Effects of System Conservation on Salinity in Lake Mead

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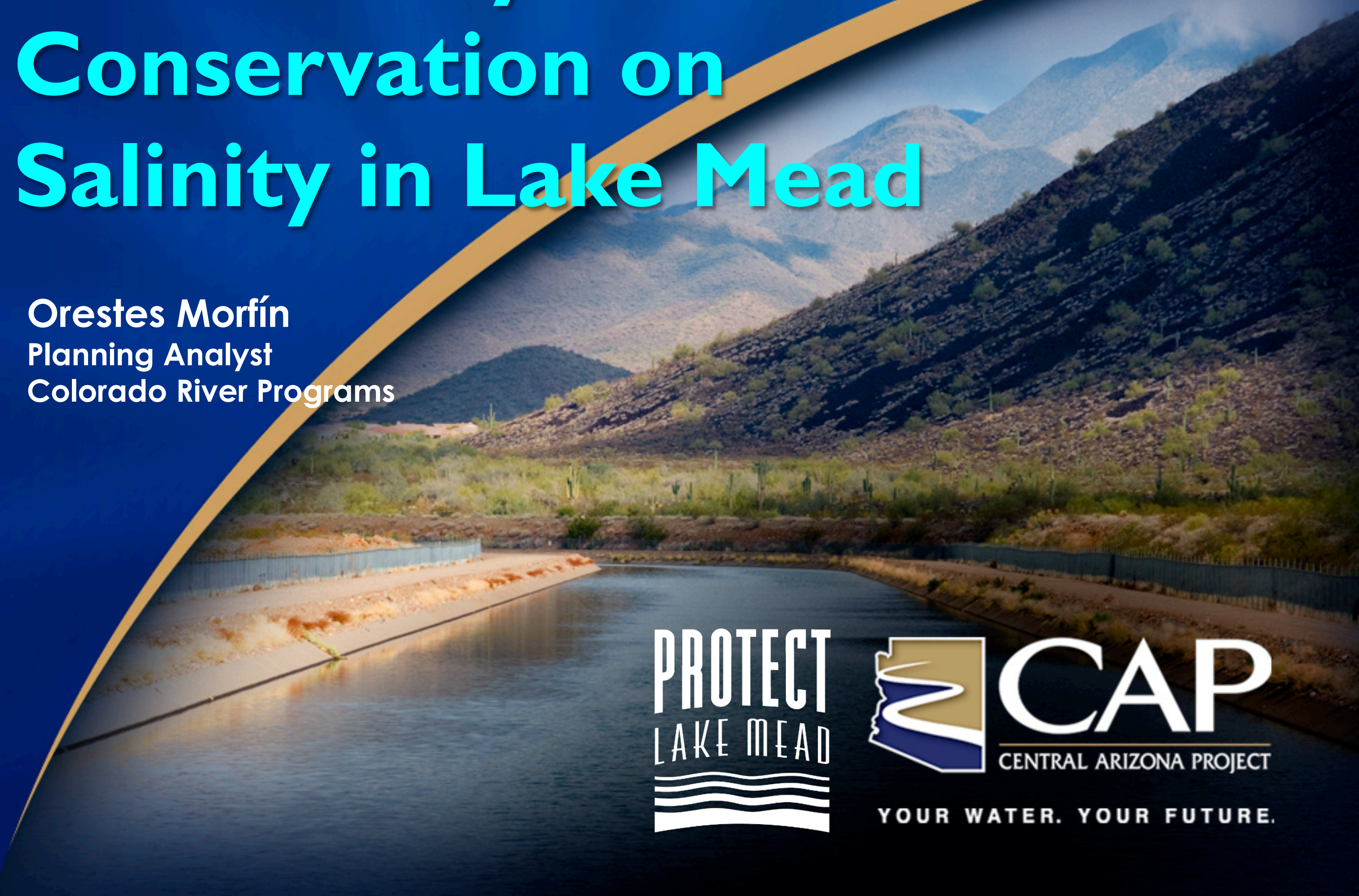
Colorado River Programs



PROTECT LAKE MEAD

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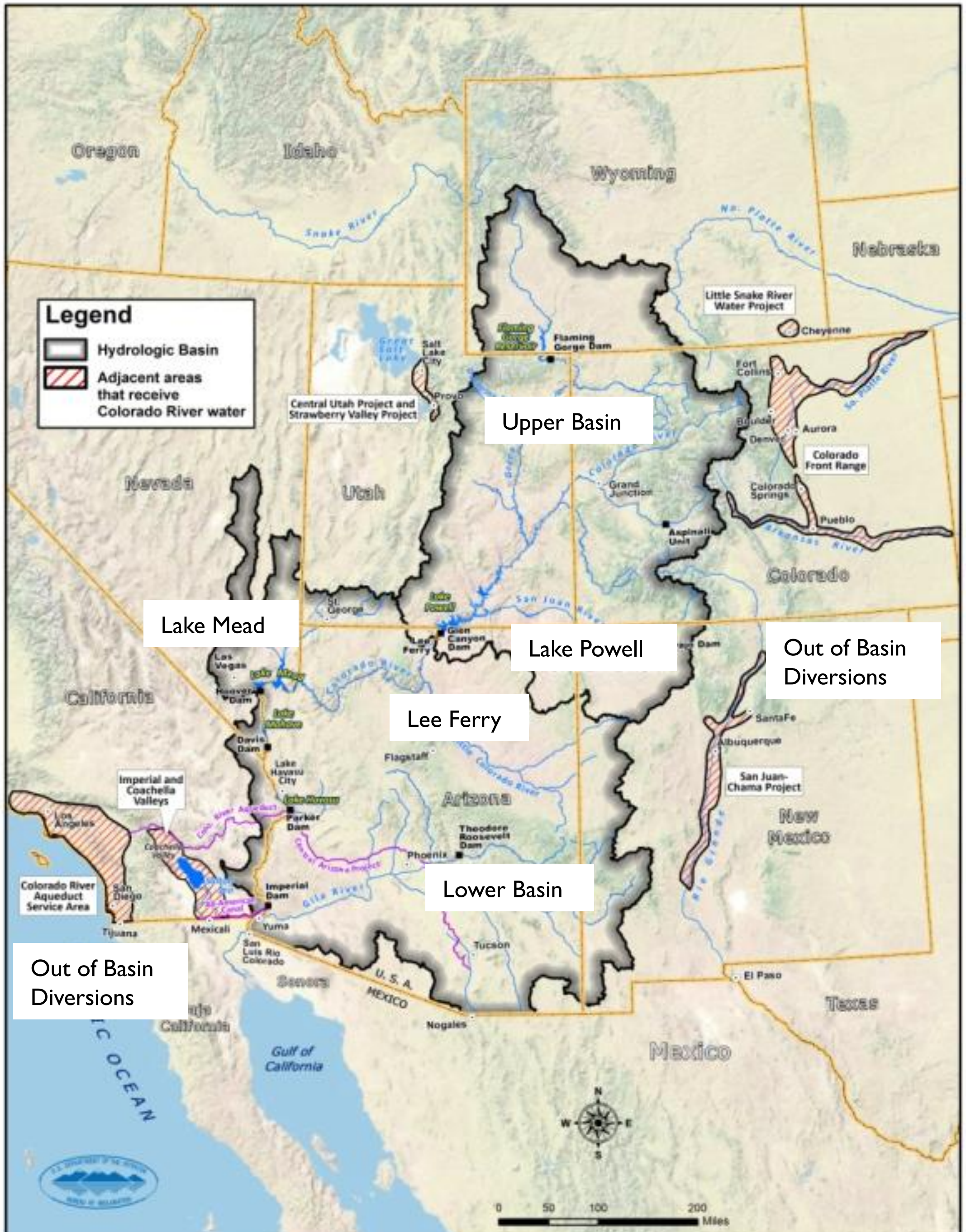
The Colorado River Basin



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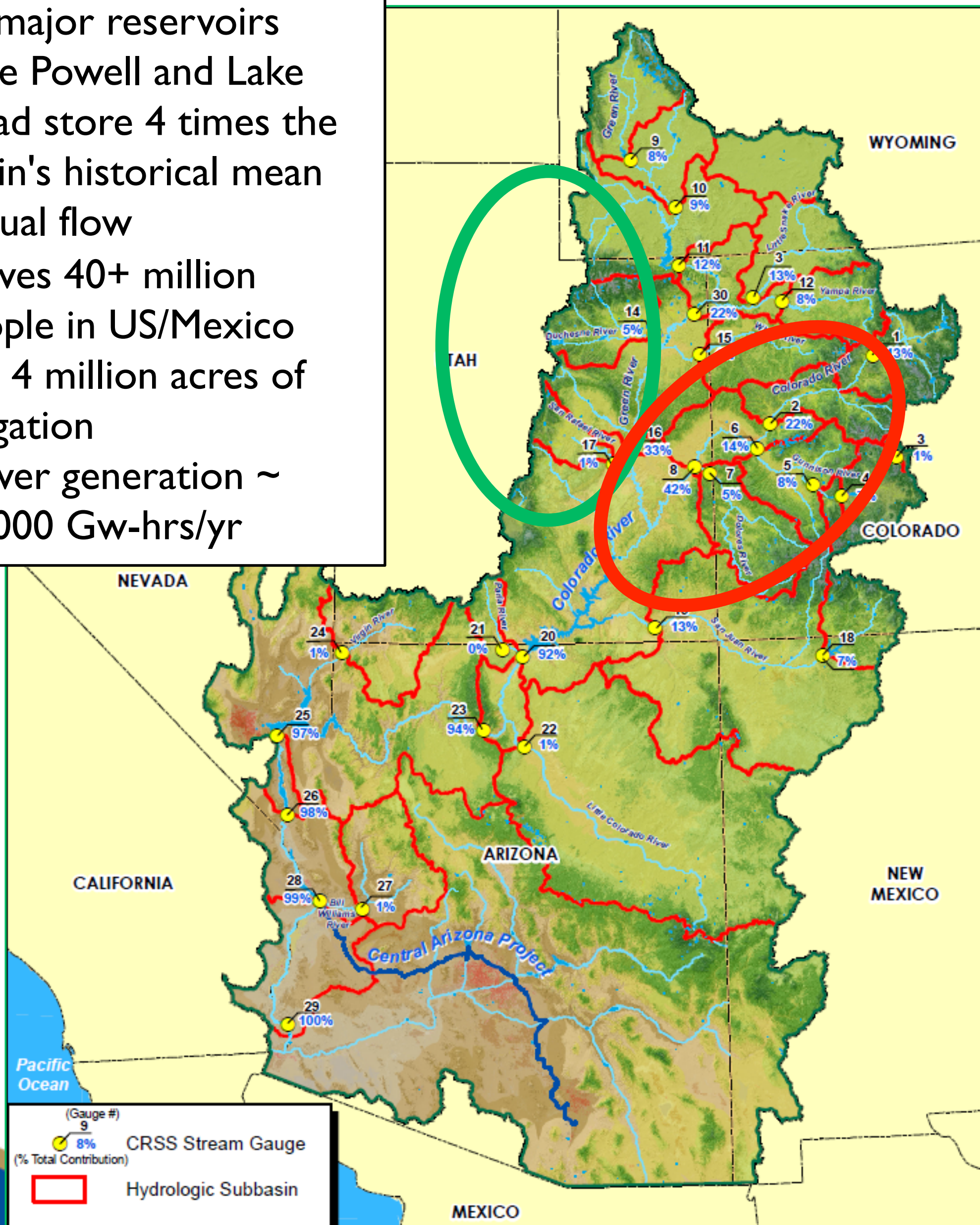
Physical Characteristics

- 10 major reservoirs
- Lake Powell and Lake Mead store 4 times the Basin's historical mean annual flow
- Serves 40+ million people in US/Mexico and 4 million acres of irrigation
- Power generation ~ 10,000 Gw-hrs/yr



- 92% of the Colorado River Basin's mean annual flow occurs above Lees Ferry (1906-2007)
- Mean annual flow is close to 15.0 MAF (18.5x10^9 m3), ranging from 5.6 MAF (6.9x10^9 m3) to 25.2 MAF (31x10^9 m3)
- Upper Colorado and Green River are the most important tributaries: 75% of annual flow.

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Water Budget at Lake Mead

- Normal Inflow =9.0 MAF

(*release from Powell + side inflows*)

- Normal Outflow =-9.6 MAF

(*AZ, CA, NV & MX delivery + downstream regulation gains/ losses*)

- Mead evaporation losses =-0.6 MAF
- Balance =-1.2 MAF

Given basic apportionments in the Lower Basin, the Mexican allotment, and an 8.23 MAF release from Lake Powell, Lake Mead storage declines about 12 ft per year.

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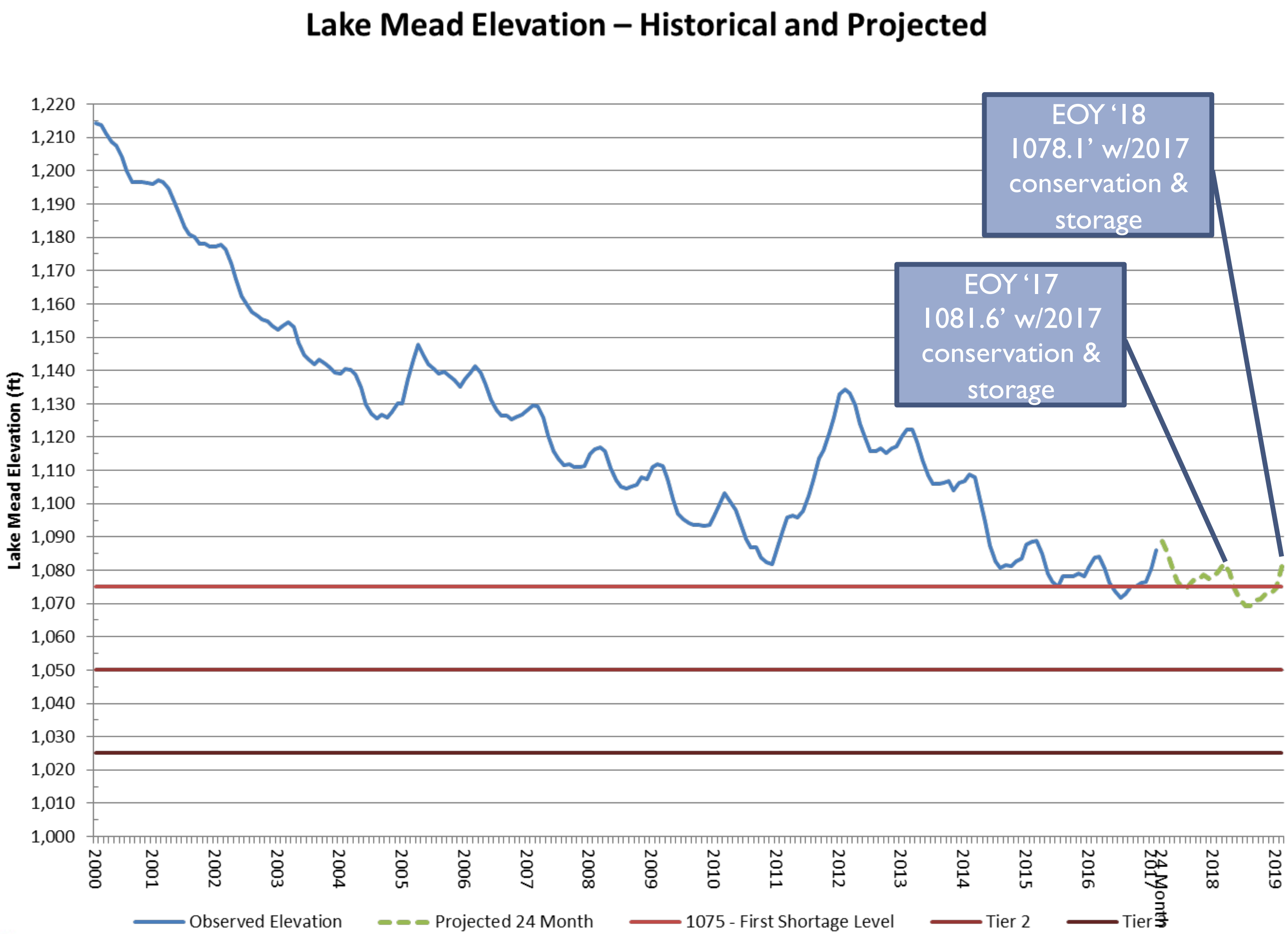
"Structural Deficit" at Lake Mead



Impact of Structural Deficit

- Results in a decline of 12+ feet in Lake Mead every year when releases from Powell are “normal” (8.23 MAF)
- Results in a decline of 4 feet in Lake Mead every year when releases from Powell are “balancing” (9.0 MAF)
- Drives Lower Basin to shortage
- CAP forced to bear obligations of others
  - Evaporation and other system losses
  - Lower Basin’s half of Mexican Treaty obligation

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Lake Mead Protection Actions & Conservation

2 Programs to Protect Lake Mead Elevations:

- Lower Basin Pilot Drought Response Actions MOU
- Pilot System Conservation Agreement

LB MOU 2014-17:
CAP = 345 KAF
MWD = 300 KAF
USBR = 50 KAF
SNWA = 45 KAF

+9'

PSCA Phase 1 2015-16:
Total funding = $11 M

PSCA Phase 2 2016-17:
Total funding = $7.5 M

+1'

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Conservation Goals

- Upper Basin Pilot System Conservation Projects
  - Increase natural flows to Lake Powell
  - Higher quality (decreased salinity from lower CU)
  - Potential for generation of long-term savings
- Dec. 2014 Lower Basin Memorandum of Understanding (MOU)
  - Decrease demands below Lake Mead

…both aim to "flatten" the Structural Deficit curve

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Salinity Control Project Areas

			Irrigated Acres	Treated Acres	EIS Goal (tons)	On-Farm Controls (tons)	Off-Farm Controls (tons)	[1]Total Tons Controlled	Indexed Initial Cost per ton $	Nominal 2016 Cost per ton $
Colorado	Grand Valley	1977	44,600	42,934	132,000	136,801	6,768	143,569	52	101
	Lower Gunnison	1982	171,000	68,460	186,000	99,847	21,187	121,034	87	148
	McElmo Creek	1989	29,000	16,163	46,000	27,358	2,447	29,805	99	146
	Mancos Valley	2004	11,700	2,773	11,940	2,434	2,035	4,469	67	30
	Silt	2005	7,400	1,783	3,990	1,461	865	2,326	93	235
Utah	Uintah Basin	1982	226,000	159,190	140,500	139,907	9,135	149,042	177	106
	Price-San Rafael	1997	66,000	35,207	146,900	83,334	1,553	84,887	36	44
	Manila-Washam	2005	8,000	3,559	17,430	7,958	0	7,958	53	40
	Muddy Creek	2004	6,000	70	11,677	71	0	71	96	n/a
	Green River	2009	2,600	399	6,540	1,287	0	1,287	104	37
Wyoming	Big Sandy River	1988	18,000	13,663	83,700	58,293	0	58,293	40	86
	Henrys Fork	2013	20,700	103	6,540	89	0	89	236	161
Tier II	(all)					6,558	964	7,522		
Totals			611,000	344,304	793,217	565,398	44,954	610,352		

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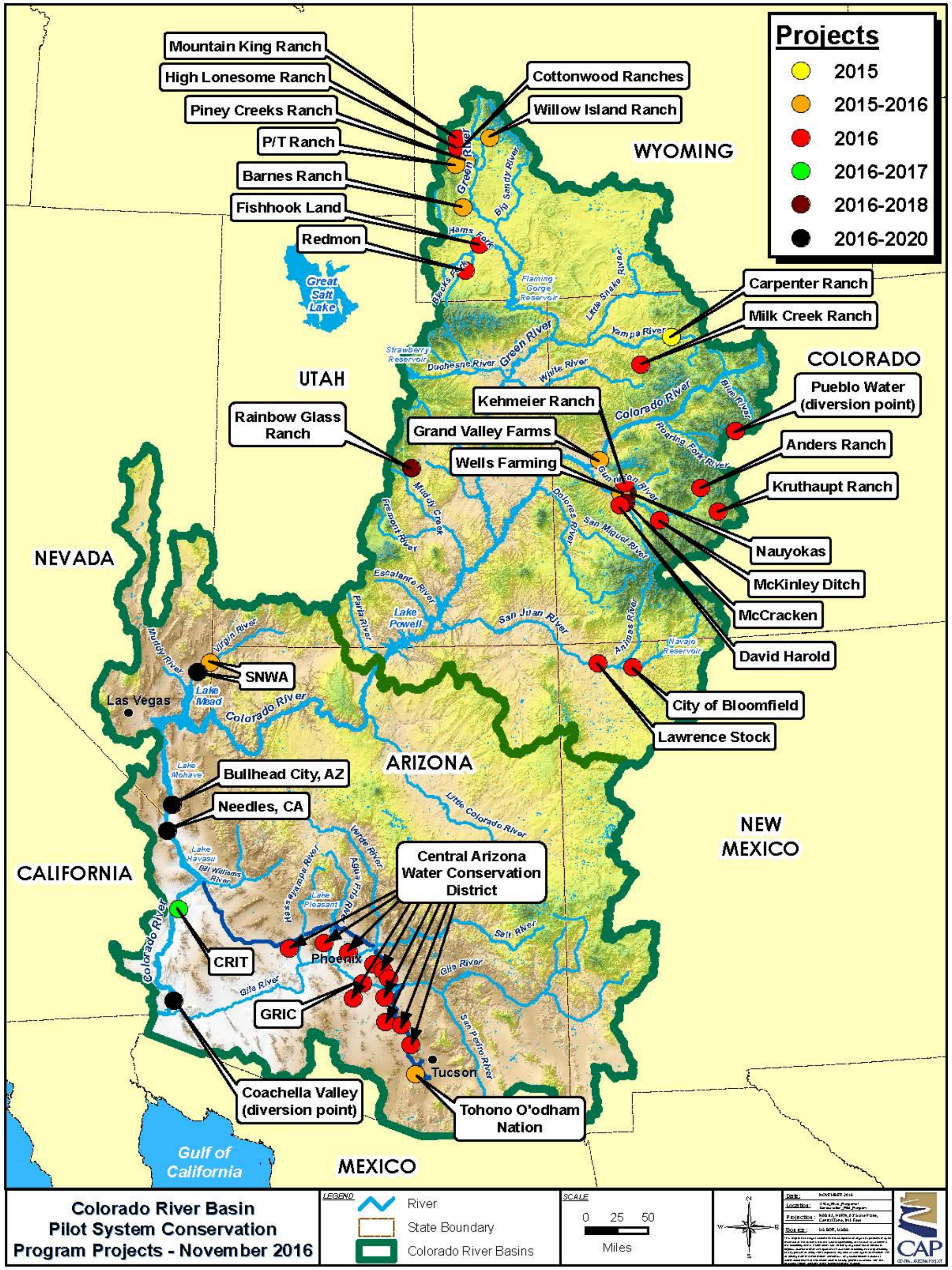

Pilot System Conservation Program

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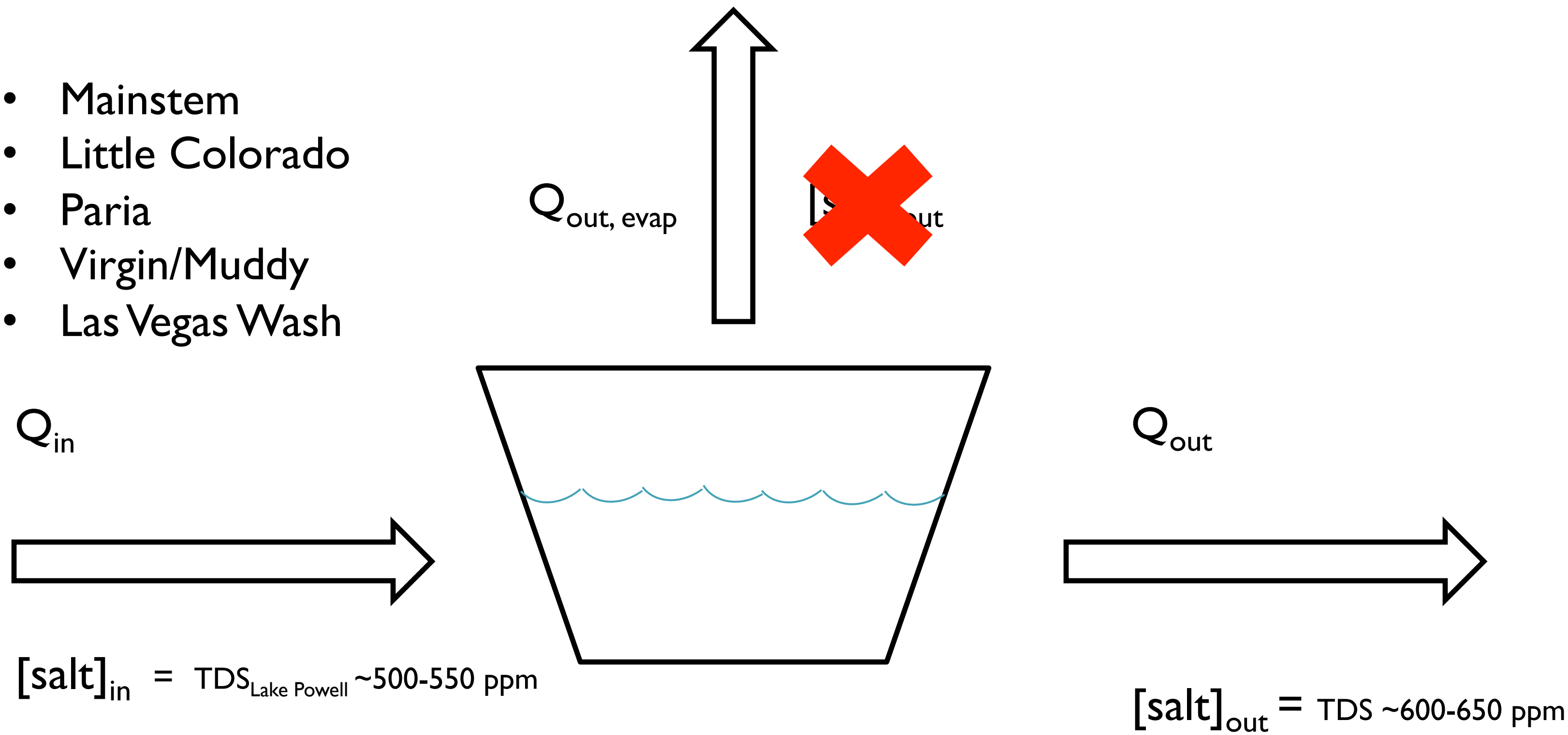
Pilot System Conservation Program

	Project Area	Acres Fallowed	Tons/Active Acre	Tons Controlled
Wyoming	Barnes Ranch	602	1.11	668.22
	Willow Island Ranch	163.2	1.11	181.15
	Redmon	40	1.11	44.40
	Fishhook Land Ranch	292	1.11	324.12
	Mountain King Ranch	1,103	1.11	1,224.33
	High Lonesome Ranch	1,631	1.11	1,810.41
	Piney Creeks Ranch	1,279	1.11	1,419.69
	P/T Ranch	285	1.11	316.35
	Cottonwood Ranches	2,462	1.11	2,732.82
Colorado	Carpenter Ranch	192.6	3.09	595.13
	Grand Valley Farms	200	6.63	1,326.00
	Wells Farming	23	6.63	152.49
	Kehmeier Ranch	67	6.63	444.21
	McCracken	10	6.63	66.30
	Nauyokas[1]	NA	6.63	NA
	Anders Ranch	106	2.77	293.62
	Kruthaupt Ranch	165	2.77	457.05
	Milk Creek Ranch	94	3.09	290.46
	McKinley Ditch	194.5	0.72	140.04
	City of Pueblo CO[2]	NA	NA	NA
	David Harold[3]	NA	6.63	NA
Utah	Rainbow Glass Ranch[4]	NA	3.83	NA
New Mexico	City of Bloomfied NM[5]	NA	5.62	NA
	Lawrence Stock	57.51	3.66	210.49
Totals		8,966.81	NA	12,697.28
Notes				
[1] Reduce irrigation and crop switch to triticale				
[2] Reduce diversion				
[3] Reduce irrigation				
[4] Crop switch from alfalfa to pasture grass				
[5] Irrigation efficiency equipment install				

Tons/active acre from Table 1. HUC8 TDS loads and yields estimated from updated UCRB SPARROW model.

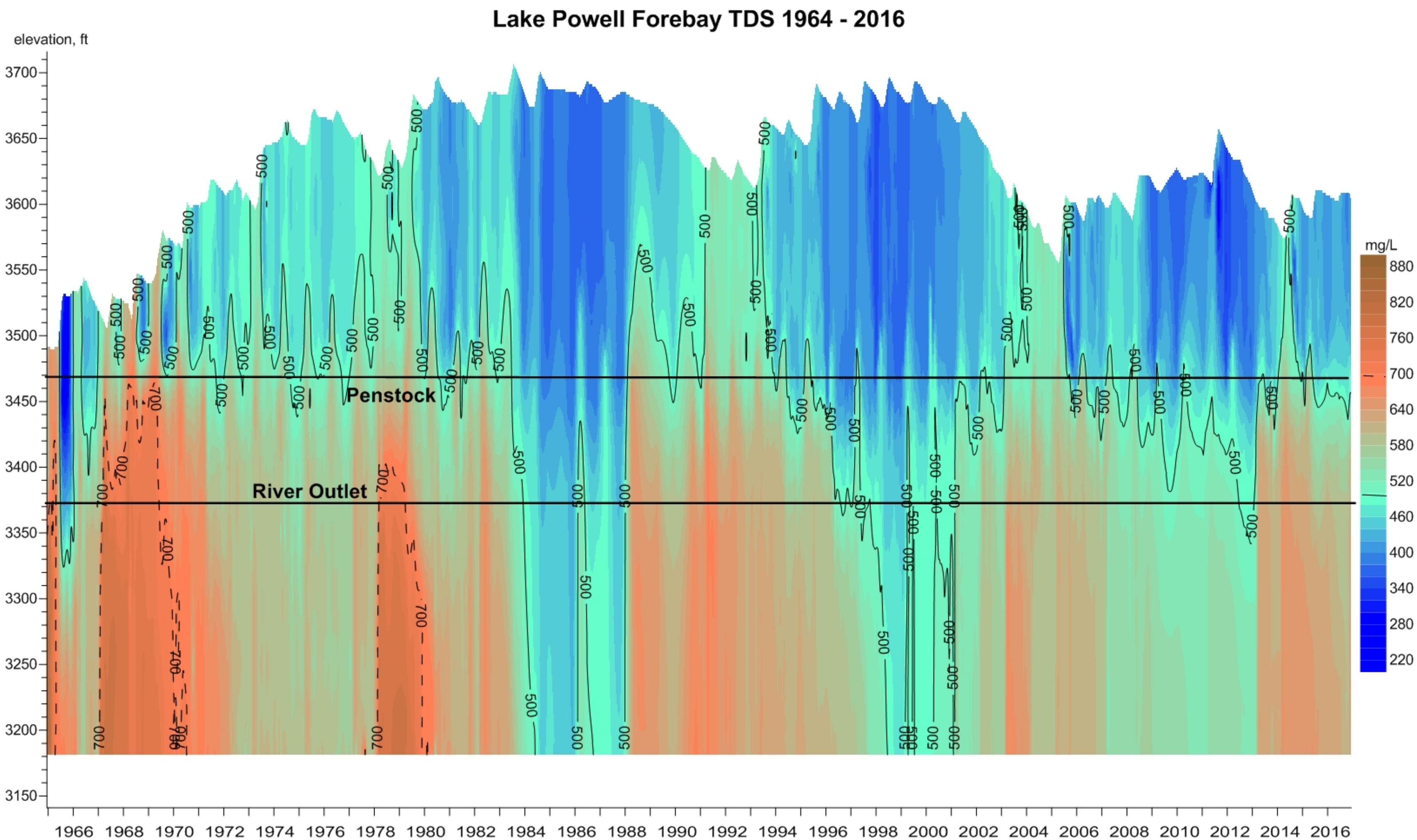
Sources of Salinity to Mead

- Mainstem
- Little Colorado
- Paria
- Virgin/Muddy
- Las Vegas Wash



- Natural
- Ag
- Reclaimed

Lake Powell Forebay TDS



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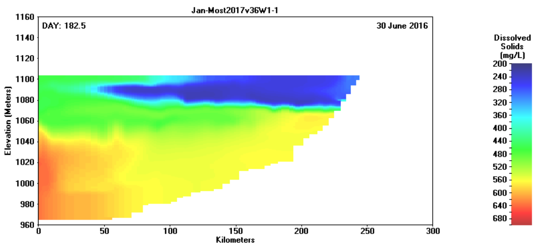
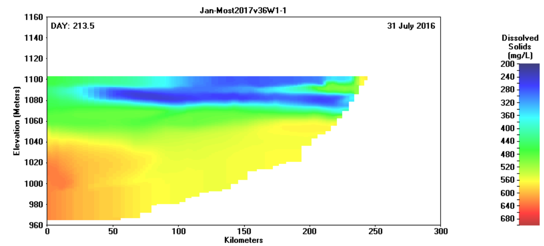
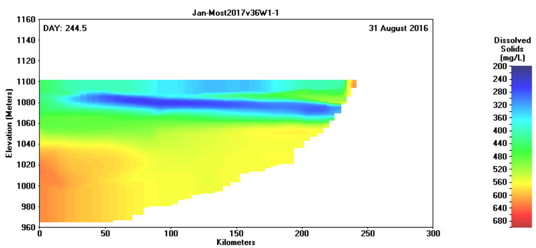
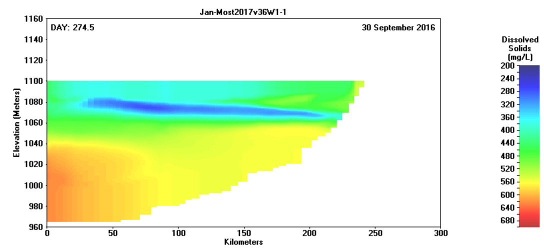
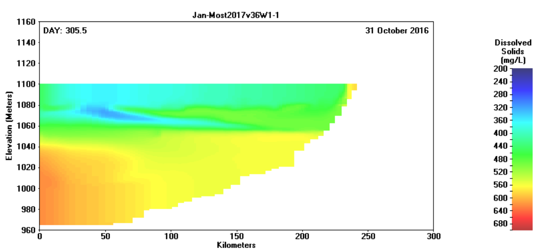
TDS in Lake Powell

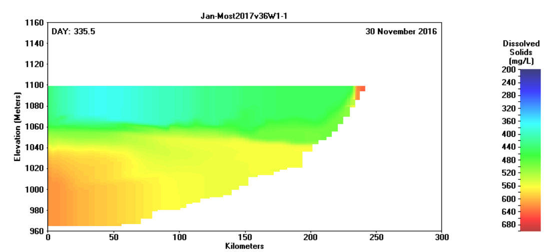












Source: USBR Lake Powell CE-Qual W2 model, courtesy of Robert Radtke and Keri Stout

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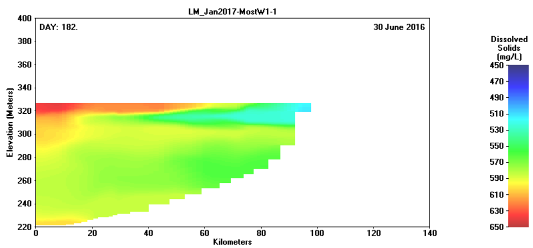
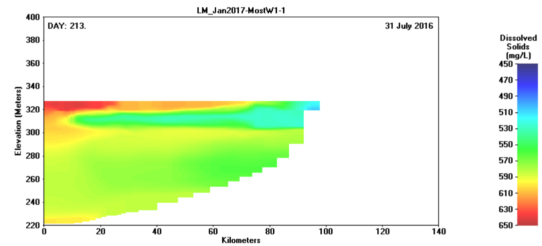
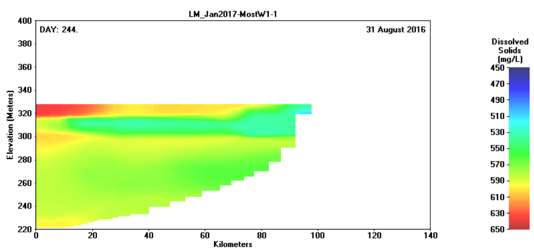
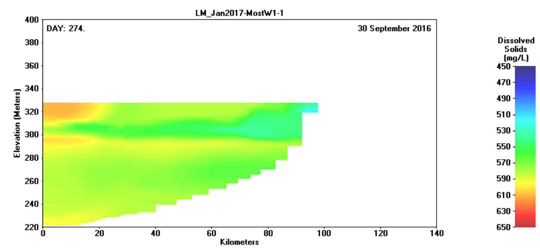
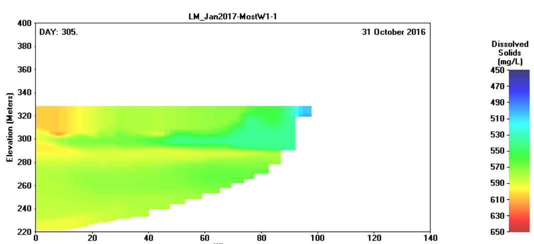
TDS in Lake Mead

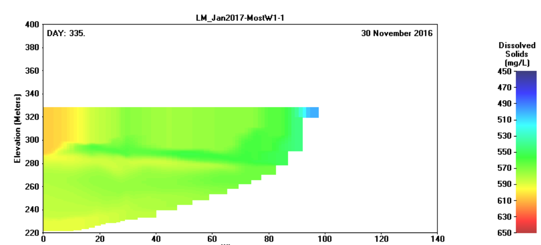












Source: USBR Lake Mead CE-Qual W2 model, courtesy of Robert Radtke and Keri Stout

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Expected Impacts

- Lower Consumptive Use in the Upper Basin
  - Improved water quality in the mainstem
  - Continued stratification in Lake Powell
  - Delayed shift in Powell outflow salinity
- Pilot System Conservation Programs in the Green, Upper Colorado, and San Juan rivers
  - Beneficial impacts on lake levels
  - Beneficial impacts on salt load coming into Lake Mead
  - Estimable but not yet observable
- Salinification of Lake Mead will continue at a reduced rate until shift in Powell outflow salinity
- Deliveries to Mexico
  - Salinity differential

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Summary

- Lake Mead is still declining due to drought and imbalances between supplies and demands
- Current projections show the '07 Guidelines may not be sufficient to address the declines
- CAP, with partners, have invested in Lake Mead protection efforts, and Basin-wide conservation, resulting in avoiding shortages in 2016 and 2017
- Conservation programs provide near-term benefits to salinity and system storage…benefit both quality and quantity
- Salinity benefits are estimable (~623,000 tons controlled) but difficult to quantify
- Conservation may make compliance with the salinity differential more difficult in the near-term.

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