An Introduction to Snowmelt and Peak Streamflow Comparisons

Rivers in Idaho generally have their highest streamflow of the season (peak flow) as a result of spring snowmelt. In a year with little springtime rain the peak flow is entirely driven by snowmelt, while during a wet spring the peak flow is typically driven by a combination of snowmelt and rainfall. The Idaho Snow Survey has compared historic snow and streamflow data for rivers throughout the state with the goal of finding a relationship that predicts when peak flows are most likely to occur based on the percentage of snow remaining at a specific SNOTEL site.

When on average the peak flow occur when a given SNOTEL site is 50% melted, the relationship is referred to as a "half melt" relationship. Example half relationships include Banner Summit SNOTEL and the Middle Fork of the Salmon River, as well as, Big Creek Summit SNOTEL and the South Fork Salmon River. Another kind of relationship is based on the melt out date (ie when zero snow water remains at a site and the site is snow free), an example would be the Big Lost River at Howell Ranch, which on average, peaks 4 days after Lost-Wood Divide SNOTEL site melts out.

Some of the analyses are based on data from a few years ago and might benefit from being updated, however the relationships should still be helpful. Spring temperature and precipitation are the driving factors in determining magnitude and timing of snowmelt streamflow peaks. Keep in mind, that spring rains can change snowmelt / streamflow relationships, especially in low snow years when rain generated peaks may exceed snowmelt dominated peak flows or in wet springs like May 2005 when precipitation was 200-300% of average.

For entire summary of these relationships see the Snow Melt / Peak Streamflow Relationships please read the end of this document

Each spring the Idaho Snow Survey updates graphs once or twice a week that show the current snow and streamflow data; these graphs contain a similar year in terms of snow and streamflow to offer additional insight about the size of potential peak flows. The Snow-Stream Comparison graphs are linked from the following webpage…
http://www.id.nrcs.usda.gov/snow/watersupply/peakflow.html

What a Snow-Stream relationships tell you?
As an example take the relationship between Big Creek Summit SNOTEL and the South Fork Salmon River, on average the South Fork Salmon River at Krassel Ranger Station peaks when Big Creek Summit SNOTEL is half melted (50% melted). That means if the snow pillow's greatest measurement of the season was 44 inches of snow water, the snow melt driven peak streamflow would be expected on average when the pillow reaches 22 inches of snow water remaining.

This relationship means that it becomes less and less likely that a higher snowmelt driven streamflow peak will occur after Big Creek SNOTEL reaches the point when half of its snow water for the season has melted. It also means that until the snow is half melted there is still plenty of snow water for a significant snowmelt driven peak to occur.

Rain is the wildcard in the equation. The snow-stream melt relationship doesn't reveal anything about the size of the peak that could be generated when a rain event combines with snowmelt. 2010 was an excellent example of this. A rain event with over 2 inches of rain combined with normal snow melt of about 0.6 inch per day and caused a daily peak flow of 6,100 cfs on the SF Salmon (this was one of the highest on record and almost twice the 1993 peak), even though the maximum snow water at Big Creek in 2010 was 25 inches (~70% of average) vs 1993 when the max snow water was 43 inches (123% of average). What is for sure is that the highest flows almost always occur when a significant rain event falls on a melting snowpack.

Some of the following relationships also reference Degree Days (DD). Degree days is another way to summarize rule of thumb analyses that were performed over the years. The degree day value for is the cumulative total of daily average temperatures that are above zero degree Celsius from a stated date. Below is an example based on counting degree days after March 1st.

Date	Ave Temperature	Daily Degree Day	Cumulative Degree Days
3/1	-5 deg C	0 DD	0 DD
3/2	3 deg C	3 DD	3 DD
3/3	7 deg C	7 DD	10 DD
3/4	4 deg C	4 DD	14 DD
3/5	-1 deg C	0 DD	14 DD
3/6	0 deg C	0 DD	14 DD
3/7	5 deg C	5 DD	19 DD

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Camas Creek near Blaine, on average, peaks:
1 day before Soldier R.S. swe reaches half melt,
51 Degree Days (DD) after Feb 1 at Soldier R.S.,
36 DD after peak SWE at Soldier R.S.,

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Bruneau River
General Observations based on **Bear Creek SNOTEL site**:
- Peak usually occurs somewhere between beginning of melt and half melt of Bear Creek SNOTEL site, except in years with below to well below normal snow when there was no real snowmelt streamflow peak.
- Bruneau River at Hot Springs gage is generally responsive to changes in snow melt rates.
- Minor streamflow peaks can occur due to pre-melt rain events in the basin.
- Magnitude of peak depends upon:
1) delay of onset of melt,
2) magnitude of snowpack
- Bear Creek usually needs a peak of about 20 inches of snow water to have an adequate runoff season or wet spring for boating. Average April 1 snow water content is 22.4 inches.

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Salmon Falls Creek at San Jacinto, Nevada
On average, Salmon Falls Creek peaks when:
- Magic Mountain peak SWE is 70% melted, or 37 days after peak SWE.
- Pole Creek peak SWE is 35% melted, or 20 days after peak SWE.

Snowmelt / peak streamflow relationships for Salmon Falls Creek were developed in conjunction with its reservoir operating guides.

Other Key Indicators

- Higher streamflow peaks occur in the range of 1-2 weeks after the peak at **Pole Creek SNOTEL site**.
- Higher peaks tend to occur in years when the peak SWE at **Magic Mountain and Pole Creek SNOTEL sites** are coincident or close in time. This is a result of the mid and high elevation snowpacks melting at the same time.
- Streamflows peaks follow jumps in temperatures at the SNOTEL sites in the basin with higher peaks occurring within a week of larger jumps in temperature. In 1993, an increase of about 25 degrees F in 4 or 5 days in early to mid-May produced the streamflow peak 4 days later.

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Middle Fork Salmon River, on average,
peaks about when **Banner Summit SNOTEL site** reaches half-melt.

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South Fork Salmon River, on average,
peaks when Big Creek Summit SNOTEL site reaches half melt.

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South Fork Boise River near Featherville, on average, peaks:
3 days after half melt at **Vienna Mine**
132 degree days (DD) after Feb 1 at Vienna Mine,
95 degree days after peak SWE occurs at Vienna Mine.

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Big Lost River at Howell Ranch, on AVERAGE,
peaks 4 days after **Lost-Wood Divide SNOTEL site** melts out.

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Big Wood River at Hailey, on AVERAGE, peaks
8 days before **Vienna Mine** swe reaches half melt,
134 Degree Days (DD) after Feb 1 at Vienna Mine,
96 DD after peak SWE at Vienna Mine,
9 days after **Galena Summit** reaches half melt,
4 days before Galena Summit melts out,
127 DD after Feb 1 at Galena Summit,
120 DD after peak SWE at Galena Summit.

Snowmelt / peak streamflow relationships for the Big Wood River were developed in conjunction with its reservoir operating guides.

General Observations for Big Wood River:

- Boise high temperatures of 70-75 degrees F for several (days 5-7 days?) days will initiate significant rise in streams.
- Boise high temperatures of 80+ degrees F (for several days?) will probably cause streamflow peak assuming Galena Summit still has some snow.
- If Galena Summit has snow and temperatures are less than 80 degrees F, remaining snow can sustain flows of 4,000 cfs.

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Payette Lake Inflow, on average, peaks:
9 days after meltout at **Bear Basin**,
6 days after half-melt at **Secesh Summit**, or
8 days before Secesh Summit melts out.
This analysis is based on years 1981-1987.

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