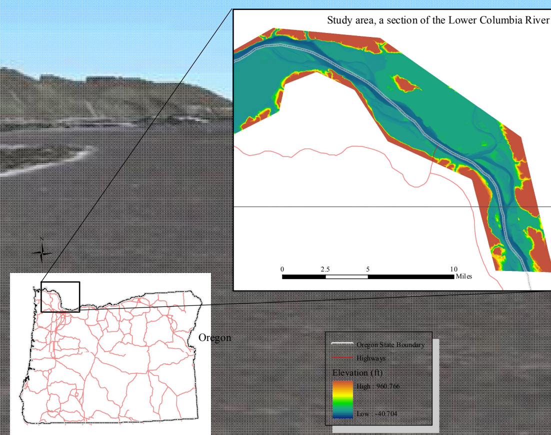
Analysis and visualization of elevation distribution in the Lower Columbia River Basin



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Digital Terrain Analysis
Fall 2008

Objectives

- Define the relationship between river stage, flooded area, and shallow water habitat area
- Refine and expand previous work by:
  - Incorporating a larger study area
  - Segmenting the study area and aggregating river reaches with similar characteristics
- Create visual representations of the terrain surface to communicate the topography and bathymetry of the study area

Shallow Water Habitat

- SWH is defined as peripheral sections of the river with 0.1 to 2m depth
    - Side channels
    - Sloughs
    - Floodplains
    - Salt marshes

- SWH provides refuge, nutrients, and is key habitat where out-migrating salmonids undergo smoltification

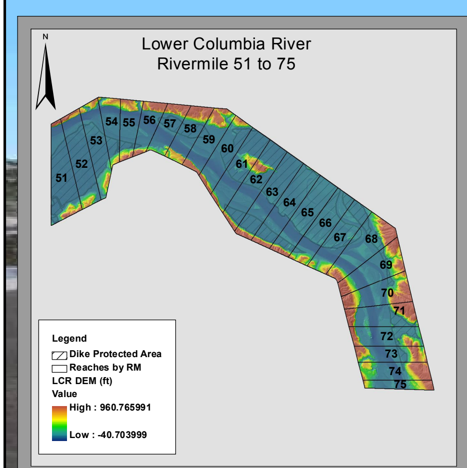
Shallow Water Habitat

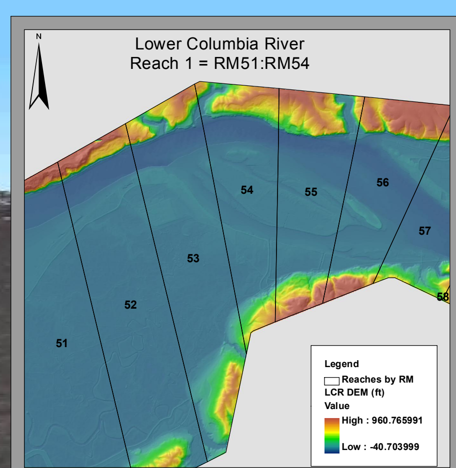
- Factors influencing the change in SWH
    - Levees/Dikes
    - Channelization of the river
        - restricts flow to shipping channel
    - Infill for agriculture or development
    - Regulation of the Hydropower system
        - Alters the flow cycle and reduces flooding
    - Climate change
        - Alters the flow cycle and reduces flooding
- By understanding the relationship between river stage and SWH the system can be optimized to provide more SWH.

Data

- Digital Elevation Model
  - LCR topography and bathymetry from rivermile 51 to rm 75
  - 10 meter resolution
  - Generated from LiDAR flown in 2005
- Digital Ortho-quads
  - USDA
  - 2 meter resolution
- Shapefiles
  - River reaches
  - Dike polygons
    - Approximate locations of dikes and protected area

Study Area





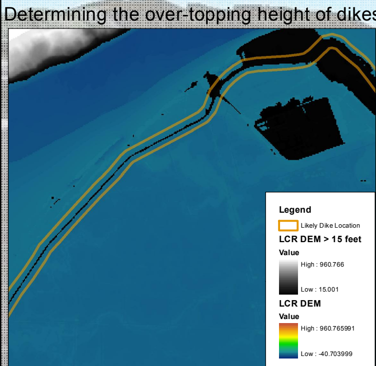
Methods

- Calculate the hypsometric curve for 1 mile reaches then group reaches based on the characteristic distribution of elevation
- Two cases
  - Undiked Topography
    - Use the DEM as derived from LiDAR
  - Diked Topography
    - Raise the protected area behind the dikes to the height at which the dikes would be over topped

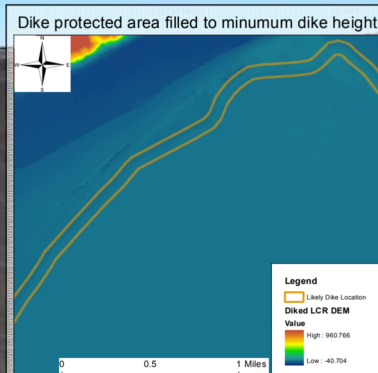
Creating the DEM to represent the dike protected case

- Identify potential levee locations
- Assign a overtopping value to the levee polygons
- Convert polygons to raster
- Use raster calculator to created the diked scenario

Determining the over-topping height of dikes



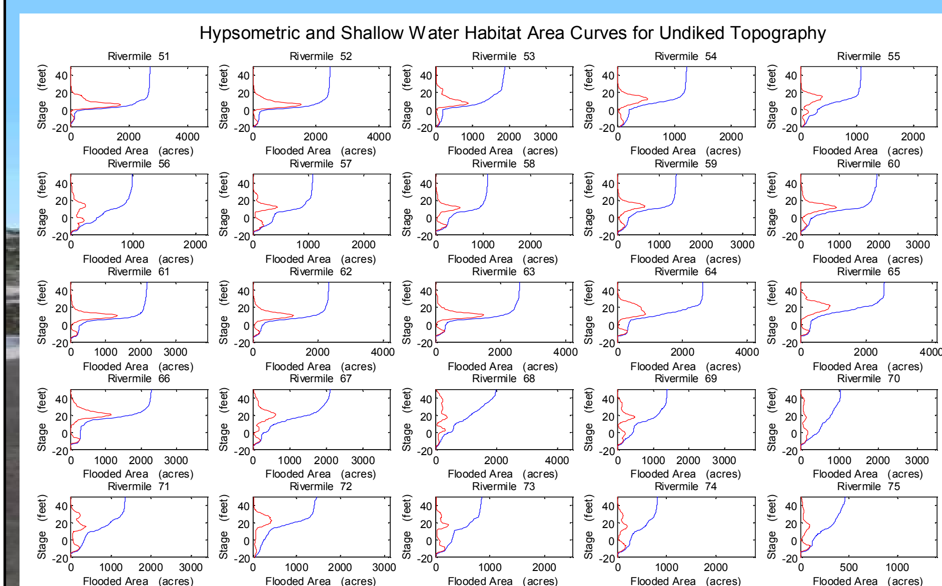
Dike protected area filled to minumum dike height



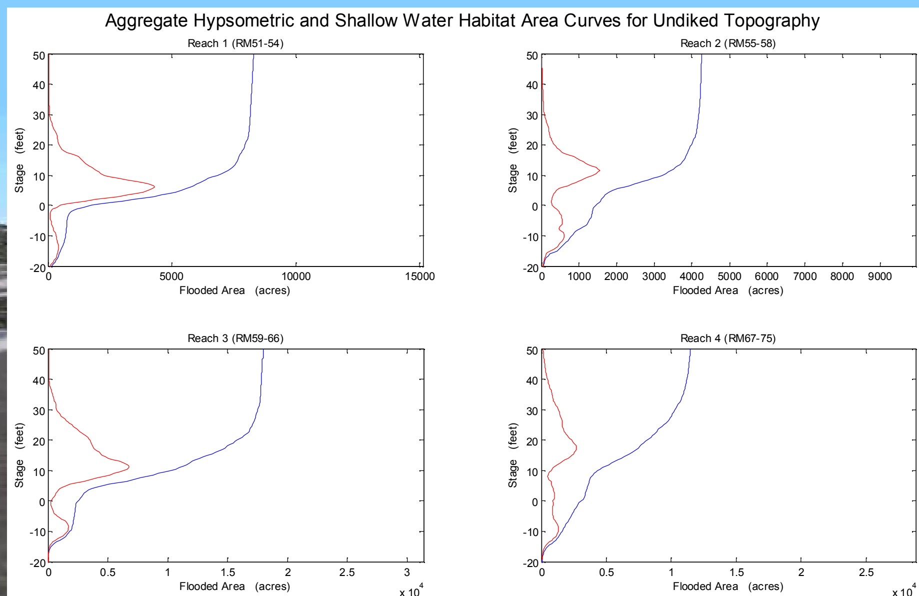
Calculating the inundated area

- Clip elevation data to create a DEM for each reach
- Export data to text files
- Calculate hypsometric curves and SWHA in MATLAB

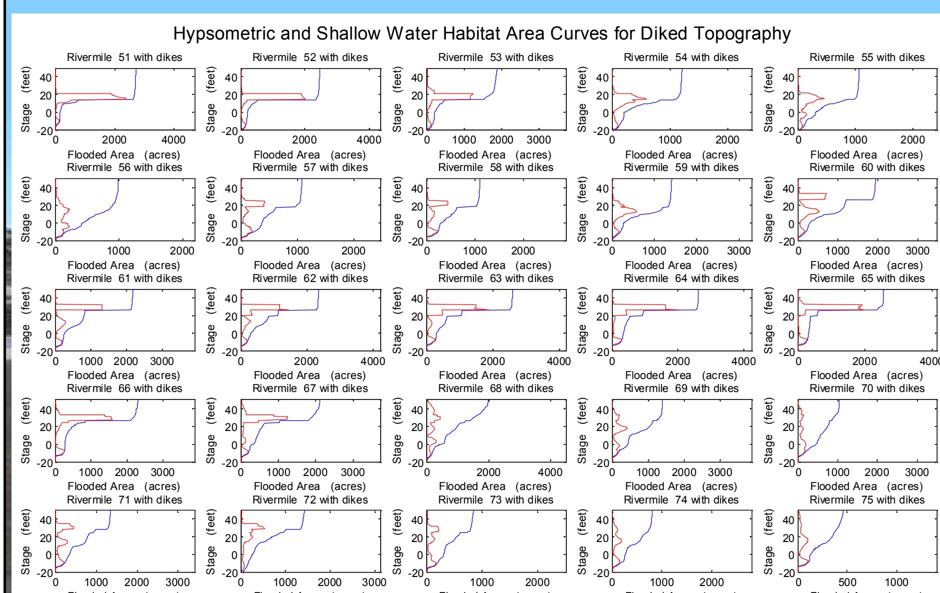
Results



Results



Results



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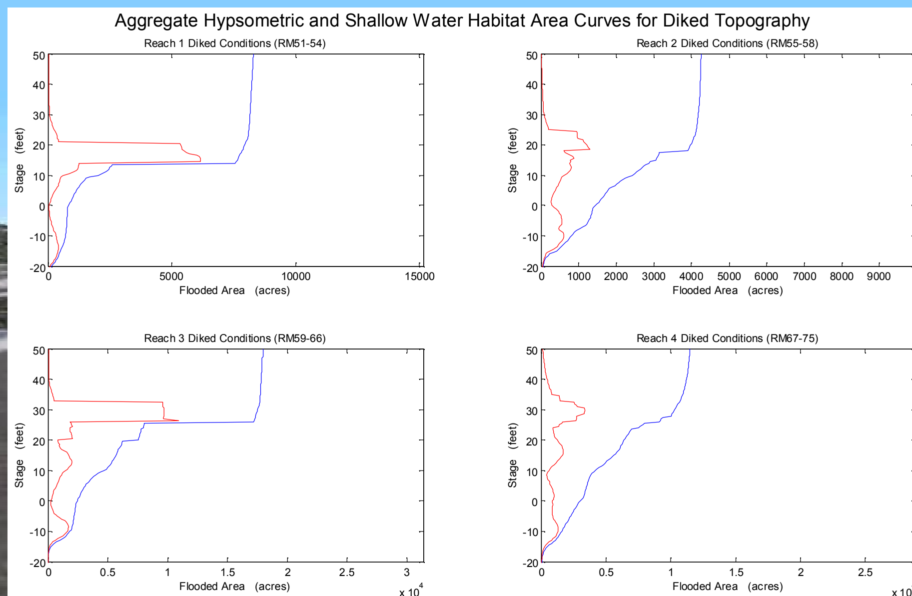
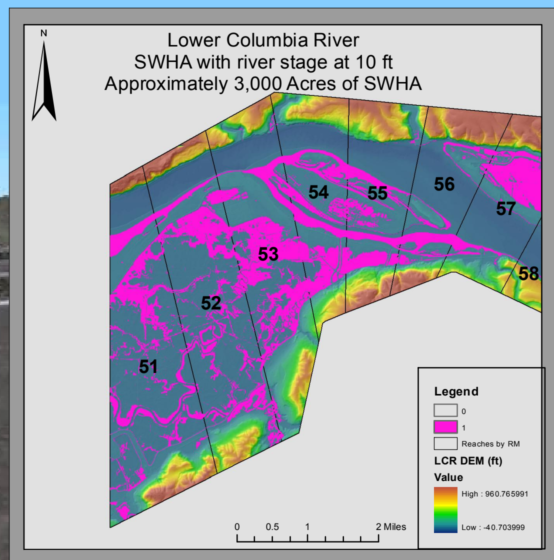


Analysis Conclusions

- Derived curves relating total inundation and SWHA to stage can be used to hindcast historic conditions
- Restoration efforts and Hydropower system fluctuations can have substantially different influences on the system depending on where and how changes are implemented
- Dike surveying would improve accuracy of analysis
- What does 3,000 acres of SWH look like?

3,000 acres of SWH, ArcMap



Visualizing the terrain

Single frame display

- Visualizing study area, ArcMap
  - Study site, DEM, image, boundaries, roads
  - Inundation to 3,000 acres of SWH
- 3D Rendering: LPS ERDAS VirtualGIS, ArcScene
  - Orthophoto quads were obtained for the study area and then mosaiced using ERDAS Imagine software from the Leica Photogammetry Suite using a weighted cutline generation method. Then, when study area was contained all within one image file, it was reprojected, then clipped to the elevation and bathymetry data (DEM).
  - select appropriate background properties, flight path & attributes, water layers for inundation, animation attributes, compressor for creating movie and compression quality
- 3D to 2D Export of *emf files of selected scenes

Visualizing the terrain

Advanced solutions for digital display, study reach

- Generation of animated fly through of study reach in ERDAS Imagine VirtualGIS
- Single pass for each animation
  - 2 animations with and without consideration towards dikes/levees
- explore multiple options
  - Variables: pitch, azimuth, roll, speed, models, background, flight paths

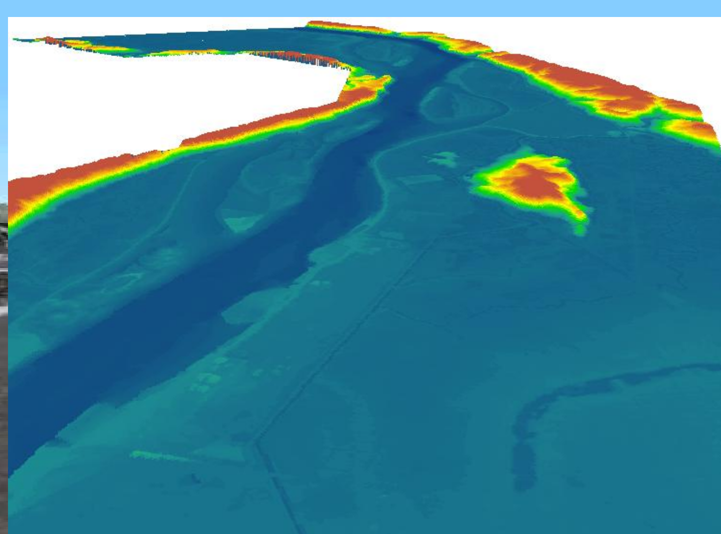
Visualizing the terrain

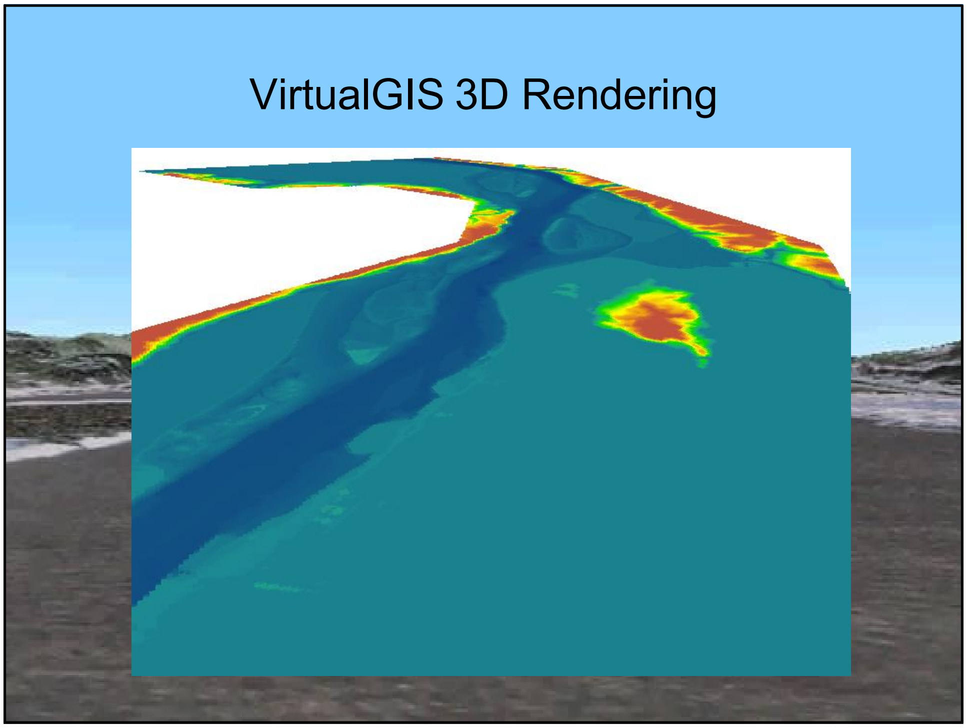
Advanced solutions for digital display, inundation

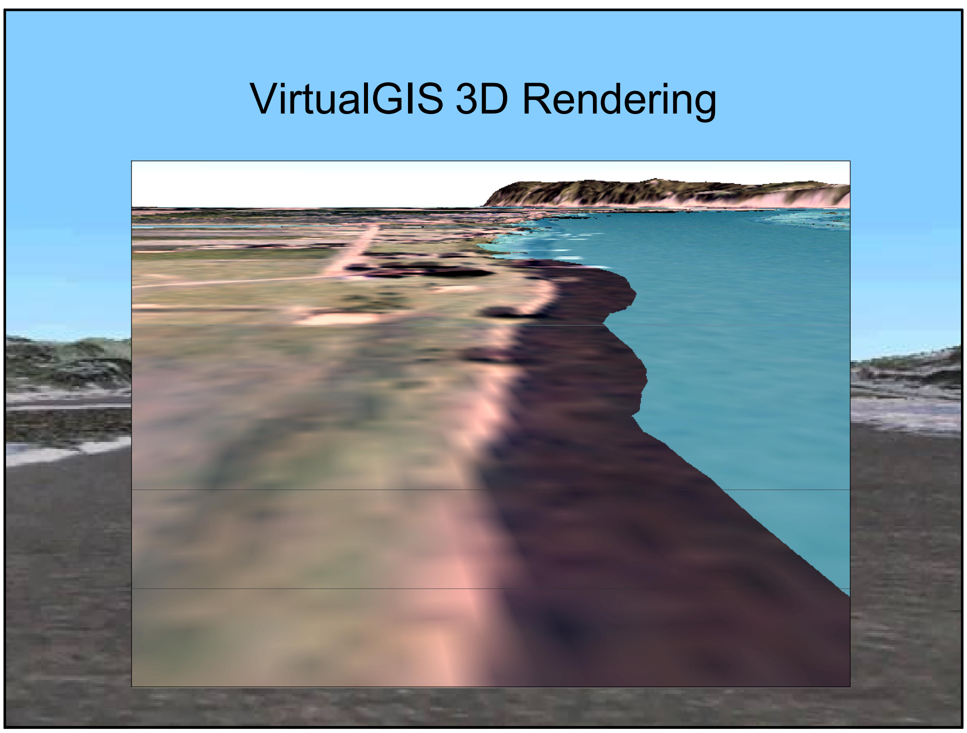
- Water layers, LPS ERDAS VitualGIS
  - 11, 13 ft Inundation, ~ lowest levee height
  - 25 ft Inundation , ~ highest levee height
- Inundated with and without taking into account levees and their alteration of flood patterns.

ArcScene 3D Rendering

VirtualGIS 3D Rendering




VirtualGIS 3D Rendering


VirtualGIS 3D Rendering

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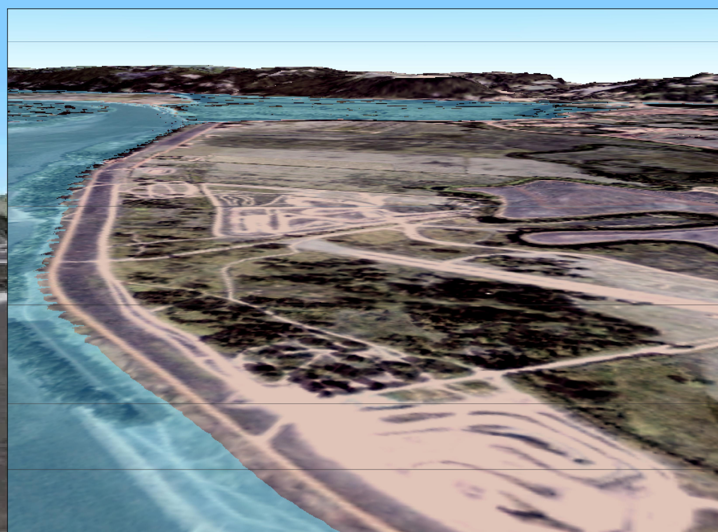
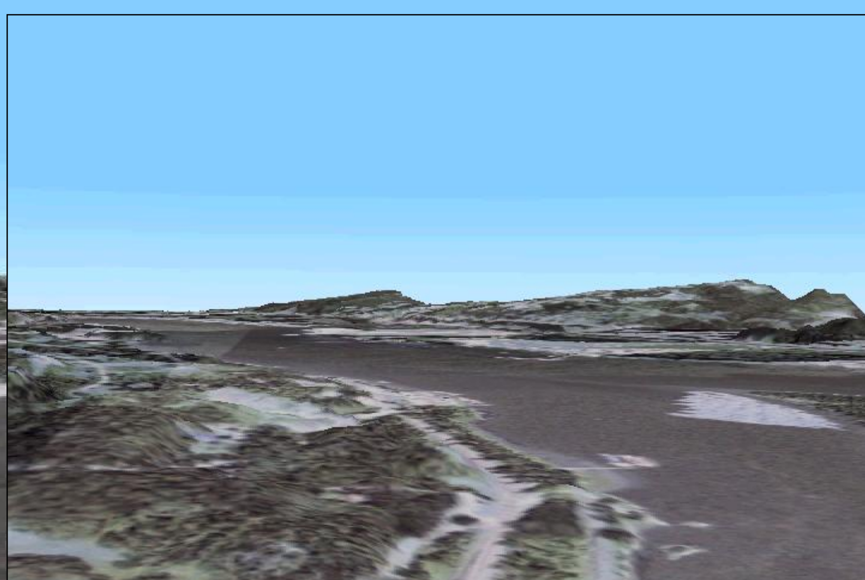
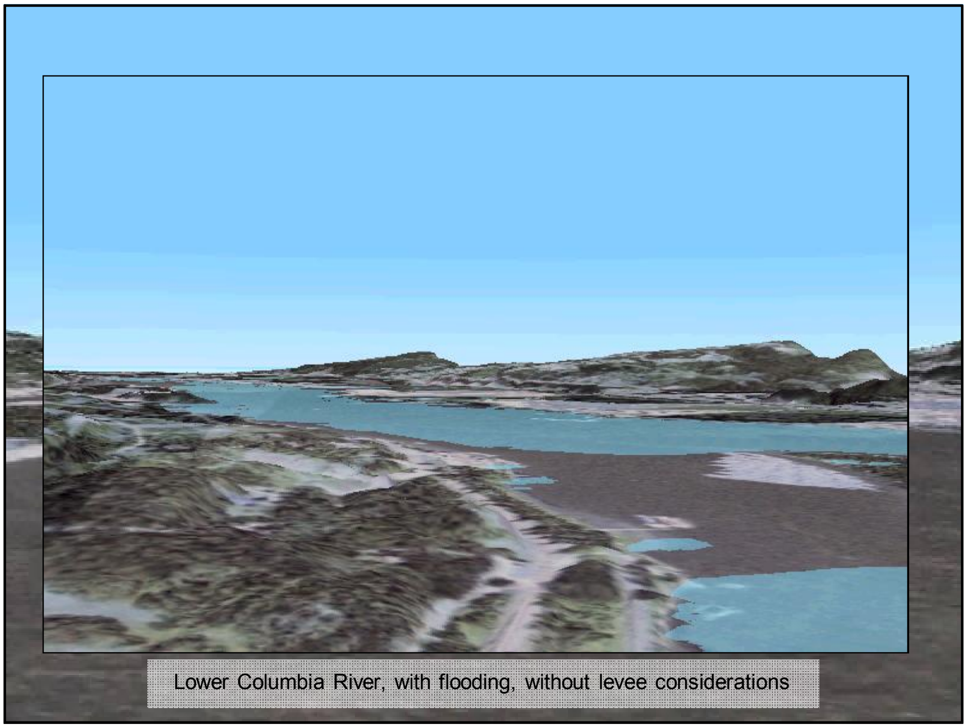
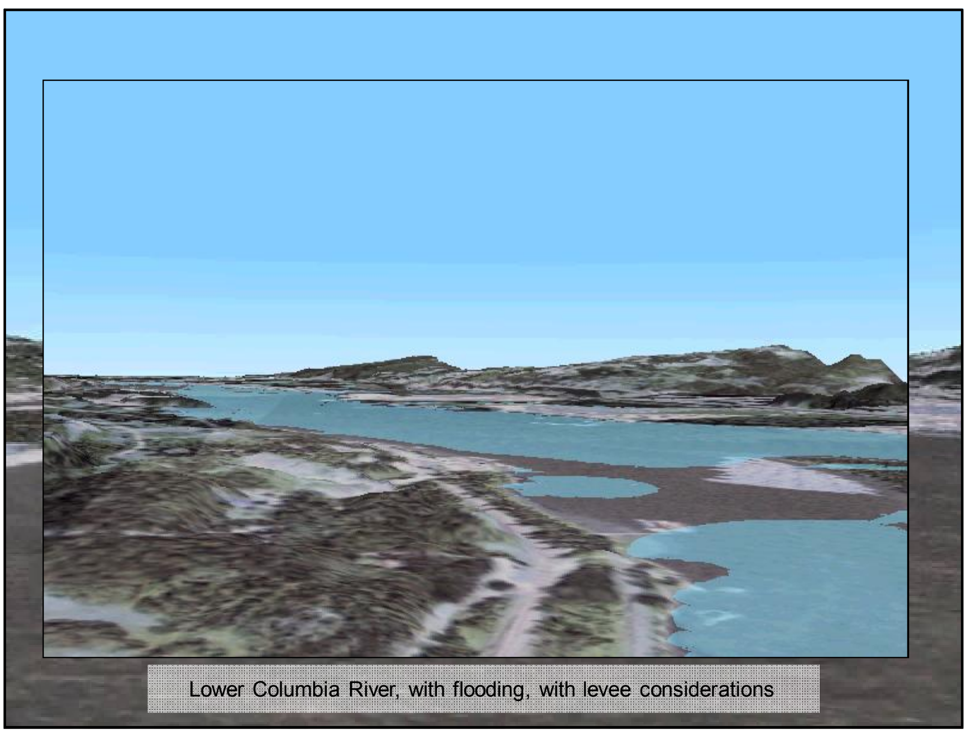




Lower Columbia River, without flooding, without levee consideration



Lower Columbia River, with flooding, without levee considerations



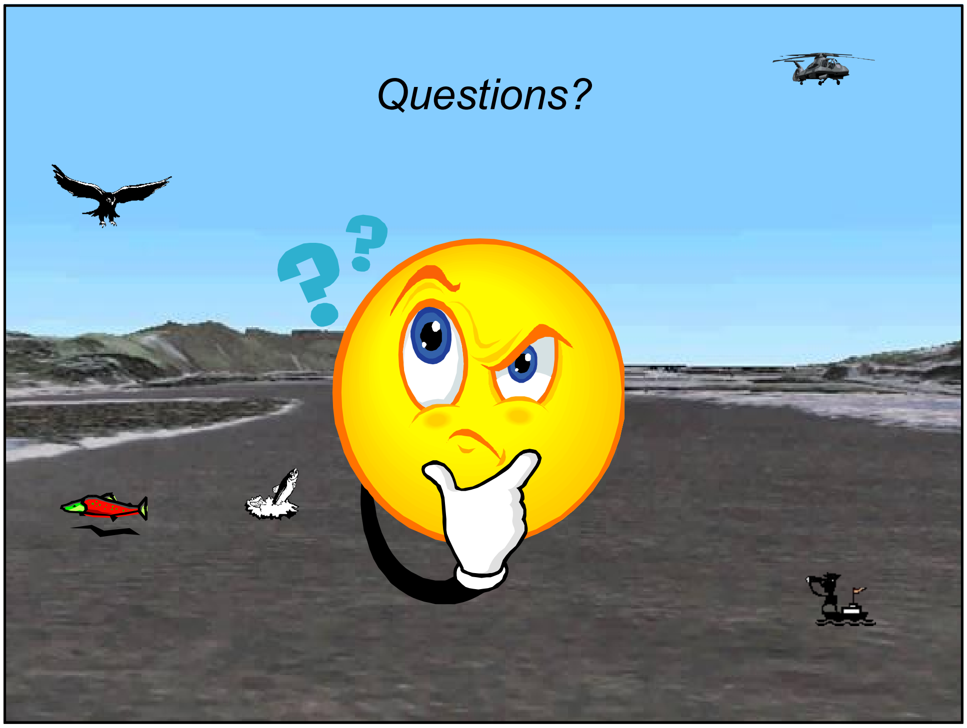
Lower Columbia River, with flooding, with levee considerations

Did you see them?

- Mosaiced lines obvious
- Flat features: boats, cities, some islands
- Pixelated images
- Flooding didn't seem that good
- No cloud/fog/water features

Visualization Conclusions

- Different programs pose different problems and solutions
  - LPS ERDAS VirtualGIS
    - Quicker rendering, "easier" interface
    - Model imports, hard to import *3ds, *kmz models
    - Difficult to export images (to *jpg, *emf form)
    - Conversion between animation tool and create movie can be troublesome
    - Mosaic lines still apparent, flat features, pixelation, flooding doesn't appear as nice as layers
  - ArcScene
    - Water features such as clouds & fog, and light easy to manipulate
    - Difficulty rendering from scene to scene
    - Excellent exploratory capability, but limited animation tools, or the animation tools are non-intuitive to an ERDAS user


Questions?