Feather River Coordinated Resource Management Watershed Monitoring Program

2011 Report

March 16, 2011 Storm Event. Clockwise from top right: Indian Creek at Flournoy Br, Lights Creek, Wolf Creek, Indian Creek at DWR Weir.

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April 2012

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Abbreviations Used in this Report

Abv-	Above
Acw-	Above confluence with
Avg-	Average
Blw-	Below
CDEC-	California Data Exchange Center
CRS-	Continuous Recording Station
DWR-	California Department of Water Resources
EBNFFR-	East Branch North Fork Feather River
EPA-	US Environmental Protection Agency
FRCRM-	Feather River Coordinated Resource Management
Max-	Maximum
Min-	Minimum
MFFR-	Middle Fork Feather River
MR-	Monitoring Reach
NTU-	Nephelometric Turbidity Unit
RAC-	Resource Advisory Committee
SCI-	Stream Condition Inventory
SWAMP-	Surface Water Ambient Monitoring Program
Temp-	Temperature
USFS-	US Forest Service
WY-	Water year

Introduction to Feather River CRM Monitoring Program

2011 Monitoring Report Summary

This report tiers to Feather River Coordinated Resource Management (FRCRM) group monitoring reports from 1999 through 2010. The 2011 Water Year (October 1, 2010- September 30, 2011) was an above average water year with 142% of normal historic precipitation for the entire Feather River Basin. The Quincy (US Forest Service gage) and Portola (CA Dept. Water Resources [DWR] gage) stations recorded percent of normal historic precipitation higher than the basin average. Quincy reported 148% of normal and Portola 156% of normal historic precipitation. There were four storm events this water year. One storm event, March 14-16 2011, peaked at 6,070 cfs at the DWR gage on Indian Creek below Indian Falls. Even though this high flow event was the largest event since 2006, it was only a 3-4 year event. The March event exceeded the ratings at many of the FRCRM gauging stations. FRCRM staff was able to measure high flows at several of the stations during some of these events.

This report includes data from the FRCRM continuous recording stations, as well data from 14 of the 22 FRCRM monitoring reaches. This year the Last Chance Creek at Doyle Crossing continuous recording station had an internal battery failure, and didn't collect data for most of the year. The Indian Creek at Flournoy Bridge continuous recording station was not replaced from the 2010 failure until late July 2011.

In 2011 Ken Cawley, consulting hydrologist, conducted a statistical analysis on FRCRM stream flow data from the Doyle Crossing, Notson Bridge, Flournoy Bridge, and Above and Below Big Flat Continuous Recording Stations. This report is discussed further on page 24.

Most important findings in this monitoring report:

- Number of days with maximum daily temperature above 75°F continues to decrease on Last Chance Creek at Doyle Crossing. See Figure 7.
- Downward trend in diurnal fluctuation despite warm air temperatures in 2011 on Last Chance Creek at Doyle Crossing. See Figures 10 and 12.
- An increase in base flow volume by 68.9 acre feet at Doyle Crossing for Aug 1 through Sept 30 in 2011 compared with the same period in 2006. This increase is not statistically significant. See Figure 18.
- An increase in base flow volume by 21.7 acre feet at Notson Bridge for Aug 1 through Sept 30 in 2011 compared with the same period in 2006. This increase is not statistically significant. See Figure 16.

Data Issues

- Flournoy Bridge transducer replaced July 28, 2011.
- Indian Creek at Taylorsville is not represented in most of the graphs, because the sensor was out of the water, only collecting high flow data. Funding has been provided by the USFS RAC, Title II funds, to install a low flow sensor in 2012.
- Turbidity sensor on Indian Creek at Taylorsville failed in 2009. The sensor will be replaced with USFS RAC funds in 2012.
- Internal battery failure on Last Chance Creek at Doyle Crossing. Data is missing from Dec 4, 2010 to July 11, 2011.

About the Feather River CRM

The FRCRM, a proactive consortium of 24 public agencies, private sector groups, and local landowners, was established in 1985 in response to widespread erosion and channel degradation in the Feather River watershed. One hundred and forty years of intensive human use has contributed to a watershed-wide stream channel entrenchment process. The FRCRM was able to initiate systematized monitoring in the Feather River watershed in 1999 to establish baseline data for assessing long-term trends in watershed condition and the potentially significant effects of restoration projects on watershed function. Most of the monitoring effort is concentrated in the Indian Creek subwatershed because of its highly degraded upper watershed condition, and high potential for benefit from restoration with many linear miles of alluvial channels. Monitoring site locations follow a nested approach. Please see the diagram at the end of the report that shows monitoring station locations with project locations.

Watershed Monitoring Program Background

Background information such as an overview of the watershed, monitoring program objectives, more detailed earlier data, and protocols can be found in the FRCRM watershed monitoring reports from 2003 and 2005. Reports can be found on the monitoring page of the FRCRM website at www.feather-river-crm.org. The monitoring network was installed in 1999 and data have been collected from 2000-2011.

Initial funding for the FRCRM's monitoring program was provided by a Clean Water Act 319(h) grant (Aug 1998 to Dec 2000). Subsequent funding sources were: the California Surface Water Ambient Monitoring Program (SWAMP) from Oct 2000 to Dec 2003 and the Plumas Watershed Forum (2004 to 2006). Physical and biological surveys of FRCRM's 22 monitoring reaches have not been conducted since 2003. Funding has been provided by the USFS RAC, Title II funds, to operate and maintain the continuous recording stations as well as complete surveys on selected monitoring reaches in 2011.

Monitoring Program Description

This report documents on-going monitoring data from the 2011 Water Year (WY) (October 1, 2010-September 30, 2011).

Three main subwatersheds of the Feather River are covered under this monitoring program:

- Indian Creek } **East Branch North Fork Feather River**
- Spanish Creek }
- Middle Fork Feather River
- North Fork Feather River

Data Collected at the Continuous Recording Stations (CRS):

- **Stage** (calibrated to flow)
- **Water Temperature**
- **Air Temperature** (except at Wolf Creek and DWR Weir)
- **Turbidity** (NTU's) **-** currently only at Indian Creek at Taylorsville (not functioning since 2009)

Much of the FRCRM restoration efforts are concentrated on reducing erosion by restoring meadow hydrologic function. This includes restoring floodplain function and groundwater recharge. The metric that the FRCRM uses to show reduced erosion is turbidity. Two metrics that may indicate restored hydrologic function are increased summer baseflow levels and decreased summer water temperatures.

Stream flow stage, air and water temperature are recorded every 15 minutes by Campbell CR10X data loggers at the following FR-CRM monitoring stations: Red Clover Creek at Notson Bridge; Last Chance Creek at Doyle Crossing and at Million Dollar Bridge; Cottonwood Creek above and below Big Flat (not on map); Indian Creek at the Calif. Department of Water Resources (DWR) weir (above the confluence of Red Clover Creek); Indian Creek at the Flournoy Bridge (below the confluence of Red Clover Creek); and Indian Creek at the Taylorsville Bridge; Lights Creek at Deadfall Lane Br.; and Wolf Creek at the Ball Field Bridge in Greenville; Spanish Creek at Dyrr Bank near Gansner Park in Quincy (2003-2010); and Sulphur Creek at Hwy 89 Br (2005-2006).

The stage, air and water temperature readings are stored as hourly averages and then summarized into daily files at the end of each water year. To continuously record turbidity, an Analite 195 laser sensor (a nephelometric probe) was installed on Indian Creek at Taylorsville Bridge in 2001 and on Spanish Creek (2001-06). The data loggers are capable of storing up to six months of data. FRCRM staff and contract technicians download data monthly to ensure reliable station operation. Because of periodic channel shifts at most of the stations, monthly calibration measurements are required. FRCRM staff is also responsible for capturing discharge measurements over the range of flows at each station in order to maintain/update the rating tables. Rating tables are reviewed and/or updated annually by Sagraves Environmental Services, Red Bluff.

Table 1. Watershed Area above Continuous Recording Stations

Watershed Area above Continuous Recording Stations (for station location see Figure 1)	
Station	**Area (acres)**
Last Chance at Doyle Crossing	61,746
Red Clover at Notson Bridge	69, 121
Indian Creek at DWR Weir	72,619
Indian Creek at Flournoy Bridge	281,132
Indian Creek at Taylorsville	343,193
Lights Creek at Deadfall Bridge	67,722
Wolf Creek at Ball Field Bridge	31,945

Data Collected at the Monitoring Reaches (MR):

Monitoring reaches are typically 1000-feet reaches located at the bottom of a subwatershed in a response reach. They are based on the USFS Pacific Southwest Region Stream Condition Inventory (SCI) technical guide (See attachment E), with some modifications and additions. Measurements that are taken are expected to reflect the condition of the watershed above the monitoring reach. Caveats with that assumption are: 1) if there is a lot of local disturbance at the monitoring reach location, measurements may be more a reflection of changes in that reach rather than watershed-wide changes; and 2) The SCI protocol monitoring reach sites were chosen based on watersheds of 5,000-10,000 acres, whereas the FRCRM monitoring reach sites encompass larger watershed areas.

The location of FRCRM monitoring reaches (as well as continuous recording stations) is complementary to the Plumas and Lassen National Forest SCI monitoring locations, and is typically on private lands that are not accessible to the Forest Service. A true assessment of any of these watersheds based on monitoring reach data should look at Forest Service SCI sites, as well as the FRCRM sites. Monitoring reach surveying was conducted biennially from 1999-2003. In 2011 14 of the 22 reaches were surveyed based on potential watershed responsiveness since 2003. It should also be noted that care was taken to conduct the survey at each site within approximately the same two weeks each year from 1999-2003, but in 2011 the sites were measured according to accessibility due to higher stream flows in the spring and early summer. It should also be noted that all of the FRCRM sites are monitored the same year. This differs from the Forest Service approach of staggering site monitoring, where a few sites are monitored each year, and each site is monitored once every five years. The FRCRM approach, where all sites are monitored the same year, allows for a potentially more valid comparison between sites.

- ***Channel morphology:*** Channel morphology at each reach has been measured in the following ways: three permanently marked channel cross-sections; channel slope (profile survey); bedload samples or pebble counts; and percentage of fines in pool tails. Streambank water depth and bank angle were measured in alluvial reaches only in 1999-2003, and were measured at all sites in 2011. Three bedload samples were taken at each reach (from the riffle closest to each permanent cross-section) in 1999. Data that were collected in 1999, but not in 2001 or 2003 are: percent shade; and stream bank stability (i.e. vegetation cover). These parameters were discontinued because the TAC agreed that they were more a reflection of site-specific characteristics than upstream watershed conditions. Percent shade and stream bank stability were taken in 2011 for reference.
- ***Water chemistry***: Water and ambient air temperatures were monitored in the summer at each monitoring reach site with Hobotemp data loggers. The temperature data loggers were installed in the shade in mid-June and collected in mid-September. Temperature was recorded every 1.5 hours for 90 days. Raw data files are stored at Plumas Corporation. Water chemistry samples were collected by DWR in June 2001 and September 2003. These samples measured various constituents (metals, nutrients, physical characteristics, and bacteria).
- ***Habitat***: Habitat measurements included pool/riffle lengths and pool depths.
- ***Macroinvertebrates***: Three samples per reach were collected. In 2001 and 2003 macroinvertebrates were stored in alcohol, and sent to the National Aquatic Monitoring Center, Utah Dept. of Fish & Wildlife in Ogden, Utah for analysis. In 2011 there was no budget for this type of analysis and macroinvertebrates were analyzed using *Biomonitoring of Streams: Using Aquatic Invertebrates as Water Quality Indicators,* David B. Herbst, Sierra Nevada Aquatic Research Laboratory, University of California (see Attachment F).
- ***Fish***: Fish surveys were completed in 2001 and 2003 by DWR (using a backpack electroshocker) to identify species present and productivity (amphibians noted, but no protocol survey).
- ***Aerial and ground photographs***: to provide visual documentation of in-stream and upland changes in vegetation and channel structure, and to support other monitoring results.
- ***Flow***: Stream flow was measured at the time of the monitoring reach survey, to put the survey data in context.

Table 2. Summary of Monitoring Reach types and years surveyed

Channel Type	Years Surveyed
Alluvial Channels	
Goodrich Cr	1999, 2001, 2011
Butt Cr	1999-2003
Wolf Cr	1999-2003, 2011
Lights Cr	1999-2003, 2011
Indian Cr abv Flournoy Br	1999-2003, 2011
Indian Cr blw Taylorsville Br	1999-2003, 2011
Greenhorn Cr acw Spanish Cr	1999-2003, 2011
Spanish Cr acw Greenhorn Cr	1999-2003, 2011
Rock Cr	1999-2003, 2011
MF Feather River @ Beckwourth	1999-2003, 2011
Sulphur Cr @ Clio	1999-2003, 2011
Red Clover Cr @ Chase Br*	1995, 2003, 2009
Last Chance Cr @ Murdock Crossing	1999-2003
Non-alluvial channels	
Spanish Cr abv Indian Cr	1999-2003
NF Feather River abv Lake Almanor	1999-2003
NF Feather River blw Lake Almanor	1999-2003
NF Feather River abv East Branch NF Feather River	1999-2003
East Branch NF Feather River abv NF Feather River	1999-2003, 2011
Red Clover Cr @ Drum Br	1999-2003
Indian Cr abv Spanish Cr	1999-2003, 2011
Jamison Cr	1999-2003, 2011
MF Feather River abv Nelson Cr	1999-2003, 2011
* Red Clover Cr @ Chase monitoring reach was discontinued with the construction of Red Clover Poco project. A new monitoring reach was established downstream below the project. The new reach was surveyed in 2010 and 2011.	

DWR Flow & Weather Stations

The California Department of Water Resources (DWR) maintains four weather stations and two continuous recording flow stations in the Feather River watershed to assist in managing the water resources. The two DWR flow stations are on Indian Creek below Indian Falls (ICR) and on the Middle Fork Feather River near Portola (MFP). Four weather stations installed by DWR in the Indian Creek watershed include Doyle Crossing (DOY) in 2000, Jordan Peak (JDP) in 2005, Thompson Valley (TVL) in 2006 and Taylorsville (TAY) in 2007. All of the DWR weather and flow stations are accessible on the DWR California Data Exchange Center (CDEC) website at cdec.water.ca.gov. Stream discharge and stage height are recorded at the DWR flow stations, while the DWR weather stations record precipitation, temperature, relative humidity, wind speed, wind direction, solar radiation and atmospheric pressure.

USFS Flow Stations

The US Forest Service (USFS) installed three continuous recording flow stations in the Feather River watershed in November and December 2011. These stations are located on Rowland Creek at the confluence with Little Last Chance Creek, Sulphur Creek below the confluence with McKenzie Creek, and Spanish Creek at the lower Spanish Ranch Bridge. Water pressure and temperature and atmospheric pressure and temperature are being continuously recorded using HOBO U20-001-04 loggers. These flow stations will be operated and calibrated by the USFS.

Figure 1. Feather River CRM Continuous Recording & Monitoring Reach Locations

* Continuous Recording Stations

1. Last Chance Creek @ Million Dollar Bridge
2. Last Chance Creek @ Doyle Crossing
3. Red Clover Creek @ Notson Bridge
4. Indian Creek @ DWR Weir
5. Indian Creek @ Flournoy Bridge
6. Indian Creek @ Taylorsville Bridge
7. Lights Creek @ Deadfall Lane Bridge
8. Wolf Creek @ Ball Field Bridge
9. Spanish Creek @ Dyrr Bank
10. Sulphur Creek @ Hwy 89 Bridge
11. Goodrich Creek
12. Butt Creek
13. Wolf Creek Abv Town Park
14. Red Clover Creek Blw Drum Bridge

• Monitoring Reaches

15. Last Chance Creek Blw Murdock Crossing
16. Indian Creek Abv Spanish Creek
17. Spanish Creek Abv Indian Creek
18. Greenhorn Creek Mouth
19. Spanish Creek Abv Greenhorn Creek
20. Rock Creek Mouth
21. Middle Fork Feather River Abv Nelson Cr
22. Jamison Creek
23. Middle Fork Feather River @ Beckwourth
24. East Branch North Fork Feather River Abv North Fork Feather River
25. North Fork Feather River Abv East Branch North Fork Feather River
26. North Fork Feather River Abv Lake Almanor

Table 3a. Upper Feather River Watershed Monitoring Sites- North Fork Feather River

Map #	Monitoring Site by Subwatershed	Monitoring Type	Yrs Surveyed/ of Operation
	North Fork Feather River (NFFR) watershed		
26	NFFR @ Domingo Springs (abv Lake Almanor)	MR*	99, 01, 03
	NFFR@ Seneca (blw Lake Almanor)	MR	99, 01, 03
25	NFFR @ above confluence with (acw) East Branch NFFR	MR	99, 01, 03
12	Butt Cr (abv 307 Br)	MR	99, 01, 03
11	Goodrich Cr	MR	99, 01, 11
24	**East Branch** mouth (acw NFFR)	MR	99, 01, 03, 11
17	**Spanish** mouth (acw Indian)	MR	99, 01, 03, 11
	Spanish Creek @ Keddie abv Blackhawk Cr.	CRS (USGS)	1933- present
19	Spanish Cr acw Greenhorn Cr	MR	99, 01, 03, 11
	Spanish Cr @ Spanish Ranch Br	CRS (USFS)	Dec 2011- present
18	Greenhorn Cr acw Spanish Cr	MR	99, 01, 03, 11
9	Spanish @ Quincy	CRS (USGS)	09- present
9	Spanish @ Dyrr Bank (Hwy 70)	CRS	2003-09
20	Rock Cr mouth	MR	99, 01, 03, 11
16	**Indian Cr** blw Indian Falls (acw Spanish Cr)	MR & CRS (DWR)	99, 01, 03, 11/ 07-present
13	Wolf Cr @ Ball Field Br	MR & CRS†	99, 01, 03, 11/ 09-present
7	Lights Cr @ Deadfall Lane Br	MR & CRS	99, 01, 03, 11/ 99-present
6	Indian Cr @ Taylorsville (TAY)	MR & CRS & Weather Station (DWR)	99, 01, 03, 11/ 99-present/ 07-present
5	Indian Cr @ Flournoy (below confluence with [bcw] Red Clover)	MR & CRS	99, 01, 03, 11/ 99-present
4	Indian Cr @ DWR weir (acw Red Clover)	CRS	99-present
	Red Clover Cr @ Chase Bridge	MR	99, 01, 03, 09
	Thompson Valley (TVL)	Weather Station (DWR)	06-present
14	Red Clover Cr @ Drum Bridge	MR	99, 01, 03
3	Red Clover @ Notson Bridge	CRS	99- present
15	Last Chance (LC) Cr @ Murdock	MR	99, 01, 03
2	Last Chance (LC) Cr @ Doyle Crossing (DOY)	CRS & Weather Station (DWR)	99- present/ 00-present
	McClellan Cr	MR (DWR)	97, 01, 05, 10
	Cottonwood Cr @ Big Flat	CRS abv & blw Big Flat	94-present
	Little Stoney Cr	MR (DWR)	97, 01, 05, 10
	Willow Cr	MR (DWR)	97, 01, 05, 10
	LC @ Alkali Flat low water crossing	MR (DWR)	97, 01, 05, 10
	Ferris Cr	MR (DWR)	97, 01, 05, 10
1	LC @ Million Dollar Bridge	CRS	04-present
	LC @ Bird-Jordan	MR (DWR)	97, 01, 05, 10
	Jordan Peak (JDP)	Weather Station (DWR)	05-present

* Monitoring Reaches (MR) refers to those surveyed by FRCRM unless otherwise noted in parentheses.
† Continuous Recording Stations (CRS) are maintained and operated by FRCRM unless otherwise noted in parentheses.

Table 3b. Upper Feather River Watershed Monitoring Sites- Middle Fork Feather River

Map #	Monitoring Site by Subwatershed	Monitoring Type	Yrs Surveyed/ of Operation
	Middle Fork Feather River (MFFR) watershed		
21	MFFR abv Nelson Cr	MR[‡]	99, 01, 03, 11
	MFFR @ Sloat	staff gage	2003- present
22	Jamison Cr @ 23N37 Br	MR	99, 01, 03, 11
	Rowland Cr at cw Little Last Chance	CRS (USFS)[§]	Dec 2011-present
10	**Sulphur** Cr @ Hwy 89 (Clio)	MR	99, 01, 03, 11
	Boulder Cr	staff gage	2003- 08
	Barry Cr	staff gage	2003- present
	Sulphur @ Lower Loop Bridge	staff gage	2003- present
	Sulphur below confluence with McKinzie Cr	CRS (USFS)	Dec 2011-present
	Sulphur @ Upper Loop Bridge	staff gage	2003- present
23	MFFR blw A23 Br (Beckwourth)	MR	99, 01, 03, 11
	MFFR near Portola (MFP)	CRS (DWR)	06- present

‡ Monitoring Reaches (MR) refers to those surveyed by FRCRM unless otherwise noted in parentheses.

§ Continuous Recording Stations (CRS) are maintained and operated by FRCRM unless otherwise noted in parentheses.

2011 Monitoring Program Findings

FRCRM is continuously collecting data throughout the upper Feather River watershed. The 2011 Water Year experienced 142% of historic average annual precipitation for the Feather River Basin. Summer average air temperature in the following chart is an average of DWR weather stations at Antelope Lake, Doyle Crossing, Quincy, and Grizzly Ridge from June 1 through September 30. The average summer air temperature for 2011 was 64.9^{o}F, which is 1.7 ^{o}F above the previous high average temperature in 2003.

Table 4. Precipitation and Summer Air Temperature Averages

Water Year (10/1-9/30)	Percent of Historic Average annual precip for the entire Feather River Basin from CDEC*	Total annual precip (inches) at Indian Cr in Genesee (Wilcox data)**	Summer Average Air Temperature^{+}
1996		59.25	
1997		61.6	
1998	144%	60.9	
1999	99%	47.2	
2000	101%	43.3	61.4
2001	56%	21.2	63.0
2002	77%	33.3	62.3
2003	111%	50.7	63.2
2004	83%	41.15	61.7
2005	109%	45.5	60.5
2006	154%	66.25	62.3
2007	60%	31.05	61.5
2008	68%	25.4	62.9
2009	84%	38.05	62.6
2010	101%	33.85	61.4
2011	142%	56.60	64.9
		44.7 = Avg	

* Averages derived by DWR from all reporting stations in the watershed. The ten stations in the Feather River Watershed are Plumas Eureka Park, Sierrraville, Vinton, Portola, Chester, Strawberry Valley, Brush Creek, Greenville, Quincy, and Nicolaus. In 2011 7/10 stations were reporting averages (Sierraville, Portola, Chester, Strawberry Valley, Brush Creek, Quincy, Nicolaus).

** The values in the Indian Creek in Genesee Precip column are unrelated to the Percent of Historic Average Annual Precip values. The Percent Historic Average is an average of weather stations throughout the watershed, which is calculated by DWR.

$^{+}$ Average derived from DWR weather stations at Antelope Lake, Doyle Crossing, Grizzly Ridge, and Quincy. Data is missing from Doyle Crossing in 2000, Grizzly Ridge in 2001, and Antelope Lake in 2007.

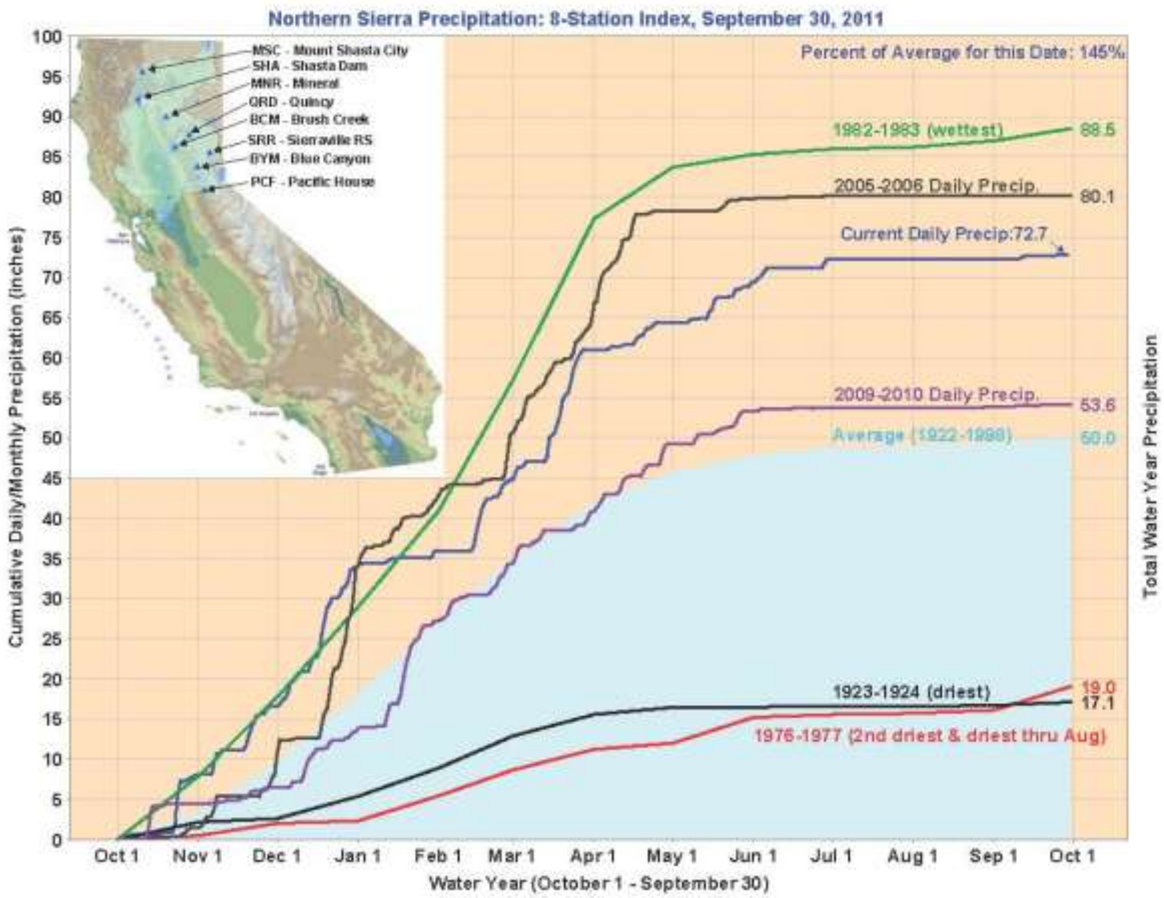


Figure 2. DWR Historic Precipitation for the Northern Sierra. 2011WY in dark blue.

Water Temperature

Introduction

The Central Valley Regional Water Quality Control Board has identified water temperature as a water quality concern in the Feather River watershed. A variety of parameters were used to compare water temperature between sites and between years. Figures 3, 4, 6, 8, and 10 analyze water temperatures from seven continuous recording stations with usable low flow data (six in Indian Creek subwatershed, and one in Spanish Creek) for the 2011WY. Figures 5, 7, 9, and 11 display water temperatures from 2000-2011 for stations affecting Genesee Valley. These are the stations expected to show the most response from pond and plug projects (Last Chance Creek @ Doyle Crossing, Red Clover Creek at Notson Bridge, and Indian Creek below Red Clover- Flournoy Bridge). Indian Creek above Red Clover at the DWR weir is included to show water temperatures on Indian Creek above the confluence of Last Chance and Red Clover creeks.

Seven Day Average of Daily Maximum Water Temperature

Figures 3-5 show seven day average of daily maximum water temperatures, which is calculated by taking a running seven day average of daily maximum water temperature for the entire water year. In Figures 3 and 5, the maximum value of the seven day averages is taken. Figure 4 shows the seven day average of daily maximum water temperatures for the entire 2011WY summer season. In past reports this section displayed the seven day average of daily mean temperatures. The US EPA found this metric masked regularly occurring large diurnal temperature variations out of a healthy range. The

US EPA also found the seven day average of daily maximum temperatures is the metric identified as the most useful in providing full protection for the individual life-history stages of key species[**]. Figures 3 and 4 show that Lights and Last Chance creeks are the two warmest channels in 2011. Figure 3 displays the duration of temperatures above 66°F for each station. Figure 5 does not show much correlation between water temperature and summer average air temperature at Last Chance and Red Clover creeks. The relationship between water and air temperature is more apparent at Indian Creek at Flournoy Bridge except in 2011. Figure 5 also shows cooler water temperatures in 2011 despite warmer air temperatures.

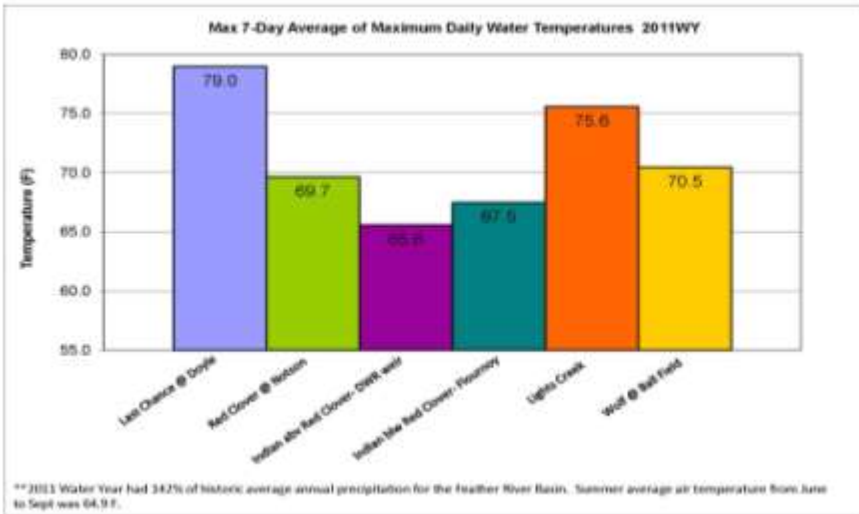


Figure 3. 2011 Seven Day Average of Daily Maximum Water Temperatures at all stations

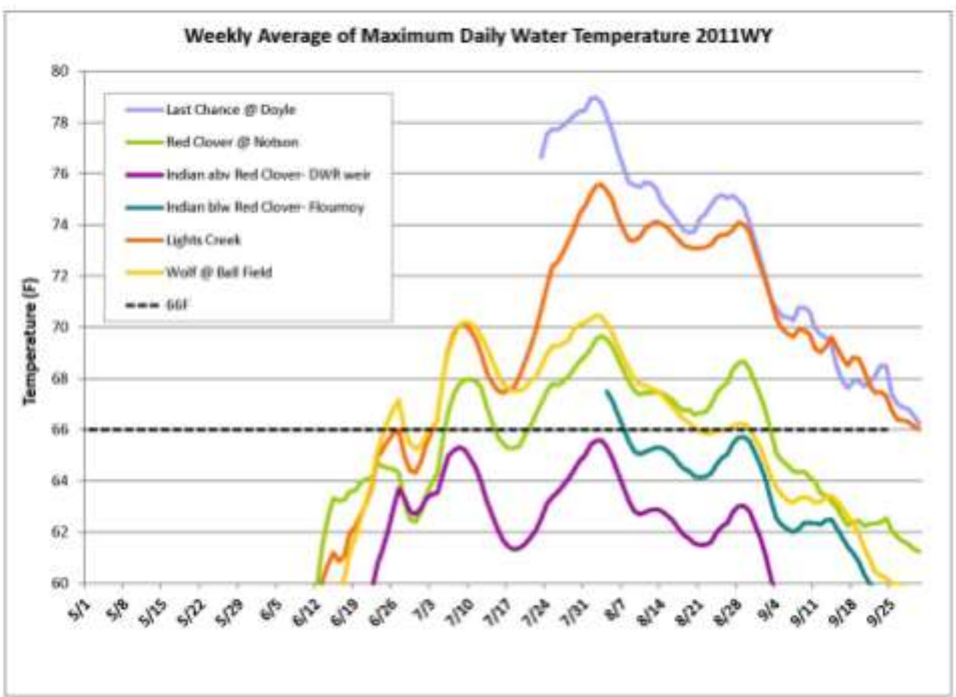


Figure 4. 2011 Seven Day Average of Daily Maximum Water Temperatures at all stations for summer season

[**] US Environmental Protection Agency, 2001. Technical synthesis: Scientific issues relating to temperature criteria for salmon, trout, and char. EPA 910-R-01-007

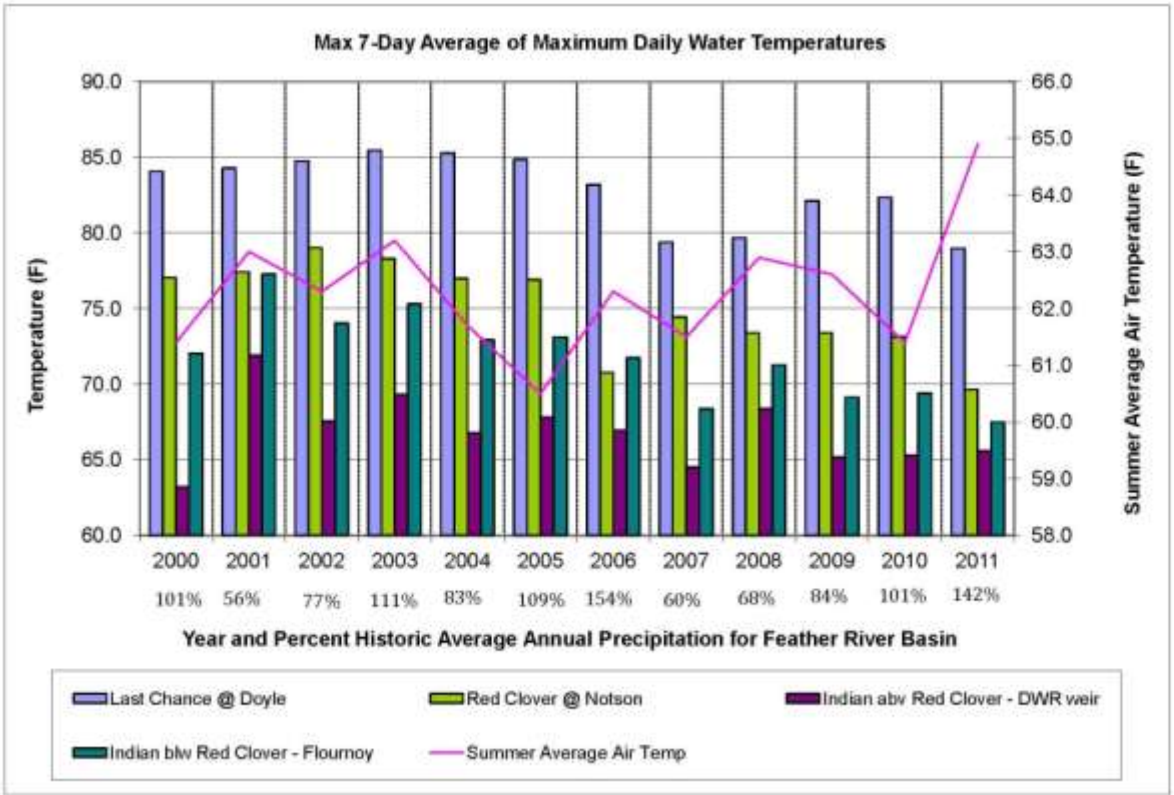


Figure 5. Seven Day Average of Daily Maximum Water Temperatures in 2000-2011 for stations affecting Genesee Valley

Daily Maximum Water Temperature >75°F

Figures 6 and 7 display the number of days with an absolute one-hour temperature greater than 75°F among the seven continuous recording stations with usable low flow data from 2011 (Fig 6) and 2000-2011 (Fig 7). A reading greater than 75°F can be lethal to coldwater fish species, even if it is just a short-term maximum temperature reading. Last Chance and Lights creeks have the most impaired temperatures monitored in the Indian Creek watershed during 2011. A downward trend in days above 75°F has been seen at Notson Bridge after 2006 (when Red Clover McReynolds project was constructed) and at Doyle Crossing after 2004 (when Last Chance Phase I was completed). Figure 8 shows number of days with a daily maximum water temperature greater than 75°F at Doyle Crossing with summer average air temperature at Doyle Crossing. This chart was added to this report based on comments, to see if the number of days greater than 75°F continued to trend downward at Doyle Crossing regardless of air temperature when charted with summer average air temperature from Doyle Crossing. It was hypothesized that air temperature might have been cooler at Doyle Crossing than the four station average air temperature shown in Figure 7. Figure 8 shows this is not the case. The air temperature at Doyle Crossing displays the same pattern as the four station average air temperature.

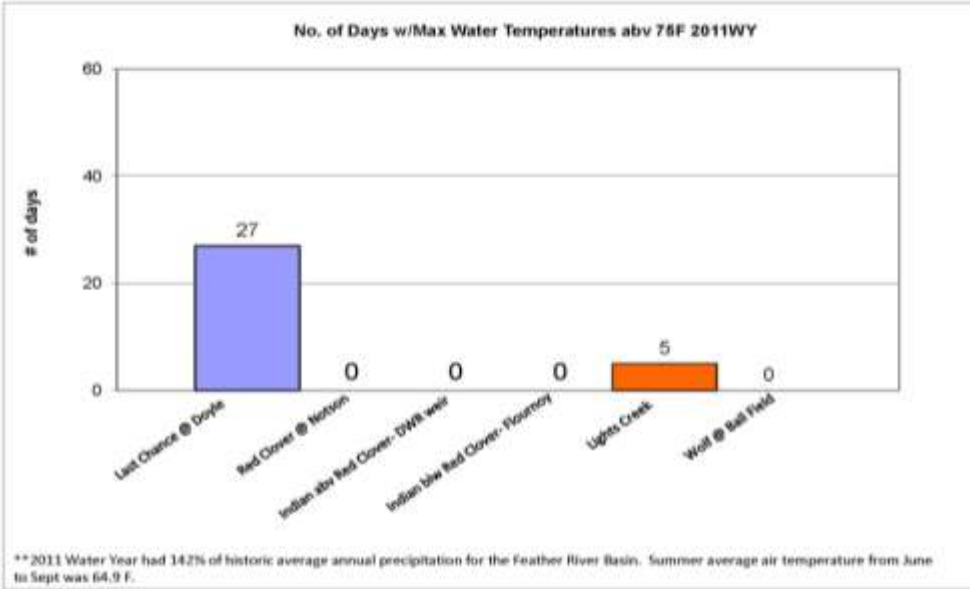


Figure 6. Number of days with maximum water temperature above 75F recorded in 2011

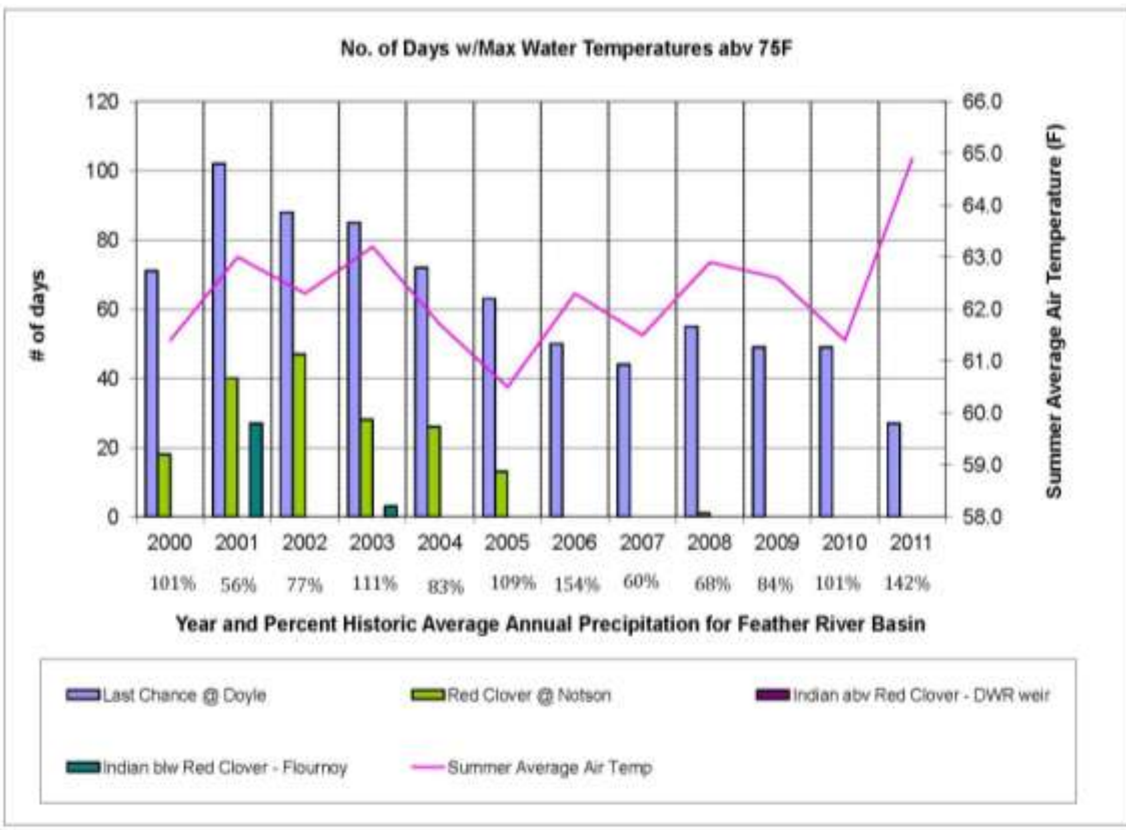


Figure 7. Number of days with maximum water temperature above 75F recorded in 2000-2010 for stations affecting Genesee Valley

Figure 8. Number of days with maximum water temperature above 75F recorded in 2000-2010 for Doyle Crossing with summer average air temperature at Doyle Crossing.

Maximum summer diurnal water temperature fluctuation

Figures 9-12 display the maximum and average diurnal water temperature fluctuation. This is calculated by finding the difference between the maximum and the minimum water temperature in a 24-hour period (diurnal fluctuation). Then, a running seven day average of the diurnal fluctuation is calculated for June 1- Sept 30. Afterward the maximum value (Figures 9 and 10) and average value (Figures 11 and 12) of the averages is taken. This parameter is heavily dependent on air temperatures and insolation. For both Figures 10 and 12, 2011 shows some of the smallest diurnal fluctuation in the entire 2000-2011 period. Last Chance Creek and Red Clover Creek seem to have been experiencing smaller diurnal fluctuations since 2005 and 2006, respectively. Stations missing in Figures 9-12 are due to significant gaps in the June 1- Sept 30 data.

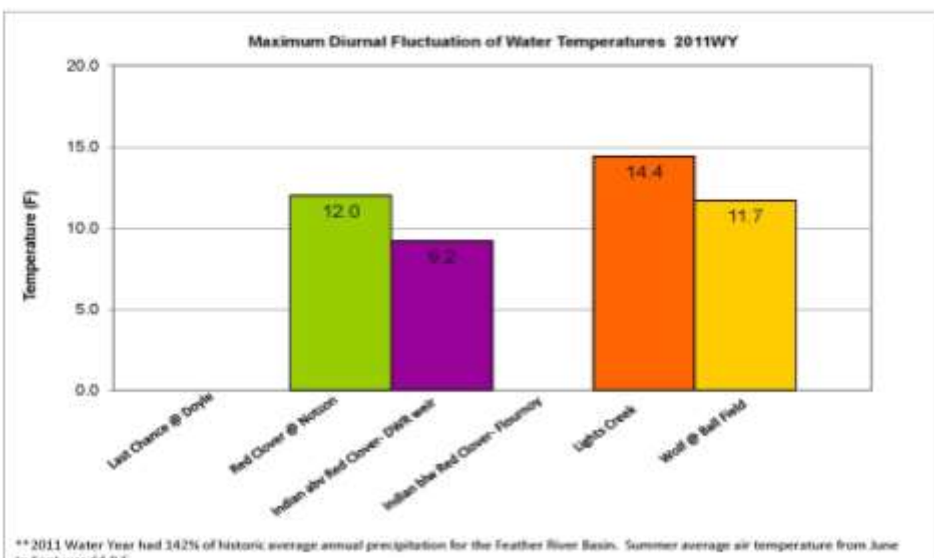


Figure 9. Maximum diurnal fluctuation of water temperature 2011

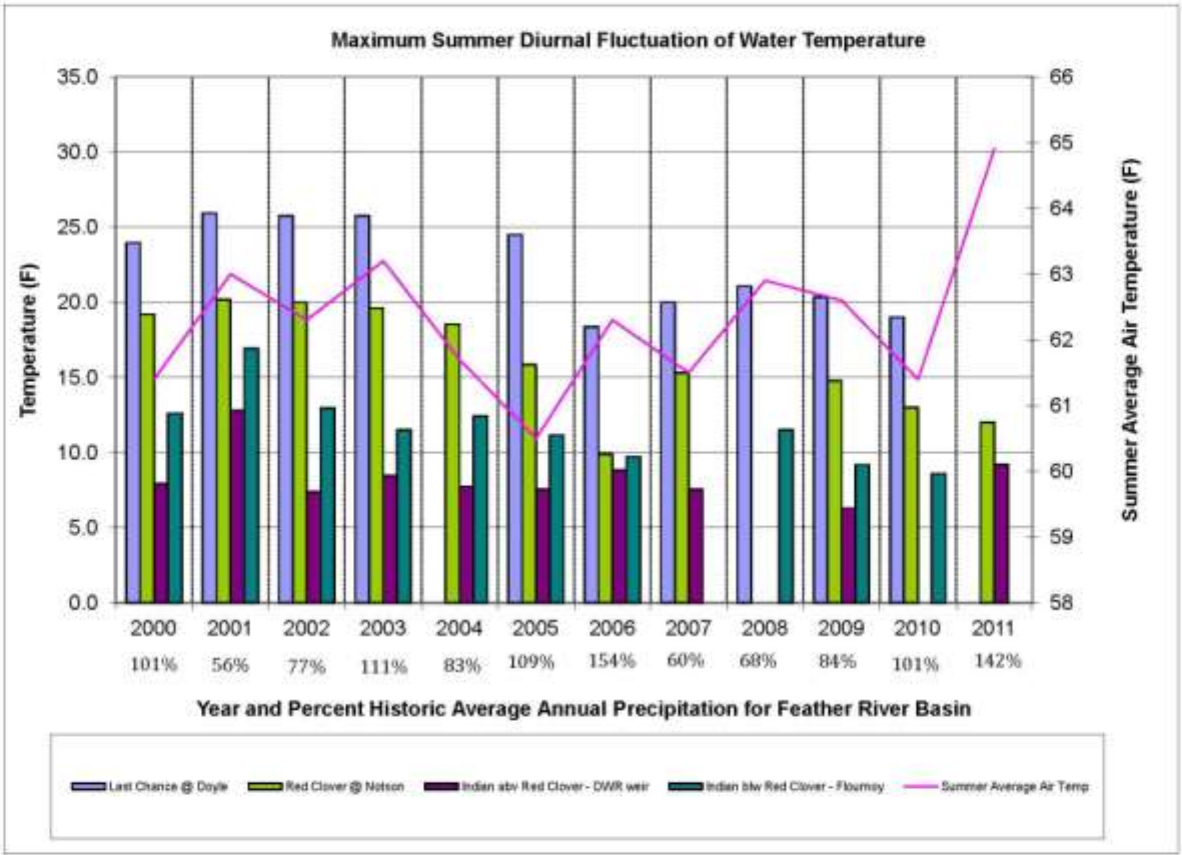


Figure 10. Maximum Diurnal Fluctuation of water temperature recorded in 2000-2011 for stations affecting Genesee Valley

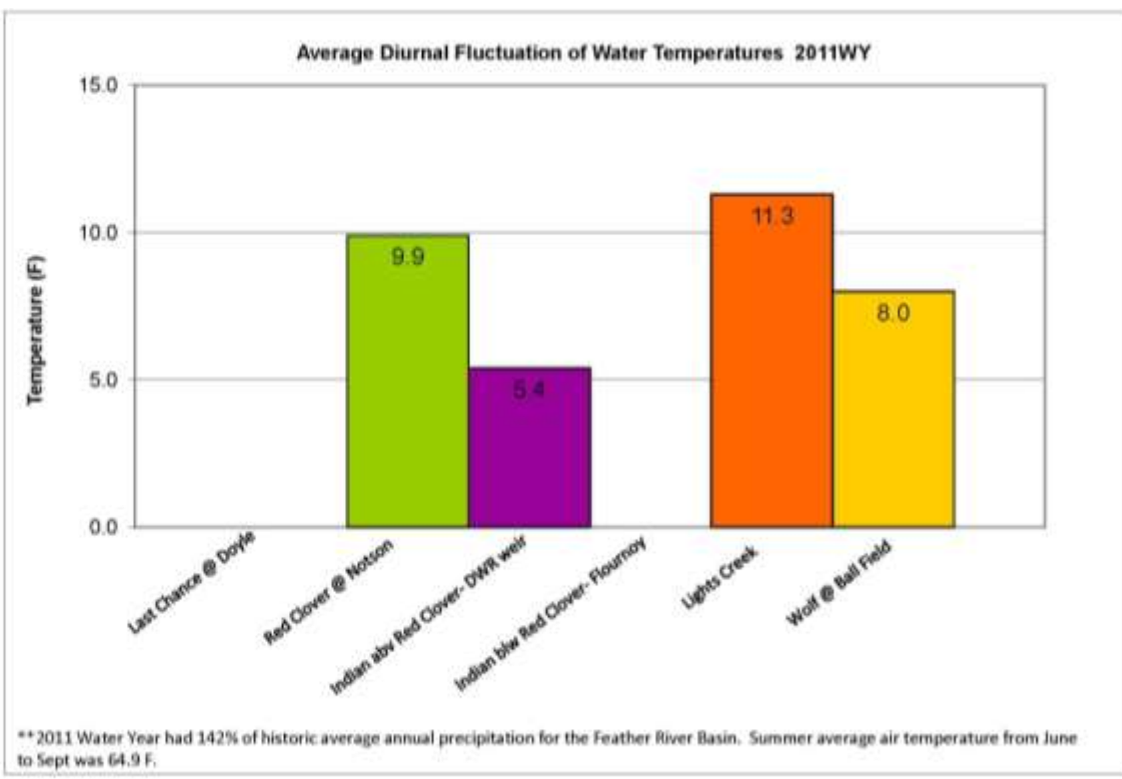


Figure 11. Average diurnal fluctuation of water temperature 2011

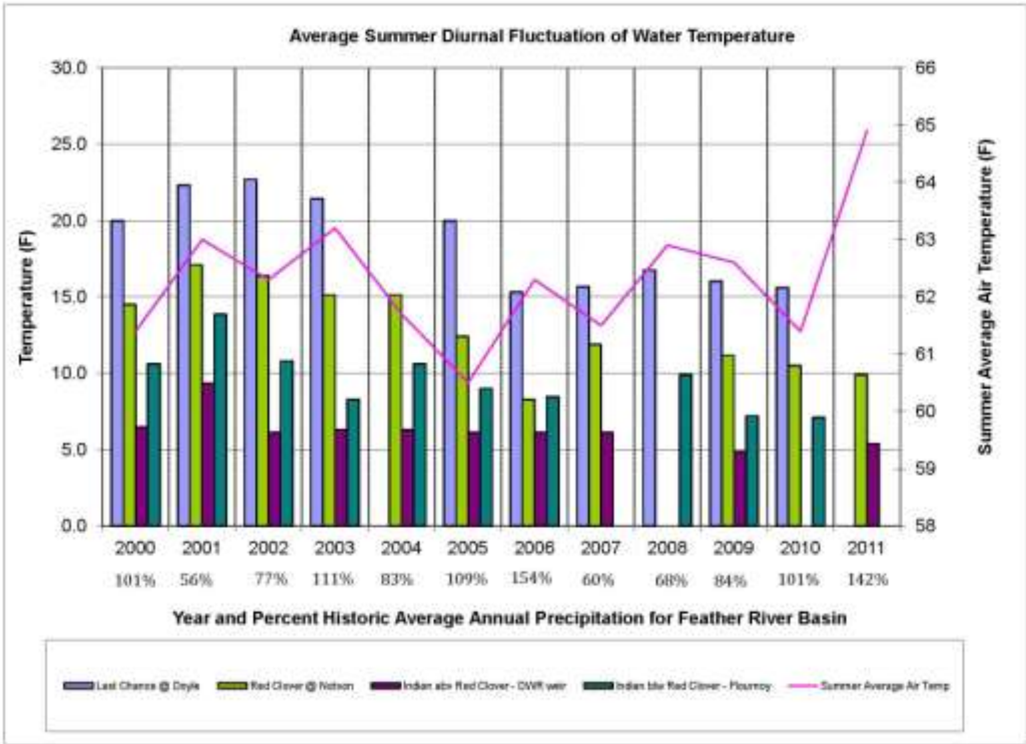


Figure 12. Average Diurnal Fluctuation of water temperature recorded in 2000-2011 for stations affecting Genesee Valley

Discussion

Last Chance Creek at Doyle Crossing and Lights Creek are consistently the most temperature impaired channels, followed by Wolf Creek. This temperature impairment of Last Chance, Wolf, and Lights creeks may be from the diminishment of groundwater recharge and release function of the watershed above these stations. Maximum daily water temperature at Doyle Crossing continues to decline, but the locally high temperature readings at Doyle Crossing on Last Chance Creek is thought to be attributed to enhanced solar radiation from water sheeting over bedrock and a 400-foot long unshaded pool above the recording station. During May-October 2011 a HOBO temperature logger was placed upstream of this pool to record water temperature previous to flowing through the unshaded section of Last Chance Creek. The temperature recorded by the HOBO logger was on average 1.3 degrees Fahrenheit cooler than the temperature recorded by the continuous recording station (CRS).

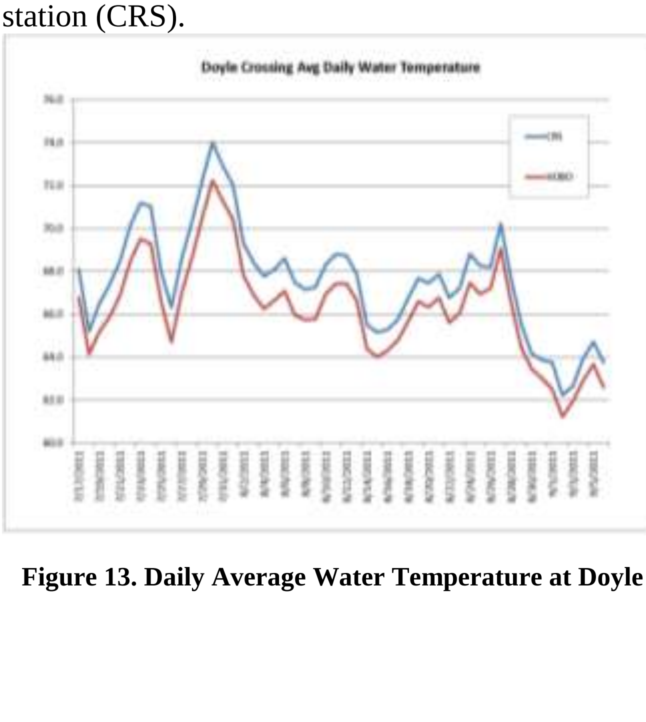


Figure 13. Daily Average Water Temperature at Doyle Crossing

Stream Flows

A primary purpose of the FRCRM's nested network of streamflow stations is to detect hydrologic change at increasing watershed scales. We have been collecting data at these stations since 2000. Stations are located from ten to thirty miles downstream of the FRCRM's on-going project focus areas. The expectation is that potential surface and sub-surface base flow changes resulting from restoration would be detected down-watershed.

Figure 14 displays the average summer (July 1- Sept 30) stream flows on Last Chance, Red Clover, and Indian creeks. Precipitation in 2006 is relatively comparable to 2011. Figure 15 displays 2011WY average summer stream flows for all continuous recording stations.

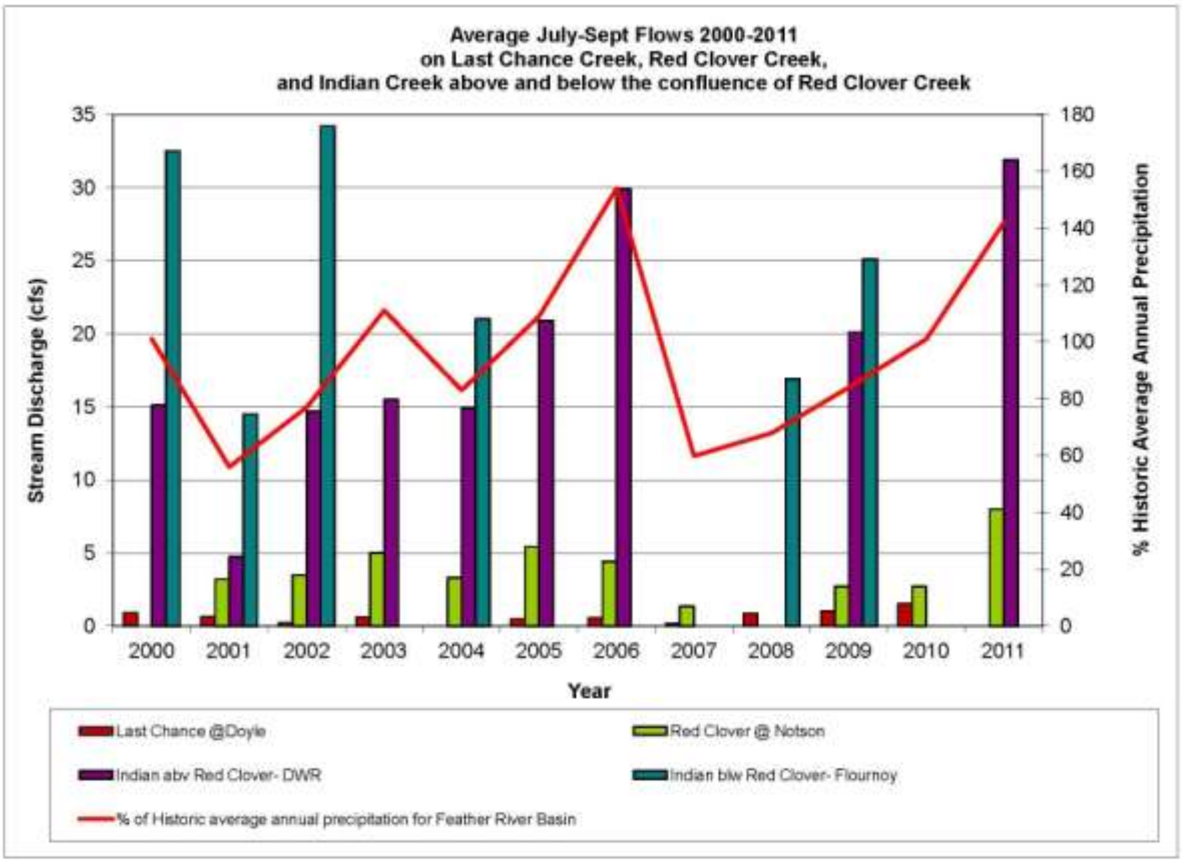


Figure 14. Average Summer Stream Flow from 2000-2011 on Last Chance Creek, Red Clover Creek, and Indian Creek above and below the confluence of Red Clover Creek

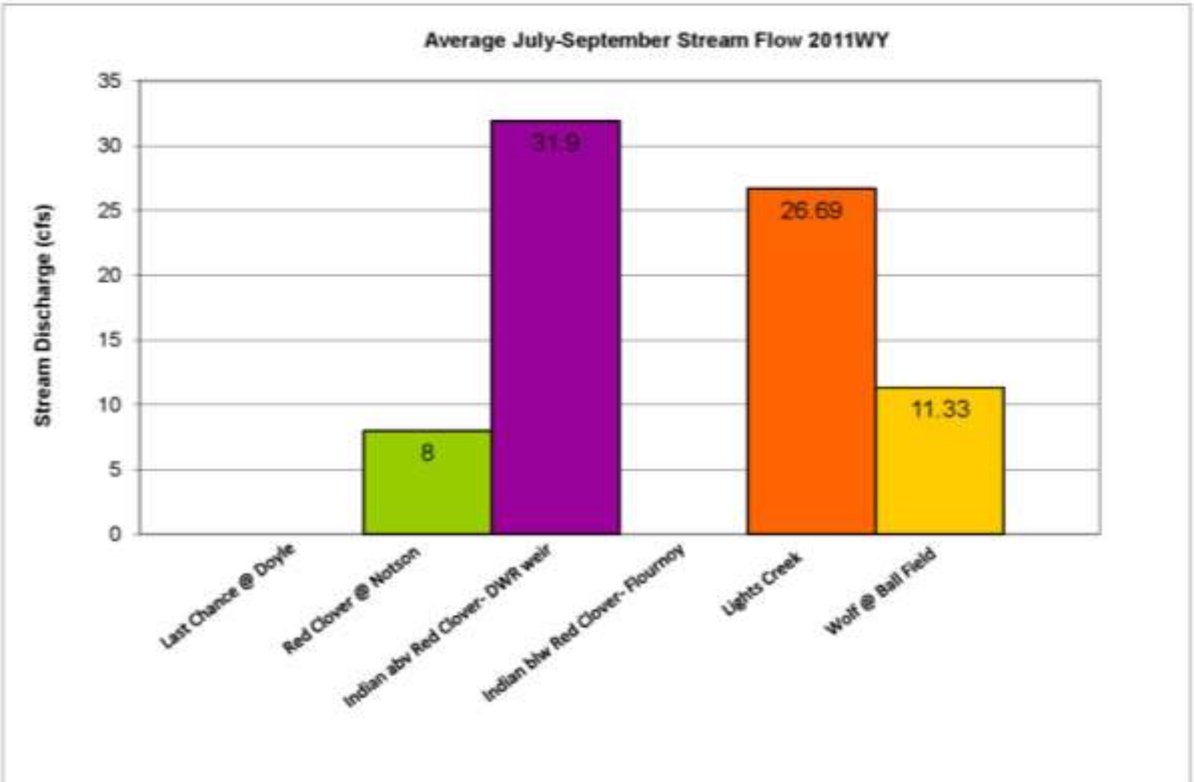


Figure 15. Average Summer Stream Flow 2011WY

Station Specific Flow Data

Figures 16 and 18 display the acre feet of water for Red Clover Creek at Notson Bridge and Last Chance Creek at Doyle Crossing, respectively, from August 1 through September 30 2000-2011. This is calculated by taking a sum of the stream flows in August and September for both stations. The following discussion compares 2006WY to 2011WY. The 2006 and 2011 water year had relatively similar percent historic precipitation, 156% and 142% respectively, although 2011 had smaller more frequent storms later into the season than 2006. Both continuous recording stations are located downstream of restoration project work. On Red Clover Creek, the Red Clover McReynolds project was constructed in 2006 and the Red Clover Poco project was constructed in 2010. Together these projects restored 538 acres of meadow floodplain. In the Last Chance creek watershed over 1,800 acres of meadow restoration occurred from 2001-2007.

Figure 16 displays Red Clover Creek at Notson Bridge. In August 1 through September 30, 2006 444.4 acre-feet of water passed by the gage. For the same dates in 2011, 466.1 acre-feet of water passed by the gage. There was an increase of 21.7 acre-feet in August and September 2011 compared with 2006, an average of 0.36 acre-feet per day (0.18 cubic feet per second).

Figure 18 shows Last Chance Creek at Doyle Crossing. August 1 through September 30, 2006 there was 43.2 acre-feet of water. The same dates in 2011 show 112.1 acre-feet of water. There was an increase of 68.9 acre-feet in August and September 2011 compared with 2006, an average of 1.13 acre-feet per day (0.57 cubic feet per second).

Figures 17 and 19 show length of channel restored over time on Red Clover Creek and Last Chance Creek respectively. These charts, from Ken Cawley's Statistical Analysis of Feather River CRM stream flow data, are included to see if there is any trend or pattern related to stream restoration miles.

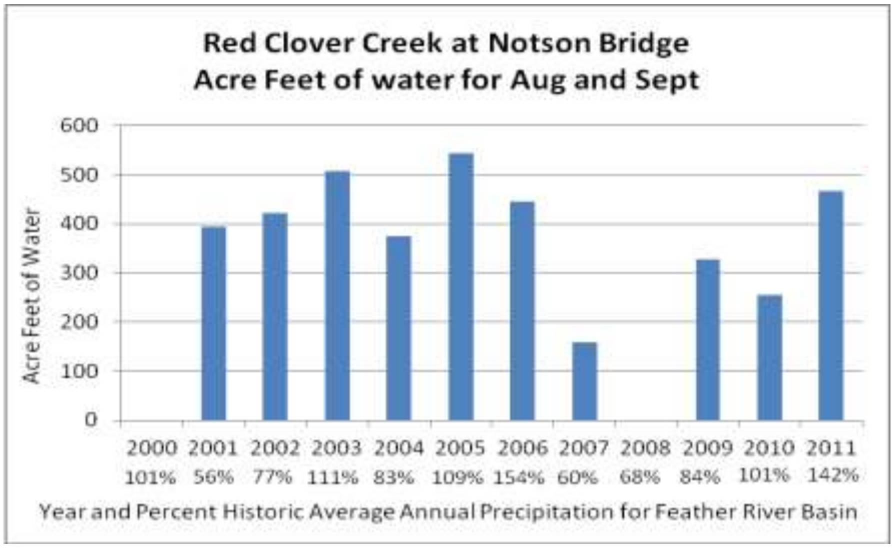


Figure 16: Acre feet of water in August and September at Notson Bridge 2000-2011

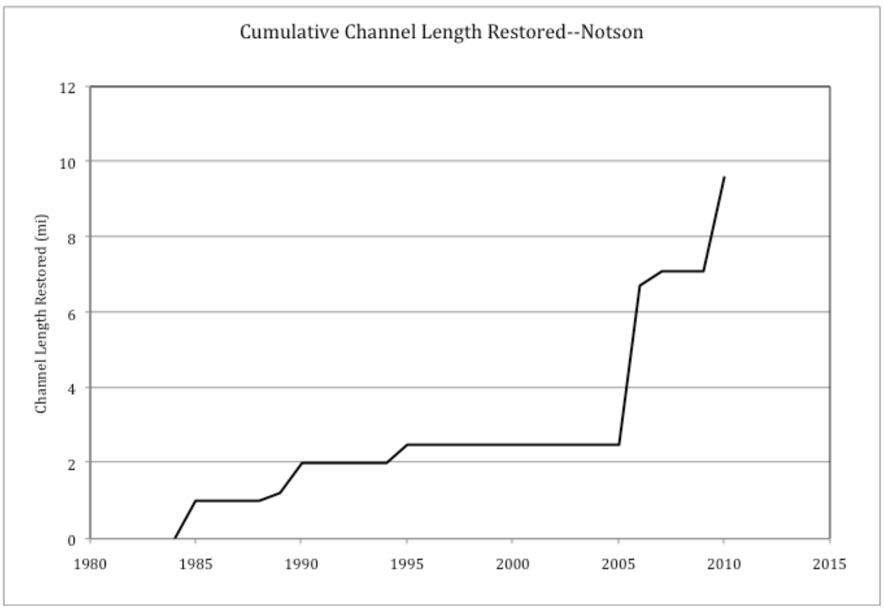


Figure 17: Length of restored channel over time on Red Clover Creek above Notson Bridge

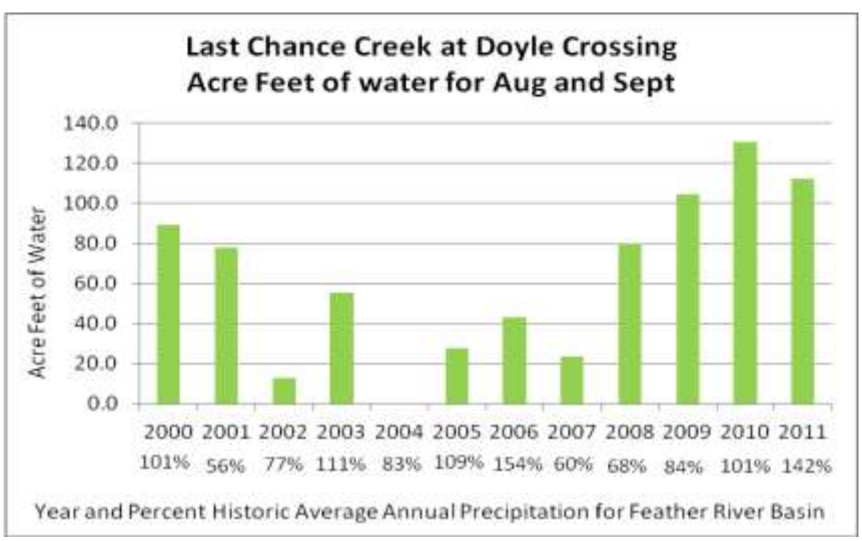


Figure 18: Acre feet of water in August and September at Doyle Crossing 2000-2011

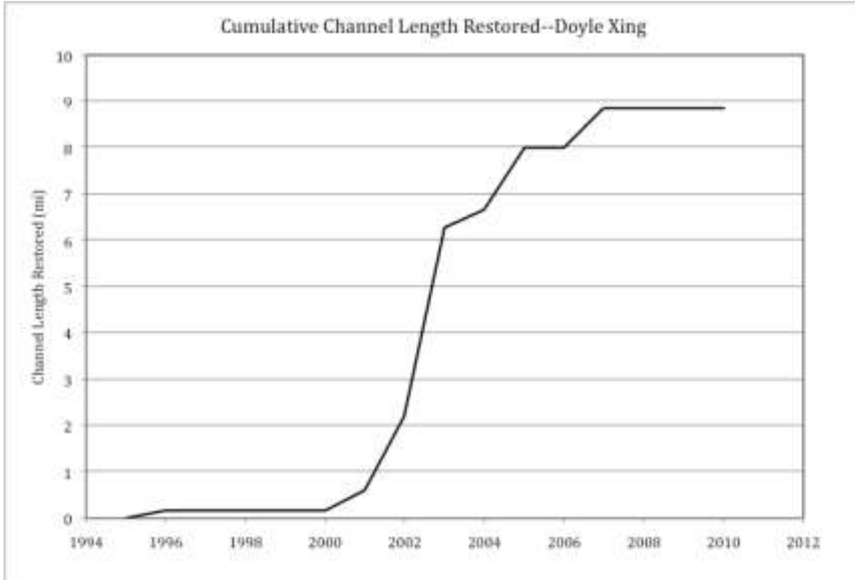


Figure 19: Length of restored channel over time on Last Chance Creek above Doyle Crossing

Statistical Analysis

In 2011 Ken Cawley, consulting hydrologist, conducted a statistical analysis on FRCRM stream flow data from the Doyle Crossing, Notson Bridge, Flournoy Bridge, and Above and Below Big Flat Continuous Recording Stations. This analysis looked for apparent trends might suggest an effect of restoration on late season base flow. Big Flat stations above and below the restoration project were divided into pre-2005 and post-2005 data sets. The stream flow for these stations showed a statistically significant difference between pre-2005 and post-2005 (riffle augmentation work implemented in 2005) in the positive direction, i.e. there was a increase in base flow at the station below Big Flat after the riffle augmentation work. Stream flow at Doyle Crossing, Notson Bridge, and Flournoy Bridge stations showed no apparent correlation (positive or negative) between stream restoration and base flow at any of the sites.

Watershed Hydrographs from continuous recording stations WY2011 (precipitation data taken at nearby weather stations)

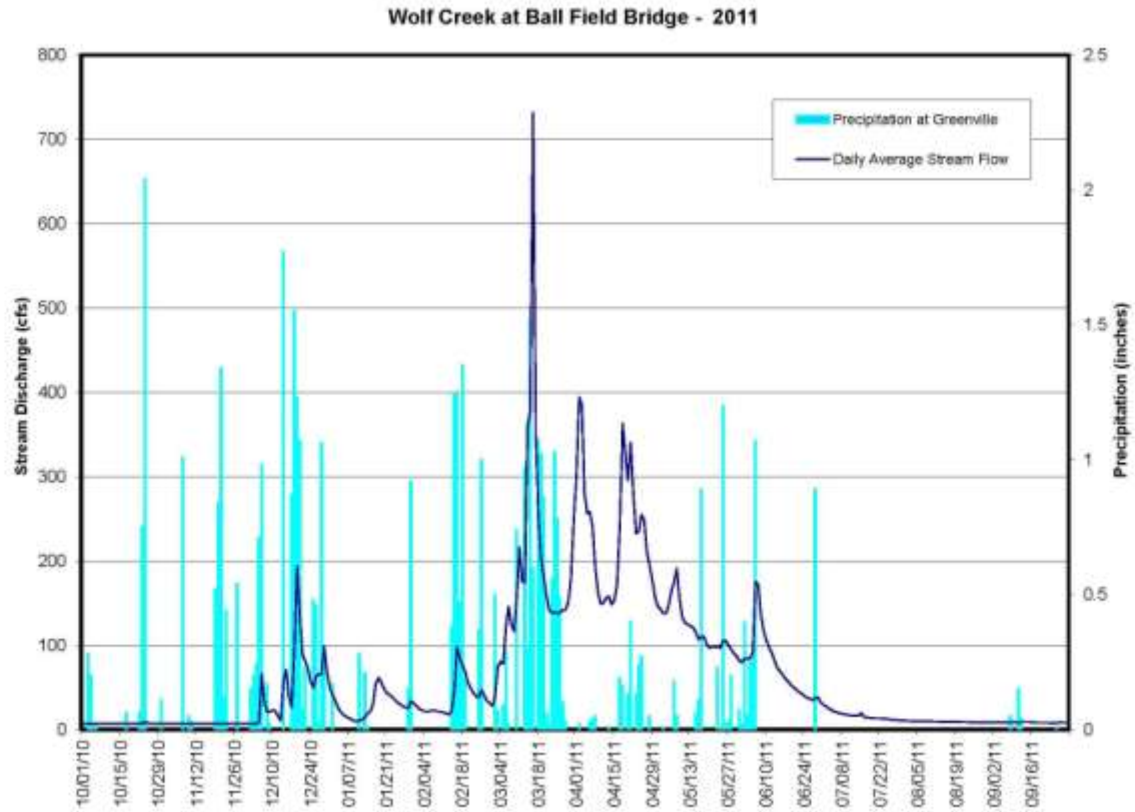


Figure 20: Wolf Creek at Ball Field Bridge Hydrograph 2011WY

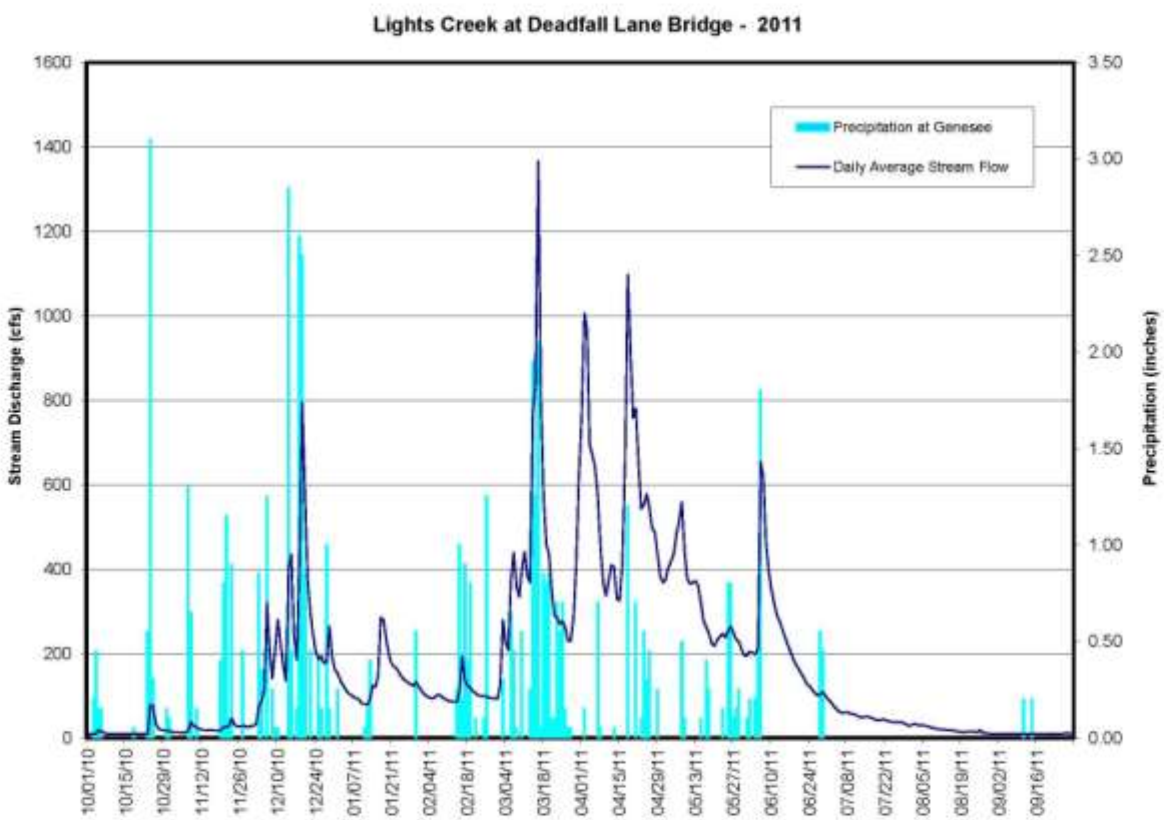


Figure 21: Lights Creek at Deadfall Lane Bridge Hydrograph 2011WY

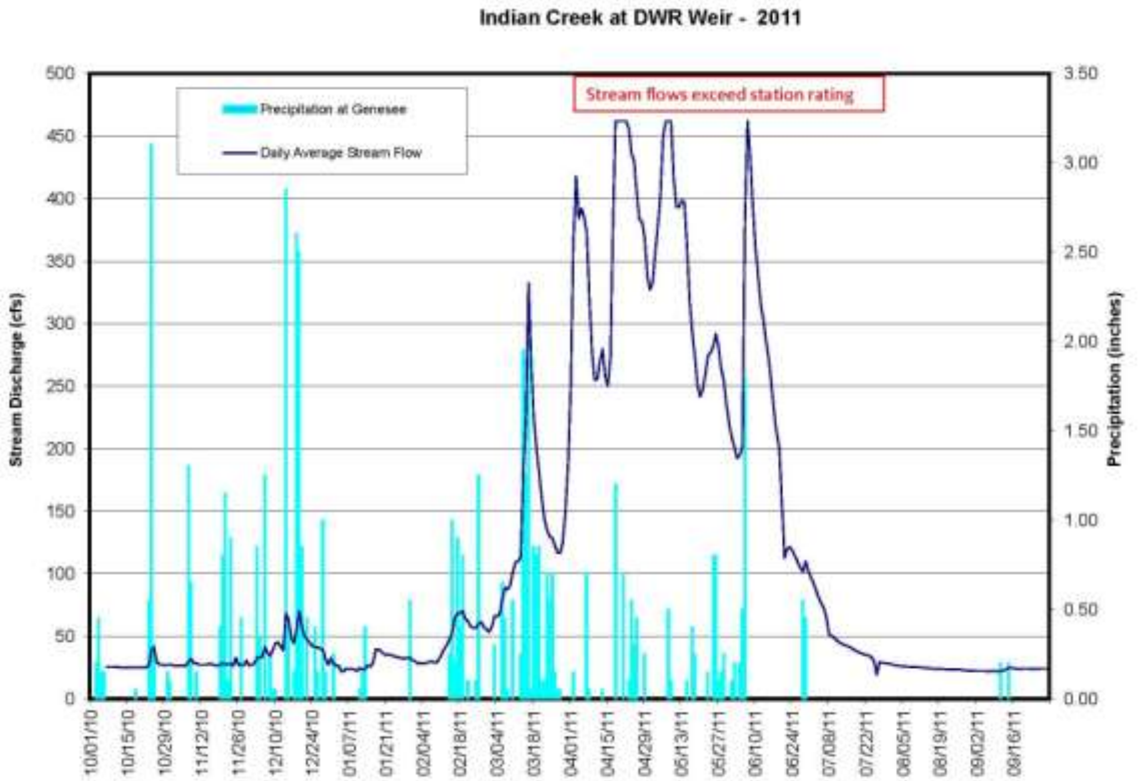


Figure 22: Indian Creek at DWR Weir Hydrograph 2011WY

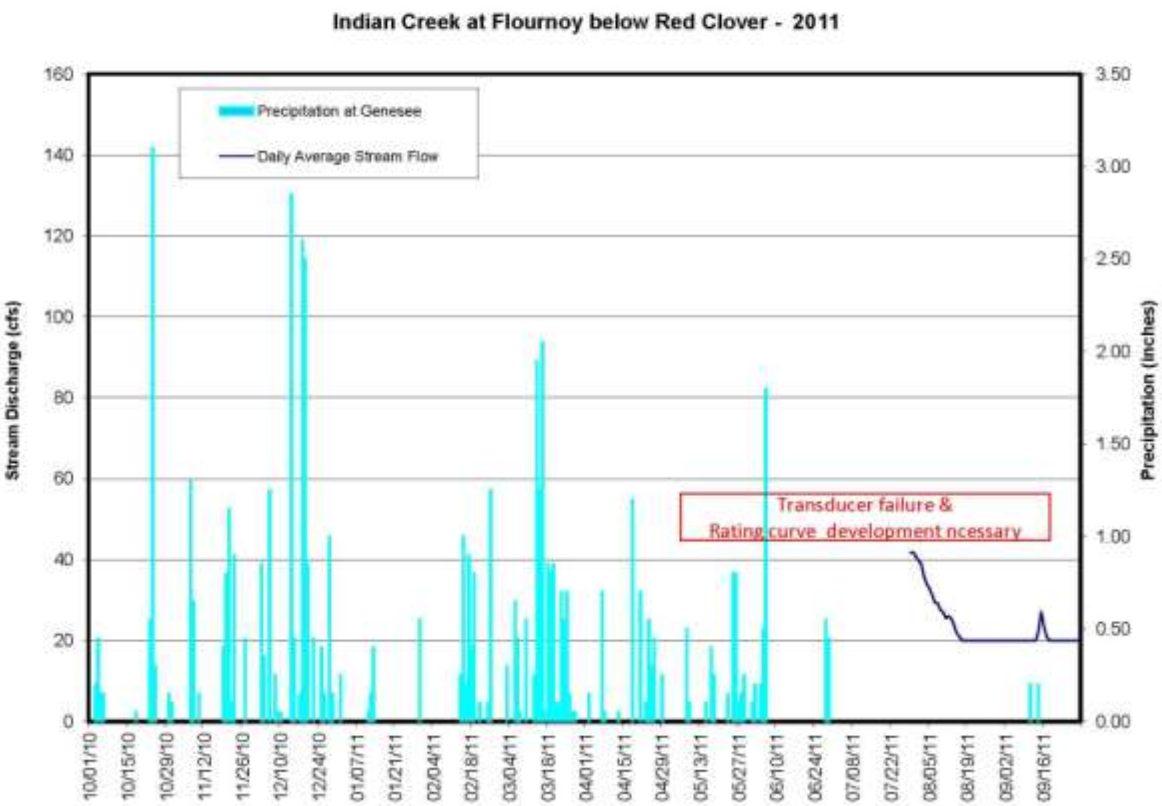


Figure 23: Indian Creek at Flournoy Bridge Hydrograph 2011WY

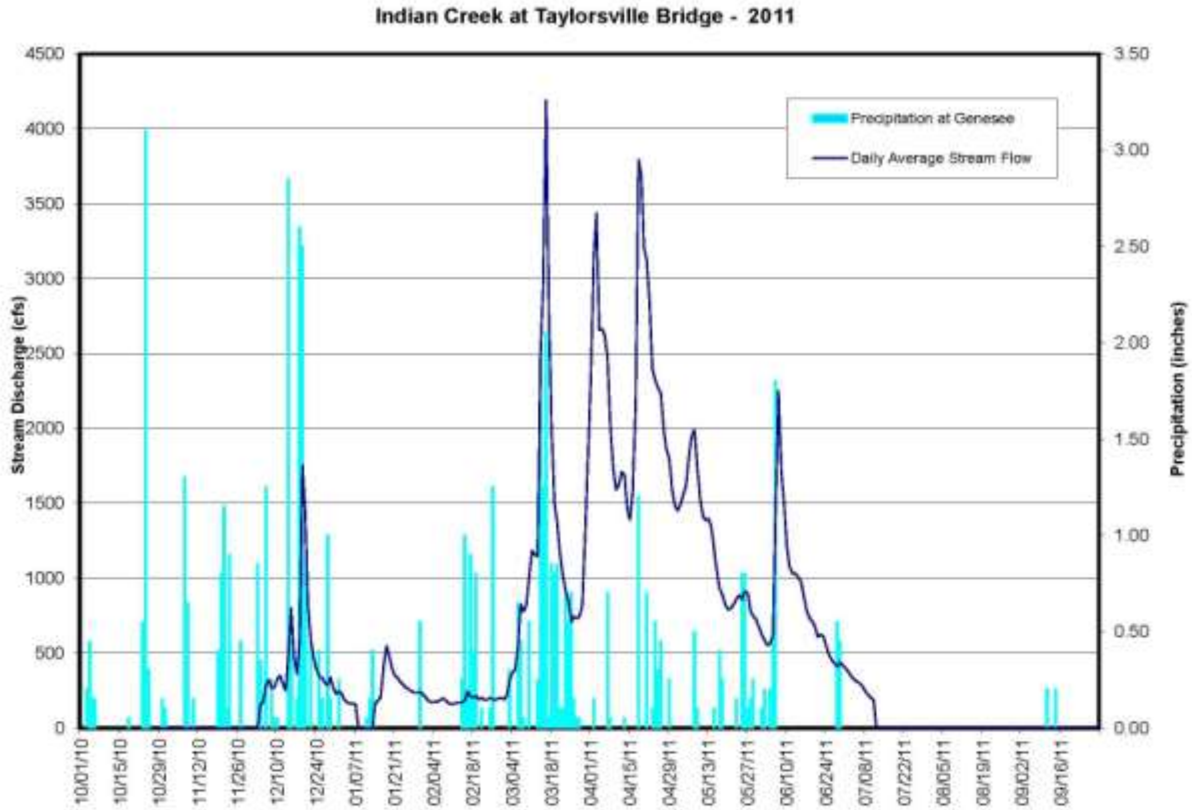


Figure 24: Indian Creek at Taylorsville Bridge Hydrograph 2011WY

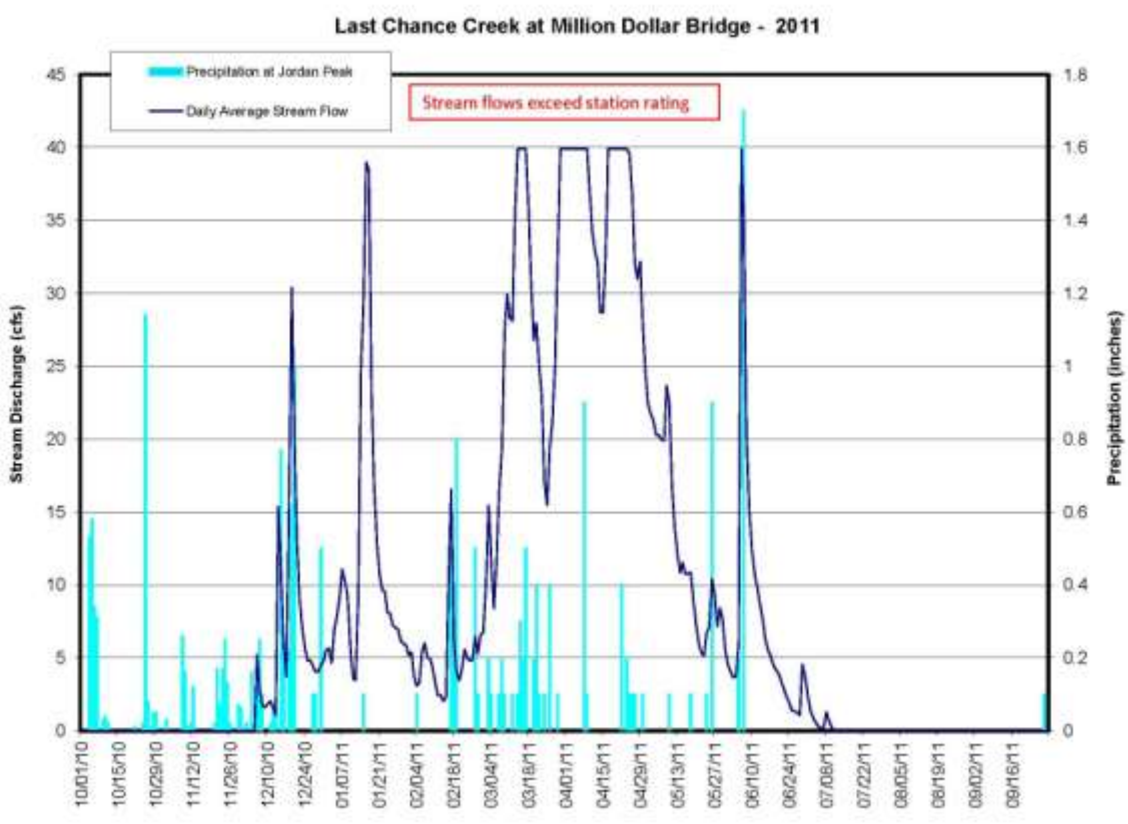


Figure 25: Last Chance Creek at Million $ Bridge Hydrograph 2011WY

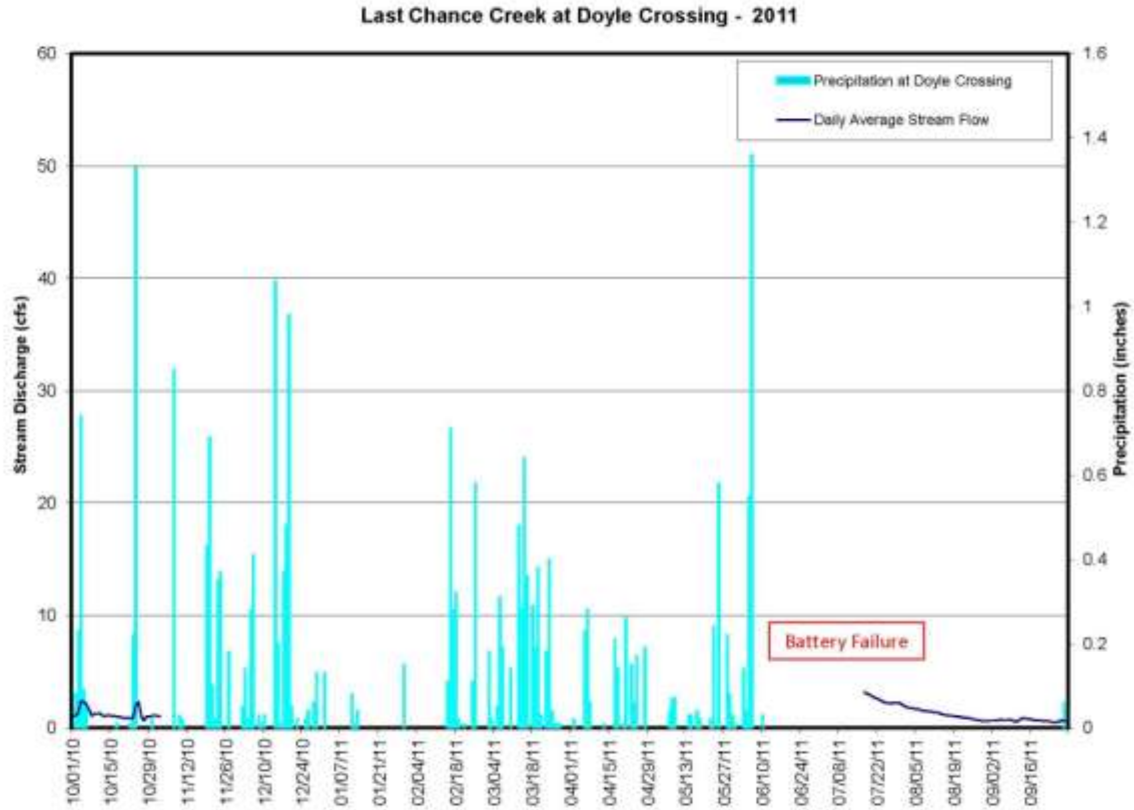


Figure 26: Last Chance Creek at Doyle Crossing Hydrograph 2011WY

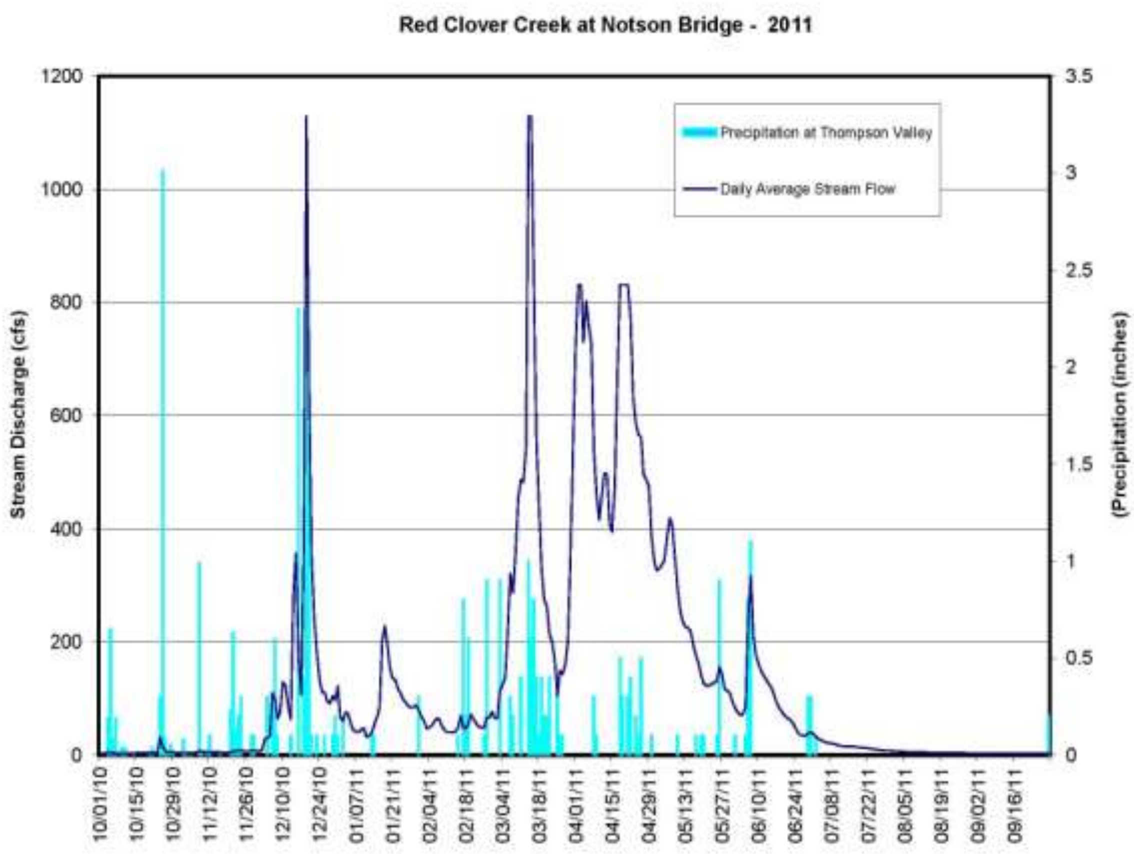


Figure 27: Red Clover Creek at Notson Bridge Hydrograph 2011WY

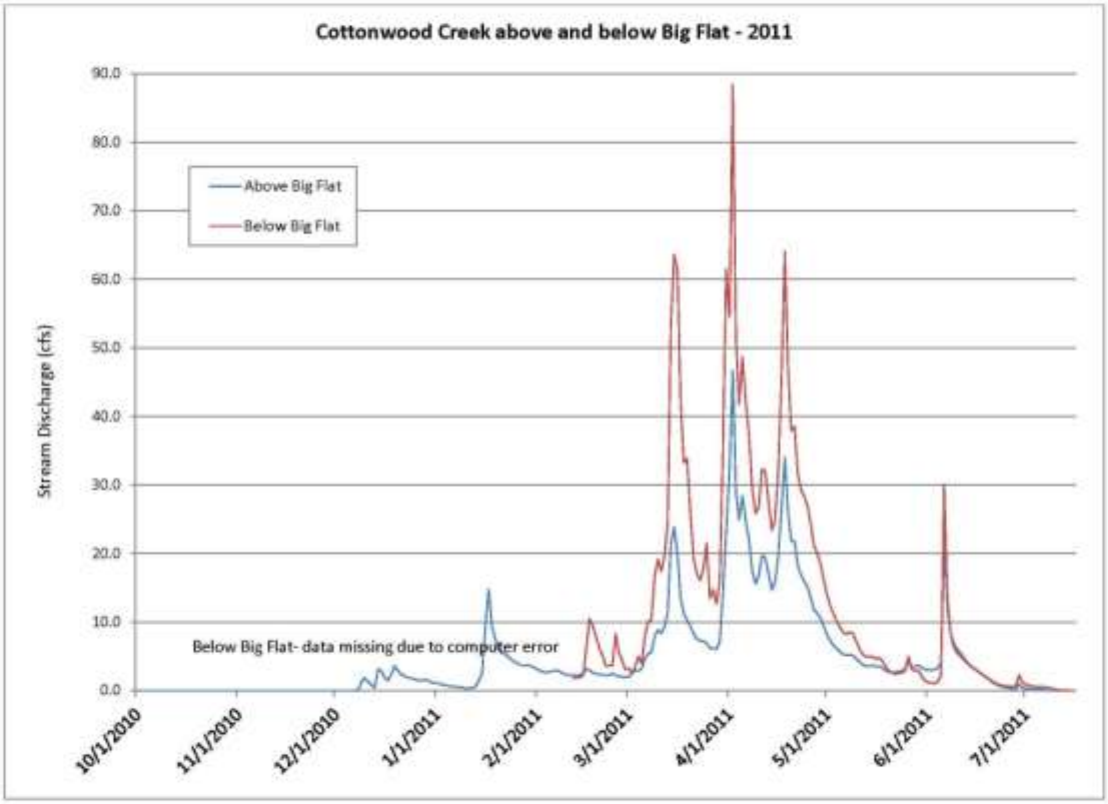


Figure 28: Cottonwood Creek above and below Big Flat Hydrograph 2011WY

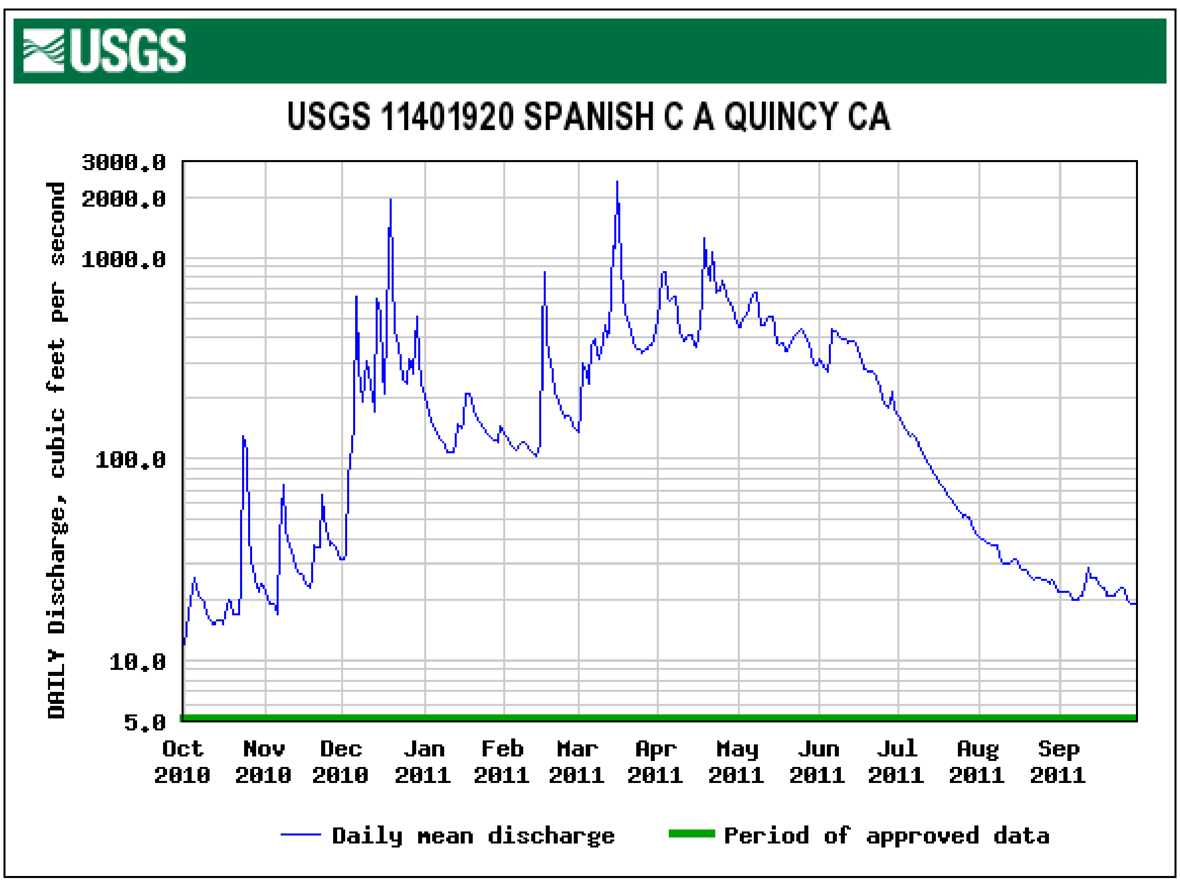


Figure 29: Spanish Creek at Quincy Hydrograph 2011WY

Turbidity

The FRCRM was established to address widespread erosion, sedimentation and associated channel degradation in the Feather River watershed. The FRCRM approach to erosion control has evolved from installing check dams and bank protection to restoring meadow floodplain function. Turbidity is a surrogate for sedimentation, measuring relative changes of fine sediment in the water. Turbidity is measured in Nephelometric Turbidity Units (NTUs). Fine sediments can be the most damaging to aquatic habitats and, in large quantities, can fill reservoirs. The FRCRM generally measures turbidity above and below a restoration project to determine if the project is capturing sediment on the floodplain and reducing the amount of sediment that flows downstream. Figure 30 shows turbidity above and below Red Clover McReynolds Restoration Project during storm events from 2007-2012. On the Red Clover McReynolds project average turbidity is 50% less below the restoration project than above.

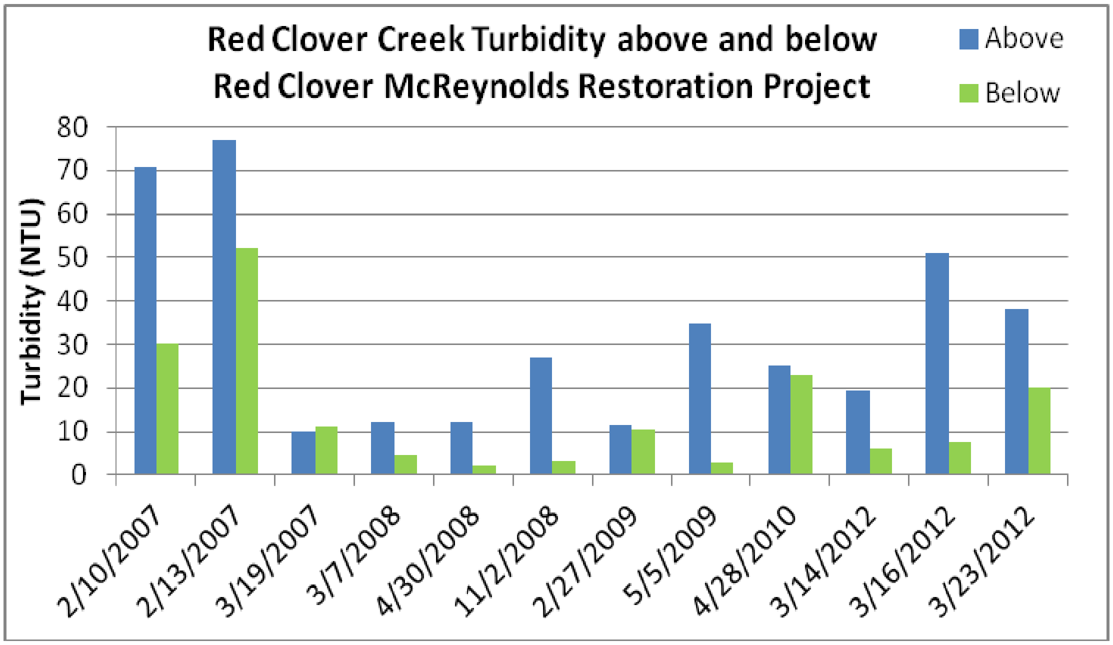


Figure 30: Red Clover Creek turbidity during storm events from 2007-2012

Monitoring Reaches

Introduction

There are 22 FRCRM Monitoring Reaches in the upper Feather River Watershed. Monitoring conducted at these reaches includes, but is not limited to, the US Forest Service Pacific Southwest Region Stream Condition Inventory (SCI) protocol. During the 2011 Water Year, 14 of the 22 Monitoring Reaches were surveyed using the SCI protocol (See attachment E). Attributes measured included macroinvertebrates, particle size distribution, stream temperature, large woody debris, bankfull stage, cross-section, width-to-depth ratio, entrenchment ratio, habitat type, pool depth, pool tail surface fine sediment, streambank stability, stream shading, stream shore water depth, streambank angle, and longitudinal profile. Macroinvertebrates are an SCI attribute, but due to financial constraints the 2011 sampling was not able to follow the SCI protocol. The protocol calls for aquatic invertebrates to be preserved in alcohol and sent to the Utah State University Bug Lab. Instead, in 2011 the macroinverebrates were sampled using a rapid assessment developed by the Sierra Nevada Aquatic Research Laboratory, University of California (See attachment F). The SCI protocol also calls for water surface gradient measurements to be taken at each cross section. The FRCRM monitoring TAC decided to replace this measurement with a longitudinal profile of the entire monitoring reach. These profile measurements were taken on the edge of water at the top of pool, pool tail crest, and other discretionary locations.

2011 was a higher than average water year. Stream flows and water levels were elevated through the month of June. SCI surveys did not commence until the first week of July. Sites with less stream flow were surveyed first, to allow other sites to become more conducive to surveys. Some sites; Jamison Cr, Middle Fork Feather River (MFFR) at Nelson Point, Indian Creek above the confluence with (acw) Spanish Creek, and East Branch North Fork Feather River above the confluence with North Fork Feather River remained difficult to survey even later in the season. HOBO® temperature loggers were lost due to swift flows on MFFR at Nelson Point and Jamison Cr. Due to high water this year surveyors found it hard to identify bankfull, or identify the same bankfull that had been recognized in the past. This may account for some differences in the width-to-depth and entrenchment ratios, as well as bankfull and floodprone widths. This year's surveys were conducted by only two people, differing from four surveyors in the past. Contractor Clay Clifton has been present on all surveys for all four sampling years.

Since past surveys in 2003 there have been two larger flow events. One event was in January 2006. This flow event was a 10-15 year event. The flow event in March 2011 peaked at 10,880 cfs at the DWR Indian Creek gauge below Indian Falls. This more recent flow event was only a 5-7 year event.

Sites are summarized individually below. To see site specific data please see: Appendix A for the site summary; Appendix B for site cross-sections; Appendix C for site pebble counts; and Appendix D for site longitudinal profiles.

Site Specific Discussion

<u>Goodrich Creek</u>

X-Sec 2 looking downstream

It appears that Goodrich Creek is still adjusting after the last big flow event. Visually the bankfull width seems to have become narrower over the past 12 years, but based on Figure 31 there is no significant difference in the width of the channel. The difference in channel width could also be due to the difficulty in interpreting bankfull. Figure 32 shows that there has been a significant difference in mean channel depth. Goodrich Creek within the monitoring reach has become significantly shallower over time.

Stream flows in 2011 probably moved sand and gravel into the reach aggrading the channel. Despite the shallow water depth, the water temperature remained cool throughout the summer. There were no days with weekly average water temperatures exceeding 66F, and no single days with absolute maximum water temperature above 75F. Despite the cool water temperatures, the number of tolerant macroinvertebrate taxa was relatively high (compared with the other sites), and has increased since 1999.

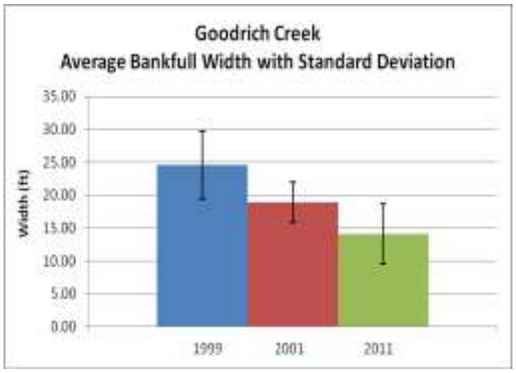


Figure 31. Goodrich Creek Bankfull Width

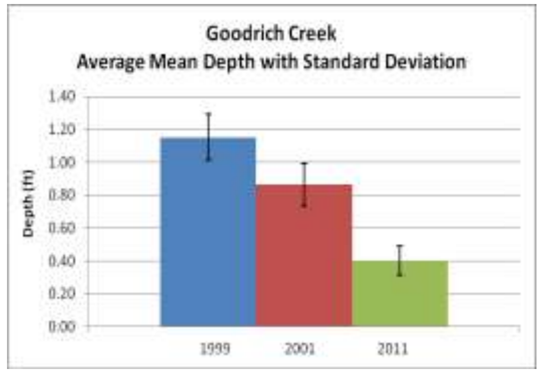


Figure 32. Goodrich Creek Mean Depth

Indian Cr above Flournoy Bridge

Indian Creek above Flournoy Bridge (below the confluence of Red Clover Creek) appears to be relatively stable. There has been an increase in bank stability due to the increased vegetation (see below photos). There has been a decrease in tolerant macroinvertebrate taxa. The riffles in the reach have moved downstream over the past eight years, and the pool depth is deeper. Floodprone width decreased in 2011, but Figure 33 shows there is no significant difference between the floodprone widths from 1999, 2003, or 2011. The difference in width is possibly due to errors in interpreting bankfull width, or because of riffle location shifts.

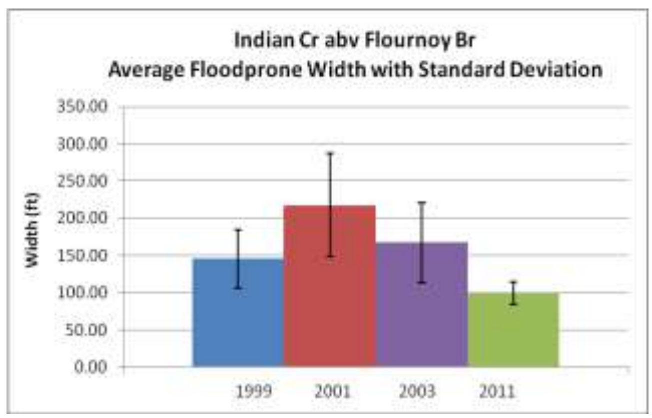


Figure 33. Indian Cr above Flournoy Br Floodprone Width

X-Sec 2 Left Bank, 1999

X-Sec 2 Left Bank, 2011

<u>Indian Creek Below Taylorsville Bridge</u>
Like Indian Creek above Flournoy Bridge, Indian Creek below Taylorsville Bridge has become more stable since 1999, and since the 1997 flood. This is due to the amount of vegetation present on the stream banks. The Taylorsville monitoring reach has also shown a decrease in tolerant macroinvertebrate taxa. Some of the habitat types have changed throughout the reach due to a beaver dam downstream of cross-section two. This caused cross-section two to be in a pool/backwater area. We did not move this cross-section. Floodprone width through the reach has narrowed since 1999-2003, but Figure 34 displays no statistically significant difference in the floodprone widths from 1999, 2003, or 2011. The difference is probably due to problems identifying bankfull width, or the shift in riffle crest location.

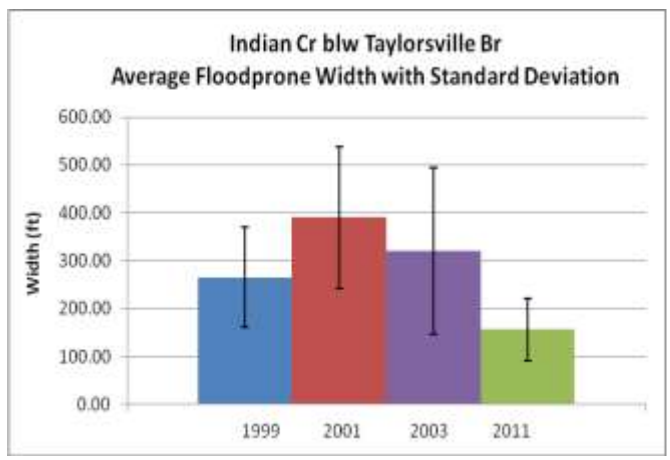


Figure 34. Indian Cr below Taylorsville Br floodprone width

X-Sec 1, Downstream, 1999

X-Sec 1, Downstream, 2001

X-Sec 1, Downstream, 2011

Lights Creek above Deadfall Lane Bridge

X-Sec 1 looking downstream

Lights Creek channel cross-sections have shown a decrease in cross-sectional area over the past twelve years. Residual pool depths have gotten deeper, as well as sediment size getting smaller. The percent tolerant macroinvertebrate species has increased notably since 1999. Lights Creek above Deadfall Lane Br. continues to be an unstable site.

X-Sec 2 left bank

Wolf Creek at Town Park

Wolf Creek appears to be relatively stable since 1999. The monitoring reach has had very little change in cross-section bankfull width, floodprone width, and depth. The channel has increased in bank stability due to increased vegetation throughout the reach. There also has been a notable decrease in pool tail fines throughout the reach.

X-Sec 1 looking downstream

Indian Creek above Spanish Creek

This monitoring reach is comprised of several bedrock sections; because of this, the Indian Creek above Spanish Creek monitoring reach is somewhat stable. The major alteration to the reach in 2011, was the location of cross-section one. The cross-section one riffle moved downstream considerably in the past eight years. The cross-section in 2011 was located directly through a pool. Due to the high water and higher flows, still present in September, the cross-section was moved downstream approximately 100 feet to the pool-tail crest.

X-Sec 1, 2011

X-Sec 1, 1999-2003 (red) X-Sec 1, 2011 (white)

Rock Creek (acw Spanish Cr)

X-Sec 3 looking upstream

Rock Creek is another monitoring reach where a significant portion of the reach is comprised of bedrock. There have not been many changes throughout the Rock Creek reach over the past 12 years. There has been a slight increase in percent tolerant macroinvertebrate taxa.

Greenhorn Creek above confluence with Spanish Creek

While the bankfull width, floodprone width, and mean bankfull depth have remained relatively stable throughout the Greenhorn Creek monitoring reach, residual pool depth and percent intolerable macroinvertebrate taxa have increased. Residual pool depths have gotten deeper and sediment size has decreased. There is no perceivable trend with stream temperature. Maximum weekly average stream temperature >66F continues to decrease, but number of days where the temperature exceeded 75 degrees has increased.

X-Sec 2 looking upstream

Spanish Creek above confluence with Greenhorn Creek

Spanish Creek above confluence with Greenhorn Creek shows a significant change in mean bankfull depth, floodprone width, and bankfull width in 2011, which signifies a significant decrease in cross-sectional area. The riffles at cross-sections one and three have moved upstream (see below photos). Bank stability has increased in the reach since 1999. This is due to the vegetation increase from lack of high flows since the 1997 flood. Spanish Creek continues to show high bedload transport.

X-Sec 1 1999, looking downstream
**note position of riffle*

X-Sec 1 2011, looking downstream

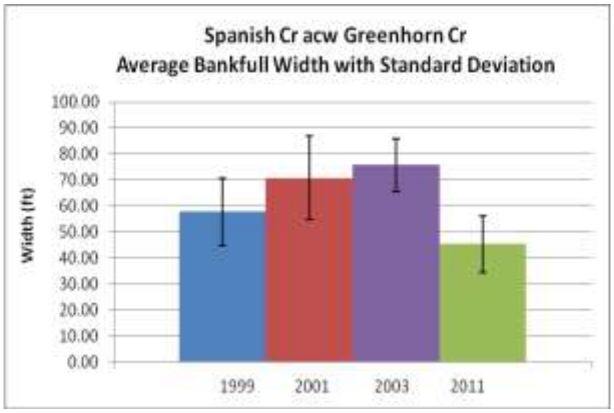


Figure 35. Spanish Creek Bankfull Width

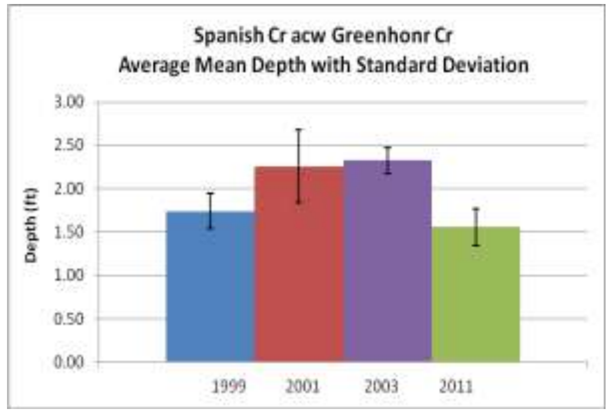


Figure 36. Spanish Creek Mean Depth

<u>East Banch North Fork Feather River above North Fork Feather</u>

The East Branch North Fork Feather River (EBNFFR) monitoring reach is showed a significant decrease in bankfull width and mean bankfull depth in 2011. This decrease signifies a significant decrease in cross-sectional area. Residual pool depth has increased, as well as the percent tolerant macroinvertebrate taxa. Substrate size has decreased over the past ten years.

X-Sec 1 looking upstream

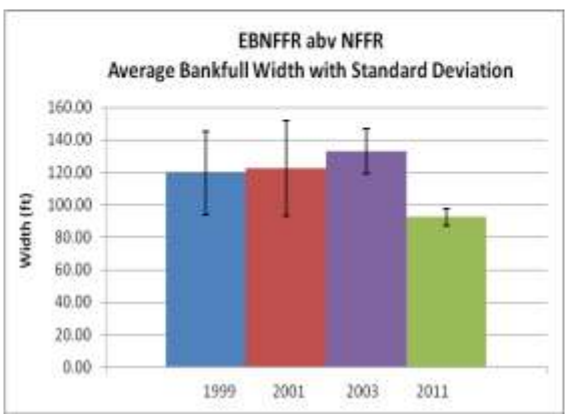


Figure 37. East Branch Bankfull Width

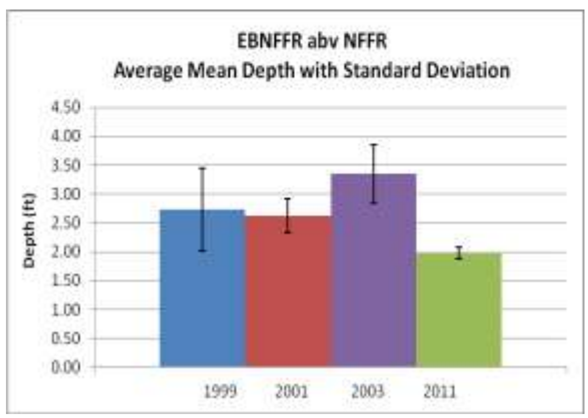


Figure 38. East Branch Mean Depth

Middle Fork Feather River below A23 Bridge

The Middle Fork Feather River has been a problematic site since 1999. In the past there has been a lack of continuous surface water through the monitoring reach during the summer months. In 2011 water from a downstream beaver dam backed up through the monitoring reach. The influence from the beaver dam rendered the reach incompatible with the Stream Condition Inventory protocol. All the riffles in the reach were flooded with minimum depths of two and a half to three feet deep. The below photos display the three cross-sections in the monitoring reach and the lack of fast water in the reach.

X-Sec 1 and downstream

X-Sec 2

X-Sec 3 and upstream

Sulphur Creek at Clio

The Sulphur Creek reach has shown an increase in pool depth, large woody debris, and pools formed by large woody debris. There has been an increase in shade throughout the reach with corresponding decreases in water temperature. Despite the cooler water temperatures there was still an increase in tolerant macroinvertebrate taxa from past surveys. The mean bankfull depth in 2011 was significantly shallower from the mean bankfull depth in 1999 and 2003.

X-Sec 1 looking upstream

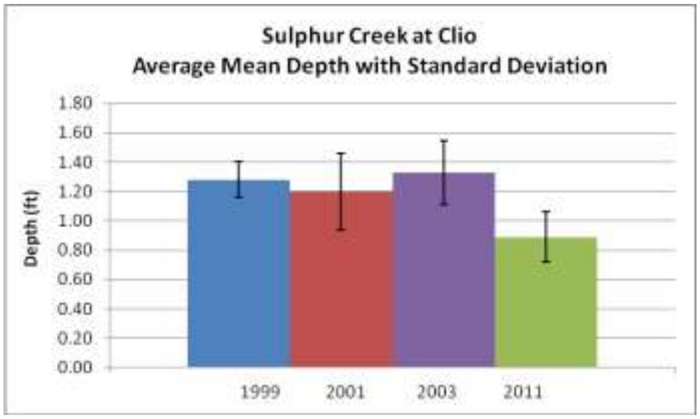


Figure 39. Sulphur Creek Mean Depth

Jamison Creek

The most noticeable difference in the Jamison Creek monitoring reach was the reduction of slow water habitat. Slow water habitat went from an average of 18% in 1999-2003 to 4% in 2011. This could be attributed to erosion from mining upstream. This erosion, combined with several years of low stream flow, could have filled in much of the slow water habitat.

X-Sec 1 looking downstream

Middle Fork Feather River at Nelson Point

X-Sec 2 looking downstream

The Middle Fork Feather River at Nelson Point appears to be relatively stable. There have been no significant changes to channel morphology through the reach. There has been a change in substrate size, which has steadily gotten smaller.

Overall Discussion

Most sites have become more stable since previous surveys in 2003 due to increased vegetation. 1997 was the highest flow year since this monitoring effort began. The highest recent flows since the 1997 event were in 2006 and 2011. Many channels have had a noticeable increase in riparian vegetation since the first SCI surveys in 1999. Many sites also had changes in bankfull and floodprone widths. These changes were probably due to difficulty interpreting bankfull at many sites.

In 2011 there were some modifications to the SCI protocol used in past survey years. The macroinvertebrate protocol changed from the SCI protocol to a rapid assessment protocol. This may account for some differences in percent tolerant macroinvertebrate taxa at monitoring sites. Also, in 2011 some survey cross-sections were no longer located on riffle crests. The USFS SCI protocol calls for static cross-section locations. Cross-section location may have affected bankfull and floodprone widths at sites where the cross-section is no longer on the riffle crest.

This set of survey data indicates it may be an appropriate way to document channel recovery after the 1997 flow event.

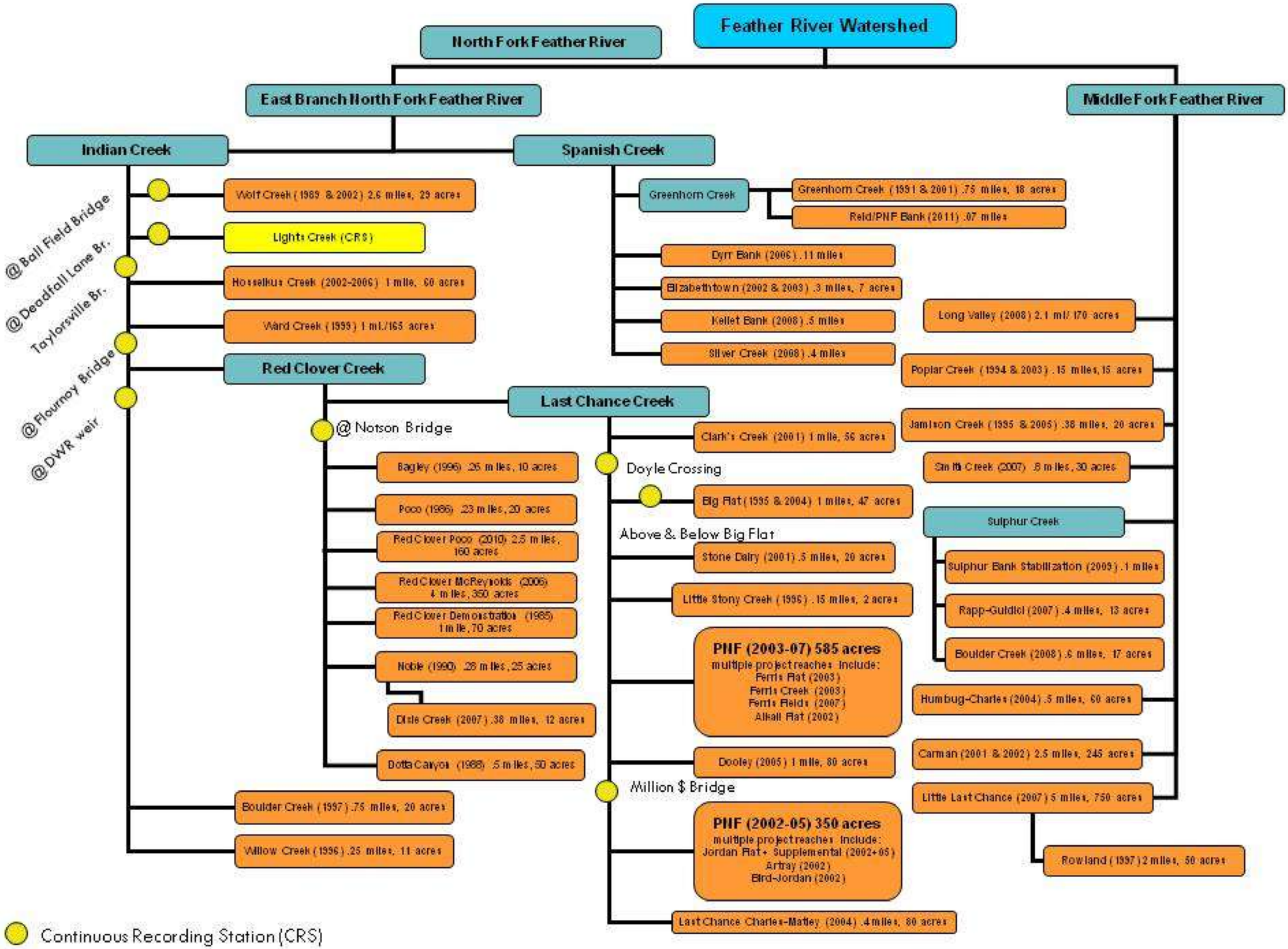
Conclusion

The 2011 Water Year was characterized by 142% of historic annual precipitation and a 5-7 year flow event. While Last Chance and Lights creeks continued to be the most impaired streams for cold water fisheries that FRCRM monitors, significant improvement in water temperatures were seen on Last Chance Creek at Doyle Crossing over the last five years of watershed monitoring data. Such water temperature improvements may be attributed to over 10 miles of channel and almost 1,500 acres of affected meadows that have been restored by FRCRM on Last Chance Creek above Doyle Crossing. Eight more miles of restoration on Last Chance Creek above Doyle Crossing is planned for construction, and we hope to see more improvements in summer water temperatures and baseflow on Last Chance Creek at Doyle Crossing. There have also been improvements seen on Red Clover Creek at Notson Bridge in 7-Day average of maximum daily water temperature. These improvements may be due to the effect of the Red Clover/McReynolds Creek Restoration Project, which restored three miles of channel nine miles upstream of Notson Bridge. An additional 2.5 miles was restored when the Red Clover Poco Project was constructed in 2010. Flows downstream of the project at Notson Bridge did not seem to be affected by project construction.

Unlike the improvements on Last Chance Creek and Red Clover Creek, we foresee little improvement in summer water quality on Lights Creek, particularly with sediment contribution from fire and subsequent rehabilitation activities following the Moonlight fire in 2007. Wolf Creek water quality may improve with the channel restoration upstream of Main Street between Setzer Road Bridge and the Greenville Campground completed by the US Forest Service.

In addition to water temperature improvements there was an increase in acre feet of water at Doyle Crossing and Notson Bridge in August and September in 2011 compared with 2006. This increase could be due to meadow restoration projects upstream of these monitoring stations. However, the increase in stream flow from pre- to post-project condition is not statistically significant. For more information on stream flow differences due to upstream restoration projects please read the 2011 Statistical Analysis of Selected Feather River Coordinated Resource Management Stream Flow Data Report by Ken Cawley.

Stream Condition Inventory surveys were conducted in 2011 on 14 of the 22 FRCRM monitoring reaches. Most sites have become more stable since previous surveys in 2003 due to increased vegetation. Many sites had changes in bankfull and floodprone widths. These changes were probably due to difficulty interpreting bankfull at many sites.



Feather River Watershed
North Fork Feather River
East Branch North Fork Feather River
Middle Fork Feather River
Indian Creek
Spanish Creek
Wolf Creek (1989 & 2002) 2.6 miles, 29 acres
Lights Creek (CRS)
Hosselkus Creek (2002-2006) 1 mile, 60 acres
Ward Creek (1999) 1 mi./165 acres
Red Clover Creek
@ Ball Field Bridge
@ Deadfall Lane Br.
Taylorsville Br.
@ Flournoy Bridge
@ DWR weir
Greenhorn Creek
Greenhorn Creek (1991 & 2001) .75 miles, 18 acres
Reid/PNF Bank (2011) .07 miles
Dyrr Bank (2006) .11 miles
Elizabethtown (2002 & 2003) .3 miles, 7 acres
Kellet Bank (2008) .5 miles
Silver Creek (2008) .4 miles
Last Chance Creek
@ Notson Bridge
Bagley (1996) .25 miles, 10 acres
Poco (1986) .23 miles, 20 acres
Red Clover Poco (2010) 2.5 miles, 160 acres
Red Clover McReynolds (2006) 4 miles, 350 acres
Red Clover Demonstration (1985) 1 mile, 70 acres
Noble (1990) .28 miles, 25 acres
Dixie Creek (2007) .38 miles, 12 acres
Dotta Canyon (1988) .5 miles, 50 acres
Boulder Creek (1997) .75 miles, 20 acres
Willow Creek (1996) .25 miles, 11 acres
Clark's Creek (2001) 1 mile, 56 acres
Doyle Crossing
Big Flat (1995 & 2004) 1 miles, 47 acres
Above & Below Big Flat
Stone Dairy (2001) .5 miles, 20 acres
Little Stony Creek (1996) .15 miles, 2 acres
PNF (2003-07) 585 acres
multiple project reaches include:
Ferris Flat (2003)
Ferris Creek (2003)
Ferris Fields (2007)
Alkali Flat (2002)
Dooley (2005) 1 mile, 80 acres
Million $ Bridge
PNF (2002-05) 350 acres
multiple project reaches include:
Jordan Flat + Supplemental (2002+05)
Artray (2002)
Bird-Jordan (2002)
Last Chance Charles-Matley (2004) .4 miles, 80 acres
Long Valley (2008) 2.1 mi/ 170 acres
Poplar Creek (1994 & 2003) .15 miles, 15 acres
Jamison Creek (1995 & 2005) .38 miles, 20 acres
Smith Creek (2007) .8 miles, 30 acres
Sulphur Creek
Sulphur Bank Stabilization (2009) .1 miles
Rapp-Guidici (2007) .4 miles, 13 acres
Boulder Creek (2008) .6 miles, 17 acres
Humbug-Charles (2004) .5 miles, 60 acres
Carman (2001 & 2002) 2.5 miles, 245 acres
Little Last Chance (2007) 5 miles, 750 acres
Rowland (1997) 2 miles, 50 acres
Continuous Recording Station (CRS)