

From: [Guinotte, John](#)
To: [Betty Grizzle](#)
Subject: mt climate report
Date: Monday, October 2, 2017 3:37:54 PM
Attachments: [Key points from MT Climate Assessment_jmg.docx](#)

Hi Betty, here is the DRAFT 2 pager on the MT climate assessment I'm working on with Steve. It could change but the main points are there. The text in bold is in agreement with the NOAA work. Here is the link to the full report.

<http://montanaclimate.org/>

John Guinotte
Spatial Ecologist
Ecological Services
U.S. Fish and Wildlife Service
Mountain Prairie Region 6
134 Union Blvd., Lakewood, CO 80228
303-236-4264
john_guinotte@fws.gov

Key points from MT Climate Assessment:

- Areas west of the Continental Divide typically exhibit milder winters, cooler summers, and a longer growing season due to the influence of warm Pacific air masses. Average annual precipitation is highest west of the Continental Divide (MT DNRC 2015).
- Mountains west of the Continental Divide are generally situated at lower elevations than those east of the Continental Divide, yet the western mountains still receive more snowfall on average each year.
- For most mountainous areas in Montana, SWE typically peaks in April or early May, but **this can vary depending on elevation, aspect (e.g., north versus south facing)**, and relative position west or east of the Continental Divide. Low-elevation SNOTEL sites west of the Continental Divide typically record maximum snowpack at the end of March and snow is absent by early May. In contrast, high-elevation sites (over approximately 8500 ft [2590 m]) exhibit peak SWE values in mid May, and **some north-facing slopes can retain snow through the end of June** (NRCS 2016).
- **Snowpack accumulated at high elevations tends to be more stable and persist longer than at low elevations, largely as a result of colder temperatures at high elevations.** Snowpack at higher elevations is also less prone to melt during short warm spells in the early spring that can degrade snowpack at lower elevations.

Observed regional trends in snowpack

- Regional trends in April 1 SWE demonstrate that average annual snowpack has declined in large portions of the American West over the period of reliable measurement (1930s to present; Figure 3-7) (Mote 2003; Hamlet et al. 2005; Mote 2006; Casola et al. 2009; Mote and Sharp 2016). Some regions, such as low-elevation sites in the northern Rocky Mountains (including Montana) and the Cascades, have experienced more drastic reductions than other sites, such as high-elevation locations in the Sierras and central Rocky Mountains.
- Both sides of the Continental Divide show long-term downward trends in April 1 SWE (Table 3-2). This observation is consistent with other studies that have described shrinking snowpack volumes in Montana and elsewhere in the western US (Mote et al. 2005; Pederson et al. 2013a; Mote and Sharp 2016). In general, April 1 SWE in Montana has declined roughly 20% over the last 80 yr, and **this decline is most pronounced at lower elevation sites.**

Table 3-2. Linear trends in snowpack for particular elevations east and west of the Divide

	West			East		
	All sites	>6000 ft (>1830 m)	<6000 ft (<1830 m)	All sites	>7000 ft (>2100 m)	<7000 ft (<2100 m)
Decline (percent over the record)	-19%	-12%	-23%	-20%	-14%	-27%

Montana's snowpack is particularly sensitive to warming

- Both empirical studies and model projections demonstrate that snowpack in the Northern Rockies and inland Pacific Northwest is more vulnerable to warming than some other regions in the West.
- Unlike Rocky Mountain regions to the south, Montana stores a significant amount of snowpack at mid and low elevations (below 8000 ft [2400 m]), particularly within the Flathead, Kootenai, and lower Clark Fork basins of northwestern Montana. In regions such as these, the projected increase in temperatures will result in reduced winter snowpack and a higher-elevation snowline (Regonda et al. 2005; Klos et al. 2014).

- Low elevations west of the Continental Divide are exposed to relatively warm Pacific air masses. These regions have experienced an increase in precipitation falling as rain instead of snow since the 1950s (Knowles et al. 2006), a trend that is expected to continue under future climate conditions (Barnett et al. 2005).

Snowpack projections for Montana

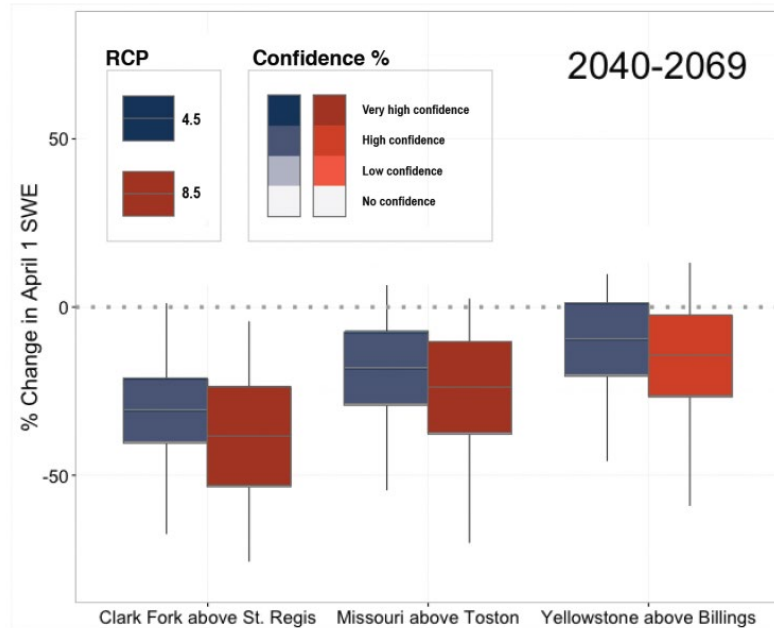


Figure 3-10. APRIL 1 SWE projections for three snowmelt-dominated basins in Montana under two scenarios (RCP4.5 and RCP8.5) and two time periods (2040-2069 and 2070-2099). Data are presented as the projected percent change in April 1 SWE between the baseline period 1970-2000 and two future time periods (2040-2069: upper panel; 2070-2099: lower panel). Box and whiskers plots show variation in projections among the different models. These types of plots appear in other graphs below that depict model projections. The line in the middle of the boxplot represents the median value of all model projections. The bottom and top of the box represent the 25th and 75th percentiles (or first and third quartiles), respectively, of model projections. The upper whisker (line extending from the box) extends from the box to the largest model value no further than 1.5*IQR from the box (where IQR is the inter-quartile range, or distance between the first and third quartiles). The lower whisker extends from the box to the smallest model projection that is no further than 1.5*IQR of the hinge. Few model projections fall beyond the end of the whiskers (i.e., outliers), and these are not shown in the figures. For explanation of specific confidence levels, refer to Future Projections in Water Chapter.

Our projections show that

- **snowpack volumes for the Montana basins studied will very likely decline in the future;** and
- the largest projected changes in snowpack appear to be located west of the Continental Divide, and are the same areas that have experienced the largest declines in April 1 SWE over the past 80 years (see, for example, the Clark Fork River in Figure 3-9).