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

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Tacoma Convention Center

Impacts to Cultural Resources
- Oil Spills
- Natural Disasters
- Wildfires

Beckett Point Example

Impacts to Cultural Resources

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
  > Manage over half-a-million paper documents and correspondence stored in multiple databases
- Virtual Records Room
  > 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
IACC 2014 – S53 Archeological Predictive Modeling

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

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**

\[ P(A|Vi) = \frac{P(Vi|A) P(A)}{P(Vi)} \]

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

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

\[ = (0.775000)(0.360714)(0.330935)(0.248200)(0.453571)(0.000445) \]

\[ = 0.00225 \]

- 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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