rainfall: August through October Monthly Standard Deviations



Displayed are the 35 year standard deviations of monthly precipitation for August, September, and October (millimeters). Calculations were performed on monthly summaries from Daymet of total monthly precipitation from the years 1980 through 2014.



August



Standard Deviation (millimeters) 25.4 mm = 1 inch



County Boundaries
State Boundaries

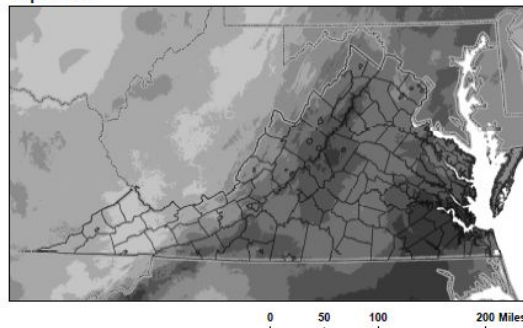
Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, Daymet, VGIN

www.cci.vt.edu/vineyards

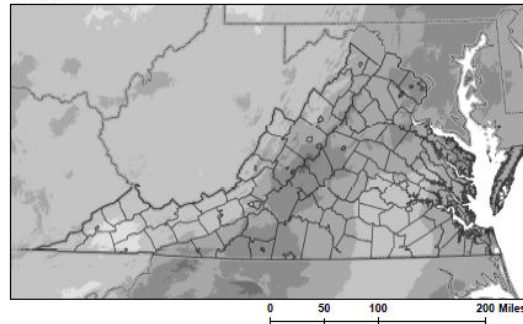
www.virginiawine.org/industry/wine-board/

Thomson, P.E., M.M. Thomson, B.W. Meyer, Y. Wei, R. Dwyer, and N. Williams. 2016. Daymet Daily Surface Weather Data on a 1-km Grid for North America. Version 3.0. ORNL DAAC, Oak Ridge, Tennessee, USA. Accessed February 17, 2016. Time period: 1980-01-01 to 2014-12-31. <http://dx.doi.org/10.3334/ORNL/DAAC/1328>

September

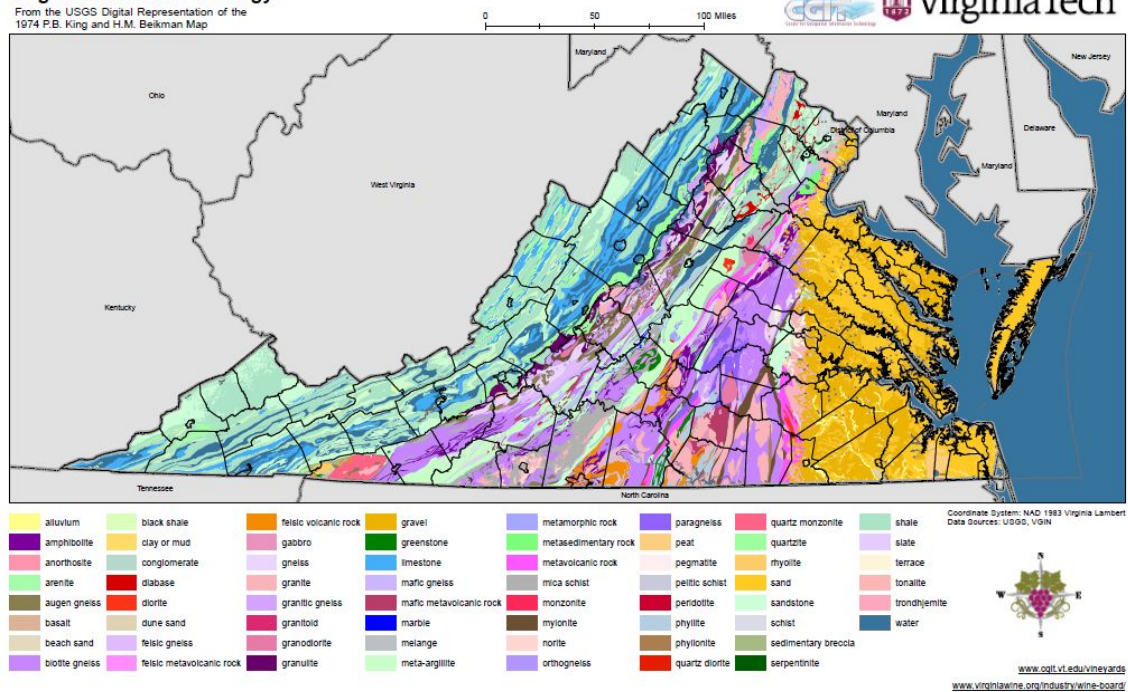


October



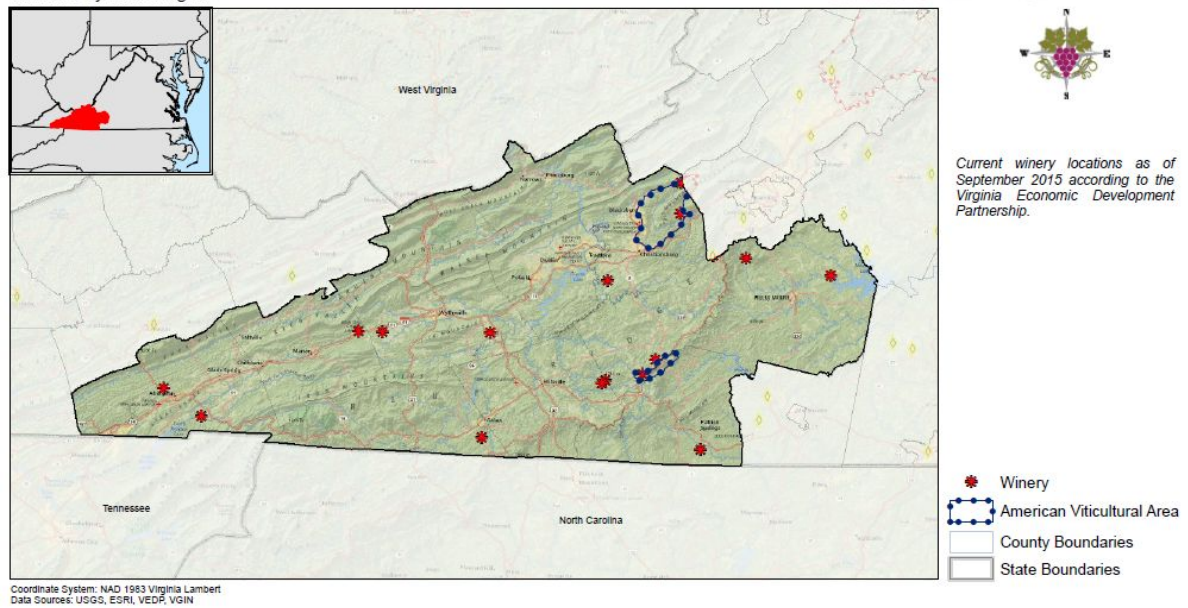
Virginia Statewide Geology

From the USGS Digital Representation of the 1974 P.B. King and H.M. Beikman Map



Blue Ridge Highlands

Wineries by Wine Region

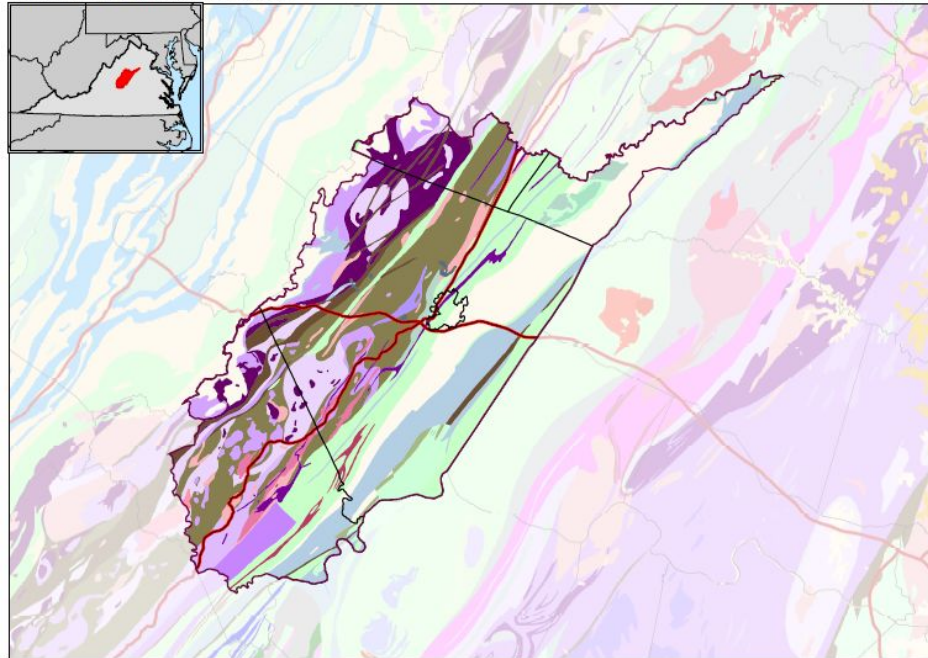


Number of wineries in region: 16

www.cgl.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/
<http://gis.yesvirginia.org/datasets>

Monticello AVA

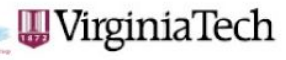
American Viticultural Area Geology



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, e-CFR, VEDR, VGIN

www.cgit.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/

County Boundaries Major Roadways State Boundaries



Geology of the Conterminous United States

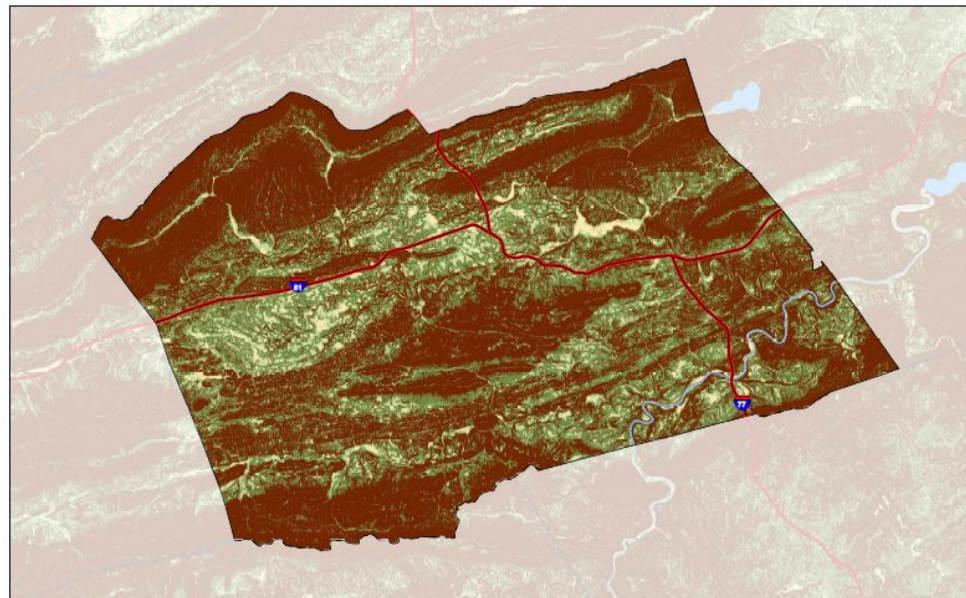
From the USGS Digital Representation of the 1974 P.B. King and H.M. Beikman Map

Rock Type

amphibolite	mafic metavolcanic rock
anorthosite	meta-argillite
augen gneiss	metasedimentary rock
biotite gneiss	mylonite
conglomerate	orthogneiss
felsic gneiss	phyllite
gneiss	quartzite
granite	sandstone
granitic gneiss	sedimentary breccia
granodiorite	shale
granulite	water
limestone	

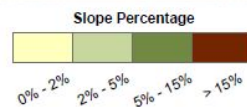
Wythe

County Slopes

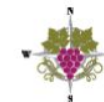
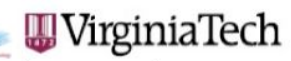


Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, VGIN, ESRI, CGIT

www.cgit.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/



Major Roadways
County Boundaries
State Boundaries



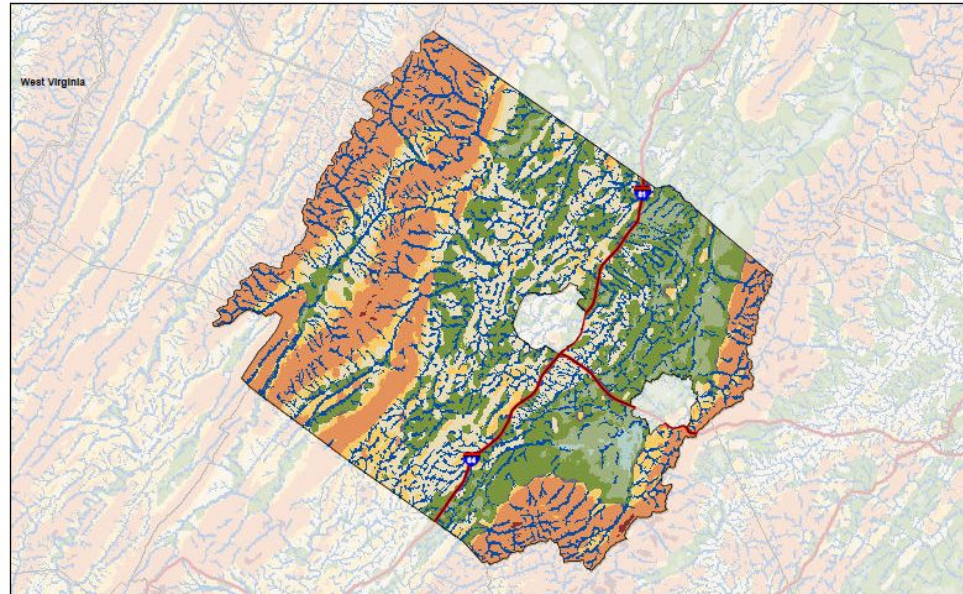
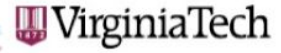
Slope was derived from the 10 meter USGS National Elevation Dataset (NED).

Slope Suitability Classes

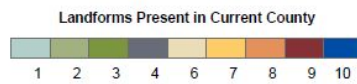
Flat Land, 0% - 2%
Suitable, 2% - 5%
Highly Suitable, 5% - 15%
Steep Slopes, > 15%

Augusta County Landforms

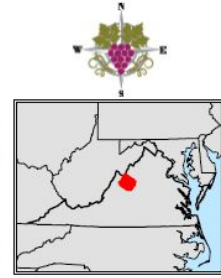
0 5 10 Miles



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, VEDR, VGIN, ESRI



Major Roadways
County Boundaries
State Boundaries



USGS Ecosystem Mapping consists of ten classes: flat plains, smooth plains, irregular plains, escarpments, low hills, hills, breaks/foothills, low mountains, high mountains/deep canyons, and drainage channels. Areas lacking in landforms i.e. water bodies are displayed as zero.

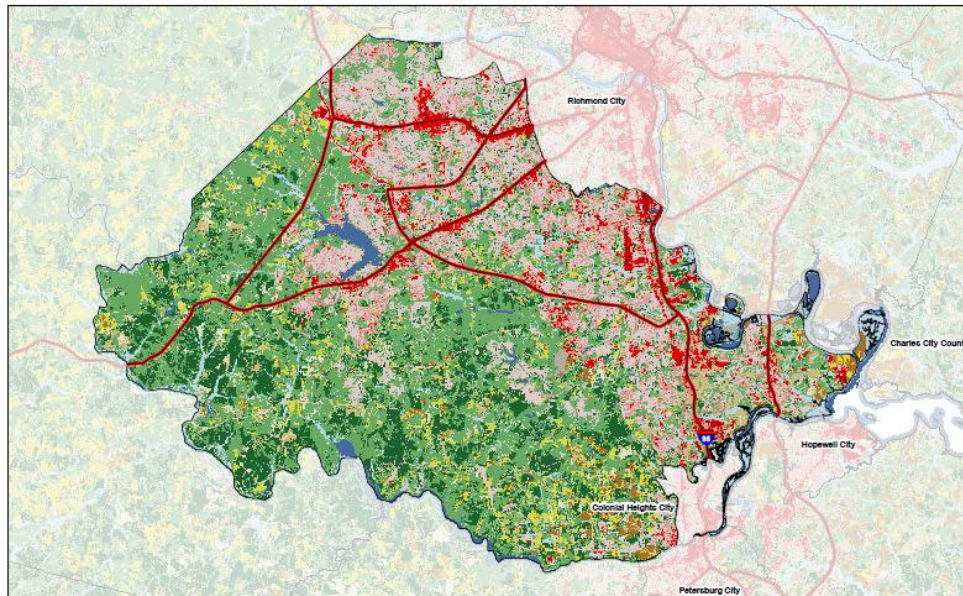
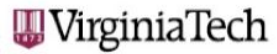
USGS Ecosystem Mapping Classes

- 0. N/A
- 1. Flat Plains
- 2. Smooth Plains
- 3. Irregular Plains
- 4. Escarpments
- 5. Low Hills
- 6. Hills
- 7. Breaks/Foothills
- 8. Low Mountains
- 9. High Mountains/Deep Canyons
- 10. Drainage Channels

www.cgt.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/

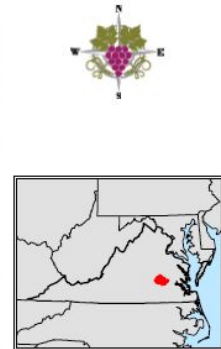
Chesterfield County 2011 NLCD Landcover

0 5 10 Miles



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, VGIN, ESRI

- | | | |
|-----------------------------|------------------|------------------------------|
| Open Water | Barren Land | Herbaceous |
| Developed, Open Space | Deciduous Forest | Hay/Pasture |
| Developed, Low Intensity | Evergreen Forest | Cultivated Crops |
| Developed, Medium Intensity | Mixed Forest | Woody Wetlands |
| Developed, High Intensity | Shrub/Scrub | Emergent Herbaceous Wetlands |



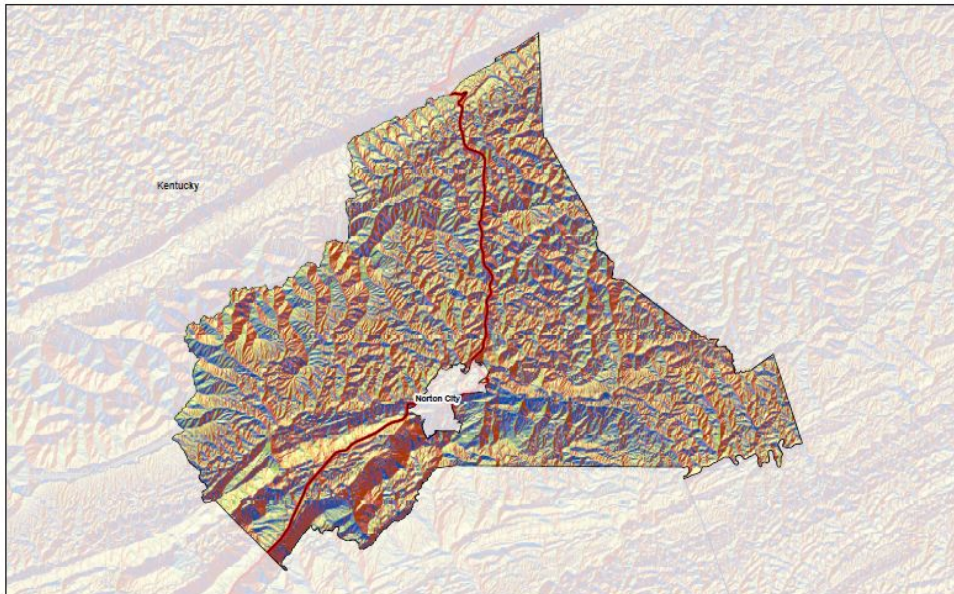
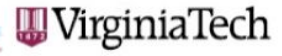
The 2011 Landcover from the National Land Cover Database.

U.S. Geological Survey, 20140331, NLCD 2011 Land Cover (2011 Edition); None, U.S. Geological Survey, Sioux Falls,

www.cgt.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/

Wise County Aspect

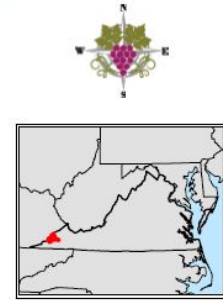
0 5 10 Miles



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, VGIN, CGIT

— Major Roadways

Aspect was derived from the 10 meter National Elevation Dataset (NED) and classified into 8 classes based on the bearing.

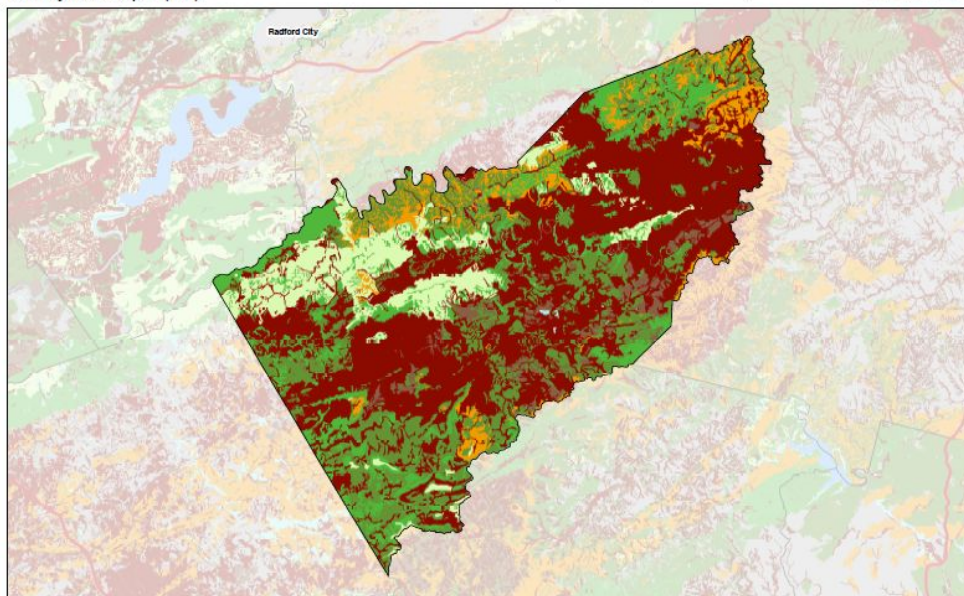
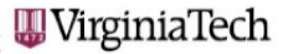


Direction	Bearing (°)
Northern	337.5 to 22.5
Northeastern	22.5 to 67.5
Eastern	67.5 to 112.5
Southeastern	112.5 to 157.5
Southern	157.5 to 202.5
Southwestern	202.5 to 247.5
Western	247.5 to 292.5
Northwestern	292.5 to 337.5

www.cgit.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/

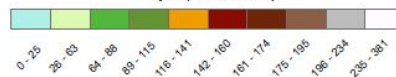
Floyd County Soil Depth (cm)

0 5 10 Miles



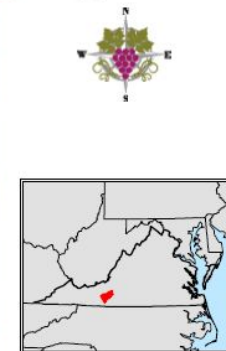
Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, Daymet, VEDP, VGIN, ESRI, US Dept of Treasury

Depth (centimeters)



— Major Roadways
□ County Boundaries
■ Waterbodies

www.cgit.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/

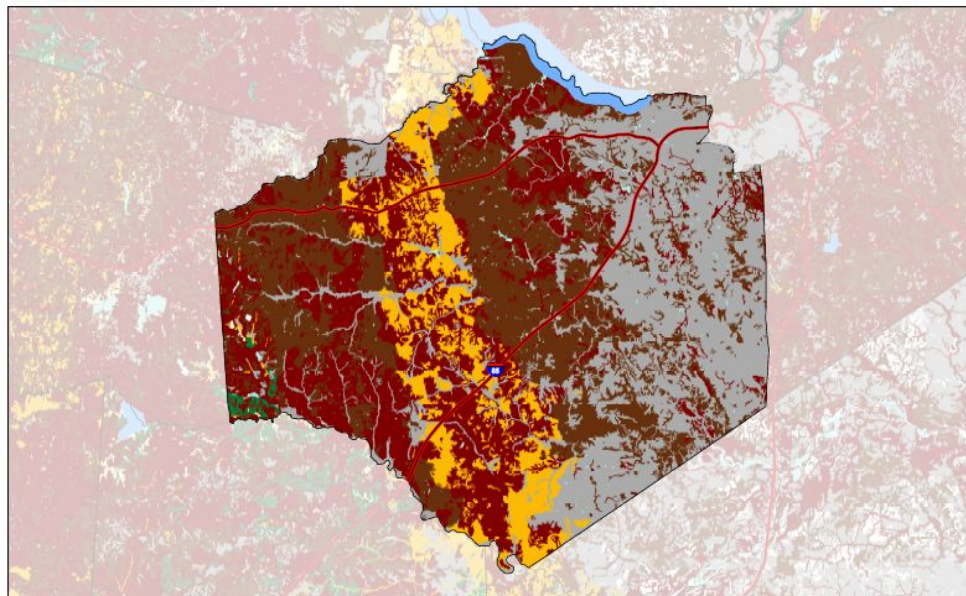
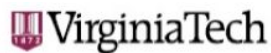


The NRCS SSURGO metadata defines the soil depth as:

The distance from the soil surface to the upper boundary of the restrictive layer.

Dinwiddie County Soil Bulk Density

0 5 10 Miles



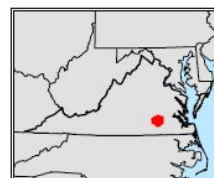
Coordinate System: NAD 1983 Virginia Lambert
Data Sources: NRCS, USGS, VGIN, ESRI

Bulk Density (g/cm³)



- Major Roadways
- County Boundaries
- Waterbodies

www.cotl.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/

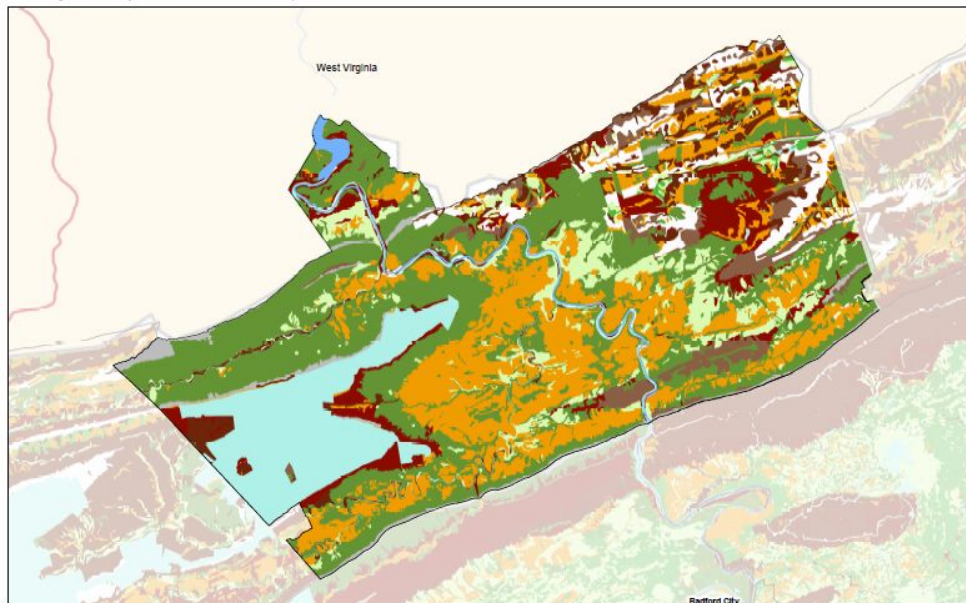
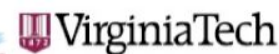


The NRCS SSURGO metadata defines the soil Bulk Density as follows:

The oven dry weight of the less than 2 mm soil material per unit volume of soil at a water tension of 1/3 bar.

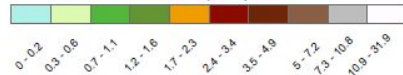
Giles County KSAT (micrometer/second)

0 5 10 Miles



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: NRCS, USGS, VGIN, ESRI

Ksat (um/s)



- Major Roadways
- County Boundaries
- Waterbodies

www.cotl.vt.edu/vineyards
www.virginiawine.org/industry/wine-board/



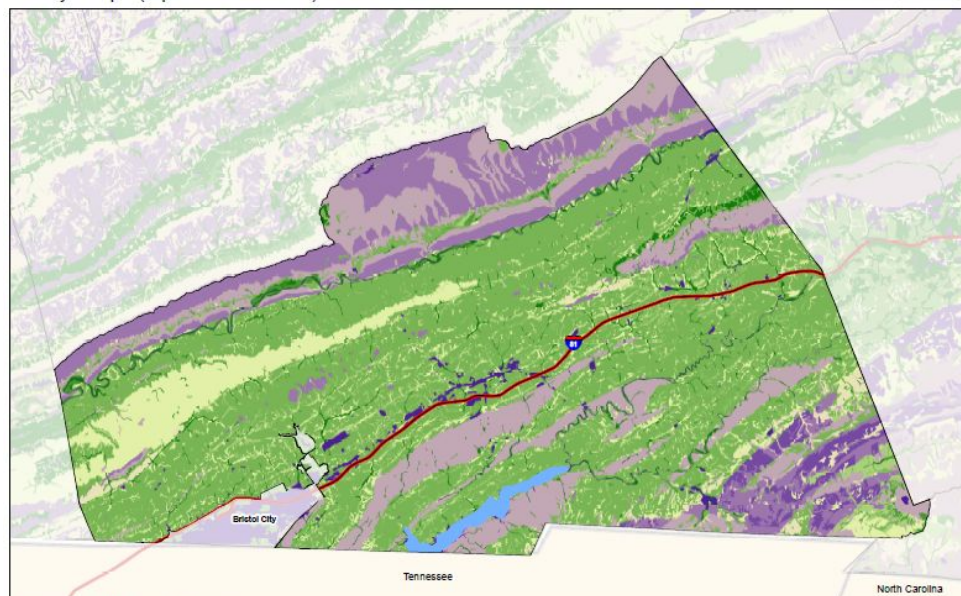
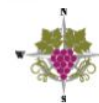
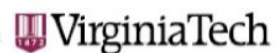
The NRCS SSURGO metadata defines the soil Hydraulic Conductivity (Ksat) as:

The amount of water that would move vertically through a unit area of saturated soil in unit time under unit hydraulic gradient.

Washington

County Soil pH (representative value)

0 5 10 Miles



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: USGS, VGIN, ESRI

Soil pH - Representative Value



Major Roadways
County Boundaries
Waterbodies

www.cgit.vt.edu/vineyards

www.virginiawine.org/industry/wine-board/

The NRCS SSURGO metadata defines soil pH as:

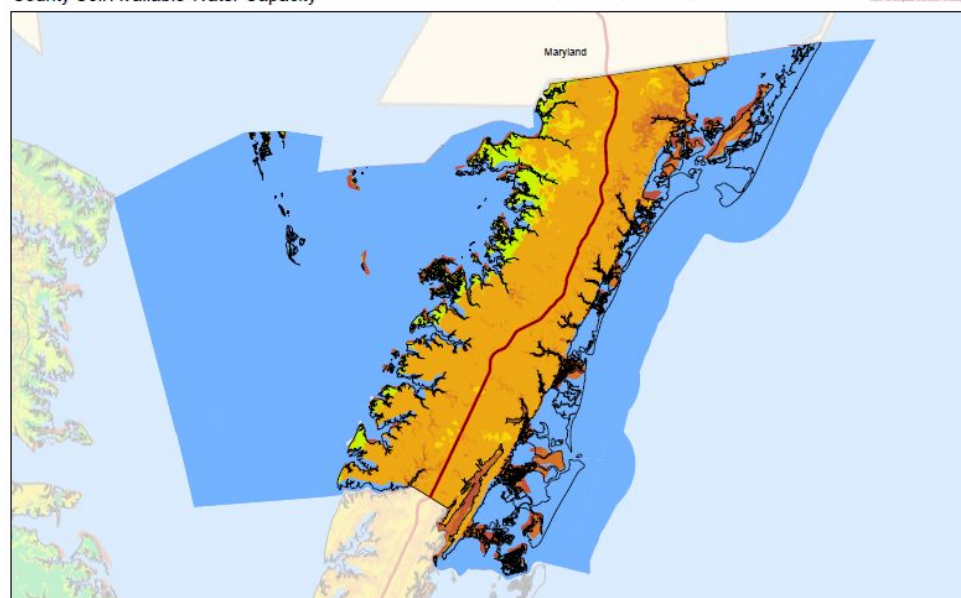
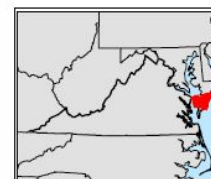
The negative logarithm to the base 10, of the hydrogen ion activity in the soil using the 1:1 soil-water ratio method. A

*Soil data not available for all jurisdictions

Accomack

County Soil Available Water Capacity

0 5 10 Miles



Coordinate System: NAD 1983 Virginia Lambert
Data Sources: NRCS, USGS, VGIN, ESRI

Available Water Capacity (cm/cm)



Major Roadways
County Boundaries
Waterbodies

www.cgit.vt.edu/vineyards

www.virginiawine.org/industry/wine-board/

The NRCS SSURGO metadata defines the soil Available Water Capacity as follows:

The amount of water that an increment of soil depth, inclusive of fragments, can store that is available to plants. AWC is expressed as a volume fraction, and is commonly estimated as the difference between the water contents at 1/10 or 1/3 bar (field capacity) and 15 bars (permanent wilting point) tension and adjusted for salinity, and fragments.