Determining Basin and Climate Characteristics using ArcGIS

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Determining Basin and Climate Characteristics using ArcGIS

Presentation Overview:

- Introduction and Description
- Determining Basin Area
- Determining Mean Annual Precipitation
- Percent of Basin with Forest Cover
- Percent of Basin Above 6,000 ft
- Determining Mean Basin Elevation

Determining Basin and Climate Characteristics using ArcGIS

- Introduction

  ArcGIS can be used to determine the basin and climate characteristics used in the USGS Regression Equations from Parrett, Charles, and Johnson, D.R., 2004, *Methods for Estimating Flood Frequency in Montana Based on Data Through Water Year 1998*: USGS WRIR 03-4308

- Description

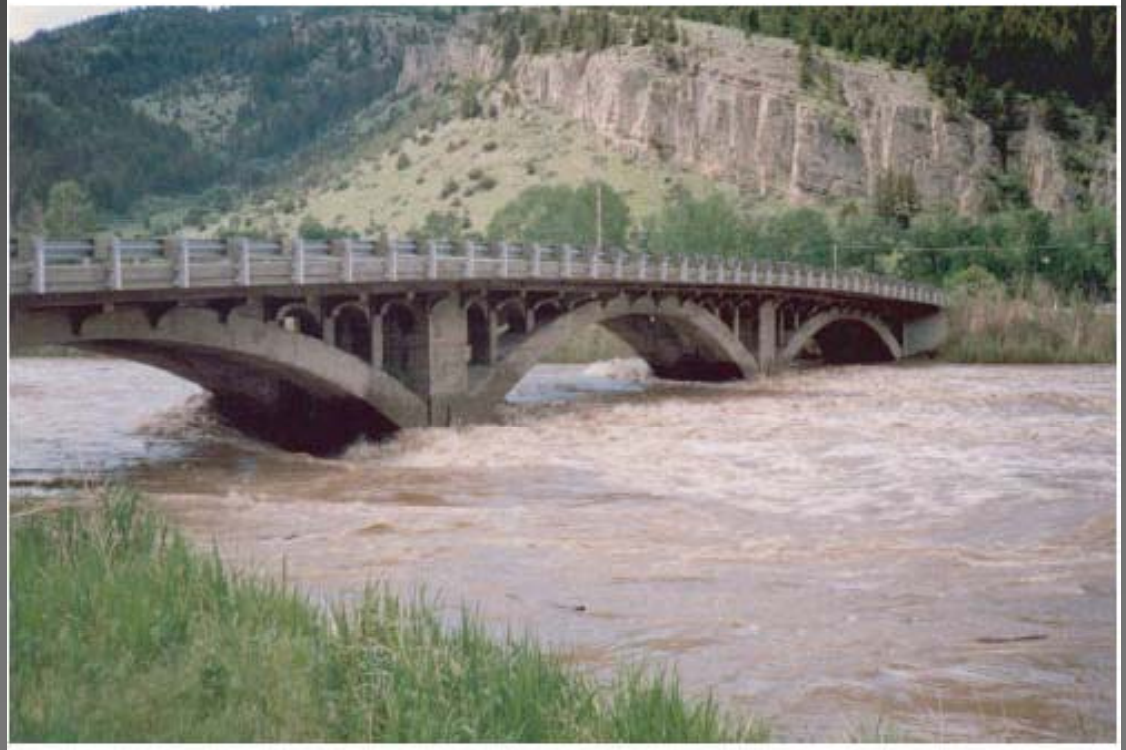
  This presentation will describe how ArcGIS can be used to determine basin area, mean annual precipitation, percent of basin with forest cover, percent of basin above 6,000 ft and mean basin elevation.

USGS
science for a changing world

In cooperation with the
BUREAU OF INDIAN AFFAIRS, BUREAU OF LAND MANAGEMENT,
CONFEDERATED SALISH AND KOOTENAI TRIBES,
MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION,
MONTANA DEPARTMENT OF TRANSPORTATION, and the
U.S. DEPARTMENT OF AGRICULTURE FOREST SERVICE

Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998

Water-Resources Investigations Report 03-4308



U.S. Department of the Interior
U.S. Geological Survey

Determining Basin and Climate Characteristics using ArcGIS

Example Area: Dayton Creek near Flathead Lake, MT

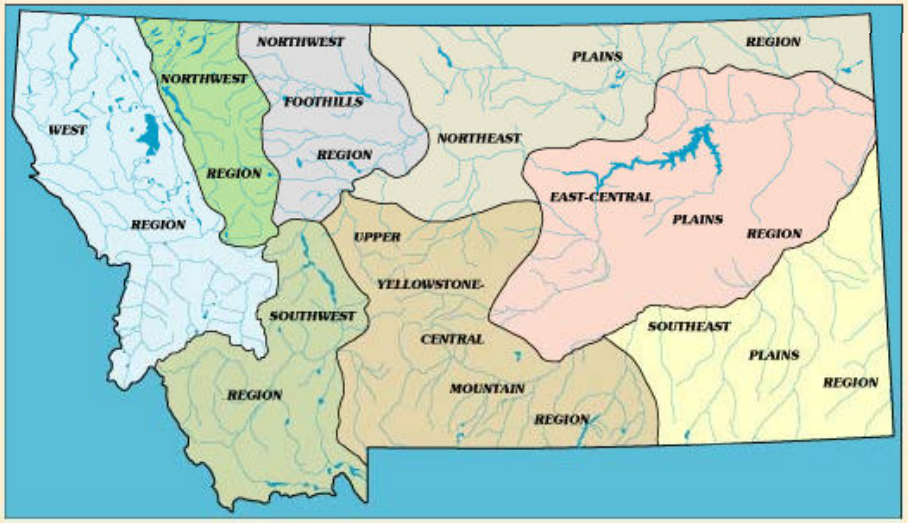
Determine Estimated Flood Discharges at Ungaged Sites in Montana

To determine flood discharges at ungaged sites, follow the prompts below and on the following pages.

1) Enter a name for this estimate Default (32 characters max)

2) Select a region of interest from map:

- West Region
- Northwest Region
- Northwest Foothills Region
- Northeast Plains Region
- East-Central Region
- Southeast Plains Region
- Upper Yellowstone -- Central Mountain Region
- Southwest Region



3) Select a method for estimating flood discharge:

- Basin and Climatic Characteristics Only
- Active-channel width only
- Bankfull width only
- Weighted estimate based on Basin and Climatic Characteristics and Active-channel width
- Weighted estimate based on Basin and Climatic Characteristics and Bankfull width
- Weighted estimate based on Active-channel width and Bankfull width
- Weighted estimate based on Basin and Climatic Characteristics, Active-channel width, and Bankfull width

Submit and continue to next page Reset

http://mt.water.usgs.gov/freq?page_type=gen_stats_1

USGS

Montana Flood-Frequency and Basin-Characteristic Data

Estimate Flood Discharges at Ungaged Sites in Montana -- (continued)

Summary of Estimation Parameters Selected:

Name for this estimation:	**Default**
Region:	**West**
Estimation method:	**Basin and Climatic Characteristics Only**

Enter values for:

Drainage area in square miles: [ ] (10 characters max)

Mean annual precipitation in inches: [ ] (10 characters max) Map of mean-annual precipitation in Montana

Percent of basin with forest cover: [ ] (10 characters max)

Submit values Reset

Determining Basin and Climate Characteristics using ArcGIS

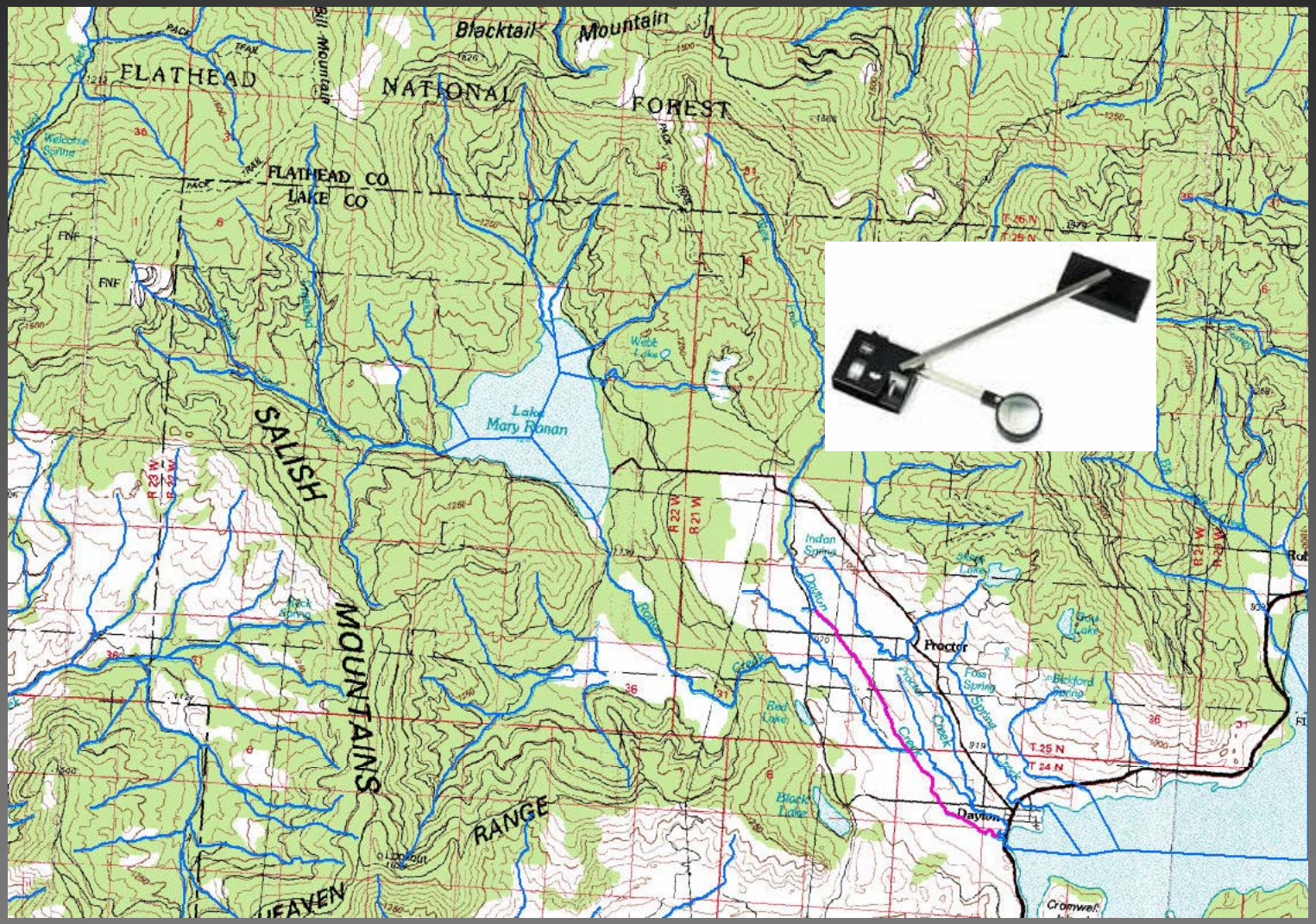
Determining Basin Drainage Area

There are several methods for determining basin area

- Manually draw them in by using contour data, or a 1:24,000 quadrangle map
- Use HUC-12 Dataset
- Use Arc Hydro Tools v1.3 extension for ArcGIS

Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Manually

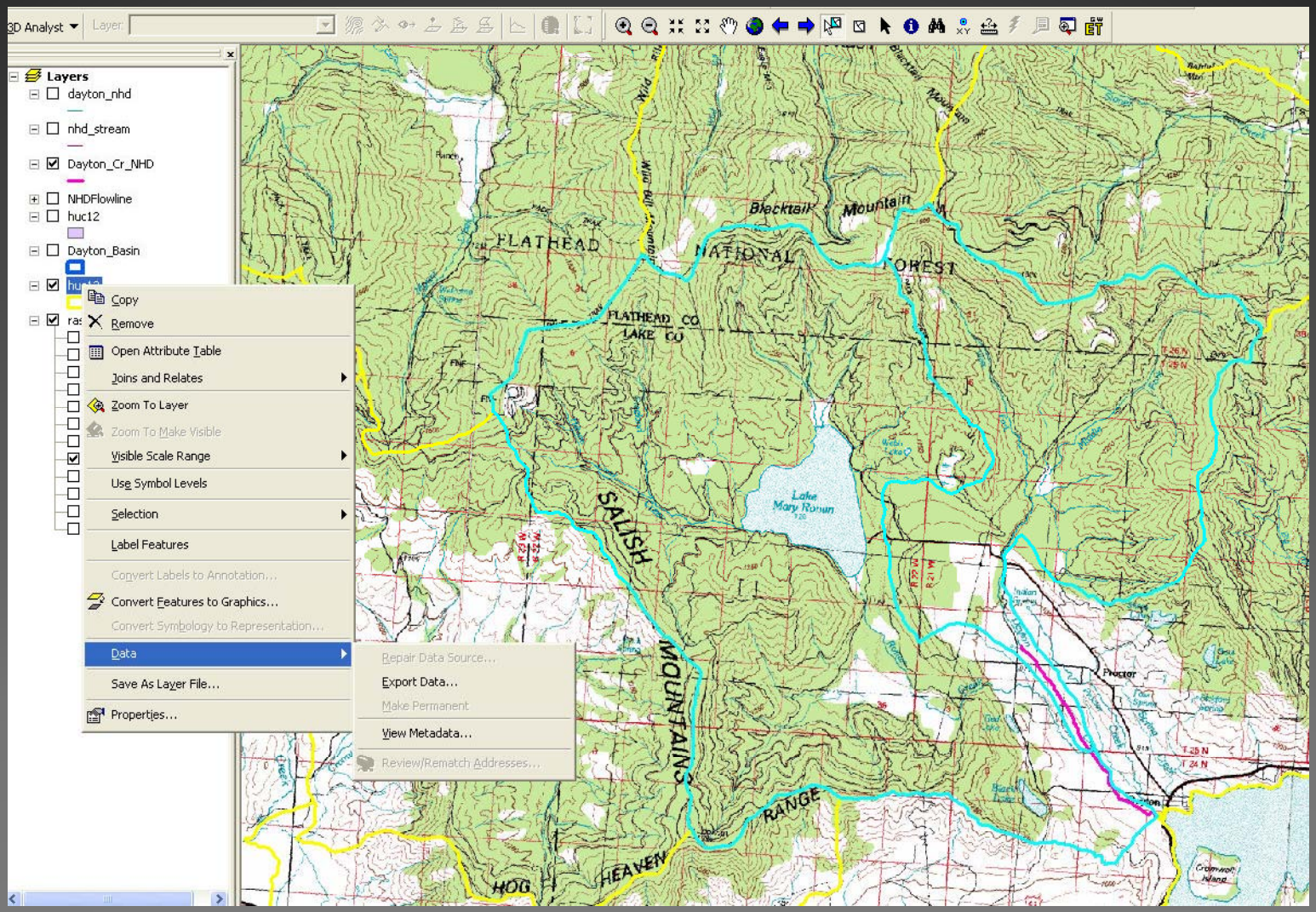


Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Using HUC-12

Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Using HUC-12

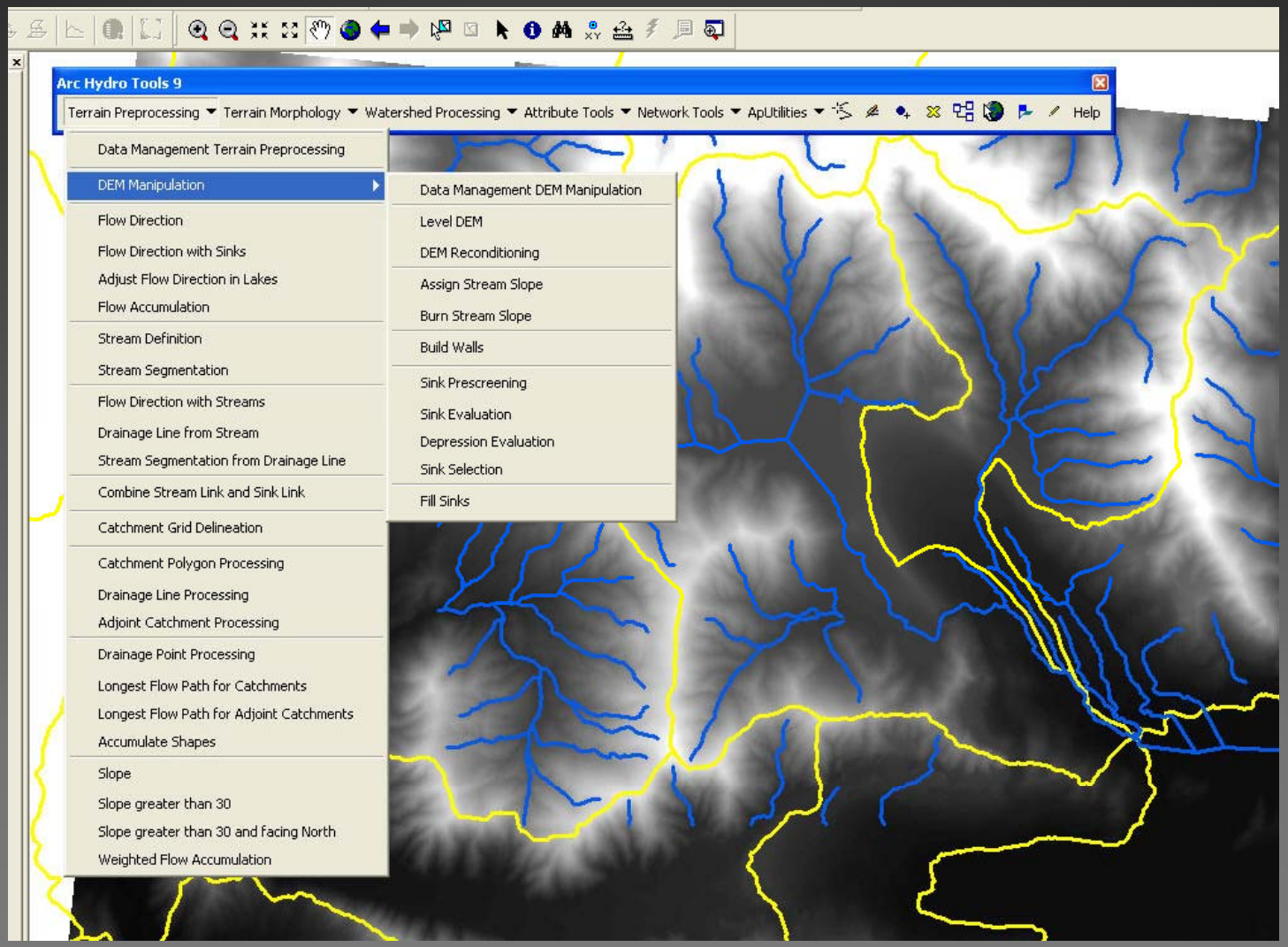


Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Using HUC-12

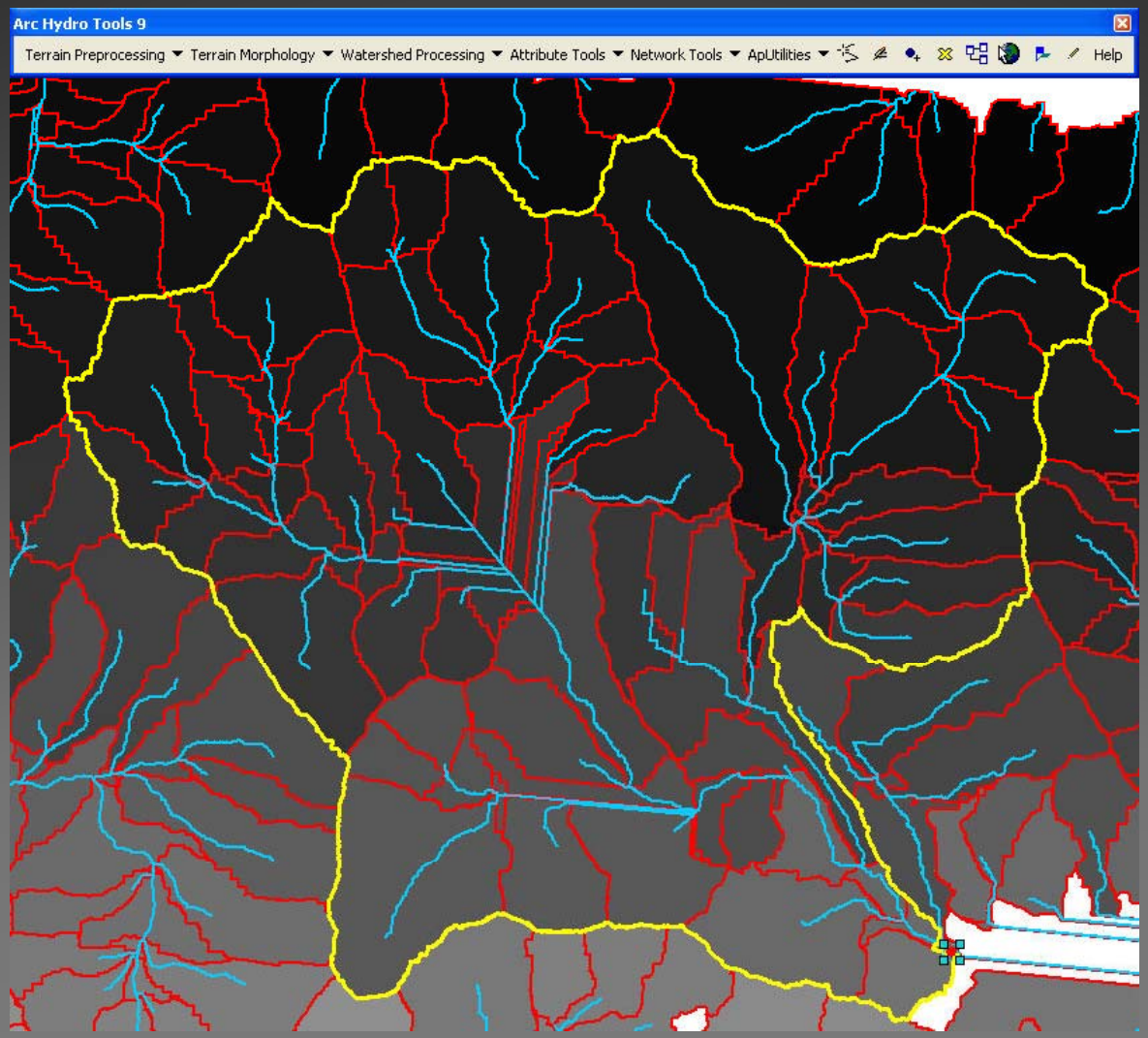
Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Using Arc Hydro Tools v1.3



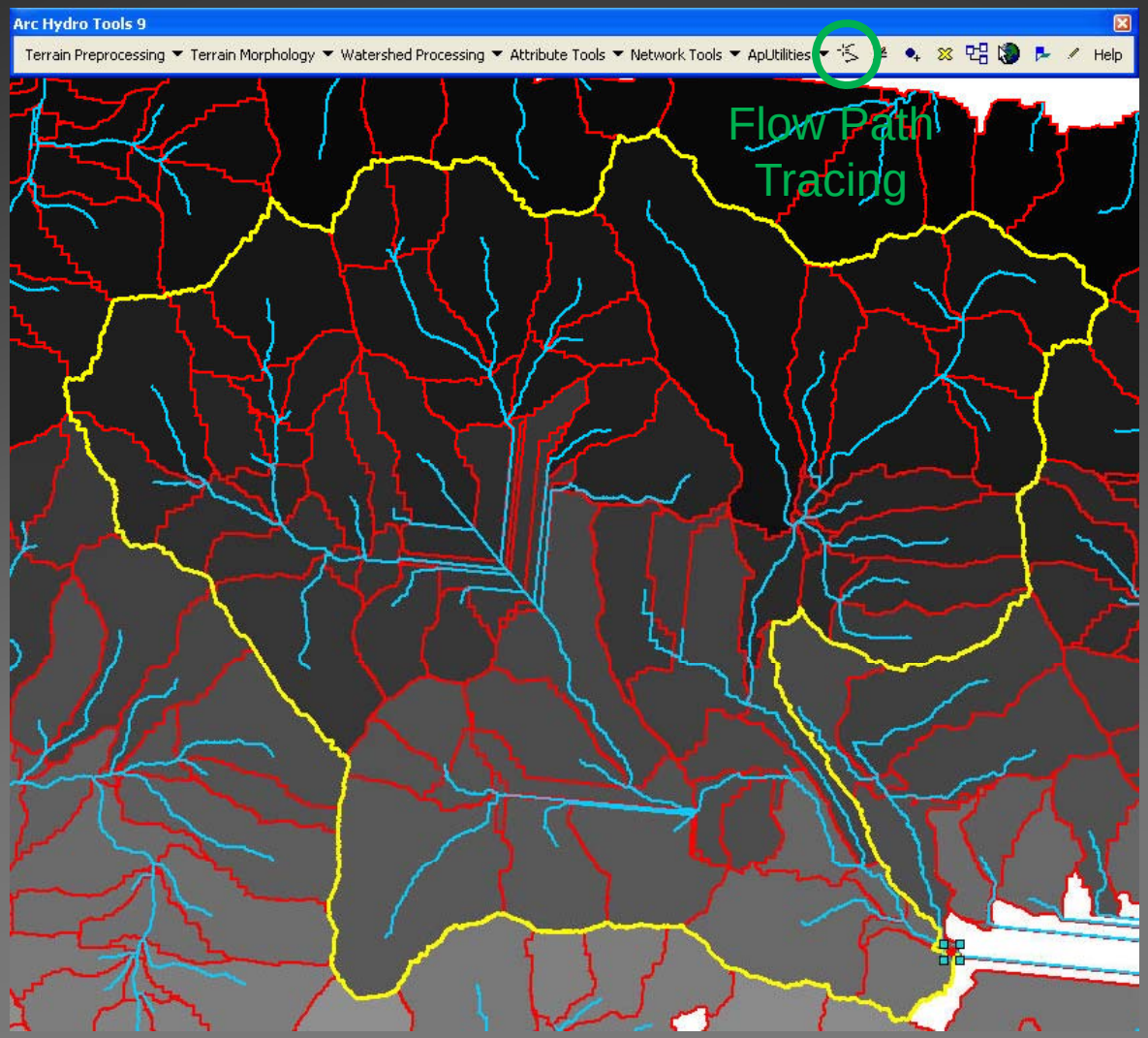
Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Using Arc Hydro Tools v1.3



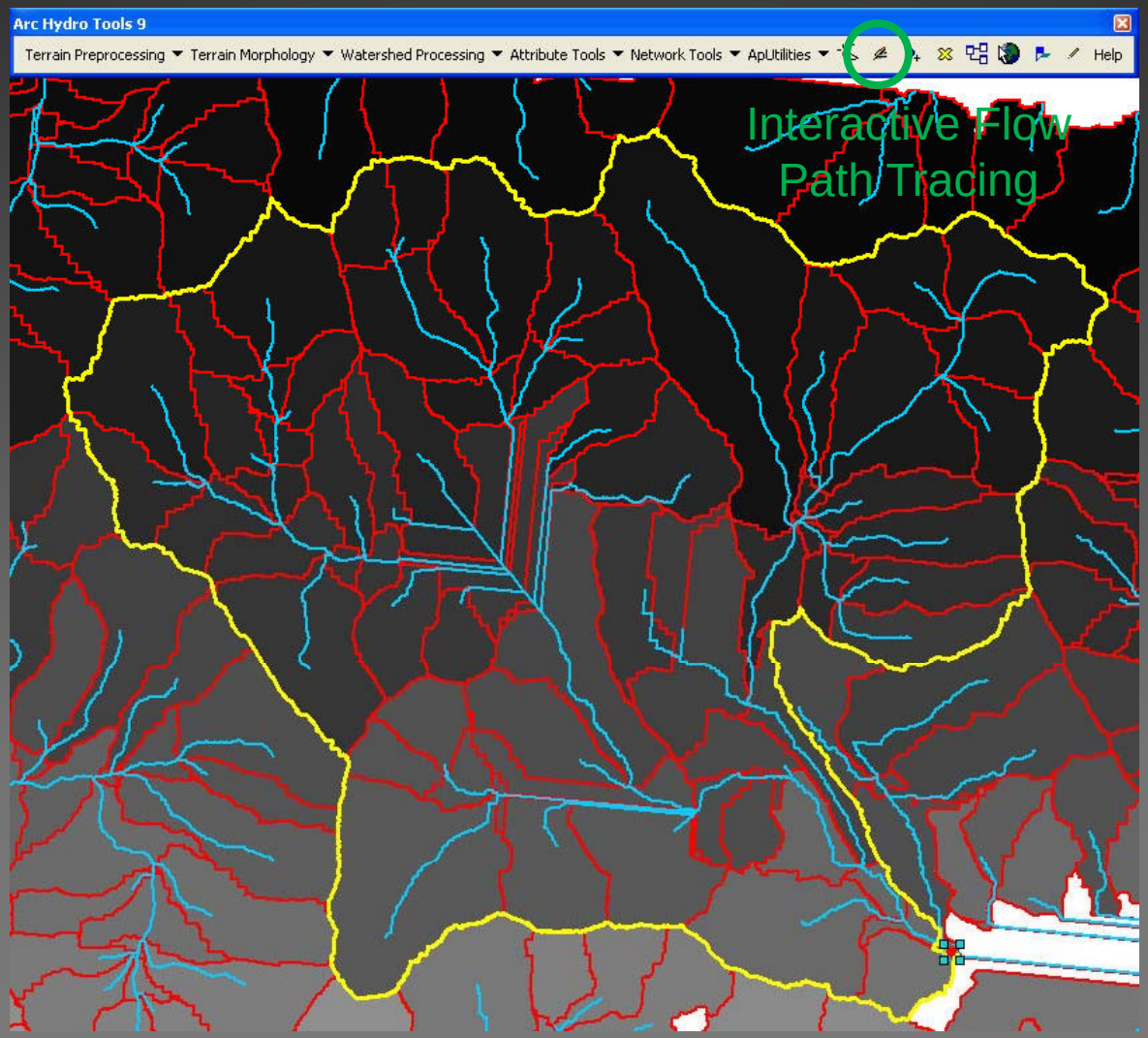
Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Using Arc Hydro Tools v1.3



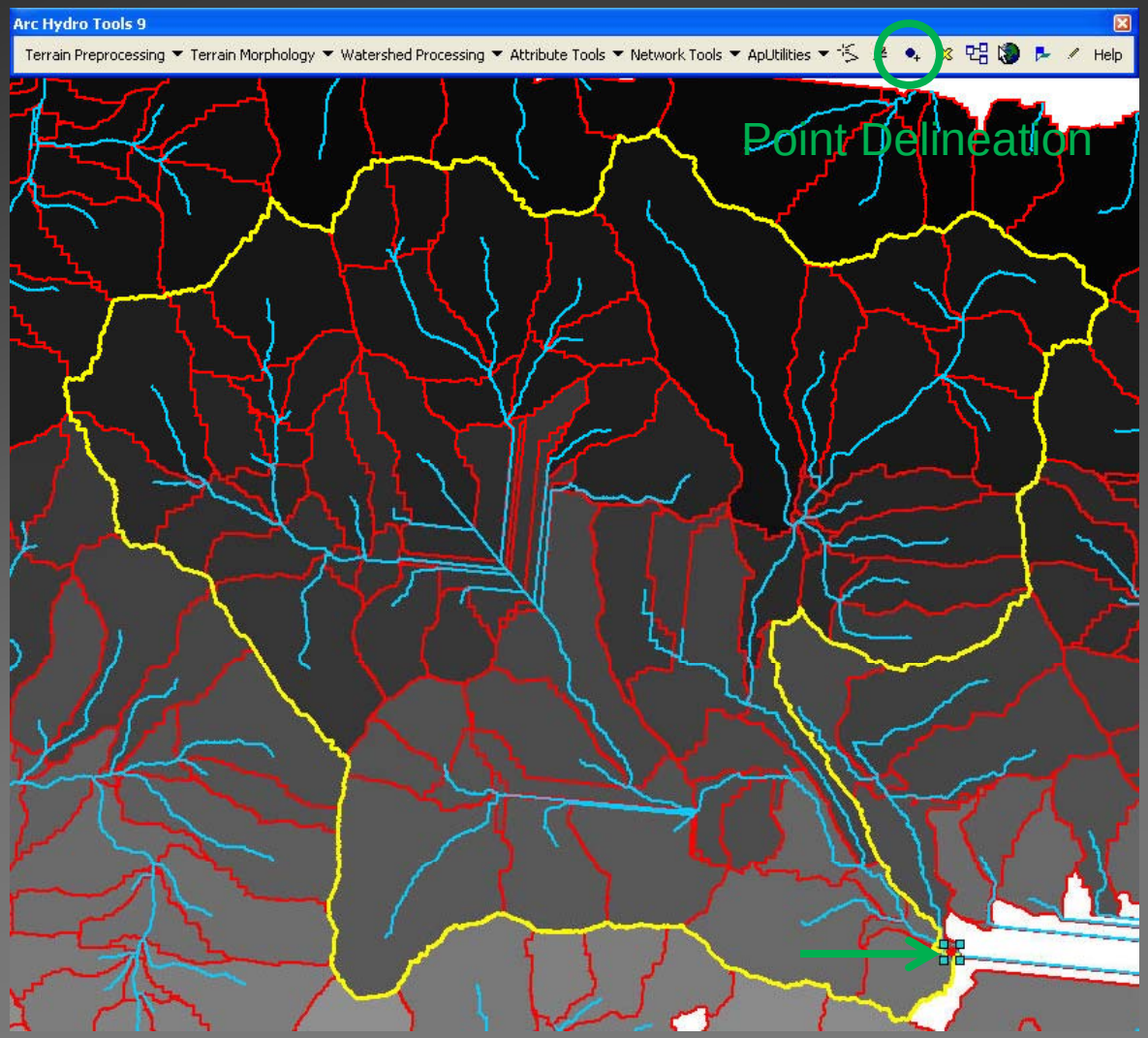
Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Using Arc Hydro Tools v1.3



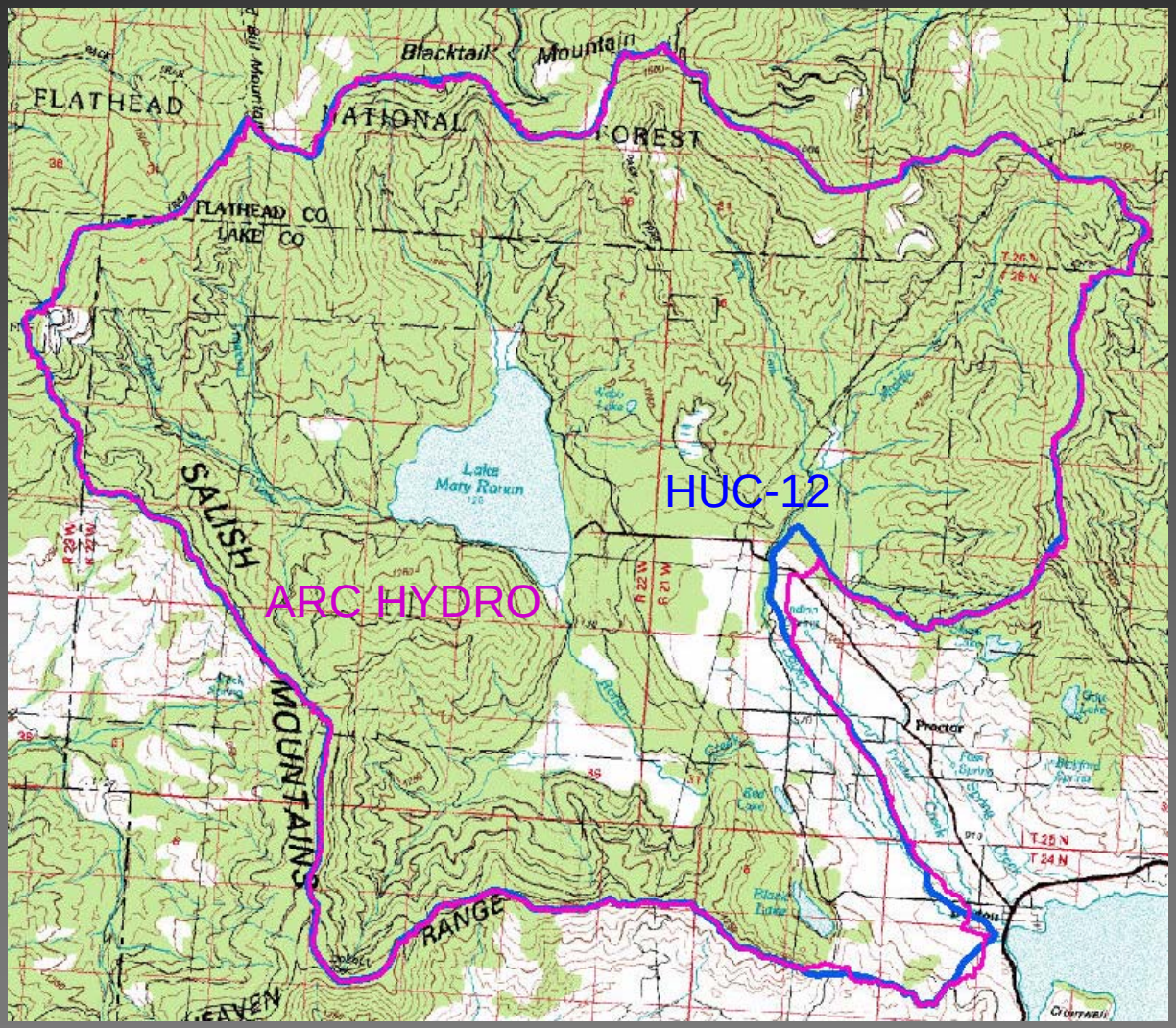
Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Using Arc Hydro Tools v1.3



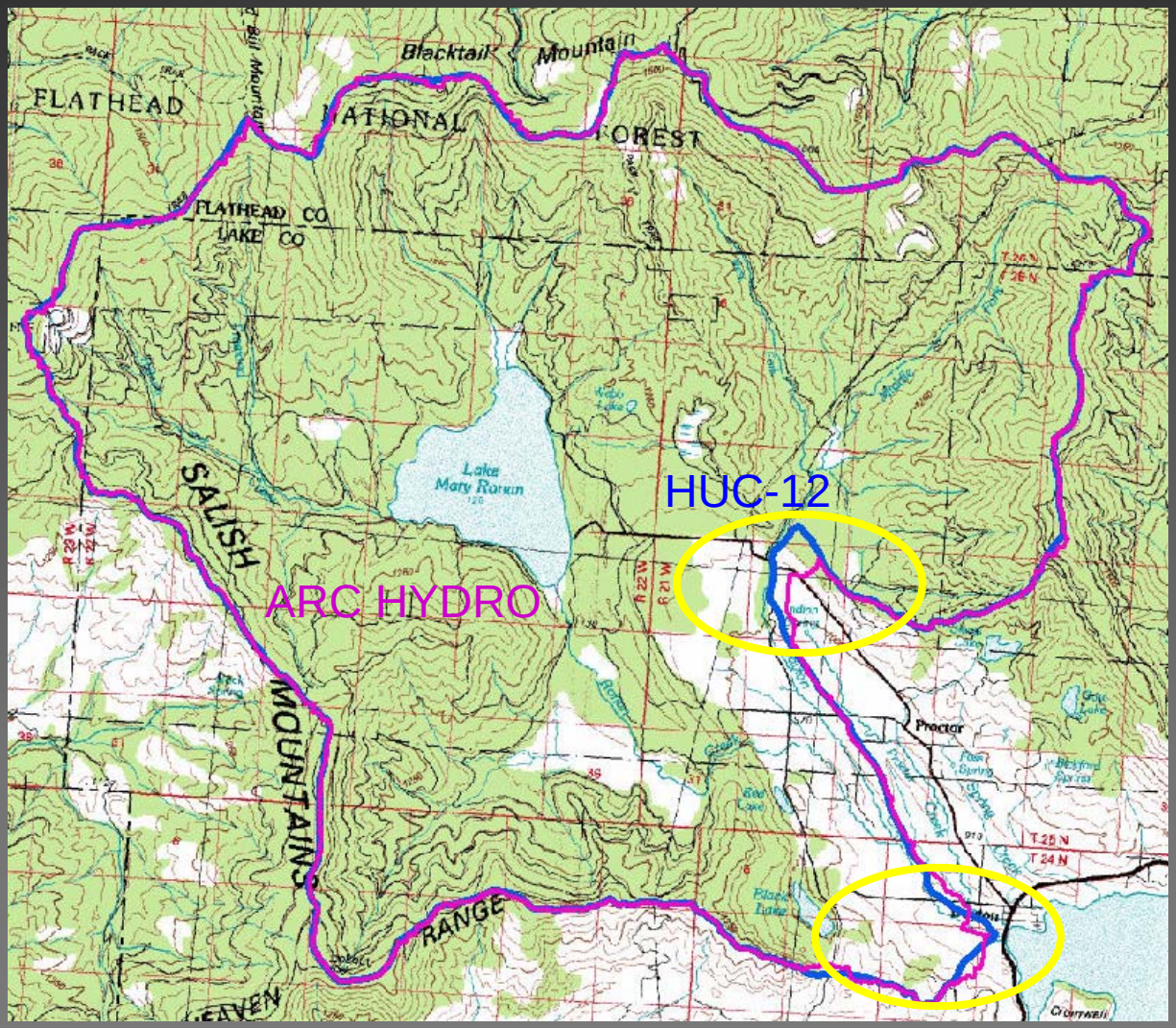
Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Comparison



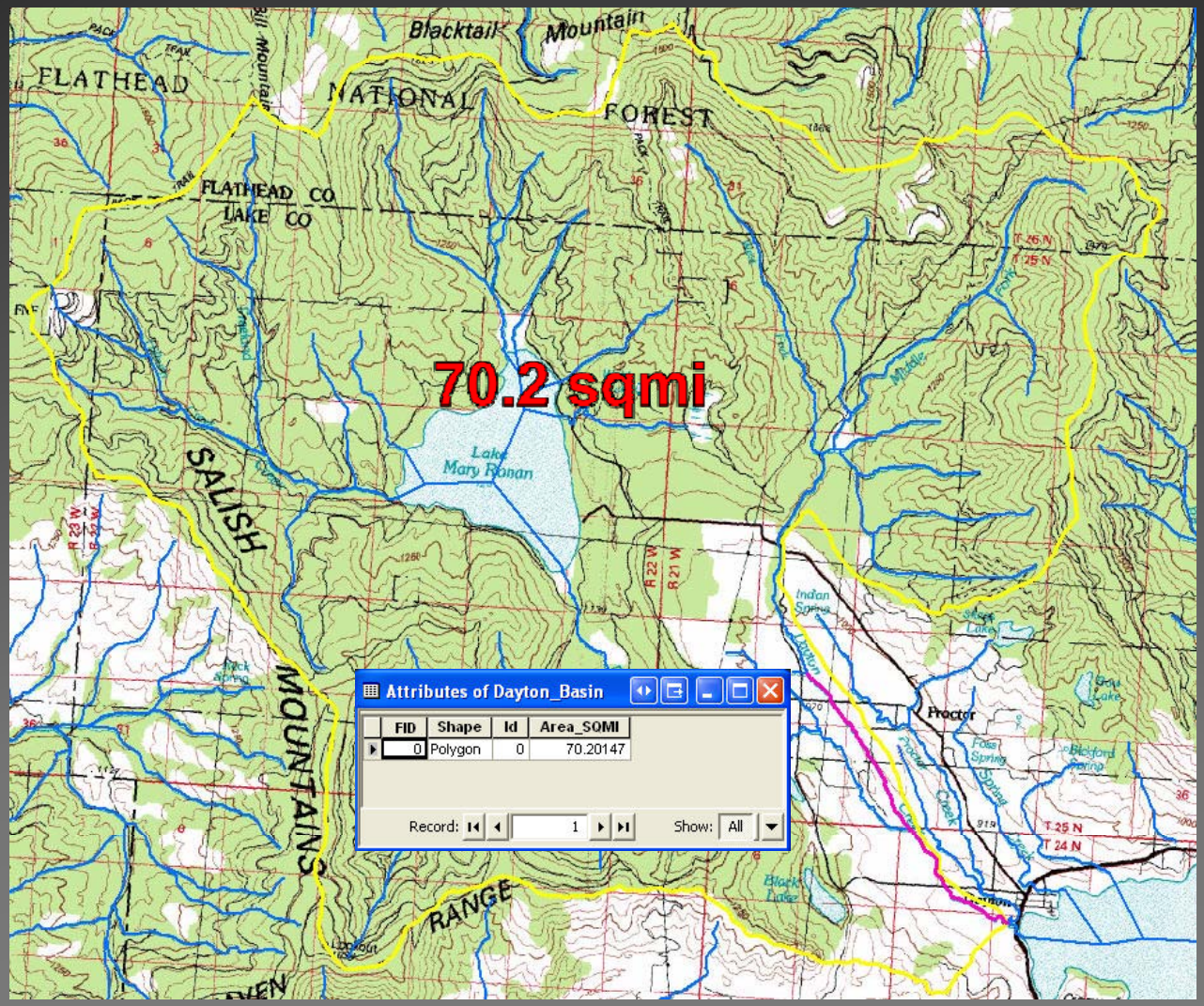
Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Comparison



Determining Basin and Climate Characteristics using ArcGIS

Determining Basin Area – Using HUC-12



USGS

Montana Flood-Frequency and Basin-Characteristic Data

Estimate Flood Discharges at Ungaged Sites in Montana -- (continued)

Summary of Estimation Parameters Selected:

Name for this estimation:	**Default**
Region:	**West**
Estimation method:	**Basin and Climatic Characteristics Only**

Enter values for:

Drainage area in square miles: 70.2 (10 characters max)

Mean annual precipitation in inches: (10 characters max) Map of mean-annual precipitation in Montana

Percent of basin with forest cover: (10 characters max)

Submit values Reset

Montana Flood-Frequency and Basin-Characteristic Data
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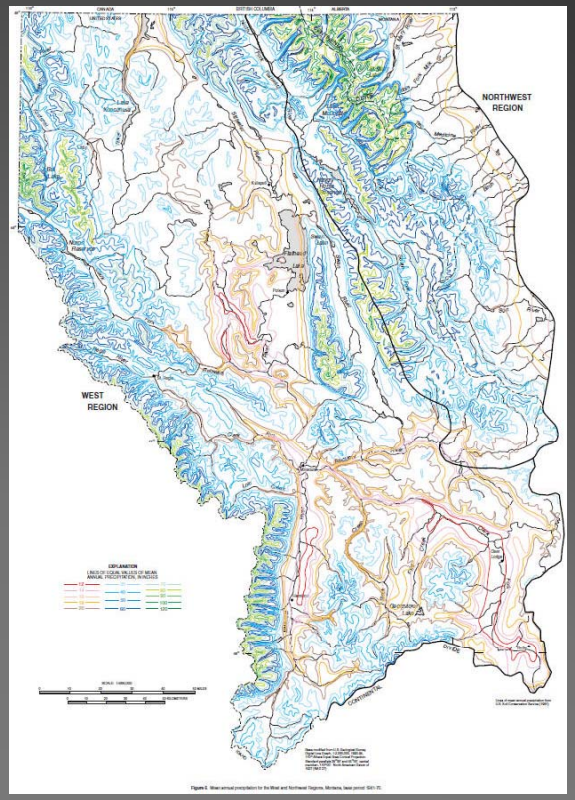
Determining Basin and Climate Characteristics using ArcGIS

Determining Mean Annual Precipitation

USGS WRIR 03-4308

- Figure 6: Mean Annual Precipitation for the West and Northwest Regions, Montana, base period 1941-70

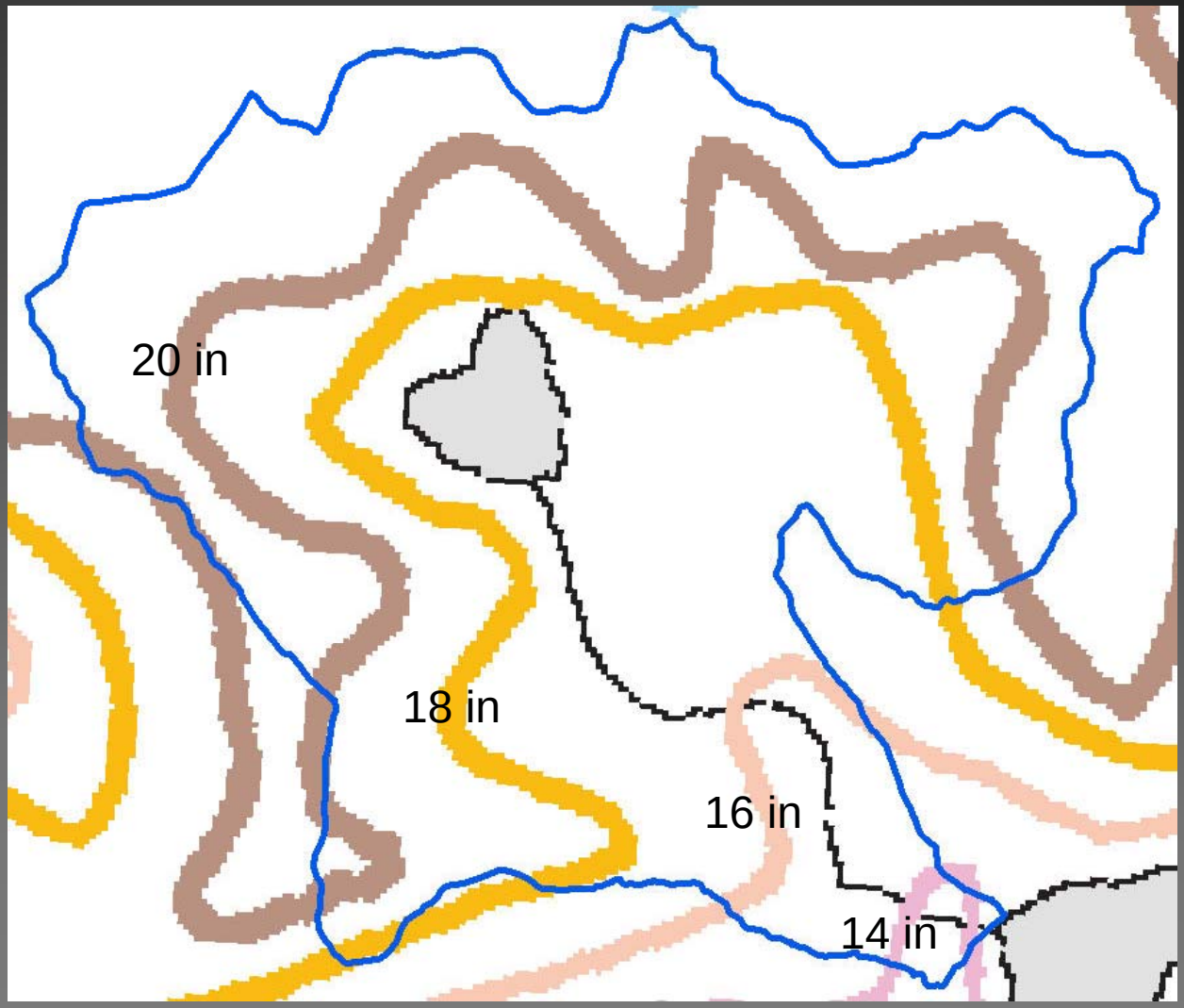
- Applies to West and Northwest Regions.



Determining Basin and Climate Characteristics using ArcGIS

Determining Mean Annual Precipitation

Figure 6: Georectified and best fit to the Dayton Creek Basin



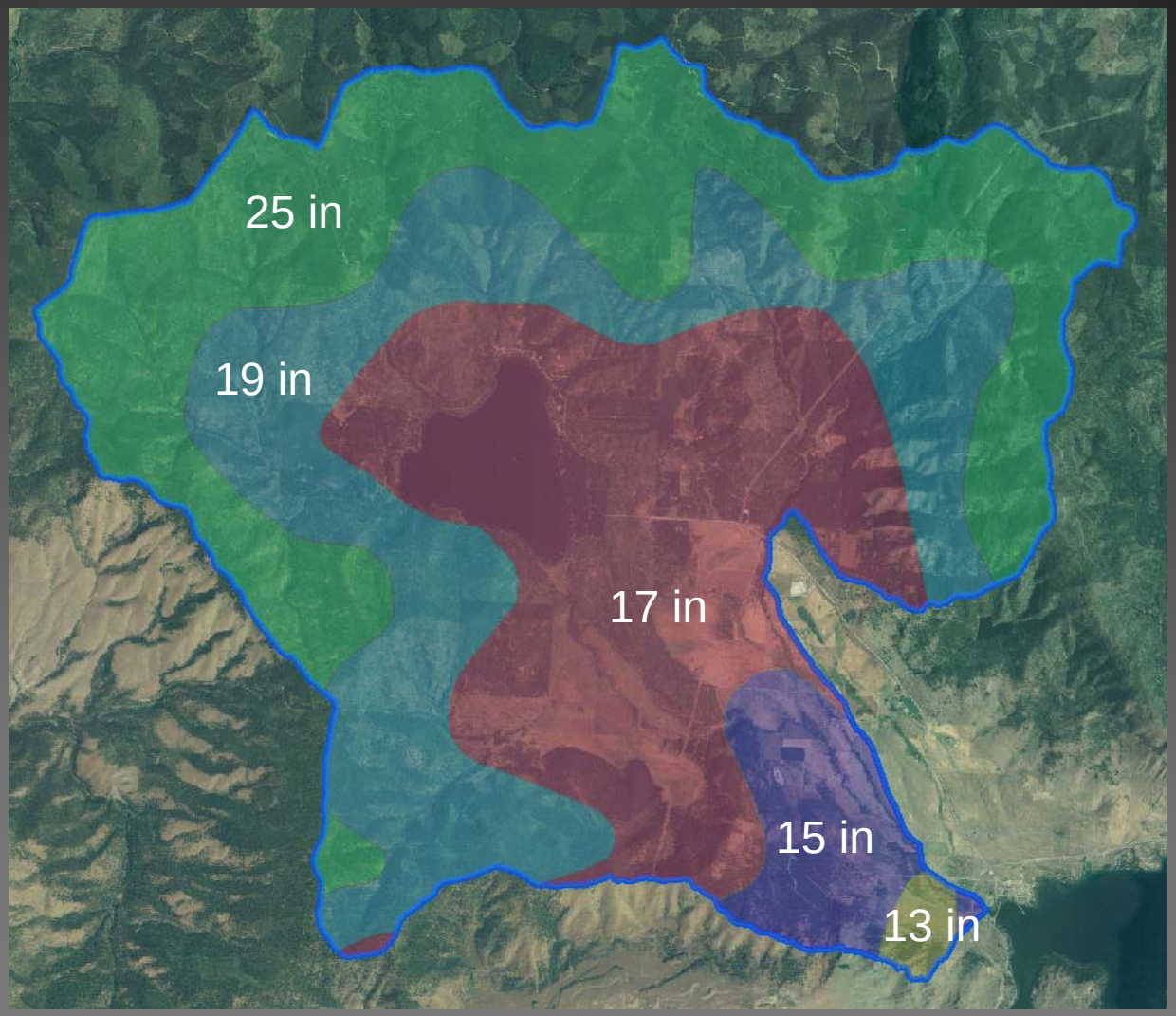
Polygons were then created between each isopleth line.

Determining Basin and Climate Characteristics using ArcGIS

Determining Mean Annual Precipitation

Mean annual precipitation determined for each polygon by selecting precipitation that was between the value from top isopleth and value from bottom isopleth.

Area for each polygon is then calculated using ArcGIS.



Determining Basin and Climate Characteristics using ArcGIS

Determining Mean Annual Precipitation

USGS Precipitation - Dayton Creek

Weighted Mean Annual Precipitation Calculations - Dayton Creek

Average Precipiaton for Subarea	Subarea	Total Area	Adjusted Precipitation	
(in)	(mi2)	(%)	(in)	
13	0.64	0.91	0.12	
15	4.31	6.13	0.92	
17	23.01	32.78	5.57	
19	19.49	27.76	5.27	
25	22.75	32.41	8.10	
TOTAL =	**70.2**	**100.0**	**20.0**	**= P**

USGS

Montana Flood-Frequency and Basin-Characteristic Data

Estimate Flood Discharges at Ungaged Sites in Montana -- (continued)

Summary of Estimation Parameters Selected:

Name for this estimation:	Default
Region:	West
Estimation method:	Basin and Climatic Characteristics Only

Enter values for:

Drainage area in square miles: 70.2 (10 characters max)

Mean annual precipitation in inches: 20 (10 characters max) Map of mean-annual precipitation in Montana

Percent of basin with forest cover: (10 characters max)

Submit values Reset

Determining Basin and Climate Characteristics using ArcGIS

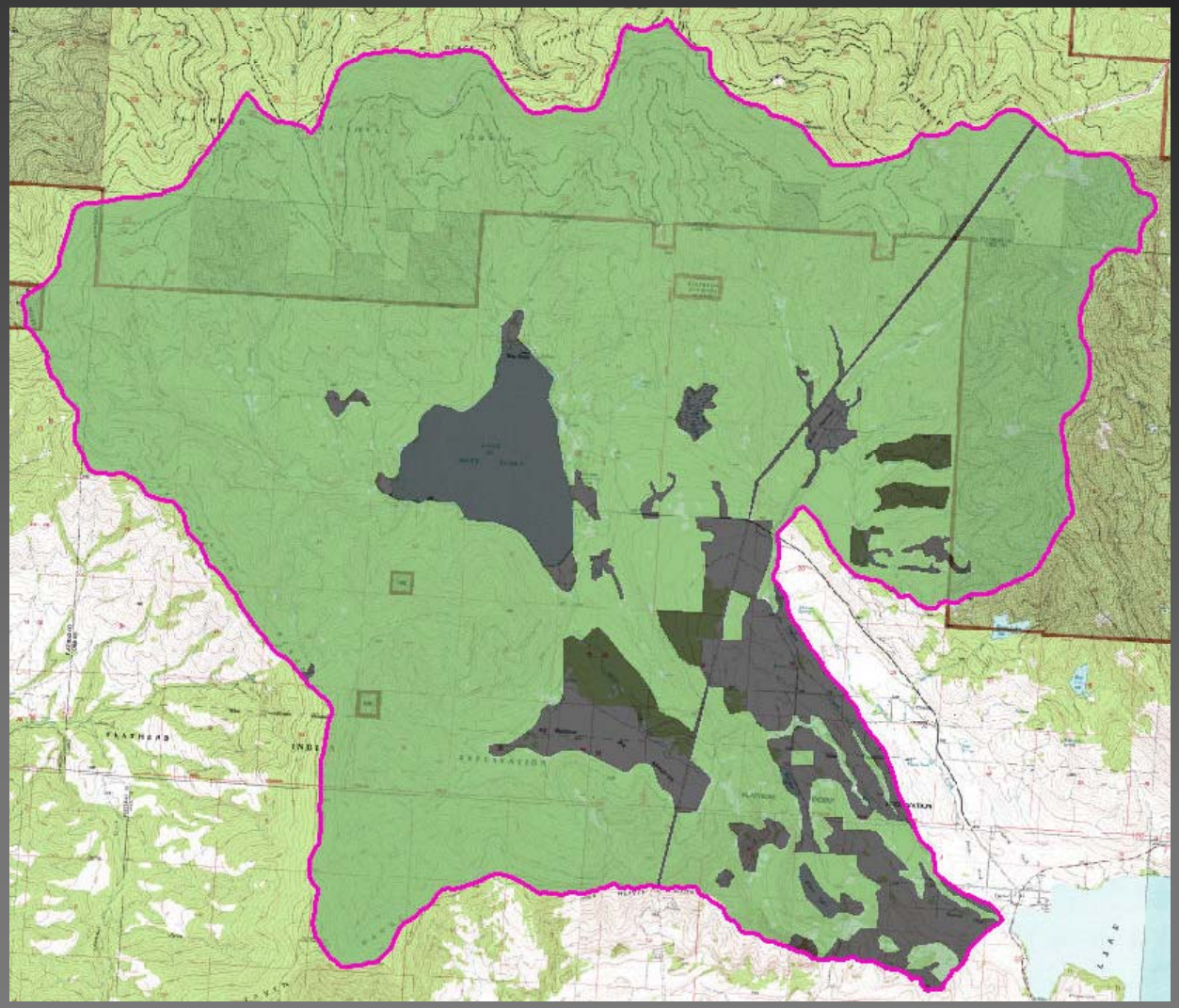
Percent of Basin with Forest Cover

- USGS determined percent forest cover by planimetry of the green-colored area of the gaged basin and dividing by the total drainage area
- A combination of imagery and a 1:24,000 quadrangle map should be used for determining percent of forest cover
- Applies to West and Southeast Plains Region

Determining Basin and Climate Characteristics using ArcGIS

Percent of Basin with Forest Cover

Polygons were created for forested and non-forested areas using a 1:24,000 quadrangle map.

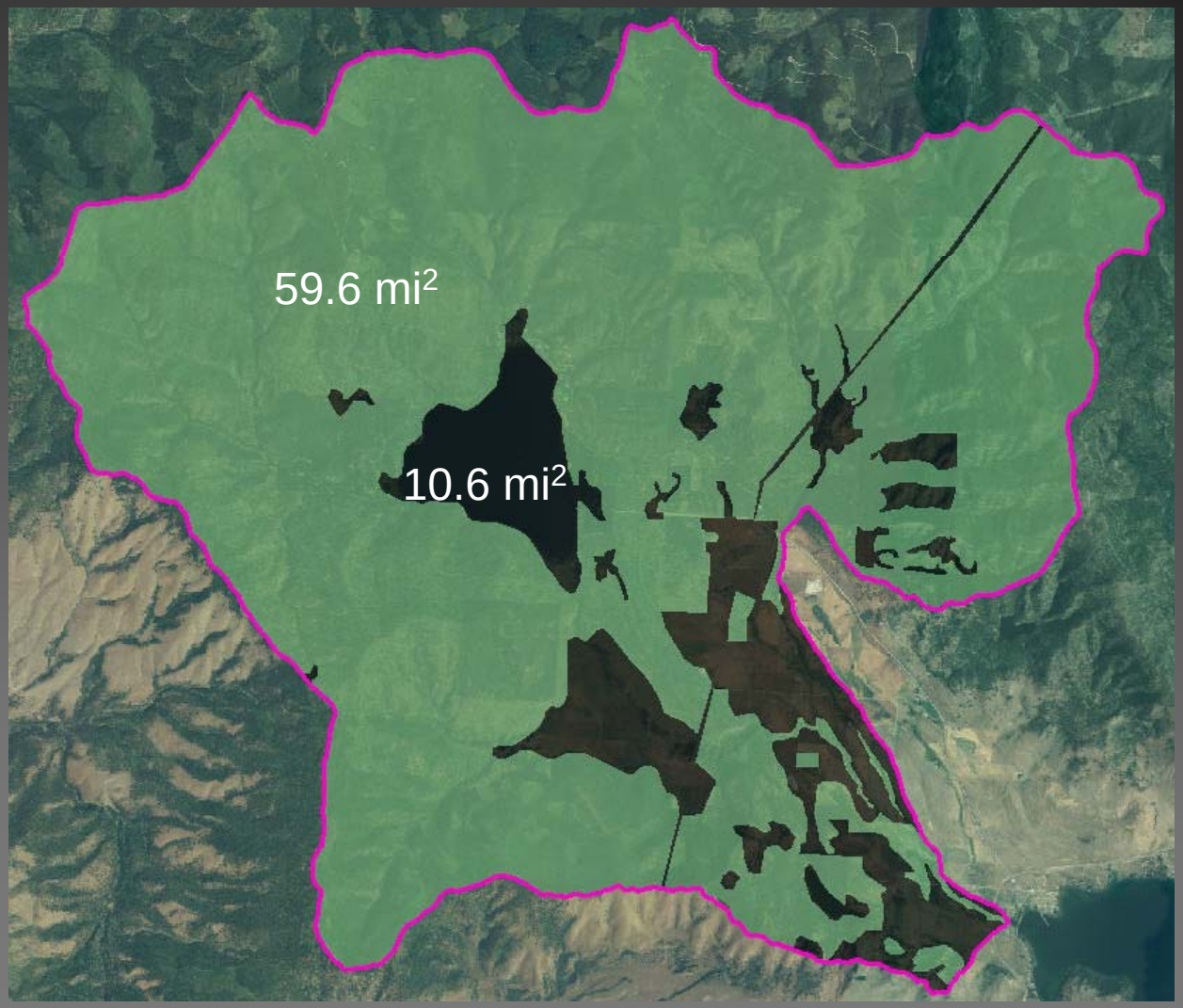


Determining Basin and Climate Characteristics using ArcGIS

Percent of Basin with Forest Cover

Imagery was then used as a check, and any areas of large noticeable difference were changed in the polygons.

The forested area was then calculated in ArcGIS.



Determining Basin and Climate Characteristics using ArcGIS

Percent of Basin with Forest Cover

Percent Forested Calculations - Dayton Creek

Forested Area (mi^2)	Total Watershed Area (mi^2)	Forested % of Dayton Creek (%)
59.6	70.2	84.8

USGS

Montana Flood-Frequency and Basin-Characteristic Data

Estimate Flood Discharges at Ungaged Sites in Montana -- (continued)

Summary of Estimation Parameters Selected:

Name for this estimation:	**Default**
Region:	**West**
Estimation method:	**Basin and Climatic Characteristics Only**

Enter values for:

Drainage area in square miles: 70.2 (10 characters max)

Mean annual precipitation in inches: 20 (10 characters max) Map of mean-annual precipitation in Montana

Percent of basin with forest cover: 84.8 (10 characters max)

Submit values Reset

USGS

Montana Flood-Frequency and Basin-Characteristic Data

Estimate Flood Discharges at Ungaged Sites in Montana -- (continued)

Summary of Estimation Parameters Selected:

Name for this estimation:	Default
Region:	West
Estimation method:	Basin and Climatic Characteristics Only
Drainage area in square miles:	70.2
Mean annual precipitation in inches:	20
Percent basin forested:	84.8

Generate Flood-Discharge Estimate

Flood Discharge Estimation:

(In the Flood Discharge table, RI is the Recurrence Interval, in years; STD ERR is the Standard Error; and 90% PRED. INTERVAL is the 90% Prediction Interval, in cubic feet per second)

```
METHOD: Regression on basin characteristics
Flood frequency estimates for
Default
West Region : A =     70.20: P =  20.00: F =  84.80
RI        DISCHARGE  STD ERR OF                90% PRED. INTERVAL
            (cfs)      PREDICTION(%)
    2        174.        60.2              68.9              437.
    5        302.        55.1             128.4              710.
   10        399.        54.1             172.2              926.
   25        531.        54.3             228.3             1240.
   50        636.        55.7             268.1             1510.
  100        742.        58.2             302.5             1820.
  200        852.        61.9             330.9             2190.
  500       1000.        67.6             362.5             2780.
```

Montana Flood-Frequency and Basin-Characteristic Data

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Determining Basin and Climate Characteristics using ArcGIS

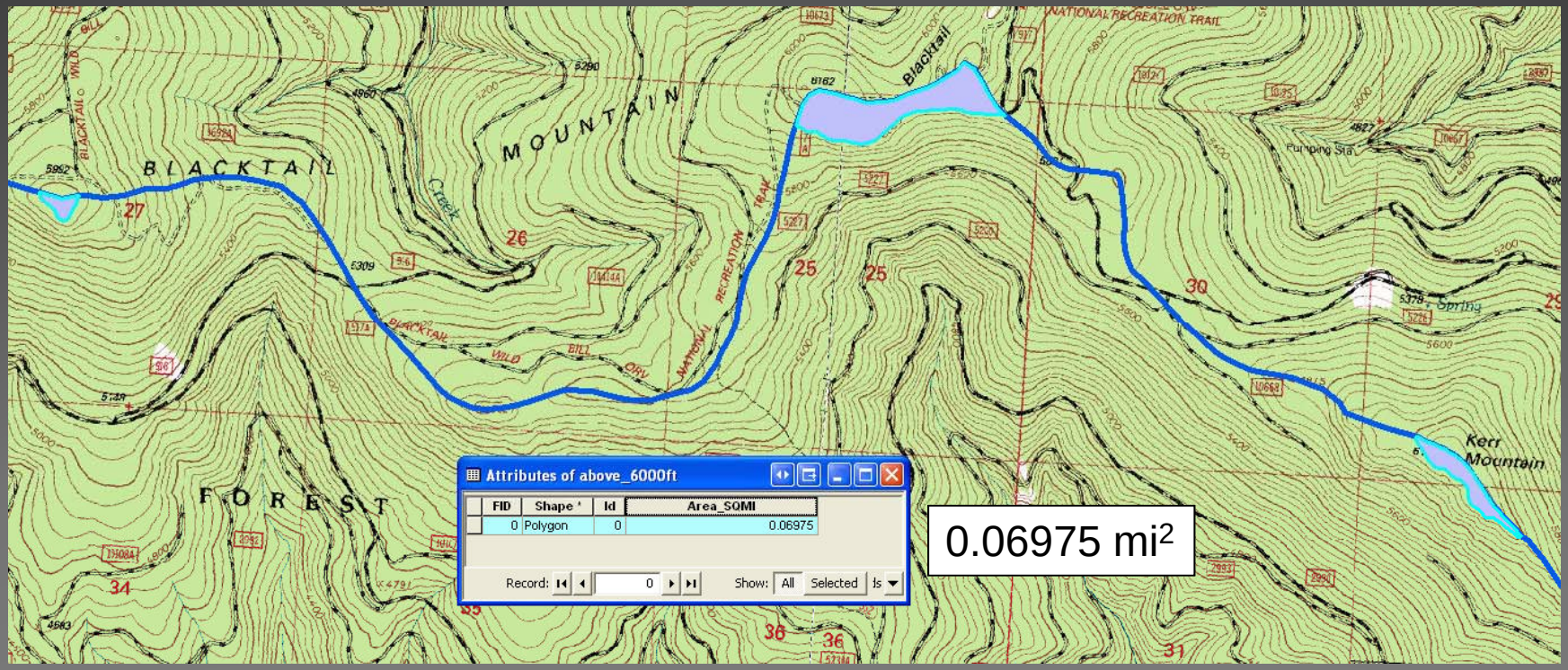
Percent of Basin Above 6,000 ft

- USGS determined this by planimetry of the area of the gaged basin above the 6,000 ft contour line and then dividing by the total drainage area
- Spatial Analyst or a 1:24,000 quadrangle map can be used to determine area above 6,000 ft.
- Applies to Upper Yellowstone-Central Mountain and Southwest Region

Determining Basin and Climate Characteristics using ArcGIS

Percent of Basin Above 6,000 ft

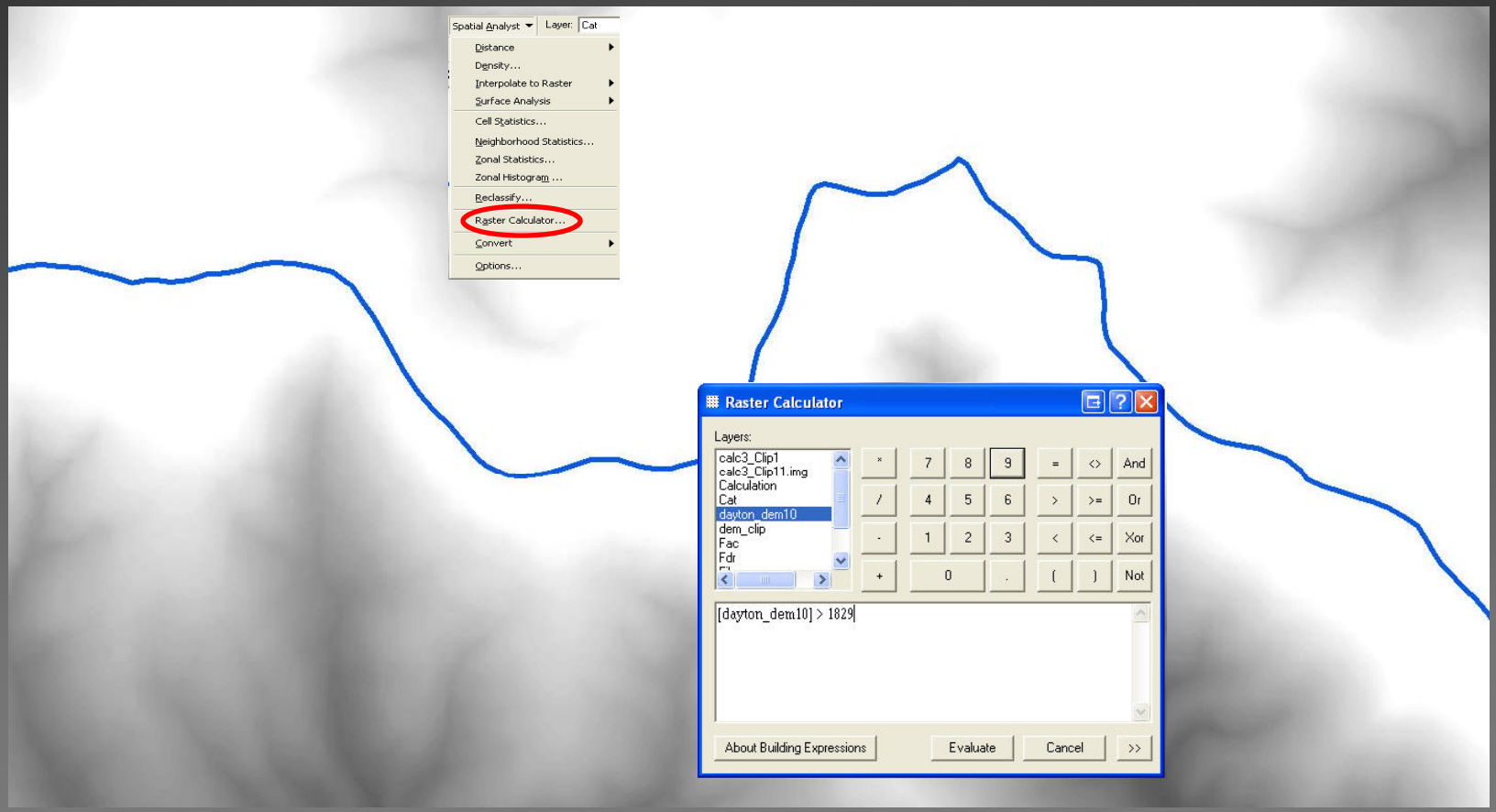
Polygons digitized, using ArcGIS, from 6,000 ft contour.
Area then calculated as shown below.



Determining Basin and Climate Characteristics using ArcGIS

Percent of Basin Above 6,000 ft

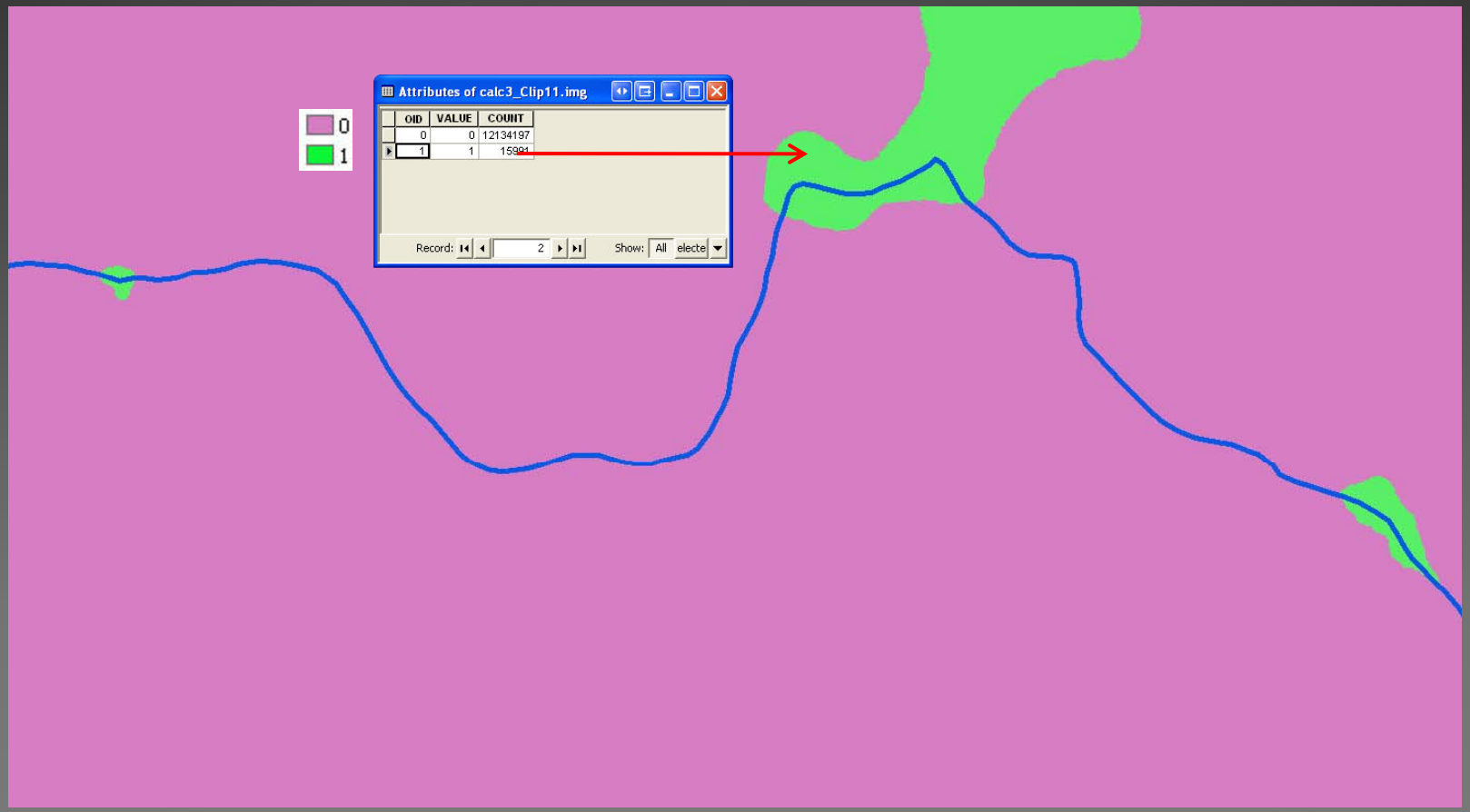
Using Spatial Analyst – Create raster using 10 meter DEM.



Determining Basin and Climate Characteristics using ArcGIS

Percent of Basin Above 6,000 ft

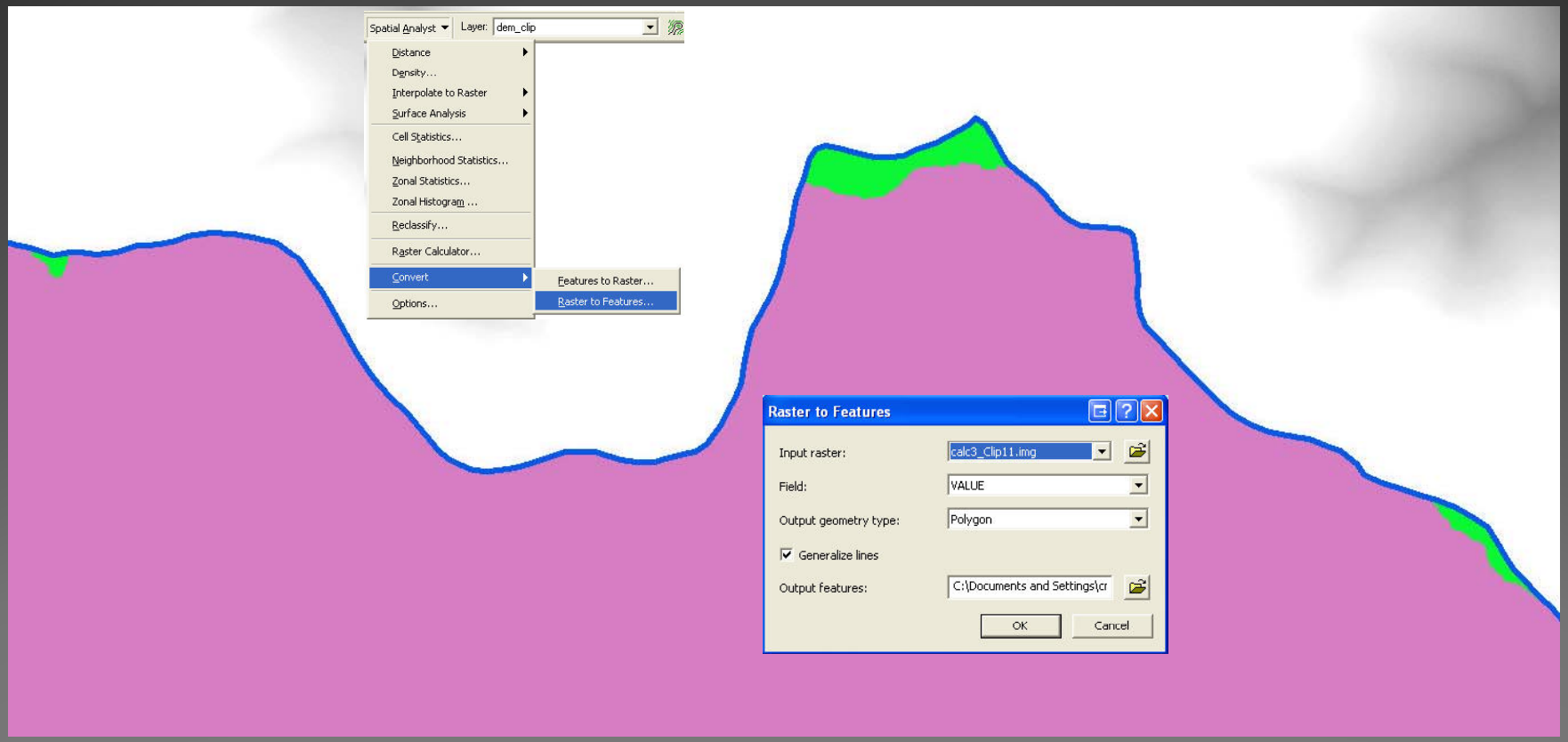
Using Spatial Analyst – A raster is created as shown here.



Determining Basin and Climate Characteristics using ArcGIS

Percent of Basin Above 6,000 ft

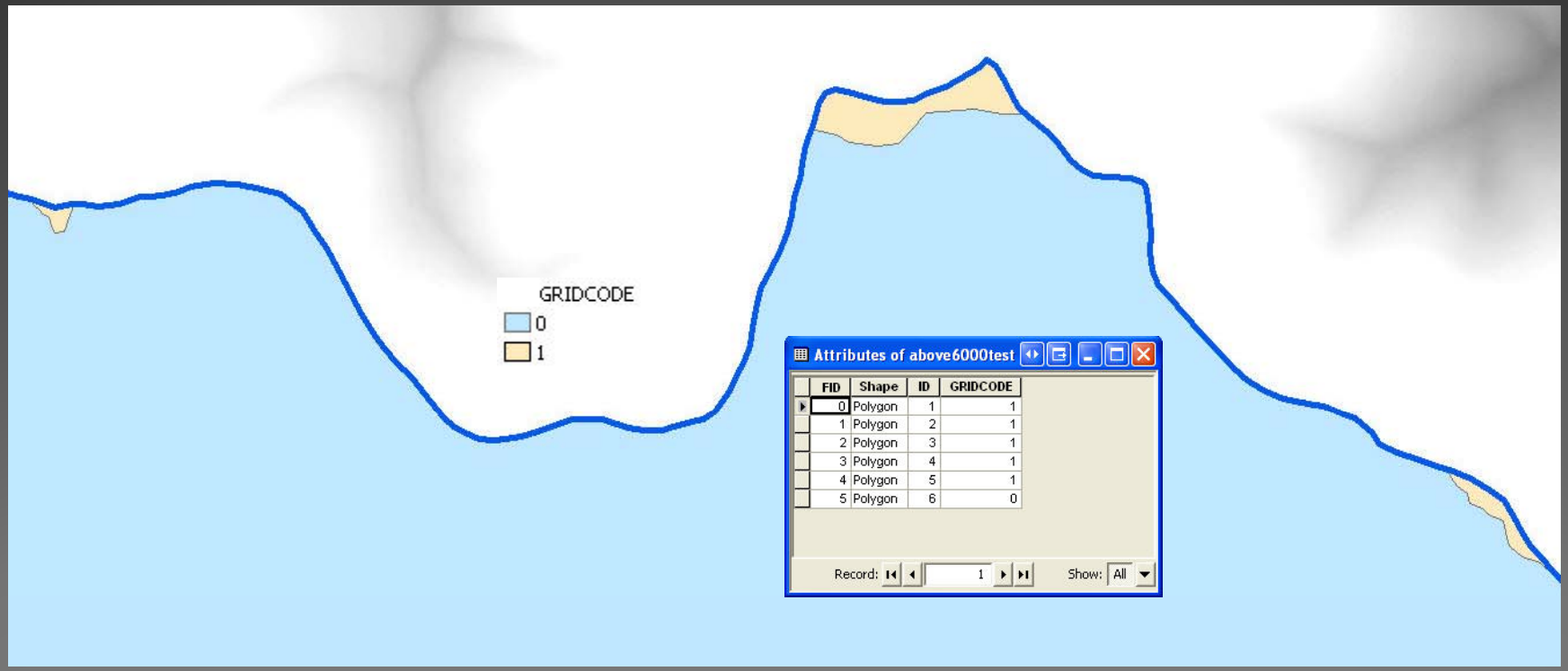
Clip and convert raster to feature.



Determining Basin and Climate Characteristics using ArcGIS

Percent of Basin Above 6,000 ft

Raster has been converted to feature.

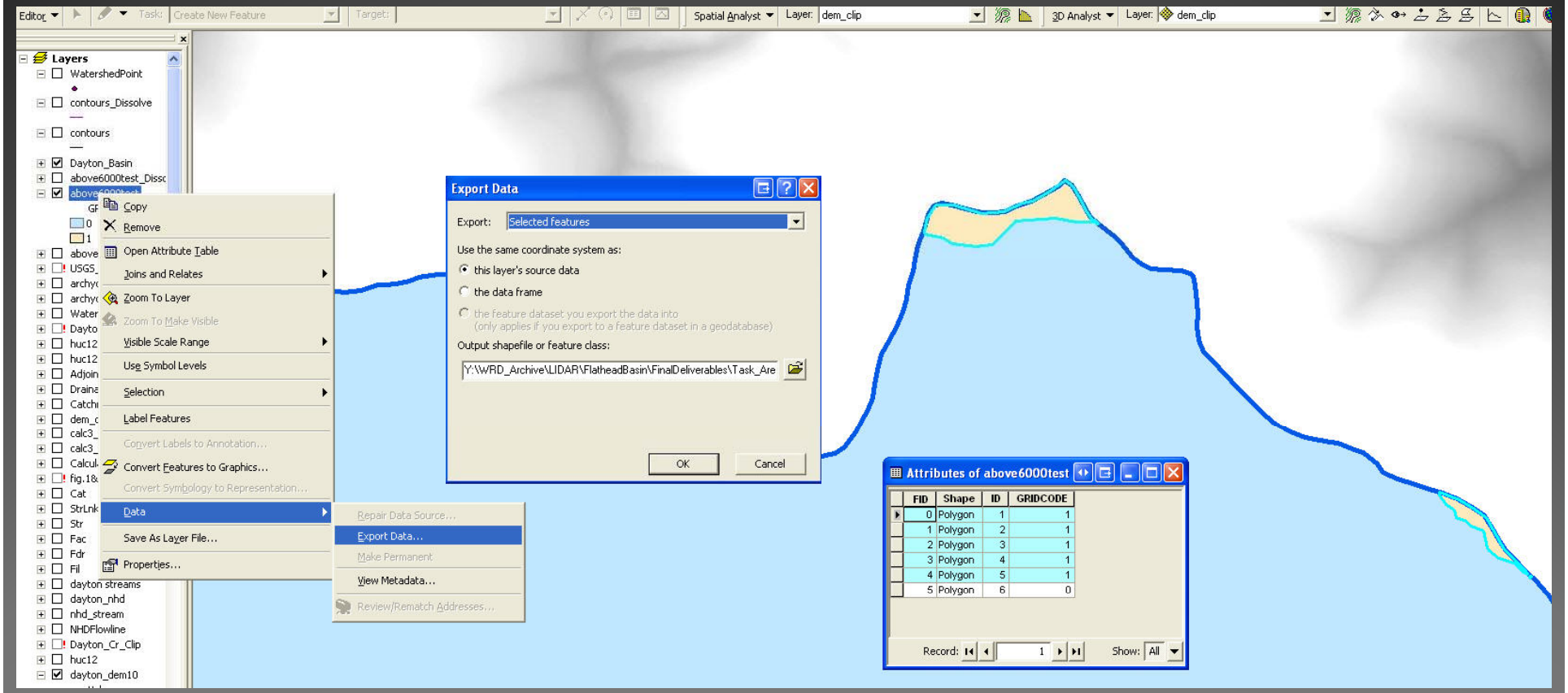


FID	Shape	ID	GRIDCODE
0	Polygon	1	1
1	Polygon	2	1
2	Polygon	3	1
3	Polygon	4	1
4	Polygon	5	1
5	Polygon	6	0

Determining Basin and Climate Characteristics using ArcGIS

Percent of Basin Above 6,000 ft

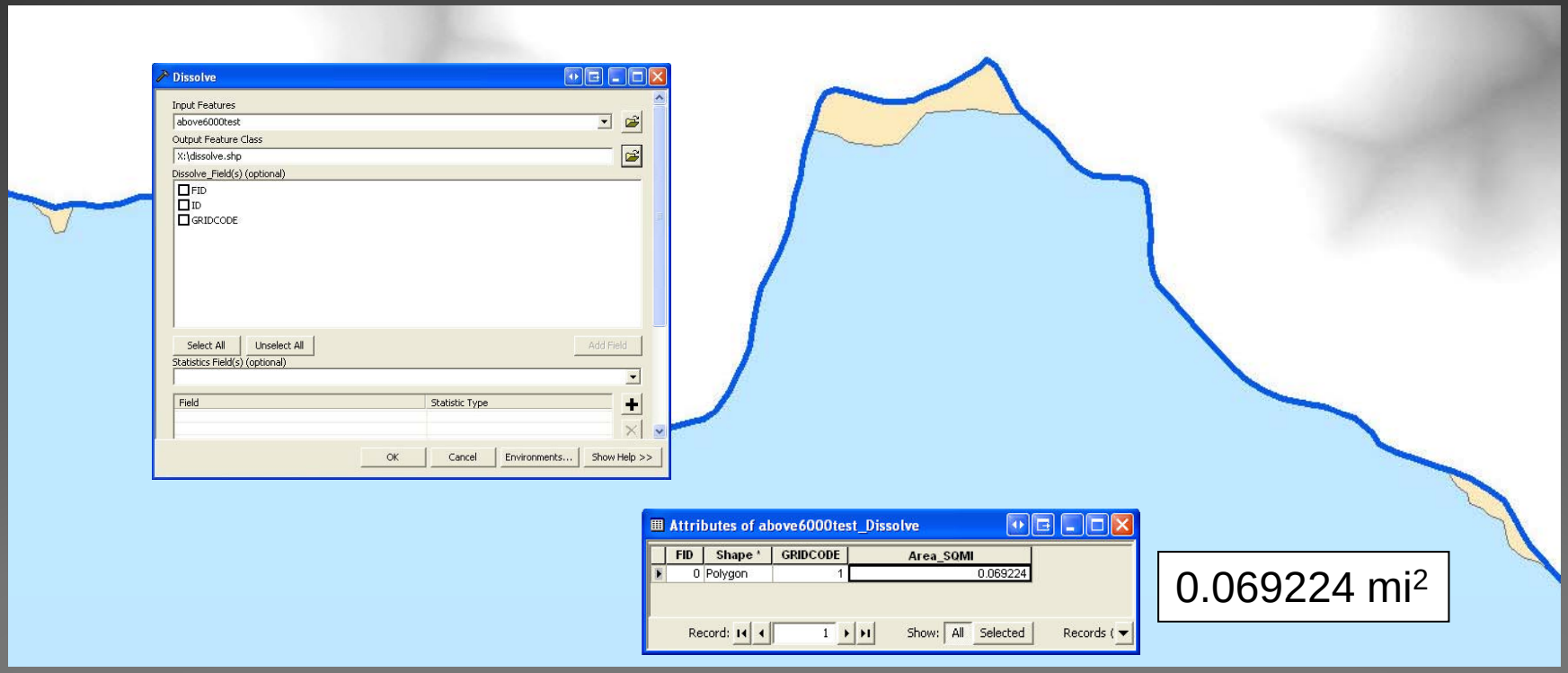
Export feature data.



Determining Basin and Climate Characteristics using ArcGIS

Percent of Basin Above 6,000 ft

Dissolve and calculate area.



Determining Basin and Climate Characteristics using ArcGIS

Percent of Basin Above 6,000 ft

Percent of Basin Above 6,000 ft

Area Above 6,000 ft	Total Watershed Area	% Above 6,000 ft
(mi^2)	(mi^2)	(%)
0.07	70.2	0.1

Determining Basin and Climate Characteristics using ArcGIS

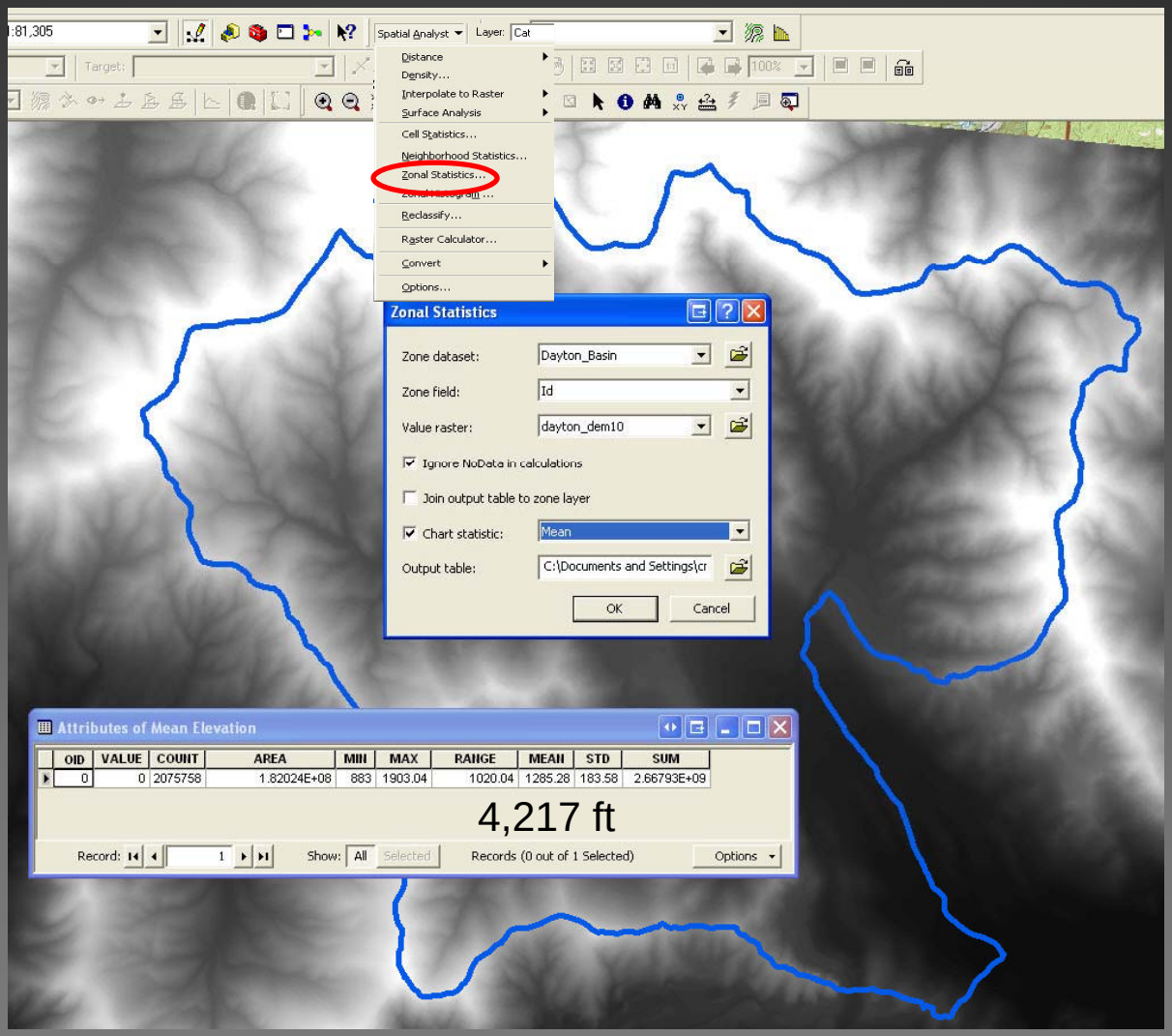
Determining Mean Basin Elevation

- USGS determined mean elevation at gaged sites by overlaying a variable-sized transparent grid on a USGS quadrangle map showing the basin boundary, summing the elevation found at each grid intersection, and dividing by the total number of grid intersections.

- Applies to Northeast Plains and East-Central Plains Region

Determining Basin and Climate Characteristics using ArcGIS

Determining Mean Basin Elevation



Determining Basin and Climate Characteristics using ArcGIS

- Limitations of Regression Equations
  - Ungaged site of interest may be located in a different region from the region where the stream originates.
  - May be unreliable if the values of the characteristics at a particular ungaged site define a location that is far removed from the center of the joint distribution of all values of the explanatory variables.
  - May also be unreliable where unique, local geohydrologic or climatic features affect floods

Determining Basin and Climate Characteristics using ArcGIS

- Designers and hydrologists required to make flood estimates at ungaged sites need to be aware of unique or recently changed conditions.
- Additional study or site-specific knowledge gleaned from site visits or conversations with long-time residents may help to determine which flood-estimation methods are applicable.

Determining Basin and Climate Characteristics using ArcGIS

Sources and helpful websites:

- USGS
  - http://mt.water.usgs.gov/freq?page_type=gen_stats_1
  - http://www.nrcs.usda.gov/programs/rwa/Watershed_HU_HUC_WatershedApproach_defined_6-18-07.pdf
  - http://water.usgs.gov/GIS/huc.html
- Arc Hydro Tools v1.3
  - http://resources.arcgis.com/content/hydro-data-model

Determining Basin and Climate Characteristics using ArcGIS

QUESTIONS?

THANK YOU

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