Snow-Flow:
Integrating Water Data into Public Education

JD Kurz

JD Kurz
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Talk Focus

- Keeping Water Education Fresh by Using Data and Audience Targeting to Create More Meaningful Educational Programs

Objective

- Provide watershed organizations with an example of how water data can be integrated into public education.

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Background

- B.S., Watershed Science (CSU)
- Worked 2 years seasonally with USFS
- Worked 4 years with a hydrology consulting firm
- Alternative teaching license
- M.A., Science Education (UNC)
- Work experience shaped my teaching philosophy

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Global Science

- Natural Resource-Based Elective
  - Juniors & Seniors
  - Small class size
  - Focus on a few standards
  - Computer access (Excel)

Real-World Science

- Paid to answer a relevant question/ solve an important problem

1. Design study
2. Collect data
3. Analyze data
4. Communicate results

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Relevance and Application

- The hallmark of learning a discipline is the ability to apply the knowledge, skills, and concepts in real-world, relevant contexts *(Colorado Academic Standards: High School Science, p11)*

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San Juan River Snow-Flow Study

- Is the amount and timing of spring runoff changing?
- Can we accurately predict the amount and timing of the spring runoff?

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Introductory Assignment (Handout)

- Introduction to Colorado watersheds, snow and flow data

Colorado Snow Data

GO TO: ftp://ftp-fc.sc.egov.usda.gov/CO/Snow/snow/watershed/daily/co_update_snow_sites.pdf

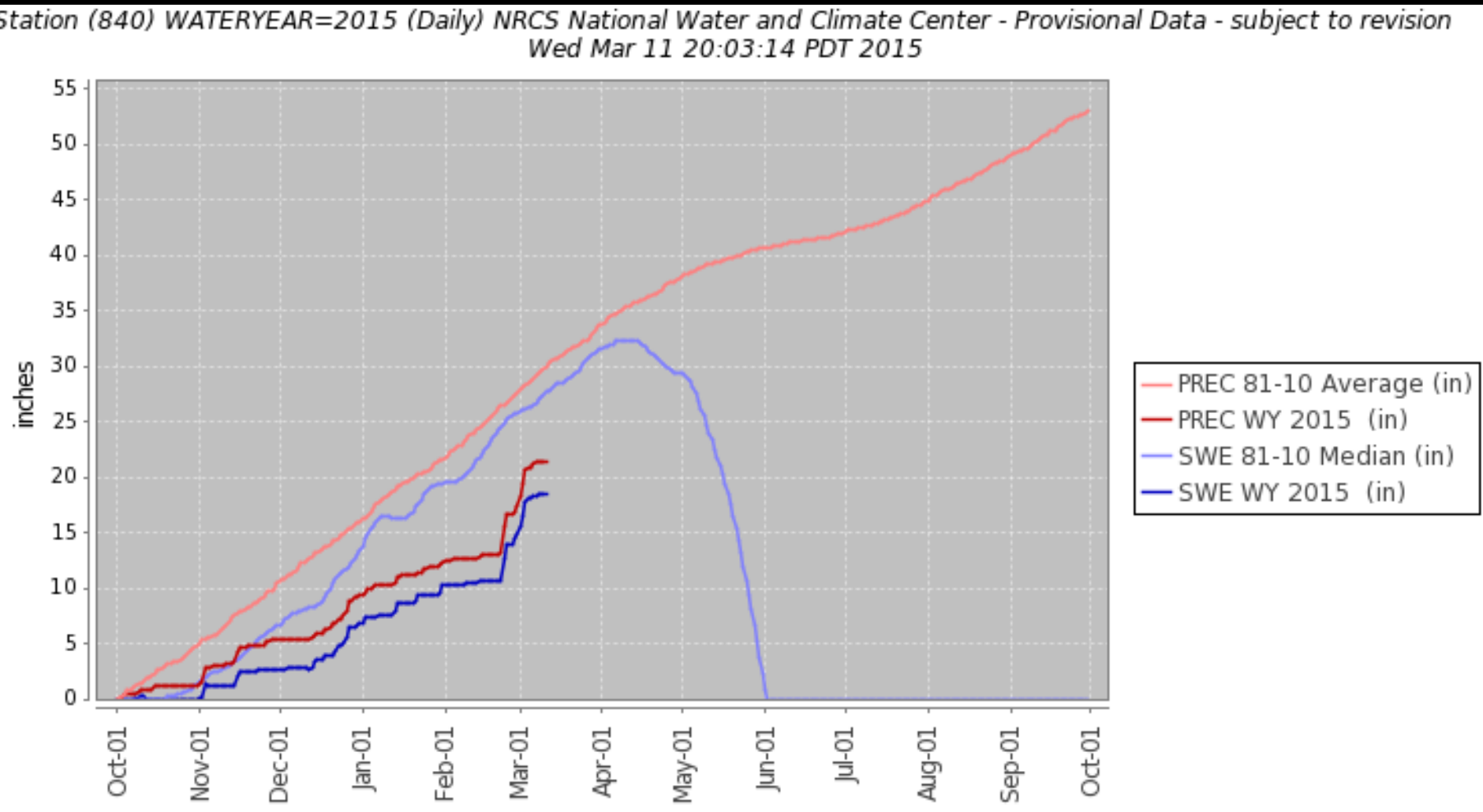
1. What is the current statewide snowpack level compared with the average? ____
   a. When was the data last updated? ____
2. What watershed has the most snow? _____
3. What watershed has the least snow? _____
4. Use Wikipedia to identify the journey of each river system to the ocean

Rivers	Trace the rivers to the ocean
Colorado	
Yampa/White	
Gunnison	
Dolores/San Juan/Animas	
Upper Rio Grande	
Arkansas	
South Platte	
North Platte	

   a. Identify the 3 major rivers that have headwater tributaries in Colorado.

Become Familiar with Snotel Graphs

http://www.wcc.nrcs.usda.gov/cgibin/site-wygraph-multi.pl?state=CO



Field Trip

- Upper San Juan Snotel Site (Wolf Creek Pass)
  - Natural Resource Conservation Service volunteered to help
    - How and why do you measure/monitor snow?
    - What is snow water equivalence (SWE)?

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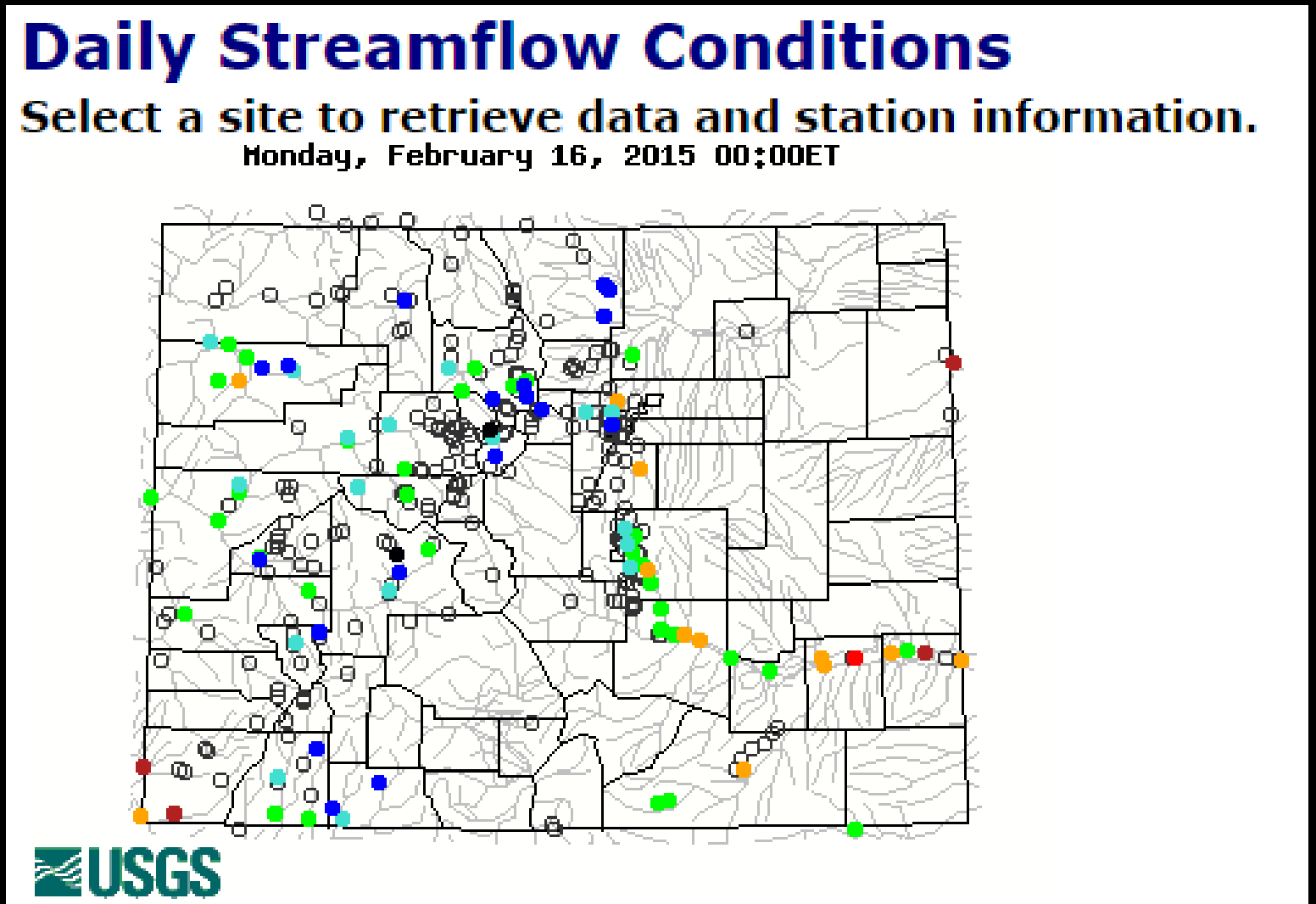
USGS Water Resources

http://waterdata.usgs.gov/nwis/rt

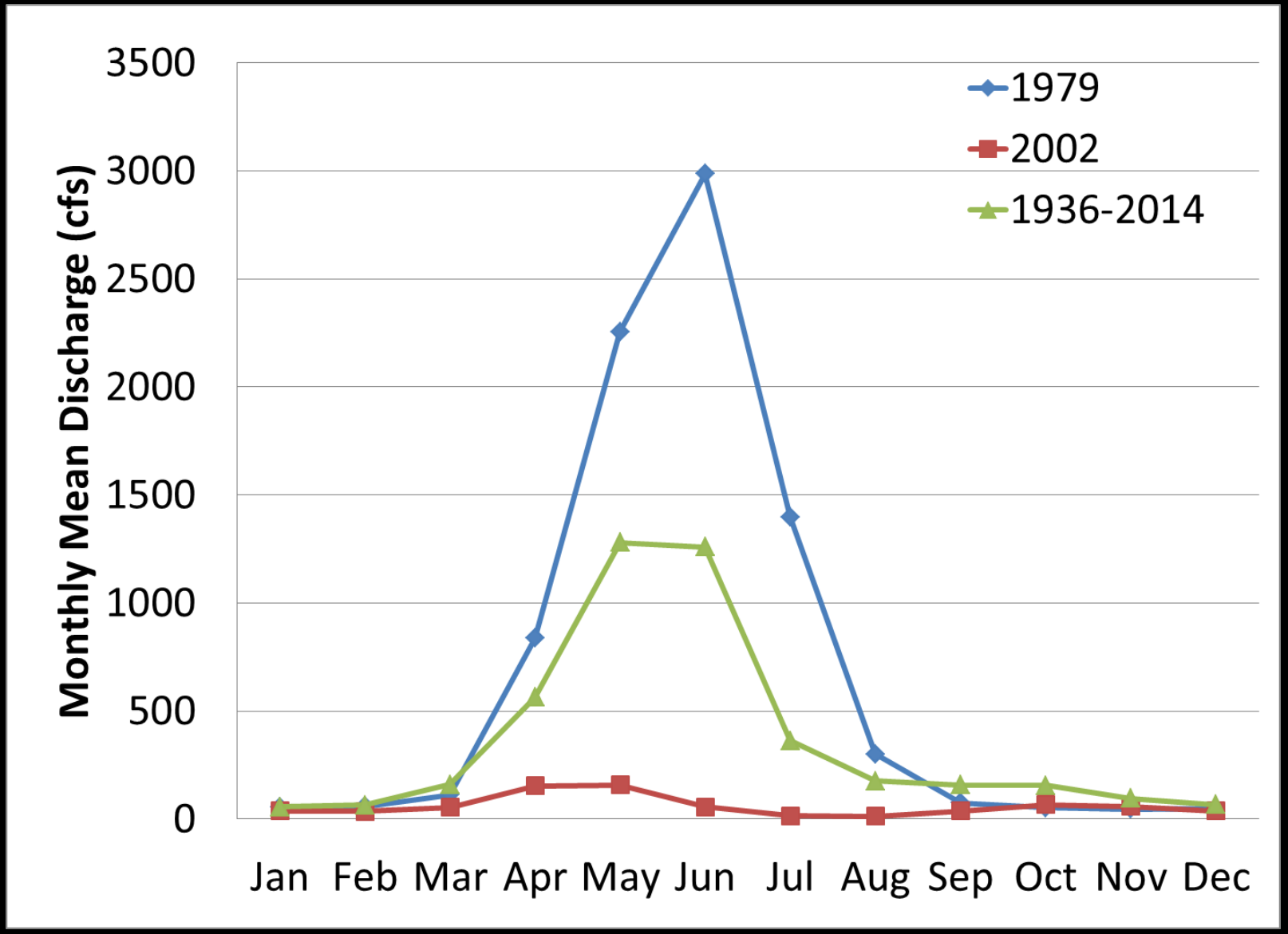


Hydrograph Characterization

- Retrieve monthly mean discharge for period of record (USGS Stream Discharge)
  - Snow-dominated/ Rain-dominated
  - Historic variation

00060, Discharge, cubic feet per second, Monthly mean in cfs (Calculation Period: 1935-10-01 -> 2012-09-30) Period-of-record for statistical calculation restricted by user												
YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1935										80.2	58	43.5
1936	40.8	42.5	158	794.4	1,332	595.6	153.6	299.7	253.1	121.4	137.3	74.8
1937	65.5	57.5	109.4	1,126	2,097	1,359	331.7	109.8	70	72.8	52.1	42.9
1938	51.8	54.8	160.2	848.7	1,411	2,103	484.4	148.2	293.9	180.2	88.9	63.2
1939	52.5	46	206.2	540.5	1,035	534	77	57.7	161.1	72.2	57.9	35.7
1940	37.5	42.7	138.5	430.7	1,048	442.5	91.6	73.1	125.6	193.1	83.1	78.6
1941	65.7	80.9	138.2	467.4	2,665	2,868	1,515	305.4	259.8	937.3	291	135.9
1942	93.2	77.1	95.8	1,050	1,593	1,821	355.8	106.4	78.8	61.9	59.3	55.3
1943	55.5	57.4	114.8	878.4	1,095	873.7	252.9	151.5	74.4	64	57.1	48.5

Historic Variation of the San Juan River: 1936 - 2014

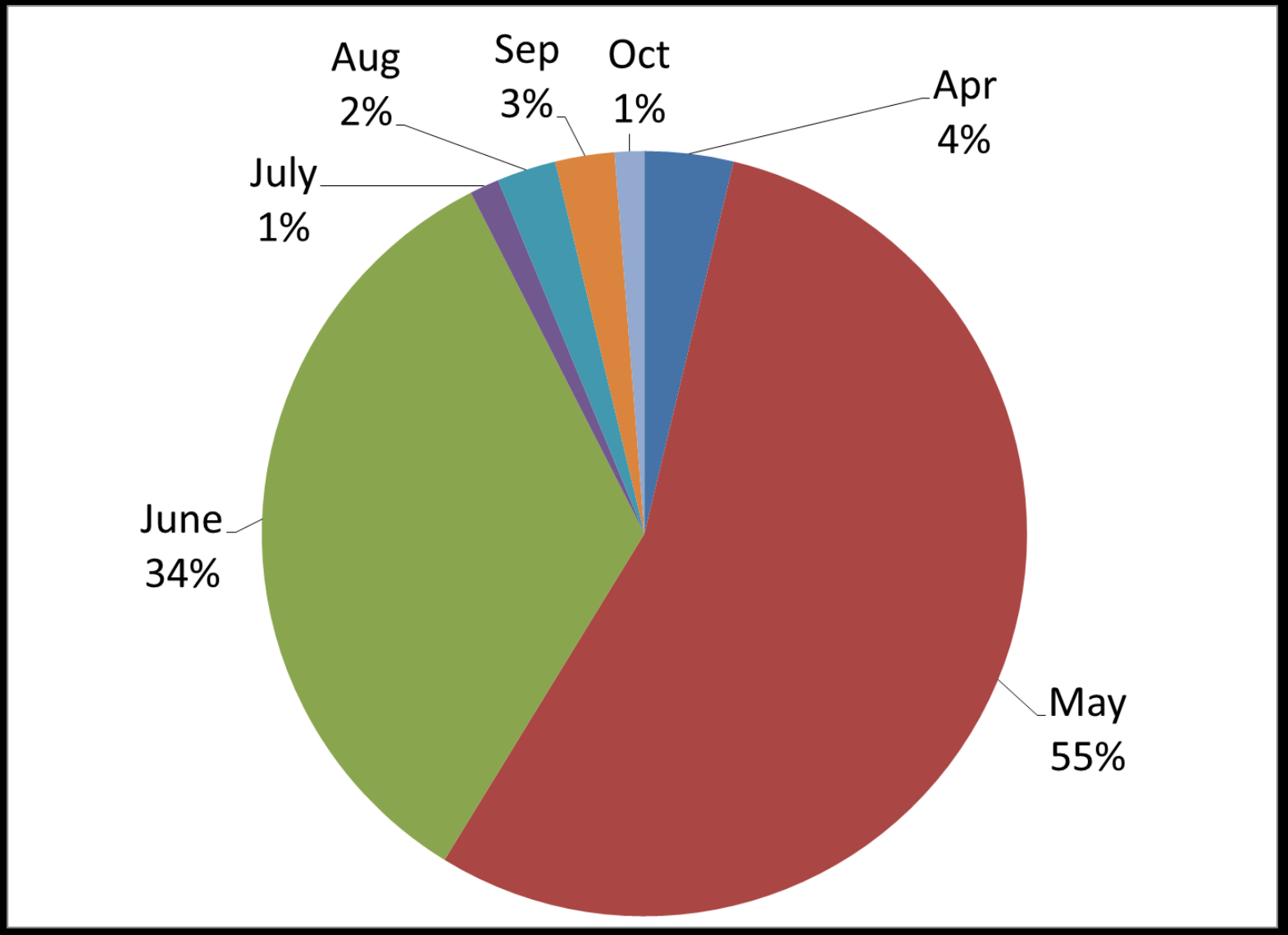


Hydrograph Characterization

- Retrieve annual peak discharge values for period of record
  - Sort by month , tally frequency

Month	Day	Year		Month	Frequency
4	27	2012		April	3
4	22	1942		May	42
4	15	2002		June	26
5	5	1936		July	1
5	18	1937		August	2
5	29	1938		September	2
5	22	1939		October	1
5	17	1940		Total	77

Timing of Historic Peak Streamflow: San Juan River (1936-2015)



Hydrograph Characterization

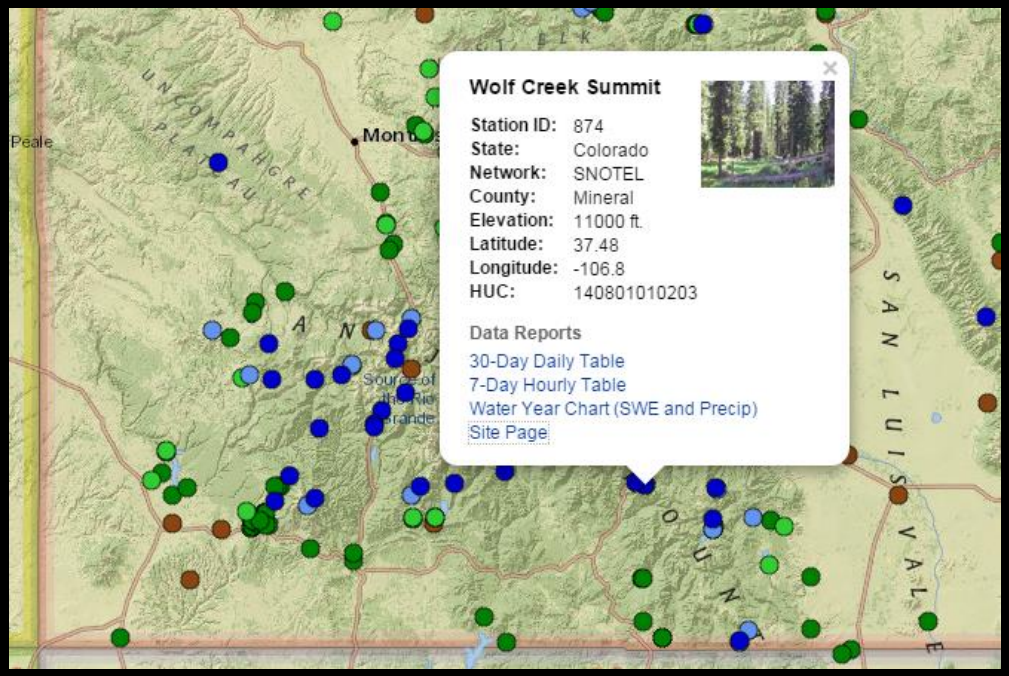
- Extract annual spring runoff peaks from period of record (eliminate rain-generated peaks)
  - Retrieve Daily Mean Values
  - 27,000 data points
  - Divide and Conquer: 10 years/student
  - Google Sheets

Peak Spring Runoff Date (cfs)	Daily Mean Peak Spring Flow (cfs)
5/5/1936	2000
5/17/1937	2950
5/29/1938	3350
5/11/1939	1300
5/17/1940	1370
5/13/1941	4670

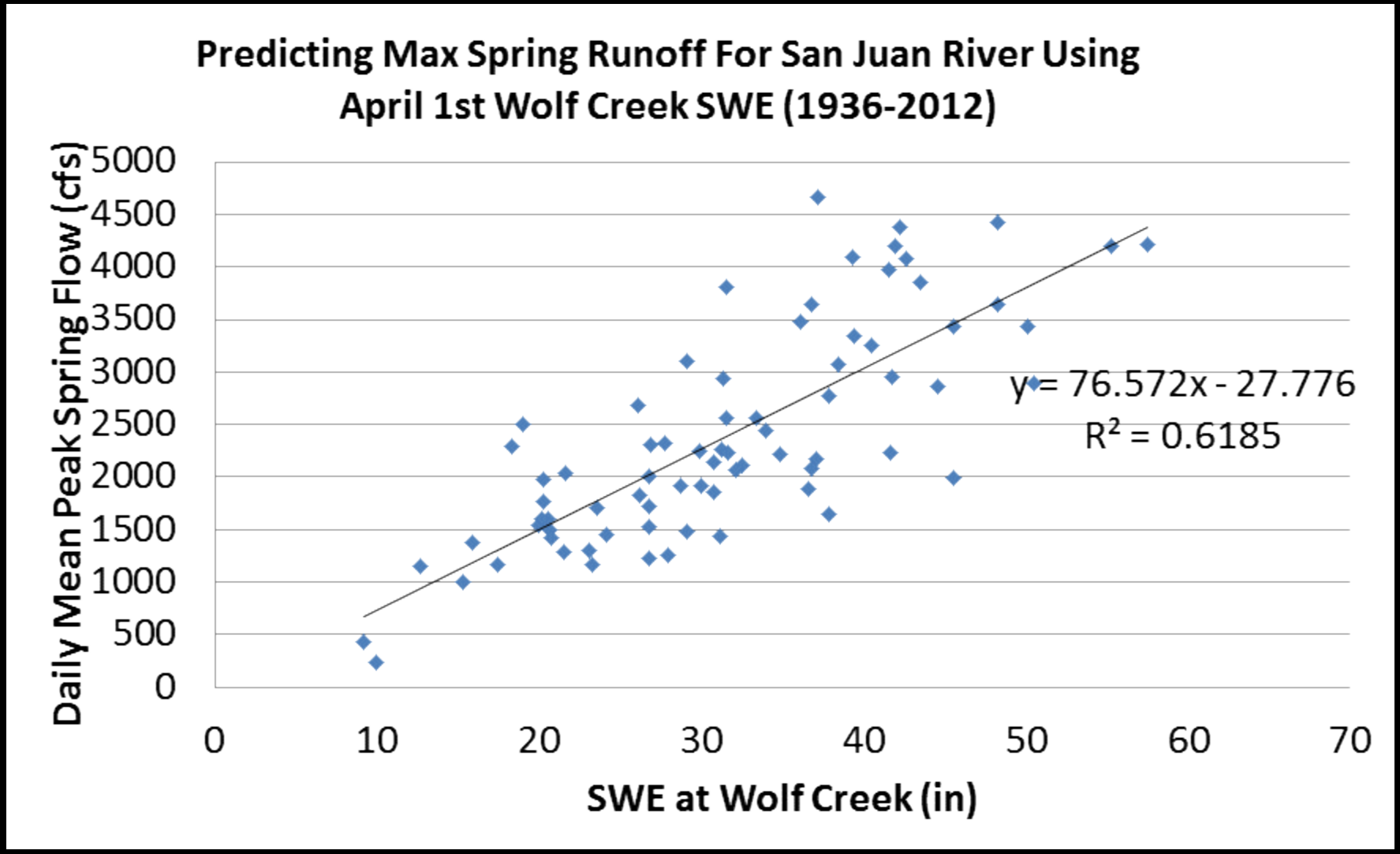
Gather Historic Snow Data

http://www.wcc.nrcs.usda.gov/nwcc/rgrpt?report=snowcourse&state=CO

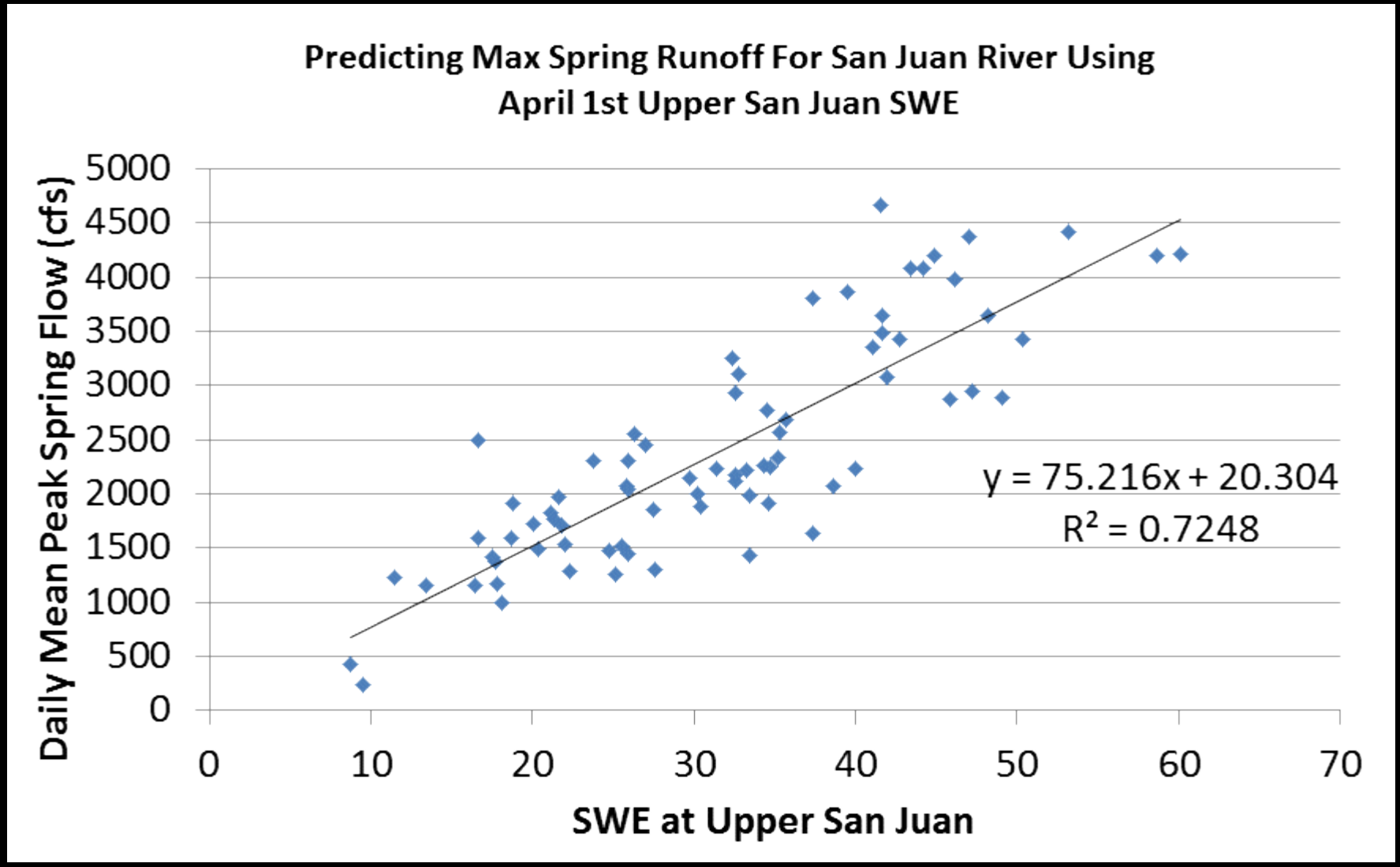
- Snow Course vs Snotel
  - Wolf Creek (1936-Present)
  - Upper San Juan (1936-Present)



Snow - Flow Correlation (Wolf Creek Summit)



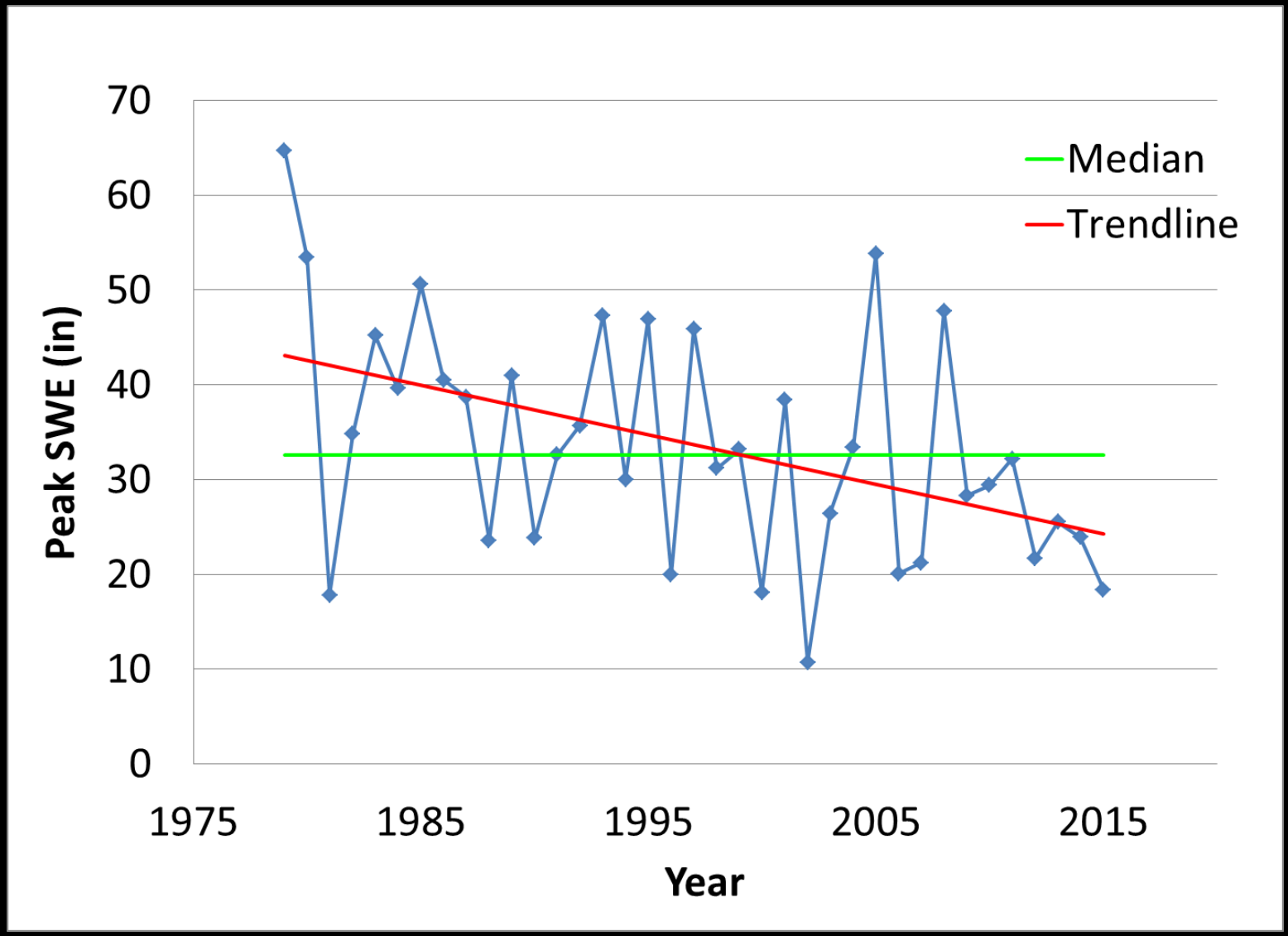
Snow - Flow Correlation (Upper San Juan)



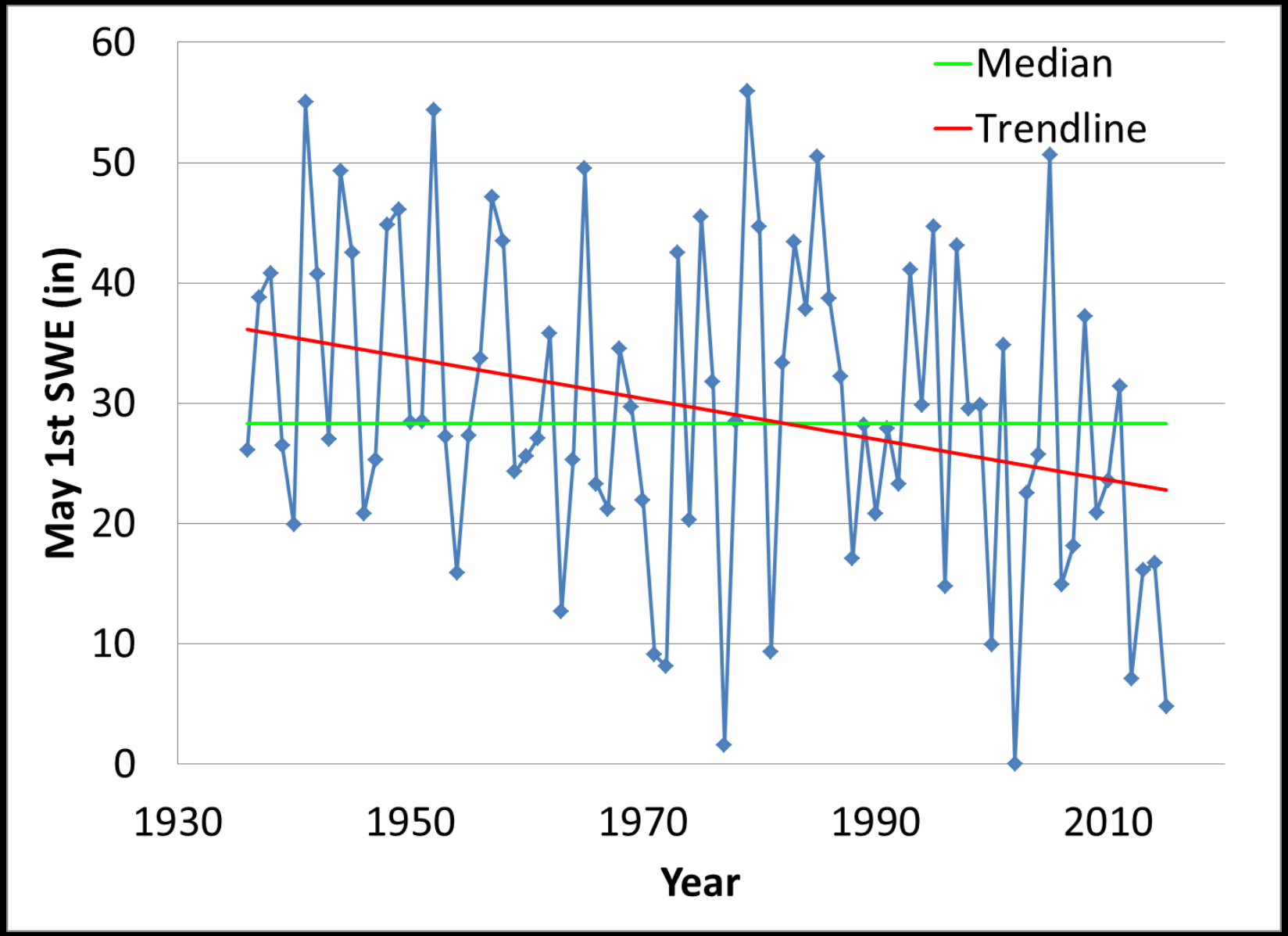
Compile Data (1936-2015)

Year	Upper San Juan May 1st SWE (in)	Upper San Juan Peak SWE Date	Upper San Juan Peak SWE Day #	Upper San Juan Peak SWE (in)	Peak Spring Runoff Date (cfs)	Peak Spring Runoff Day Number	Daily Mean Peak Spring Flow (cfs)
1979	55.9	4/20/1979	110	64.7	5/27/1979	147	4220
1980	44.7	4/14/1980	105	53.4	6/10/1980	162	3430
1981	9.3	4/18/1981	108	17.8	5/3/1981	123	1600
1982	33.3	4/5/1982	95	34.8	5/3/1982	123	1990
1983	43.4	4/23/1983	113	45.2	5/31/1983	151	3080
1984	37.8	5/9/1984	130	39.6	5/24/1984	145	3810
1985	50.5	4/30/1985	120	50.6	6/9/1985	160	3650
1986	38.7	4/30/1986	120	40.5	6/7/1986	158	3260
1987	32.2	4/16/1987	106	38.7	6/9/1987	160	2770
1988	17.1	3/22/1988	82	23.6	5/18/1988	139	1710
1989	28.2	3/7/1989	66	41	5/10/1989	130	1640

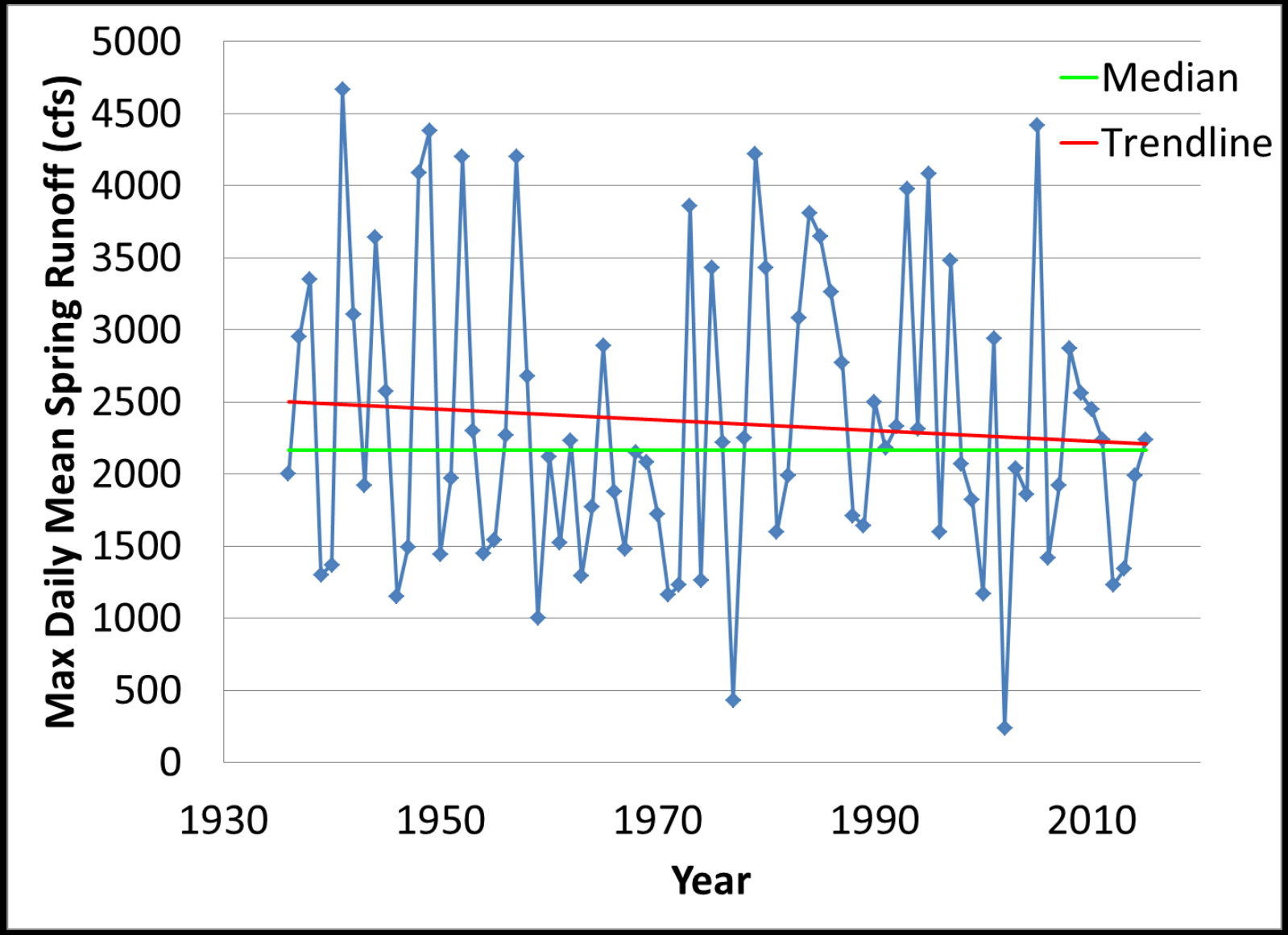
Trend in Peak Snow Water Equivalence: Upper San Juan SNOWTEL (1979-2015)



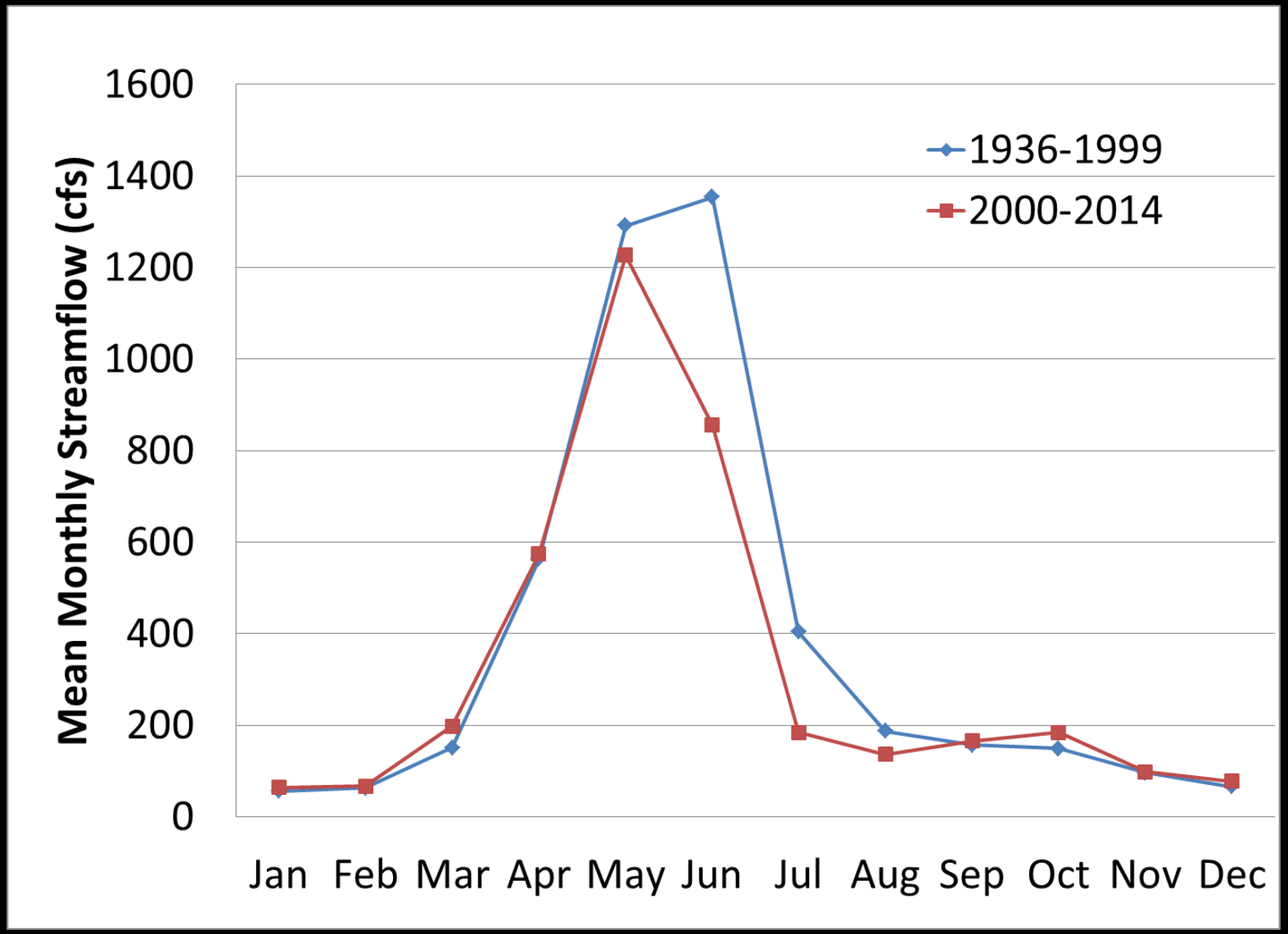
Trend in May 1st Snow Water Equivalence: Upper San Juan Snow Course (1936-2015)



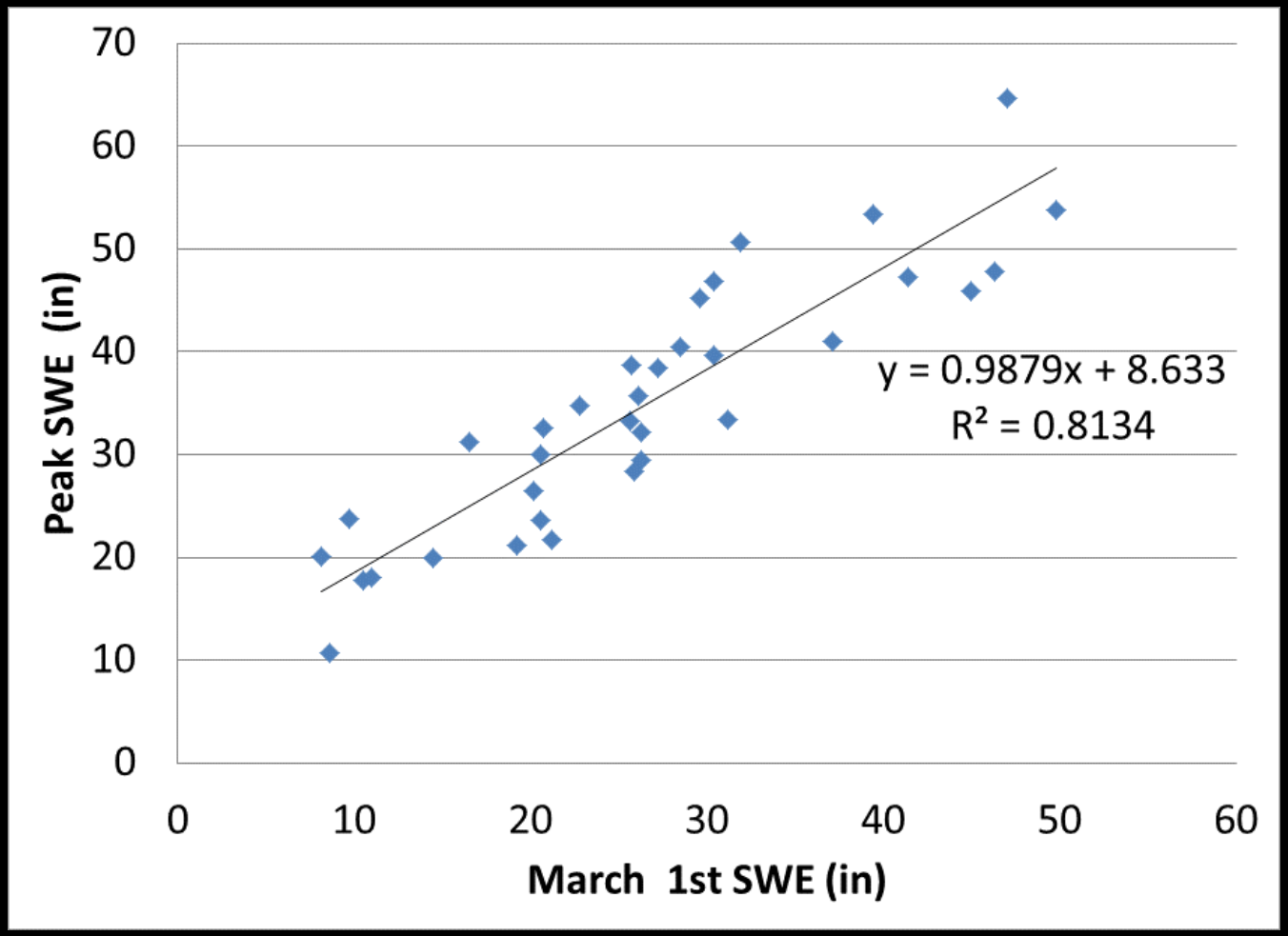
Trend in Peak Spring Runoff
San Juan River: Pagosa Springs, CO (1936-2015)



Hydrograph Comparison
San Juan River: 1936-2014

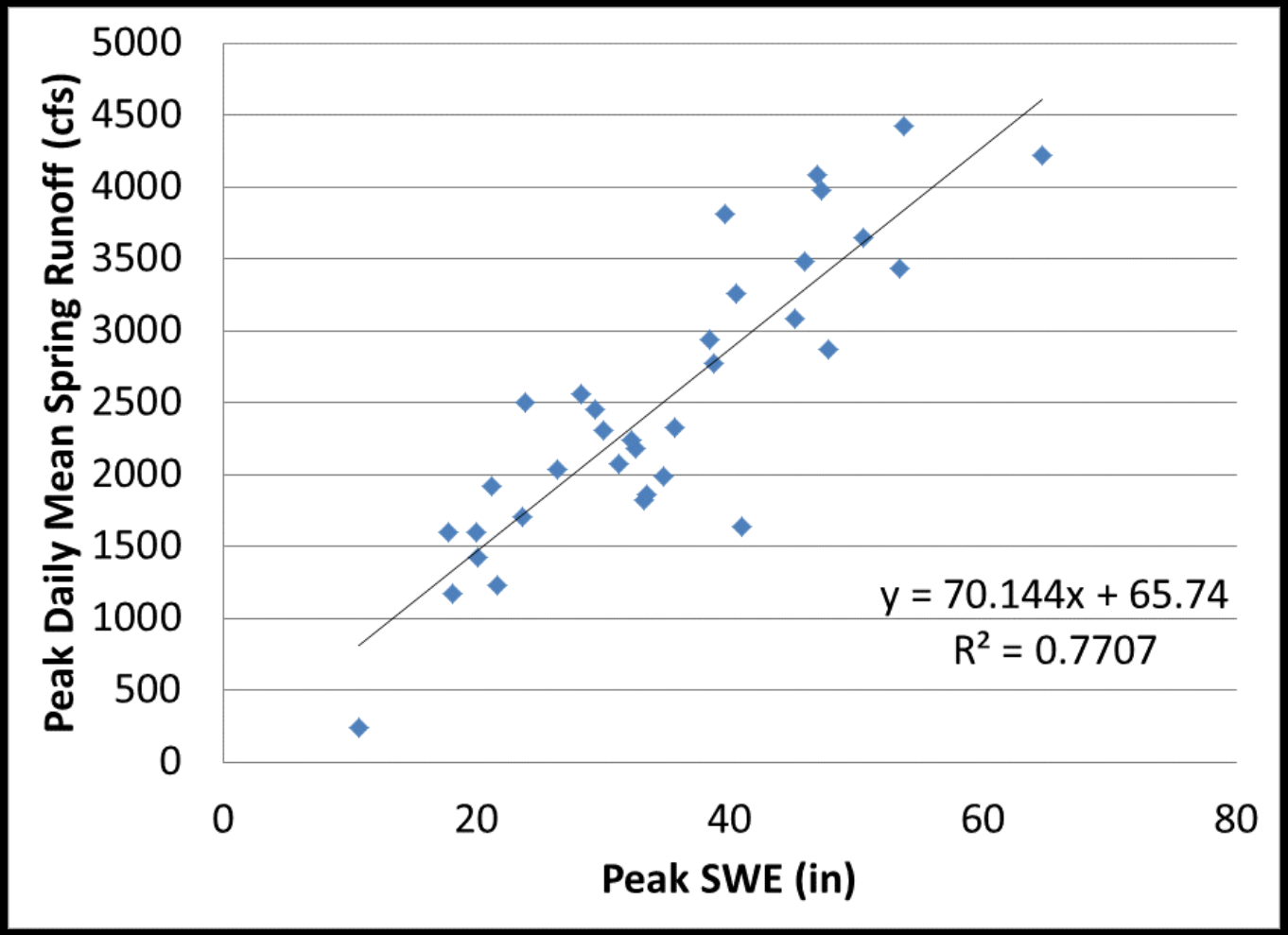


Predicting Peak SWE from March 1st SWE (Upper San Juan: 1979-2012)



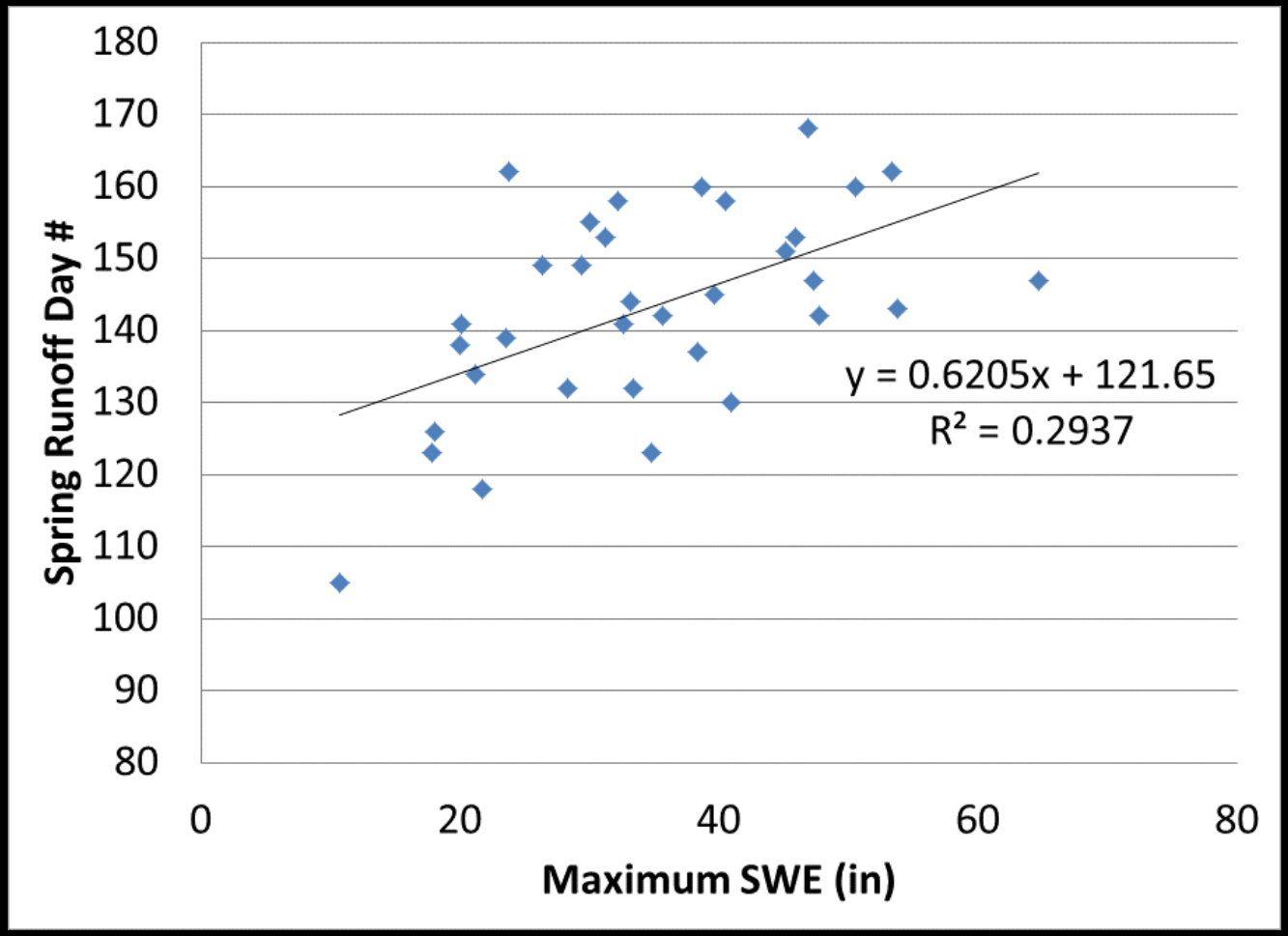
Mar 1st SWE (in)	Median Mar 1st SWE (in)	Predicted Peak SWE Prediction (in)	Median Peak SWE (in)	Stnd Error	m	b	r^2	Yrs
15	26	23	33	±5.4 in	0.9879	8.633	0.81	34

Predicting the San Juan River Peak Spring Runoff from the Upper San Juan Peak SWE (1979-2012)



Peak SWE (in)	Median Peak SWE (in)	Predicted Peak Spring Runoff - Daily Mean	Median Peak Spring Runoff (cfs)	Stnd Error	m	b	r^2	Yrs
23	33	1679	2180	±480 cfs	70.144	65.74	0.78	34

Predicting Peak Spring Runoff Date from Upper San Juan Peak SWE (1979-2012)



Peak SWE (in)	Median Peak SWE (in)	Predicted Peak Spring Runoff Peak Day #	Predicted Spring Runoff Peak Date	Stnd Error	Median Date	m	b	r^2	Yrs
23	33	136	5/16	±12 days	24-May	0.621	122	0.3	34

Communicate Results

- Wrote an article for the local paper to describe study and to invite the public
- Personally invited snow and water-related business owners
  - Ski industry
  - Rafting industry
  - Fishing industry
  - Forest service
- Students presented to 45 attendees

NASA

Is the amount and timing of spring runoff changing?

- Peak SWE appears to be decreasing
  - Less March snowfall in since 2000
- May 1st SWE appears to be decreasing
  - Less snow, melting earlier
- A meager SWE can still generate large peak flow in May it melts quickly
  - Volume would be a better indicator of change than peak flow
- Pacific Decadal Oscillation?

Can we accurately predict the amount and timing of the spring runoff?

- Not really (easier to predict flow then timing)
- Peak SWE predicts runoff within +/- 460cfs (0.77 r^2)
- Peak SWE predicts within +/- 12 days (0.29 r^2)
- Others variables: temperature, wind, dust on snow, rain on snow
- 2015 runoff season (lots of rain)

Future Studies: Changes due to 2013 West Fork Fire

USFS

Future Studies: Changes due to Widespread Spruce Beetle Kill

Student Feedback

- “The audience seemed really into us!”
- “I bet more people would like to hear our results.”
- Most excited that our study had not been done before (original research)