



Growing Regions and Site Selection for Grapes

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KENTUCKY
WINE

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Department of Horticulture

State of the Grape and Wine Industry in Kentucky

- Viticulture industry
 - Number of growers =212
 - Number of acres =~700 acres
 - Potential yield = 4550 tons/year
 - Potential value of grapes = US\$ 5,460,000/year
 - Potential value of wine = US\$ 43,680,000/year
 - Potential value of the industry= US\$109,200,000/year
 - Increased demand for Kentucky grown grapes

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Challenges to Viticulture Industry

- Climate
 - Site Selection
- Soils
 - Vineyard Soils
- Cultivar selection
 - Matching cultivars to sites
- Proximity to Crop Hazards

Three Aspects of Site Selection for Commercial Viticulture

- Determining factor for commercial success
- The three aspects of site selection
 - Climate
 - Soils
 - Proximity to Crop Hazards



Climate

- Prevailing weather of a geographic region
- Three categories
 - Macroclimate
 - Mesoclimate
 - Microclimate



Macroclimate

- Climate of a large region – Many square miles
- The Lower Midwest
- In Kentucky
 - Continental climate, temperatures fluctuate daily
 - Humid
 - Severe winters (Minimum winter temperatures)
 - Warm summers
 - Most rainfall in the summer months

Components of Macroclimate for Viticulture

- Dormant season
 - Frequency of critical winter temperatures
 - Winter severity index
- Beginning of the growing season
 - Spring frost index
- During the growing season
 - Growing degree days
 - Frost-free days
 - Growing season mean temperature



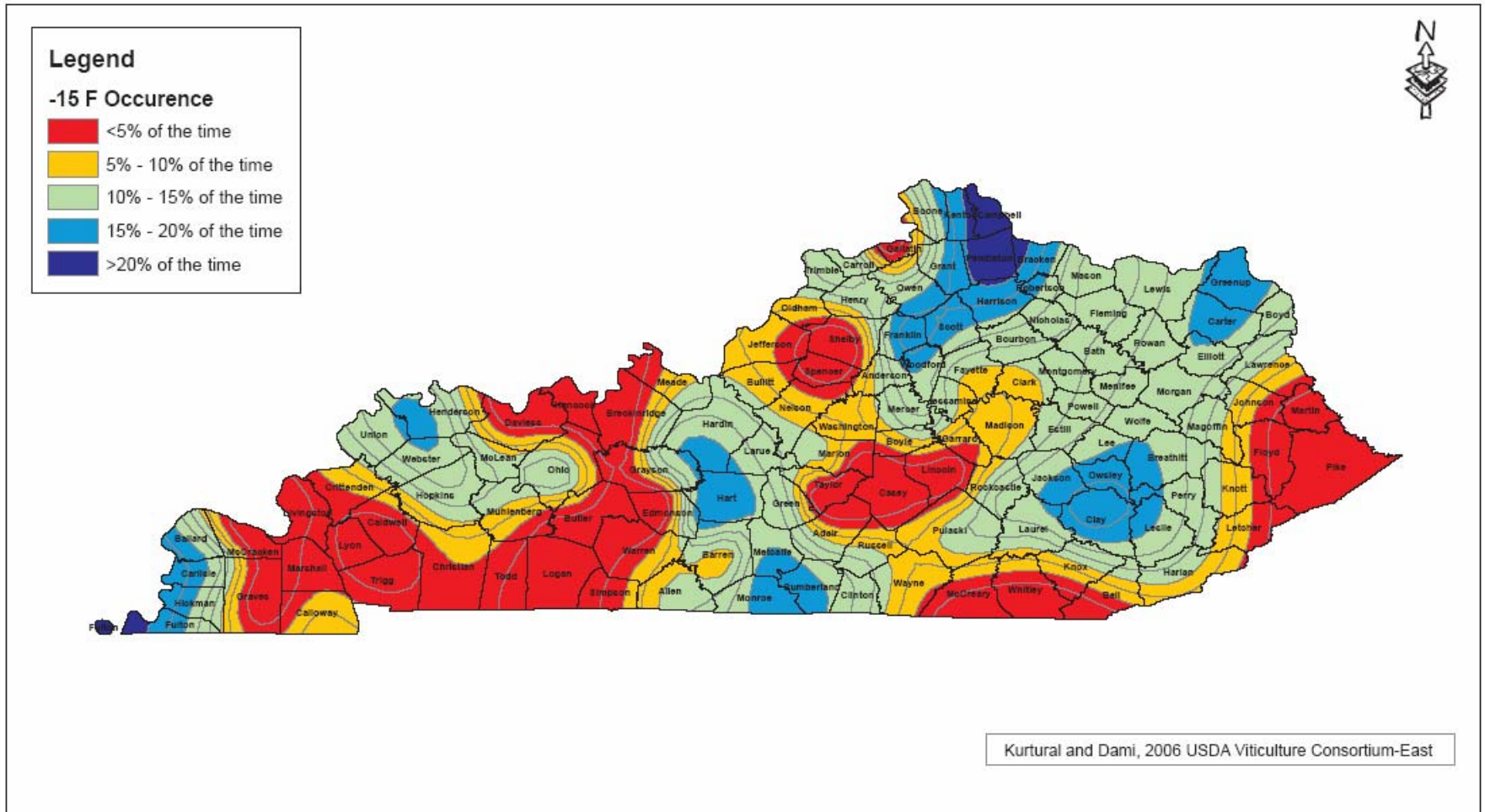
Frequency of critical winter temperatures

- Occurrence defines where grapes can be grown **COMMERCIALY**
- Critical thresholds
 - For European (*V.vinifera*) -8°F
 - For French-American hybrids (*Vitis* spp.) -15°F
 - For certain American (*V. aestivalis*, *labruscana*) -25°F to -30°F

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Occurrence of -15 F 1974-2005



0 65 130 260 Kilometers

Winter severity index

- The WSI is calculated by the mean temperature of the coldest month (January) in any given 30-year period.
- Damage and death can occur in French-American and native grapevines if the winter temperature falls below 5F
- Ranking of WSI in Kentucky
 - If the WSI is <5F then the winters are extremely cold
 - If the WSI is between 5oF and 14oF very cold
 - If WSI is between 14F and 23F cold
 - If WSI is between 23F and 32F mildly cold.

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Types of Freezes

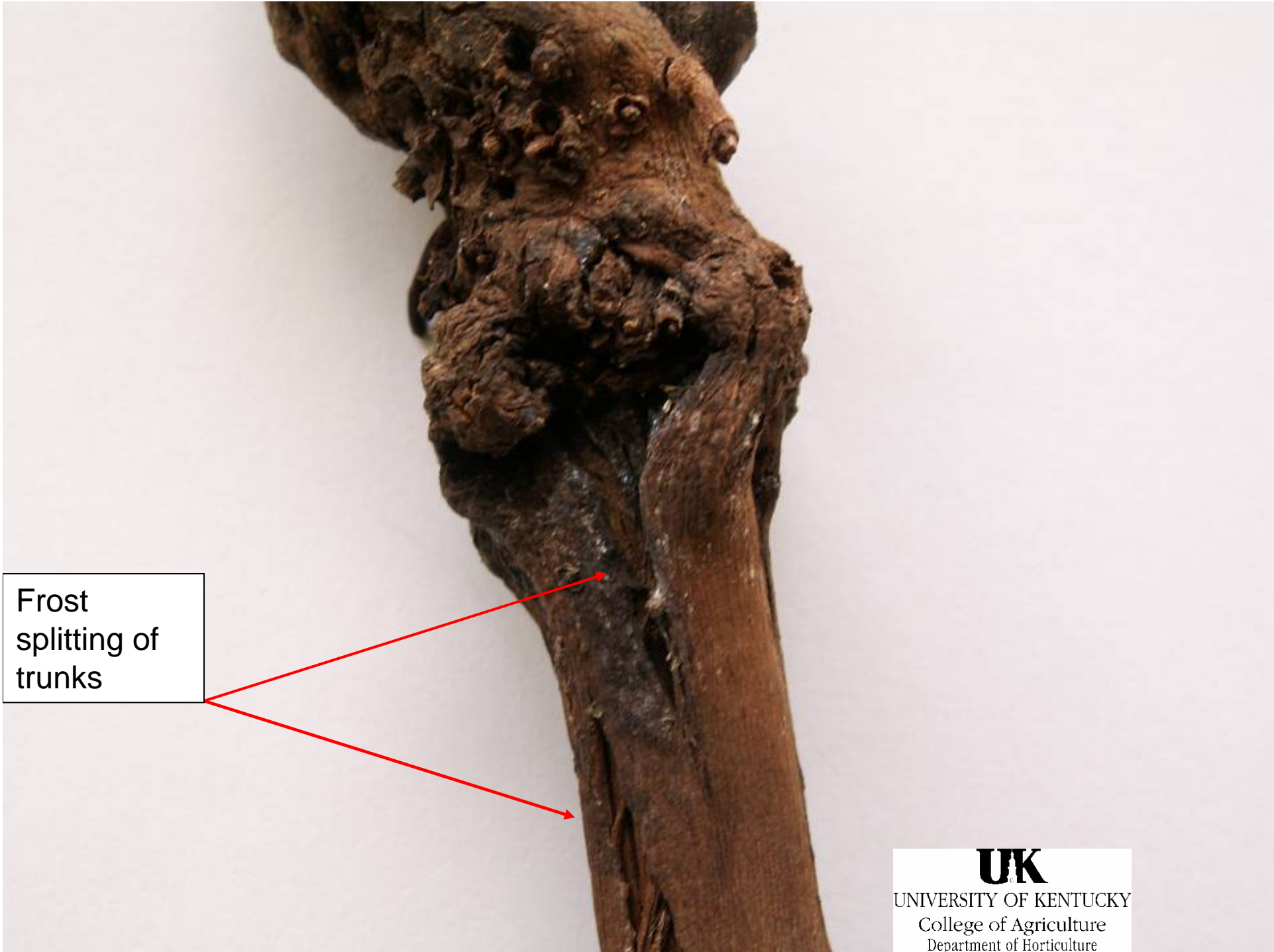
- **Advection:** Entire frontal system, little to temperature stratification, 'top-down', decreasing temperature with increasing altitude (During Winter)
- **Radiative:** Calm clear weather, as the ground cools after sunset. Cold air settles in low areas (Spring and Fall)

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Freeze Injury

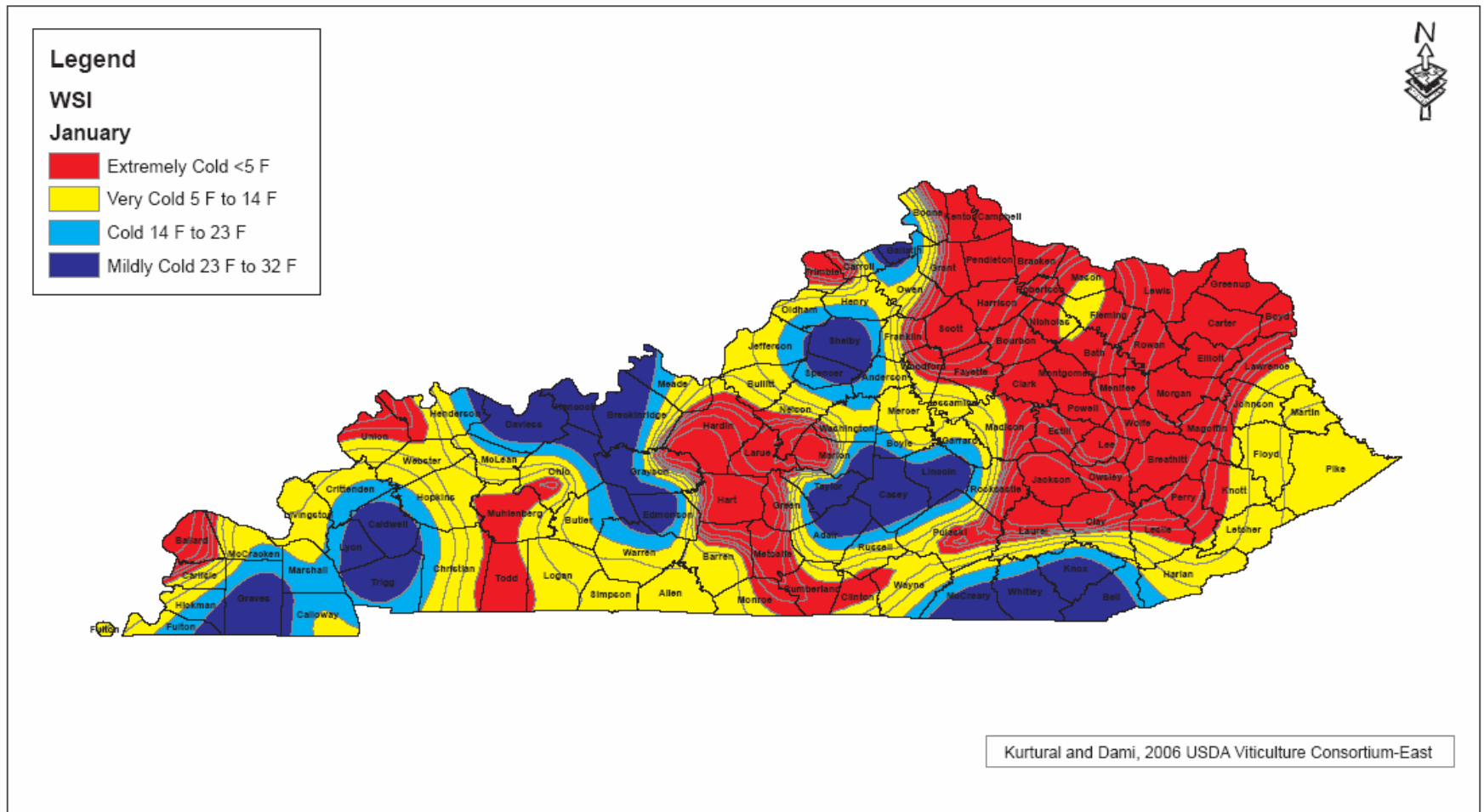
- Permanent parts of the grapevine being damaged by sub-freezing temperatures
- Common injuries
 - Winter sunscald
 - Splitting of trunks
 - Death of dormant buds
 - Death of tissue in canes



Frost
splitting of
trunks

Winter Severity Index in Kentucky

Winter Severity Index in January



Beginning of the Growing Season

- Spring Frost Index (SFI)
- SFI is a measure of the site's continentality, or tendency to produce large fluctuations in temperature over short periods of time.
- Bud break is influenced by air temperature and grapevines tend to break bud early if temperatures warm up quickly in early spring
- April is the month where grape growers face the most damage from spring frosts.
- SFI values less than 9 have *very* low frost risk
- SFI values 9 to 11 have low frost risk
- SFI values of 11.5 to 13 have moderate frost
- SFI values of 13.0 or greater are *high* risk

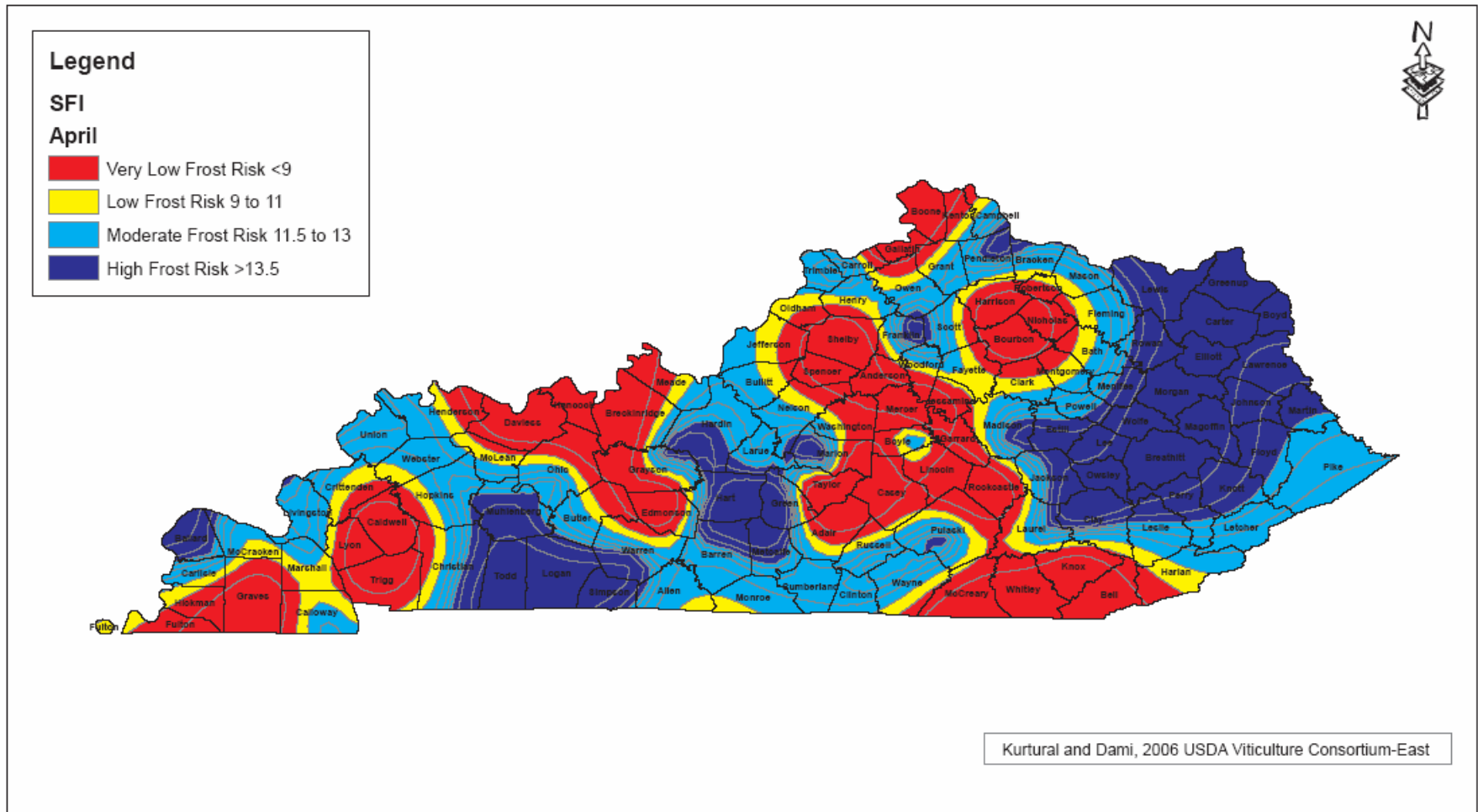


Grape buds in Early Spring



SFI in Kentucky

Spring Frost Index



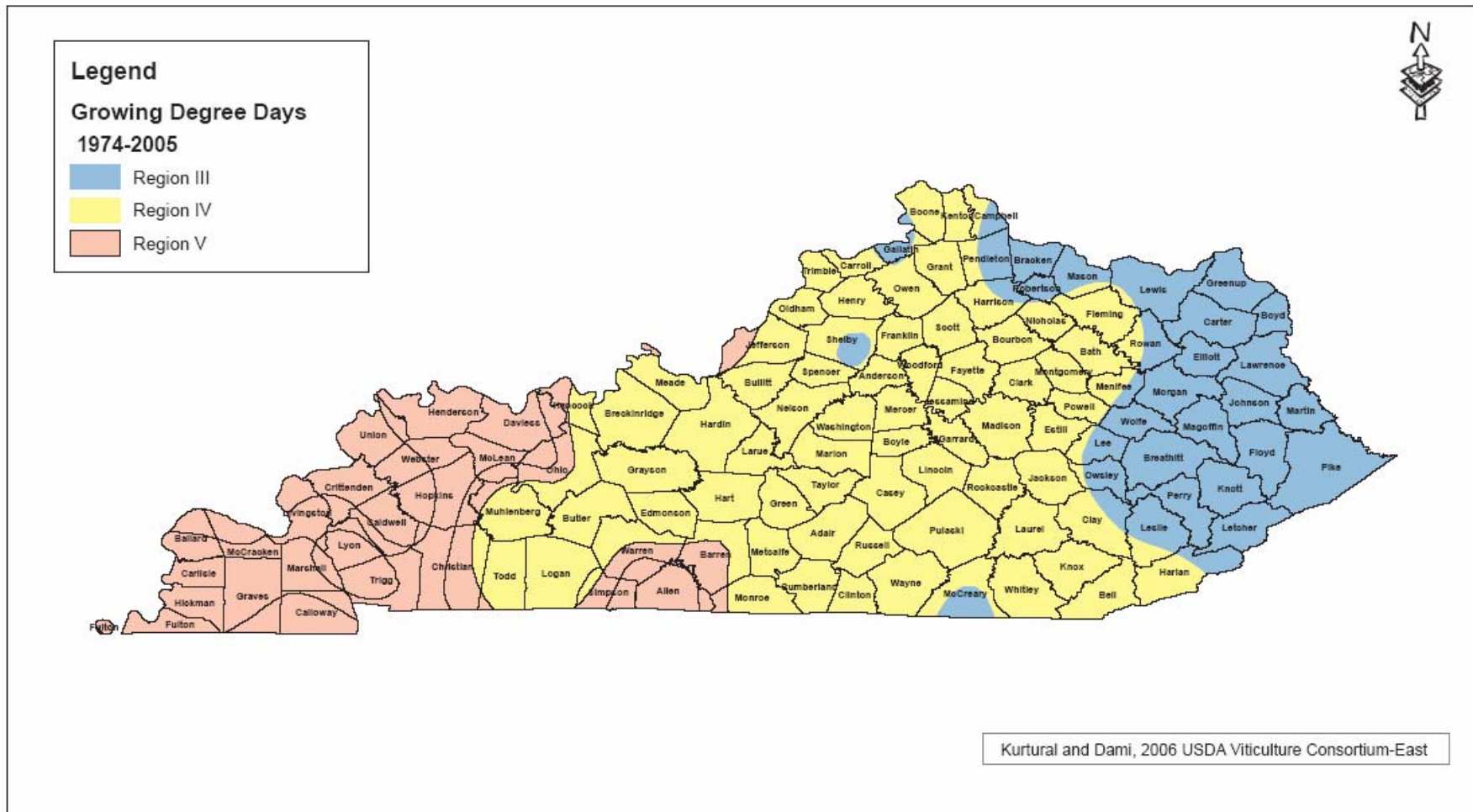
During the Growing Season

- Growing degree days (GDD)
- The GDD summation between 1 April and 31 October has been used to predict the grapevine's ability to mature a high quality crop
- The Amerine and Winkler GDD summation divides a given area into five regions based on the GDD summation.
- The region I is characterized as regions accumulating less than 2500F
- Region II accumulating between 2501F and 3000F GDD
- Region III between 3001F to 3500F GDD
- Region IV between 3501F GDD to 4000F GDD,
- and Region V more than 4000oF GDD.
- In Kentucky, there are no areas of the state that fall within the Region I or Region II window.



Growing Degree Days in Kentucky

Growing Degree Day (50 F) Accumulation



Length of Growing Season

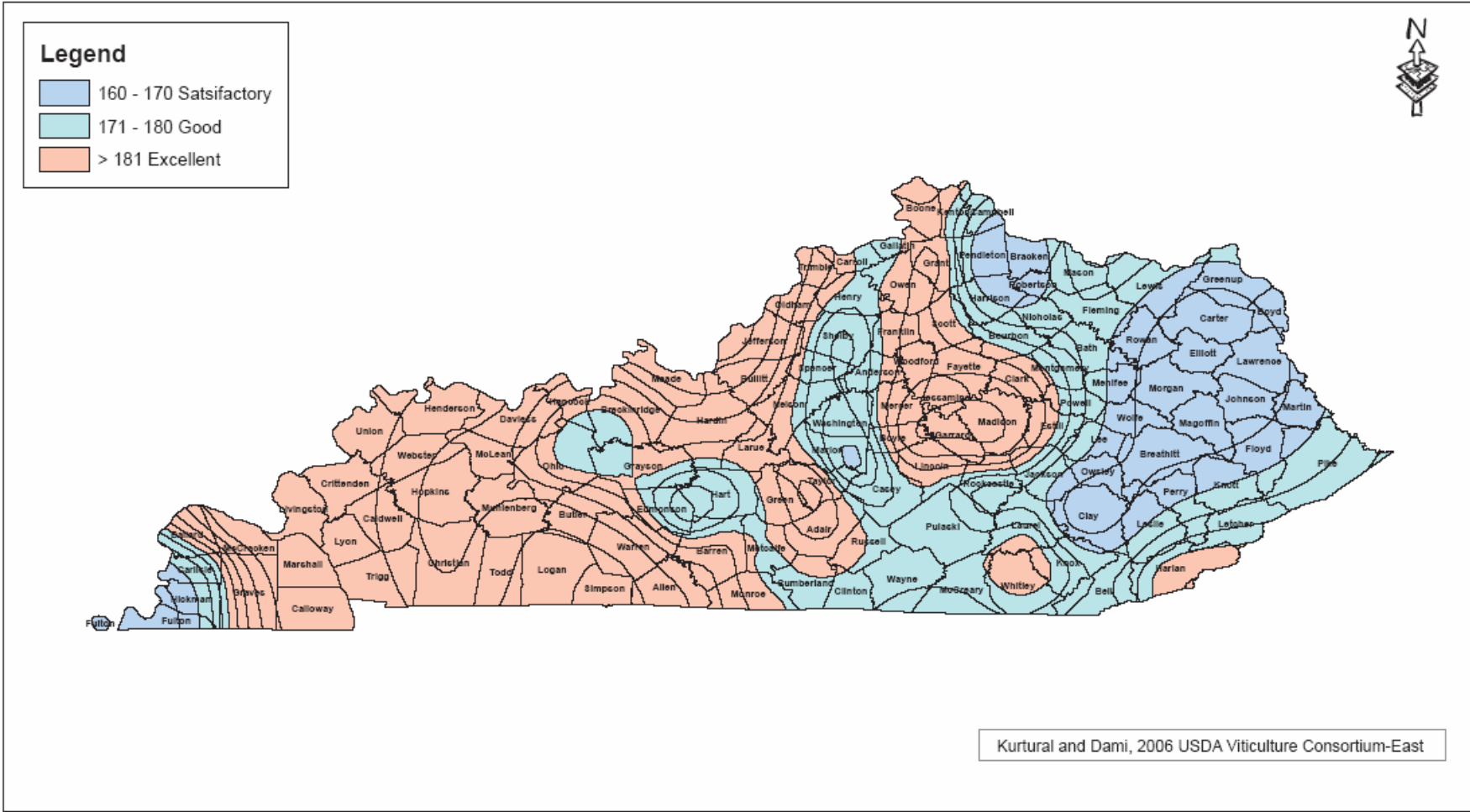
- Number of Frost Free Days (FFD)
- The length of the growing season (FFD) however is more limiting to viticulture than GDD accumulation.
- The FFD actually determines ecological boundaries of sustainable viticulture.
- General rule of thumb
 - 150 FFD (early ripening varieties)
 - 190 FFD (late ripening varieties)

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Frost free days in Kentucky

Frost Free Days 1974 - 2005



Growing Season Mean Temperature

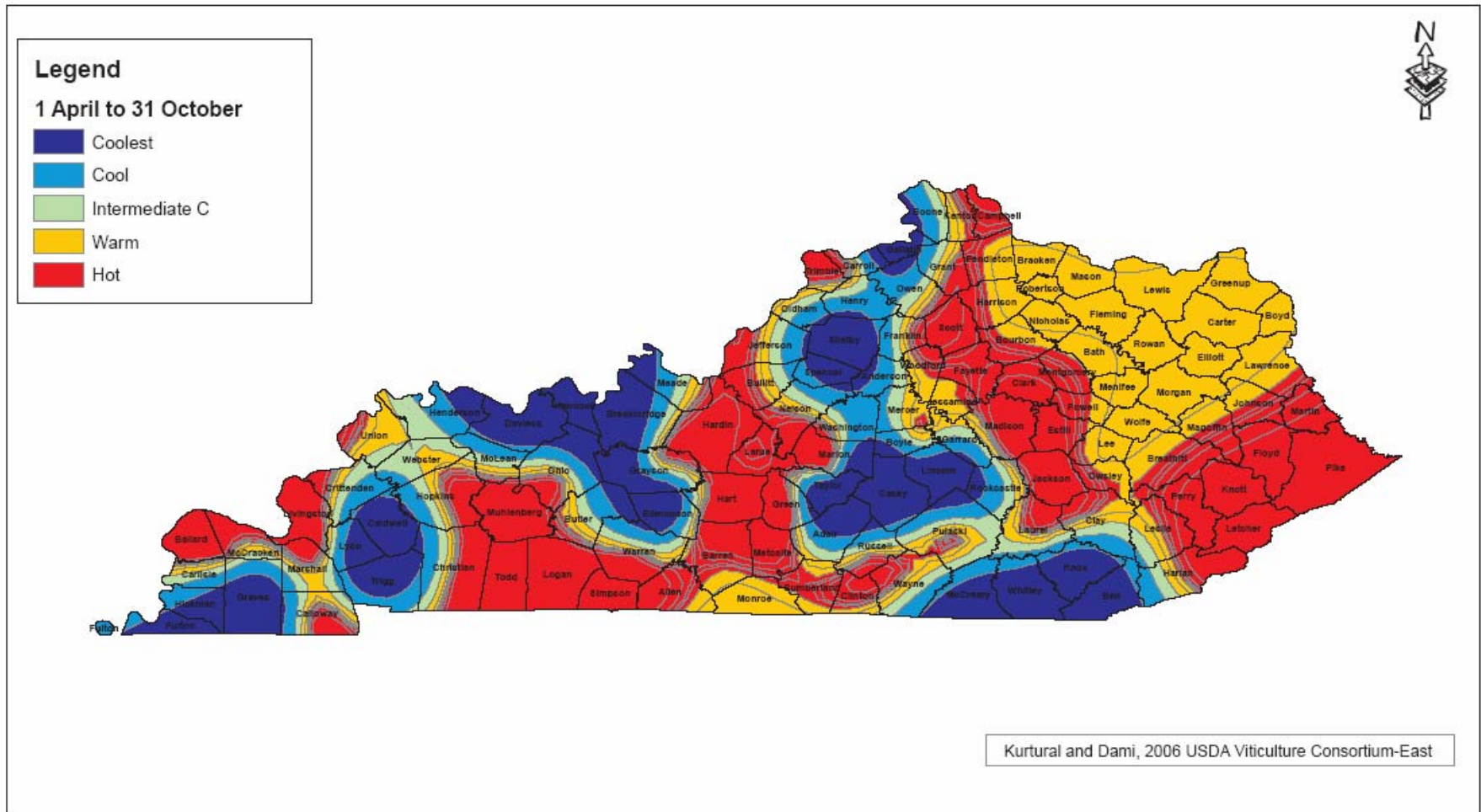
- Cooler climates generally produce the best quality table wines
- Evidence suggests that it is lower temperatures during the growing season that are of special significance
- A cooler growing season – often with considerable diurnal temperature variation slows down development; better balances can be achieved, and more aroma and flavor constituents are accumulated.

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Growing Season Mean Temperature in Kentucky

Growing Season Mean Temperature



Macroclimate Composite Analysis

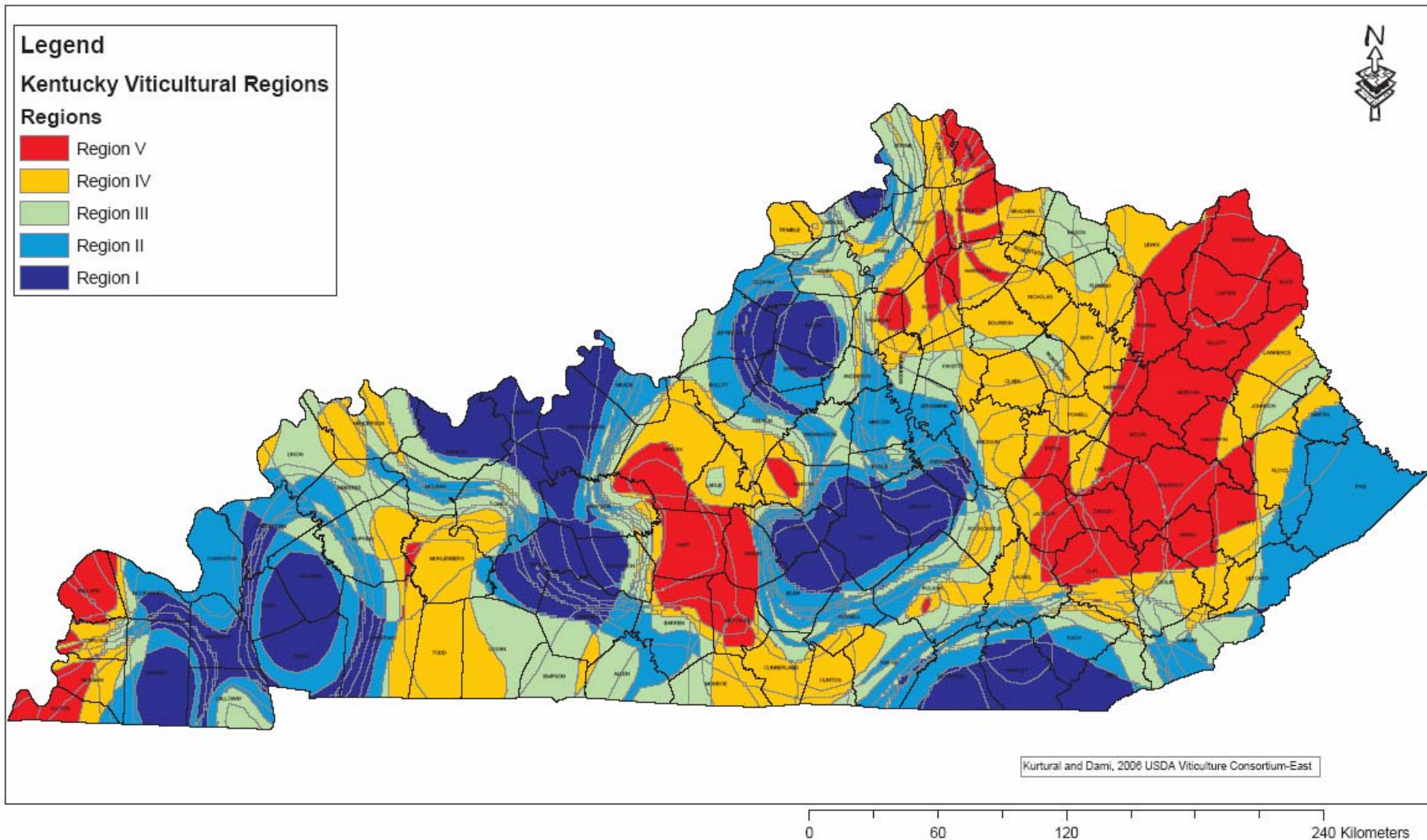
- 5 distinct viticultural regions in Kentucky
- Vinifera grapes are NOT a commercial option
- High value hybrids and high value American cultivars are driving the industry

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Viticultural Regions of Kentucky

Viticultural Regions of Kentucky



Properties of the Grape Growing Regions

	Region I	Region II	Region III	Region IV	Region V
Occurrence of -15F ^[1]	<5%	5%-10%	10%-15%	15%-20%	>20%
Winter severity index ^[2]	Mildly cold	Cold	Very cold	Extremely cold	Extremely cold
Spring frost index ^[3]	<9	9-11	11.5-13	11.5-13	>13.5
Growing degree days ^[4]	Region III/IV	Region III/IV	Region IV	Region IV	Region V
Frost free days ^[5]	>181d	>181d	171-180d	160-170d	160-170d
Growing season mean temperature ^[6]	Coolest	Cool	Intermediate	Warm	Hot

^[1] Occurrence of -15F percent of the time between 1974-2005.

^[2] Mean temperature of January between 1974-2005. Extremely cold <5F, Very cold 5F to 14F, Cold 14F to 23F, Mildly cold 23F to 32F.

^[3] Spring frost index (SFI) for April: Difference between average mean and average minimum for the month of April between 1974-2005.

^[4] Growing degree days calculated using 50F base temperature between 1 April and 30 October 1974-2005

^[5] Days between last spring frost occurrence at 32F and first fall frost occurrence at 32F between 1974-2005.

^[6] Growing season mean temperature is calculated as the mean of daily maximum temperatures between 1 April and 30 October 1974-2005.



	Region I	Region II	Region III	Region IV	Region V
Hybrid red cvs.	Chambourcin	Chancellor	Chancellor	DeChaunac	Frontenac
	Chancellor	Corot Noir	DeChaunac	GR-7M	Leon Millot
	Corot Noir	GR-7M	GR-7M	Frontenac	Marechal Foch
	Noiret	Noiret	Frontenac	Leon Millot	Marquette
		St. Croix	Leon Millot	Marechal Foch	St. Croix
		St. Vincent	Marechal Foch	Marquette	St. Vincent
			Marquette	St. Croix	
			St. Croix	St. Vincent	
Hybrid white cvs.	Cayuga white	Cayuga white	Frontenac gris	Frontenac gris	Edelweiss
	Chardonel	Frontenac gris	LaCrescent	LaCrescent	Frontenac gris
	Seyval blanc	Seyval blanc	LaCrosse	LaCrosse	LaCrescent
	Traminette	Valvin Muscat	Seyval blanc	Seyval blanc	LaCrosse
	Valvin Muscat	Vidal blanc	Vignoles		
	Vidal blanc	Vignoles			
	Vignoles				
American red cvs.	Alden	Alden	Alden	Alden	Alden
	Catawba	Catawba	Catawba	Catawba	Catawba
	Delaware	Delaware	Delaware	Delaware	Delaware
	Norton	Fredonia	Fredonia	Fredonia	Fredonia
		Norton		Steuben	Steuben
American white cvs.	Niagara	Niagara	Niagara	Niagara	Niagara



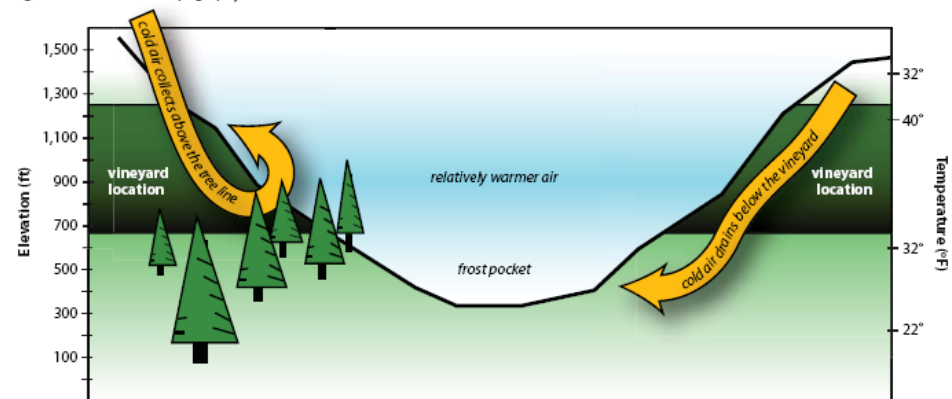
Mesoclimate?

- Mesoclimate = Local climate
 - More specific than macroclimate
- Components of mesoclimate
 - Absolute and relative elevation
 - Compass orientation (aspect)
 - Slope of the land
 - Interact to affect mesoclimate of site

Factors Affecting Radiative Freezes and Mesoclimate Suitability for Vineyards

- Absolute elevation
 - Warmest air is found at the higher elevations
- Percent Slope
 - Fosters emergence of thermal belts during radiative cooling events
- Aspect (cardinal direction slope faces)
 - Critical determinant of:
 - Radiation interception
 - Temperature
 - Soil moisture regimes
- Their effects are additive for avoidance of radiative freezes

Figure 2. Effects of site topography on mesoclimate.





Building a Model for Mesoclimate Suitability Determination

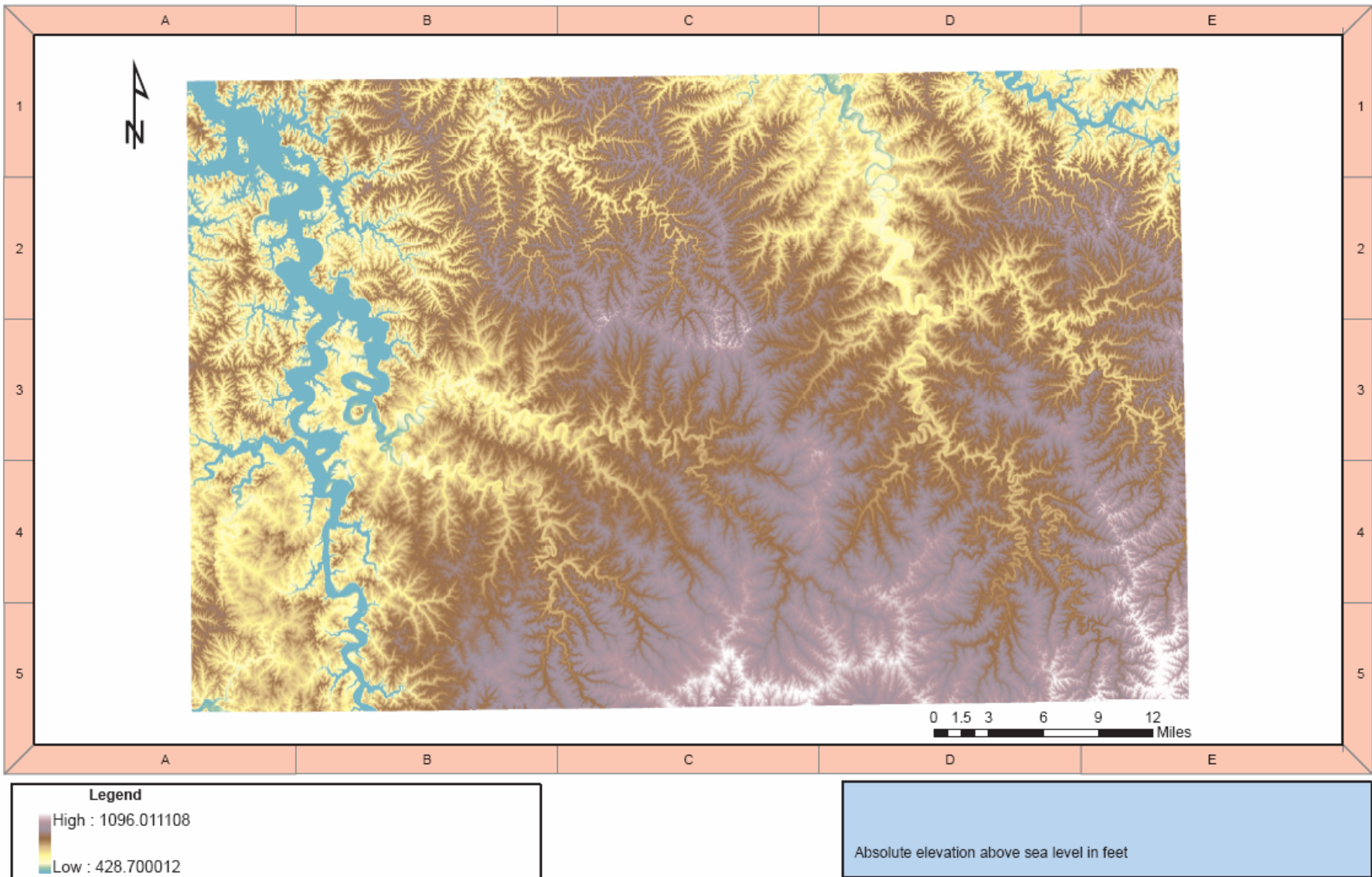
- Statistical analysis of historical climate data and survey of existing perennial plantings based on:
 - Absolute elevation:
 - Slope:
 - Aspect:

Absolute Elevation (ASL)

- To avoid radiative freeze events
- Upper and lower limits of thermal belts
- ASL regressed on
 - Spring temperatures (April)
 - Last spring frost
 - First fall frost
- Weighted linear indexing for ranking of ASL to define upper and lower limits of thermal belts

<u>ASL (feet) ranking</u>	<u>Point value</u>
1290-1600	10
850-1290	20
800-850	18
750-800	16
700-750	14
650-700	12
600-650	10
550-600	8
500-550	6
450-500	4
<450	2

Absolute Elevation above sea level (in feet) of Fayette Co. in Kentucky

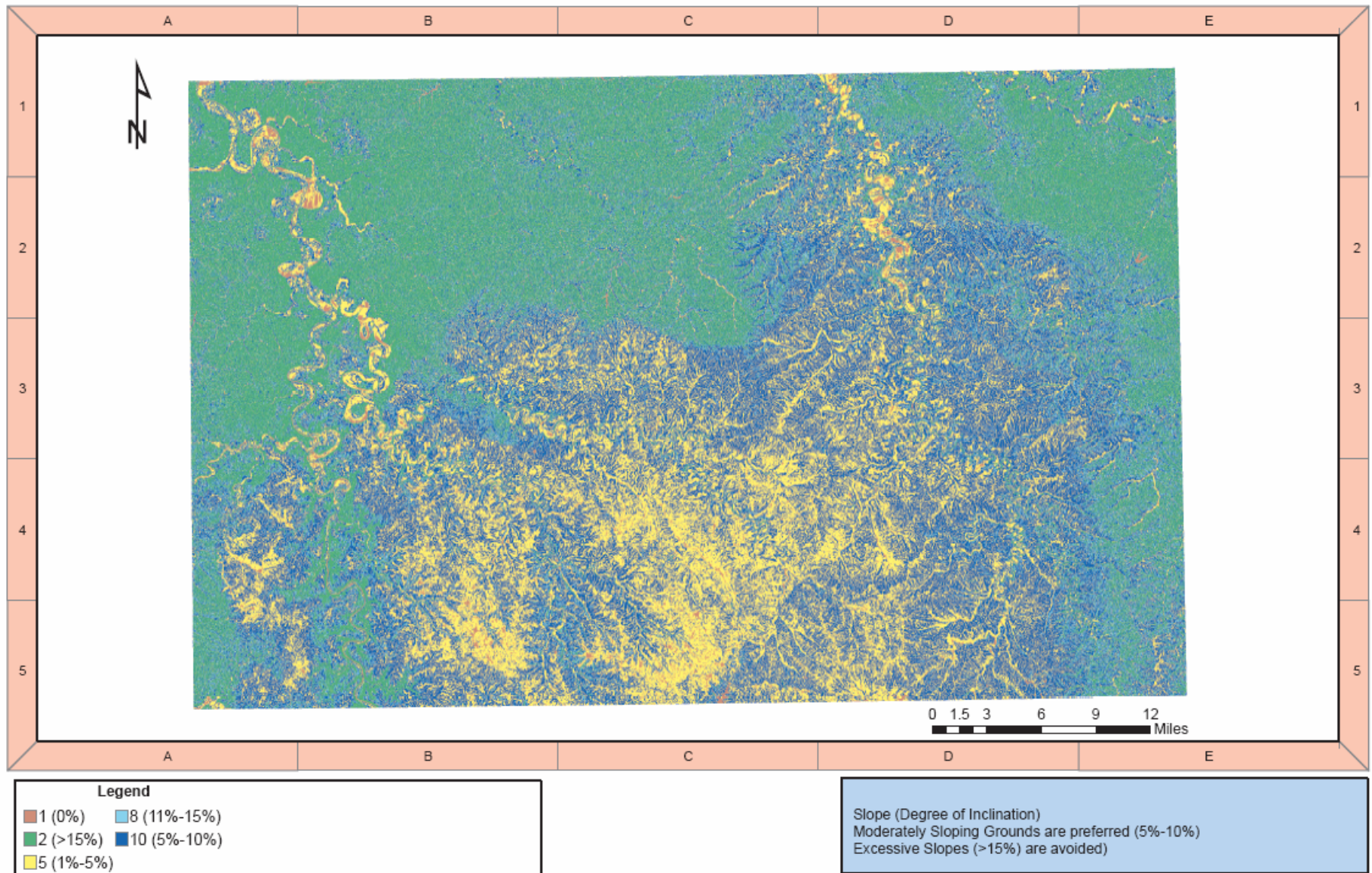


Slope

- Inclination or declination land surface varies from horizontal
- Flat land 0%
- Vertical cliffs 100%
- Slight to moderate slopes are desirable (5%-10%)
- Slopes >15% are hazardous and prone to erosion
- Weighted linear indexing for ranking of slopes to accelerate drainage of dense cold air

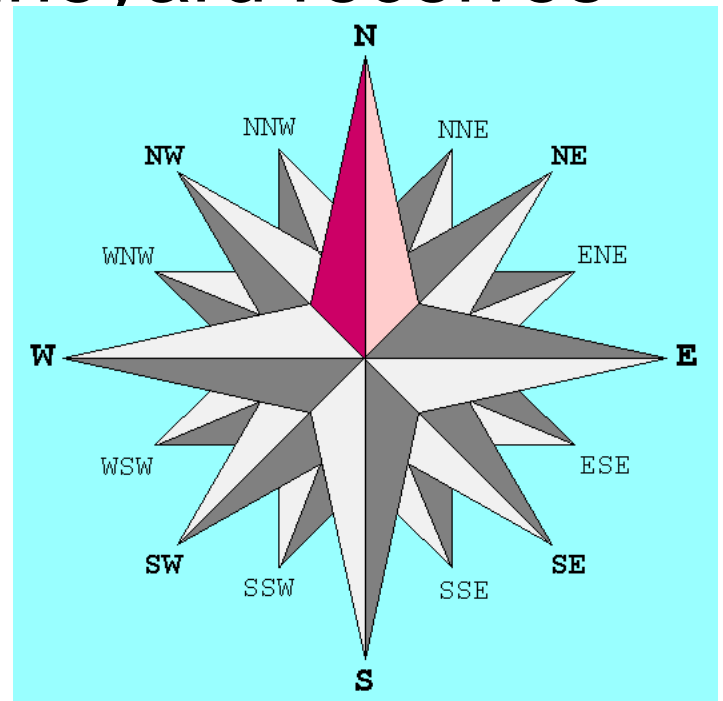
<u>Slope (%)</u>	<u>Point value</u>
5-10	10
11-15	8
1-4	5
>15	2
Flat (0)	1

The slope (percent inclination) of Fayette Co. in Kentucky and its reclassification



Aspect

- Prevailing compass direction the slope faces
- Affects angle of sunlight vineyard receives

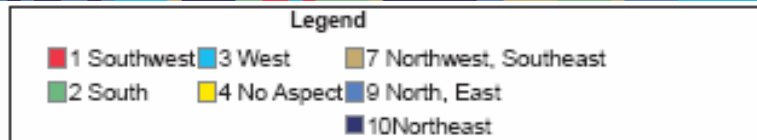
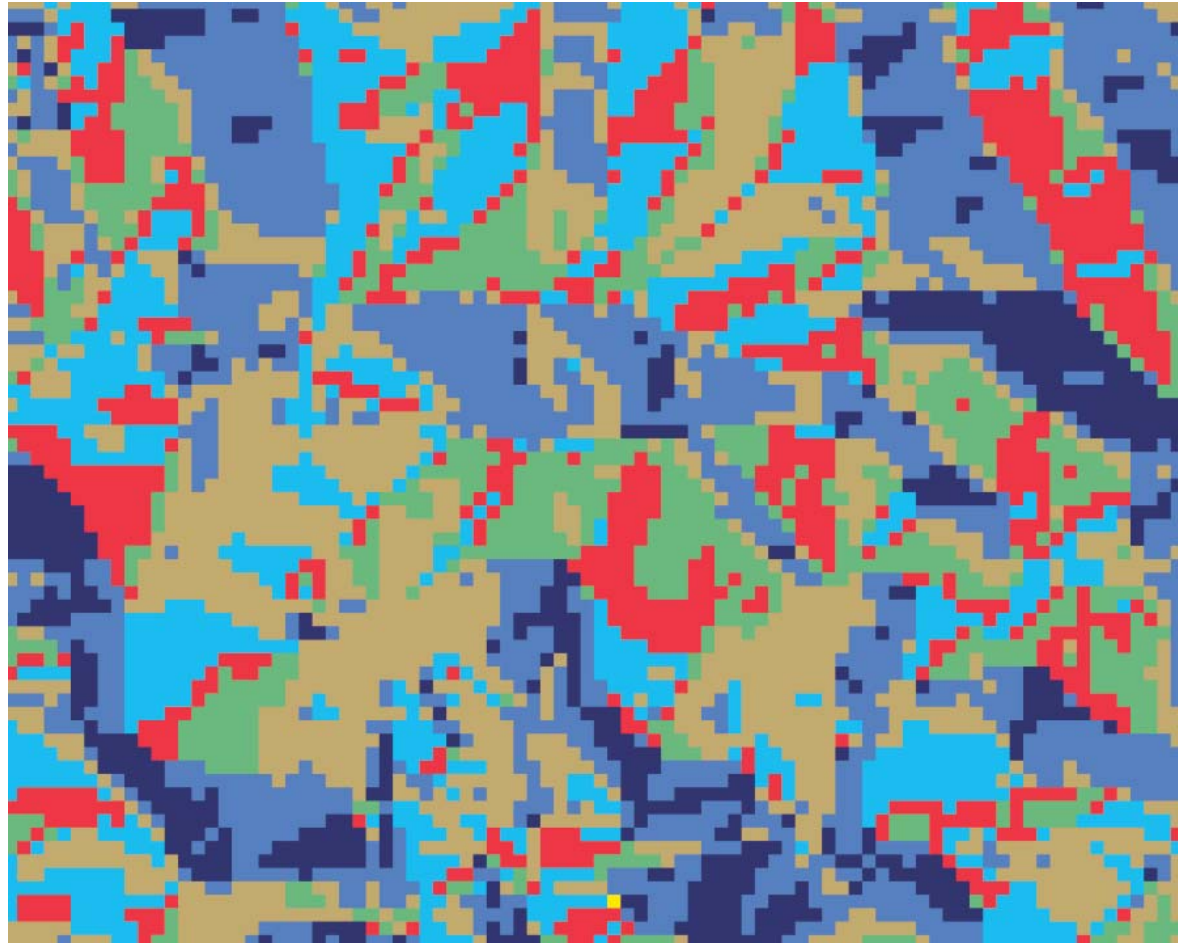


Relative effects of aspect of vineyard site on grapevine phenology and physical parameters

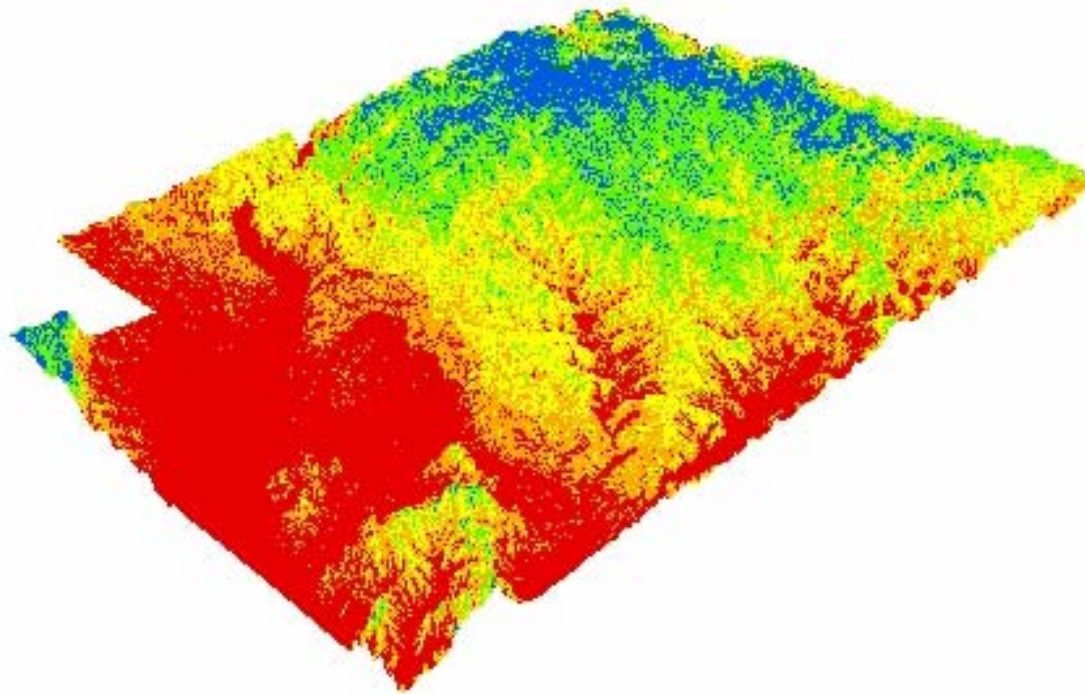
	ASPECT			
	<u>North</u>	<u>South</u>	<u>East</u>	<u>West</u>
Time of budbreak	Retards	Advances	Retards	Advances
Daily vine max T	Less	Greater	Less	Greater
Foliage drying	No effect	No effect	Advanced	Retarded
Radiant fruit heat	Less	Greater	Less	Greater
Radiant vine heat	Less	Greater	Less	Greater
Min. winter T	Lower	Higher	-	-
Length of season	Shorter	Longer	-	-



The aspect of Fayette Co in Kentucky and its Point Value according to the model



3D application of the Mesoclimate Model





Application of the GIS Model to Existing Sites

- End-product delivery via Internet Map Server or DVD
- Cooperative Extension Service enters USPS Mailing Address
- Location is displayed on screen with 100m² resolution
- Results are interpreted
- Hard-copy map is delivered to grower with recommendations by Cooperative Extension Service

Find

Edit Standardization

HouseNum: 1200

PreDir: [Dropdown]

PreType: [Dropdown]

StreetName: BUCKRUN

StreetType: RD

SufDir: [Dropdown]

City: VERSAILLES

State: KY

Postcode: [Text]

Show all candidates

Find Stop New Search Cancel

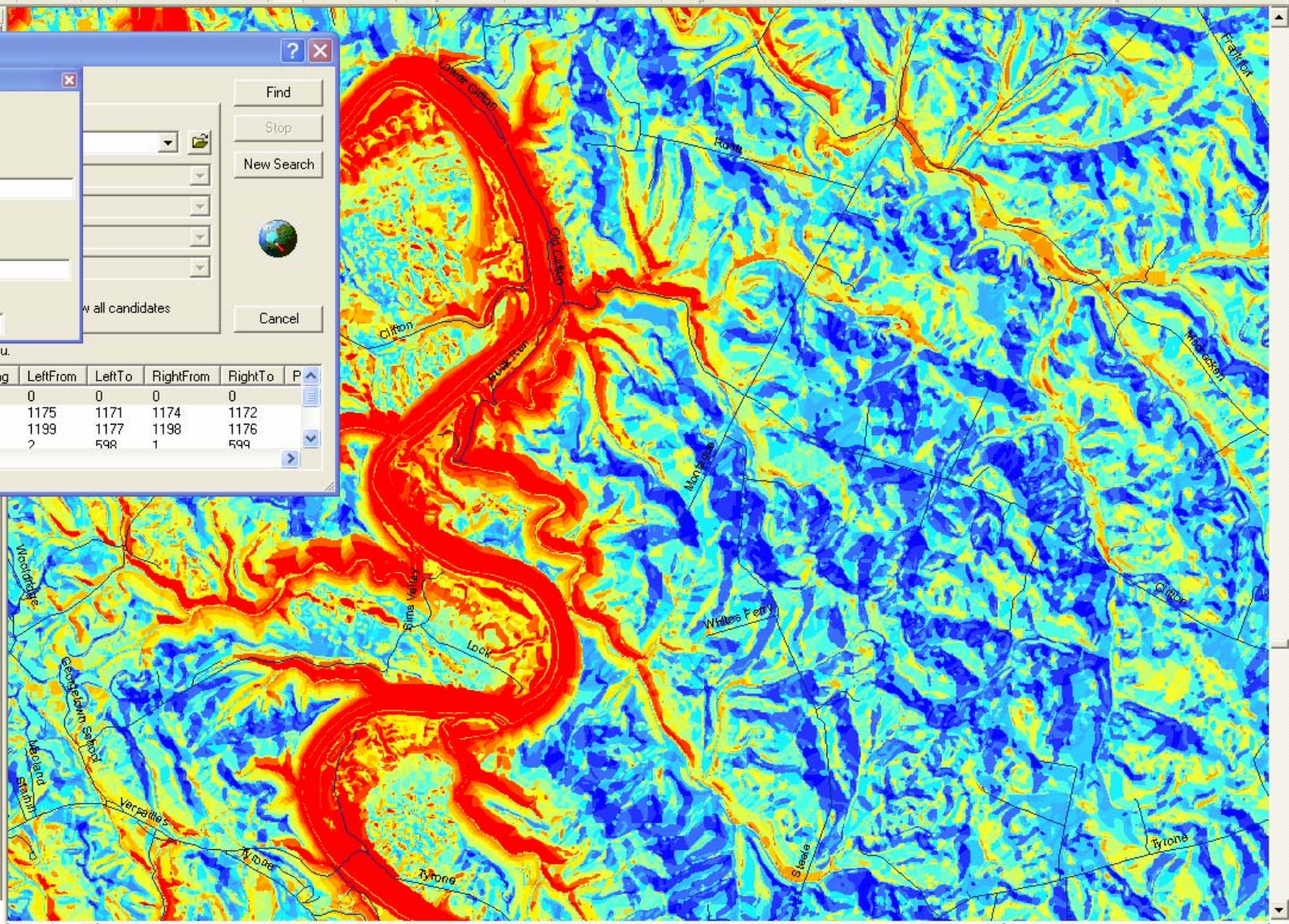
Right-click a row to show context menu.

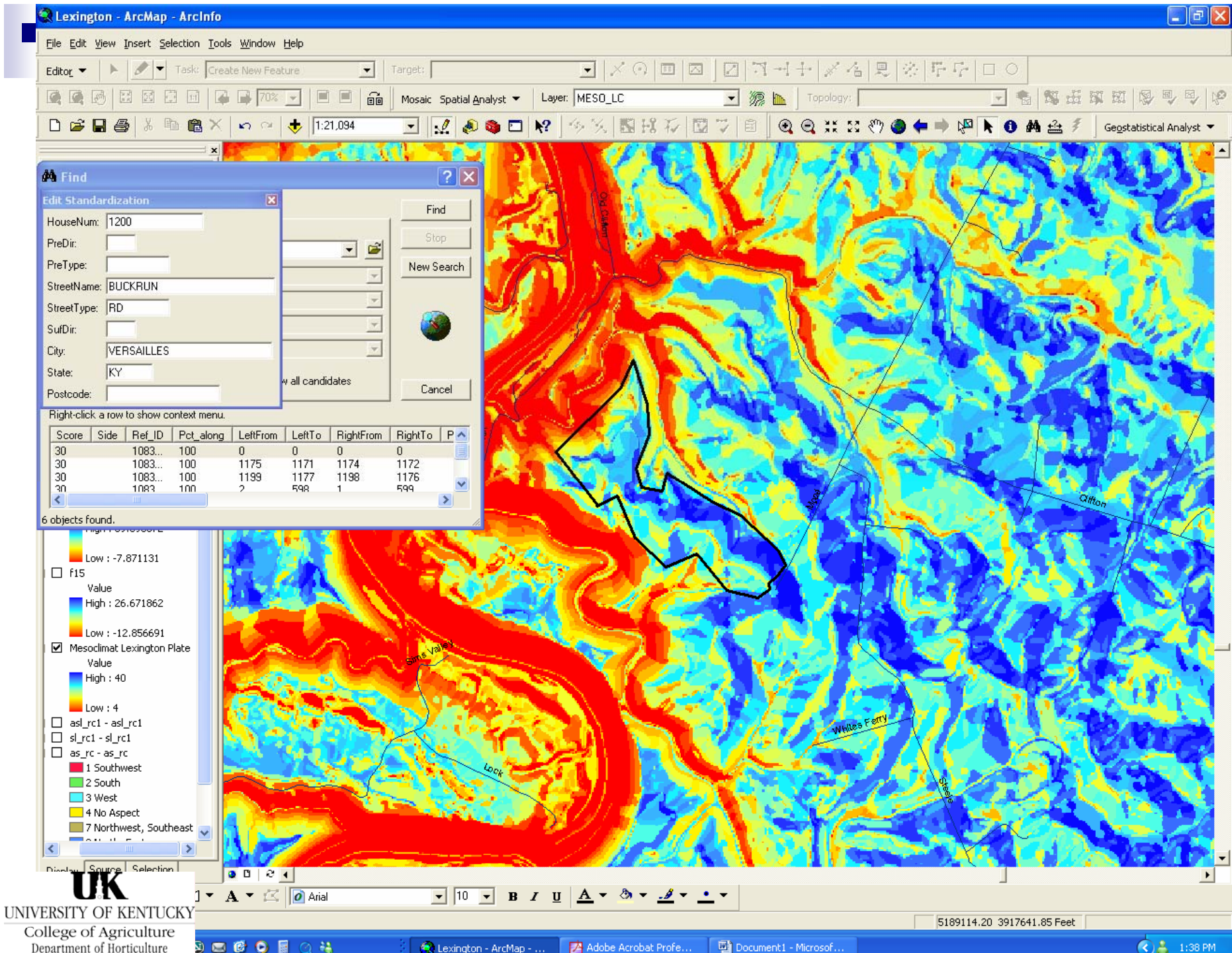
Score	Side	Ref_ID	Pct_along	LeftFrom	LeftTo	RightFrom	RightTo	P
30		1083...	100	0	0	0	0	
30		1083...	100	1175	1171	1174	1172	
30		1083...	100	1199	1177	1198	1176	
30		1083...	100	2	598	1	599	

6 objects found.

Legend

- Low : -7.871131
- f15 Value High : 26.671862
- Mesoclimat Lexington Plate Value High : 40
- Low : 4
- asl_rc1 - asl_rc1
- sl_rc1 - sl_rc1
- as_rc - as_rc
- 1 Southwest
- 2 South
- 3 West
- 4 No Aspect
- 7 Northwest, Southeast

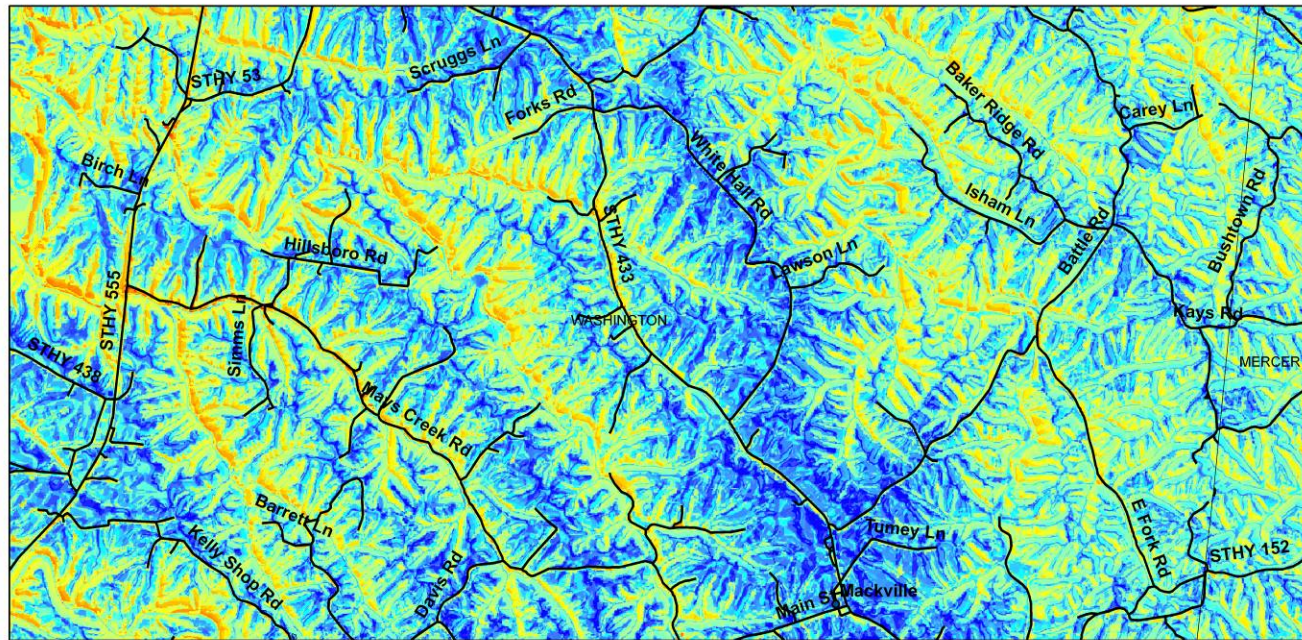




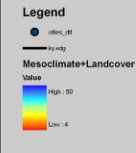
Hard copy delivered to prospective growers

FAIR FAMILY PROSPECTIVE VINEYARD SITE ANALYSIS

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Site visit performed by Dr. Kurtural and associate. As with other successful vineyards visited in the county, this is an operational farm where tobacco is grown and has been grown for quite some time. The owners have little to no background in perennial horticultural crops. The farm has varied topography with the Best possible location sitting on a greeben with a northerly slope with silty mixed mesic soil, running perpendicular to the State Highway 433. The gently rolling slope would provide a benefit to novice growers such as the 'Fairs'. The recommended varieties for the 'Best' possible locations are:
 Wine (processing) grapes of the Red varieties are:
 'Cabernet Franc', 'Chancellor', 'Chambourcin', 'NY70', 'Norton'
 Wine (processing) grapes of the White varieties are:
 'Cayuga', 'Chardonef', 'Edelweiss', 'Frontenac Gris', 'Seyval blanc', 'Villard blanc', 'Vidal blanc', 'Traminette', 'Vignoles', 'Viognier'





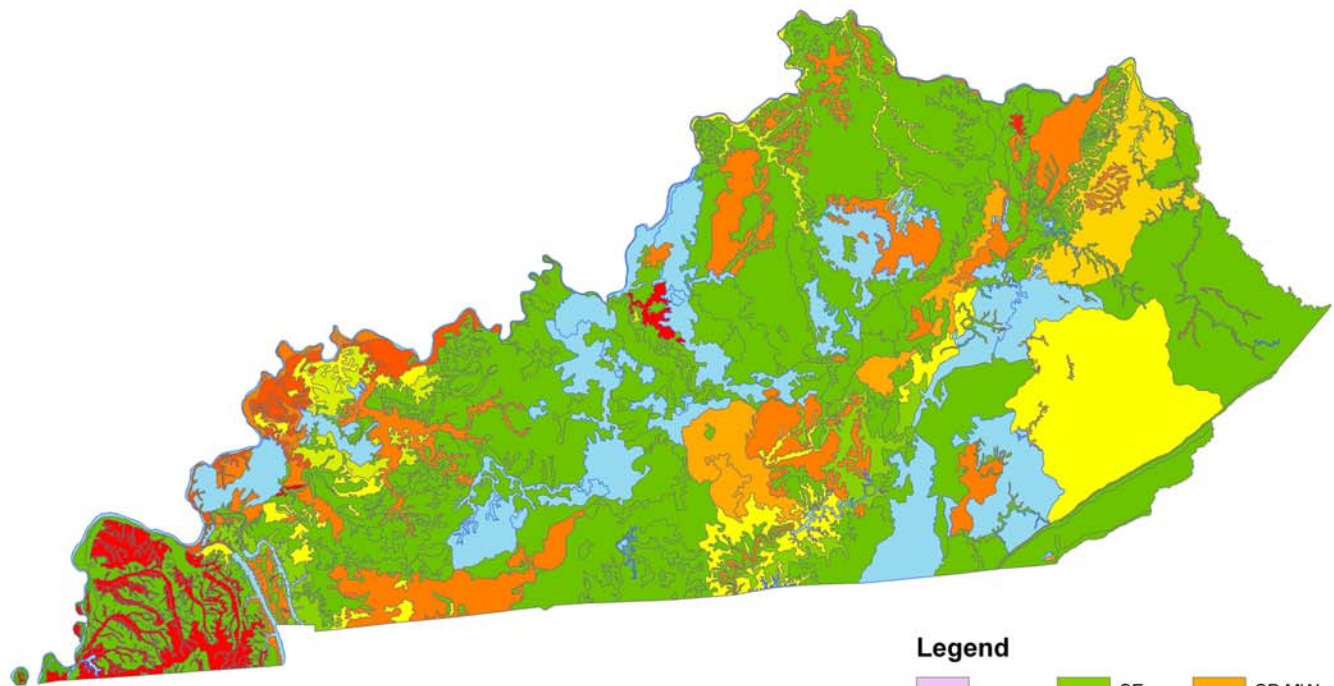
The Great Mystery.. SOILS

- Not a determining factor for grape or wine quality
- Important soil factors
 - Internal water drainage
 - Soil organic matter percentage
 - Soil pH

Internal water drainage

- Best vineyard soils
 - Deep and spreading root growth
 - Steady but moderate supply of water
 - >50 mm of drainage per hour
 - Can be amended during site establishment with tiling but is expensive

Drainage



Legend

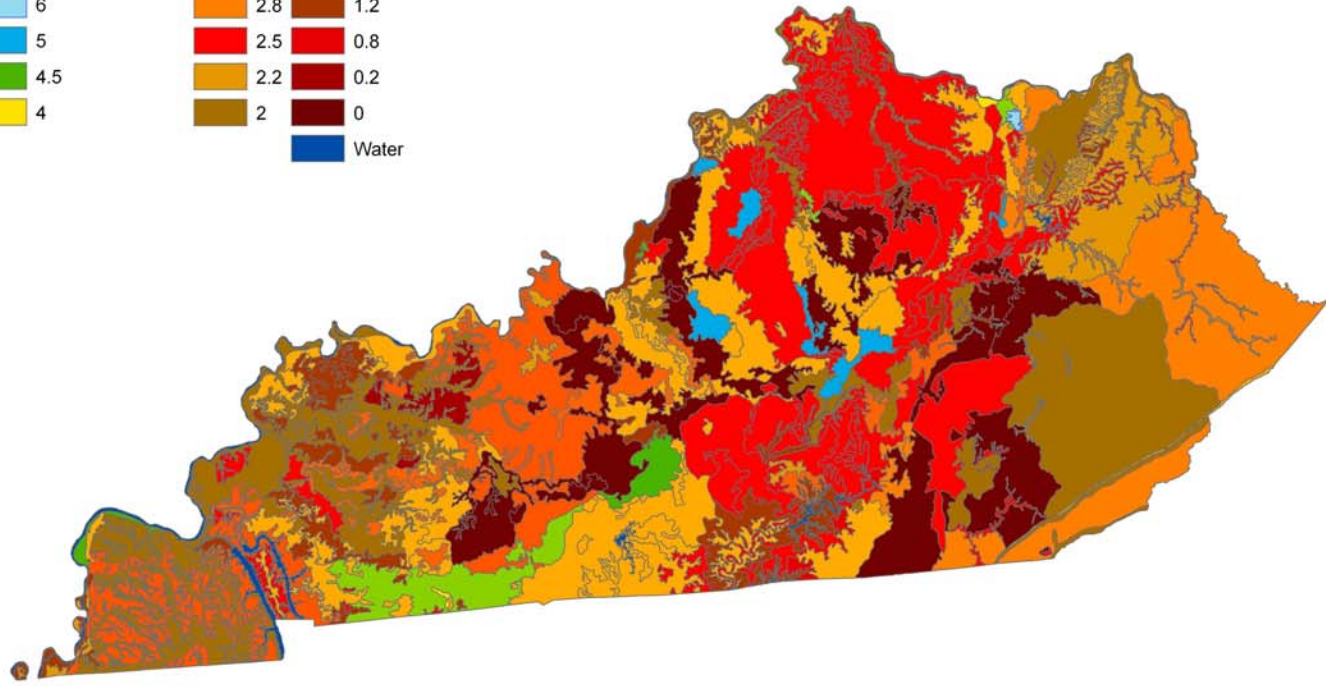
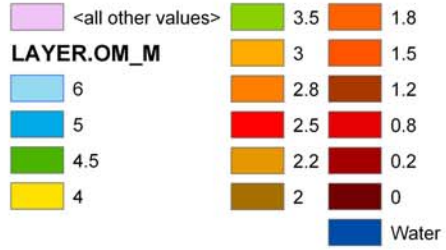
Drainage		
No Data	SE	SP,MW
E	W,MW	SP
W	MW,W	P,VP
	MW	VP,P
	MW,SP	P

Organic Matter Percentage

- Contributes to:
 - Porosity
 - Structure
 - Moisture
 - Availability of nutrients
- Not greater than 3%-5% OM

Percent Organic Matter

Legend








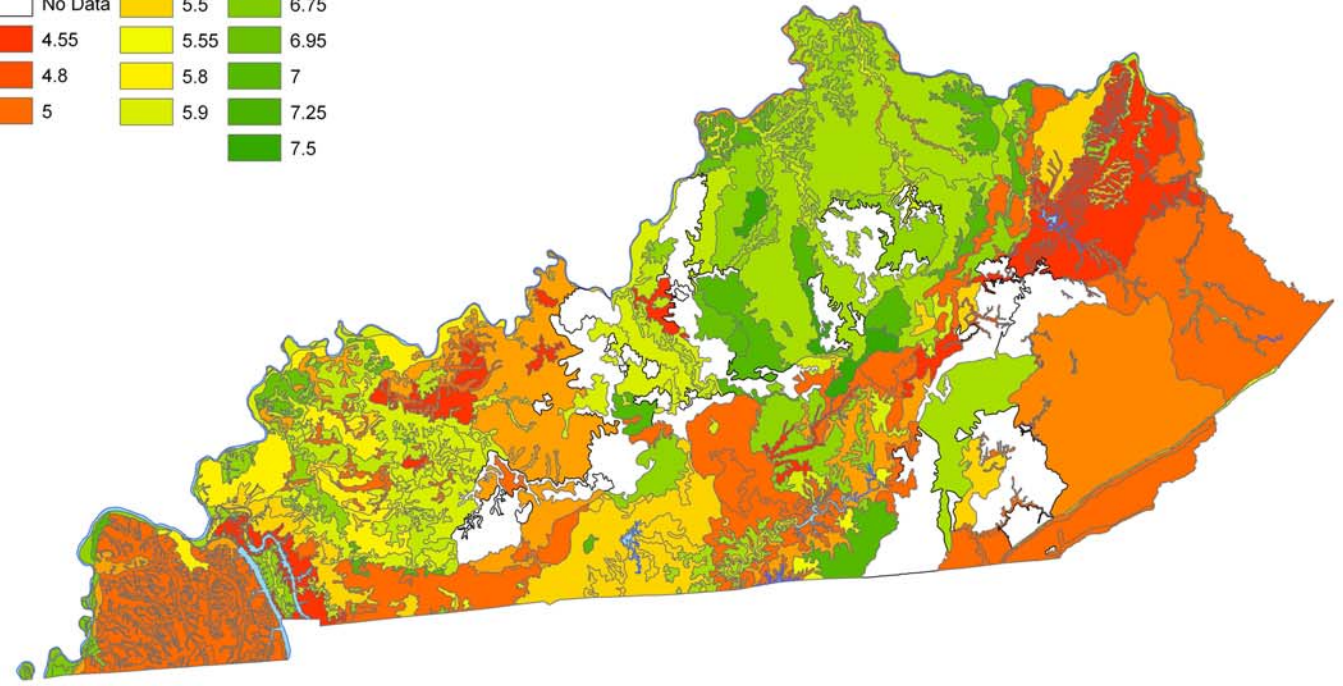
Soil pH

- Easiest property to modify
- Soil pH between 6.0 -6.8 provide optimum nutrient availability
- Soil pH < pH5 increases Aluminum solubility

Soil pH

Legend

		5.05		6.2
Soil pH		5.25		6.45
		5.45		6.7
		5.5		6.75
		5.55		6.95
		5.8		7
		5.9		7.25
				7.5



Texture

- Direct effects are poorly defined
- Indirect effects on soil hydrology
 - Water holding capacity
 - Internal water drainage
- Ideal sites have:
 - Loam
 - Sand-loam
 - Sand-clay-loam

Ideal vineyard soil test values

Chemical properties	Value range
Soil pH	pH: 5.5 to 6.8
Organic matter %	#: 2-3
Phosphorus	P: 40-50lbs/A
Potassium	K: 250-300 lbs/A
Magnesium	Mg: 200-250 lbs/A
Zinc:	Zn: 8-10 lbs/A
Boron:	B:1.5-2.0 lbs/A

Proximity to Crop Hazards

- Elements outside climate and soil requirements
- Herbicide drift
- Deer depredation
- Bird damage

Herbicide Drift

- Growth regulator type herbicides
 - 2,4-D used in row crops, right of ways, golf courses etc.
 - Cause injury and/or serious stunting
- High risk areas should be avoided



Epinasty, fanning of the laminae

Deer Depredation

- Affects young and mature vines
- Most devastating in newly set vines
- Sites close to woodlands are more prone to damage
- Extent and cost of protection methods depends on severity



Deer feeding !!!!

Bird Damage

- Cause damage by feeding on berries
- Sugar:acid ratio reach palatable values
- Proximity of vineyard to wooded areas, power lines increases risk



Summary

- Suitable vineyard site is matched to appropriate cultivars
- NO SITE IS PERFECT
- More emphasis on CLIMATE and TOPOGRAPHY than SOILS

Ideal Vineyard is Located...

- Highest surrounding area
- Gentle sloping terrain
- Critical temperatures occur < 15% of the time in 30 year period
- Spring and Fall Frosts are Minimum
- Soils are deep and well-drained with moderate OM
- NOT surrounded by woods



Acknowledgements

- Dr. Imed E. Dami, Ohio Ag. Res. Dev. Cent.
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- Kentucky Grape and Wine Council

