

Weed Distribution Modeling with KRESS

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Introduction

- Invasive plant species are transforming vegetative communities across the western United States.
- Some plants have already expanded to their full range, while many others are still invading new habitats.
- We believe that modeling techniques can predict habitats that are subject to invasion and improve detection and control efforts.

Introduction (cont.)

- **Our objective was to quantify the environmental range of weed species in Oregon.**
 - Yellow starthistle (*Centaurea solstitialis* L.)
 - Russian knapweed or hardheads (*Acroptilon repens* (L.) DC.)
 - Spotted knapweed (*Centaurea biebersteinii* DC.)
 - Perennial Pepperweed (*Lepidium latifolium* L.)
 - Common Gorse (*Ulex europaeus* L.)
- **Determined from topographic, climatic, and soils data, allowing us to predict where this plant might grow in the future.**

Weed Data Sources

- **ODA Weed Database:** maintained by Oregon Department of Agriculture, Plant Division, Noxious Weed Control
- **WeedMapper:** internet reporting of weed locations
 - Reported weeds from citizens are verified by ODA and County Staff
 - Weed Reports from Professionals
- **Acquired Weed Locations:** contributions from USFS, USDI/BLM, County Weed Boards, OSU etc.
- **Infestations are updated annually and posted as maps to the web.**

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WeedMapper is a collection of spatial information on the distribution of weeds in the state of Oregon. The site shows known locations of noxious weeds throughout the state as collected by responsible federal, state, and local agencies. Maps are viewable at the state or county level.

WeedMapper is designed to facilitate identification, reporting, and verification of noxious weeds in Oregon. Besides providing maps of known infestations of the most serious weed pests, it also contains detailed information on each weed with photographs to assist identification.

Depending on the types of information desired, WeedMapper users can follow these links:

[General information about noxious \(A,B,T listed\) weed species](#)

[Find the geographic distribution of a weed species](#)

[Report weed locations to ODA](#)

[Links to other websites of interest](#)

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NOXIOUS WEED SIGHTING REPORT FORM

Please Provide the Following Information:

Name:

E-mail Address:

Confirm E-mail Address:

Address:

Phone: (###)###-####

Date: (MM-DD-YY)

Noxious Weed Species:

Number of plants: In Quantity

or In Acres

WeedMapper Weed Reporting Form (cont.)

Specific location:		
	Lat Long	UTM Easting Northing
Coordinates: (if known)	<input type="text"/>	<input type="text"/>
Township:	<input type="text"/>	
Range:	<input type="text"/>	
Section:	<input type="text"/>	
Quarter:	<input type="text"/>	
Type of Location:	Roadside <input type="button" value="v"/>	Associated Plants: <input type="text"/>
Other location details:	<input type="text"/>	

Types of Data on Weeds

- Distribution of weeds were generated from two types of data collected by botanists and weed specialists.
 - Oregon Department of Agriculture has been recording the location of this plant by noting the section (mile² or 2.59 km²) and township in which infestations were found.
 - USDI Bureau of Land Management, the USDA Forest Service, and OSU have mapped infestations using Global Positioning Systems (GPS) technologies.



**EXAMPLE OF MODEL
YELLOW STARHISTLE**

Yellow Starthistle Distribution in the United States

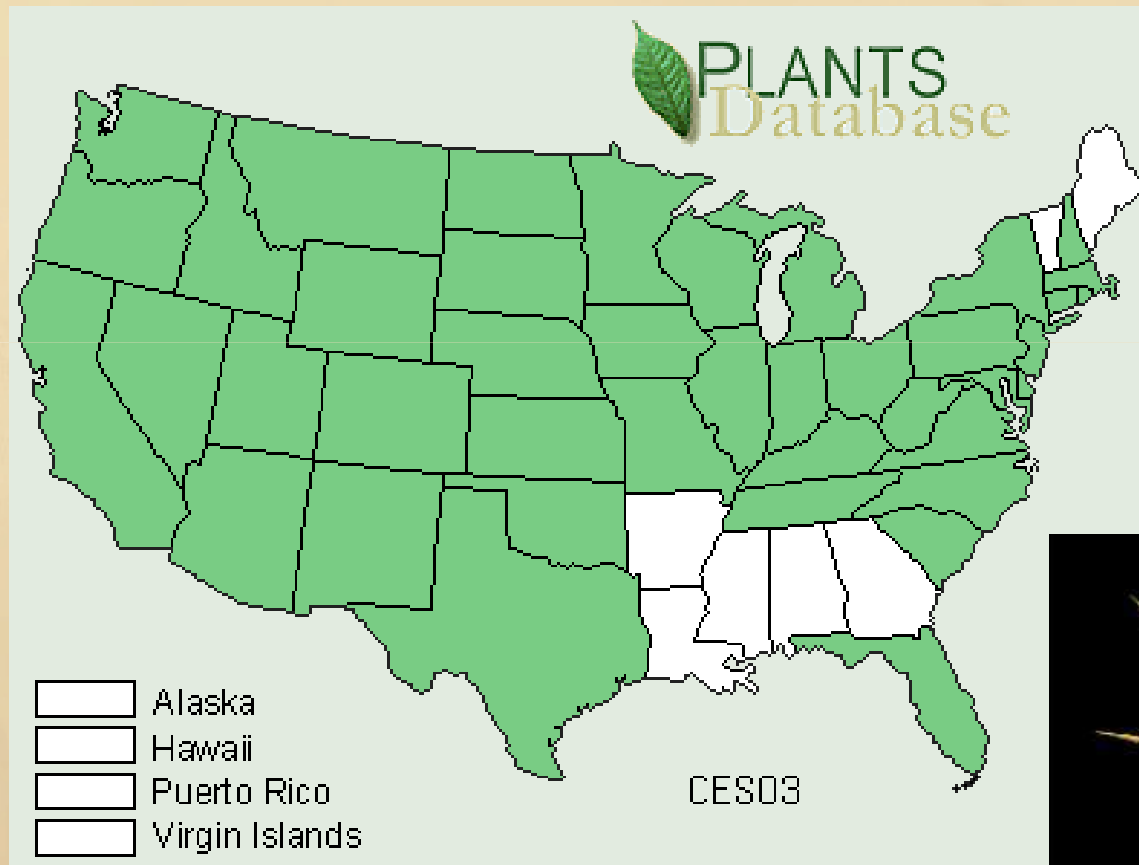
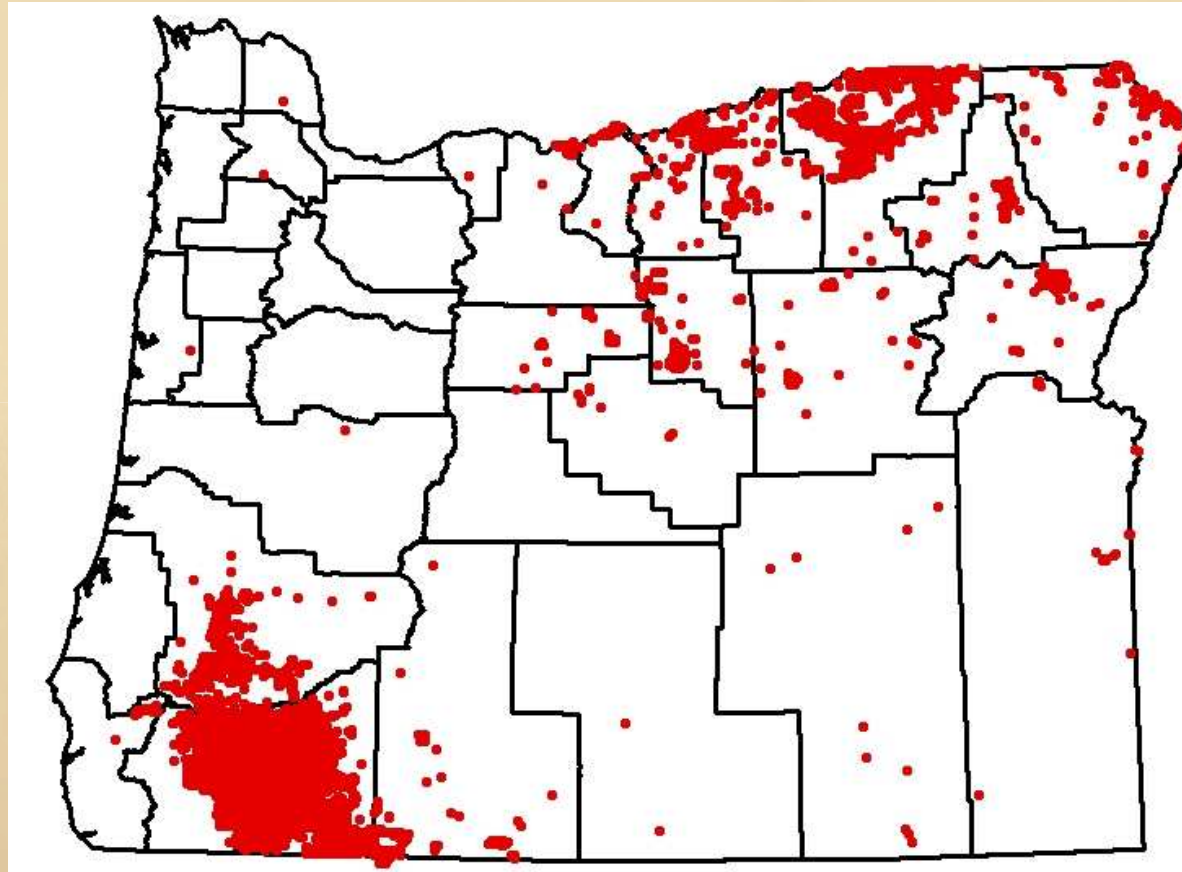


Image courtesy of St. Mary's College of California. ©St. Mary's College of California, Brother Alfred Brousseau.

Known Distribution of Yellow Starthistle (*Centaurea solstitialis* L.) in Oregon 2006

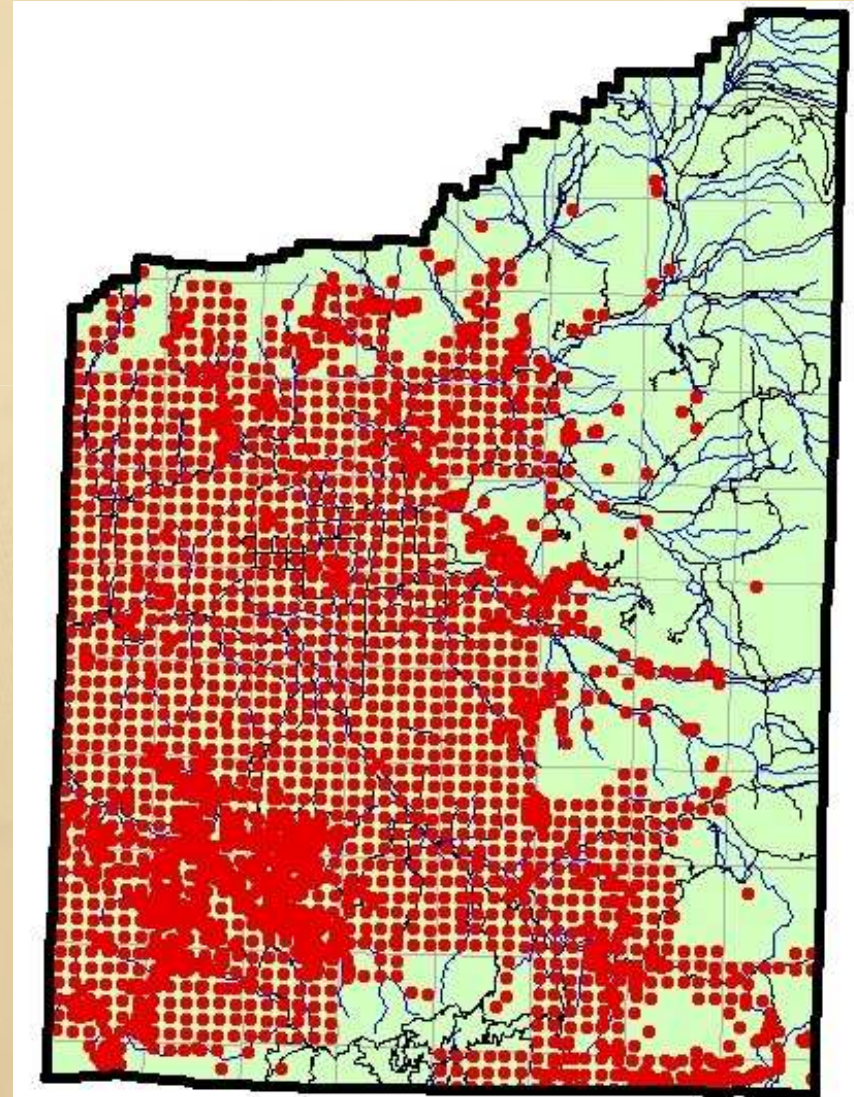
We have about
28,00 individual
locations with
Yellow Star
thistle in
Oregon.



As of 2006, 2,892 Cells in Oregon have Yellow Starthistle
Oregon has 64,740 Cells (4.46% of the State is Infested)

Yellow Starthistle Distribution in Jackson County, Oregon

- The regular pattern of ODA Data at the 1 square mile scale can be seen against the GPS collected finer resolution data.

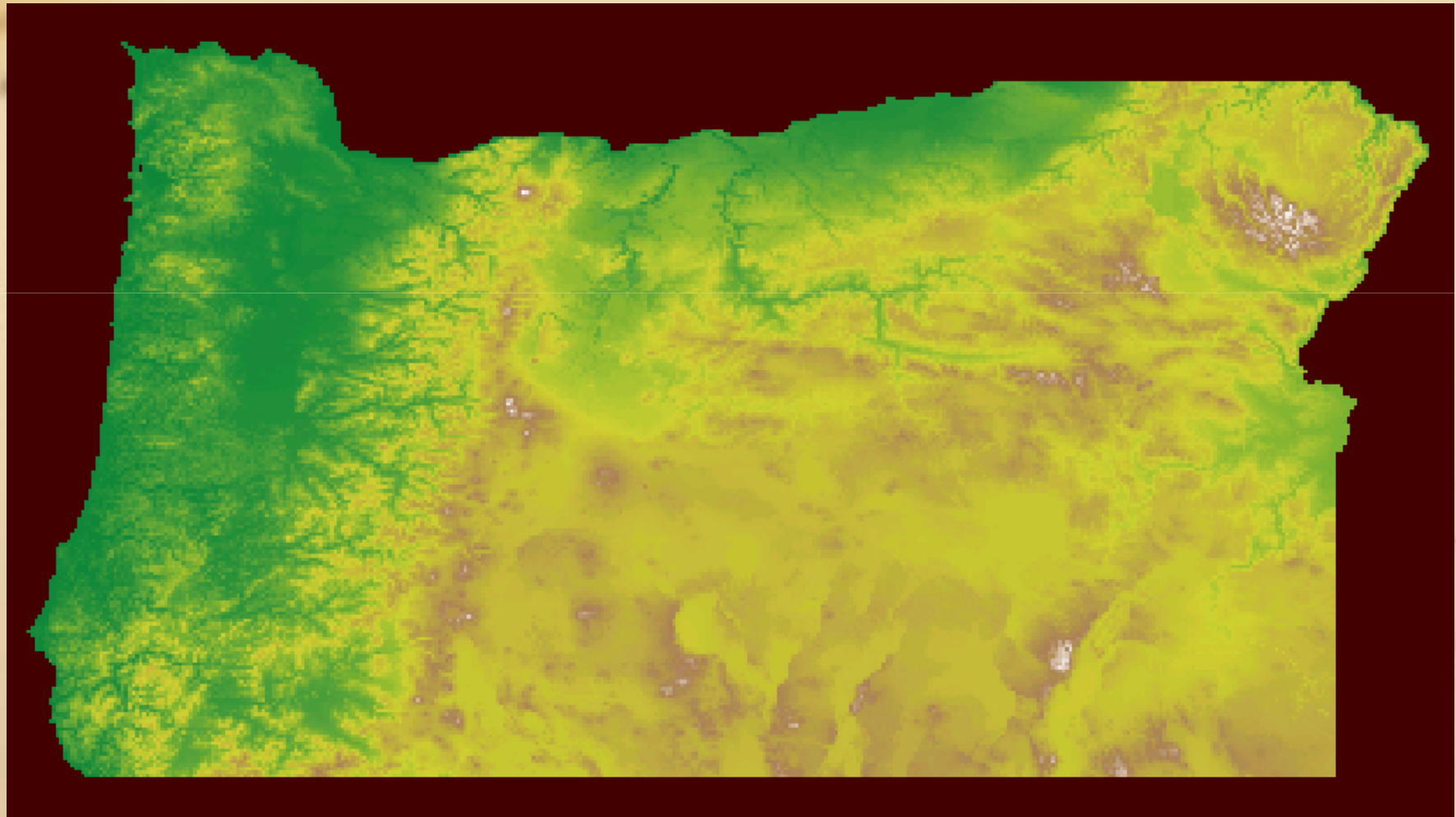


The background of the slide features a faded, sepia-toned image of a map with a compass rose in the upper left corner. The map shows a grid of latitude and longitude lines, and the compass rose has some numbers like '091' and '07' visible. The overall tone is warm and historical.

Modeling Effort Uses the Following

- Elevation data was obtained from the US Geological Service, EROS Data Center and resampled to 1.25 arc-minute resolution from GTOPO30 data set.

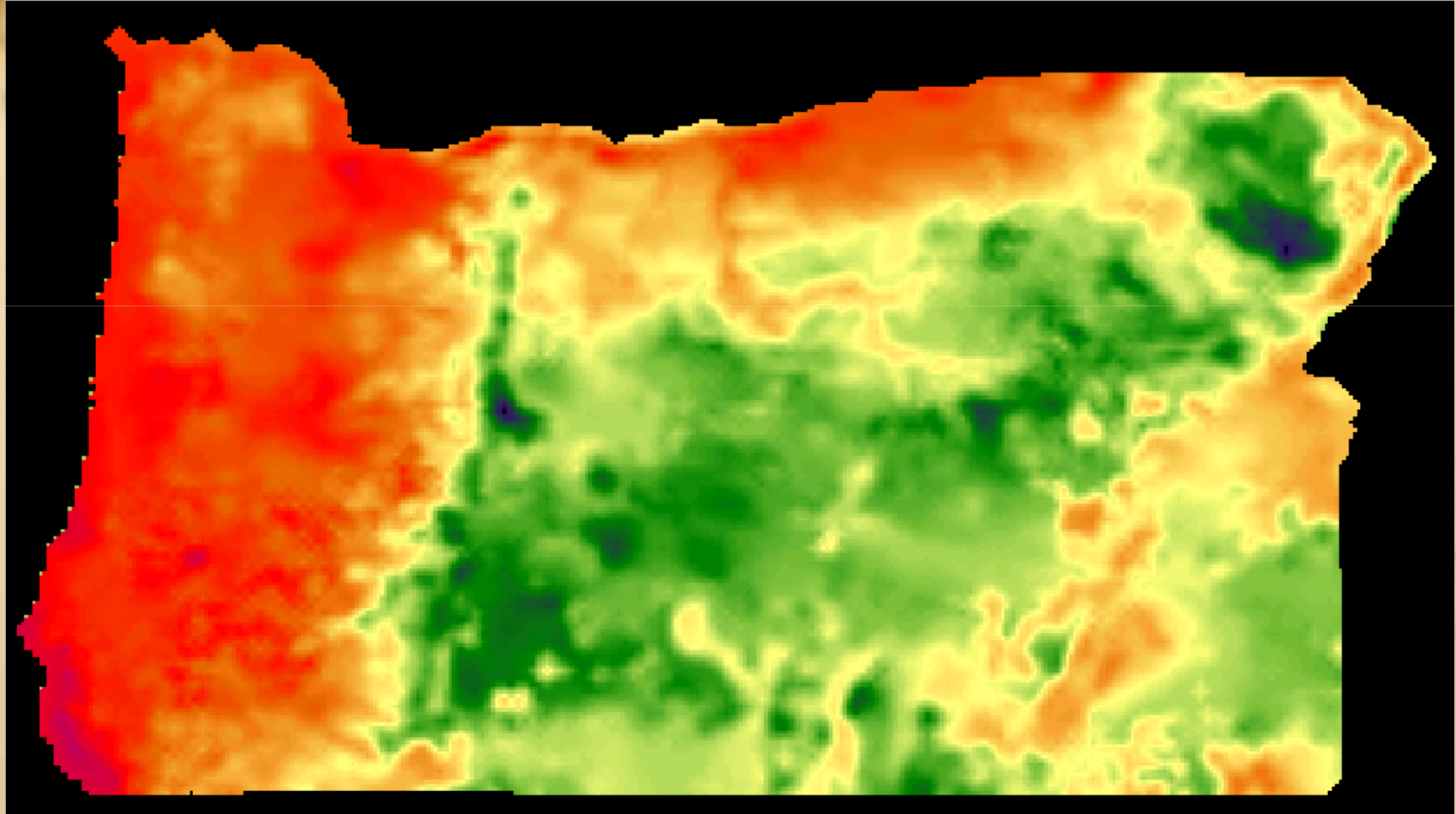
Elevational Data Set (USGS GTOPO 30)



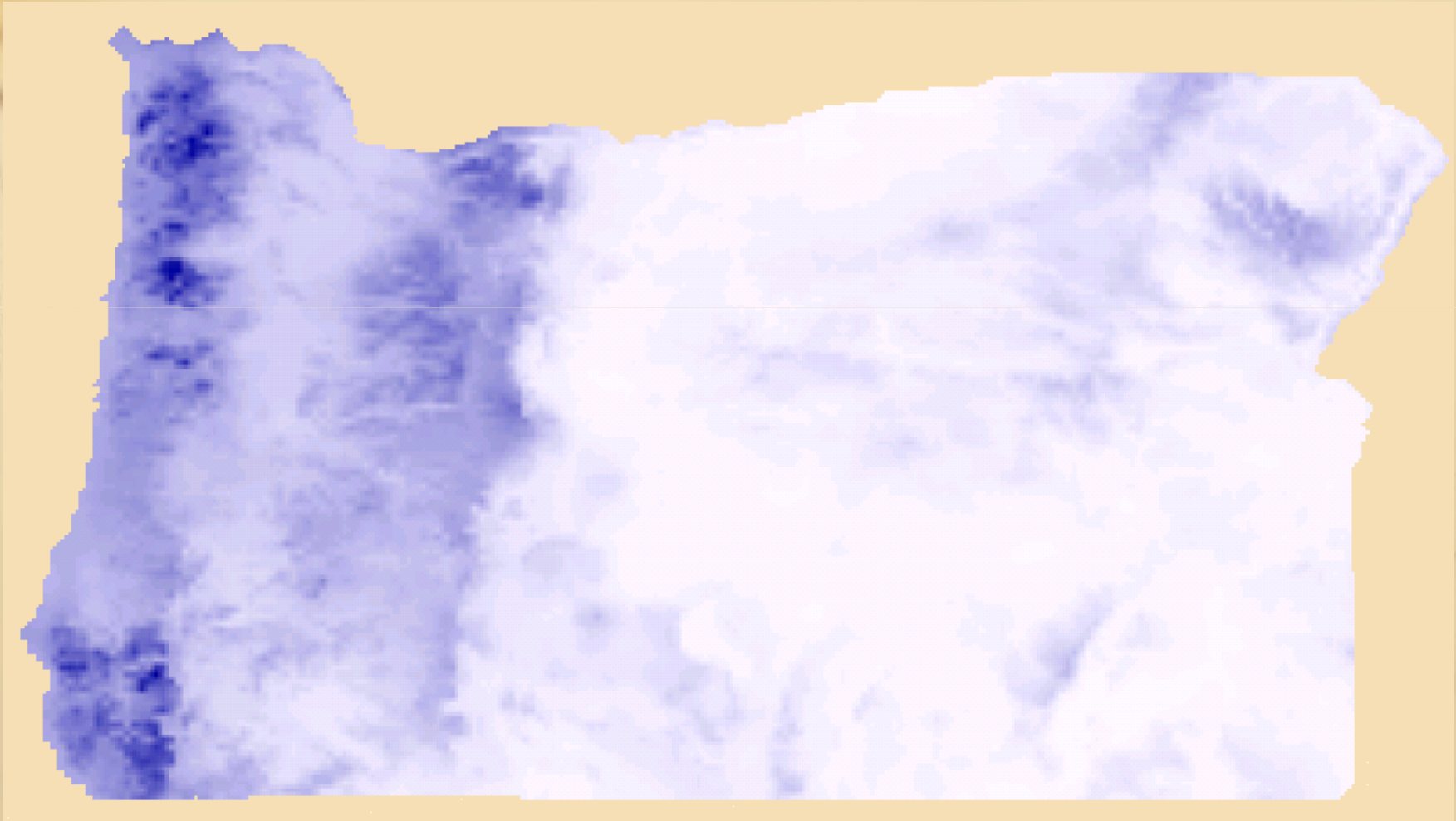
Modeling Effort Uses the Following

- Climate data sets were produced at 1.25 arc-minute resolution (3.9 km²) for Oregon and were obtained from the *Climate Source, Inc.*
- Data included:
 - mean annual precipitation
 - annual temperature extremes
 - mean temperature
 - wet days
 - growing degree-days base 10C (50F)
 - day between freezing temperatures.

Oregon Minimum Temperature



Oregon Precipitation in Millimeters

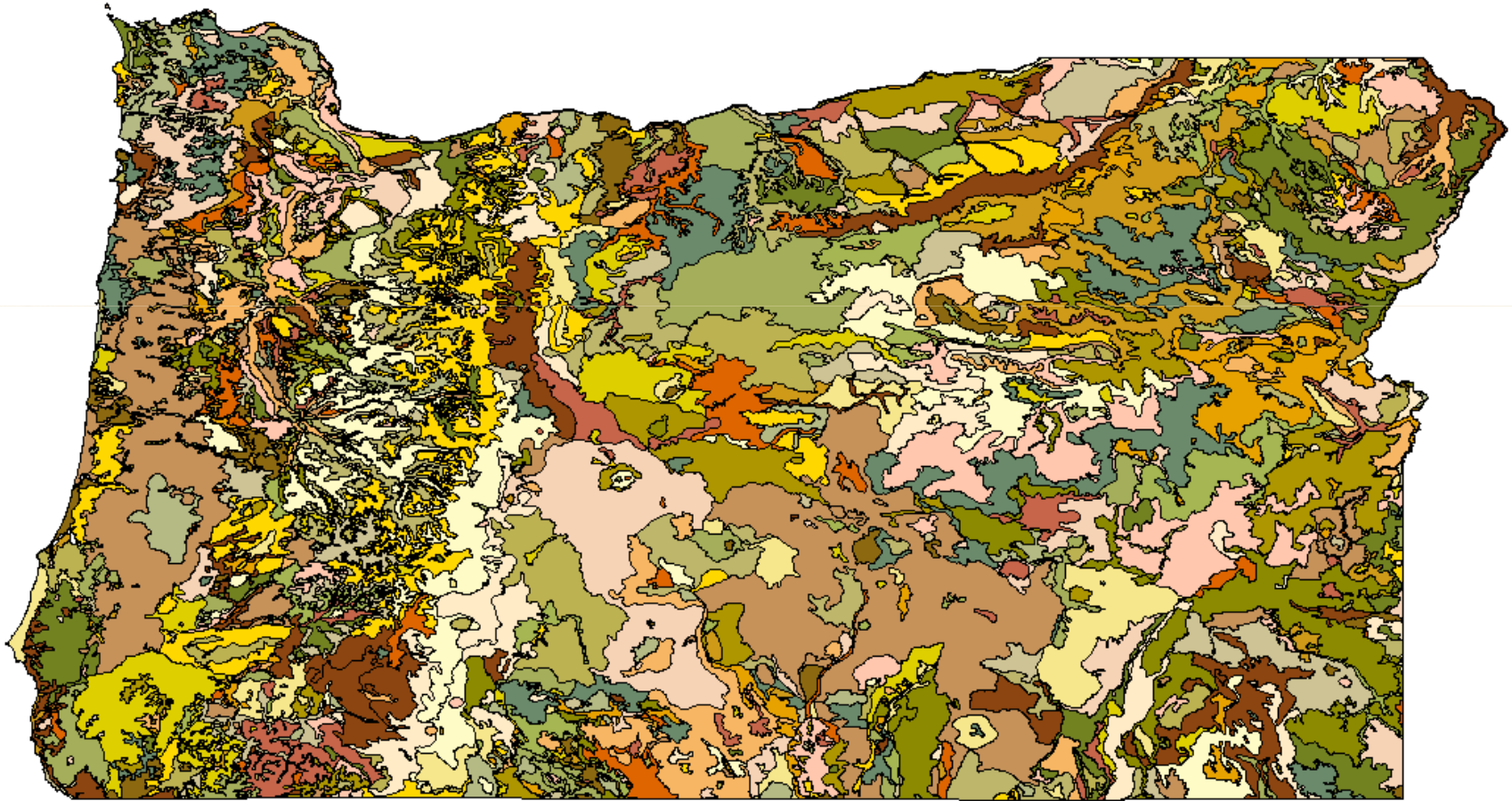


The background of the slide features a faded, sepia-toned image of a map with a compass rose in the upper left corner. The map shows some geographical lines and a scale, with the numbers '091' and '07' visible on the compass rose. The overall tone is warm and historical.

STATSGO Soil Data

- Soil maps for the State Soil Geographic (STATSGO) database are produced by generalizing the detailed soil survey data.
- The mapping scale for STATSGO is 1:250,000.
- This level of mapping is designed to be used for broad planning and management uses covering state, regional, and multi-state areas.

STATSGO Soil Data



STATSGO Soils Data

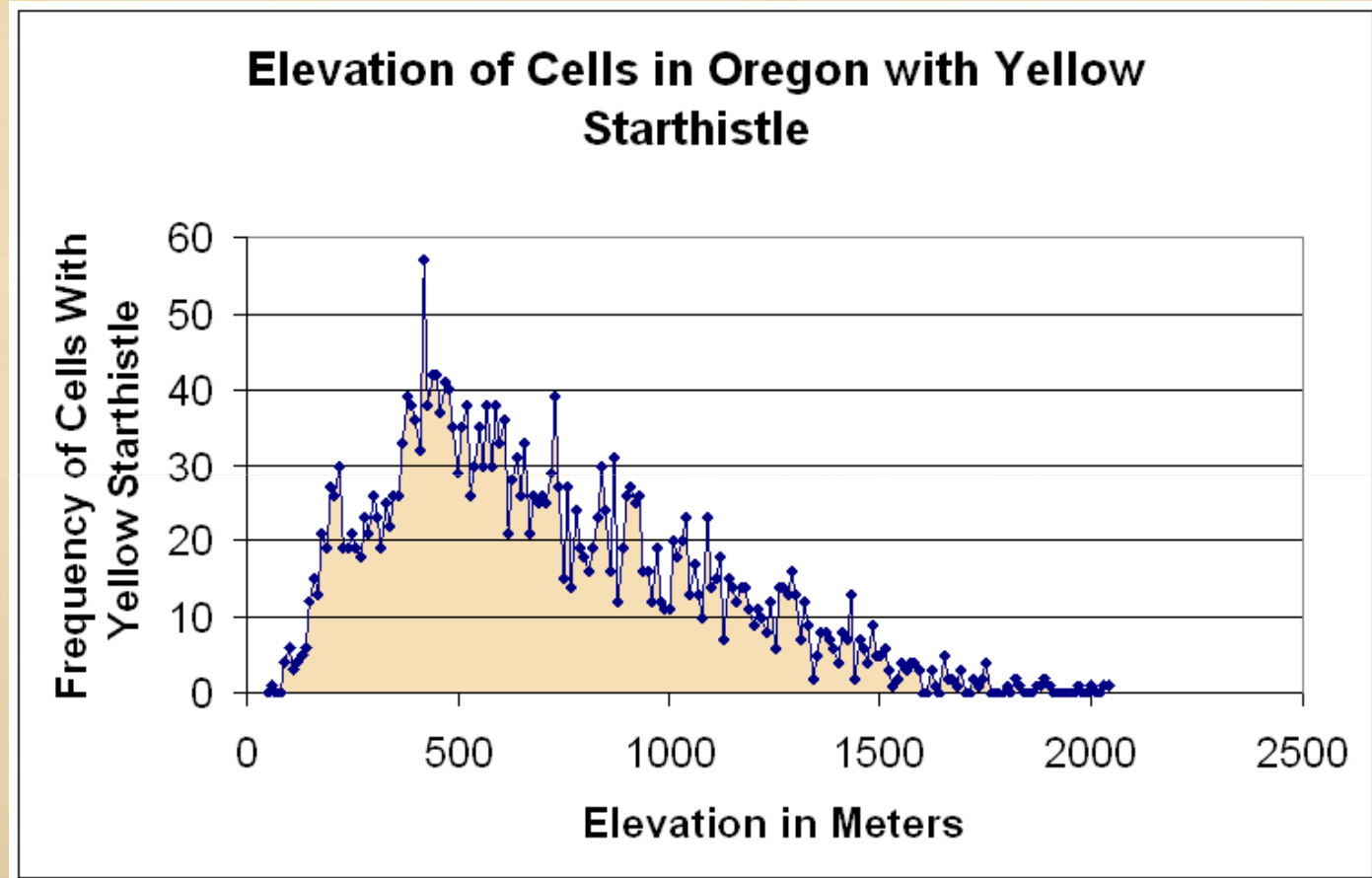
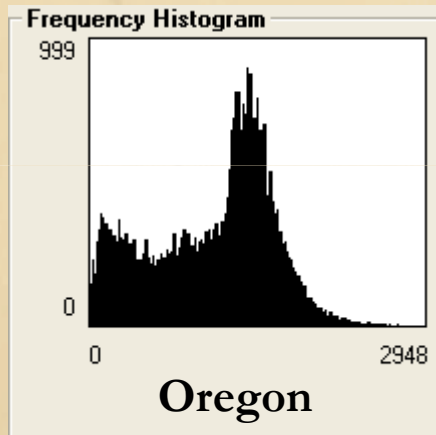
- 1326 Statsgo Soil types in the state
- 236 Soil Types had Yellow Starthistle Infestations
 - 76 Soil types had more than 50% of their cells infested.
 - 164 Soil types had more that 5% of their cells infested.
 - 72 Soil Types had between 0.03 and 5% of their cells infested
- 1090 Soils had no recorded Yellow Starthistle



Extraction of Ecological Tolerance

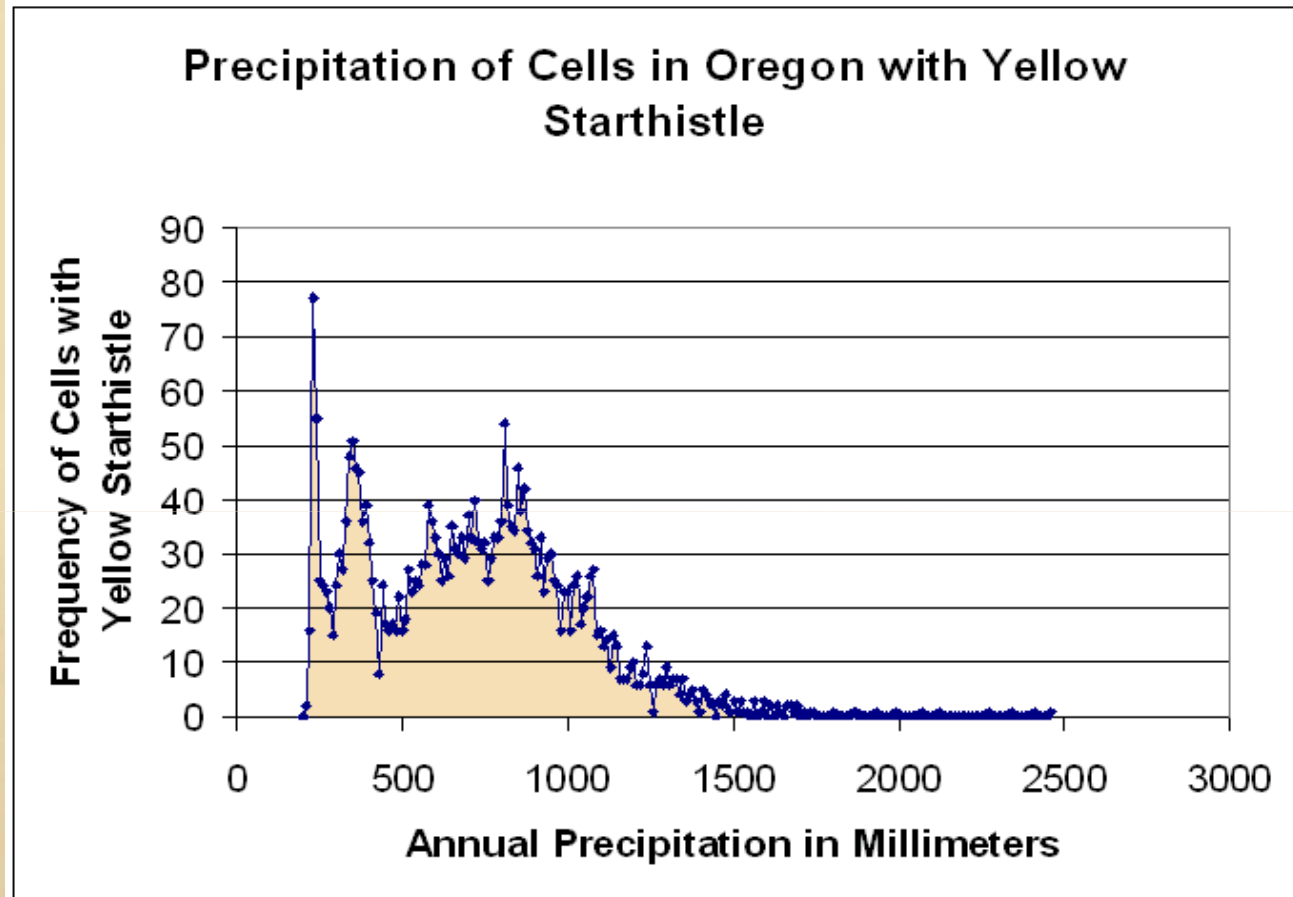
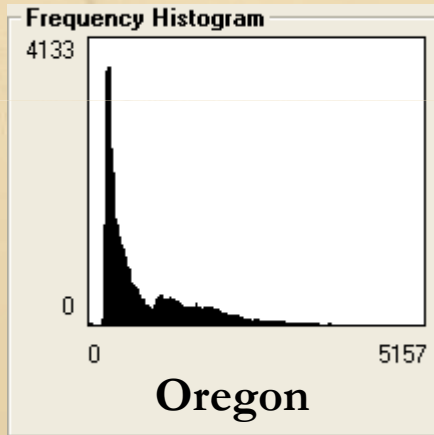
Yellow Starthistle

Elevation Range of Yellow Starthistle



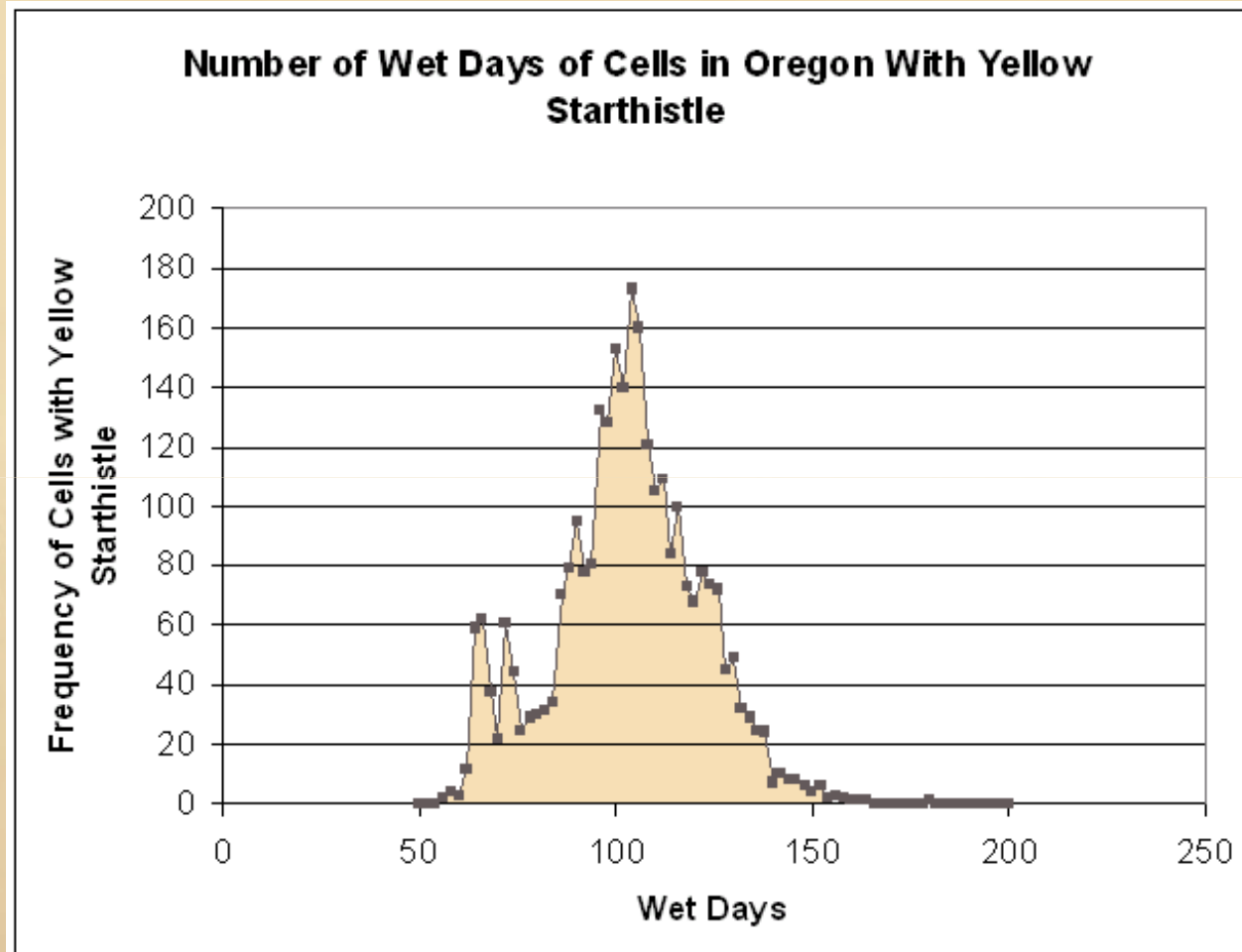
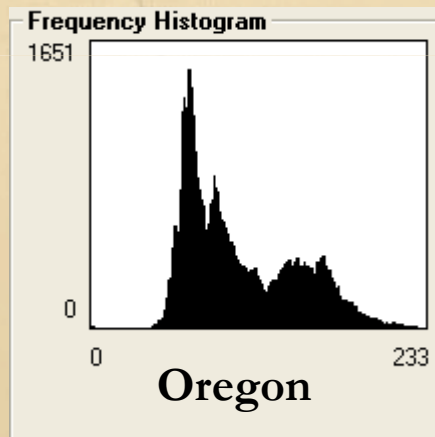
Mean elevation of cells (3.96 km²) with yellow starthistle in Oregon. The lowest mean elevation was 54m, the highest 2032m, and the mean 697m. Yellow starthistle grows across a very broad range of elevations but is most common below 1500m. We believe that elevation is not a significant barrier to the spread of this plant in Oregon.

Precipitation Range of Yellow Starthistle



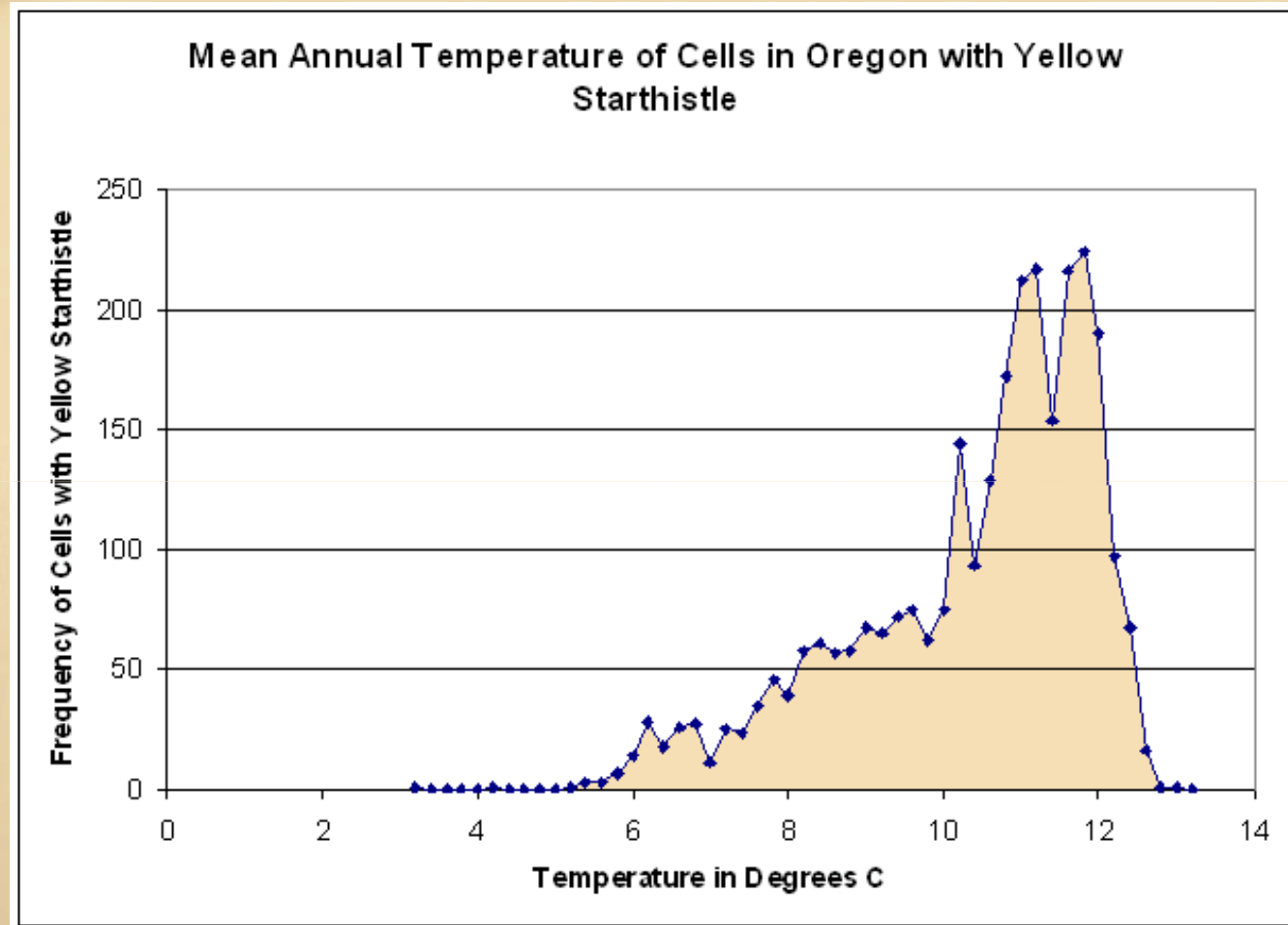
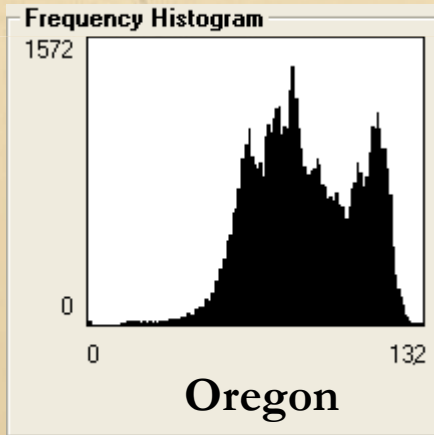
Mean annual precipitation in mm of 3.96 km² cells in Oregon with yellow starthistle infestations. The lowest mean precipitation was 208mm, the highest 2453mm, and the mean 707mm. Yellow starthistle grows across a very broad range of precipitation but is most common below 1000 mm/year.

Wet Days Range of Yellow Starthistle



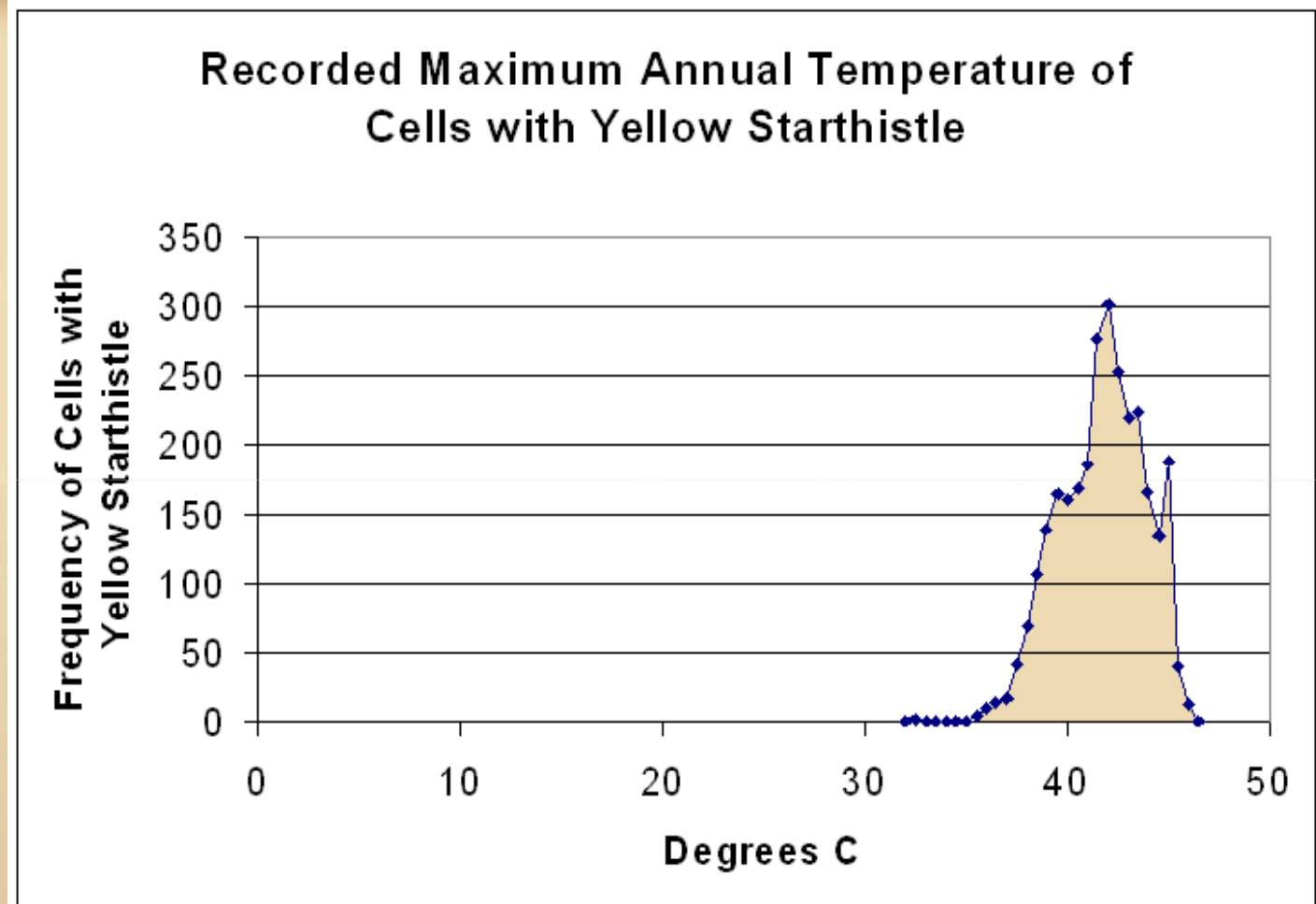
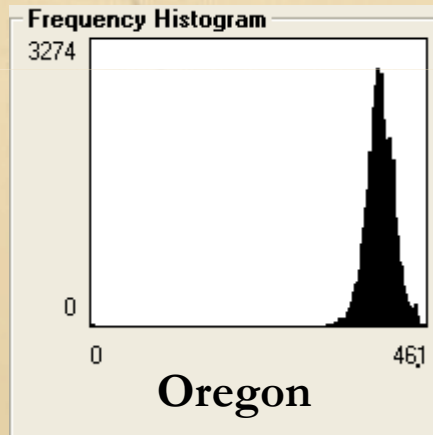
The number of days with measurable precipitation during the year for areas of Oregon with yellow starthistle. The range in the number of wet days was from 55 to 180 with a mean of 102.

Mean Annual Temperature Range of Yellow Starthistle



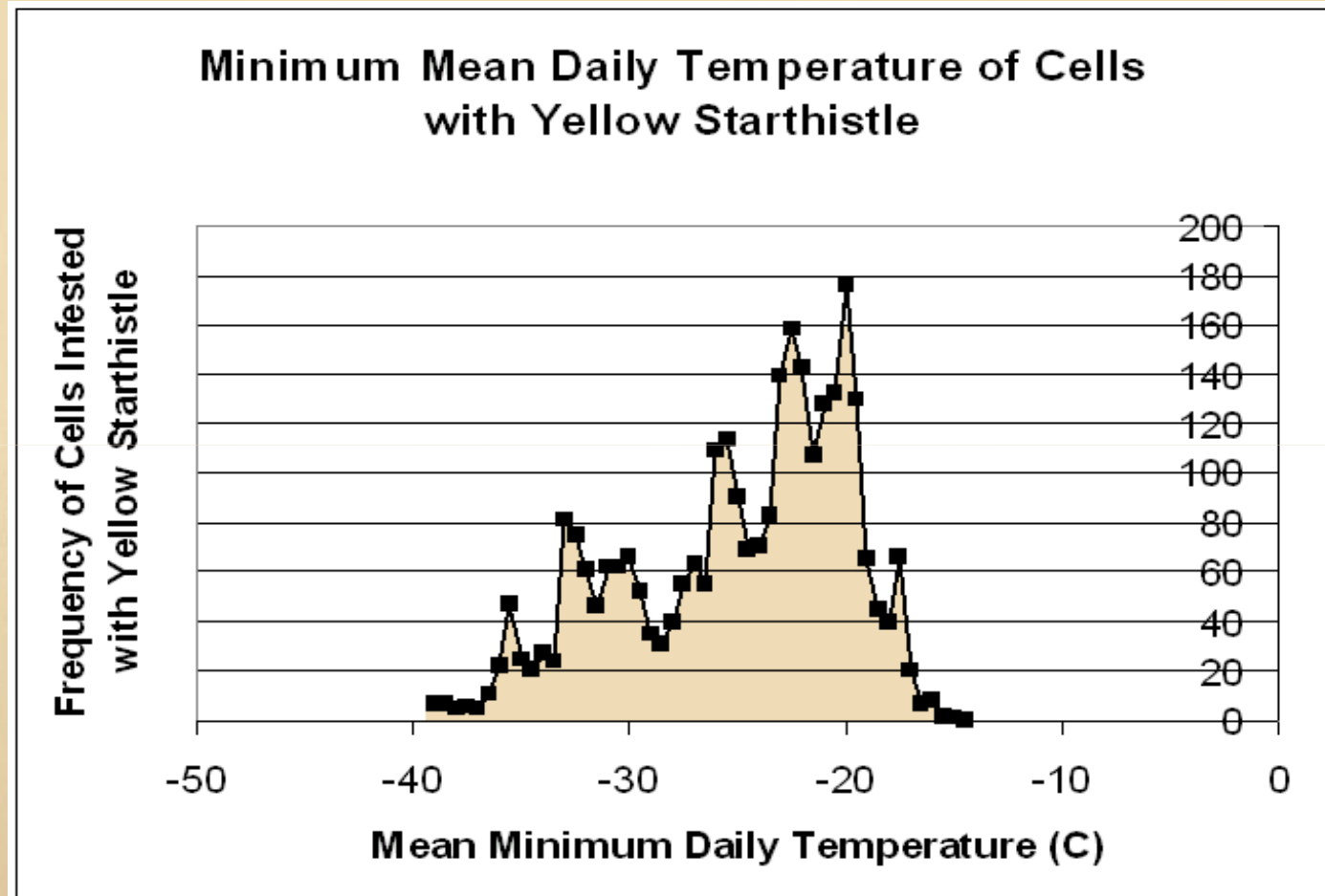
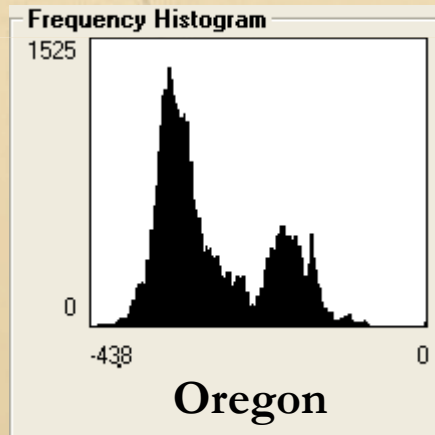
Mean annual temperature of locations in Oregon with yellow starthistle infestations. Mean Annual Temperature varied from 3.2 °C to 13.0 °C with a mean of 10.3 °C.

Recorded Extreme Maximum Annual Temperature of Cells with Yellow Starthistle



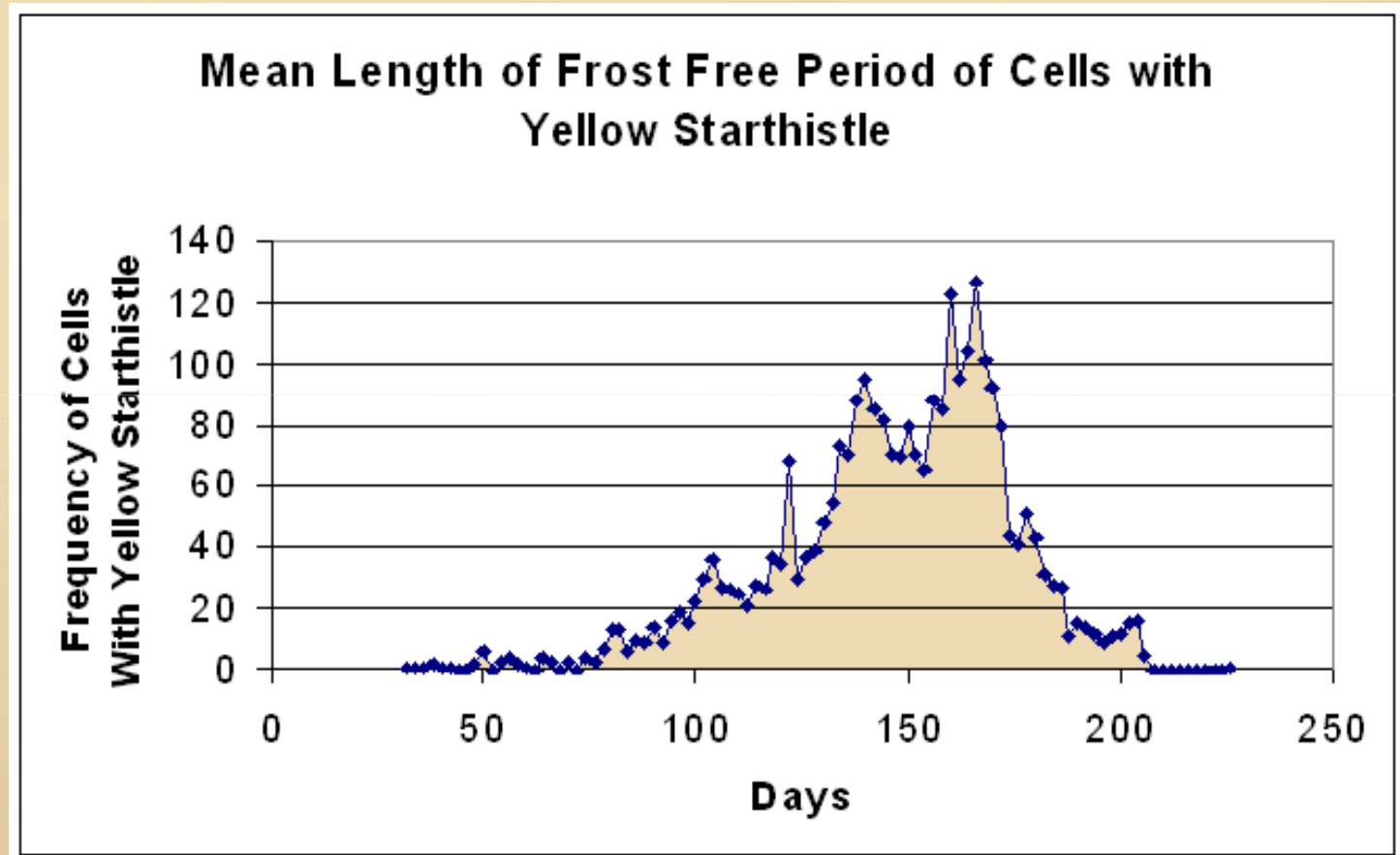
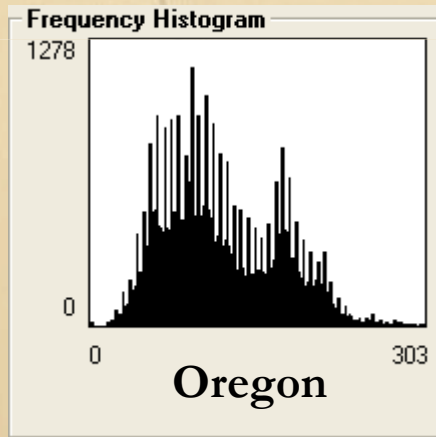
Annual mean monthly maximum temperature in degree Celsius (°C) for cells in Oregon with a yellow starthistle infestation. Annual maximum temperatures recorded ranged from 32.5 °C to 46.0 °C with a mean of 41.5 °C.

Mean Minimum Daily Temperature Range of Yellow Starthistle



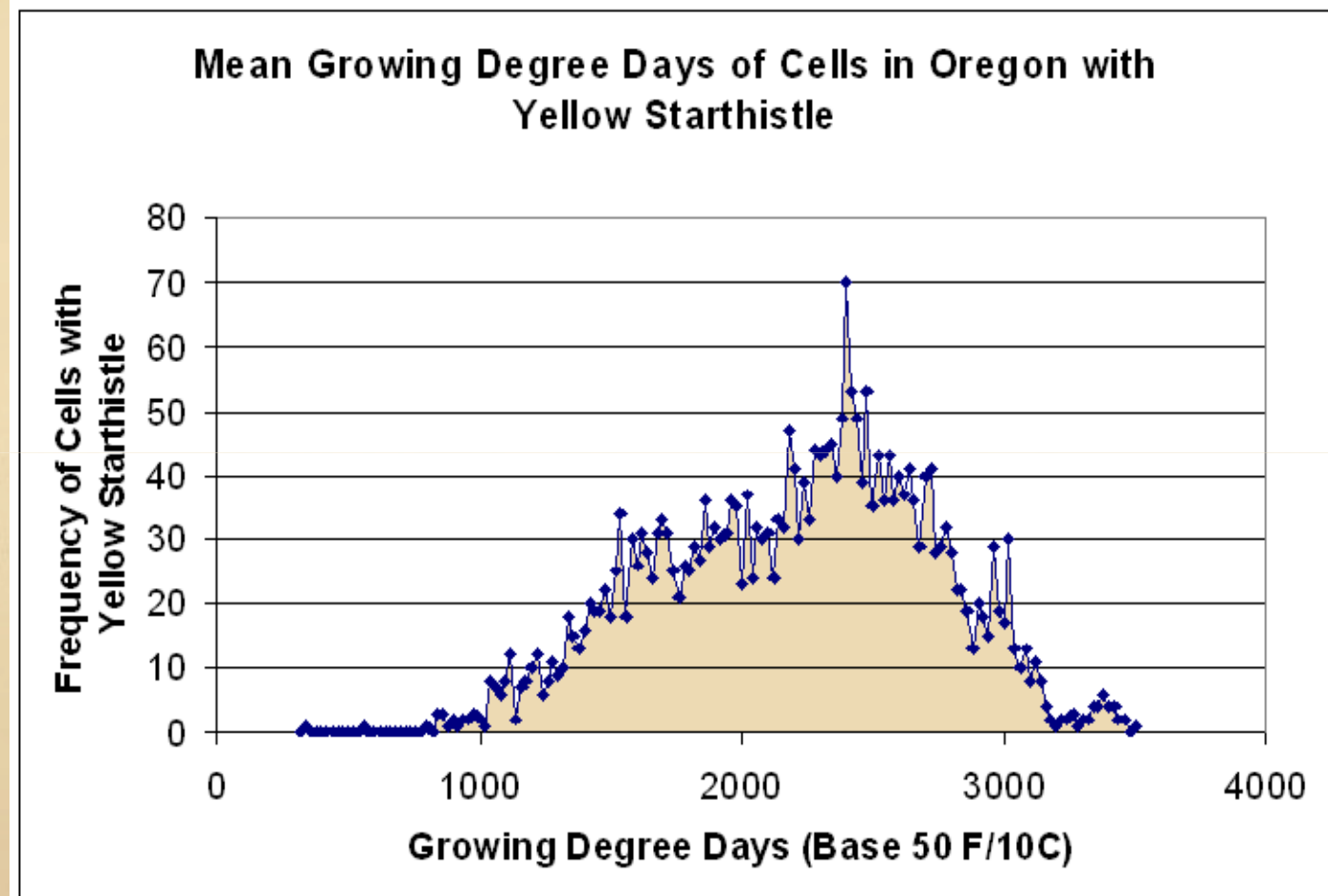
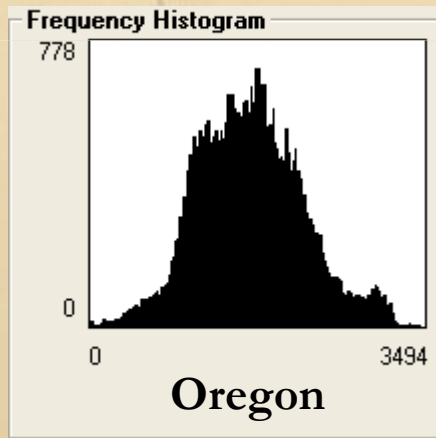
Mean minimum daily temperature in degree Celsius (°C) for cells in Oregon with a yellow starthistle infestation. Temperatures ranged from -39.0 °C to -13.7 °C with a mean of 23.7 °C.

Frost-free Period of Yellow Starthistle



Mean length of the freeze-free season for cells in Oregon with a yellow starthistle infestation. Cell size is 3.96 km². Mean length of the freeze-free season ranged from 32 days to 225 days with a mean of 146 days.

Growing Degree Days Range of Yellow Starthistle



Growing Degree Days base 50°F (10C) of cells in Oregon with a yellow starthistle infestations. Cell size is 3.96 km². Mean Growing Degree Days base 50°F ranged from 338 degree days to 3494 degree days with a mean of 2192.

Climatic Model

- Areas of the state that fall within the climatic range of 3.8 km² cell with existing yellow starthistle infestations were classified as potential risk regions.
- Areas that fall outside the range of values for annual precipitation, number of wet days, annual maximum temperature, mean minimum temperature, and growing degree days (base 10° C or 50° F) are shown as low risk regions.

Elevation Tolerance of Yellow Starthistle in Oregon

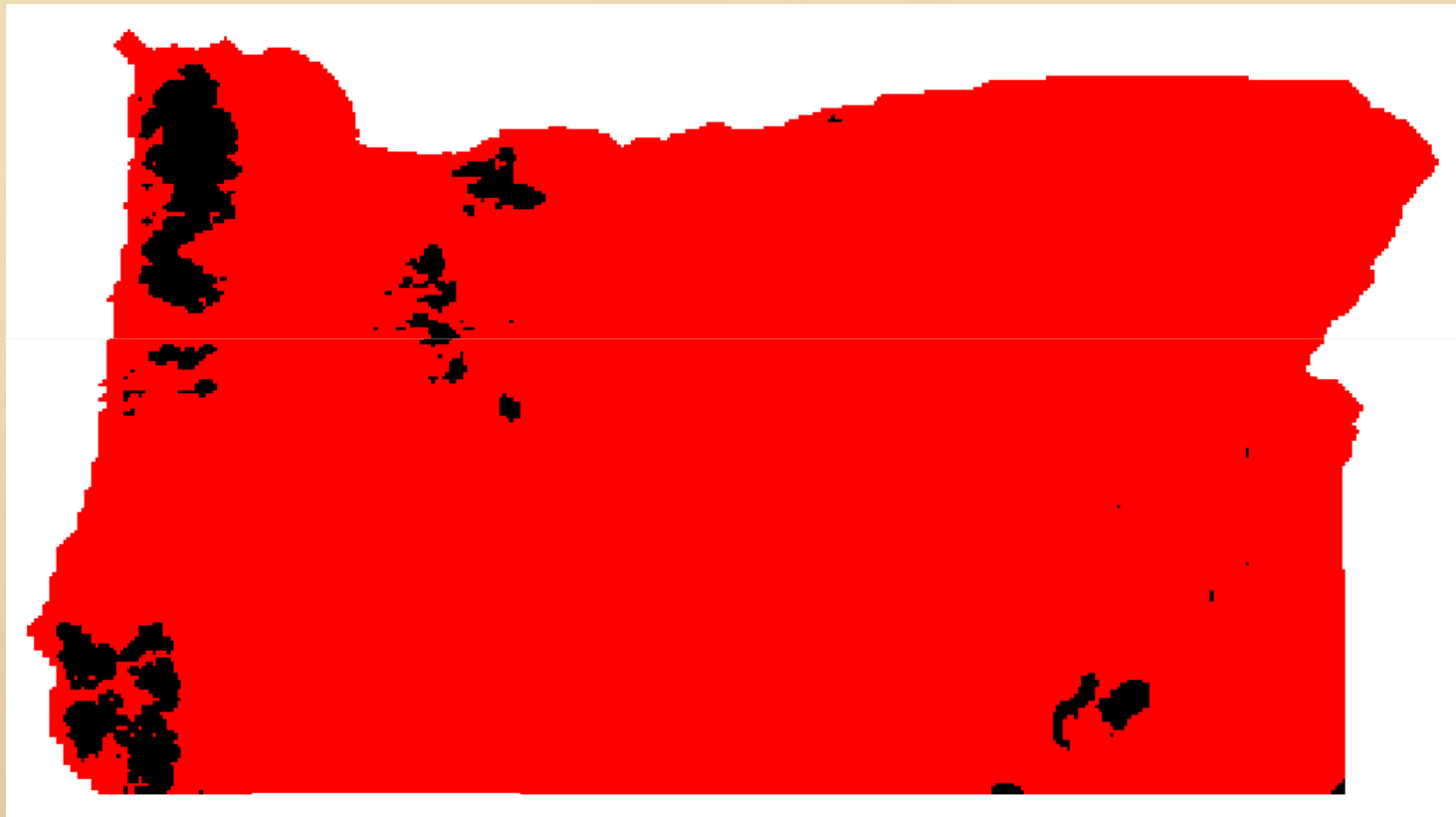
Red areas are
within the
range of
current
populations of
Yellow
Starthistle



The elevation range of Yellow Starthistle in Oregon is from 54m to 2032m with a Standard Deviation of

Precipitation Tolerance of Yellow Starthistle in Oregon

Red areas are within the range of current populations of Yellow Starthistle



The precipitation range of Yellow Starthistle in Oregon is from 208mm to 2453mm with a Standard Deviation of 320mm.

Growing Degree Days (50F) Tolerance of Yellow Starthistle in Oregon

Red areas
are within
the range of
current
populations
of Yellow
Starthistle

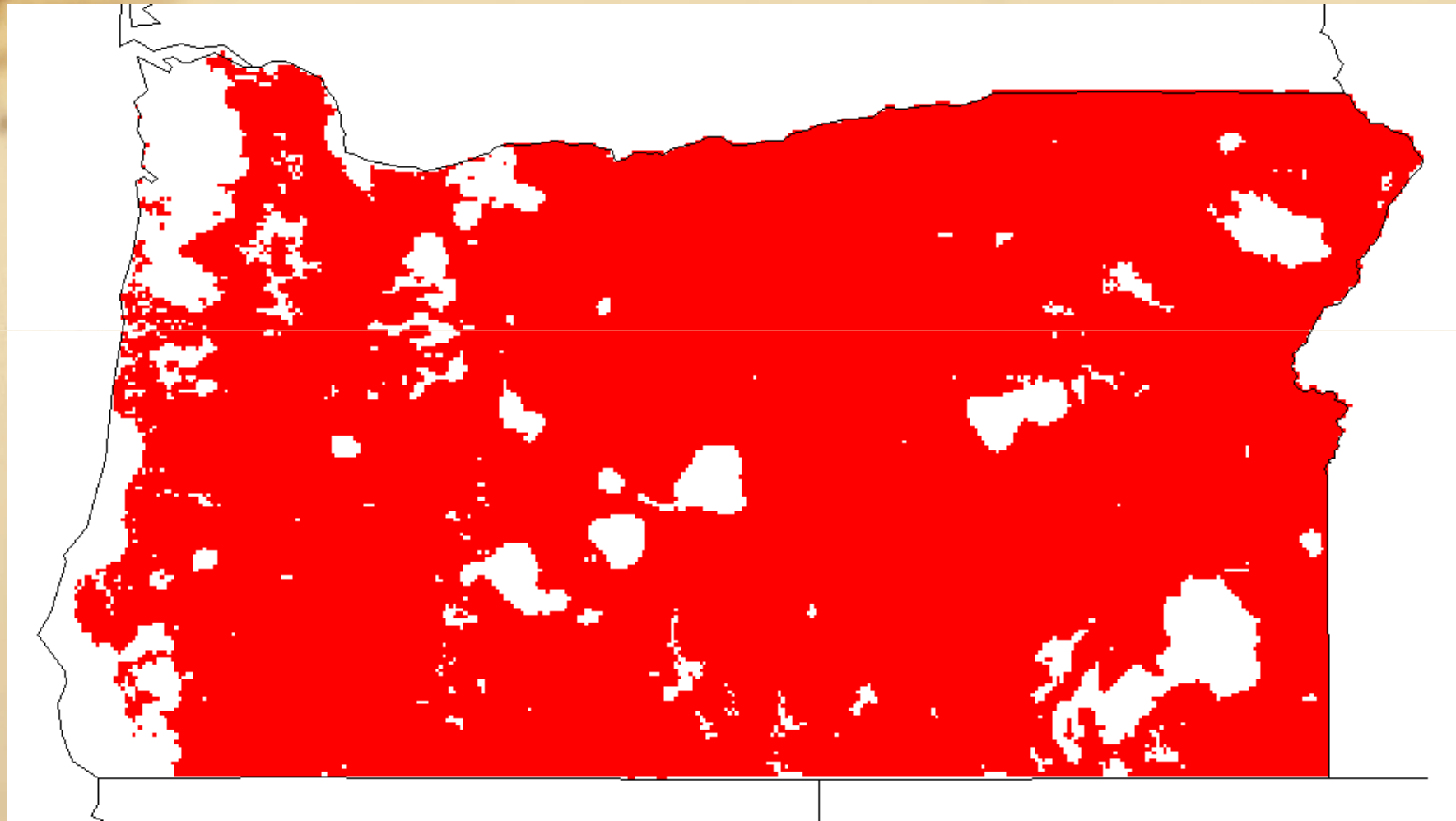


The Growing Degree Day (50°F) range of Yellow Starthistle in Oregon is from 338 to 3494 GDD with a mean of 2193 GDD.

Simple Yellow Starthistle Model

- A rectangular parallelepiped model is a n-dimensional model where the range of each parameter under which yellow starthistle grows is imposed on the full Oregon dataset to predict where the plant can potentially grow.
- We applied 12 climatic variables and elevation for our first approximation.

Parallelepiped Model of Yellow Starthistle Distribution based on Climate & Elevation

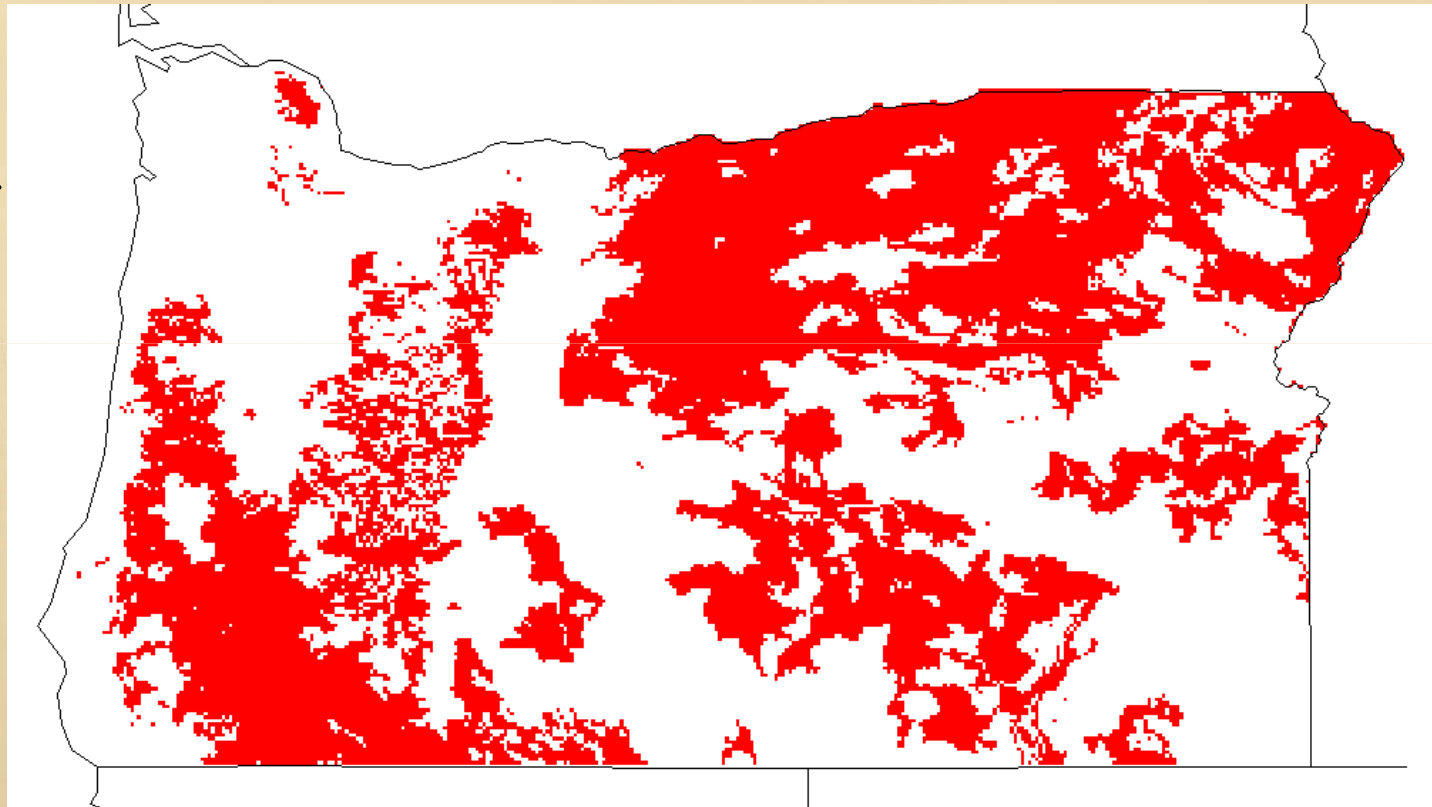


Model Including Soil Classes

- A more restrictive model was produced by including the requirement that the soils (NRCS STATSGO soil classification) had to be the same as those on which yellow starthistle was currently growing in Oregon.

STATSGO Soil Tolerance of Yellow Starthistle in Oregon

Red areas are within the range of climatic variables current populations of Yellow Starthistle



The Cells with Soils that currently support Yellow Starthistle in Oregon are shown in Red.

KRESS Modeler

Kinetic Resource and Environmental Spatial Systems Modeler

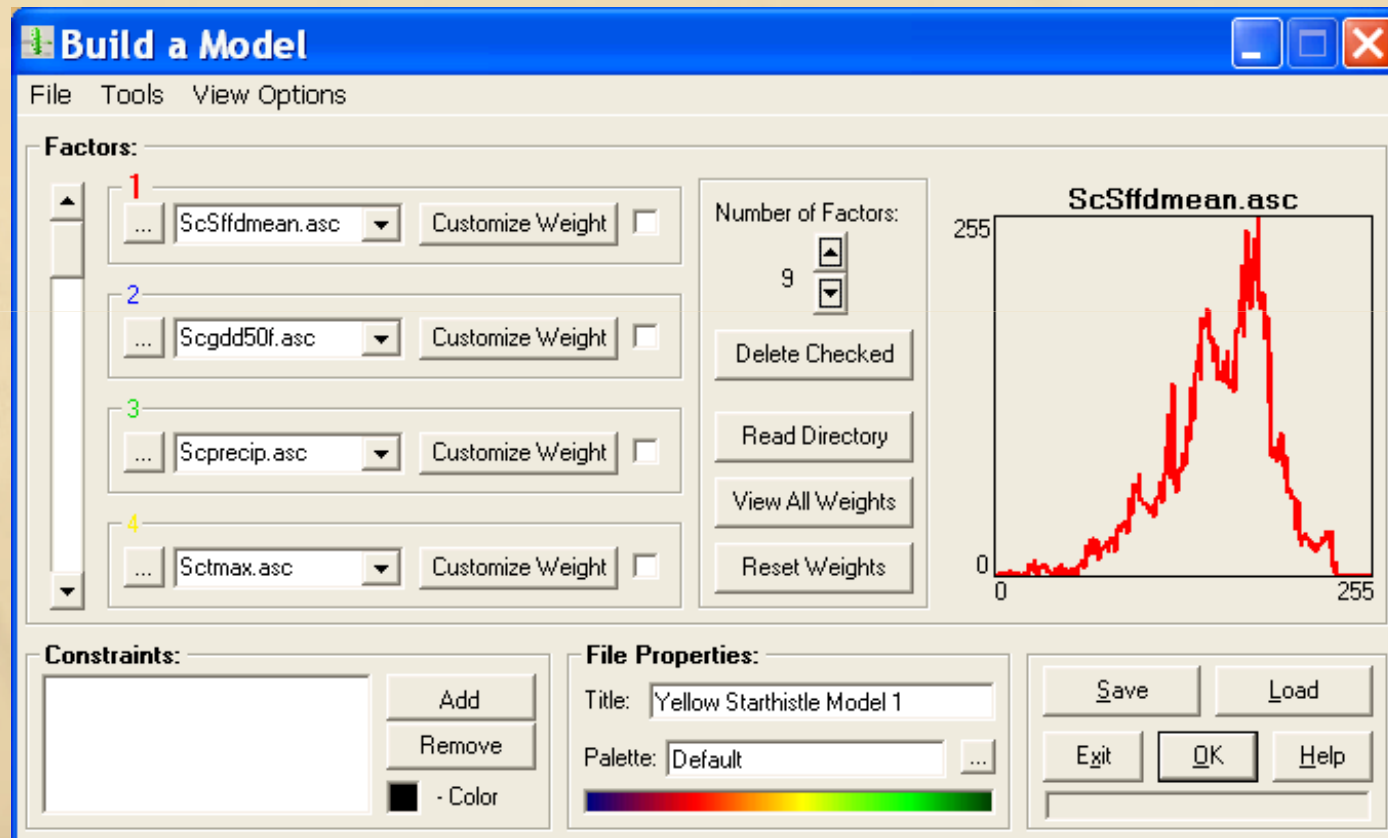
- Free-form landscape systems modeler using a Weighted Sum/Multi-Criteria Evaluation (MCE) approach with deterministic rules
- Uses multiple criteria or factors (up to 200) in a mathematical modeling approach to find areas that meet criteria or are suitable for a purpose.
- Can apply either linear or non-linear relationships across landscapes.

The background of the slide features a faded map with a compass rose in the upper left corner. The compass rose has numbers '091' and '071' visible. The map shows various geographical features and lines, suggesting a focus on environmental or spatial modeling.

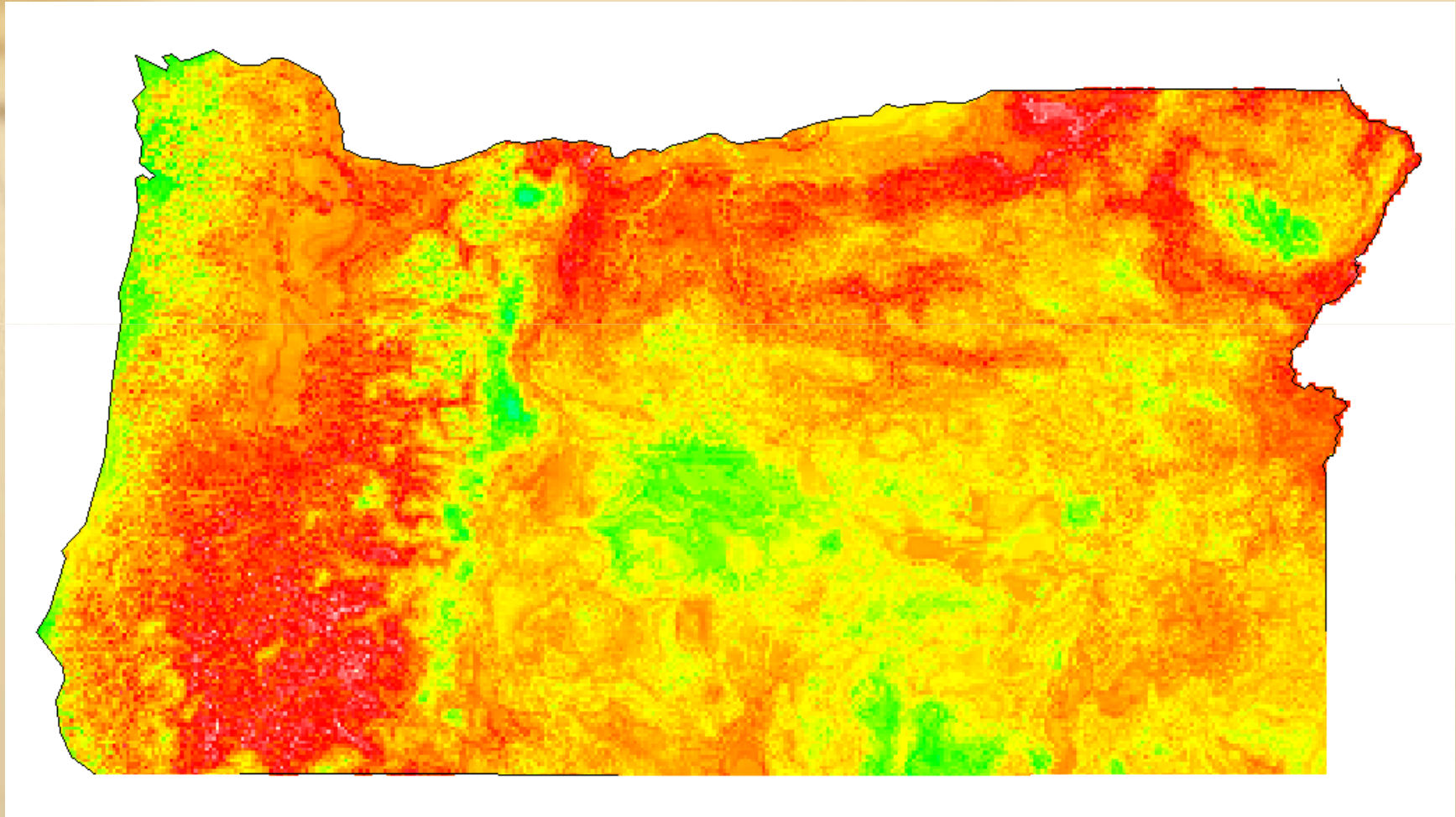
KRESS Modeler

- Allowed us to build a Non-linear Model based on environmental conditions under which yellow starthistle currently grows.
- Areas in the state with conditions similar to the conditions of sites with high frequencies of yellow starthistle are given a higher probability of infestation.

KRESS Modeler



KRESS Model of Potential Yellow Starthistle Distribution in Oregon



Red = High Risk

Yellow = Moderate Risk

Green = Low Risk

Yellow Starthistle

- Based upon our data which does not have all locations in the state.
- Infestations occur on 2892 cells (3.9 km²) in Oregon out of a total of approximately 64,740 cells.
- Of the total land area in the state approximately 4.5% of the surface area is currently infested.

Yellow Starthistle

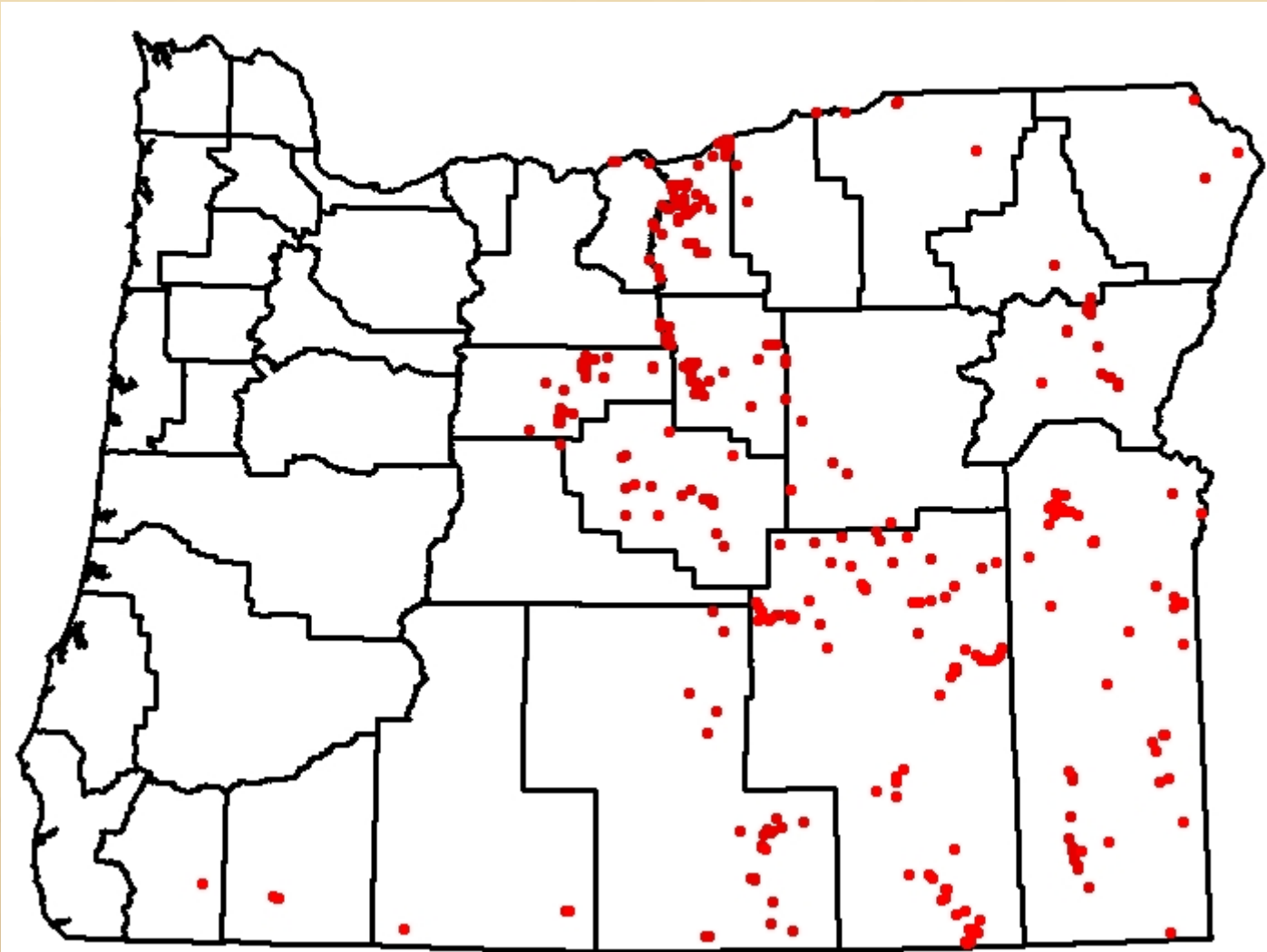
- According to our Rectangular Parallelepiped Climate/Elevation Model yellow starthistle has the potential to occupy more than 87% of the state.
- According to our Climate/Elevation/Soil Model yellow starthistle has the potential to occupy more than 42% of the state.
- 4.46% of the State is Currently Infested



Yellow Starthistle Models

- We believe that Climate/Elevation/Soil represents a conservative estimate of the areas in which yellow starthistle can persist or expand.
- We have not determined which sites will be heavily infested or those in which infestations will be relatively weak and believe that this analysis will need to be done with data collected at higher resolution.

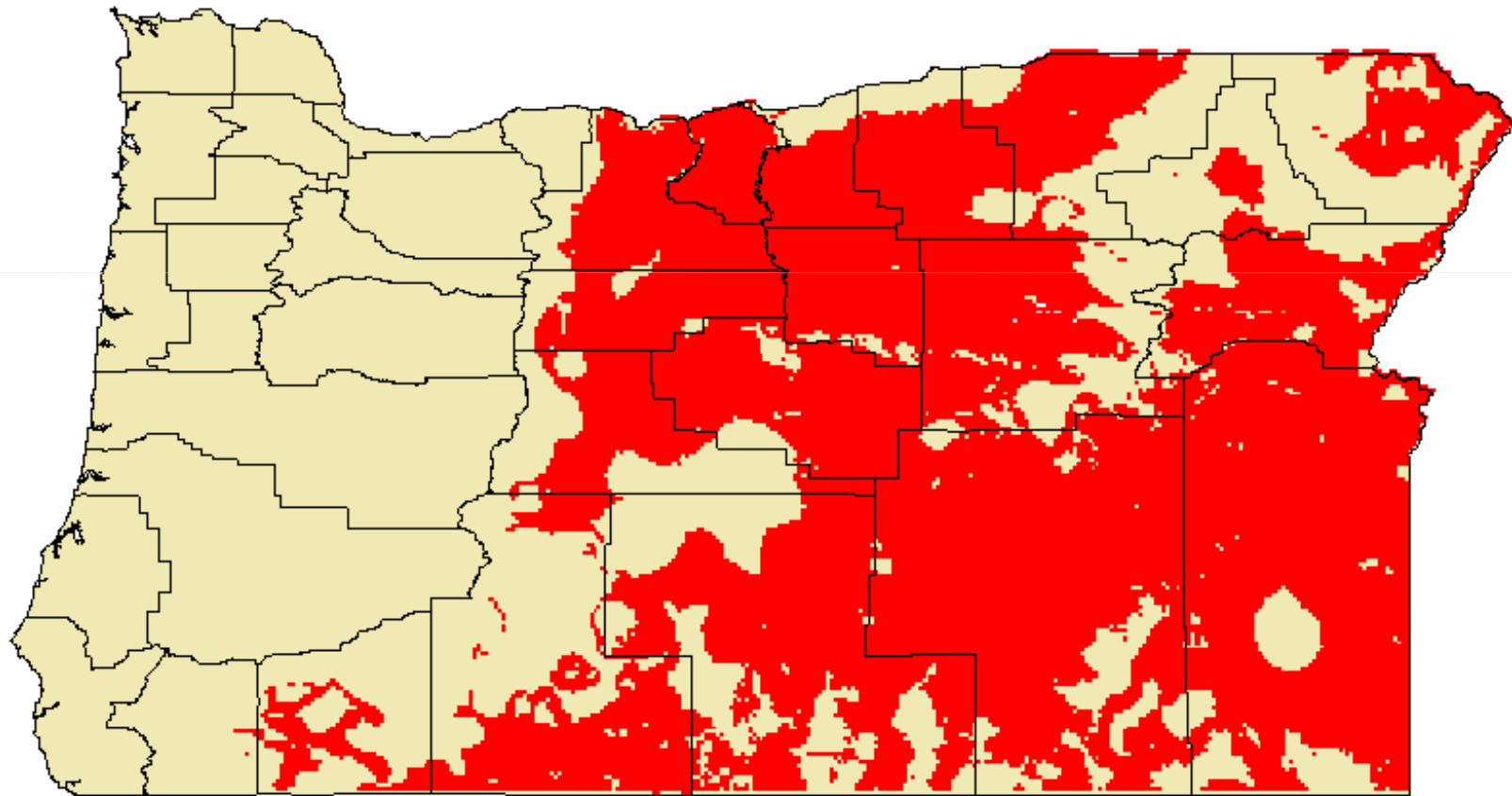
Russian knapweed
(*Acroptilon repens* (L.) DC.)



Russian Knapweed

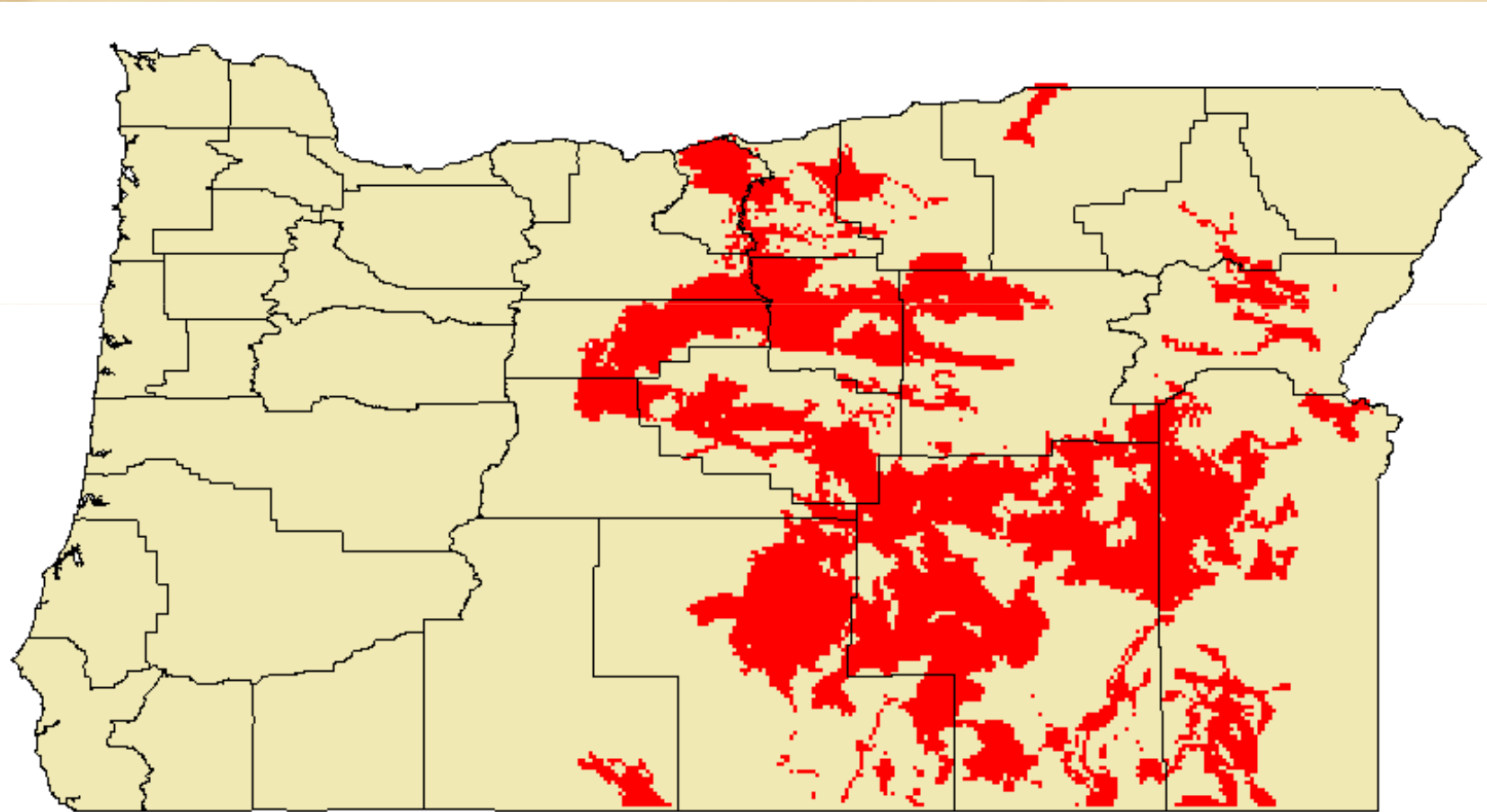
- Based upon our data which does not have all locations in the state.
- Infestations occur on 160 cells in Oregon out of a total of approximately 64,740 cells.
- Of the total land area in the state approximately 0.2% of the surface area is currently infested.

Russian Knapweed Model Based on Climate & Elevation



Geographic Projection (latitude/longitude NAD 1983)

Russian Knapweed Model Based on Climate & Soil

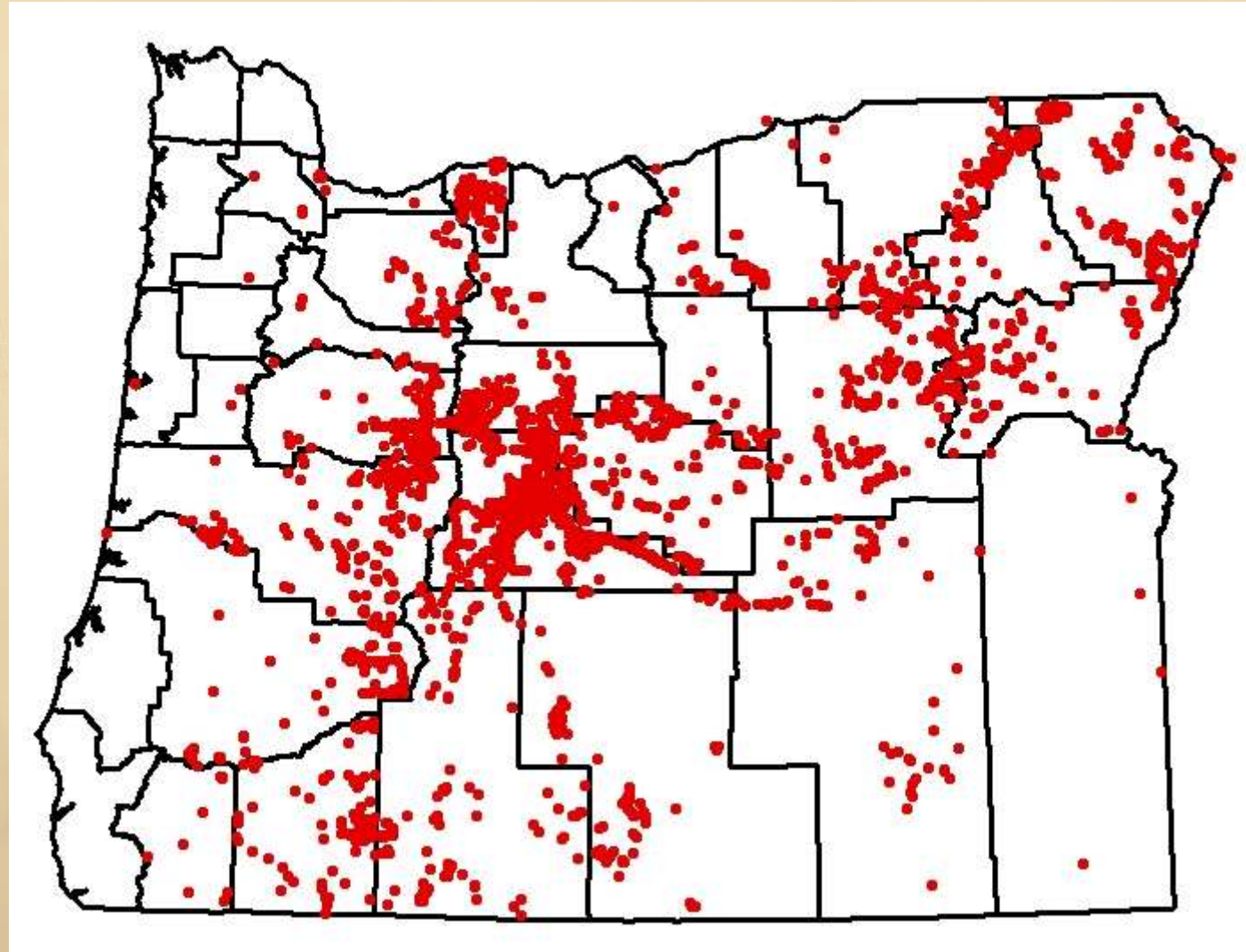


Geographic Projection (latitude/longitude NAD 1983)

Russian Knapweed

- According to our model Russian knapweed has the potential to occupy much of the state.
 - Climate/Elevation Model (49% of Oregon)
 - Climate/Elevation & Soil Model (18% of Oregon)
 - Currently 0.2% of the surface area is infested.
- Both the restrictive (including soil type) model and the more general climate model suggest a much broader range for Russian knapweed in the future.

Spotted Knapweed
(*Centaurea maculosa* auct. non Lam.)

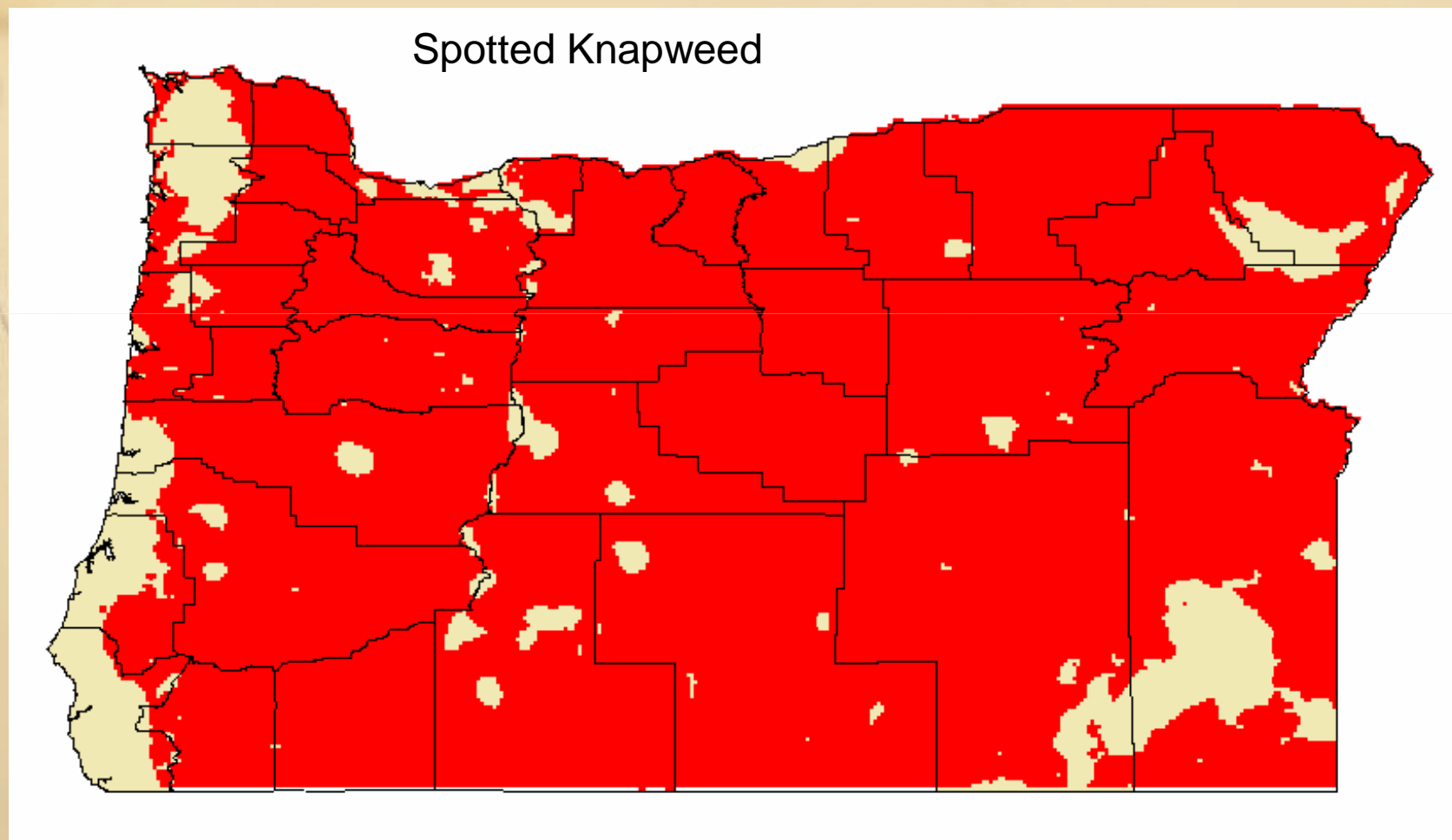




Spotted Knapweed

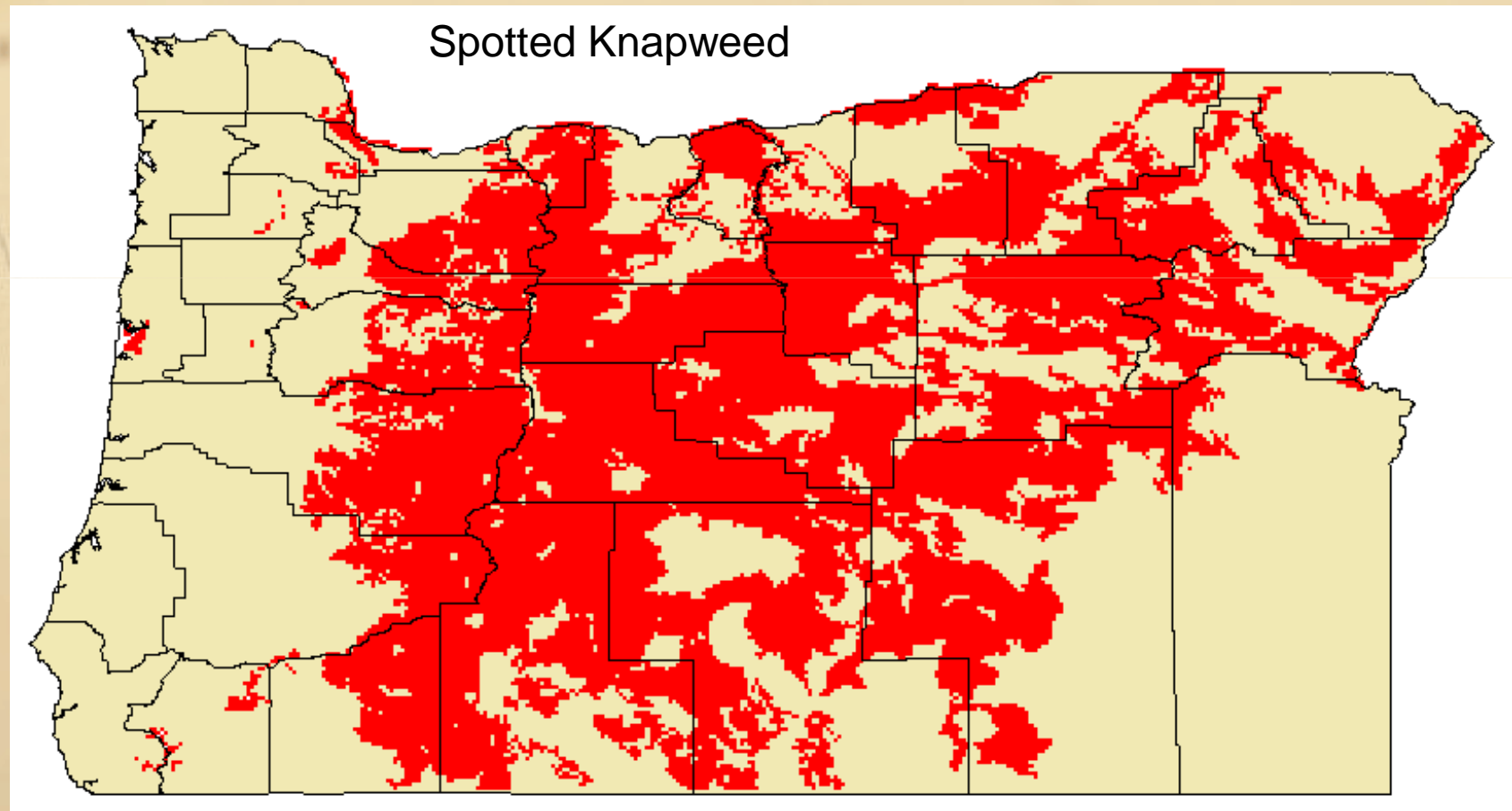
- Based upon our data which does not have all locations in the state.
- Infestations occur on 881 cells in Oregon out of a total of approximately 64,740 cells.
- Of the total land area in the state approximately 1.4% of the surface area is currently infested.

Spotted Knapweed Model Based on Climate



Geographic Projection (latitude/longitude NAD 1983)

Spotted Knapweed Model Based on Climate and Soil



Geographic Projection (latitude/longitude NAD 1983)

Spotted Knapweed

- According to our model spotted knapweed has the potential to occupy much of the state.
 - Climate/Elevation Model (90% of Oregon)
 - Climate/Elevation & Soil Model (41% of Oregon)
 - 1.4% of the surface area of Oregon is currently infested.
- Both the restrictive (including soil type) model and the more general climate model suggest a much broader range for spotted knapweed in the future.

Acknowledgements

- For support and funding we acknowledge:
 - Oregon State University
 - Oregon Experiment Station
 - USDA Forest Service
 - USDI Bureau of Land Management
 - Oregon Department of Agriculture
- We thank Mr. Steve Bulkin (USFS) and Ms. Lesley Richman (USDI/BLM) for technical support.



A c k n o w l e d g e m e n t s

- We also thank Dr. George Taylor and Dr. Chris Daley of the Oregon Climatic Service and the Climate Source for climatic data and advice.

