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A method of deriving operation-specific ski run classes for avalanche risk management decisions in mechanized skiing

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Table S1: Qualitative run characterization with attribute names and levels.

Attribute name	Question	Levels
Access		
Required flying conditions	How do you generally feel about the accessibility of this run when the cluster of runs is accessible?	1. I can always get to this run. 2. It is often possible to make this work. 3. Conditions need to line up to make this work. 4. Flying conditions need to be perfect to consider this run
Particular pickup features	What other access feature of the pickup(s) of this run stand out?	1. Avalanche overhead hazard during regular cycles. 2. Avalanche overhead hazard during large cycles. 3. Common presence of triggers for overhead avalanche hazards
Type of Terrain		
Type of terrain	What type(s) of skiing terrain does this run include?	1. Glaciated terrain 2. Non-glaciated alpine terrain 3. Extreme alpine terrain (faces) 4. Open slopes at tree line or below tree line 5. Glades at tree line or below tree line 6. Open canopy/snow forest (individual tree crowns do not overlap) 7. Burnt forest 8. Cut blocks 9. Large avalanche path formed from above 10. Dense forest 11. Open planar slopes 12. Highly featured/convoluted terrain
Skiing Experience		
Skiing difficulty	What is the difficulty level of this run when conditions are good?	1. Easy 2. Moderate 3. Challenging
Overall guest experience	When the conditions on this run are good, what is your opinion of the overall skiing experience that his run offers?	1. Poor (Happy to move on) 2. Fair (Not bad skiing) 3. Good (A good product) 4. Very good (This is why guests come back for more) 5. Exceptional (Life changing mountain experience)

Table S1: Continued.

Attribute name	Question	Levels
Operational Role(s)		
Operational role(s)	What particular operational role(s) does this run have in your program?	1. Safe and accessible under almost all conditions run 2. Signature run (defines your operation) 3. Destination run (objective of a circuit) 4. Bread and butter run (high efficiency production run) 5. Key jump run (might not have good skiing, but makes a circuit work) 6. Time management run (can be used to keep busy for a while, e.g., during fuel run) 7. Regular lunch run 8. Not preferred run (only considered if running out of options for reasonable skiing) 9. Open season run (only considered under bombproof conditions) 10. Rarely visited, but important under special circumstance
Hazard Potential		
Steepness	What is the steepness of the most serious slopes on this run?	1. Gentle (no significant avalanche slopes on ski lines) 2. Moderately steep (concerned about avalanches under specific condition) 3. Moderate with steep pitches (always concerned about avalanches) 4. Sustained steep (always concerned about avalanches)
Exposure to avalanche slopes on the ski line(s)	If moderately steep or steep, what is the exposure to avalanche slopes on this run?	1. A single smaller avalanche slope capable of producing Size 1.5-2.5 2. Multiple smaller avalanche slopes capable of producing Size 1.5-2.5 3. Large avalanche slopes producing Size 3.0 or larger
Avalanche related terrain hazards	What avalanche related terrain hazards stand out on this run?	1. Avalanche overhead hazard during regular cycles (Size 3.0 or smaller) 2. Avalanche overhead hazard during large events only (Size 3.5 or larger) 3. Common presence of triggers for overhead avalanche hazard (e.g., ice fall, cornice) 4. Unavoidable unsupported terrain shapes 5. Lack of surface roughness 6. Frequent performers that retain hazard and wait for human triggering 7. Frequent natural avalanche which stabilize the slope 8. High consequence terrain when caught
Other hazards	What other hazards stand out on this run?	1. Crevasse hazard, isolated 2. Crevasse hazard, widespread and/or unavoidable 3. Cornices directly affecting the ski line(s) 4. Tree well hazard 5. Open creeks, vent holes, rock crevasses 6. Particularly large tree bombs 7. Potentially particularly challenging for rescues and/or finding a lost skier
Overall friendliness	In terms of hazards, what is your sense of the overall friendliness of the terrain on this run?	1. Very friendly 2. Friendly 3. Neutral 4. Unfriendly 5. Very unfriendly

Table S1: Continued.

Attribute name	Question	Levels
Guide-ability		
Guide-ability	What is your opinion of the guide-ability of this run?	1. Very easy (i.e., the terrain naturally leads guests to the right line) 2. Easy 3. Difficult 4. Very difficult (i.e., requires detailed instructions and a close eye on the guest)

Table S2: Average seasonal and overall percentages of run list ratings for the six groups of similarly managed ski runs at NEH.

Group	n	Run list rating	2013	2014	2015	2016	2017	Overall
1	8	open	97%	97%	94%	98%	>99%	97%
		closed due to avalanche hazard	<1%	3%	<1%	<1%	<1%	1%
		other hazards / not discussed	2%	0%	5%	1%	0%	2%
2	9	open	95%	79%	61%	91%	>99%	86%
		closed due to avalanche hazard	1%	21%	3%	5%	<1%	6%
		other hazards / not discussed	4%	0%	36%	4%	0%	9%
3	2	open	98%	90%	69%	97%	63%	84%
		closed due to avalanche hazard	0%	10%	<1%	0%	1%	2%
		other hazards / not discussed	2%	0%	30%	3%	36%	15%
4	13	open	87%	80%	79%	74%	85%	81%
		closed due to avalanche hazard	10%	20%	5%	14%	12%	12%
		other hazards / not discussed	3%	0%	16%	12%	3%	7%
5	13	open	56%	28%	61%	53%	36%	47%
		closed due to avalanche hazard	42%	71%	30%	39%	64%	49%
		other hazards / not discussed	2%	1%	9%	8%	0%	4%
6	14	open	31%	18%	35%	33%	25%	29%
		closed due to avalanche hazard	67%	82%	36%	50%	70%	61%
		other hazards / not discussed	2%	<1%	29%	17%	5%	10%

Table S3: Average seasonal and overall percentages of run list ratings for the seven groups of similarly

Group	n	Run list rating	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Overall
1	44	open	95%	95%	91%	90%	97%	86%	96%	92%	92%	98%	95%	93%
		closed due to avalanche hazard	3%	4%	5%	7%	<1%	6%	<1%	4%	5%	<1%	<1%	3%
		other hazards / not discussed	2%	1%	4%	3%	3%	8%	3%	4%	3%	1%	5%	4%
2	38	open	81%	77%	82%	67%	85%	59%	86%	76%	77%	94%	93%	80%
		closed due to avalanche hazard	15%	20%	13%	27%	6%	20%	5%	17%	14%	3%	2%	13%
		other hazards / not discussed	4%	3%	5%	6%	9%	21%	9%	7%	9%	3%	5%	7%
3	48	open	67%	56%	62%	48%	62%	40%	65%	50%	52%	78%	74%	59%
		closed due to avalanche hazard	27%	39%	31%	41%	18%	35%	23%	39%	35%	18%	20%	30%
		other hazards / not discussed	6%	5%	7%	11%	20%	25%	12%	11%	13%	4%	6%	11%
4	12	open	55%	43%	52%	42%	49%	27%	47%	32%	44%	70%	60%	47%
		closed due to avalanche hazard	33%	49%	37%	45%	10%	25%	29%	35%	35%	21%	33%	32%
		other hazards / not discussed	12%	8%	11%	13%	41%	48%	24%	33%	21%	9%	7%	21%
5	31	open	45%	29%	37%	28%	35%	22%	40%	25%	36%	60%	46%	37%
		closed due to avalanche hazard	48%	64%	56%	60%	35%	50%	48%	61%	51%	35%	49%	51%
		other hazards / not discussed	7%	7%	7%	12%	30%	28%	12%	14%	13%	5%	5%	13%
6	21	open	35%	22%	33%	21%	29%	18%	30%	17%	29%	57%	38%	30%
		closed due to avalanche hazard	48%	67%	52%	63%	16%	29%	39%	44%	46%	31%	53%	44%
		other hazards / not discussed	17%	11%	15%	16%	55%	53%	31%	39%	25%	12%	9%	26%
7	33	open	18%	10%	17%	5%	10%	9%	15%	10%	21%	32%	26%	16%
		closed due to avalanche hazard	70%	81%	73%	81%	50%	53%	70%	71%	62%	62%	68%	67%
		other hazards / not discussed	12%	9%	10%	14%	40%	38%	15%	19%	17%	6%	6%	17%