Determination of the relationship between river stage and shallow water habitat area for juvenile salmonids in the Lower Columbia River

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GIS II
Winter 2008

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 Area

- Factors influencing the change in SWHA
  - Levee/Dike construction
  - Channelization of the river
    - restricts flow to shipping channel
  - Infill for agriculture or other development
  - Regulation of the Hydropower system
    - Alters the flow cycle and reduces flooding
  - Climate change
    - Alters the flow cycle and reduces flooding

Research Goals

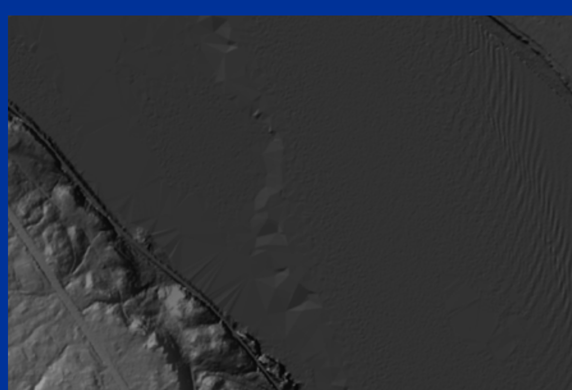
- Implement a tidal-fluvial model to hindcast the daily max river stage at tide stations back to the late 1800's
- Model the relationship between river stage at all levels and SWHA
- Combine the two models to assess the change in availability of SWHA

Implementation of GIS

- Manage elevation data from several sources
- Post-processing of LiDAR data
- Merging of topographic and bathymetric data sets
- Interpolation of river surface from stage gauge data
- Calculation of inundated area

Post Processing LiDAR

- The LiDAR signal is scattered when it strikes water and the return signal results in an erroneous elevation value.

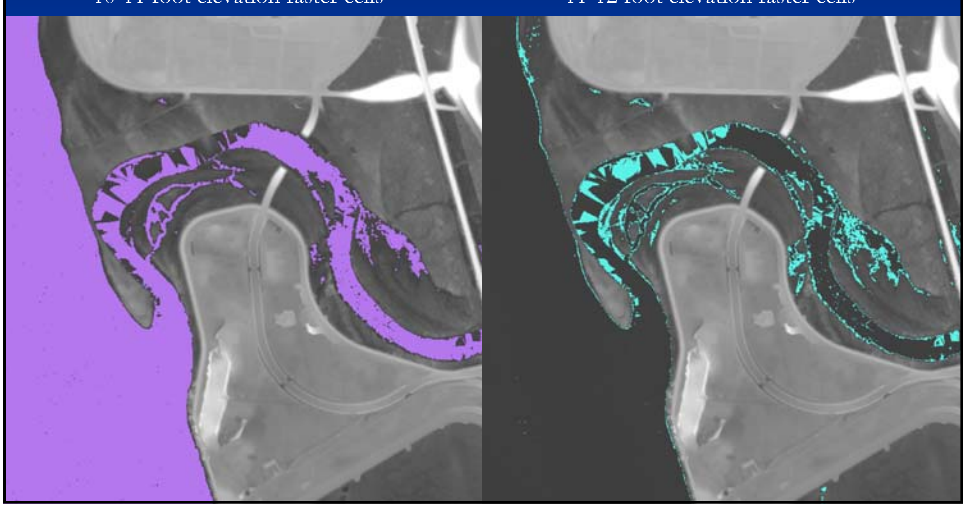


Post Processing LiDAR

- Reclassify the raster to bins with 0.5 ft intervals
- Convert raster to polygons
- Convert polygons to polylines
- Generate raster ramps for the lower elevation data to highlight the transition from the water surface to terrain.
- Use ArcMap editor to digitize shoreline features in a file geodatabase.
  - Polylines and raster ramps distinguish the transition from water surface to shoreline. Digital orthophotos are used for reference, but shoreline selection is based on the LiDAR data.
- Once the shoreline is delineated use the boundaries to clip out the bad data resulting from the LiDAR scattering off the water surface.

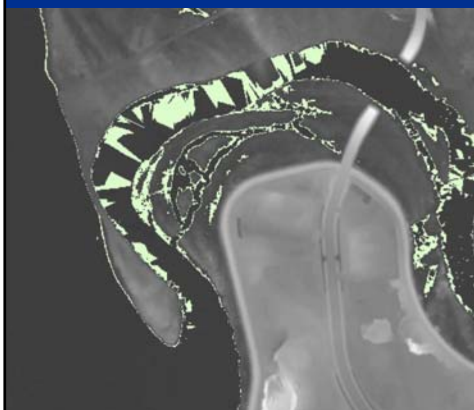
Binning intervals of elevation data

10-11 foot elevation raster cells　　11-12 foot elevation raster cells

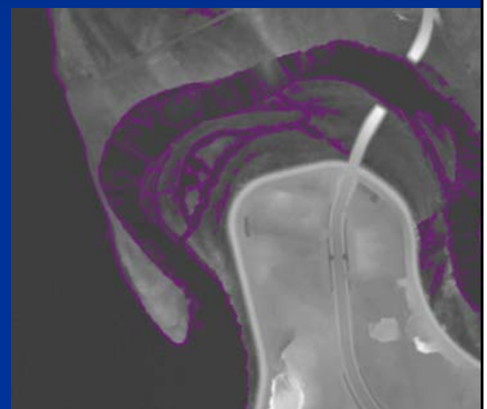


Raster to Polygons to Polylines

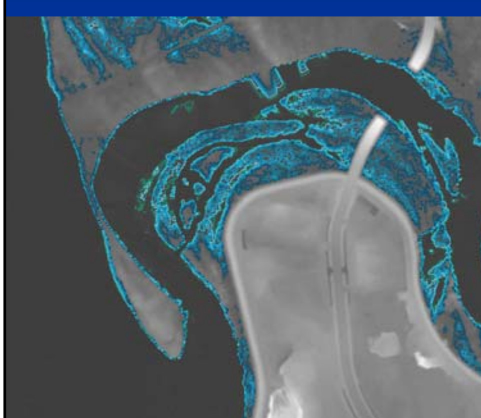
11-12 foot elevation polygons



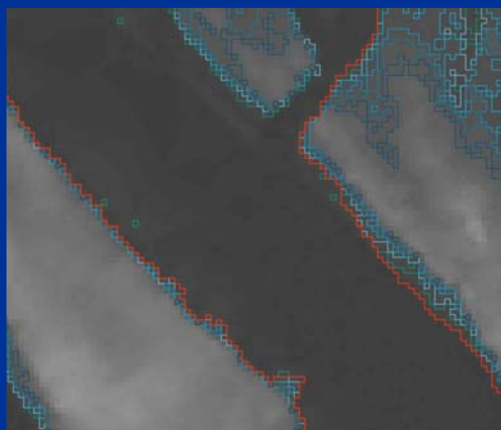
11-12 foot elevation polylines

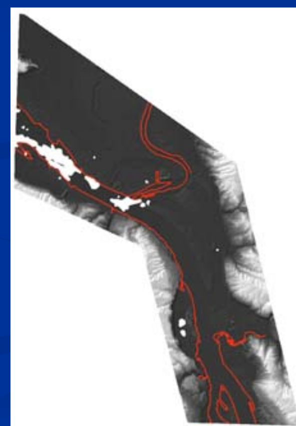


Digitizing the shoreline



Digitizing the shoreline



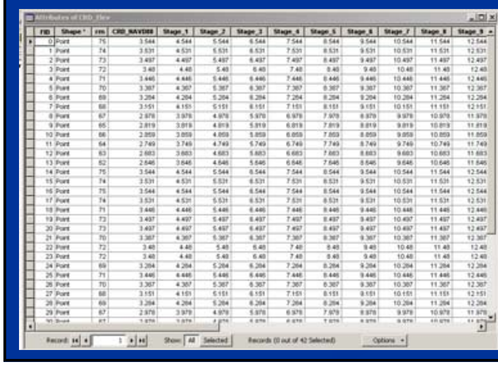


Calculating SWHA

- Build shapefile to locate tide gauge stations and build an attribute table containing the stage data
- Interpolate the river surface for river stages from datum to historic maximum
- Use raster calculator to calculate water depth of the flooded areas.
- Use raster calculator to count the flooded cells
- Iterative process

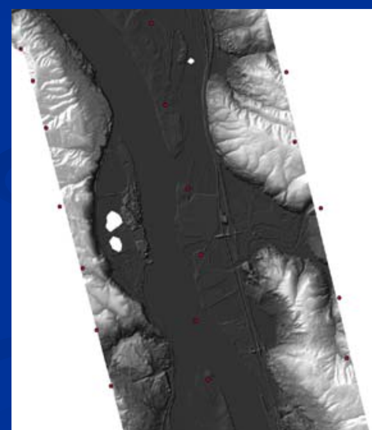
Migrate Tide Gauge Data to ArcGIS

- Create file geodatabase to locate tide gauge stations
- Create an attribute table containing the stage data for river surface interpolations



FID	Shape *	rm	CRD_NAVD88	Stage_1	Stage_2	Stage_3	Stage_4	Stage_5	Stage_6	Stage_7	Stage_8	Stage_9
0	Point	75	3.544	4.544	5.544	6.544	7.544	8.544	9.544	10.544	11.544	12.544
1	Point	74	3.531	4.531	5.531	6.531	7.531	8.531	9.531	10.531	11.531	12.531
2	Point	73	3.497	4.497	5.497	6.497	7.497	8.497	9.497	10.497	11.497	12.497
3	Point	72	3.48	4.48	5.48	6.48	7.48	8.48	9.48	10.48	11.48	12.48
4	Point	71	3.446	4.446	5.446	6.446	7.446	8.446	9.446	10.446	11.446	12.446
5	Point	70	3.387	4.387	5.387	6.387	7.387	8.387	9.387	10.387	11.387	12.387
6	Point	69	3.284	4.284	5.284	6.284	7.284	8.284	9.284	10.284	11.284	12.284
7	Point	68	3.151	4.151	5.151	6.151	7.151	8.151	9.151	10.151	11.151	12.151
8	Point	67	2.978	3.978	4.978	5.978	6.978	7.978	8.978	9.978	10.978	11.978
9	Point	65	2.819	3.819	4.819	5.819	6.819	7.819	8.819	9.819	10.819	11.819
10	Point	66	2.859	3.859	4.859	5.859	6.859	7.859	8.859	9.859	10.859	11.859
11	Point	64	2.749	3.749	4.749	5.749	6.749	7.749	8.749	9.749	10.749	11.749
12	Point	63	2.683	3.683	4.683	5.683	6.683	7.683	8.683	9.683	10.683	11.683
13	Point	62	2.646	3.646	4.646	5.646	6.646	7.646	8.646	9.646	10.646	11.646
14	Point	75	3.544	4.544	5.544	6.544	7.544	8.544	9.544	10.544	11.544	12.544
15	Point	74	3.531	4.531	5.531	6.531	7.531	8.531	9.531	10.531	11.531	12.531
16	Point	75	3.544	4.544	5.544	6.544	7.544	8.544	9.544	10.544	11.544	12.544
17	Point	74	3.531	4.531	5.531	6.531	7.531	8.531	9.531	10.531	11.531	12.531
18	Point	71	3.446	4.446	5.446	6.446	7.446	8.446	9.446	10.446	11.446	12.446
19	Point	73	3.497	4.497	5.497	6.497	7.497	8.497	9.497	10.497	11.497	12.497
20	Point	73	3.497	4.497	5.497	6.497	7.497	8.497	9.497	10.497	11.497	12.497
21	Point	70	3.387	4.387	5.387	6.387	7.387	8.387	9.387	10.387	11.387	12.387
22	Point	72	3.48	4.48	5.48	6.48	7.48	8.48	9.48	10.48	11.48	12.48
23	Point	72	3.48	4.48	5.48	6.48	7.48	8.48	9.48	10.48	11.48	12.48
24	Point	69	3.284	4.284	5.284	6.284	7.284	8.284	9.284	10.284	11.284	12.284
25	Point	71	3.446	4.446	5.446	6.446	7.446	8.446	9.446	10.446	11.446	12.446
26	Point	70	3.387	4.387	5.387	6.387	7.387	8.387	9.387	10.387	11.387	12.387
27	Point	68	3.151	4.151	5.151	6.151	7.151	8.151	9.151	10.151	11.151	12.151
28	Point	69	3.284	4.284	5.284	6.284	7.284	8.284	9.284	10.284	11.284	12.284
29	Point	67	2.978	3.978	4.978	5.978	6.978	7.978	8.978	9.978	10.978	11.978

Record: 1 Show: All Selected Records (0 out of 42 Selected) Options



River Surface Interpolation

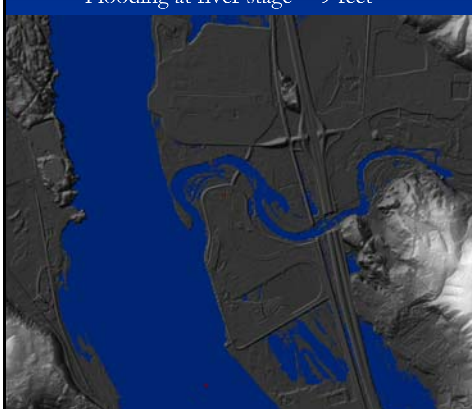
- Point data at tide stations used to interpolate surfaces at regular intervals of stage height:
  Datum, 6, 9, 12, 15, 18, 21, 24, 30 feet
- Spline Interpolation results in a surface that
  - Passes exactly through the data points
  - Minimizes curvature
  - Results in a smooth surface
- Statistical Interpolation Methods
  - Resulted in anomalies near data points
  - Input data too sparse

Raster calculations to calculate water depth, flooded area, and SWHA

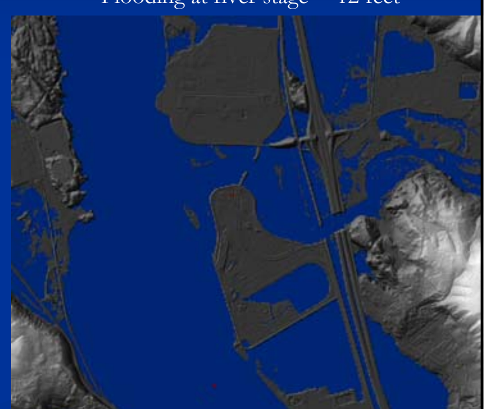
- Water Depth = River Surface Interpolation – DEM
  - Raster with values from ≈ -1000 to 25
  - Dpthx = [Stgx] – [DEM]
- Flooded area represented by all positive values
  - Fldx = con([Dpthx] > 0 ,1)
- SWHA consists of flooded area with 0.1m to 2m depth
  - SWHAx = con([Dpthx] > 0.1 & [Dpthx] < 2, 1)

Resulting Raster Surfaces

Flooding at river stage = 9 feet



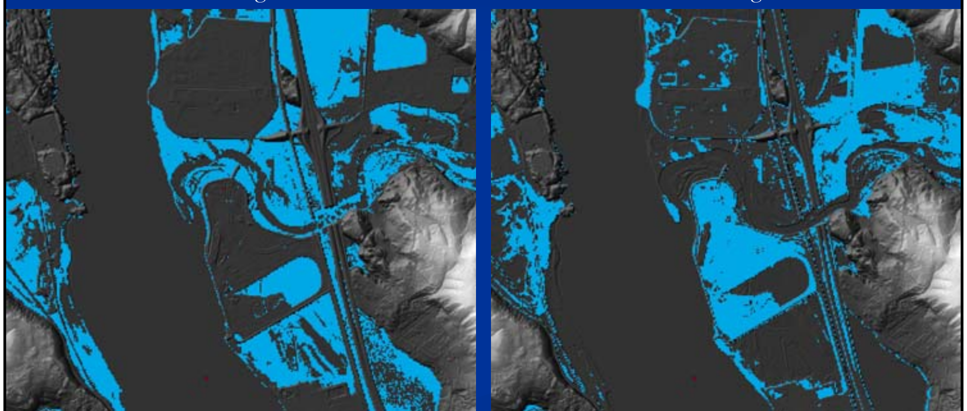
Flooding at river stage = 12 feet



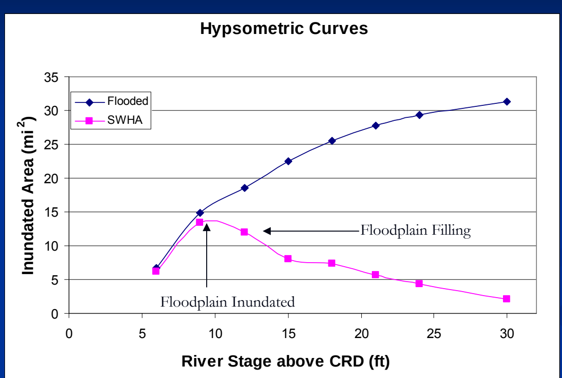
Resulting Raster Surfaces

SWHA at river stage = 15 feet

SWHA at river stage = 21 feet



Results



Flooded area and SWHA calculated at each stage level by multiplying the number of inundated cells by the cell size.

Conclusions

- Hypsometric curve shows expected behavoir
- More work to be done
  - Defining the shoreline
  - Merging in bathymetry
  - Increase the resolution of the stage intervals

Questions?