DEPARTMENT OF ARCHAEOLOGY & HISTORIC PRESERVATION
Protect the Past, Shape the Future

Protecting the Past Using Tools of the Future: Archaeology Predictive Modeling

A Presentation by:
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Beckett Point Example

Tacoma Convention Center

Impacts to Cultural Resources



Impacts to Cultural Resources



- Oil Spills
- Natural Disasters
- Wildfires

Regulatory Environment

- **Federal**
  - > Indian Graves and Records
  - > Archaeological Sites & Records
  - > Section 106 (Federal Nexus – Stimulus Money)
- **Washington State**
  - > State Environmental Policy Act SEPA
  - > Shorelines Management Act
  - > Forest Practices Act
  - > Growth Management Act
  - > Executive Order 0505

Washington State Laws

- Protects Native American graves on ALL non-federal lands: state/county/city/private lands
- Provides for penalties for knowing disturbance: Class C felony-
  - > Up to five years in prison &/or $10,000 fine
  - > Provides for civil action by tribe for violations to include damage/ emotional distress

Managing These Risks

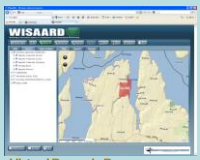
Issues
- Non-renewable resources
- Need to plan for projects costs
- Reduce in-the-field surprises
- Need to make technically sound, defensible decisions
- Emergency Management

Solution
- Predictive Modeling

Benefits
- Build more accurate budgets
- Reviews completed from Desktop
- Complete Section 106 requirements

Preparing for Predictive Modeling

DAHP Records Room



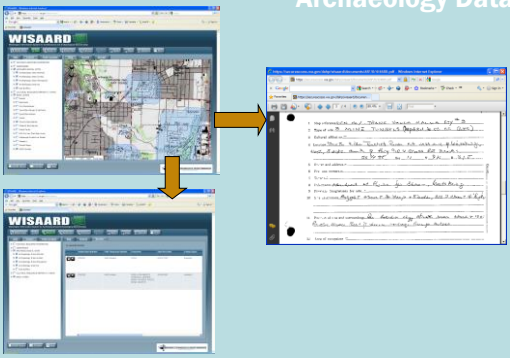
Virtual Records Room

> Manage over half-a-million paper documents and correspondence stored in multiple databases

> Quickly and Efficiently Retrieve and Update Information

> Make technical, legally sound decisions

Archaeology Data



Extend Protection of Resources Through Analysis

- **Issues**
  - Archaeology Resources Need to be Considered Everywhere
  - Impossible (too expensive) to survey everything
- **Solution**
  - Predictive Modeling
- **Benefits**
  - Planning: Protect Resources by avoiding in the first place/ reduced need for mitigation
  - Prioritize Surveying and Money
  - Protect Additional Resources

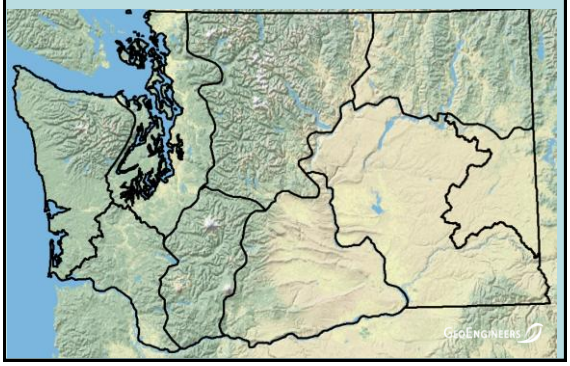
What is a Predictive Model?

- A predictive model correlates the locations of known archaeological sites, and "negative" locations of sites, with environmental characteristics.
- For this model we used environmental data, GIS and probability (Bayesian) statistics to determine the probability of finding a site within a 100 x 100 foot cell.

Benefits of Modeling

- Apply advanced planning in a regulatory setting
- Quicker access to additional archaeology information/ research for projects
- Consistent framework/approach using statistical methods
- Guides archaeological surveys and directs testing programs

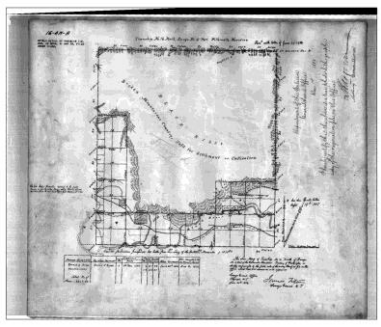
Statewide Study Areas



Key Criteria for Selecting Data

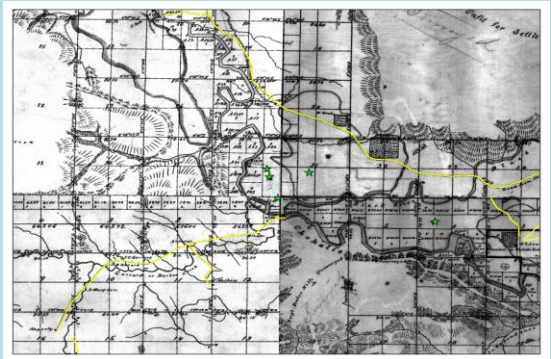
- Available in GIS format or available for conversion to GIS format
- Easily obtainable from public sources
- Available for the entire state
- Available at a reasonable scale or resolution for the model
- Identified by archaeologists as relevant

Government Land Office Maps



- Late 1880s
- Georeferenced over 2,400 GLO maps
- Digitized features; Trails and Native American settlements or graves

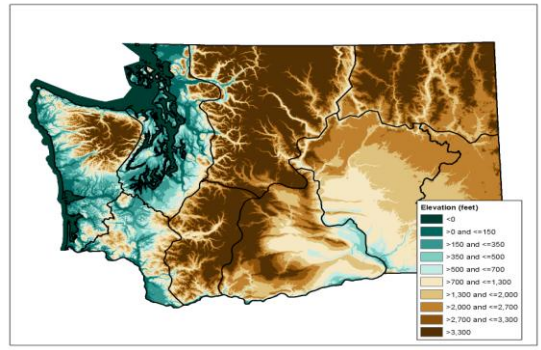
Government Land Office Maps



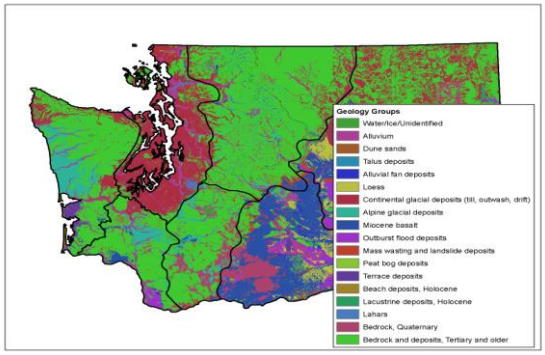
Environmental Data Used for Modeling

- Value Data
  - Elevation
  - Slope Percent
  - Aspect
  - Distance to Water
- Categorical Data
  - Soils
  - Geology
  - Landforms

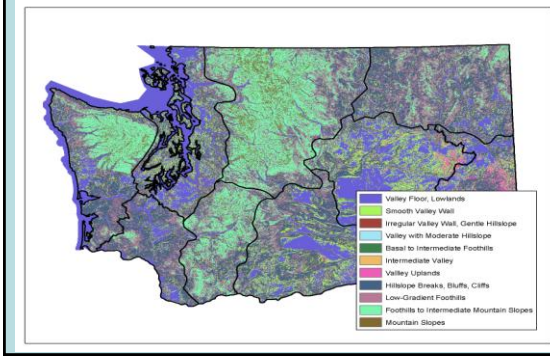
Elevation



Geology

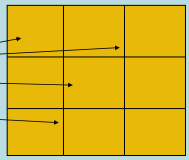


Landforms



Summarize Groups to the Cell Level

- Geology
  - Alluvial Fans (Group 1)
  - Basalt (Group 2)
  - Rock Outcrops (Group 3)
  - Etc.
- Each cell is assigned a group for each environmental data set



Assign Groups to Each Cell

Geology Group 1 Aspect Group 5 Soil Group 8 Slope Group 3	Geology Group 3 Aspect Group 2 Soil Group 5 Slope Group 7	

Calculate Probabilities

- Calculate Probabilities for each data group
  - Probability that it occurs throughout the Study Area
  - Probability that an archaeological site occurs within that data group
- The probability of randomly finding an archaeological site

Assign Probabilities to Cells Based on Group

Geology Group 6
Study Area Probability (0.775000)
Archaeology Probability (0.806382)

Slope Group 2
Study Area Probability (0.360714)
Archaeology Probability (0.249387)

Elevation Group 4
Study Area Probability (0.330935)
Archaeology Probability (0.423274)

Etc….

Bayesian Probability Calculations

$$P(A/Vi) = \frac{P(Vi/A)\,P(A)}{P(Vi)}$$

$$= \frac{P[(E1/A)(E2/A)(E3/A)(E4/A)(E5/A)]*P(A)}{P[E1*E2*E3*E4*E5]}$$

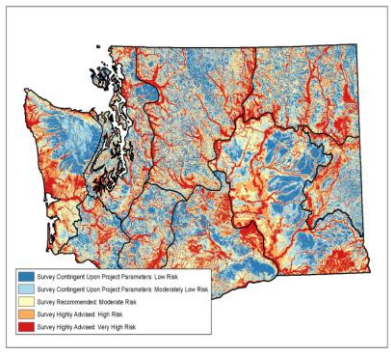
Example Conditions: Geol 6, Slope 2, Elev 4, Aspect 5, DTW 1

$$= \frac{(.775000)(.360714)(.330935)(.248200)(.453571)(.000445)}{(.806382)(.249387)(.423274)(.263093)(.091690)}$$

=0.00225

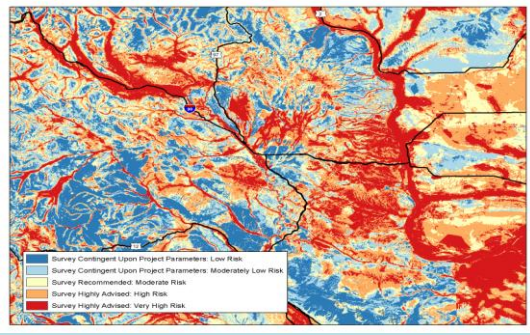
- Bayesian Probabilities Calculations do not require specialized statistical software – thereby making updating easier

Bayesian Scores

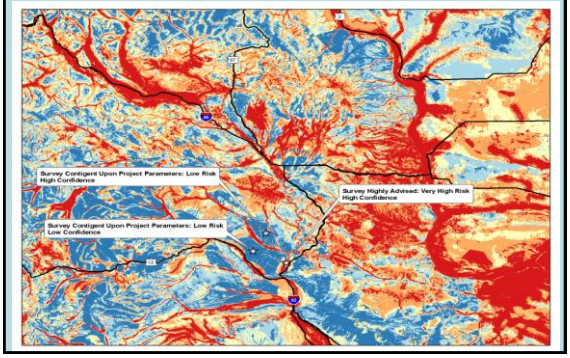


- Important to note that Low or Very Low still have potential to have sites, simply a lower potential.

Evaluate Projects



Adding Confidence to Predictions



Conclusions

- Plan ahead, undiscovered sites are out there
- Does NOT replace ground surveys, but does help prioritize surveys and density of surveys
- Augments archaeologist's knowledge of area prior to surveys being conducted

Collaboration

- Washington Department of Archaeology and Historic Preservation
- Washington Public Works Board
- Washington Department of Transportation
- Washington Department of Natural Resources
- Yakama Nation
- Suquamish Tribe

THANKS!!

Questions / Comments?

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