

Snowmaking at Colorado Mountain Resorts

As of 9/2019



Recent objections to snowmaking NEPA documents request assessment of cumulative snowmaking impacts

- Requested a programmatic overview of snowmaking impacts from Colorado's White River National Forest (WRNF) on Colorado River flows.
- Requested that the overview also address changes to runoff flows and timing.
- WRNF agreed to conduct further studies.

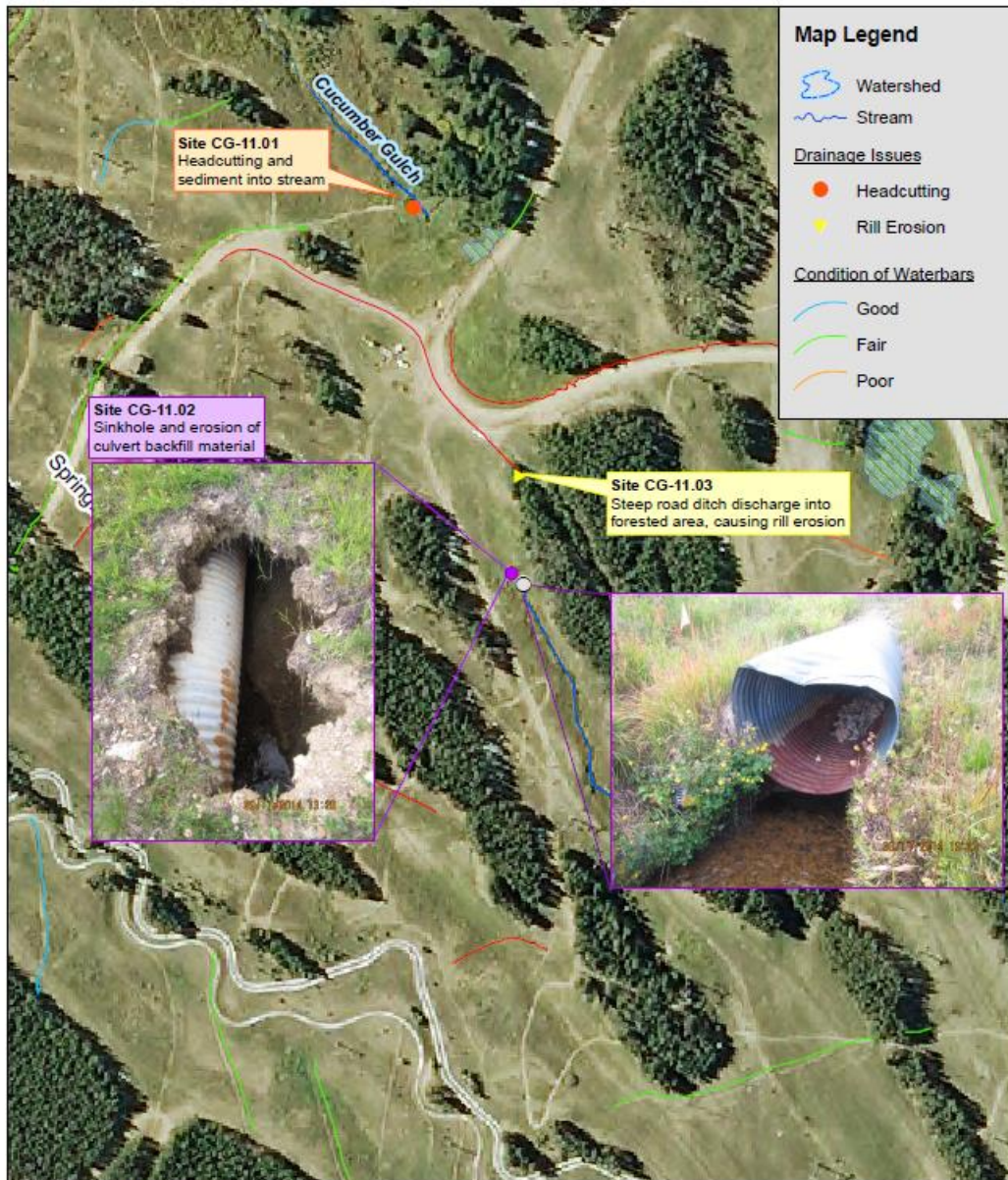


Snowmaking Impacts on Runoff Flows and Timing

- Snowmaking typically begins in October/November, ends in January.
- Increases total spring/summer discharge from affected watersheds, typically by 5% to 10%.
- Extends the duration of snowmelt, and may delay peak discharge.
- Snowmaking actually offsets ongoing shifts toward earlier snowmelt caused by climate change and ski run tree clearing. Overall, snowmelt and peak runoff in the central Rockies have shifted 1 to 4 weeks earlier over the last 35 years (Lukas et al., 2014).

Mitigation for Snowmaking Impacts: Hillslope Scale

- All ski areas on FS land in Colorado must apply **best management plans (BMPs)** as part of their approved Special Use Permits.
- Approved projects on these ski areas include **project design criteria (PDC)**, which are project-specific BMPs and other measures.
- White River National Forest (WRNF) also has a list of **general design criteria (GDC)** that apply to all ski areas it oversees.
- Any new construction requires submission and FS approval of **construction plans**, including applicable BMPs.
- FS is moving toward requiring resort-wide **drainage management plans (DMPs)** with location-specific direction to minimize runoff impacts.



Breckenridge DMP sample page

Background: 2013 NAIP Photography

RESOURCE
ENGINEERING, INC.
409 Colorado Avenue # Glenwood Springs, CO 81601
Voice: (970) 846-6777 - Web: www.resource-eng.com



Breckenridge Ski Resort
2015 DMP Update - Phase 1
Figure 3: Site CG-11



Scale:
1 in = 200 ft



Date: 03/16/2015
File: 113-15.13
Drawn: RP
Approved: RSF

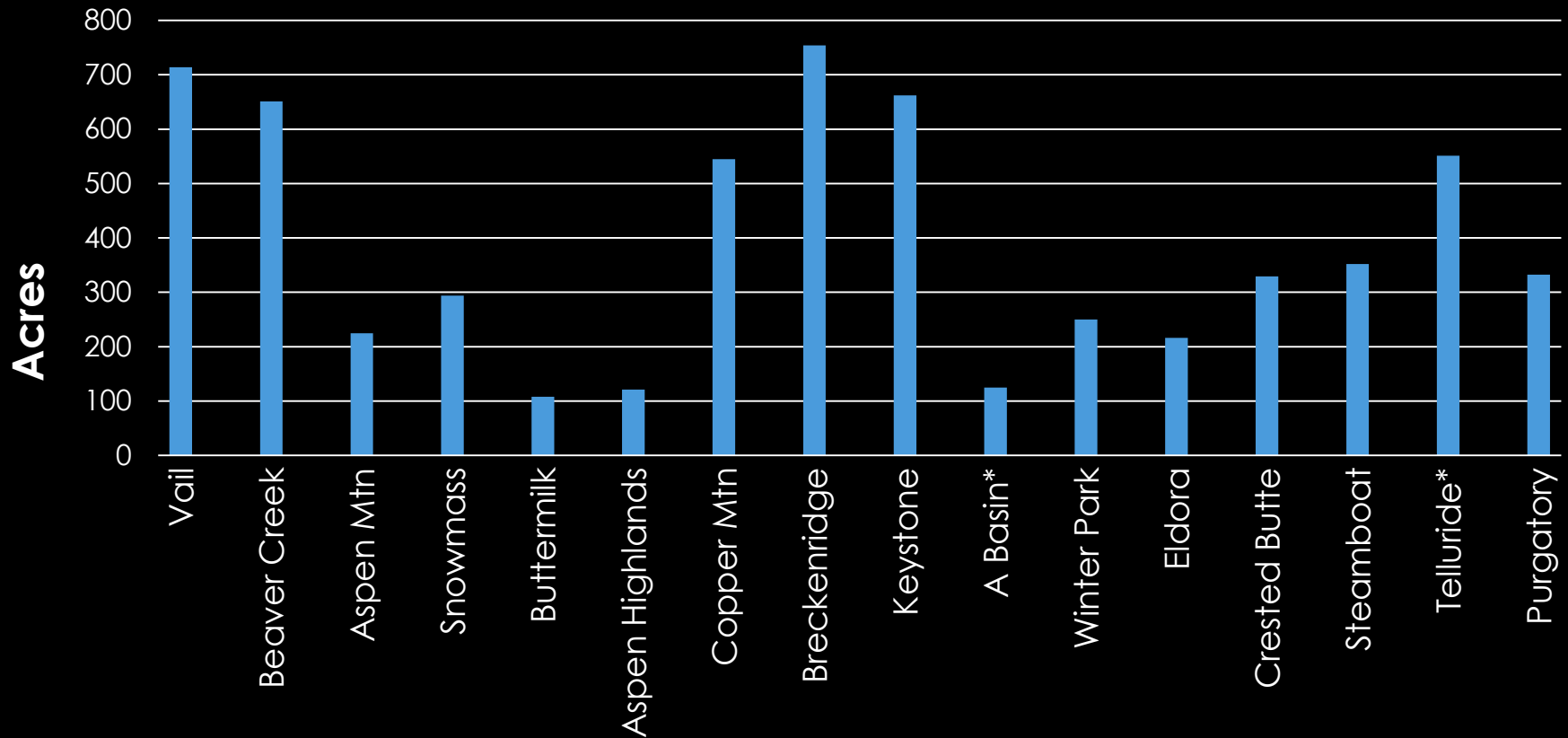
Stream Health Assessments

Stream Health Class	% of Reference Site	Habitat Condition
Robust	> 74 or < 126	Stream exhibits <i>high integrity</i> relative to its natural potential (reference) condition. Physical, chemical and/or biologic conditions suggest that State assigned water quality uses are supported.
At Risk	59 to 73 or 127 to 141	Stream exhibits <i>moderate integrity</i> relative to its reference condition. Water quality uses are at risk and may be threatened.
Diminished	< 58 or > 142	Stream exhibits <i>low integrity</i> relative to its natural reference condition. Water quality uses may not be supported.

Cumulative Impacts

What are the potential cumulative impacts of snowmaking water withdrawal, at all Colorado ski areas, on the Colorado River and its T&E fish species?

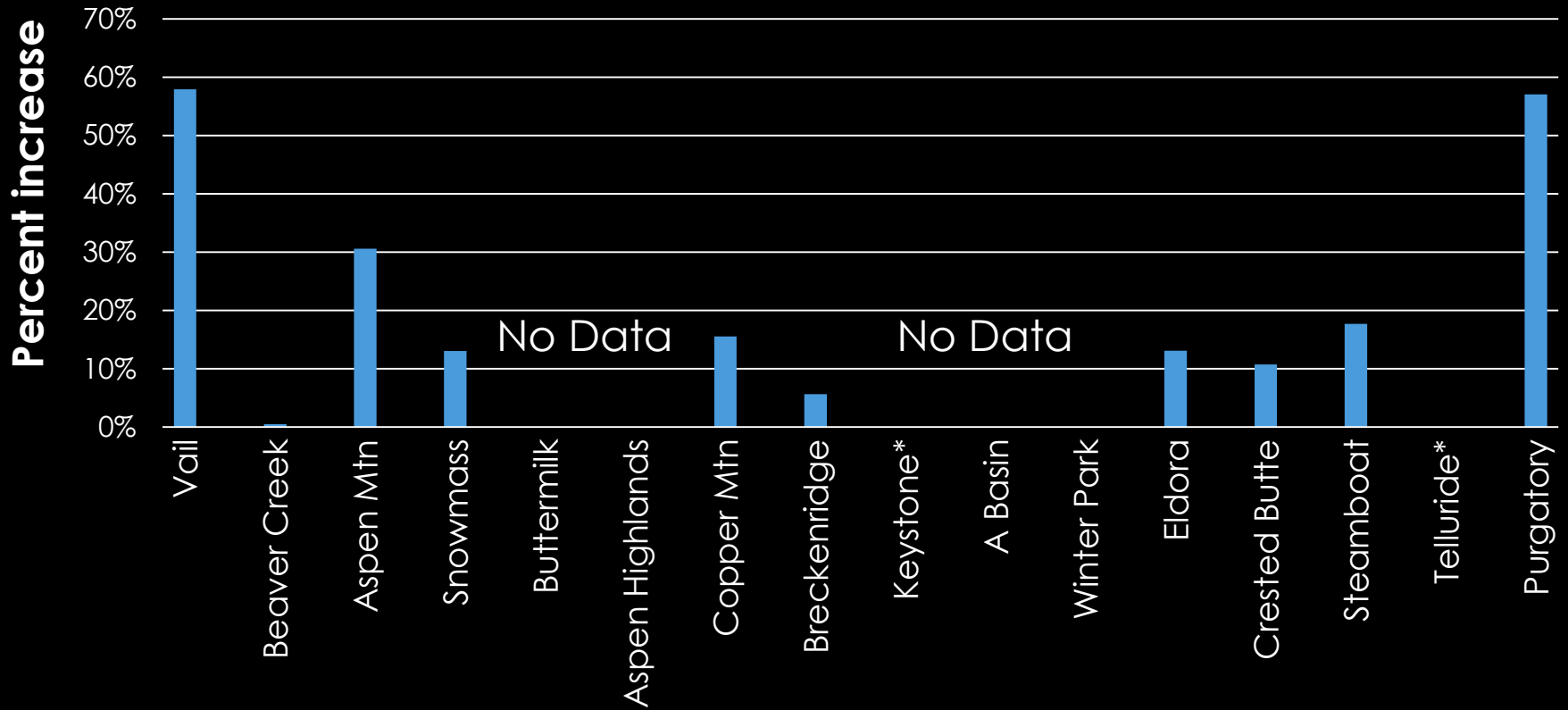
Snowmaking Acreage Currently Approved



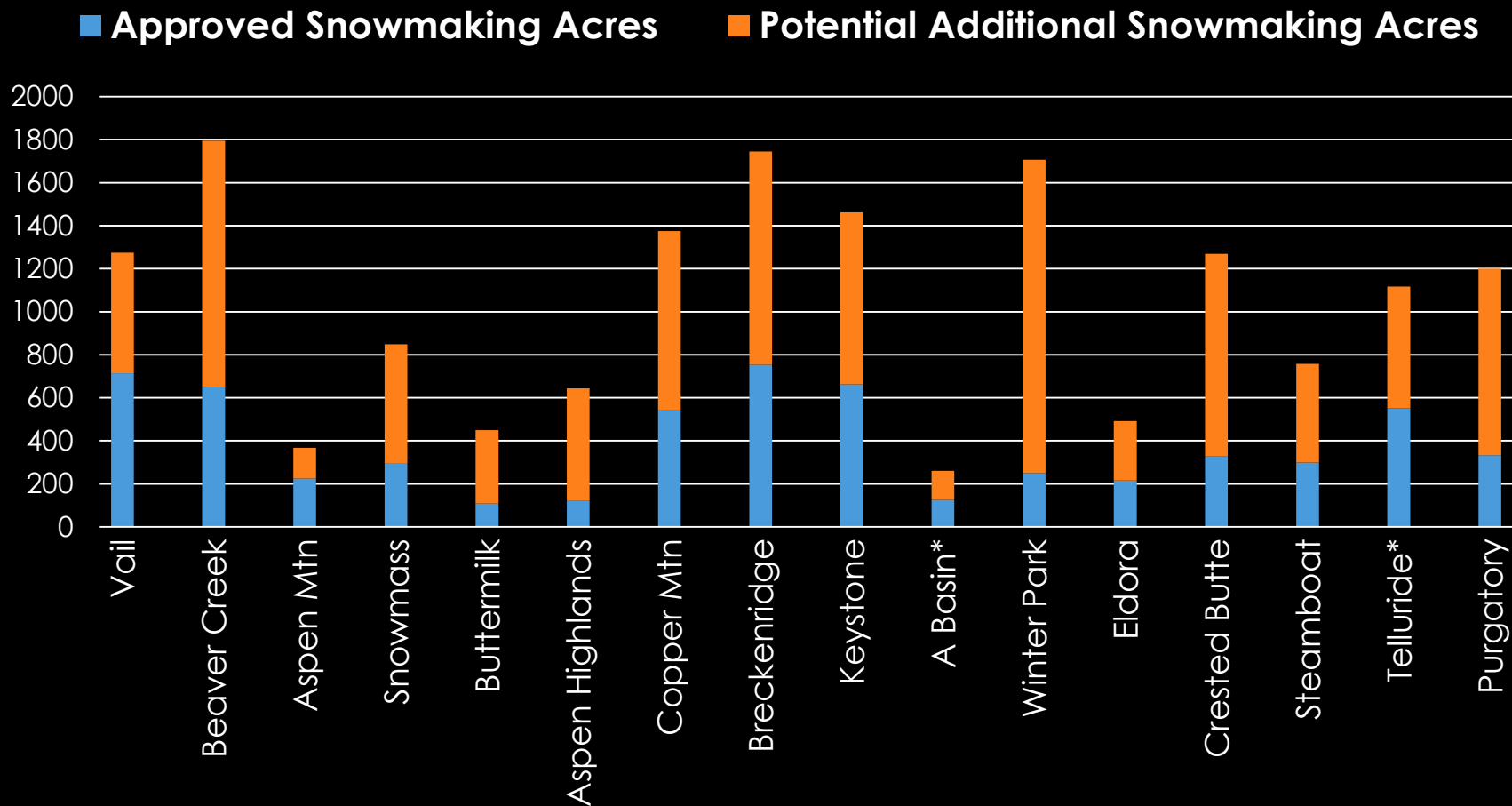
**Data for these ski areas are based on most recent master development plans (MDPs)*

Snowmaking Acreage Increase in Latest NEPA Approval

vs. Previously-Approved Acreage

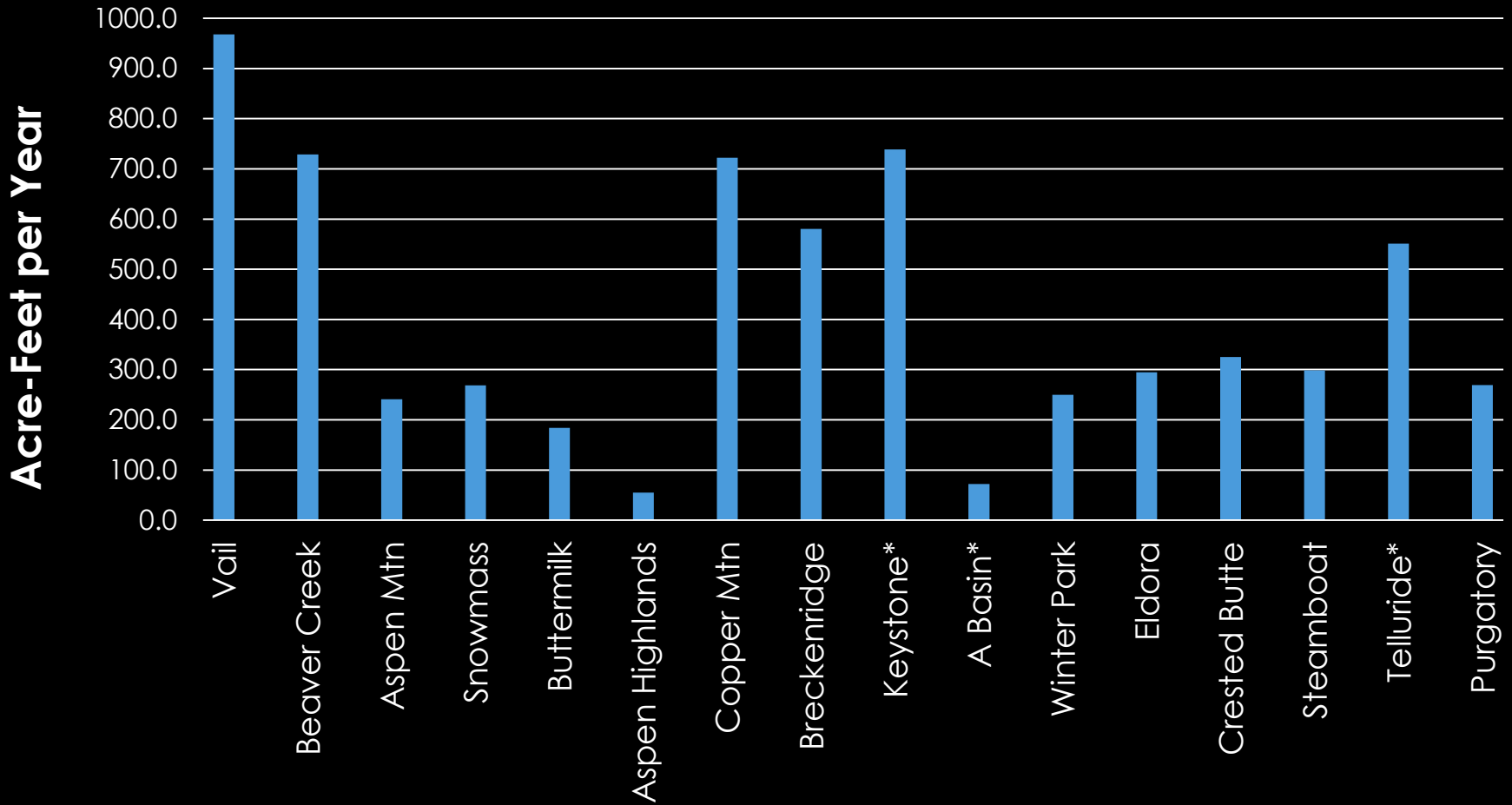


Approved Snowmaking, Percent of Total *Potential* Acreage[‡]



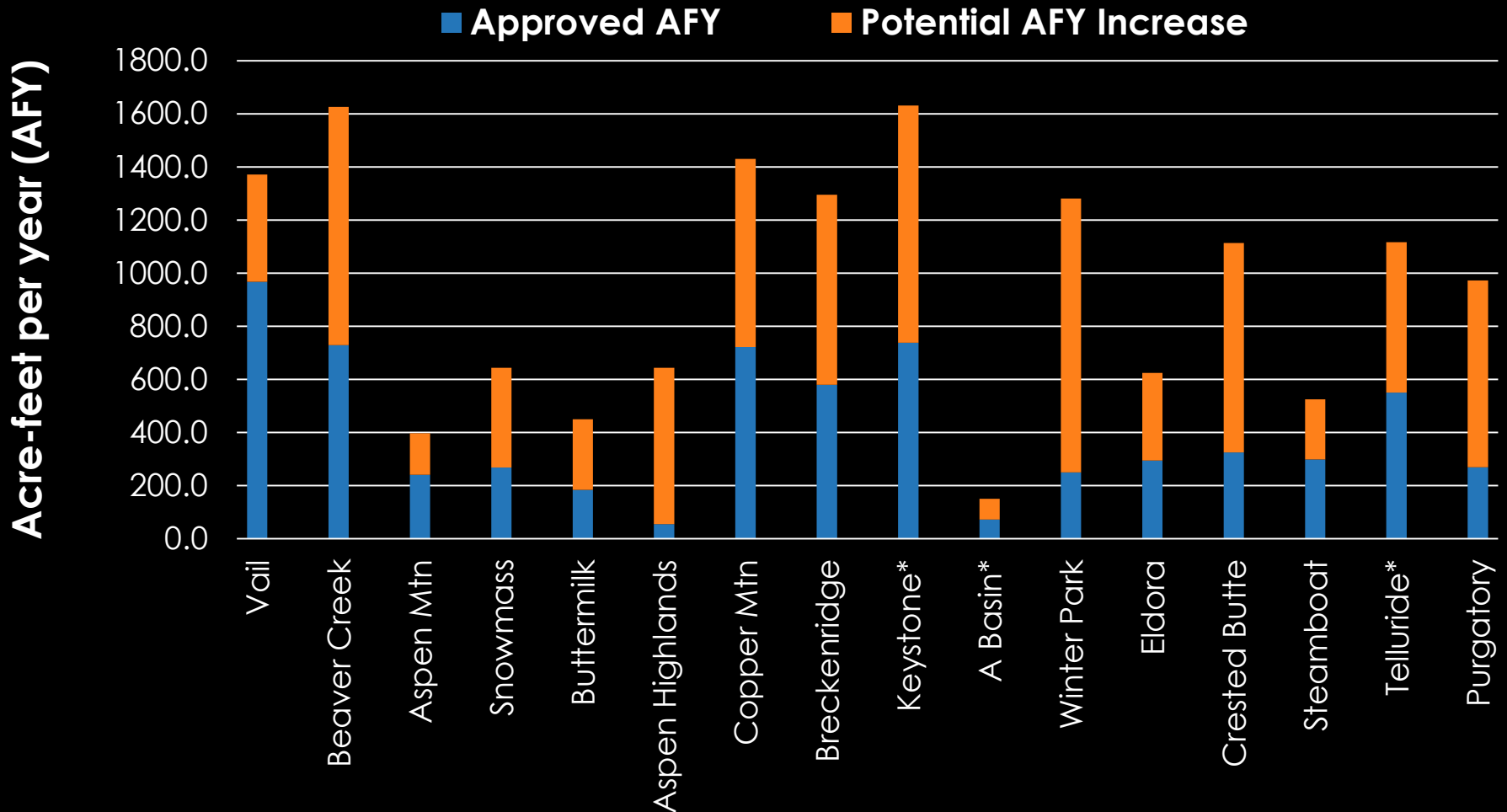
[‡]Glades, gated runs, & terrain above treeline are excluded from potential acres

Snowmaking Volume Currently Approved



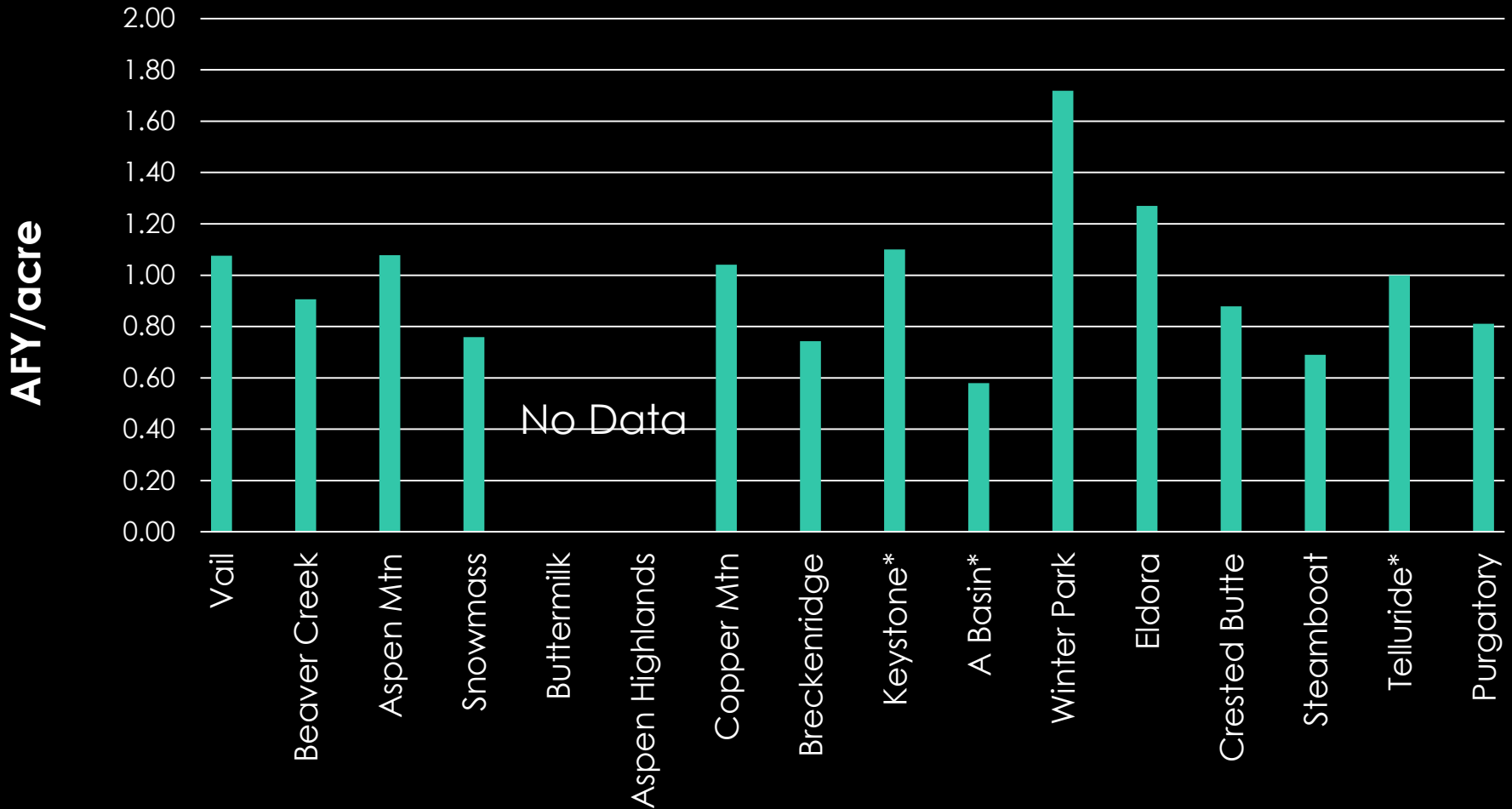
**Data for resorts marked with an asterisk (*) are based on most recent MDPs*

Approved Snowmaking, as Percent of Total *Potential* Volume



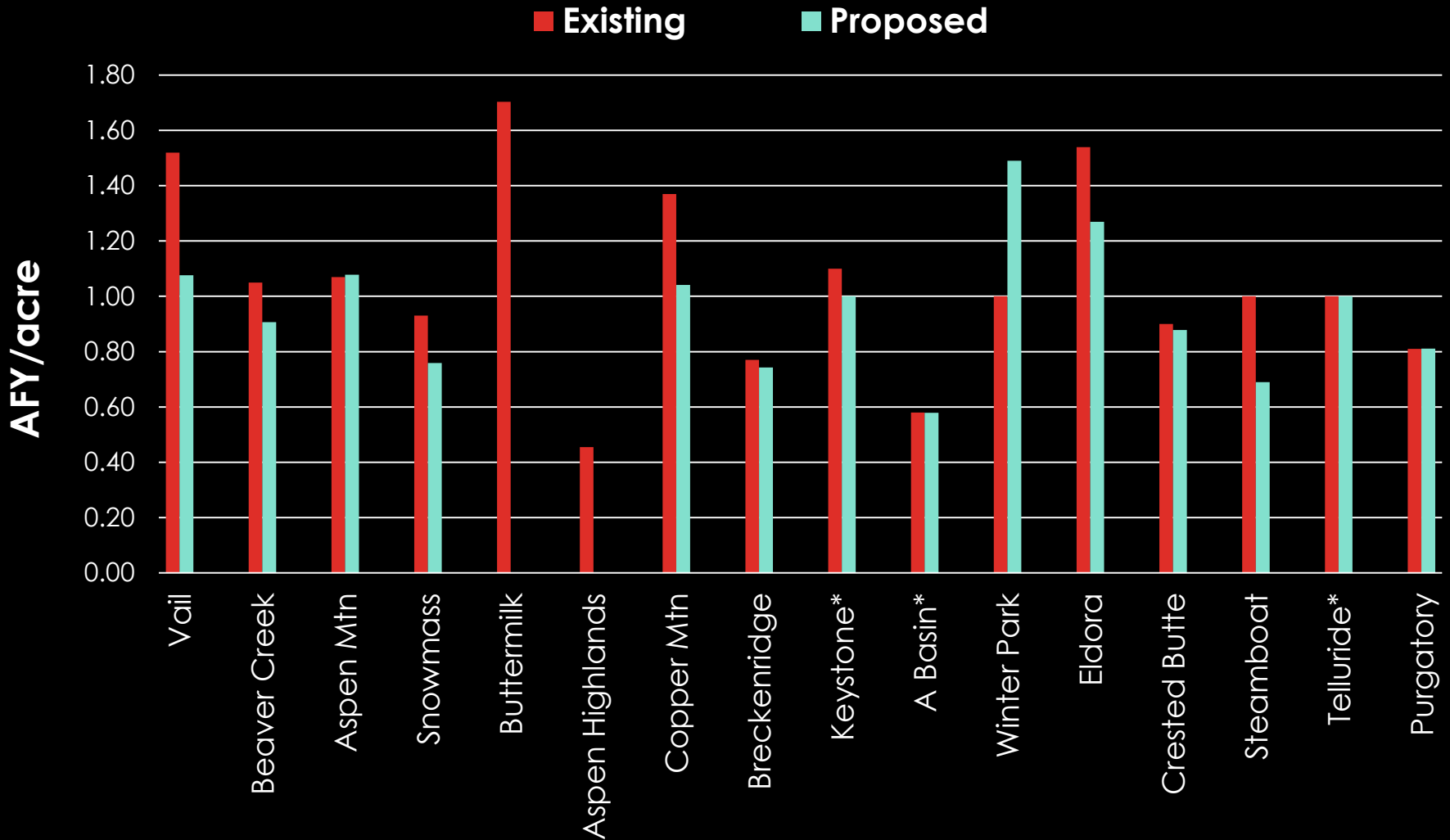
Assumes current snowmaking efficiencies persist, and no water restrictions

Proposed Snowmaking Efficiency



Higher numbers = lower efficiency due to old equipment, low elevations, etc.

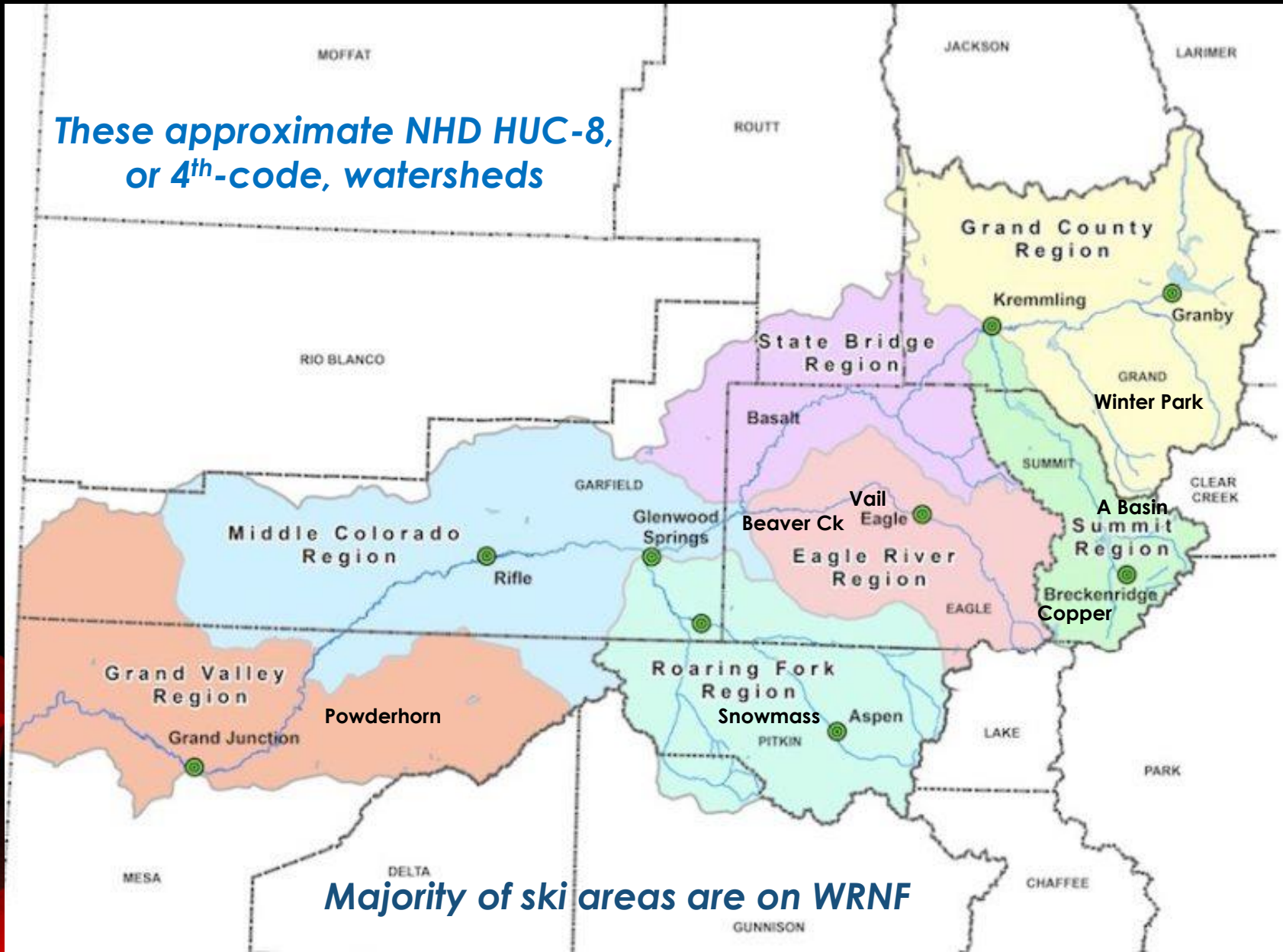
Snowmaking Efficiency



Proposed efficiencies do not include halfpipes and other terrain park features.

Colorado River watershed above its confluence with the Gunnison River

These approximate NHD HUC-8, or 4th-code, watersheds



Majority of ski areas are on WRNF

CO River losses if all WRNF snowmaking water is consumed:

Mean Annual Flow in Colorado River below Glenwood Springs, 1967-2018: **2,434,862 AFY***

Total snowmaking volume proposed in NEPA documents for WRNF ski areas, 2013 to 2018: **531.8 AFY**

Proposed snowmaking, as percent of mean annual flow: **0.022%**

Potential total snowmaking (existing + proposed + other potential), as percent of mean annual flow: **0.396%**

But most snowmaking water eventually returns to streams.

Colorado Ski Country USA (1986) performed an analysis based on the USFS' WRENS hydrologic model. Found that **20% to 25%** of snowmaking snow landing on slopes is lost to evaporation, transpiration, and sublimation.

An additional **5% to 7%** may be lost to:

- evaporation and sublimation during snowmaking;
- leaks, ice blockages and other inefficiencies in the snowmaking system itself.

Using conservative 30% consumptive loss, more realistic estimates for cumulative WRNF snowmaking impacts on the Colorado River are:

Total consumptive snowmaking proposed in WRNF ski area NEPA documents, 2013 to 2018: **159.5 AFY**

Proposed consumptive WRNF snowmaking, as percent of mean annual flow: **0.007%**

(flow is **15,262 times greater** than consumptive loss)

Potential total consumptive snowmaking (existing + proposed + other potential), as percent of mean annual flow: **0.119%**

Actual water diversions would be even less, due to:

- Increased snowmaking efficiency
- Water rights:
 - *diversion amount limits*
 - *prescribed uses*
 - *priority*
- USFWS biological opinions (BOs), including the Upper Colorado River (Above Gunnison River Confluence) Programmatic BO (1999)
- Additional **minimum instream flow** requirements (e.g., municipal)