UPPER SAN JOAQUIN WATERSHED NASA ASO PROJECT

A Cooperative Effort Among Friant Contractors and other Stakeholders

Presentation at SJRRP Water Management Goal Technical Feedback Meeting

May 18, 2017

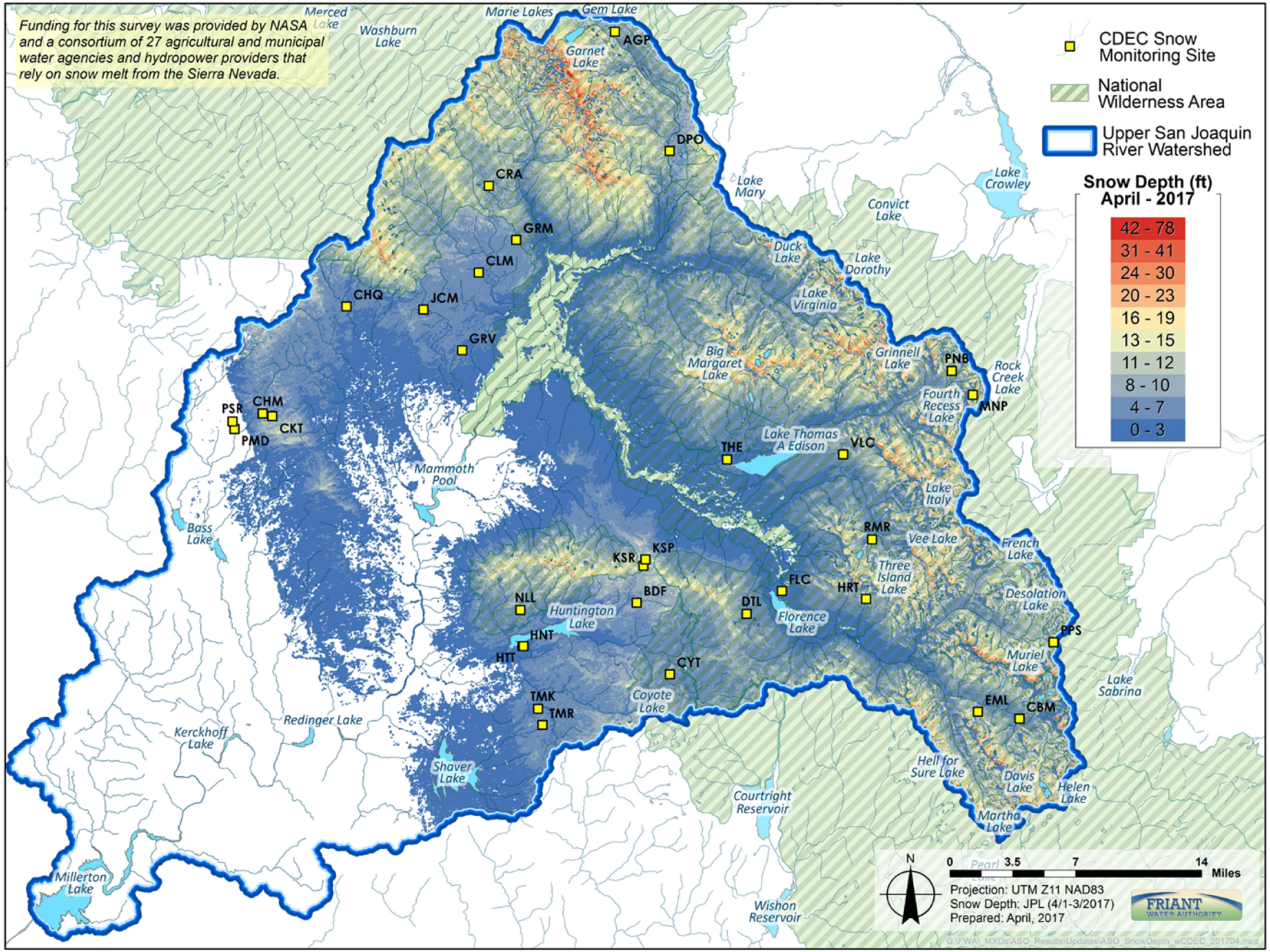
OVERVIEW OF PRESENTATION

- NASA Airborne Snow Observatory
  - Purpose of Effort
  - Participants, now and future
  - Outputs
  - DWR/Reclamation incorporation into Water Supply Forecasting
  - Next Steps

PURPOSE OF ASO SURVEY

- Context
  - History of uncertain forecasts based on economical methods
  - Needs for precision increase with more demands on our water (esp. for SJRRP)
  - Uncertainty from on-ground measurements, plus future rain
  - Much of the snow falls in Wilderness areas where surveying is prohibited
  - 2016 Friant was coming out of dry year, effects of conservative forecasting resulted in 10% less than possible Class 1 allocation in spring

- Program Objectives
  - It actually reduces uncertainty
  - DWR and Reclamation will use it


Funding for this survey was provided by NASA and a consortium of 27 agricultural and municipal water agencies and hydropower providers that rely on snow melt from the Sierra Nevada.
CDEC Snow Monitoring Site
National Wilderness Area
Upper San Joaquin River Watershed
Snow Depth (ft)
April - 2017
42 - 78
31 - 41
24 - 30
20 - 23
16 - 19
13 - 15
11 - 12
8 - 10
4 - 7
0 - 3
AGP
DPO
CRA
GRM
CLM
CHQ
JCM
GRV
PSR
CHM
CKT
PMD
THE
VLC
PNB
MNP
RMR
KSR
KSP
BDF
NLL
FLC
HRT
DTL
HNT
HTT
CYT
TMK
TMR
PPS
EML
CBM
Marie Lakes
Gem Lake
Garnet Lake
Merced Lake
Washburn Lake
Lake Mary
Convict Lake
Lake Crowley
Duck Lake
Lake Dorothy
Lake Virginia
Big Margaret Lake
Grinnell Lake
Rock Creek Lake
Fourth Recess Lake
Lake Thomas A Edison
Mammoth Pool
Lake Italy
Vee Lake
French Lake
Three Island Lake
Desolation Lake
Florence Lake
Huntington Lake
Muriel Lake
Lake Sabrina
Bass Lake
Coyote Lake
Redinger Lake
Kerckhoff Lake
Shaver Lake
Courtright Reservoir
Hell for Sure Lake
Davis Lake
Helen Lake
Martha Lake
Pearl
Millerton Lake
Wishon Reservoir
N
0
3.5
7
14
Miles
Projection: UTM Z11 NAD83
Snow Depth: JPL (4/1-3/2017)
Prepared: April, 2017
FRIANT WATER AUTHORITY
G:\FWA_MXDs\ASO_Results\Updates\ASO_SnowDepth_wCDEC_201704.mxd

PARTICIPANTS AND SUPPORTERS

- SJR Basin surveys
  - From get-go, has been a united Friant effort. Almost all Friant Contractors currently participating financially
    - South Valley Water Agency was first to commit $
    - Friant Water Authority and Friant North Authority Provided three-year commitment to provide funding for the program
    - FWA took lead with USBR to reach agreements with DWR and NASA to get $ to the right place
  - Additional financial supporters include SJRECWA, Mammoth Lakes Community WD

PARTICIPANTS AND SUPPORTERS

- Modeling Efforts
  - DWR model development for runoff forecasting
  - NASA and Reclamation sponsorship of model development for SWE estimation and incorporation into runoff model
- Other basins and surveys
  - Tuolumne, Owens Lake, Mono Lakes, all sponsored through local efforts
  - DWR obtained $900k for additional basin surveys, and possible mid-month surveys of the SJR basin

PARTICIPANTS AND SUPPORTERS

- Other Supporters
  - The Bay Institute, Southern California Edison, Friant Power Authority, academics, and others
  - These supporters demonstrate the broad public benefits for this program

OUTPUTS

- Survey Results
  - SWE
  - Depths
  - Albedo
- Packaging
  - Basin breakout

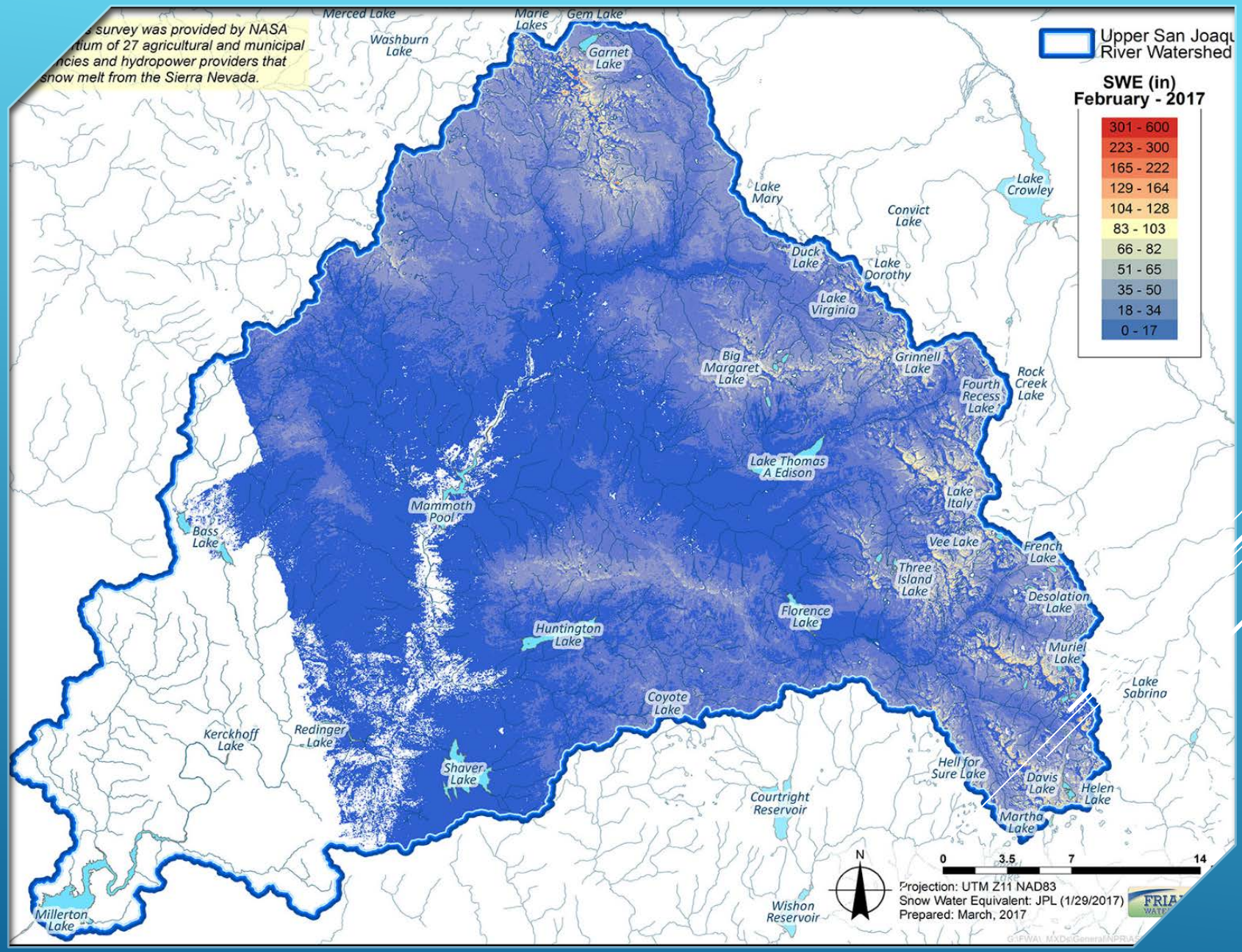
NEXT STEPS

- Joint white paper with NASA and DWR
  - Demonstration of broad public benefits that can be derived from the survey
    - “Existing Challenges and Project benefits”
  - Proposed plan for DWR to take on the effort

FEBRUARY 2017

SWE DEPTH (IN)

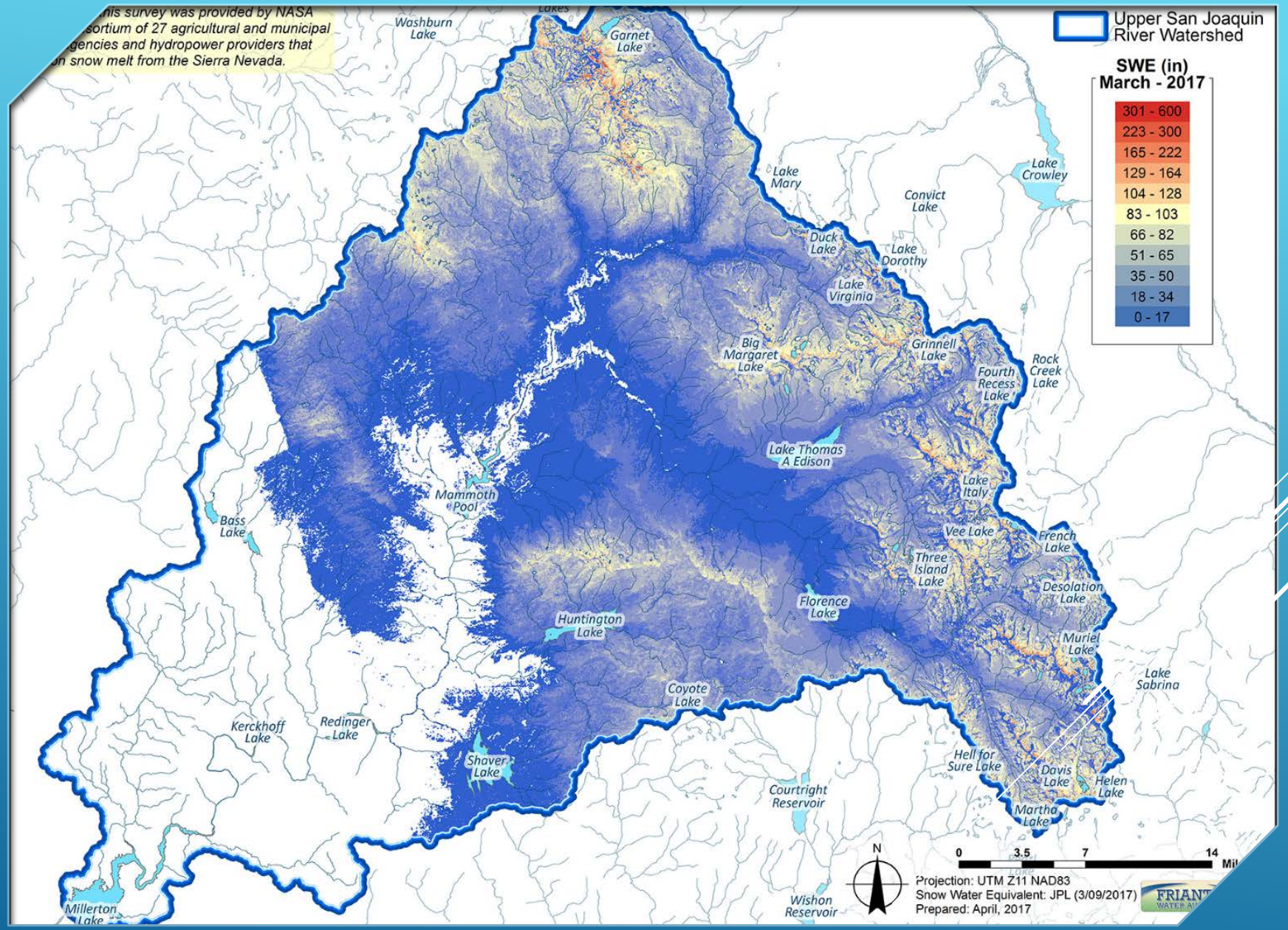
1.6 MAF SWE



MARCH 2017

SWE DEPTH (IN)

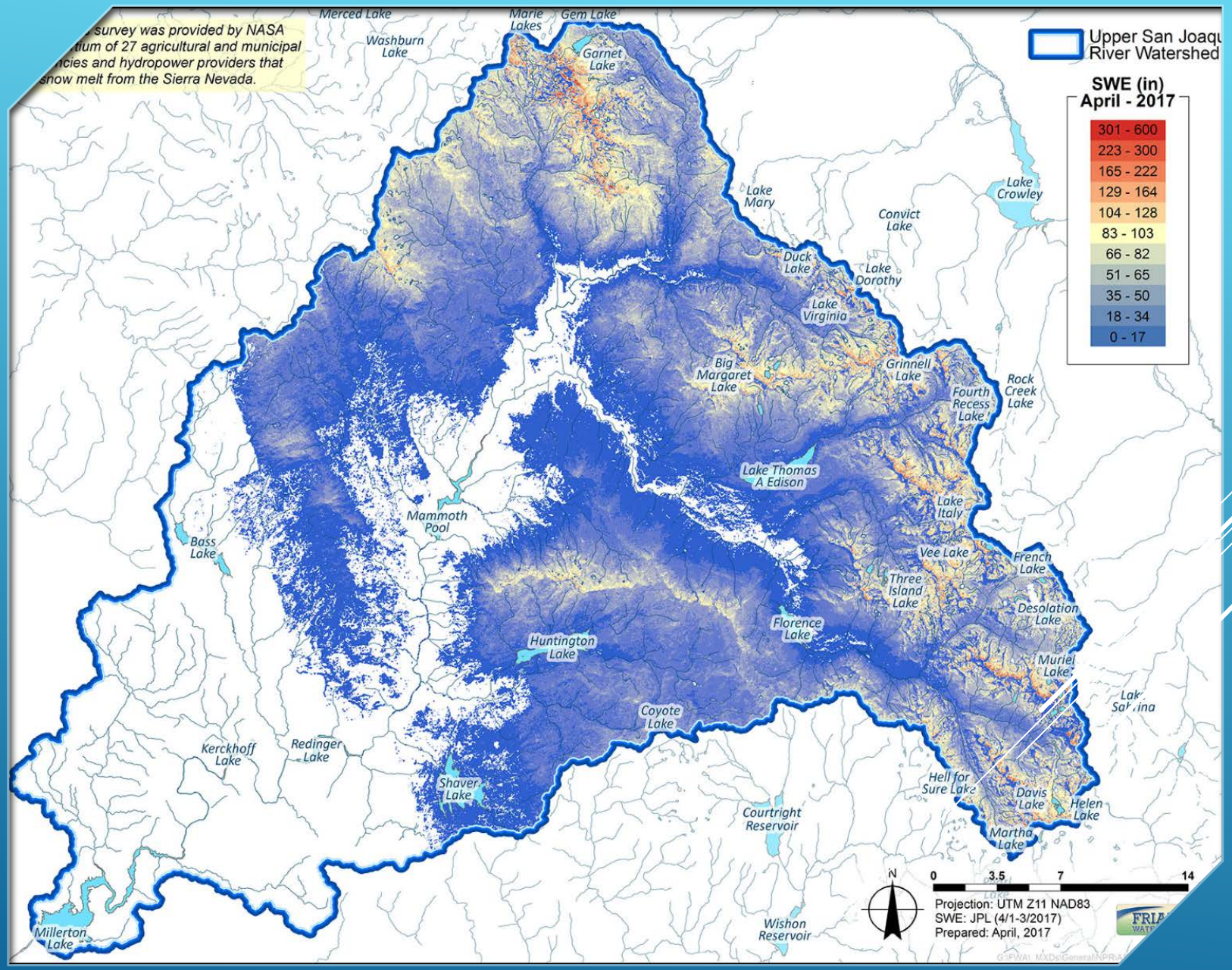
2.4 MAF SWE



APRIL 2017

SWE DEPTH (IN)

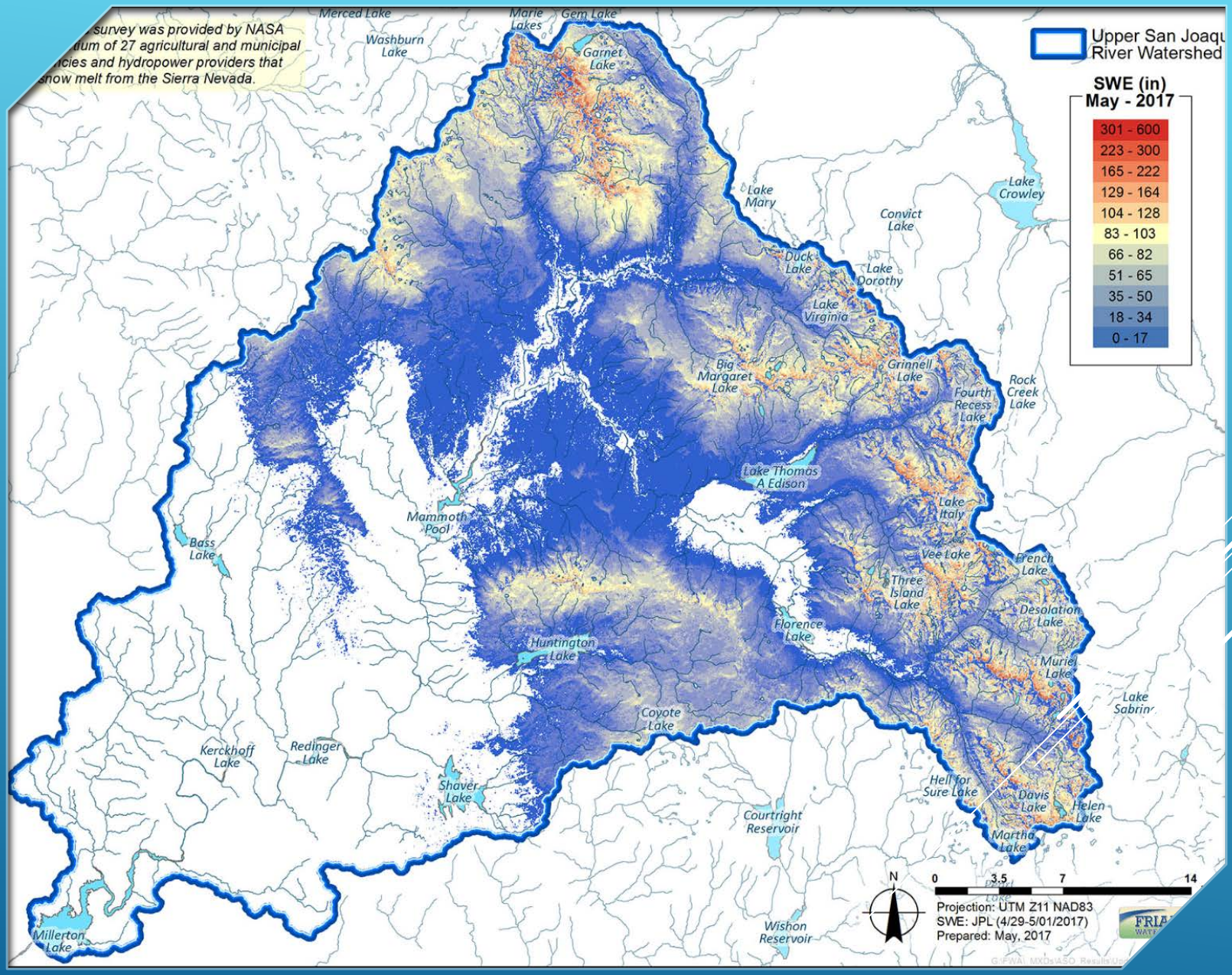
2.2 MAF SWE



MAY 2017

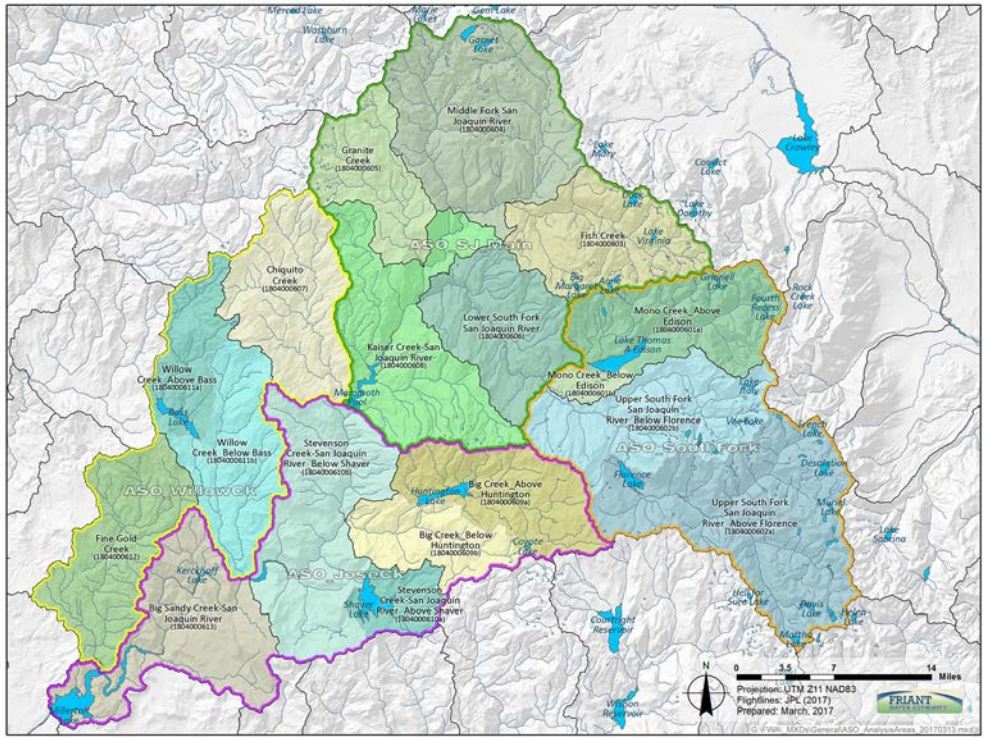
SWE DEPTH (IN.)

2.4 MAF SWE



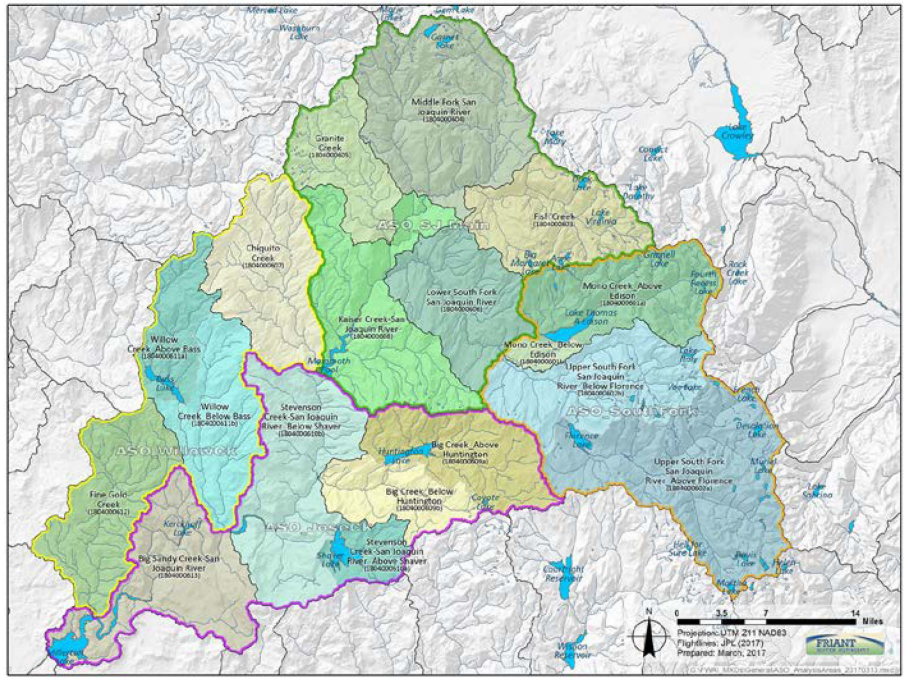
Airborne Snow Observatory

San Joaquin April 2017 Surveys



			TOTAL SWE (MAF)	2.397	2.198	-9%
			SWE (AF)	2,396,732	2,197,607	
				MARCH	APRIL	
Flight date	Basin	HUC_ID		SWE (AF)	SWE (AF)	
ST USCASJ20170402	**SJ_Main_**			**1,093,364**	**1,027,234**	**-6%**
1 USCASJ20170402	Middle_Fork_San_Joaquin_River	1804000604		470,542	466,909	
2 USCASJ20170402	Lower_South_Fork_San_Joaquin_River	1804000606		91,230	61,283	
3 USCASJ20170402	Kaiser_Creek-San_Joaquin_River	1804000608		127,328	104,907	
4 USCASJ20170402	Granite_Creek	1804000605		164,514	160,513	
5 USCASJ20170402	Fish_Creek	1804000603		239,750	233,621	
USCASJ20170309f1	**WillowJose**			**417,155**	**299,672**	**-39%**
6 USCASJ20170309f1	Willow_Creek	1804000611b		17,703	8,428	
7 USCASJ20170309f1	Willow_Creek	1804000611a		15,150	11,876	
8 USCASJ20170309f1	Stevenson_Creek-San_Joaquin_River	1804000610b		18,180	9,642	
9 USCASJ20170309f1	Stevenson_Creek-San_Joaquin_River	1804000610a		16,993	8,845	
10 USCASJ20170309f1	Fine_Gold_Creek	1804000612		-	-	
11 USCASJ20170309f1	Chiquito_Creek	1804000607		114,995	86,455	
12 USCASJ20170309f1	Big_Sandy_Creek-San_Joaquin_River	1804000613		-	-	
13 USCASJ20170309f1	Big_Creek	1804000609b		61,789	42,416	
14 USCASJ20170309f1	Big_Creek	1804000609a		172,345	132,010	
USCASJ20170309f2a1	**SouthFork**			**886,212**	**870,7[illegible]**	**-2%**
15 USCASJ20170309f2	Upper_South_Fork_San_Joaquin_River	1804000602b		196,672	1[illegible]4,126	
16 USCASJ20170309f2	Upper_South_Fork_San_Joaquin_River	1804000602a		445,119	448,867	
17 USCASJ20170309f2	Mono_Creek	1804000601b		6,852	2,[illegible]47	
18 USCASJ20170309f2	Mono_Creek	1804000601a		237,570	235,362	

SNOWPACK AGGREGATED BY RESERVOIR

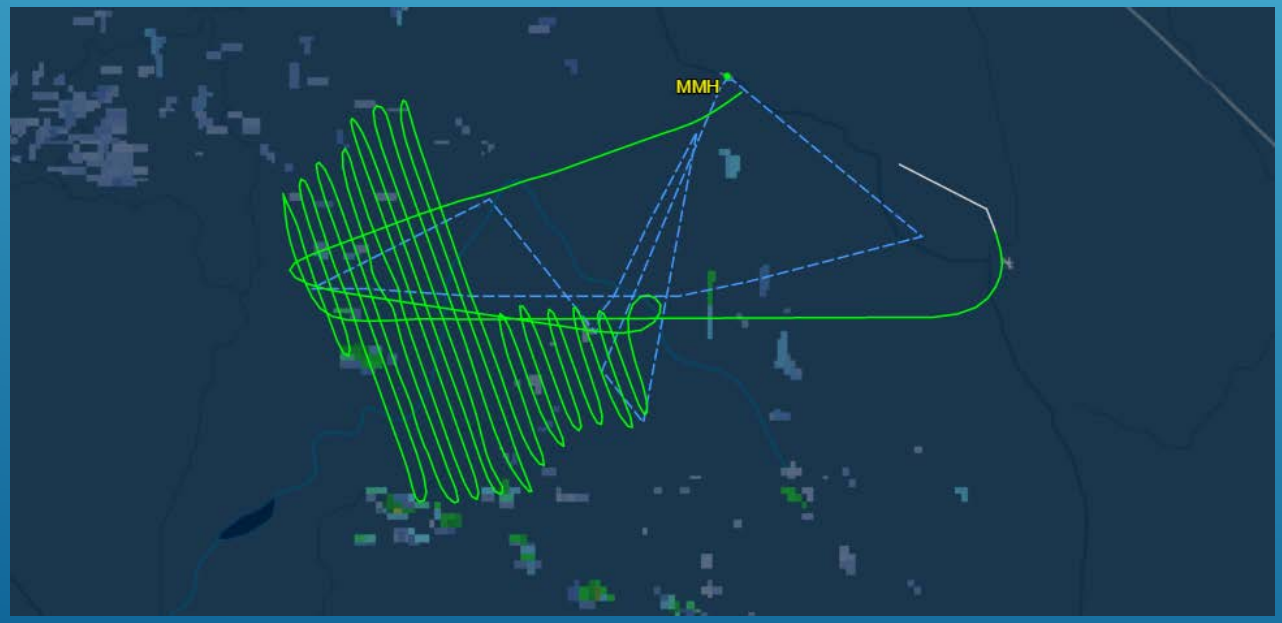


May 1 data	Florence	Edison	Huntington	Shaver	Bass	Mammoth	Millerton
Summation (AF)	500,737	257,302	192,821	4,276	11,583	1,341,200	51,060
Basin Fraction	23%	12%	9%	0%	1%	61%	2%
Mean Elevation (ft)	11,248’	10,736’	9,061’	7,585’	8,041’	9,700’	8,219’

SNOWPACK AGGREGATED BY ELEVATION

Elevation	Area (sq mi)	Jan 29 ASO AF	Mar 8 ASO AF	Apr 1 ASO AF	May 1 ASO AF
1000-2000	*103*	57	39	55	0
2000-3000	*95*	53	19	103	0
3000-4000	*97*	527	250	196	12
4000-5000	*98*	6583	3088	1243	168
5000-6000	*143*	28796	28501	7314	948
6000-7000	*190*	111163	154407	86574	38052
7000-8000	*209*	200582	327370	243602	197749
8000-9000	*194*	284464	465466	409346	457522
9000-10000	*195*	332984	543359	511027	589622
10000-11000	*153*	305042	471079	491931	551495
11000-12000	*108*	249341	357875	390736	456658
12000-13000	*21*	35850	49384	54612	65633
13000+	*1*	797	837	848	1120
Basin Total (AF)		**1,556,239**	**2,401,674**	**2,197,587**	**2,358,979**

- Data Availability
  - 3 or 4 days for data collection
  - 2 or 3 additional days for processing
  - Millions of independent pixel measures of snow thickness
  - Ground based density measurements used to calculate Snow Water Equivalent



JAN 30 FLIGHT TRACE, 22,000’ FLIGHT ALTITUDE

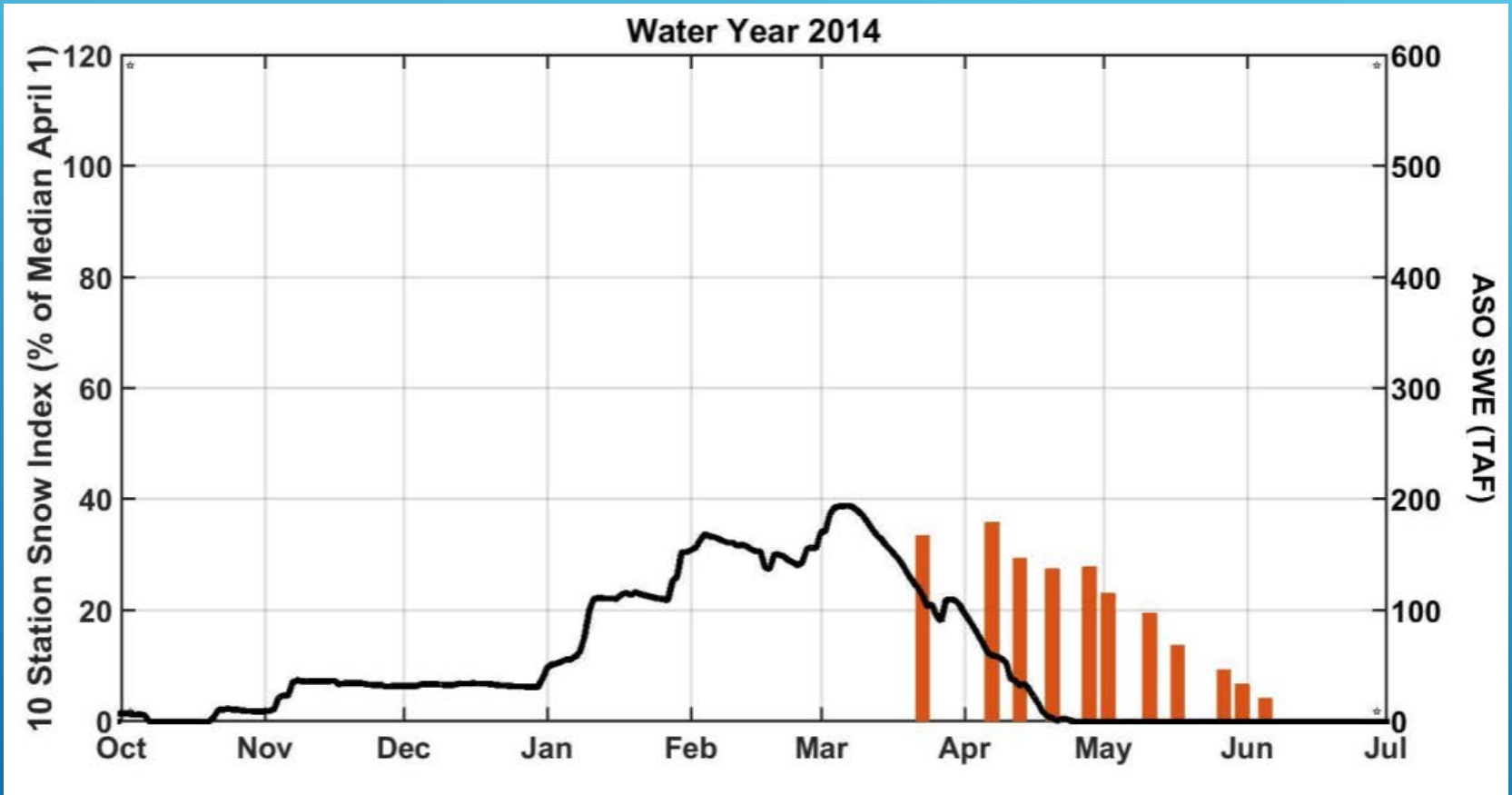
BEECHCRAFT KING AIR STATIONED AT MAMMOTH LAKES

Comparison with DWR & NWS 90% Forecast, used to adjust "blending" for reservoir ops and SJRRP

	February 1	March 1	April 1	May 1*
DWR April-July 90% NR Forecast	1,690	2,180	2,110	2,151
NWS April-July 90% NR Forecast	1,990	2,430	2,360	2,700
ASO Existing Snowpack (adjusted for snow-off error and date)	1,590 TAF	2,400 TAF	2,320 TAF	2,405 TAF

* NOTE APRIL OBSERVED NATURAL RIVER WAS 515 TAF

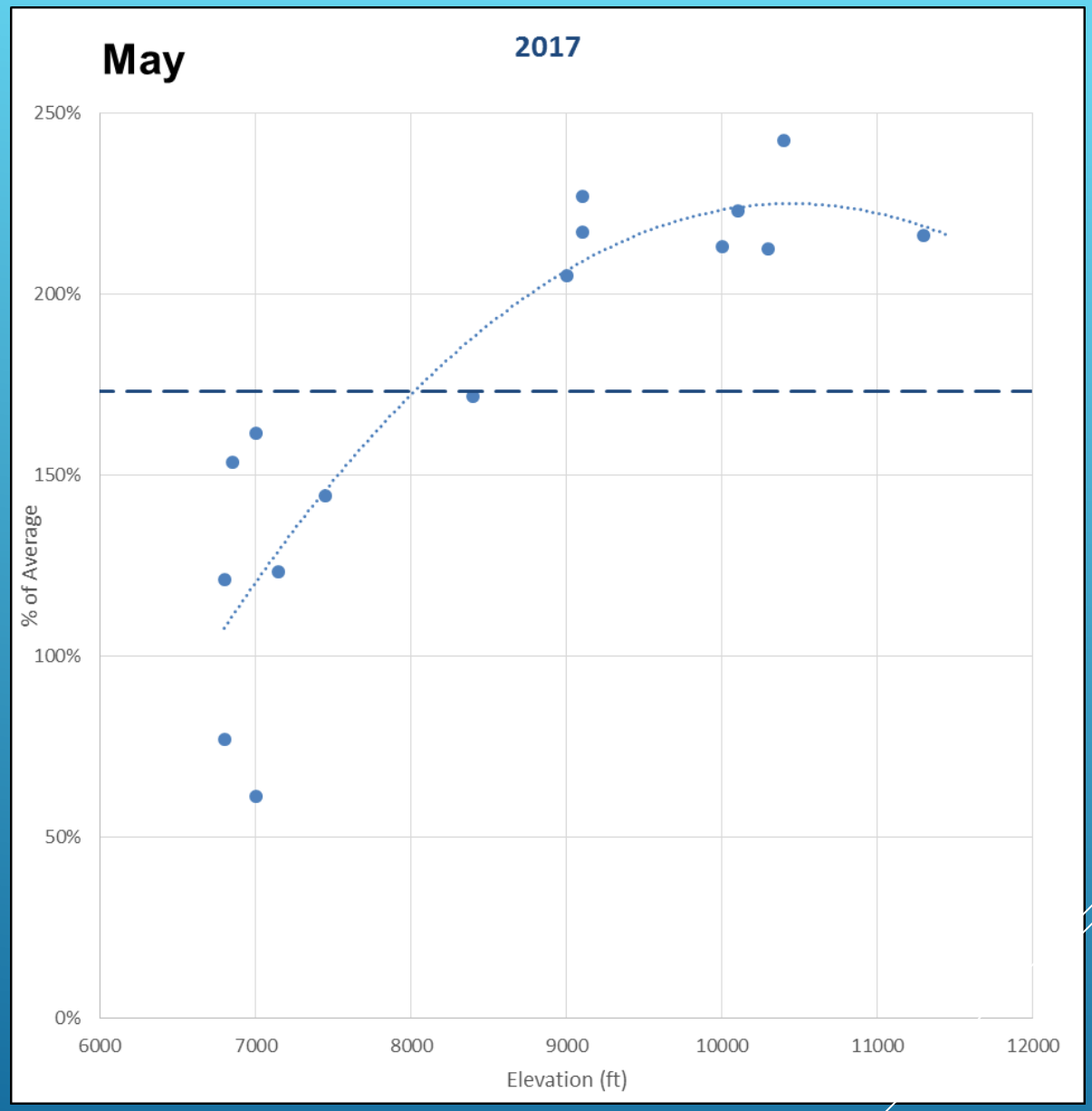
Snowpack can persist long after ground-based stations register zero snow



SWE FROM SNOW PILLOWS IN TUOLUMNE WATERSHED (BLACK LINE) SHOWN WITH ASO FLIGHTS (ORANGE BARS)

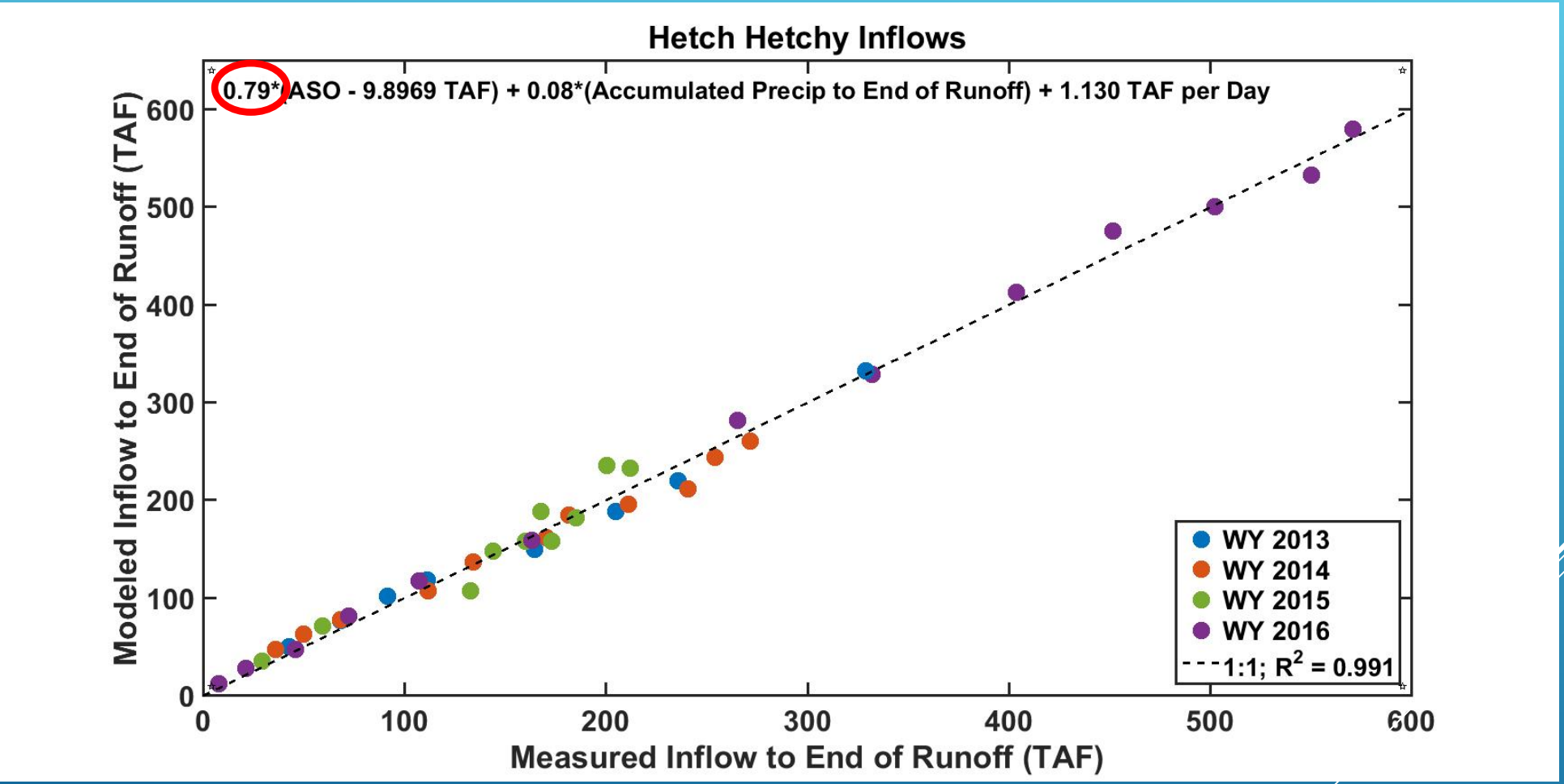
ASO measures beyond the last snow course measurement (May 1)

ASO can also teach us which of these snow course stations is most representative of the snowpack



PERCENT OF APRIL 1 AVERAGE FROM SNOW COURSES

How much snowpack actually produces runoff?



REGRESSION FROM HETCH HETCHY / TUOLUMNE

RUNOFF RATIO

- Runoff Ratio will vary from year to year
  - Dry antecedent conditions will have a lower ratio and vice versa
  - Smaller snowpack will have a lower ratio and vice versa
  - Greatest uncertainty in wet years
    (2017 data is extremely helpful)
- Determine Empirically
  - Multiple years will be needed to pin down the ratio
  - Data from similar watersheds can be substituted
- Determine by Modeling
  - ISNOBAL and PRMS

MODELING

- ISNOBAL
  - Snow accumulation and melt
  - Driven by actual weather data and medium-term forecast
  - Sophisticated handling of snow physics – each factor is independent, not lumped
- Precipitation Runoff Modeling System (PRMS)
  - Rain and snow precipitation, soil interaction, and runoff
  - Each factor is independent, not lumped
- Combination of models is sought to produce state of the art forecast

2017-2019 EFFORTS (3-YEAR PILOT)

- Agricultural Research Service (Danny Marks, USDA-Boise)
  - ISNOBAL development for San Joaquin
  - Utilize approach tested in Tuolumne/Hetch Hetchy
  - Weekly runoff forecast
- Dept. of Water Resources (Dave Rizzardo)
  - PRMS development for San Joaquin
  - Handoff of ISNOBAL output to PRMS input
  - Better B120 water supply forecasts
- National Weather Service
  - ASO data used to adjust snowmelt curves

LONG-TERM EFFORTS

- White Paper and Plan
  - Justification for full funding and broad participation
  - Paired with Sierra Nevada-wide funding request
  - Multiple benefits under one umbrella
  - Economy of scale
- Water Supply
  - Agricultural planning
  - Manage around canal capacity
  - Environmental / Fish flows
- Forest Management
  - Fire Management
  - Tree Mortality / Climate Change
  - Illegal “grow” operations