Applications of GIS analysis in determining hops habitat in Oregon and the risk of powdery mildew

Nicki Dwyer March 11, 2010 Geog592

http://www.minnpost.com/markneuzil/2008/01/14/550/price_for_hops_used_to_make_beer_is_going_up_and_you_know_what_that_means

What are hops?

- This flower is exclusively used for beer.
- A key ingredient in beer
- Adds flavor and acts as a preservative
- Volatile hops agriculture directly influences beer cost

http://brewpublic.com/tag/lisa-morrison/

http://www.spiceworld.uk.com/product_info.php?products_id=1220

Why Oregon?

http://thefullpint.com/main/wp-content/uploads/2008/10/rogue-farms-hop-field.jpg

- The ideal hops growing environment:
  - Is between the 35th and 55th parallel
  - Has ample moisture
  - Has no more than 150 days of frost
  - Has warm summers
  - Has sandy loam soil, with a pH of 6.5 to 7.5
- The valleys in the Northwest are perfect for hops agriculture

Portland has the 2nd most breweries in the country

Model for assessing ideal hops habitat in Oregon

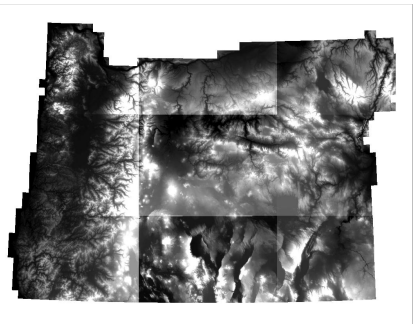
A multi-criteria decision making process

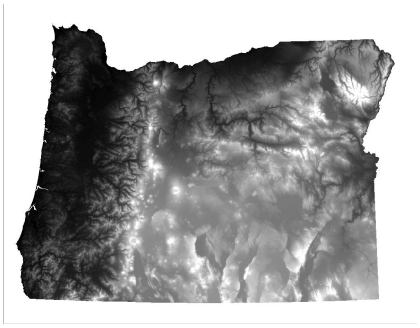
Factors:

- Elevation: below 3000 feet
- Slope: under 8 degrees
- Graticule: nearest to 45th parallel
- Precipitation: 30 inches per year
- Vegetation environment: woodlands/grasslands

Data Management

- Clipped all layers to Oregon boundary
- Used “mosaic to new raster” tool to combine 9 DEMs
- Simplified vegetation data





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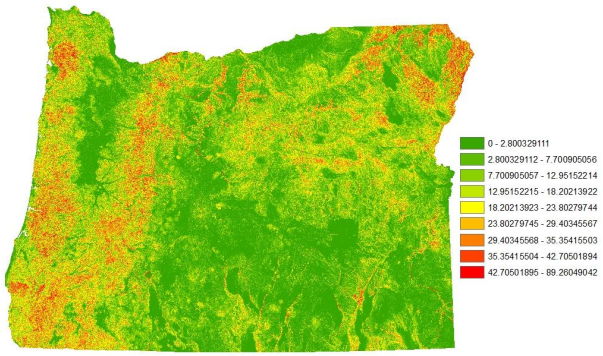
Rowid	VALUE *	COUNT	GAPCODE	ORCODE	DISPLAY	HABNAME	HABCODE	LCCODE	LCNAME	OR_ESNAME	GAPNAME	SYMBOLOGY
0	1	2332423	11	11	11 Water	Water (Lakes and Ponds, Rivers and Streams, Bays)	43	111	Water	Water	Water	Riparian
1	2	524903	15	15	15 CRP Lands	Old Field, Abandoned Cropland, Clearcuts, CRP	31	640	Fallow	CRP Lands	CRP Lands	CRP lands
2	3	3766911	21	21	21 Developed, Open Space (Roads, Parks, Golf Cou	Suburban	41	210	Recreation - Developed Open Space	Developed, Open Space (Roads, Parks, Golf Courses, O	Developed, Open Space (Parks, Golf Courses, Open Space)	Developed
3	4	2979644	22	22	22 Developed, Low Intensity	Rural Residential	34	220	Low Density Residential	Developed, Low Intensity	Developed, Low Intensity	Developed
4	5	995290	23	23	23 Developed, Medium Intensity	Suburban	41	230	Developed, Medium Intensity	Developed, Medium Intensity	Developed, Medium Intensity	Developed
5	6	292579	24	24	24 Developed, High Intensity	Urban	42	240	Urban and Industrial	Developed, High Intensity	Developed, High Intensity	Developed
6	7	28	32	24	24 Developed, High Intensity	Urban	42	240	Urban and Industrial	Developed, High Intensity	Quarries/Strip Mines/Gravel Pits	Rock
7	8	383	61	88	88 High Structure Agriculture	High Structure Agriculture	19	610	High Structure Agriculture	High Structure Agriculture	Orchards/Vineyards	Vineyards
8	9	8962220	81	81	81 Agriculture - Hay/pasture	Pasture/Hay	32	810	Pasture/Hay	Agriculture - Hay/pasture	Agriculture - Hay/pasture	Agriculture
9	10	1682109	82	82	82 Agriculture - Irrigated	Cultivated Crops	14	820	Cultivated Crops	Agriculture - Irrigated	Agriculture - Irrigated	Agriculture
10	11	451189	88	88	88 High Structure Agriculture	High Structure Agriculture	19	610	High Structure Agriculture	High Structure Agriculture	High Structure Agriculture	Agriculture
11	12	158403	3118	3135	3135 Alpine Bedrock and Scree	Alpine and Subalpine Habitats	3	312	Rock or Lava	Alpine Bedrock and Scree	North Pacific Alpine and Subalpine Bedrock and Scree	Rock
12	13	576965	3128	3128	3128 Volcanic Rock, Lava Flow or Cinder Land	Lava Flows	23	312	Rock or Lava	Volcanic Rock, Lava Flow or Cinder Land	Inter-Mountain Basins Volcanic Rock and Cinder Land	Badland
13	14	94866	3129	3129	3129 Blue Mountain Cliff and Canyons	Cliff and Canyon	9	312	Rock or Lava	Blue Mountain Cliff and Canyons	Rocky Mountain Cliff, Canyon and Massive Bedrock	Rock
14	15	66742	3130	3130	3130 Alpine Ice Field	Alpine and Subalpine Habitats	3	120	Perennial Ice/Snow	Alpine Ice Field	North American Alpine Ice Field	Tundra
15	16	164143	3135	3135	3135 Alpine Bedrock and Scree	Alpine and Subalpine Habitats	3	312	Rock or Lava	Alpine Bedrock and Scree	Rocky Mountain Alpine Bedrock and Scree	Rock
16	17	286844	3140	3128	3128 Volcanic Rock, Lava Flow or Cinder Land	Lava Flows	23	312	Rock or Lava	Volcanic Rock, Lava Flow or Cinder Land	North Pacific Volcanic Rock and Cinder Land	Badland
17	18	16149	3152	5258	5258 Salt Desert Scrub	Deserts, Playas and Ash Beds	15	311	Playa or salt flat	Salt Desert Scrub	Inter-Mountain Basins Wash	Badland
18	19	22710	3155	3135	3135 Alpine Bedrock and Scree	Alpine and Subalpine Habitats	3	312	Rock or Lava	Alpine Bedrock and Scree	North Pacific Montane Massive Bedrock, Cliff and Talus	Rock
19	20	2724	3158	3158	3158 Coastal Cliff, Bluff and Headland	Cliff and Canyon	9	312	Rock or Lava	Coastal Cliff, Bluff and Headland	North Pacific Coastal Cliff and Bluff	Canyon
20	21	682528	3160	3160	3160 Inland Sand Dune	Dunes	16	314	Dune	Inland Sand Dune	Inter-Mountain Basins Active and Stabilized Dune	Dune
21	22	7916	3165	3165	3165 California Coastal Dunes	Dunes	16	314	Dune	California Coastal Dunes	Mediterranean California Northern Coastal Dune	Dune
22	23	9036	3167	3167	3167 California Serpentine Barren	Coastal and Valley Grasslands	10	710	Perennial Grasslands/Herbaceous	California Serpentine Barren	Mediterranean California Serpentine Barrens	Barrens
23	24	1446	3179	3158	3158 Coastal Cliff, Bluff and Headland	Cliff and Canyon	9	312	Rock or Lava	Coastal Cliff, Bluff and Headland	Klamath-Siskiyou Cliff and Outcrop	Canyon
24	25	288357	3173	3173	3173 Intermountain Basin Cliff and Canyon	Cliff and Canyon	9	312	Rock or Lava	Intermountain Basin Cliff and Canyon	Inter-Mountain Basins Cliff and Canyon	Canyon
25	26	1164588	3174	3174	3174 Ash Bed	Deserts, Playas and Ash Beds	15	313	Ash or Badland	Ash Bed	Columbia Plateau Ash and Tuff Badland	Badland
26	27	168693	3177	3177	3177 North Pacific Coastal Sand Dune	Dunes	16	314	Dune	North Pacific Coastal Sand Dune	North Pacific Maritime Coastal Sand Dune and Strand	Dune
27	28	2434672	3179	3179	3179 Playa	Deserts, Playas and Ash Beds	15	311	Playa or salt flat	Playa	Inter-Mountain Basins Playa	Playa

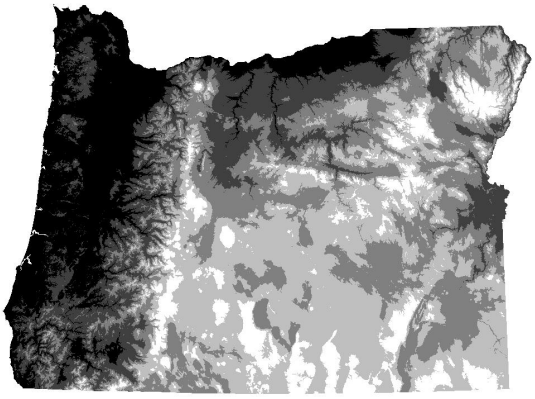
Derived Layers

- Slope analysis



Reclassify

- For weighted overlay, all data inputs must have discrete, rather than continuous values



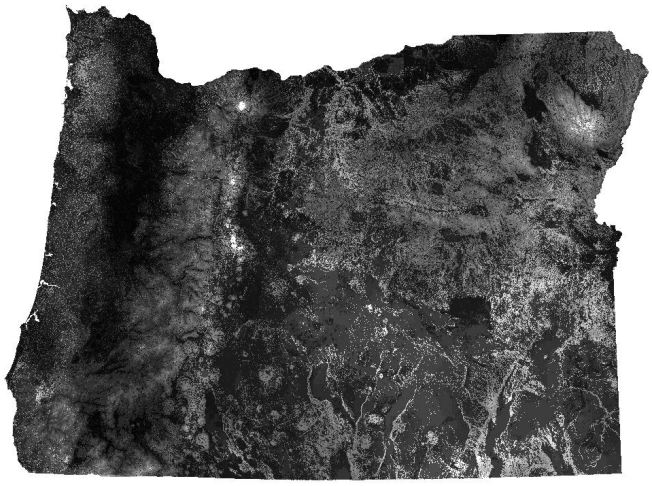
Analytic Hierarchy Process (AHP)

How important is A relative to B?	Preference index assigned
equally important	1
moderately more important	3
strongly more important	5
very strongly more important	7
overwhelmingly more important	9

	elevation	slope	graticule	precipitation	vegetation
elevation	1	1/5	1/3	1/7	3
slope	5	1	3	3	7
graticule	3	1/3	1	1/3	3
precipitation	7	1/3	3	1	7
vegetation	1/3	1/7	1/3	1/7	1

criterion	geometric mean	weight
elevation	0.491	**0.069**
slope	3.160	**0.444**
graticule	1.000	**0.140**
precipitation	2.178	**0.306**
vegetation	0.296	**0.042**
sum	7.120	1.000

Weighted Overlay



Downy mildew and hops production

- Downy mildew
  - Thrive in moist habitats, humidity, rain
  - 65 degrees is ideal temp.
  - Older hops is not as sensitive

http://plant-disease.ippc.orst.edu/disease.cfm?RecordID=599

Future Research

- Use true data of hop farms to validate model
- Compare yearly crop yield with the year's climate
  - Extrapolate, using an almanac, how upcoming weather patterns may affect crop yield
- Continue to map the occurrence of powdery mildew, what factors are causing powdery mildew to destroy crops, and when and where is this not as much of an issue

Limitations

at The Brew Site

- Not enough data
  - Day-to-day weather data
  - Current hops farms
- Indirect uses of data, i.e. using vegetation as an indicator of soil suitability
- Arbitrary ranking of factors
- More research about how powdery mildew effects hops, and what perpetuating conditions are the most important

References

- Foyston, John. “Glut of hops unlikely to lower beer prices.” *The Oregonian*: October 27, 2009.
- Hiller, Susan M., Gale A. Gingrich and Alfred Haunold. “Growing Hops - In the Home Garden.” Oregon Hop Commission: 2010.
- Royle, D.J. 1978. “Powdery mildew of the hop.” Pages 381-409 in: *The Powdery Mildews*. D.M. Spencer ed. Academic Press, London.
- Turechek, W. W., Mahaffee, W. F., and Ocamb, C. M. “Development of management strategies for hop powdery mildew in the Pacific Northwest.” Online. Plant Health Progress doi:10.1094/PHP-2001-0313-01-RS.
- Turechek, W. W., Mahaffee, W. F. “Spatial Pattern Analysis of Hop Powdery Mildew in the Pacific Northwest: Implications for Sampling.” *Ecology and Epidemiology*: May 2004.

Questions?

http://www.ars-grin.gov/cor/cool/hops.html