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Managing Water in the West

Temperature Management in the Upper Sacramento River–

What Can We Learn from Looking at the Historical Data?

John Burke

Bureau of Reclamation

CALFED Science Program Workshop

April 1, 2008

U.S. Department of the Interior
Bureau of Reclamation

The Data

- **Shasta-Trinity Water Quality Network: 1990-Present**
  - Water temp, turbidity, DO, some air temp
- **Reservoir Temperature Profiles: 1970's – Present**
  - Approx. Monthly, sometimes more frequent
- **Operations Data**
  - Storage, discharge, elevation, STCD operation
- **Hydrologic and Meteorologic data**
  - Streamflows, Air Temps: CDEC, NOAA

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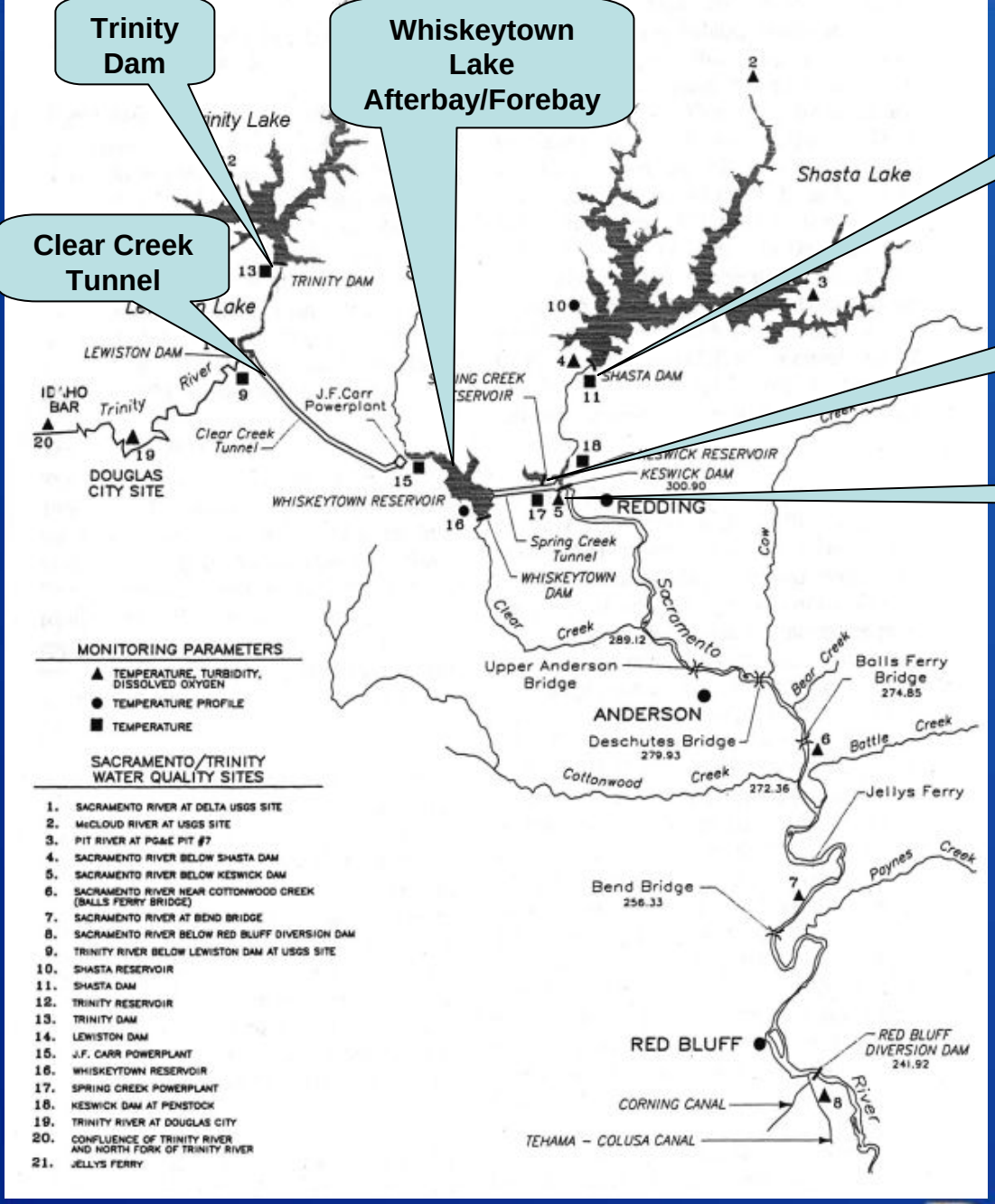

Northern CVP Network

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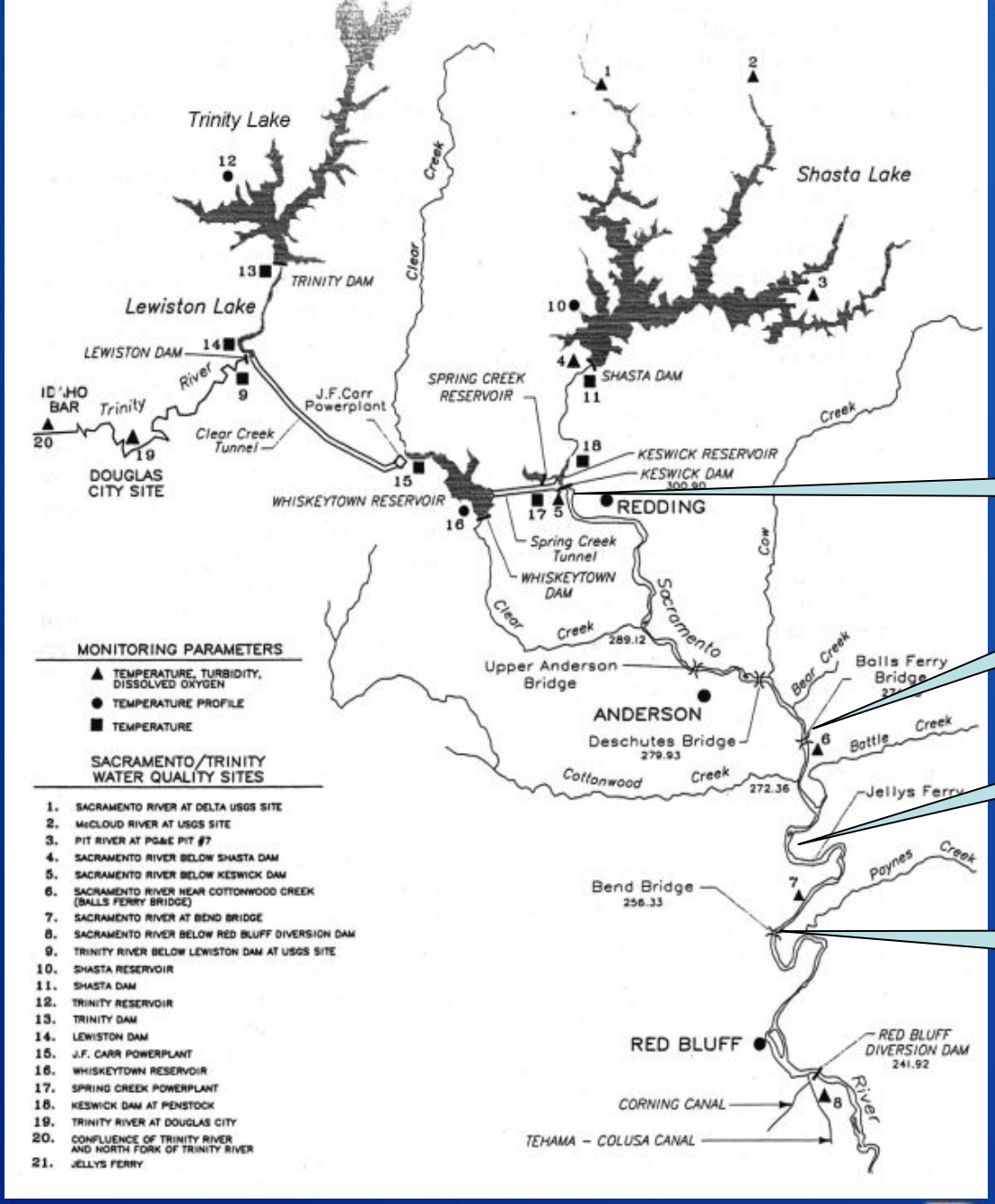
Northern CVP Network



Keswick Dam

Balls: RM 27

Jellys: RM 36

Bend: RM 45

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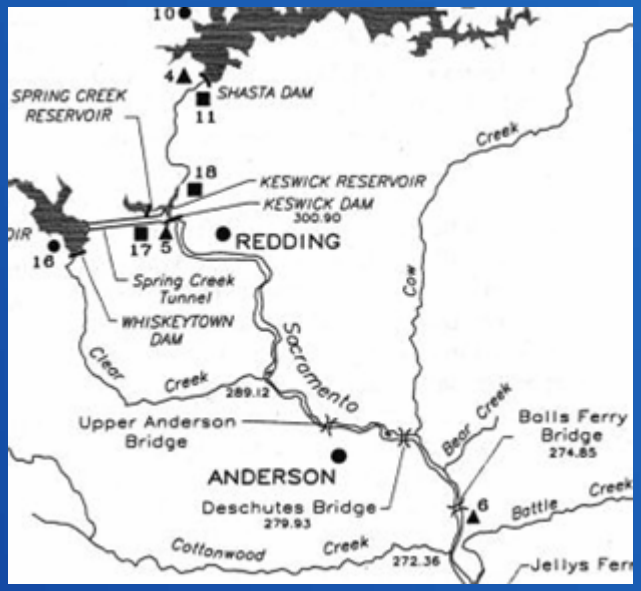
Means of Control

- **Source of Reservoir Withdrawal**
- **Rate of Flow**
- **Configuration of STCD Gates**



- *Simple enough, but each of the "Means of Control" has significant complexity and has effects from lots of variables*

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The Variables

Significantly Effect Temperature Management Planning and Performance

- **Hydrological:**
  - Overall Water Supply, Distribution over Basins,Distribution over Time, Flood Inflows, Presence of warm creek inflows
- **Climatological:**
  - Temperature of Reservoir Inflows, Atmospheric Temps, Meteorological Anomalies
- **Limnological:**
  - Stratification Cycle, Temperature Profile anomalies
- **Operational:**
  - CVP Demands and Responsibilities that constrain storage and release. Performance of SCTD. Obtaining “Thermal Connection” between Trinity and Sacramento

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Challenges

- Beneficially Incorporating Trinity R. exported water
- Responding to extreme or unexpected Atmospheric temps
- Balancing Use vs. Conservation of Cold Water given uncertain duration of temp management season
- Early season warm water input from tributary creeks
- Flood Control Ops, esp. late season, that force cold water release

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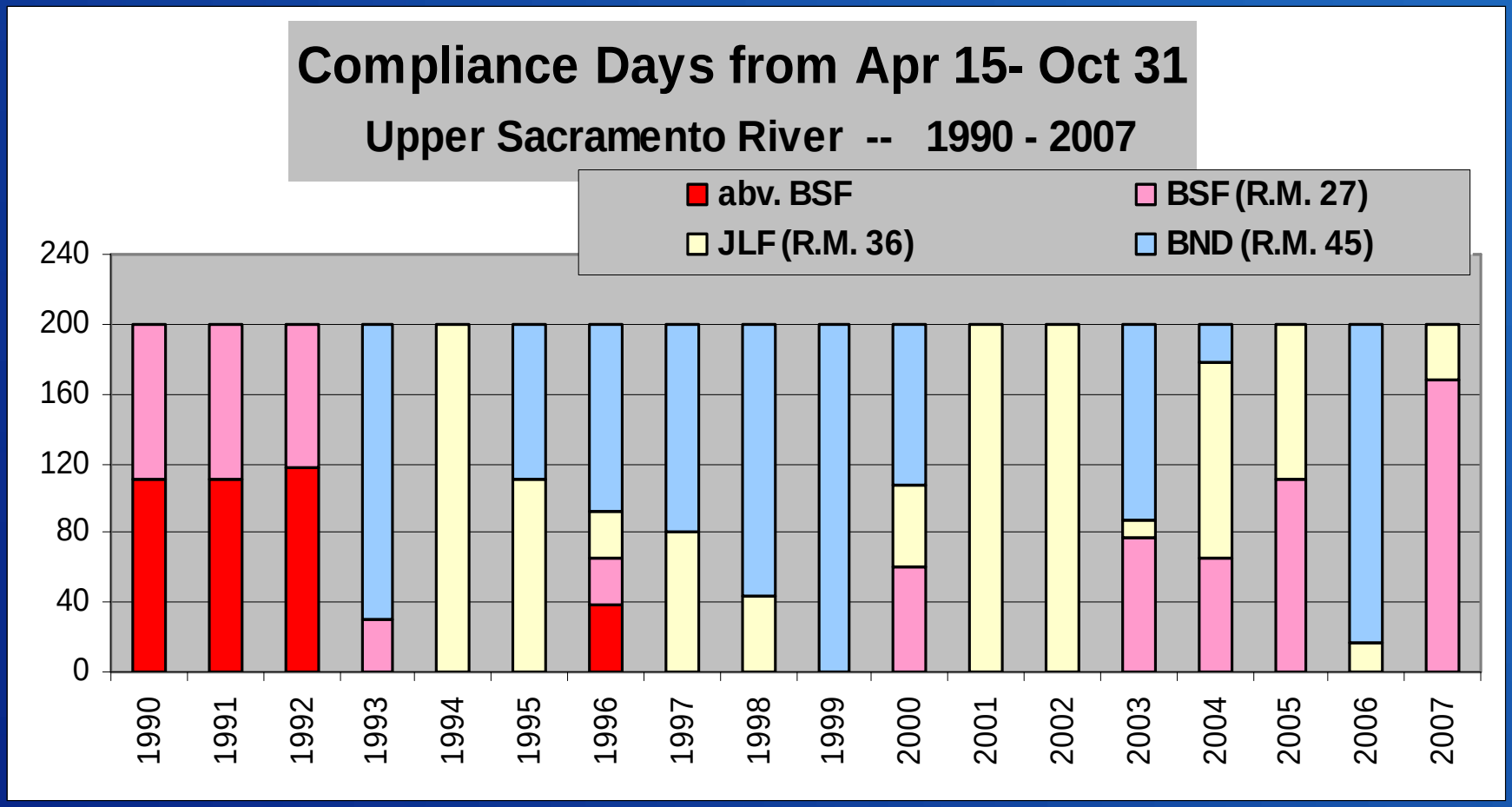

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Wanted: A Simple Index of Overall Performance

- **Defined:** "Time-weighted River Miles of Protected Habitat blw. Keswick from Apr 15 to Oct 31"
- **Protected Habitat** = River Temps targeted 56 F degrees or less (usually referred to as "Compliance Point")
- **The Season**: April 15- Oct 31 is 200 days

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River Miles below Keswick

- Bend Bridge = 45 miles
- Jellys Ferry = 36 miles
- Balls Ferry = 27 miles
- Above Balls Ferry = assigned as 20 miles

- <u>Protected River Miles Index Calculation</u>:
  - Weighted Average for period Apr 15-Oct 31 = ((45*Bend Days) + (36*Jellys Days) + (27* Balls Ferry days) + (20 * Abv. Balls Ferry Days)) / 200 Days

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Number of "Compliance Days" at Sites on Upper Sacramento River Apr 15- Oct. 31

and Simple Index Value for River Miles Protected Each Season

WY	Abv. BSF	BSF RM 27	JLF RM 36	BND RM 45	R.M. Index
1990	110	90	0	0	23.2
1991	111	89	0	0	23.1
1992	117	83	0	0	22.9
1993	0	31	0	169	42.2
1994	0	0	200	0	36.0
1995	0	0	110	90	40.1
1996	38	28	27	107	36.5
1997	0	0	81	119	41.4
1998	0	0	44	156	43.0

WY	Abv. BSF	BSF RM 27	JLF RM 36	BND RM 45	R.M. Index
1999	0	0	0	200	45.0
2000	0	61	46	93	37.4
2001	0	0	200	0	36.0
2002	0	0	200	0	36.0
2003	0	78	9	113	37.6
2004	0	66	112	22	34.0
2005	0	111	89	0	31.0
2006	0	0	16	184	44.3
2007	0	168	32	0	28.4

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What Helps Explain Variance in Performance?

- **Separation of Data into Wet Years and Dry Years**
  - Dry Years well behaved/ Wet Years effects are more complex

- **<u>Better</u>: Body of Cold Water in Shasta at Beginning of Season (Storage < 52F per profile near May 1)**

- **<u>Best</u>: Add in the Seasonal (May-Oct) Volume of Spring Creek Powerplant flow – this helps explain remaining variance, in Dry years—but not in Wet**

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Seasonal Atmospheric Temps

Redding Average Temp May-Oct 1990-2007

no obvious effect on seasonal performance

Hottest:

- **2003 (75.9F)**
- **2001 (75.6F)**
- **1992 (75.5F)**
- **2006 (75.4F)**
- **2002 (75.1)**

- **Coolest:**
  - **1998 (71.3F)**
  - **2000 (72.6F)**
  - **1995 (72.9F)**
  - **1993 (72.9F)**
  - **2005 (73.1F)**

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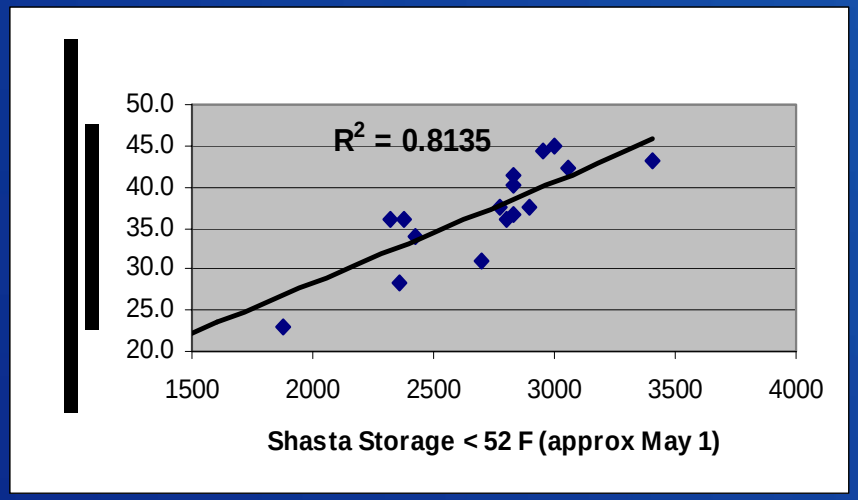
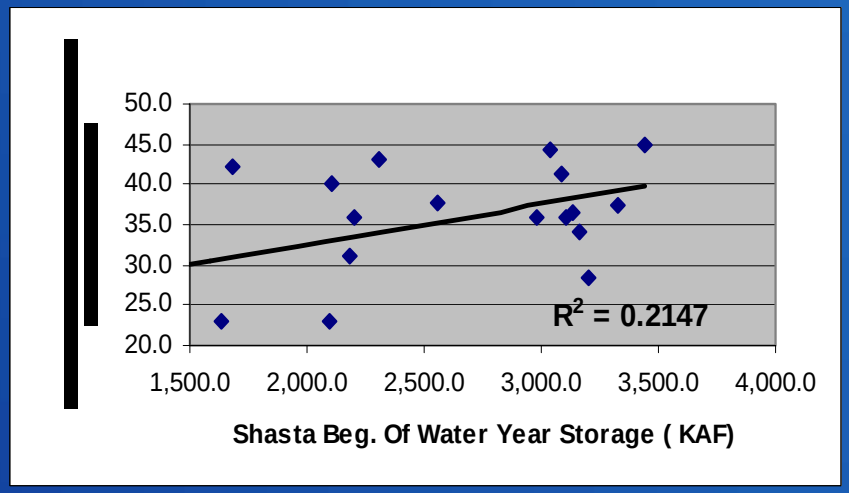
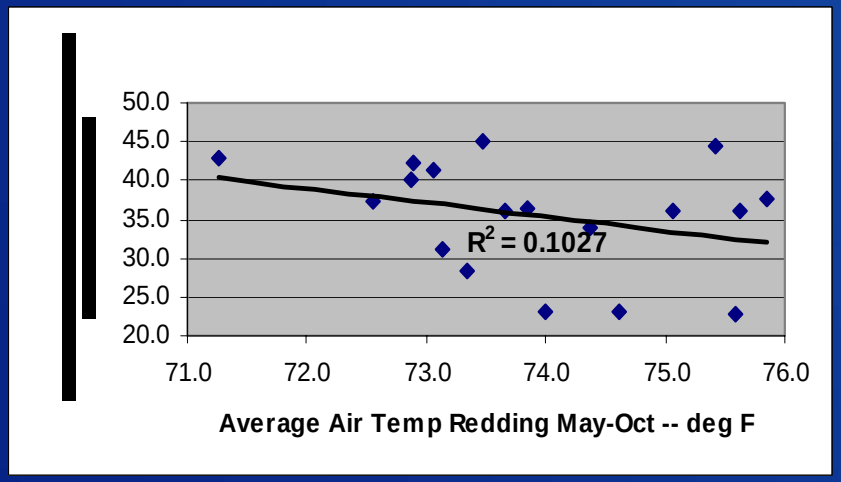
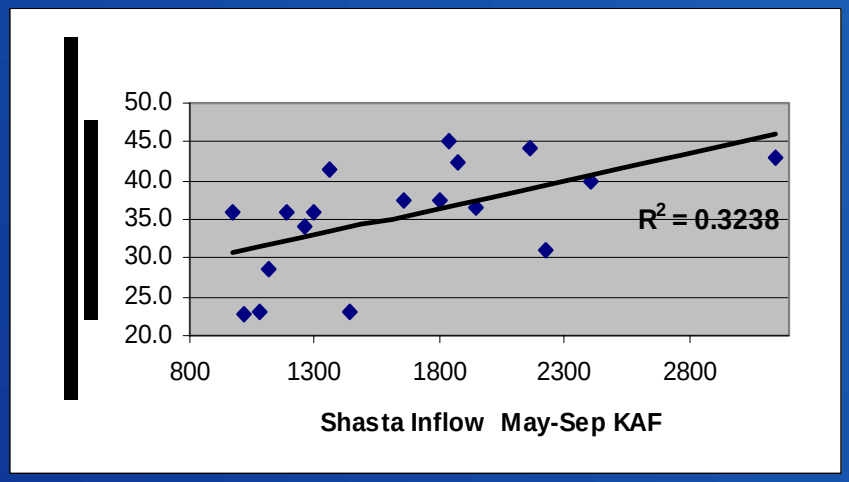
Sacramento River Temperature Habitat Relationships Using All years 1990-2007









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Wet/Dry Years 1990-2007
Shasta May-Sep Inflow: Dry < 1450 KAF

- Dry Years
  - 1990
  - 1991
  - 1992
  - 1994
  - 1997
  - 2001
  - 2002
  - 2004
  - 2007
- Wet Years
  - 1993
  - 1995
  - 1996
  - 1998
  - 1999
  - 2000
  - 2003
  - 2005
  - 2006

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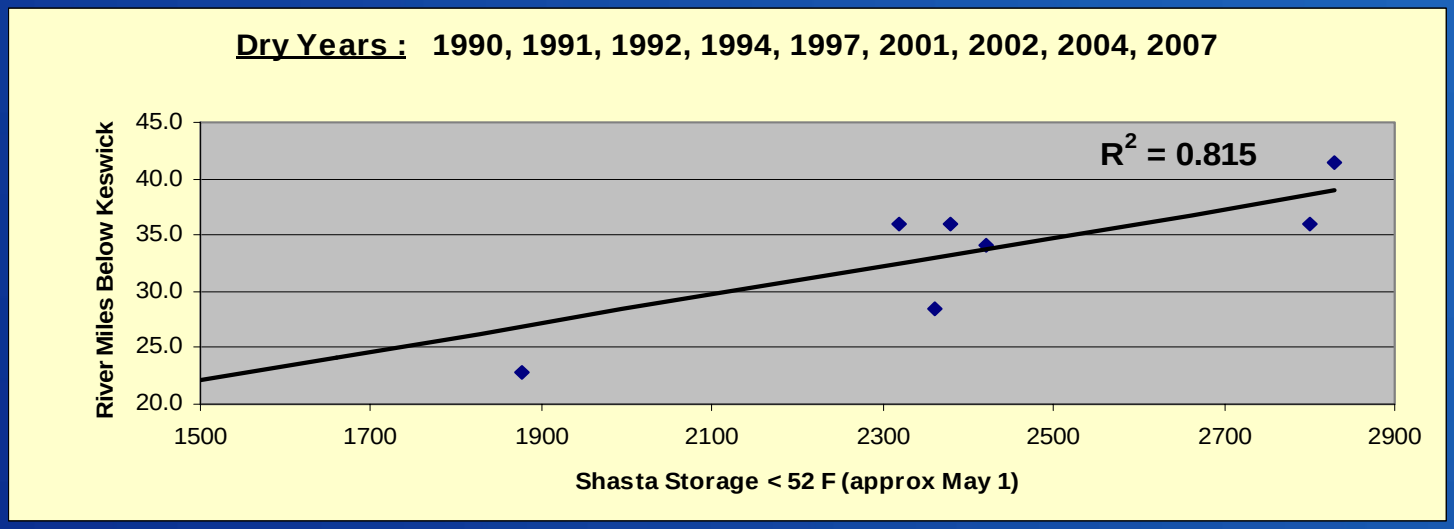
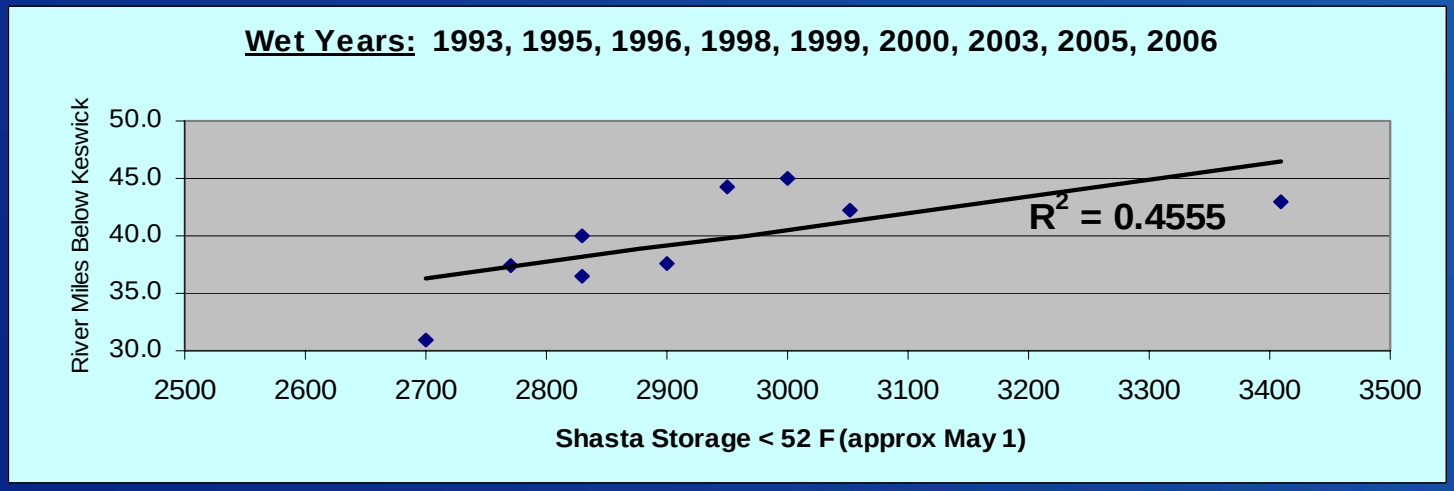
Sacramento River Temperature Habitat

River Mile Index vs. Shasta Storage < 52F (near May1)





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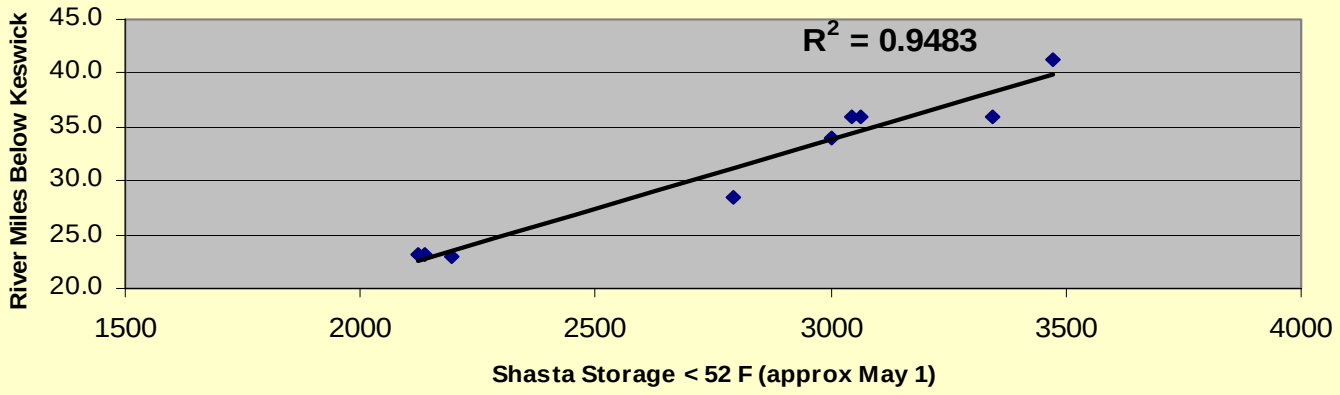
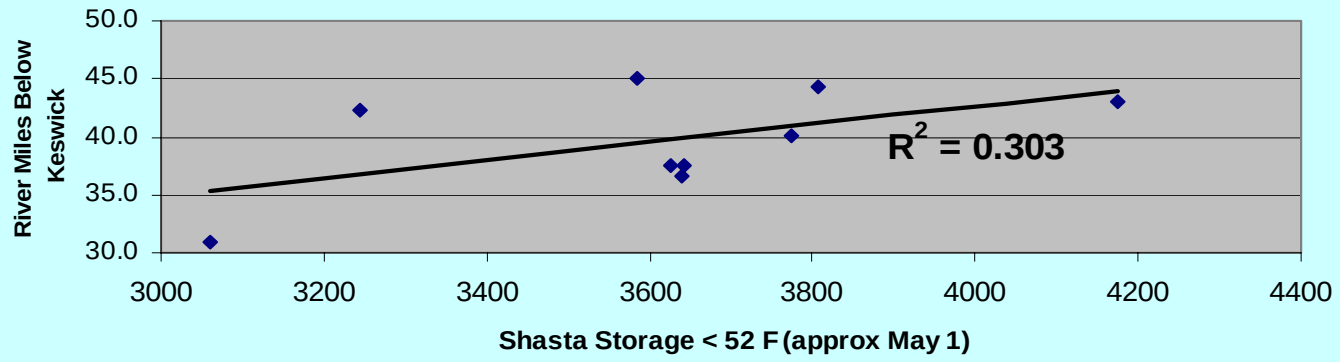
Sacramento River Temperature Habitat

River Mile Index vs. SCPP (May-Oct) *plus* Shasta Storage < 52F (near May1)

Dry Years : 1990, 1991, 1992, 1994, 1997, 2001, 2002, 2004, 2007



Wet Years: 1993, 1995, 1996, 1998, 1999, 2000, 2003, 2005, 2006



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The End

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By John Burke

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Water Year	Sac River Hyd. Index 40/30/30	Shasta Inflow - (KAF)	May-Sep Inflow (KAF)	Apr 30 Shasta Storage (KAF)	Sep 30 Shasta Storage (KAF)	May-Sep Inflow Wet or Dry	Spring Creek Powerplant May-Oct (KAF)	Keswick Release May-Oct (KAF)
					3211			
1987	D	3944	1,092	4,036	2,108	D	671	3750
1988	C	3931	1,173	3,233	1,586	D	812	3744
1989	D	4745	1,133	3,743	2,096	D	651	3511
1990	C	3616	1,437	2,484	1,637	D	641	3117
1991	C	3051	1,083	2,202	1,340	D	627	2644
1992	C	3622	1,013	2,671	1,683	D	315	2463
1993	AN	6825	1,876	4,263	3,102	W	191	3486
1994	C	3087	973	3,534	2,102	D	746	3286
1995	W	9638	2,409	4,165	3,136	W	944	4632
1996	W	6846	1,948	4,308	3,089	W	810	4193
1997	W	7424	1,357	3,937	2,308	D	642	3710
1998	W	10294	3,146	4,061	3,441	W	767	4710
1999	W	7196	1,834	4,256	3,328	W	584	3627
2000	AN	6839	1,656	4,153	2,985	W	873	3889
2001	D	4141	1,301	4,020	2,200	D	667	3876
2002	D	5052	1,187	4,297	2,558	D	546	3788
2003	AN	6363	1,800	4,536	3,159	W	727	4124
2004	BN	5739	1,260	4,060	2,183	D	583	3971
2005	AN	5639	2,228	4,207	3,035	W	361	4118
2006	W	9242	2,167	4,057	3,205	W	858	4245
2007	D	3955	1,120	3,901	1,879	D	434	3868

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