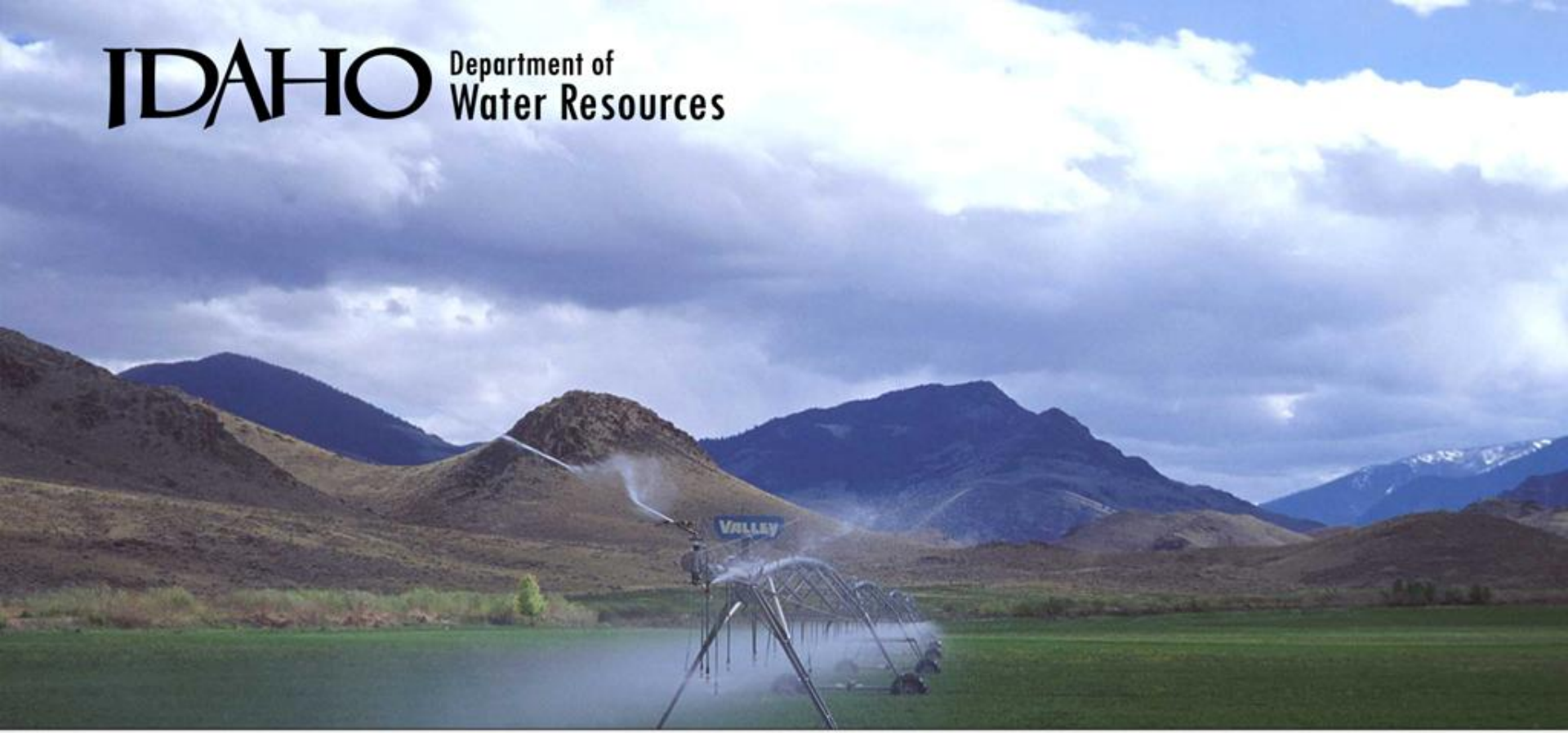


Big Wood: Winter Evapotranspiration and Areal Recharge

Presented by Mike McVay
Wood River MTAC October 3, 2013

Winter ET

We can estimate Growing Season Evapotranspiration (ET) with METRIC and NDVI better than using the K_c x ET_r Method. What about Winter ET?

METRIC is not applicable/available for winter months.

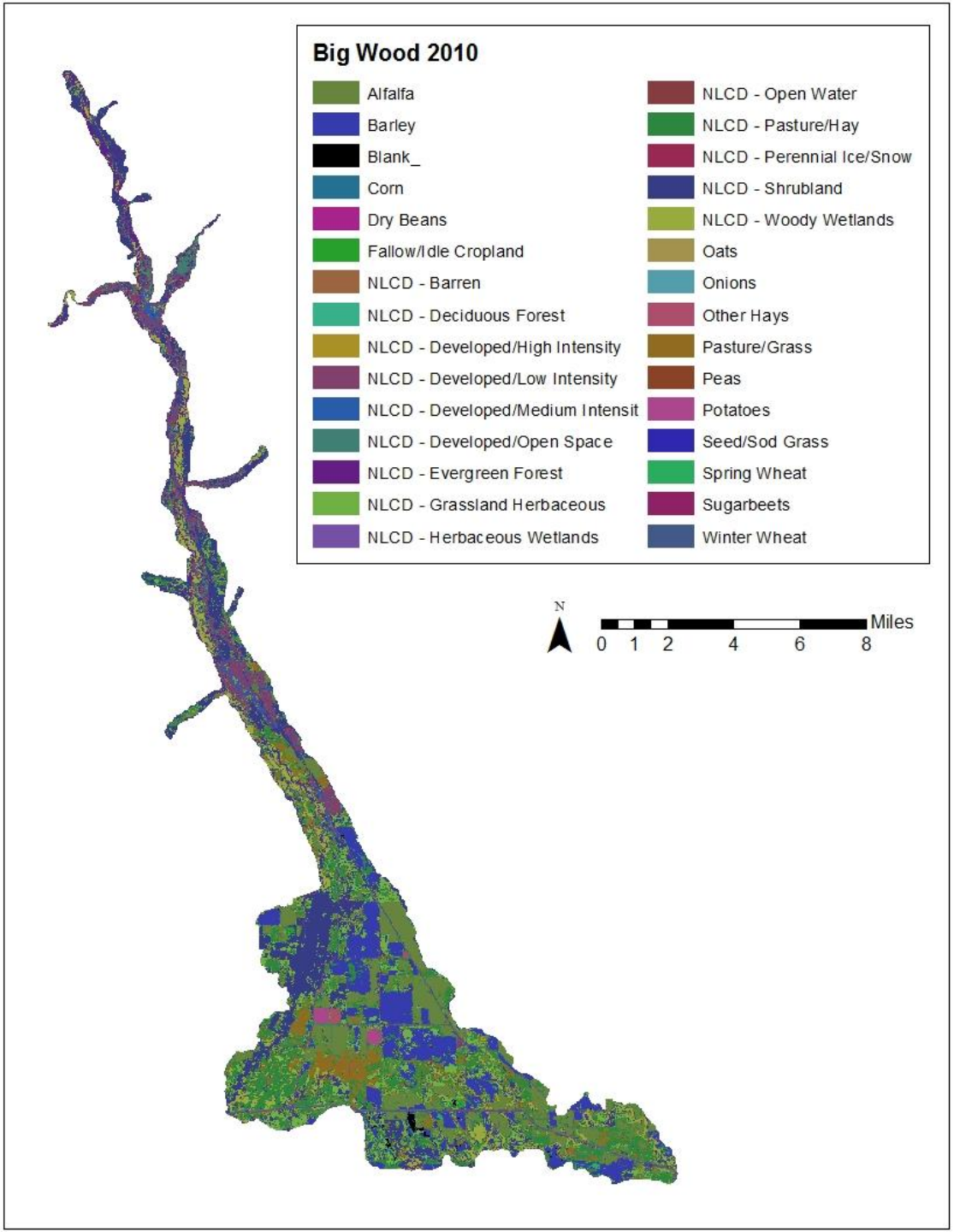
Need to employ another method to estimate Winter ET.

ET Idaho has information that we can use…based on land use.

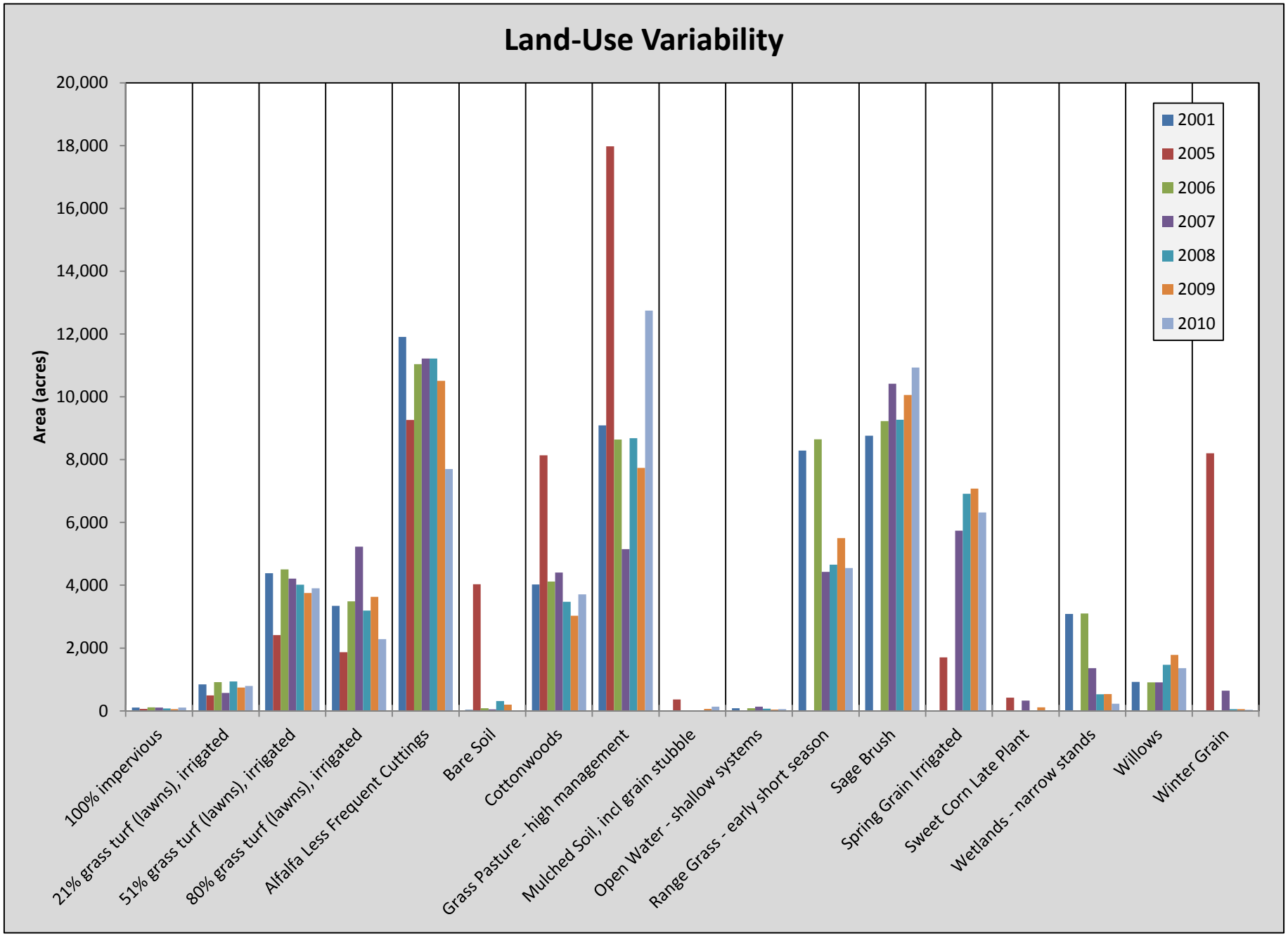
Land Use and Winter ET

Previously discussed the unreliable nature of county crop data. Also discussed availability of GIS-based land-use data for 2001, 2005, 2006, 2007, 2008, 2009, 2010.

Although the GIS data appear to be generally representative, there are still some large and unexplained year-to-year land-use differences.



Although there are many land-use classifications, not all are in ET Idaho. ET Idaho classes were assigned according to Bartolino, 2007.


Land-Use Variability
Area (acres)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2001
2005
2006
2007
2008
2009
2010
100% impervious
21% grass turf (lawns), irrigated
51% grass turf (lawns), irrigated
80% grass turf (lawns), irrigated
Alfalfa Less Frequent Cuttings
Bare Soil
Cottonwoods
Grass Pasture - high management
Mulched Soil, incl grain stubble
Open Water - shallow systems
Range Grass - early short season
Sage Brush
Spring Grain Irrigated
Sweet Corn Late Plant
Wetlands - narrow stands
Willows
Winter Grain

Land Use and Winter ET

Winter ET is largely a function of cover, not land use.

During the winter, the majority of plants stop transpiring. Evaporation/sublimation (ablation) continues at a much reduced rate. The rate depends largely on insulating cover.

In ET Idaho, winter ET rates fall into 3 general categories:

1. Bare Soil
2. Covered Soil (covered with non-growing vegetation)
3. Partially Covered Soil.

Since the ET rates are small during winter months, the volumetric differences in ablated water is small between land-use types.

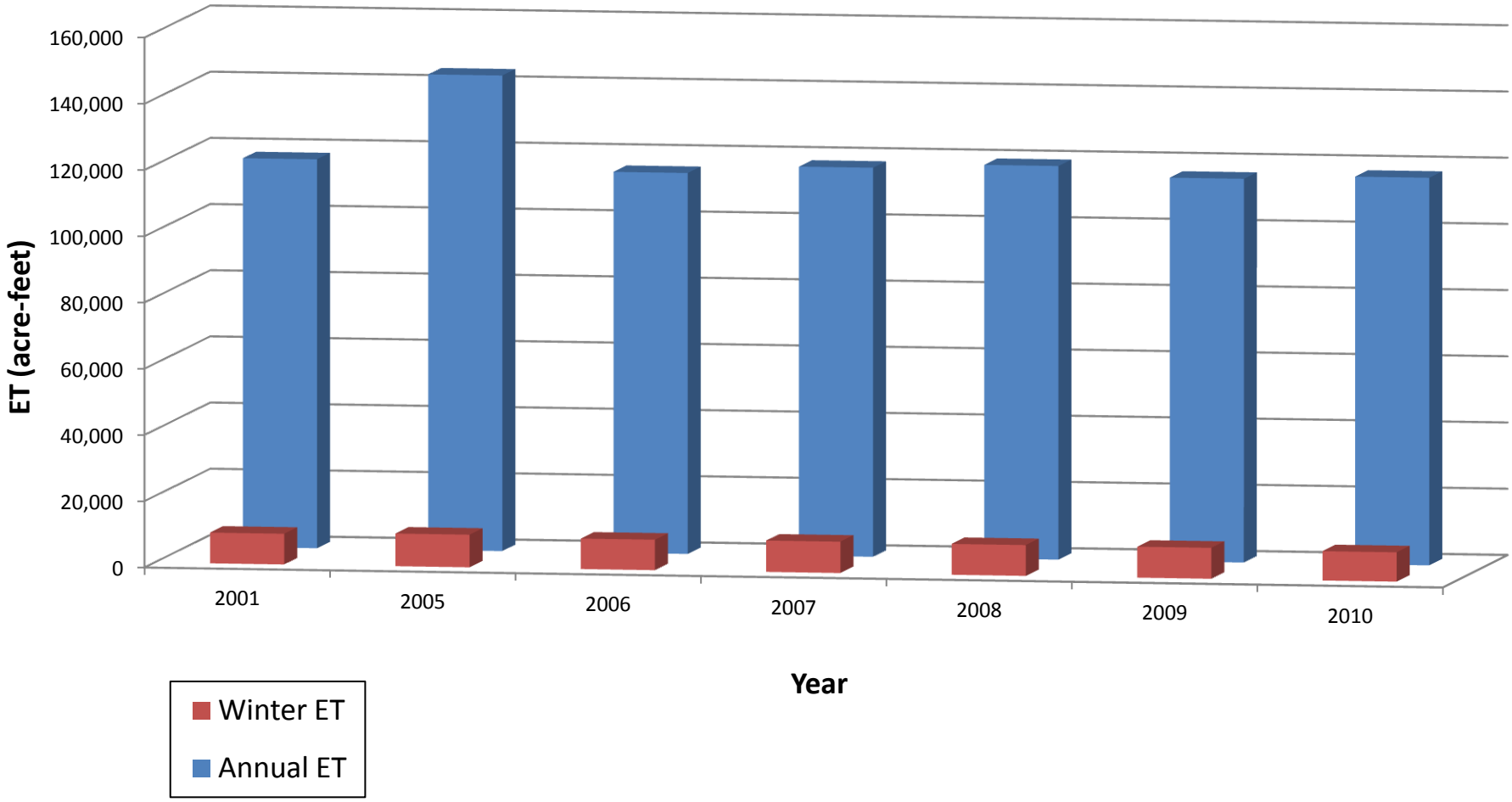
Land Use and Winter ET

Average ET rates (mm/day)

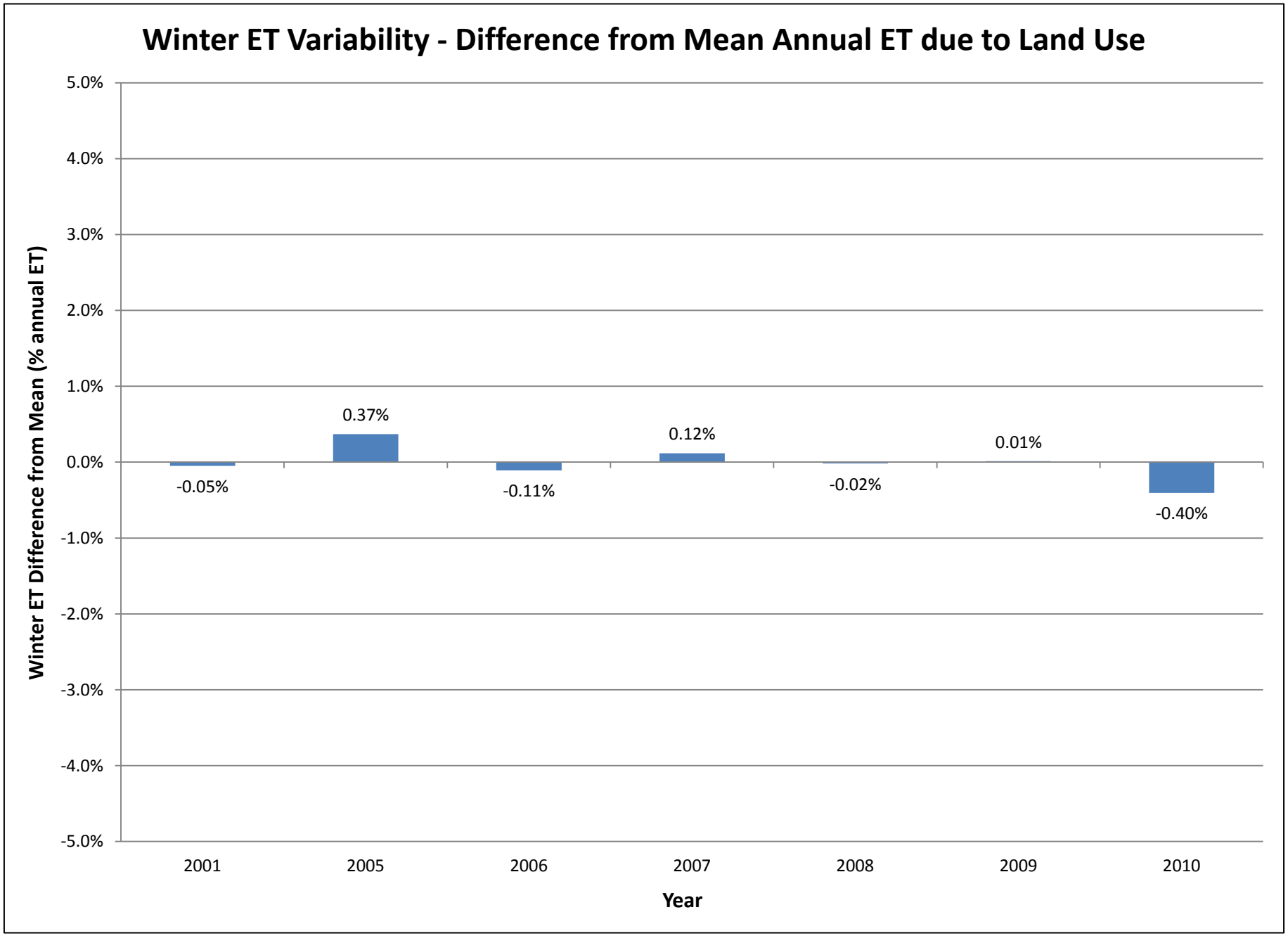
Picabo	Nov	Dec	Jan	Feb	Mar
100% impervious	0	0	0	0	0
21% grass turf (lawns), irrigated	0.21	0.11	0.14	0.23	0.45
51% grass turf (lawns), irrigated	0.21	0.11	0.14	0.23	0.45
80% grass turf (lawns), irrigated	0.21	0.11	0.14	0.23	0.45
Alfalfa Less Frequent Cuttings	0.47	0.29	0.36	0.58	0.88
Bare Soil	0.4	0.28	0.36	0.57	0.81
Cottonwoods	0.32	0.2	0.25	0.39	0.71
Grass Pasture - high management	0.21	0.11	0.14	0.23	0.45
Mulched Soil, incl grain stubble	0.3	0.2	0.25	0.39	0.67
Open Water - shallow systems	0.68	0.29	0.34	0.63	1.32
Range Grass - early short season	0.3	0.2	0.25	0.39	0.7
Sage Brush	0.3	0.2	0.25	0.39	0.7
Spring Grain Irrigated	0.3	0.2	0.25	0.39	0.69
Sweet Corn Late Plant	0.42	0.29	0.36	0.58	0.88
Wetlands - narrow stands	0.32	0.2	0.25	0.39	0.71
Willows	0.33	0.2	0.25	0.39	0.72
Winter Grain	0.44	0.28	0.35	0.57	1.07

Since the ET rates are small during winter months, the volumetric differences in ablated water is small between land-use types.

ET Variation due to Land Use



ET calculated using GIS land-use and average ET rates from ET Idaho. Does not consider weather.


Winter ET Variability - Difference from Mean Annual ET due to Land Use
Winter ET Difference from Mean (% annual ET)
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
-1.0%
-2.0%
-3.0%
-4.0%
-5.0%
-0.05%
0.37%
-0.11%
0.12%
-0.02%
0.01%
-0.40%
2001
2005
2006
2007
2008
2009
2010
Year

Variability in Winter ET

Using the CDL and NLCD GIS data sets, and ET Idaho monthly average ET rates :

Average Growing Season ET = 121,000 AF
Winter ET = 9,300 AF.

Winter ET is 8% of Growing Season ET.

The maximum uncertainty due to land use is approximately **0.4%** of the annual ET. Therefore, inaccuracies in the land-use data appears to be negligible for Winter ET estimation.

Propose using ETIdaho daily data from Picabo AgriMet in conjunction with the CDL and NLCD land-use data to estimate Winter ET.

However, we don’t have ET Idaho data for Hailey and Ketchum.

Variability in Winter ET

Winter ET is also influenced by elevation. Higher elevations are generally colder and get more snow, which can reduce ET.

Station	Elevation
Picabo Agrimet	4900
Hailey Range Station	5350
Ketchum Ranger Station	5890
Mackay Ranger Station	5910

Average Fraction of Picabo	Nov	Dec	Jan	Feb	Mar
Hailey	1.01	1.02	0.98	0.92	0.74
Mackay (sub for Ketchum)	0.77	0.92	0.88	0.81	0.70

Propose using Picabo AgriMet Winter ET values, adjusted for elevation.

Adjust Picabo ET	Nov	Dec	Jan	Feb	Mar
Hailey	--	--	--	-10%	-25%
Ketchum	-25%	-10%	-10%	-20%	-30%

Winter Areal Recharge

Due to freezing temperatures, there may be temporal dislocation of Winter Precipitation and Winter Recharge.

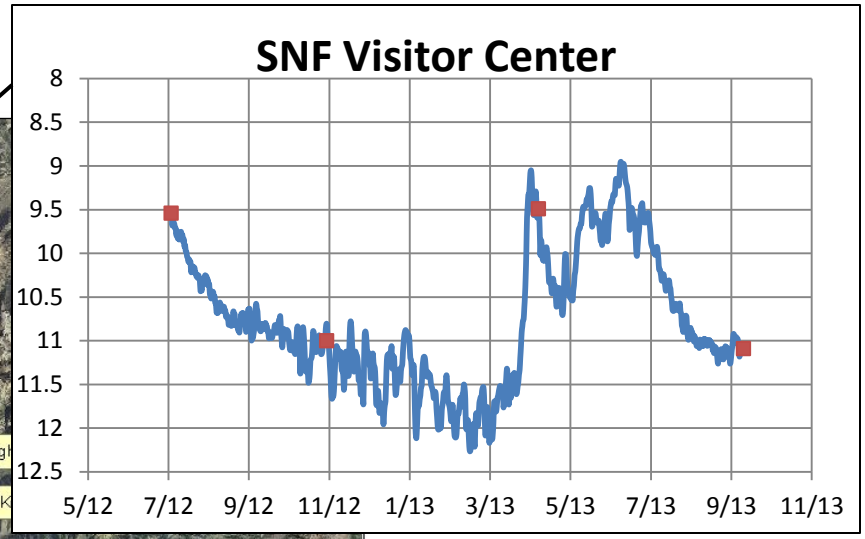
Propose delaying part of the winter recharge until spring.

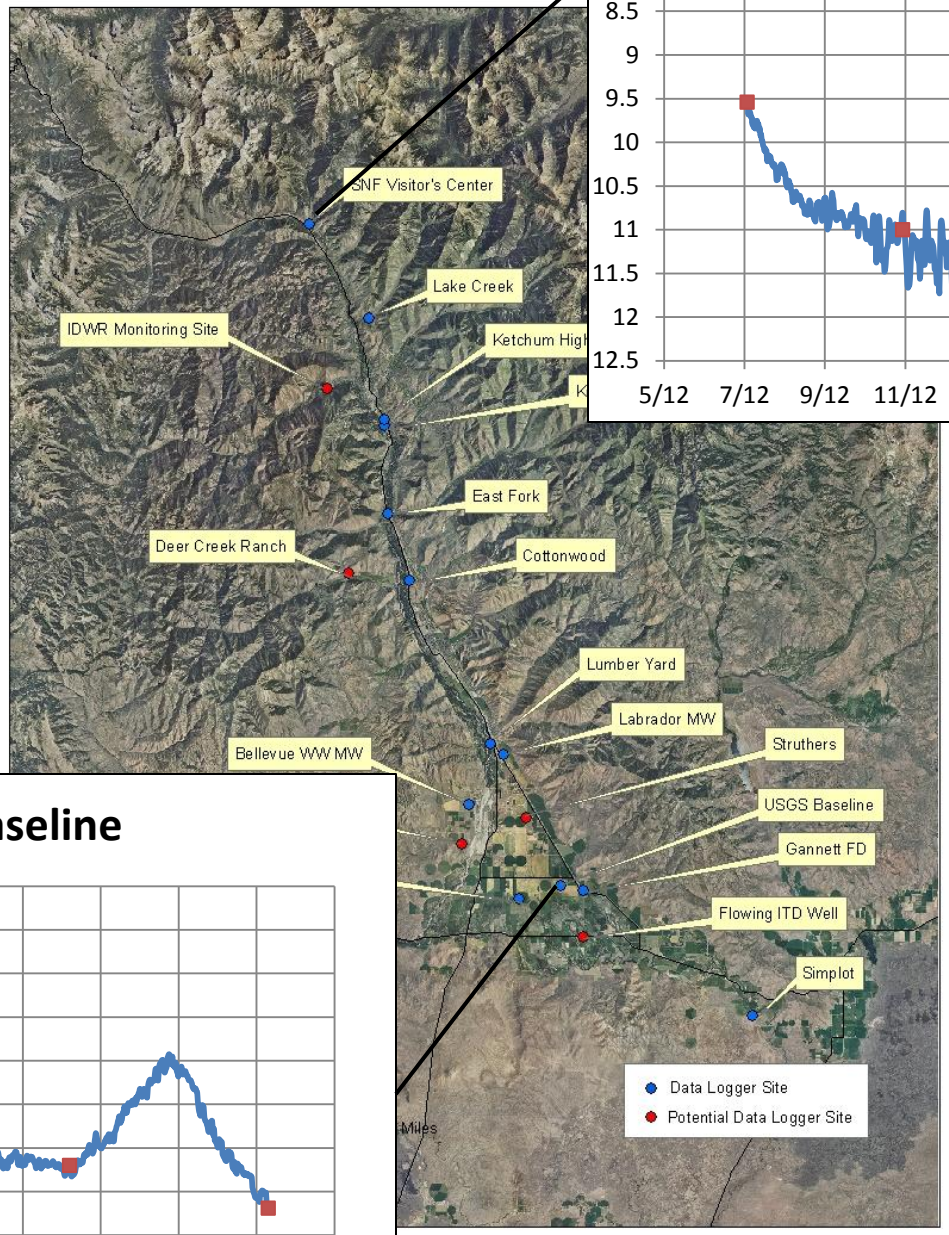
For the months of December, January and February apply 25% of Effective Precipitation in the month that it occurs, and apply the remaining 75% in March.

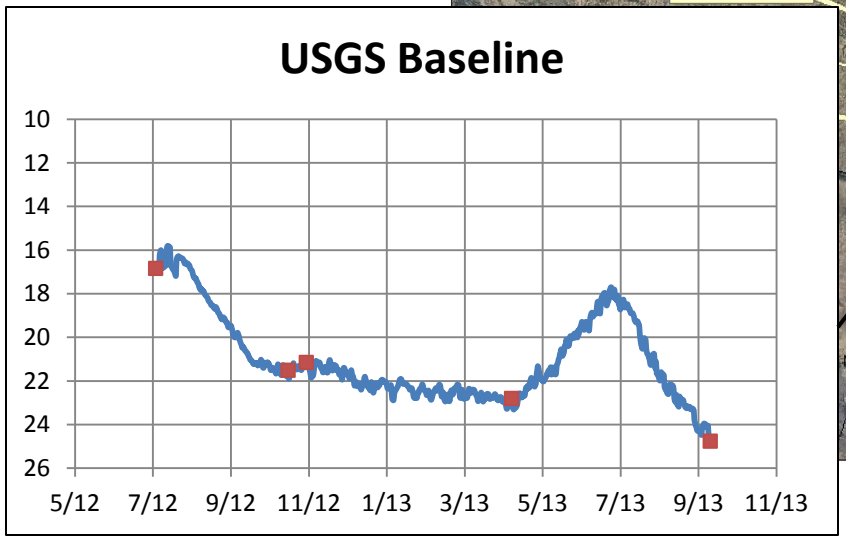
	Dec	Jan	Feb	Mar
Available for Recharge or Runoff	0.25 Eff Precip	0.25 Eff Precip	0.25 Eff Precip	(0.75 Dec Eff Precip)+(0.75 Jan Eff Precip)+(0.75 Feb Eff Precip)+March Eff Precip

GW Hydrographs indicate water levels begin to rise in March and April .

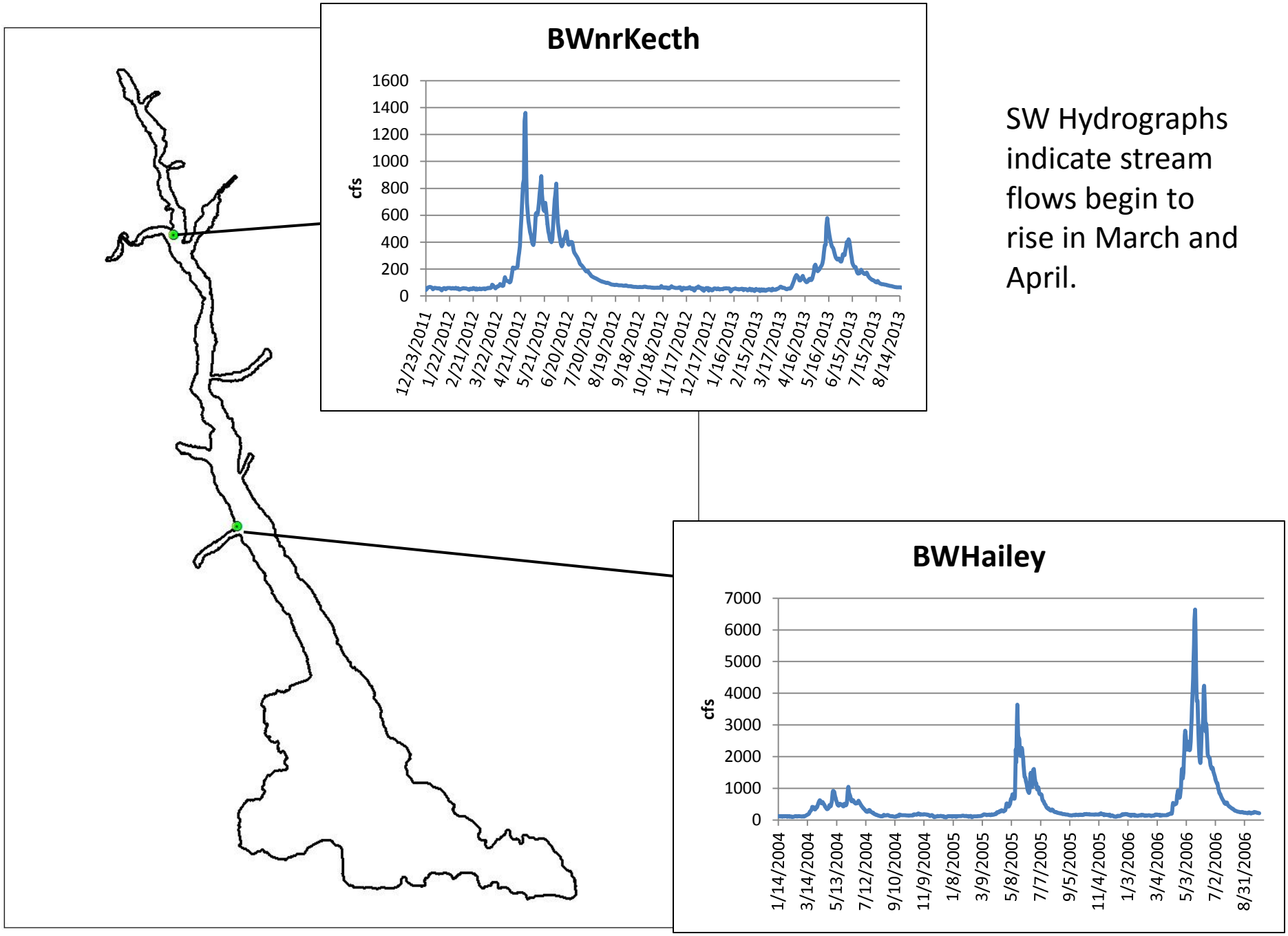
Average Temperature indicates melt starts in March.







Ketchum Melt Temp	Picabo Melt Temp
4/1/1995	3/9/1995
3/9/1996	2/7/1996
3/18/1997	3/16/1997
3/22/1998	3/11/1998
3/14/1999	3/15/1999
3/26/2000	3/21/2000
3/7/2001	3/5/2001
3/22/2002	3/21/2002
3/8/2003	3/7/2003
3/9/2004	3/11/2004
3/7/2005	3/5/2005
4/3/2006	3/19/2006
3/8/2007	2/7/2007
4/12/2008	4/10/2008
3/17/2009	2/16/2009
3/27/2010	3/2/2010



SW Hydrographs indicate stream flows begin to rise in March and April.

Parsing Winter Runoff and Recharge

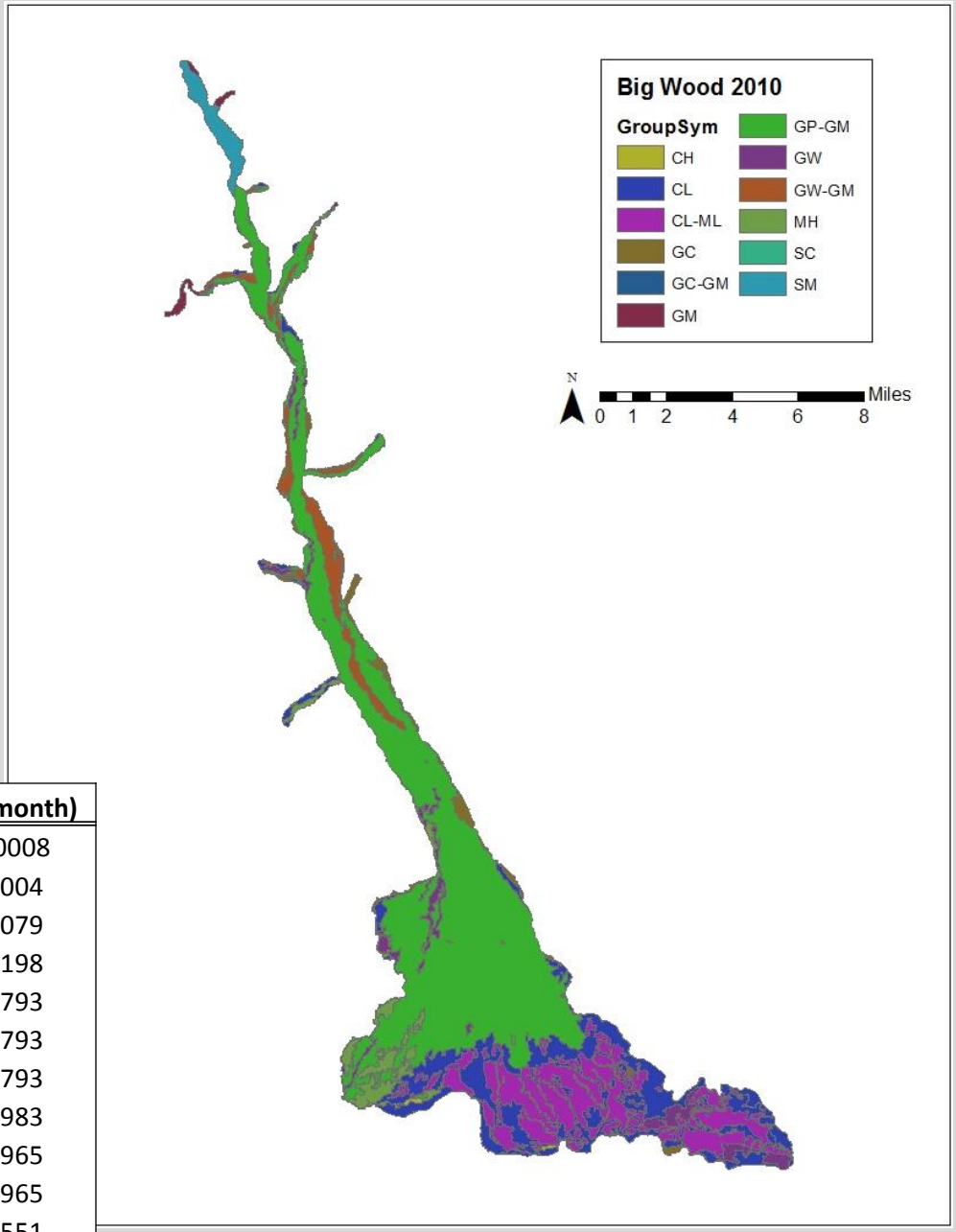
Calculating runoff using traditional methods (like SCS) for winter runoff is not compatible with our method of accumulating frozen precipitation for application in the spring.

Instead, try soils-based infiltration to limit recharge and obtain runoff as a residual.

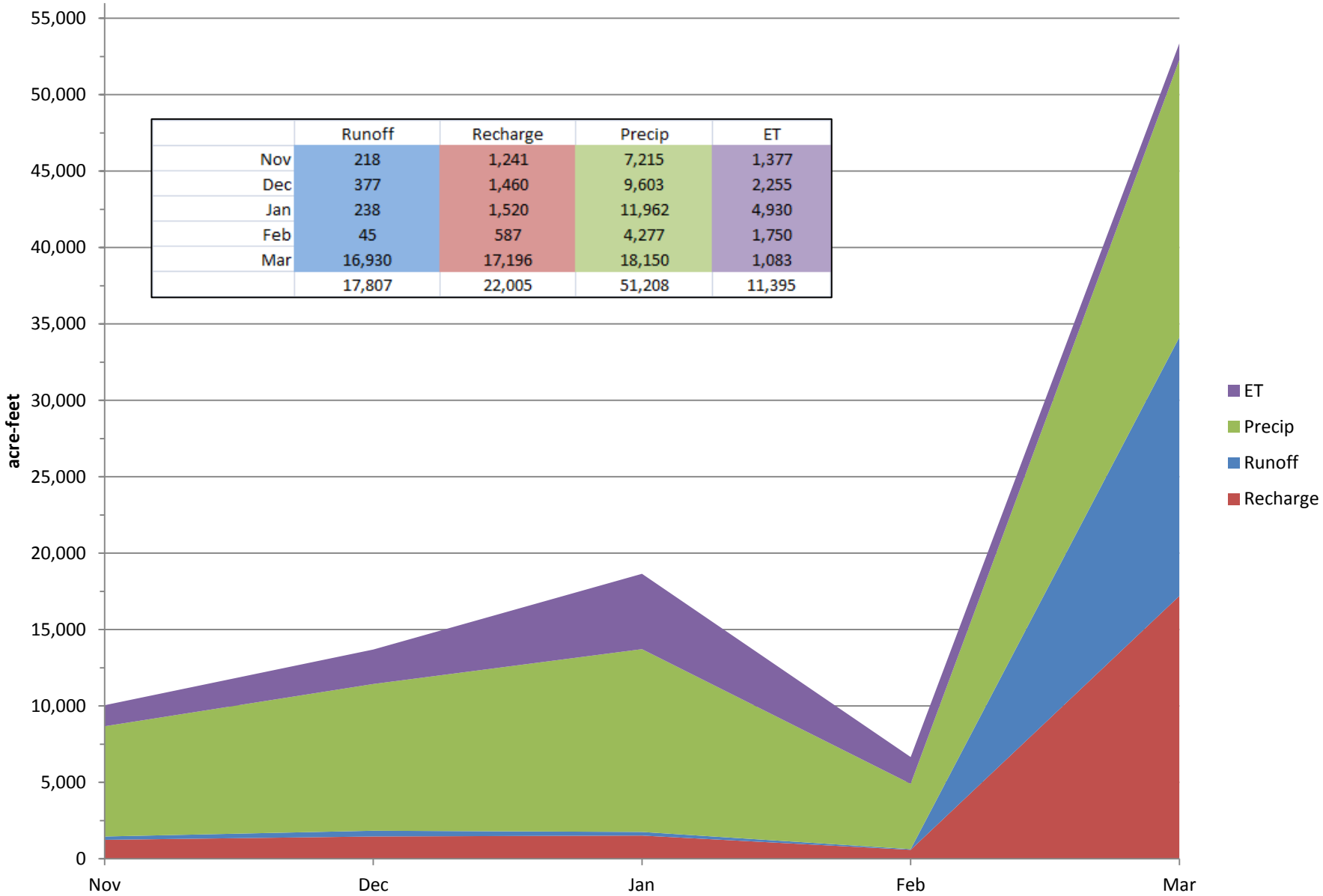
Effective Precipitation (P_e) = Precipitation – ET
IF P_e<= Infiltration Capacity THEN Infiltration = P_e
ELSE Infiltration = Infiltration Capacity
Runoff = P_e – Infiltration

USCS Soil Class	Symbol	Range in K (in/hr)
High Plasticity Clay	CH	1.3x10-7 to 1.3x10-5
Low Plasticity Clay	CL	1.3x10-5 to 1.3x10-3
Clayey Gravel	GC	1.3x10-4 to 1.3x10-2
Silty Gravel	GM	1.3 x 10-4 to 13.5
Poorly Graded Gravel	GP	6.8 to 137
Well Graded Gravel	GW	1.3 to 137
High Plasticity Silt	MH	1.3x10-6 to 1.3x10-5
Low Plasticity Silt	ML	1.3x10-5 to 0.07
Low Plasticity Organic Silt	OL	1.3x10-5 to 1.3x10-2
Clayey Sand	SC	1.3x10-5 to 0.7
Silty Sand	SM	1.3x10-4 to 0.7
Poorly Graded Sand	SP	0.07 to 0.7
Well Graded Sand	SW	0.7 to 68

Big Wood USCS oil Class	Symbol	K (in/hr)	K (ft/month)
High Plasticity Clay	CH	1.30E-06	0.00008
High Plasticity Silt	MH	6.50E-06	0.0004
Low Plasticity Clay	CL	1.30E-04	0.0079
Clay and Silt	CL-ML	3.25E-04	0.0198
Clayey Sand	SC	1.30E-03	0.0793
Clayey Gravel	GC	1.30E-03	0.0793
Clayey and Silty Gravel	GC-GM	1.30E-03	0.0793
Silty Sand	SM	3.25E-03	0.1983
Silty Gravel	GM	6.50E-03	0.3965
Well Graded Gravel and Silty Gravel	GW-GM	6.50E-03	0.3965
Poorly Graded Gravel and Silty Gravel	GP-GM	9.10E-03	0.5551
Well Graded Gravel	GW	1.3	79.300



1994-1995 Winter



	Runoff	Recharge	Precip	ET
Nov	218	1,241	7,215	1,377
Dec	377	1,460	9,603	2,255
Jan	238	1,520	11,962	4,930
Feb	45	587	4,277	1,750
Mar	16,930	17,196	18,150	1,083
	17,807	22,005	51,208	11,395

2005-2006 Winter

	Runoff	Recharge	Precip	ET
Nov	177	1,190	7,891	2,422
Dec	1,639	3,661	22,361	1,162
Jan	998	2,853	16,479	1,074
Feb	44	729	4,300	1,205
Mar	21,126	18,609	8,519	2,660
	23,984	27,042	59,550	8,523

Concluding Winter ET and Areal Recharge

Winter ET is largely a function of land cover. However, Winter ET rates are low and variability is less of a concern. **Propose** using GIS data in conjunction with ET Idaho for assigning Winter ET. Need to adapt for earlier stress periods – maybe early, mid and late model-periods winter land use to account for municipal growth.

Winter ET also a function of elevation. **Propose** using ET Idaho values from the Picabo AgriMet station adjusted for elevation at Hailey and Ketchum.

Freezing temperatures theoretically limit recharge and runoff in the winter. **Propose** applying 25% of December, January and February Effective Precipitation in the occurrence month, and the remaining 75% of each month in March (with 100% of March).

Estimating runoff in the winter is difficult. **Propose** using soils-based infiltration rates to calculate recharge, and obtaining runoff as a residual.