Water yield monitoring and modeling at ski areas to inform vegetation management decisions in beetle-affected watersheds on the White River National Forest

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W TIEHACK
DO NOT
ENTER
Earth
Haulmark

What is happening at ski areas?

- Mountain pine beetle epidemic
- Dead trees pose hazards
- Dead stands do not meet desired conditions
- Vegetation management plans propose large clearcuts and partial harvest treatments
- Existing resource concerns
- New development proposals

What motivates the USFS to model water yield at ski areas?

- Increased water yield
- Rill and gully erosion
- Channel network extension
- Stream channel incision
- Unstable stream banks
- Sedimentation
- Landslides
- Debris flows

- Thresholds for:
- Resource damage
- Damage to infrastructure

Widespread tree mortality at ski areas demands action! There is already too much water in critical watersheds. We must balance the need for action with the need to protect resources and infrastructure.

Stream gauging – methods

- Pressure transducers
- Data loggers
- Staff gauges
- Discharge measurements
- Rating curves give discharge from stage
- Data processed using methods modified from USGS protocols

Water yield modeling – methods

- WRENSS (the original)
- Most useful for analyzing clear cuts
- Input cover type by aspect, gross precip.

$$\text{Runoff} = \text{PPT}_{gross} - \text{ET}$$

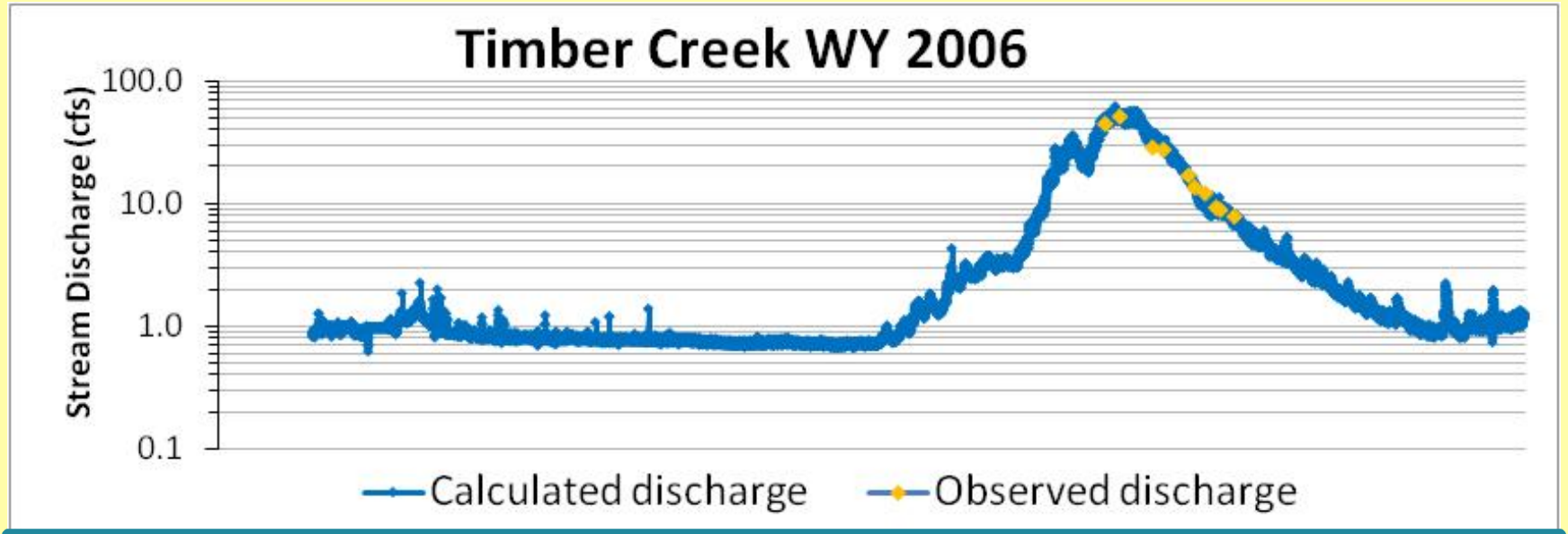
EPA, 1980. An Approach to water resources evaluation of non-point silvicultural sources – a procedural handbook. 1980. EPA-600/8-80-012. US EPA Environmental Research Laboratory. Athens, GA

- WRENSS (modified)
- Analyze partial harvest
- Analyze mortality
- Models canopy interception

$$\text{Runoff} = \text{PPT}_{net} - \text{ET}$$

Troendle, C.A. Nankervis, J.M. and Porth, L.S. 2003. The impact of Forest Service Activities on the Stream Flow Regime in the Platte River. Submitted to US Forest Service Region 2. Denver, CO

Calibrating and adjusting water yield models based on observations

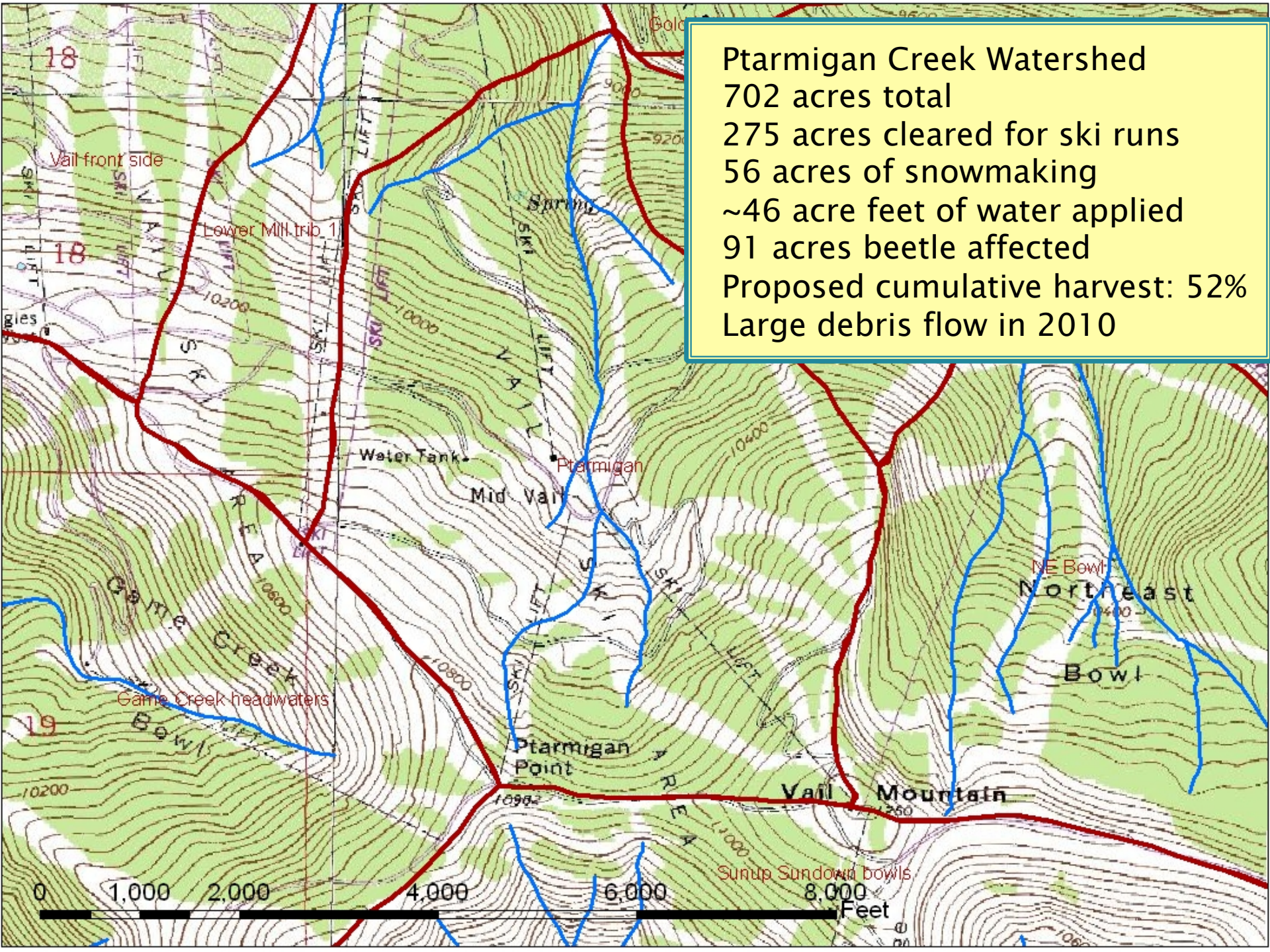


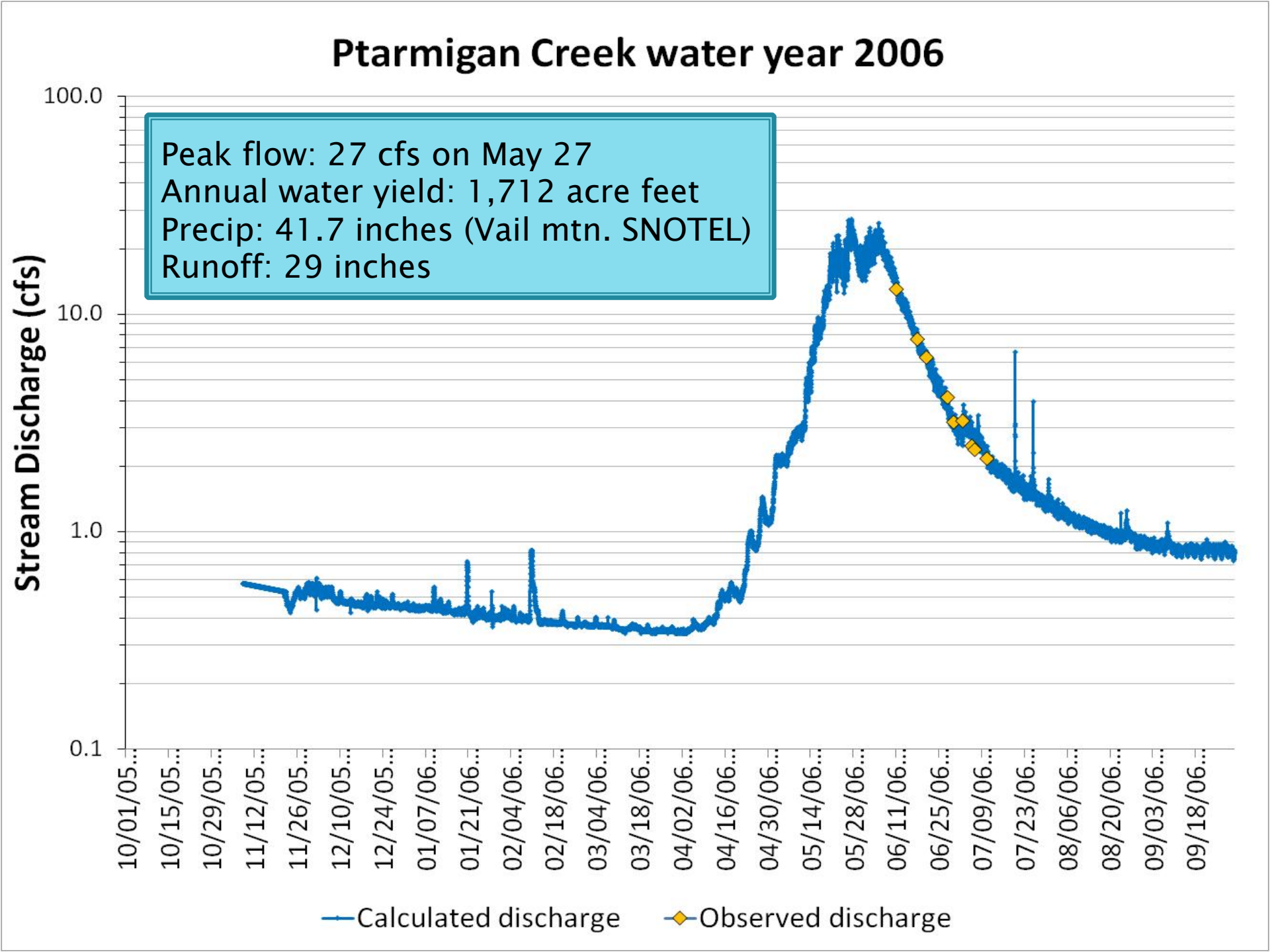
Calculate annual runoff from hydrograph

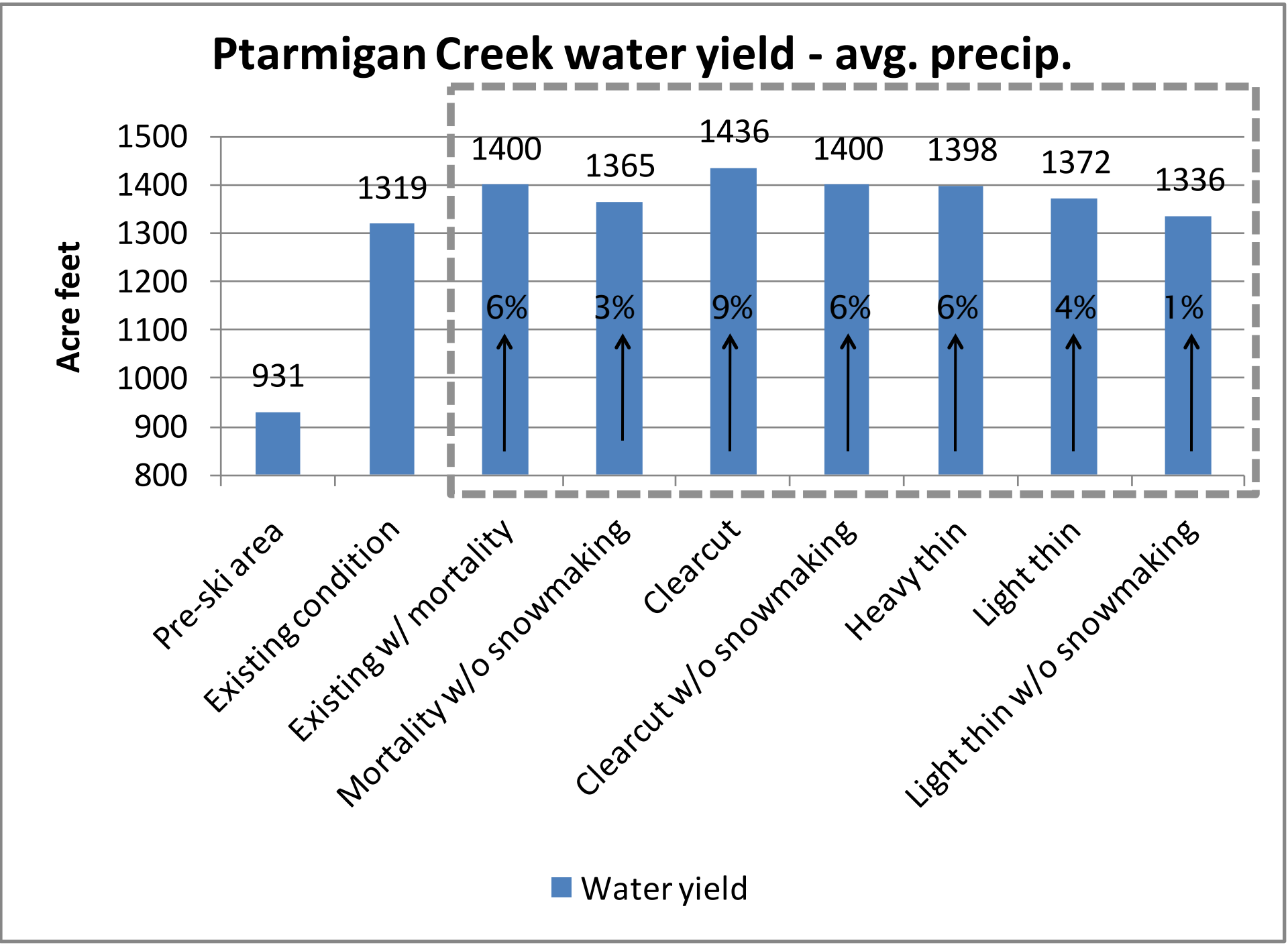
Model runoff for existing conditions using best available precip data

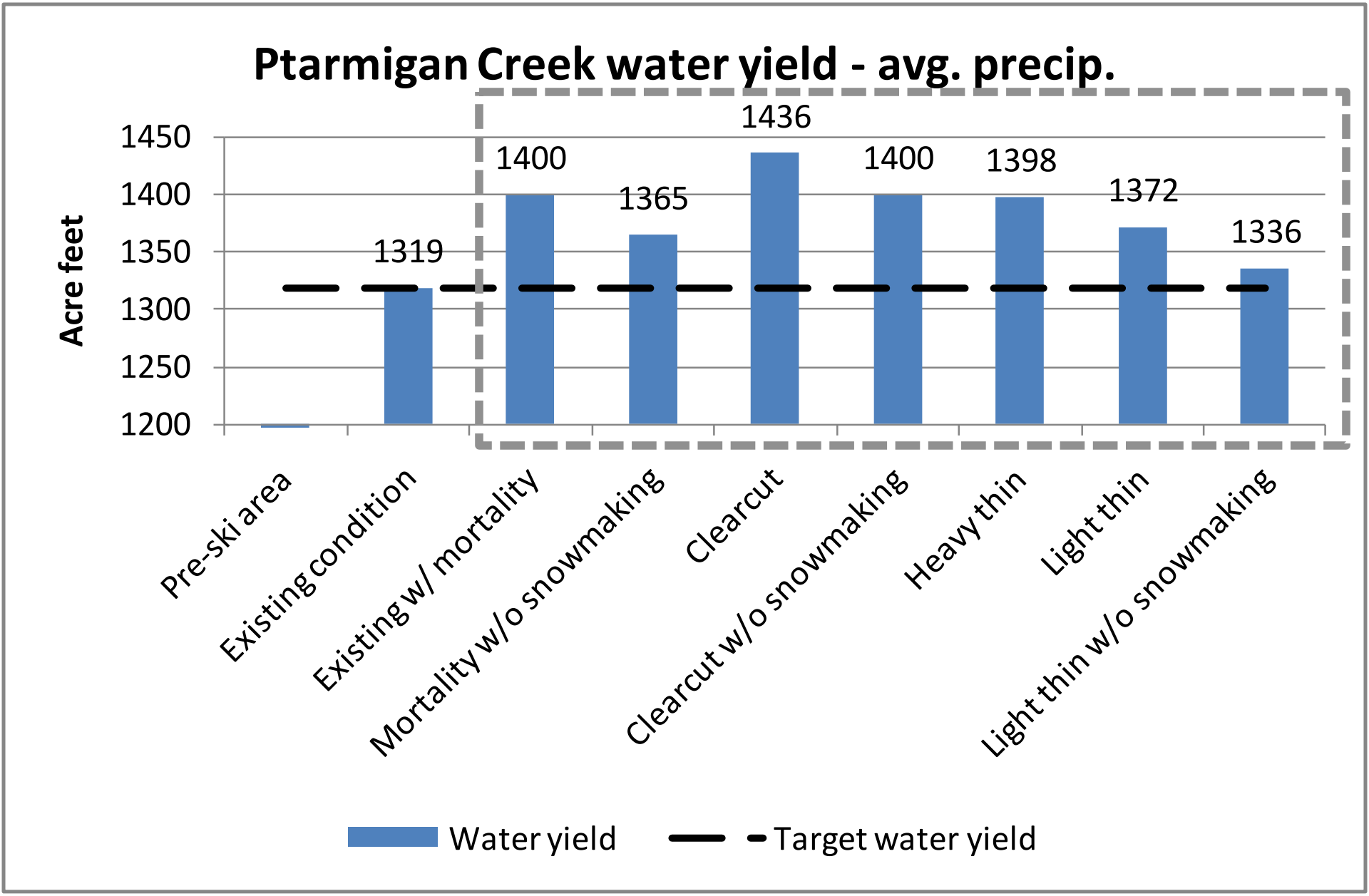
Adjust gross precipitation until modeled runoff equals measured

Model runoff for proposed or expected conditions


Ptarmigan Creek Watershed
702 acres total
275 acres cleared for ski runs
56 acres of snowmaking
~46 acre feet of water applied
91 acres beetle affected
Proposed cumulative harvest: 52%
Large debris flow in 2010
Vail front side
Lower Mill trib 1
Spring
Water Tank
Ptarmigan
Mid Vail
Game Creek
Game Creek headwaters
Ptarmigan Point
Vail Mountain
NE Bowl
Northeast
Bowl
Sunup Sundown bowls
0
1,000
2,000
4,000
6,000
8,000
Feet


Ptarmigan Creek water year 2006
Peak flow: 27 cfs on May 27
Annual water yield: 1,712 acre feet
Precip: 41.7 inches (Vail mtn. SNOTEL)
Runoff: 29 inches
Stream Discharge (cfs)
100.0
10.0
1.0
0.1
10/01/05...
10/15/05...
10/29/05...
11/12/05...
11/26/05...
12/10/05...
12/24/05...
01/07/06...
01/21/06...
02/04/06...
02/18/06...
03/04/06...
03/18/06...
04/02/06...
04/16/06...
04/30/06...
05/14/06...
05/28/06...
06/11/06...
06/25/06...
07/09/06...
07/23/06...
08/06/06...
08/20/06...
09/03/06...
09/18/06...
Calculated discharge
Observed discharge


Ptarmigan Creek water yield - avg. precip.
Acre feet
1500
1400
1300
1200
1100
1000
900
800
931
1319
1400
1365
1436
1400
1398
1372
1336
6%
3%
9%
6%
6%
4%
1%
Pre-ski area
Existing condition
Existing w/ mortality
Mortality w/o snowmaking
Clearcut
Clearcut w/o snowmaking
Heavy thin
Light thin
Light thin w/o snowmaking
Water yield


Ptarmigan Creek water yield - avg. precip.
Acre feet
1450
1400
1350
1300
1250
1200
1319
1400
1365
1436
1400
1398
1372
1336
Pre-ski area
Existing condition
Existing w/ mortality
Mortality w/o snowmaking
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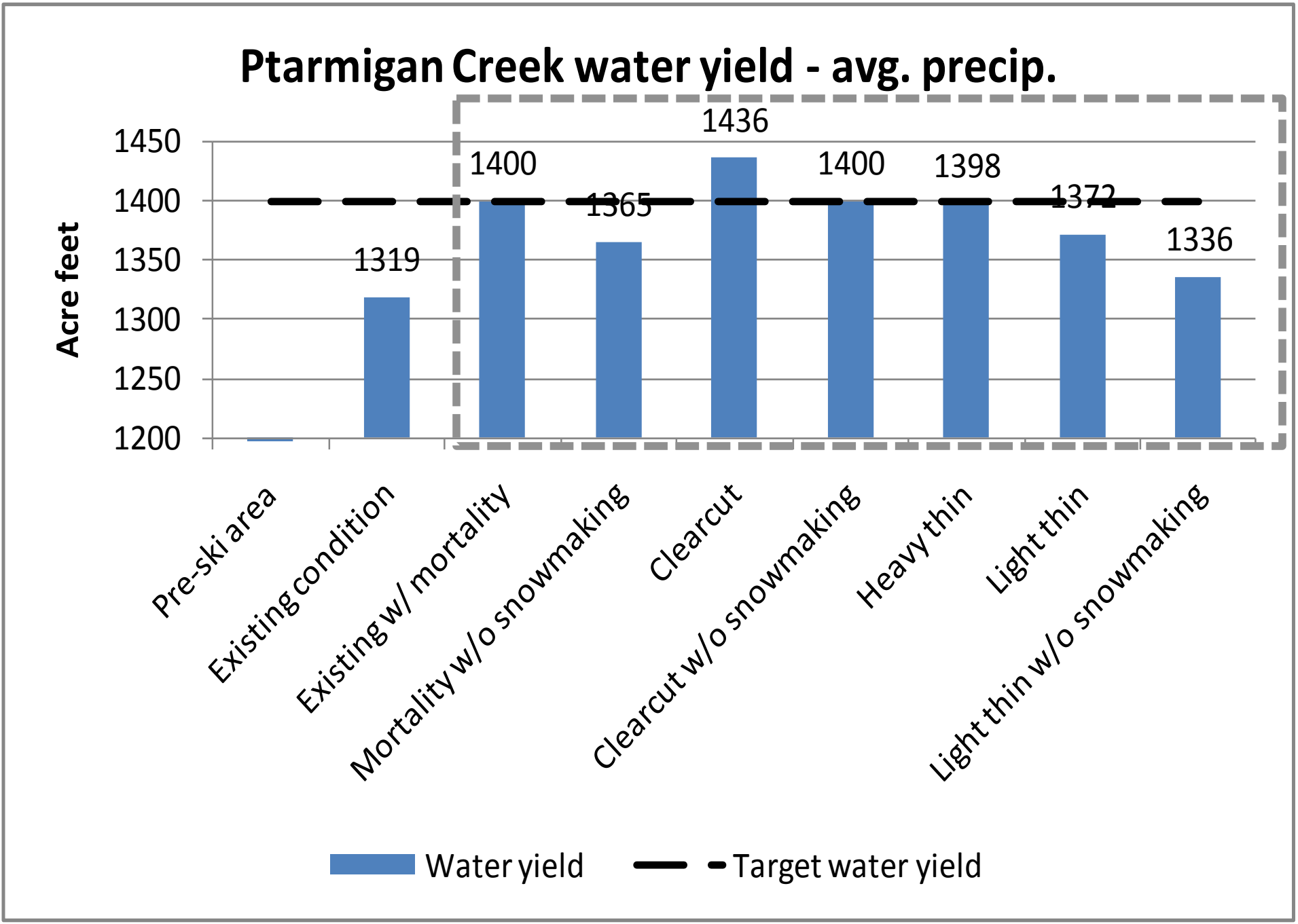
Clearcut w/o snowmaking
Heavy thin
Light thin
Light thin w/o snowmaking
Water yield
Target water yield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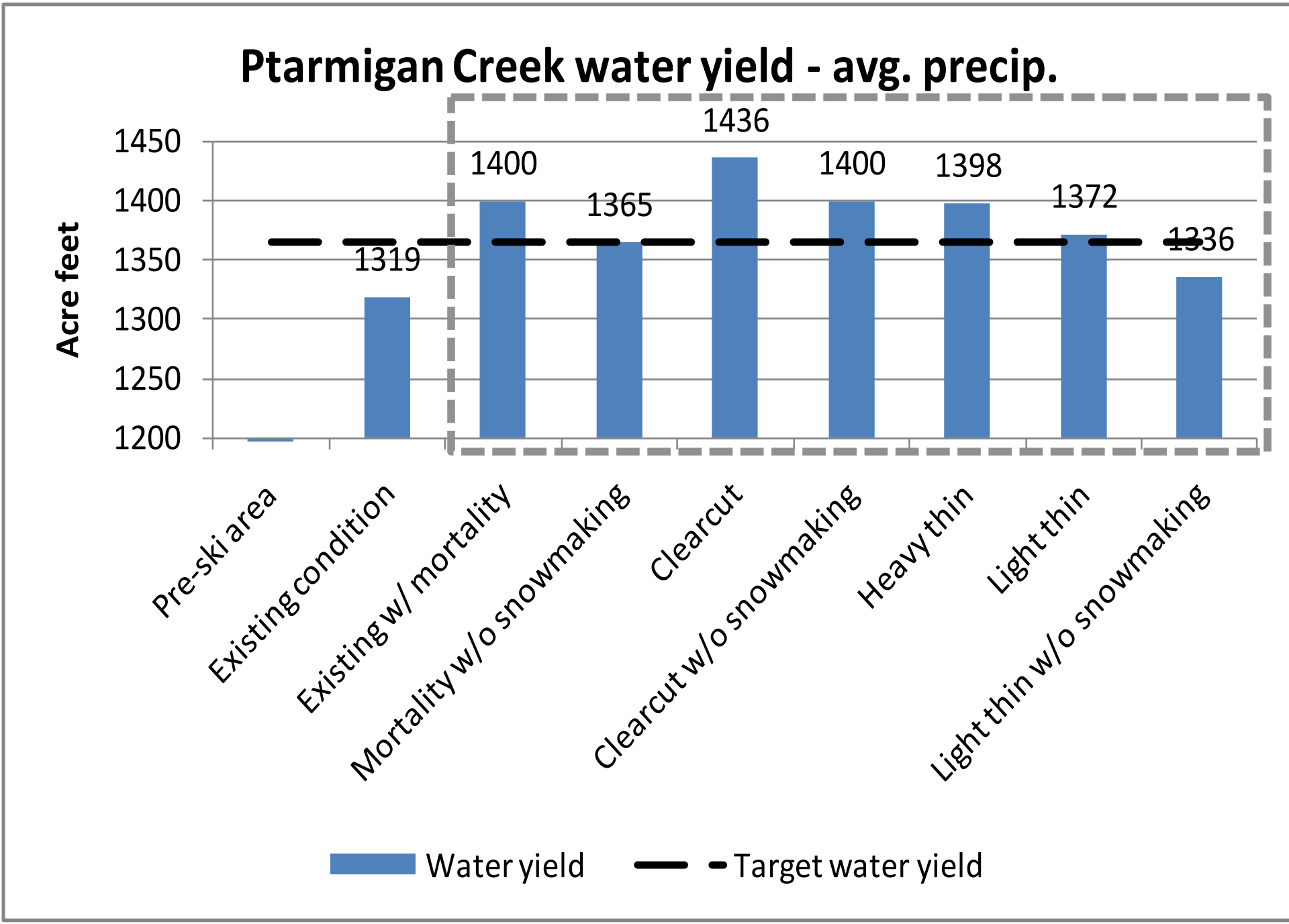
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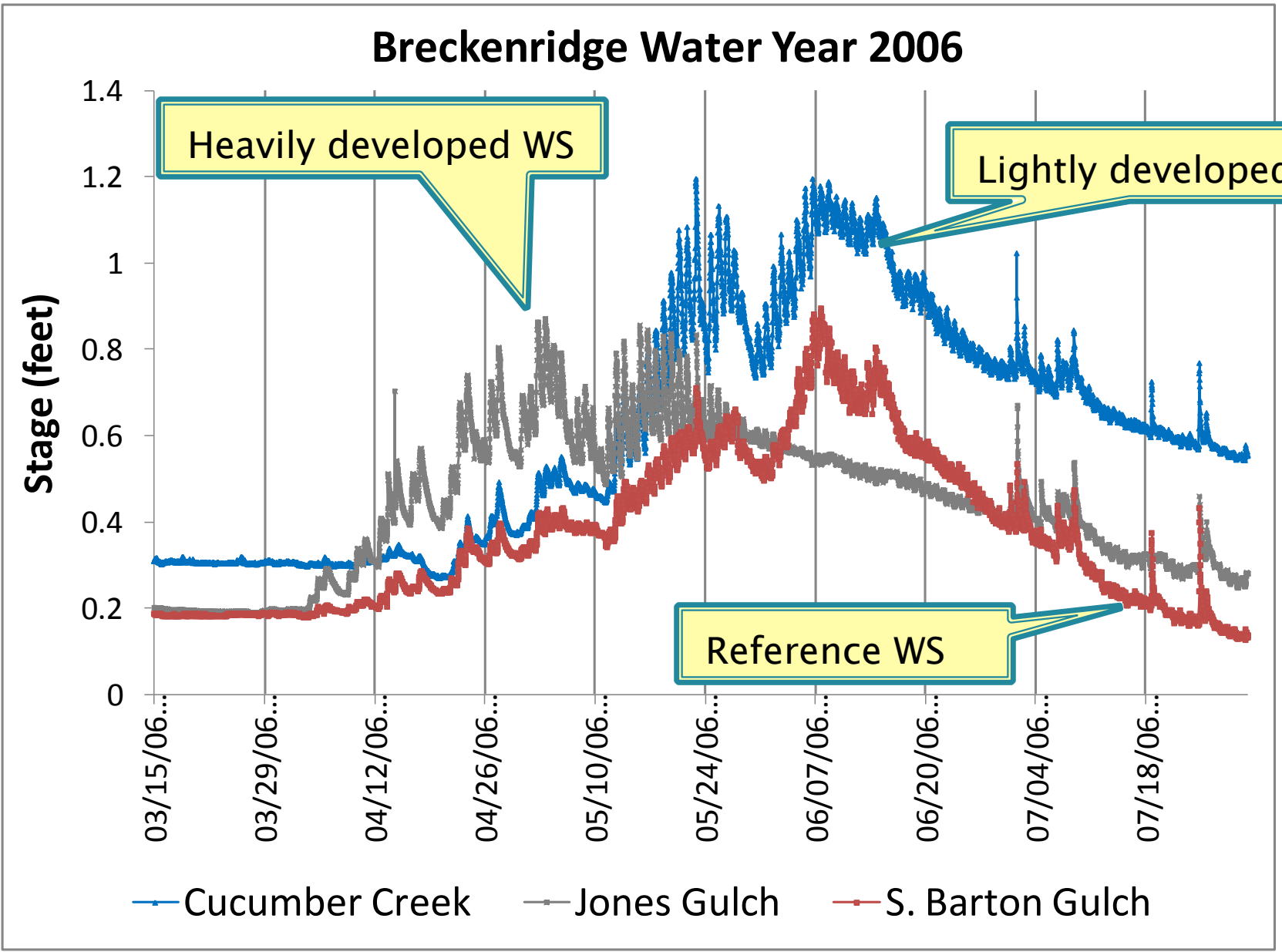
Water yield
Target water yield

The hydrologic effects of the pine beetle epidemic will be in addition to changes caused by past management actions.



Conclusions

- WRENSS is useful for informing management decisions on intensively managed landscapes where unacceptable consequences could occur
- Bark beetle effects will be in addition to the effects of past management
- Response to beetle mortality is likely to have greater effect than mortality alone
- Relative comparisons using WRENSS require little calibration, however calibrated models are more useful for defining specific water yield targets
- Overall water yield is a more readily predictable indicator than peak flow, though not necessarily the most applicable in terms of cause and effect
- Water yield monitoring and modeling on the White River National Forest provides a strong basis for further study

Questions?