

Riparian Recruitment along the Middle Fork American River, Rubicon River, and Comparison Rivers

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## **Riparian Recruitment along the Middle Fork American River, Rubicon River, and Comparison Rivers**

Recruitment along each of the reaches where tree cores analyses were completed is summarized below. Recession rates are discussed in Section 6.2.1.

***Middle Fork American River Bypass Reach*** – On the Middle Fork American River downstream of Middle Fork Interbay, the majority of the trees established following large flows in 1986 and 1996–1997 when relatively low magnitude spring flow events occurred (approximately 700–1,400 cfs) (Figures G-1 and G-2). Approximately one-third of the sampled trees (10 trees) established prior to 1975. The younger trees (all species) that were dated (1996 and younger) were all established less than two feet above summer baseflow, near the water's edge (Figure G-5 and Table G-1). In comparison, the older trees (some established soon after construction of Middle Fork Interbay Dam) were rooted near the estimated bankfull elevation (four to six feet above summer baseflow).

***Middle Fork American River Peaking Reach*** – Tree cores were collected from two sites (at RM 17.0 and RM 4.8) (Table G-1). Both sites have wide cobble and sand bars, similar to those at the NF31.3 study site. At the upper peaking reach site (RM 17.0), almost all the dated trees established following events that occurred between 1996 and 2001. The majority of these trees were established above elevations that would be inundated at approximately 1,000 cfs. At the lower site, the dated trees were rooted near the active channel and established following two successful recruitment events with recurrence intervals between 5 and 10 years, between 1996 and 2001 and in 1986 and 1987 (Figure G-1).

***Rubicon River*** – The majority of the trees established between 1995 and 2000, with most trees establishing after the 1997 high flows (approximately 17,100 cfs downstream from the dam and greater than 27,500 cfs downstream from the South Fork Rubicon River) (see Figure AQ 10-4 and Figure G-2). An event of this magnitude would likely have scoured most vegetation that had previously been established along the channel (e.g. during events that occurred in the early to mid-1980s). Low magnitude spills (<< Q1.5 magnitude flow) occurred during the subsequent years. Most of the trees were established less than 6 feet above the baseflow water elevation. A few trees that established during previous events were also dated, including in the early 1970s following a spill. These were typically rooted at higher elevations than the trees that established in the late 1990s (Figure G-5 and Table G-1).

***Comparison Rivers*** – The majority of the cored trees established in the years following the large 1986 and 1997 events (recurrence intervals were greater than the ten year event on both rivers) (Figures G-1 and G-4). Both of these high flow winter events were followed by low to moderate magnitude spring flows, and subsequent years without high winter flows. Almost all the trees that were dated were established at elevations that would primarily be inundated only during wet and above normal water years (greater than 3 feet above summer baseflow) (Table G-1). At NF31.3, the white alders were established at lower elevations than the Fremont cottonwoods. In the narrower sections

in the unimpaired comparison NFMF2.3 study site, trees were established across a range of elevations, with some trees rooted at elevations that were infrequently inundated even during wet and above normal water years (Figure G-5). In these narrower reaches with coarse substrate, limited areas with suitable substrate, available water, and protection from scouring high flows for riparian vegetation to establish exist.

## **TABLES**



**Table G-1. Summary of Tree Core Data on the Bypass, Peaking, and Comparison Reaches and Inundation Frequency Under Current Operations.**

Study Site <sup>1</sup>	Sampling Date	Transect Number	Location Description	Species <sup>3</sup>	Elevation Above Water Surface (ft)	DBH <sup>2</sup> (cm)	Years of Growth	Year Established	Inundation Frequency Per Year <sup>5</sup>	Inundation Frequency Per Wet and Above Normal Water Years	Inundation Frequency Per Below Normal, Dry, and Critically Dry Water Year
<b>Middle Fork American River</b>											
MF29.4	9/25/2006	Transect 2	Right Bank near water edge - on island	SALA6	0.4	8.1	6	2000	Periodically	Periodically	Infrequently
			Left Bank near water edge	POFR2	0.89	3.2	8	1998	Infrequently	Infrequently	Rarely
			Right Bank near water edge	SALA3	1.02	6.7	9	1997	Infrequently	Infrequently	Rarely
			Left Bank near water edge	ALRH2	1.43	9.2	10	1996	Infrequently	Infrequently	Rarely
			Left Bank near water edge	ALRH2	1.72	7.5	7	1999	Rarely	Infrequently	Rarely
			Historic Bankfull - Right Bank	ALRH2	4.78	28.9	39	1967	Rarely	Rarely	Rarely
			Right Bank near water edge	ALRH2	1.06	7.3	5	2001	Infrequently	Infrequently	Rarely
			Historic Bankfull - Right Bank	ALRH2	4.84	24	20	1986	Rarely	Rarely	Rarely
			Right Bank near water edge	SALA6	0.97	4.5	5	2001	Infrequently	Infrequently	Rarely
			Historic Bankfull - Right Bank	ALRH2	4.52	27.5	44	1962	Rarely	Rarely	Rarely
			Left Bank near water edge	ALRH2	1.44	7.7	7	1999	Infrequently	Infrequently	Rarely
			Historic Bankfull - Right Bank	ALRH2	4.88	31.6	47	1959	Rarely	Rarely	Rarely
			Historic Bankfull - Left Bank	ALRH2	5.15	21	38	1968	Rarely	Rarely	Rarely
			Historic Bankfull - Left Bank	ALRH2	5.46	25.9	25	1981	Rarely	Rarely	Rarely
MF28.6	9/27/2006	Transect 1	Left Bank	ALRH2	0	7.7	7	1999	Periodically	Frequently	Periodically
			Right Bank	ALRH2	1.2	7.5	8	1998	Infrequently	Infrequently	Rarely
			Right Bank	ALRH2	1.2	10.3	8	1998	Infrequently	Infrequently	Rarely
			Right Bank	ALRH2	1.4	20.9	20	1986	Infrequently	Infrequently	Rarely
			Left Bank	ALRH2	1.4	9.1	7	1999	Infrequently	Infrequently	Rarely
			Right Bank	ALRH2	4	43.1	37	1969	Rarely	Rarely	Rarely
			Left Bank	ALRH2	2	32.2	8	1998	Rarely	Infrequently	Rarely
			Left Bank	ALRH2	1	8.4	8	1998	Infrequently	Infrequently	Rarely
			Right Bank	ALRH2	3.7	30	28	1978	Rarely	Rarely	Rarely
			Left Bank	ALRH2	2	46.2	20	1986	Rarely	Infrequently	Rarely
			Right Bank	ALRH2	0.4	9.6	8	1998	Periodically	Periodically	Infrequently
			Right Bank	ALRH2	3.9	40	39	1967	Rarely	Rarely	Rarely
			Right Bank	ALRH2	5.2	35.8	38	1968	Rarely	Rarely	Rarely
			MF17 <sup>4</sup>	9/25/2006	Downstream of Transect 2	Right Bank Bankfull	ALRH2	0.86	12.9	8	1998
Right Bank Bankfull	ALRH2	1.22				8.9	10	1996	Infrequently	Periodically	Rarely
Right Bank Bankfull	ALRH2	1.97				17.6	10	1996	Infrequently	Infrequently	Rarely
Right Bank Bankfull	ALRH2	3.31				10.6	7	1999	Rarely	Rarely	Rarely
Historic Bankfull - Right Bank	ALRH2	4.12				6.6	7	1999	Rarely	Rarely	Rarely
Historic Bankfull - Right Bank	ALRH2	4.12				7.7	7	1999	Rarely	Rarely	Rarely
Historic Bankfull - Right Bank	ALRH2	4.18				11.7	10	1996	Rarely	Rarely	Rarely
Historic Bankfull - Right Bank	SALA3	4.21				11.2	10	1996	Rarely	Rarely	Rarely
Historic Bankfull - Right Bank	FRLA	4.21				15.1	11	1995	Rarely	Rarely	Rarely
Historic Bankfull - Right Bank	SALA3	6.06				9.4	8	1998	Rarely	Rarely	Rarely
Historic Bankfull - Right Bank	CEOCC2	6.42				4.3	8	1998	Rarely	Rarely	Rarely
Historic Bankfull - Right Bank	SALA3	6.51				11.6	20	1986	Rarely	Rarely	Rarely
MF4.8/ 6.0 <sup>4</sup>	9/26/2006	Transect 1	Left Bank	ALRH2	0	20.4	20	1986	Periodically	Periodically	Infrequently
			Left Bank	ALRH2	0.2	14.5	8	1998	Periodically	Periodically	Infrequently
			Left Bank	ALRH2	0.5	34.5	11	1995	Periodically	Periodically	Infrequently
			Left Bank	ALRH2	1.1	19	11	1995	Infrequently	Periodically	Rarely
			Left Bank	ALRH2	1.1	39.4	8	1998	Infrequently	Periodically	Rarely
			Left Bank - lower bar	ALRH2	1.2	19.2	8	1998	Infrequently	Periodically	Rarely
			Left Bank - lower bar	ALRH2	1.6	9.3	10	1996	Infrequently	Periodically	Rarely
			Left Bank	ALRH2	2	8.8	8	1998	Infrequently	Infrequently	Rarely
			Left Bank	ALRH2	2	20.1	19	1987	Infrequently	Infrequently	Rarely
			Left Bank - lower bar	ALRH2	2	18	11	1995	Infrequently	Infrequently	Rarely
			Left Bank	ALRH2	3.5	46	20	1986	Rarely	Infrequently	Rarely
			Left Bank	ALRH2	4.8	19.1	25	1981	Rarely	Rarely	Rarely

Table G-1. Summary of Tree Core Data on the Bypass, Peaking, and Comparison Reaches (continued).

Study Site <sup>1</sup>	Sampling Date	Transect Number	Location Description	Species <sup>3</sup>	Elevation Above Water Surface (ft)	DBH <sup>2</sup> (cm)	Years of Growth	Year Established	Inundation Frequency Per Year	Inundation Frequency Per Wet and Above Normal Water Years	Inundation Frequency Per Below Normal, Dry, and Critically Dry Water Year			
<b>Rubicon River</b>														
R25.7	7/24/2008	Downstream of Transect 2	Right bank	ALRH2	0.28	3.5	10	1998	Rarely	Infrequently	Rarely			
			Right bank	ALRH2	0.81	4.7	11	1997	Rarely	Infrequently	Rarely			
			Right bank	ALRH2	0.81	5.5	10	1998	Rarely	Infrequently	Rarely			
			Right bank	ALRH2	1.07	6	10	1998	Rarely	Infrequently	Rarely			
			Right bank	ALRH2	1.15	5.3	11	1997	Rarely	Infrequently	Rarely			
			Right bank	ALRH2	1.51	4.8	10	1998	Rarely	Rarely	Rarely			
			8/22/2008	Left bank	ALRH2	0.42	4.1	13	1995	Rarely	Infrequently	Rarely		
				Left bank	ALRH2	0.9	4.4	13	1995	Rarely	Rarely	Rarely		
				Left bank	ALRH2	1.02	6.1	10	1998	Rarely	Rarely	Rarely		
				Left bank	ALRH2	1.08	5.1	10	1998	Rarely	Rarely	Rarely		
	Right bank	ALRH2		1.87	10.1	36	1972	Rarely	Rarely	Rarely				
	Right bank	ALRH2		1.88	9.9	38	1970	Rarely	Rarely	Rarely				
	Left bank	ALRH2		2.32	4	13	1995	Rarely	Rarely	Rarely				
	Right bank	ALRH2		2.62	8.8	34	1974	Rarely	Rarely	Rarely				
	Right bank	ALRH2		2.82	14.5	38	1970	Rarely	Rarely	Rarely				
	Right bank	ALRH2		2.96	6.2	33	1975	Rarely	Rarely	Rarely				
	R20.9	9/26/2006	Transects 1 and 2	Left Bank	ALRH2	0.6	19	8	1998	Infrequently	Periodically	Infrequently		
				Left Bank	ALRH2	0.78	19.3	8	1998	Infrequently	Periodically	Rarely		
				Left Bank	ALRH2	0.84	6	8	1998	Infrequently	Periodically	Rarely		
				Left Bank	ALRH2	0.9	21.8	8	1998	Infrequently	Periodically	Rarely		
Left Bank				ALRH2	1.59	15	8	1998	Rarely	Infrequently	Rarely			
Left edge of water				ALRH2	1.87	13.9	8	1998	Rarely	Infrequently	Rarely			
Left Bank				ALRH2	2.6	21.4	8	1998	Rarely	Rarely	Rarely			
Left Bank				ALRH2	2.74	13.5	8	1998	Rarely	Rarely	Rarely			
Left Bank				ALRH2	3.16	12.9	8	1998	Rarely	Rarely	Rarely			
Left Bank				ALRH2	7.58	16.7	29	1978	Rarely	Rarely	Rarely			
Left Bank				ALRH2	4.4	19.9	45	1961	Rarely	Rarely	Rarely			
Left Bank				ALRH2	12.23	31	24	1982	Rarely	Rarely	Rarely			
Left Bank				ALRH2	4.25	4	10	1996	Rarely	Rarely	Rarely			
Left Bank				ALRH2	0	7	7	1999	Periodically	Periodically	Periodically			
On top of left bank undercul				ALRH2	3.6	37	36	1970	Rarely	Rarely	Rarely			
R2.6/ 3.5				9/25/2006	Downstream of Transect 3	Left Bank	ALRH2	0.8	14.7	8	1998	Periodically	Periodically	Infrequently
						Left Bank	ALRH2	0.9	20.2	8	1998	Infrequently	Periodically	Infrequently
						Left Bank	SALA3	0.9	10.2	8	1998	Infrequently	Periodically	Infrequently
						Left Bank	SALA6	1.4	8.9	6	2000	Infrequently	Periodically	Rarely
						Left Bank	ALRH2	1.5	16.8	8	1998	Infrequently	Periodically	Rarely
	Left Bank	ALRH2	1.5			13.3	8	1998	Infrequently	Periodically	Rarely			
	Left Bank	ALRH2	1.6			11.7	7	1999	Infrequently	Infrequently	Rarely			
	Left Bank	SALA3	1.7			6.7	11	1995	Infrequently	Infrequently	Rarely			
	Left Bank	SALA3	1.8			6.7	6	2000	Infrequently	Infrequently	Rarely			
	Left Bank	POFR2	1.5			5.4	11	1995	Infrequently	Periodically	Rarely			
	Left Bank	ALRH2	1.4			13.5	10	1996	Infrequently	Periodically	Rarely			
	Left Bank	ALRH2	1.1			8.5	8	1998	Infrequently	Periodically	Infrequently			
	Left Bank	ALRH2	1.3			5	8	1998	Infrequently	Periodically	Rarely			
	Left Bank	ALRH2	1.3			9.7	8	1998	Infrequently	Periodically	Rarely			
	Left Bank	SALA6	1.4			8.9	6	2000	Infrequently	Periodically	Rarely			
	Left Bank	ALRH2	0.8			14.7	8	1998	Periodically	Periodically	Infrequently			
	Left Bank	SALA3	0.9			10.2	8	1998	Infrequently	Periodically	Infrequently			
	Left Bank	ALRH2	1.5			13.3	8	1998	Infrequently	Periodically	Rarely			
	Left Bank	ALRH2	1.6			23.4	7	1999	Infrequently	Infrequently	Rarely			



**Table G-1. Summary of Tree Core Data on the Bypass, Peaking, and Comparison Reaches (continued).**

Study Site <sup>1</sup>	Sampling Date	Transect Number	Location Description	Species <sup>3</sup>	Elevation Above Water Surface (ft)	DBH <sup>2</sup> (cm)	Years of Growth	Year Established	Inundation Frequency Per Year	Inundation Frequency Per Wet and Above Normal Water Years	Inundation Frequency Per Below Normal, Dry, and Critically Dry Water Year
<b>North Fork of the Middle Fork American River</b>											
NFMF2.3	8/27/2007	Transect 1	Right bank	ALRH2	1.42	4.7	20	1987	Periodically	Periodically	Infrequently
			Right bank	ALRH2	2.9	7	12	1995	Rarely	Infrequently	Rarely
			Right bank	ALRH2	3.01	6	16	1991	Rarely	Infrequently	Rarely
			Right bank	ALRH2	3.06	6.15	20	1987	Rarely	Infrequently	Rarely
			Right bank	ALRH2	3.33	7.6	14	1993	Rarely	Rarely	Rarely
			Right bank	ALRH2	3.73	8.4	20	1987	Rarely	Rarely	Rarely
		Transect 2	Right bank	ALRH2	1.28	5.3	30	1977	Periodically	Periodically	Infrequently
			Right bank	ALRH2	3.38	6.7	20	1987	Rarely	Rarely	Rarely
			Right bank	ALRH2	3.45	4.5	24	1983	Rarely	Rarely	Rarely
		Transect 3	Right bank	ALRH2	2.25	3.1	14	1993	Periodically	Periodically	Infrequently
			Right bank	ALRH2	3.17	8.2	25	1982	Infrequently	Periodically	Infrequently
			Right bank	ALRH2	3.32	6.6	12	1995	Infrequently	Periodically	Rarely
			Right bank	ALRH2	3.63	6.1	10	1997	Infrequently	Infrequently	Rarely
			Right bank	ALRH2	3.63	7.4	10	1997	Infrequently	Infrequently	Rarely
			Right bank	ALRH2	3.8	12.9	32	1975	Infrequently	Infrequently	Rarely
		Transect 3	Right bank	ALRH2	5.39	11.5	37	1970	Rarely	Rarely	Rarely
Right bank	ALRH2		7.24	13.7	32	1975	Rarely	Rarely	Rarely		
<b>North Fork American River</b>											
NF31.3	9/14/2007	Transect 4	Left bank	POFR2	2.72	3.7	7	2000	Infrequently	Infrequently	Rarely
		Transect 3	Left bank	POFR2	3.01	3.9	7	2000	Infrequently	Periodically	Rarely
			Right bank	ALRH2	6.29	6	10	1997	Rarely	Rarely	Rarely
		Transect 3	Right bank	ALRH2	6.35	6.5	20	1987	Rarely	Rarely	Rarely
			Right bank	POFR2	5.94	3.3	14	1993	Rarely	Rarely	Rarely
		Transect 2	Left bank	ALRH2	1.68	3.3	7	2000	Periodically	Periodically	Infrequently
			Left bank	ALRH2	2.45	4	7	2000	Infrequently	Periodically	Infrequently
			Left bank	ALRH2	2.47	3.6	7	2000	Infrequently	Periodically	Infrequently
			Left bank	ALRH2	3.2	4	7	2000	Infrequently	Infrequently	Rarely
			Left bank	POFR2	3.43	6.4	10	1997	Infrequently	Infrequently	Rarely
			Left bank	POFR2	3.86	5.1	10	1997	Rarely	Infrequently	Rarely
			Left bank	POFR2	4.1	4.4	16	1991	Rarely	Rarely	Rarely
			Left bank	POFR2	6.57	3.6	10	1997	Rarely	Rarely	Rarely
			Left bank	POFR2	6.82	5	10	1997	Rarely	Rarely	Rarely
			Left bank	POFR2	8.21	6.6	12	1995	Rarely	Rarely	Rarely

<sup>1</sup> Refer to Table AQ 10-1 for corresponding 2006 quantitative study site numbers.

<sup>2</sup> DBH: Diameter at breast height.

<sup>3</sup> ALRH2 - white alder; CEOCC2 - California button willow; POFR2 - Fremont cottonwood; SALA6 - arroyo willow; SALA3 - red willow

<sup>4</sup> Inundation frequencies were based on average daily flows in the peaking reach.

<sup>5</sup> Inundation Frequency: Rarely (<5% of year); Infrequently (5-25% of year); Periodically (25-75% of year); Frequently (>75% of year).



## FIGURES



**Figure G-1. Number of Trees Dated and Cumulative Distribution by Year along the Middle Fork American River and Comparison Rivers (top) and Rubicon River and Comparison Rivers (bottom).**

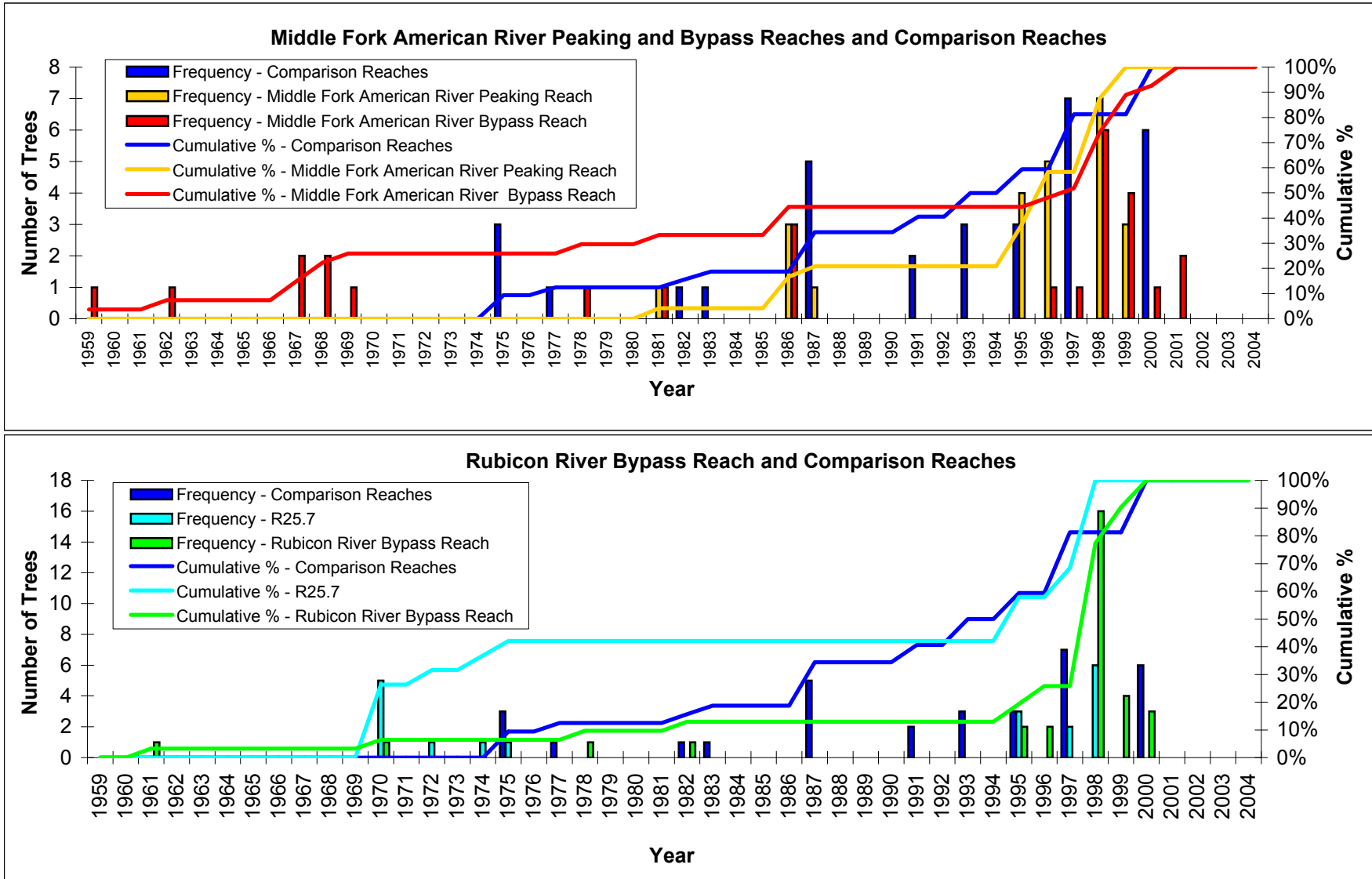
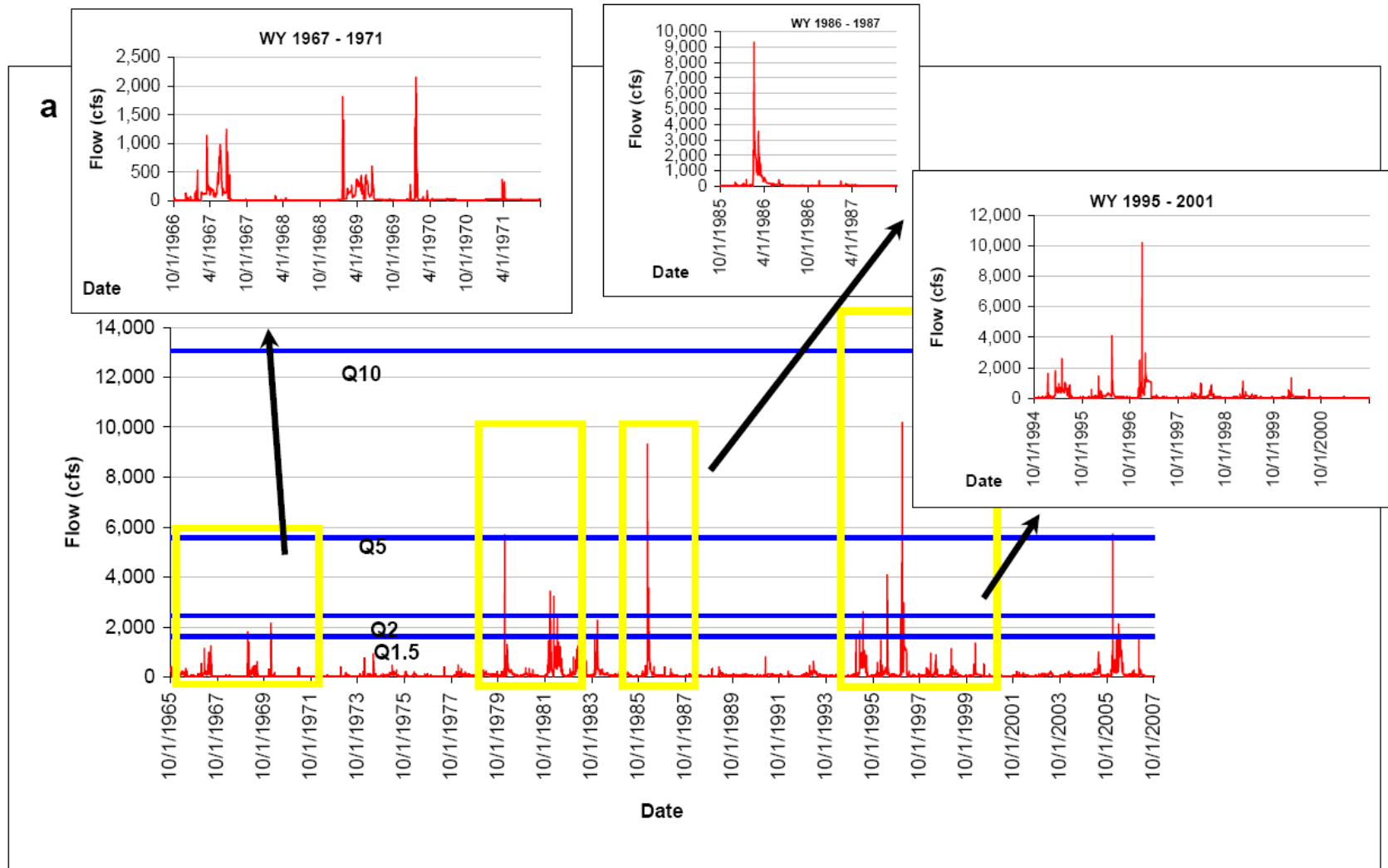
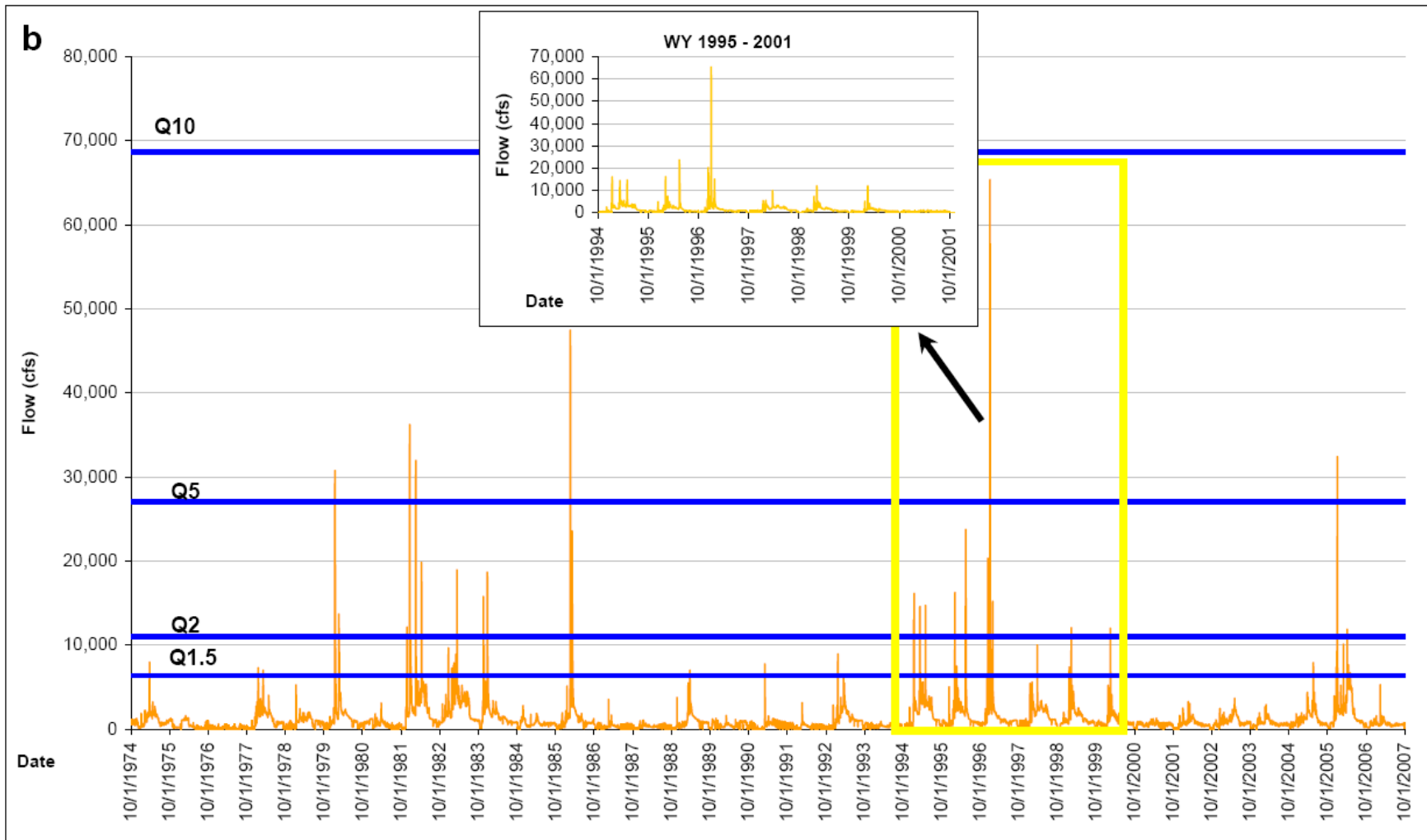


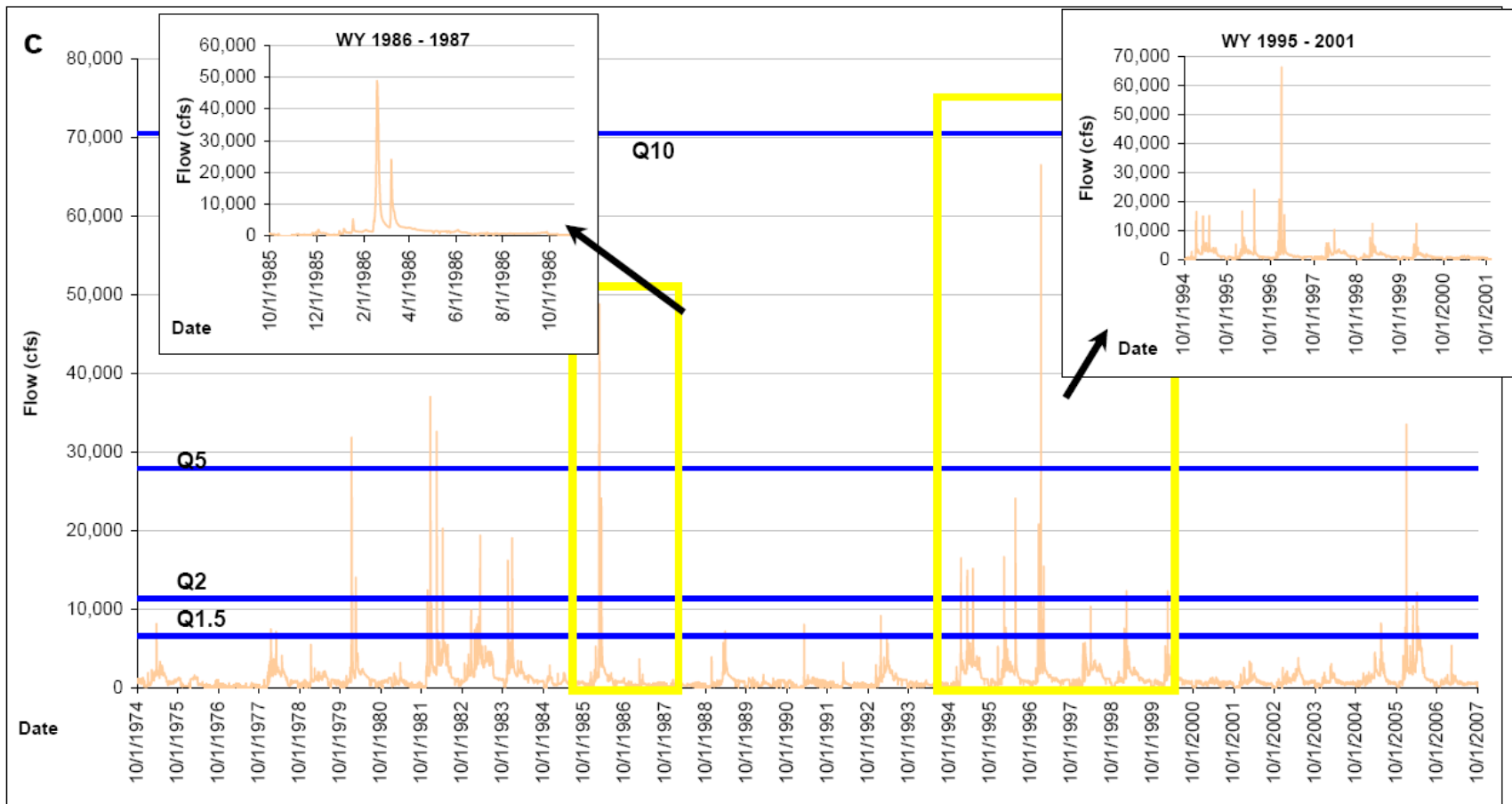
Figure G-2. Riparian Tree Successful Recruitment Events on the Middle Fork American River - Below Middle Fork Interbay (MF29.4 and MF28.6) (a); Upper Peaking Reach (MF17.0) (b); and near Buckeye Bar (MF4.8) (c)<sup>1,2</sup>.



**Figure G-2. Riparian Tree Successful Recruitment Events on the Middle Fork American River - Below Middle Fork Interbay (MF29.4 and MF28.6) (a); Upper Peaking Reach (MF17.0) (b); and near Buckeye Bar (MF4.8) (c)<sup>1,2</sup> (continued).**



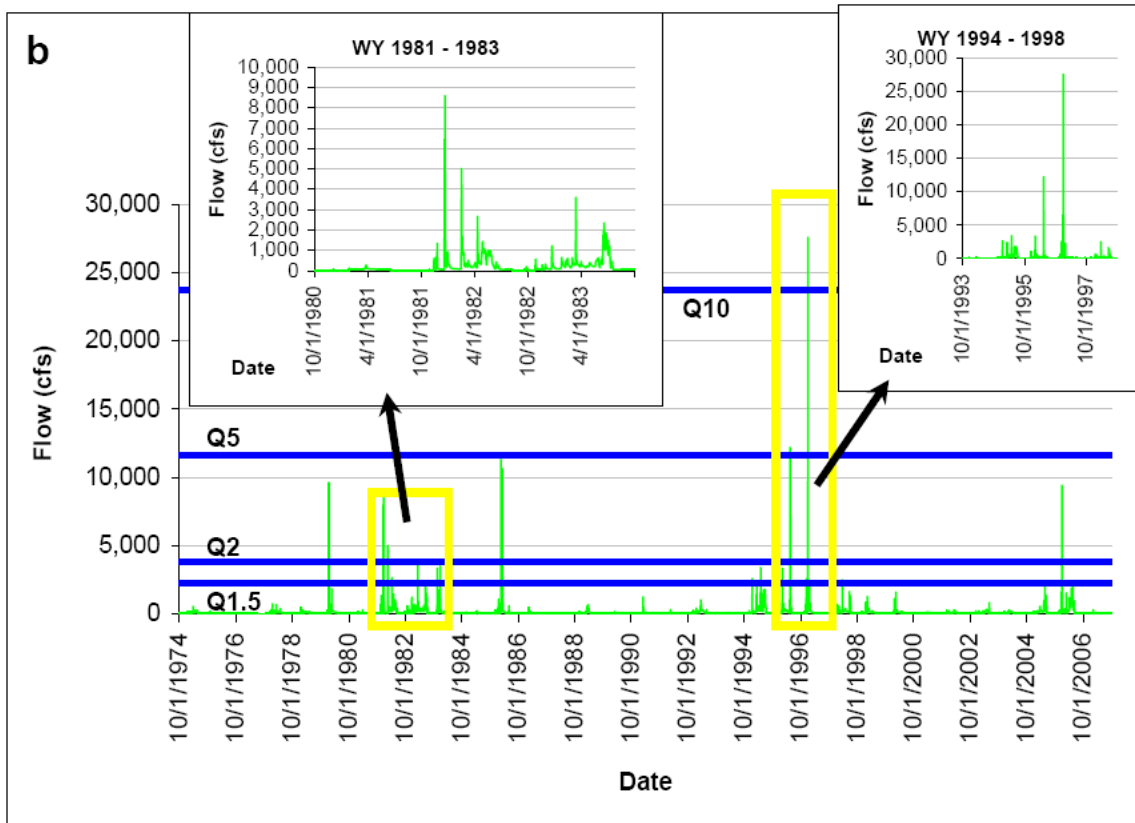
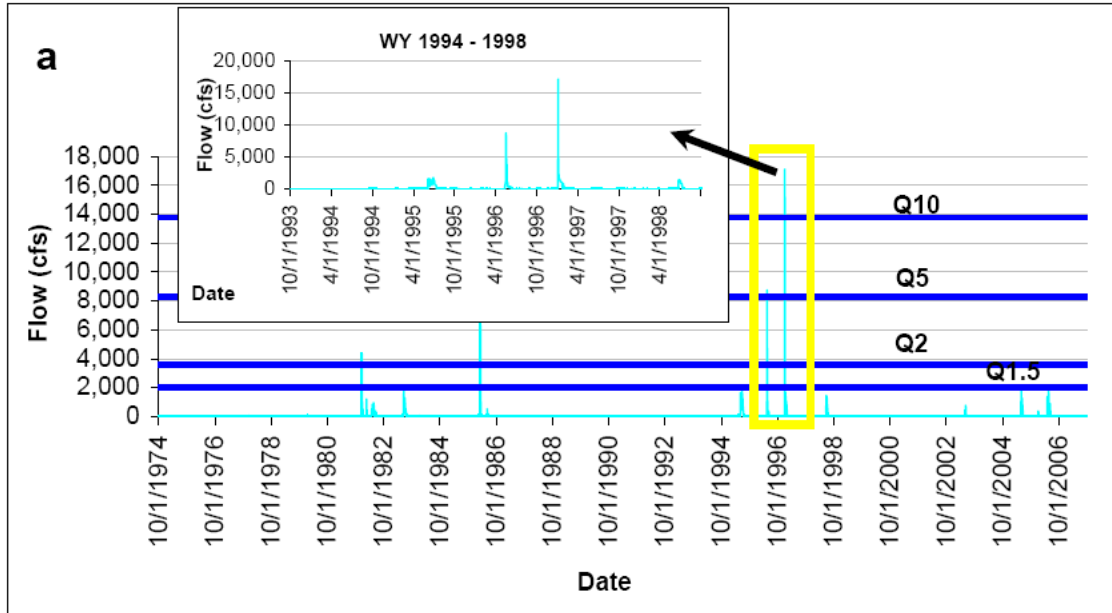
**Figure G-2. Riparian Tree Successful Recruitment Events on the Middle Fork American River - Below Middle Fork Interbay (MF29.4 and MF28.6) (a); Upper Peaking Reach (MF17.0) (b); and near Buckeye Bar (MF4.8) (c)<sup>1,2</sup>(continued).**



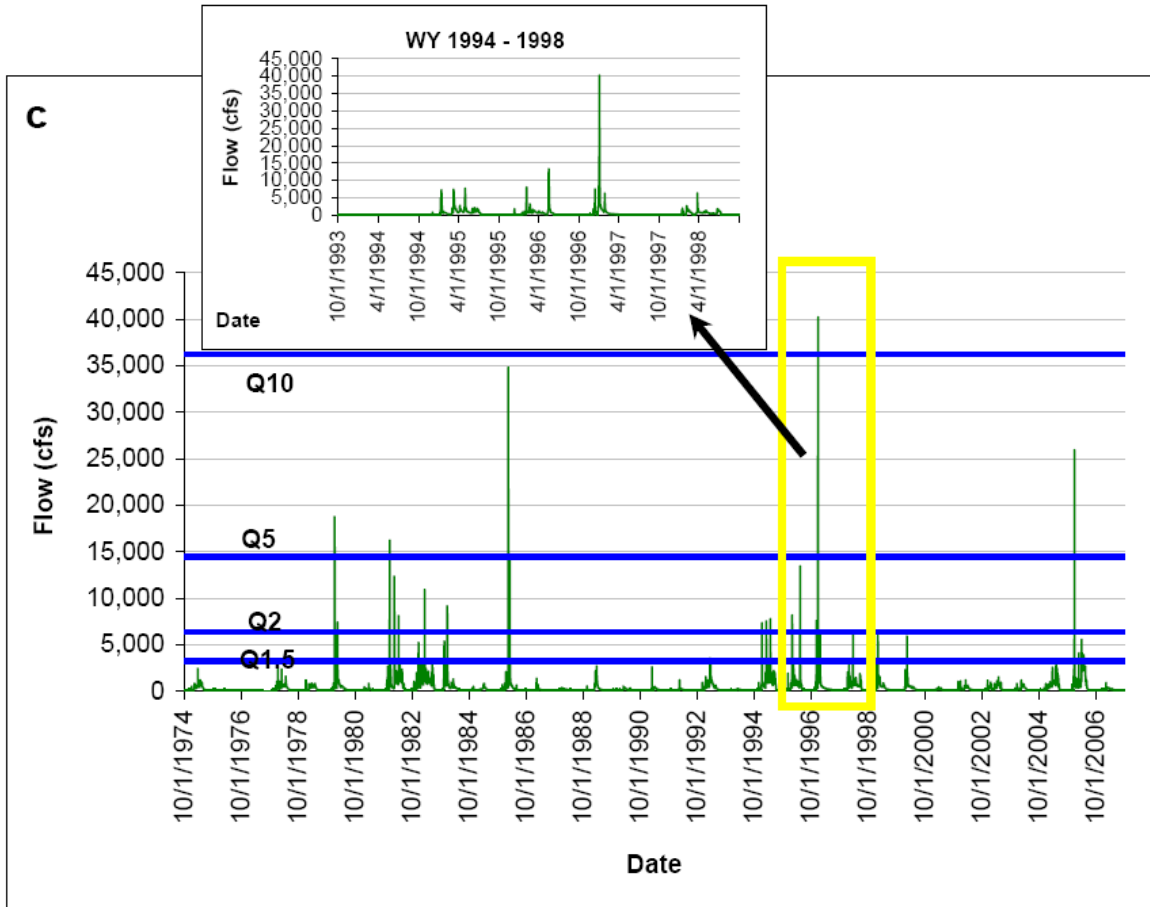
<sup>1</sup>Data Source: USGS gaging station 11427770 for 10/1/1965 to 10/1/1974; and Operations Model for the reach in which the riparian study sites are located for 10/1/1974 to 10/1/2007.  
<sup>2</sup> Recurrence intervals calculated from unimpaired flow data are shown on the plots.



**Figure G-3. Riparian Tree Successful Recruitment Events on the Rubicon River - Below Hell Hole Dam (R25.7) (a); Below South Fork Rubicon River Confluence (R20.9) (b); and Below the Long Canyon Creek Confluence (R2.6/ 3.5) (c)<sup>1,2</sup>.**



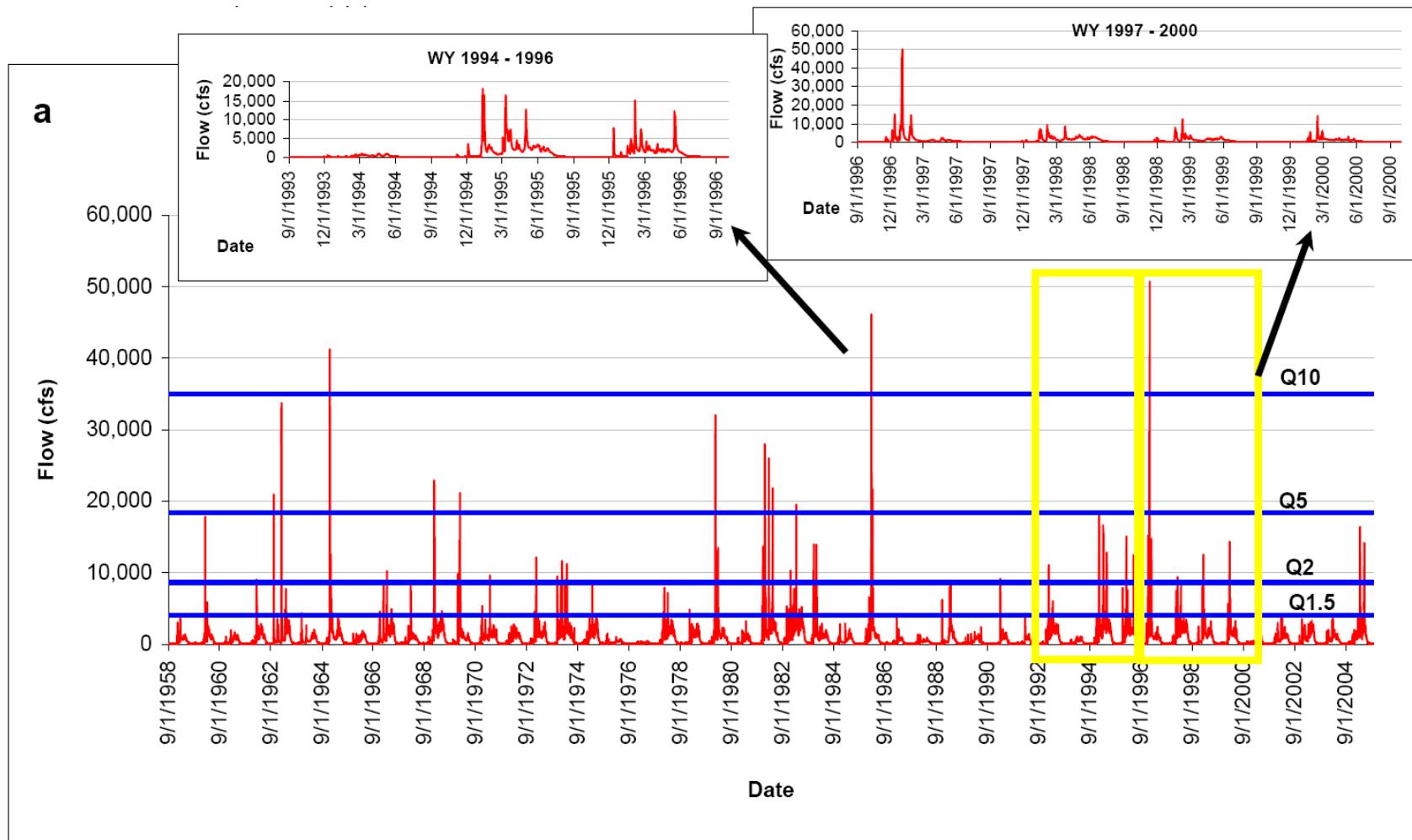
**Figure G-3. Riparian Tree Successful Recruitment Events on the Rubicon River - Below Hell Hole Dam (R25.7) (a); Below South Fork Rubicon River Confluence (R20.9) (b); and Below the Long Canyon Creek Confluence (R2.6/ 3.5) (c)<sup>1,2</sup> (continued).**



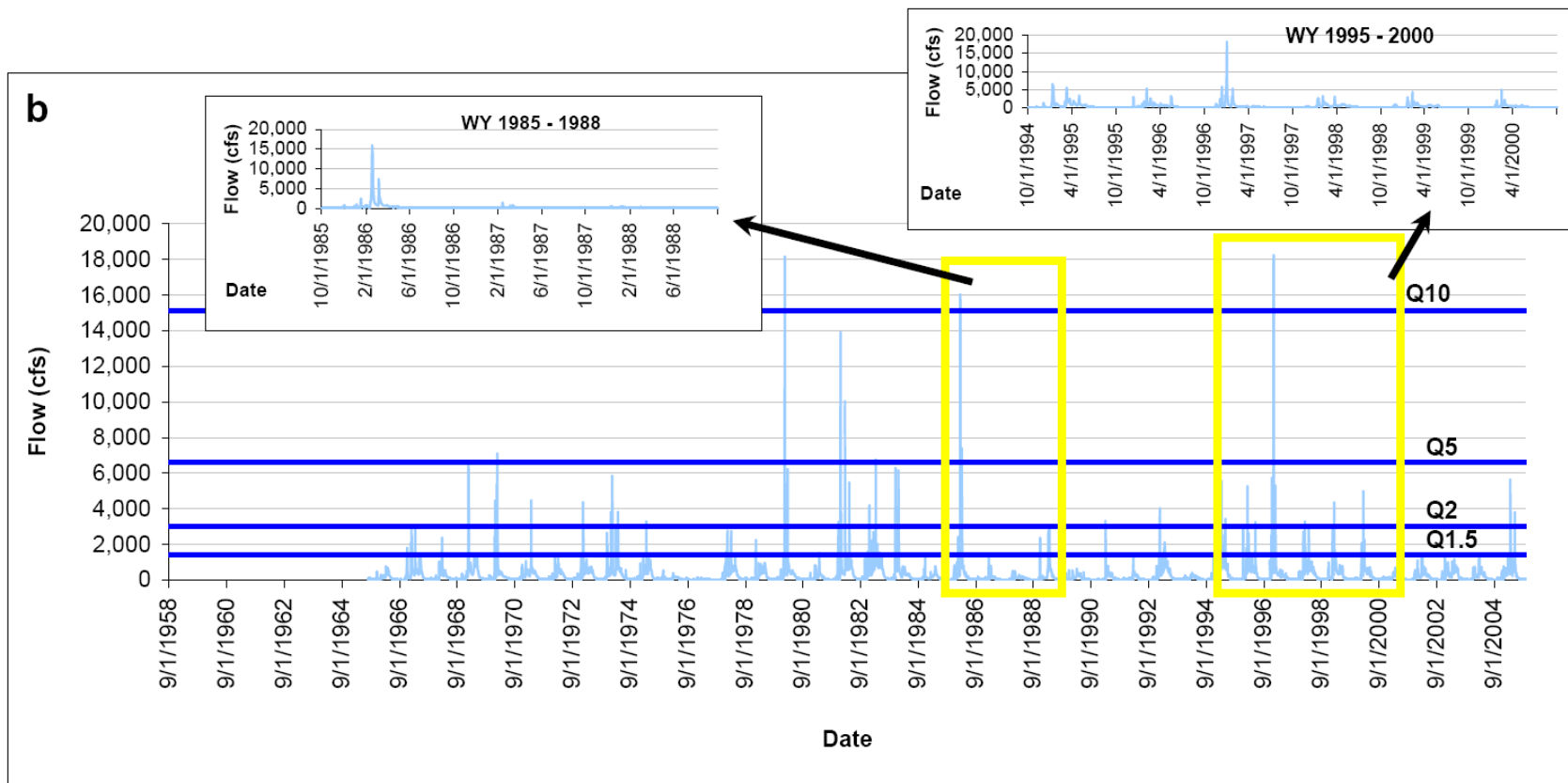
<sup>1</sup> Data Source: Impaired daily hydrology: Operations Model.

<sup>2</sup> Recurrence intervals calculated from unimpaired flow data are shown on the plots.

**Figure G-4. Riparian Tree Successful Recruitment Events on the North Fork American River (NF31.3) (a) and North Fork of the Middle Fork American River (NFMF2.3) (b)<sup>1</sup>.**



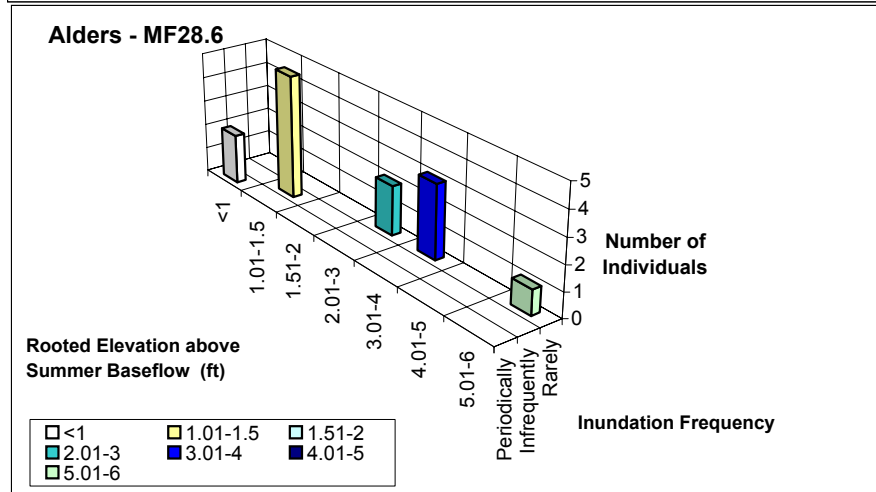
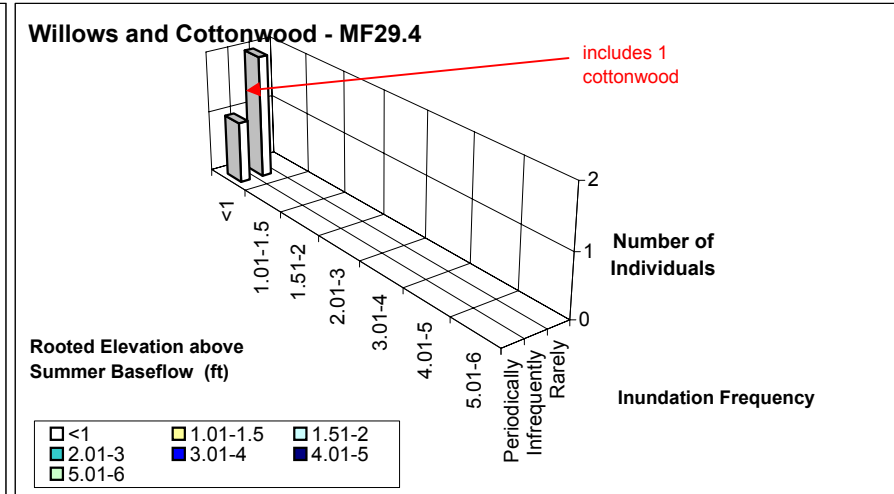
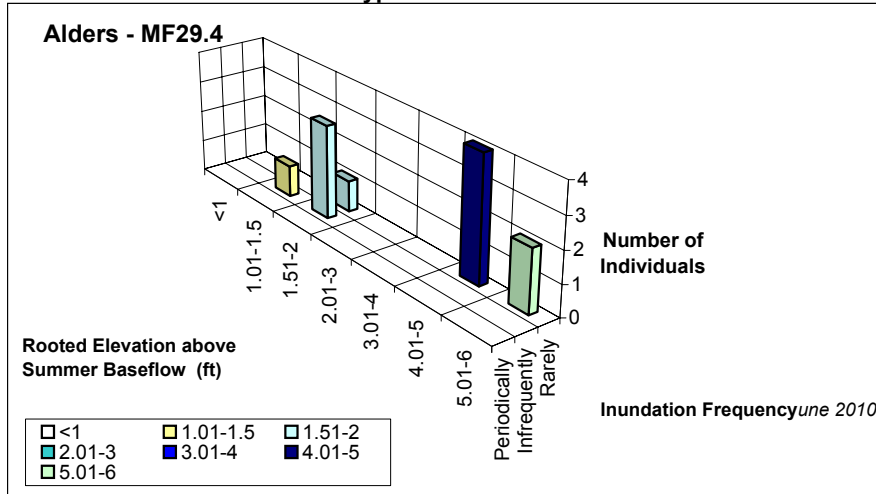
**Figure G-4. Riparian Tree Successful Recruitment Events on the North Fork American River (NF31.3) (a) and North Fork of the Middle Fork American River (NFMF2.3) (b)<sup>1</sup> (continued).**



<sup>1</sup> Data Source: North Fork American River Flows: USGS gaging station 11427000 (North Fork American River at North Fork Dam). North Fork of the Middle Fork American River Flows: USGS gaging station 11433260 (near Foresthill) and Operations Model for the period of record.

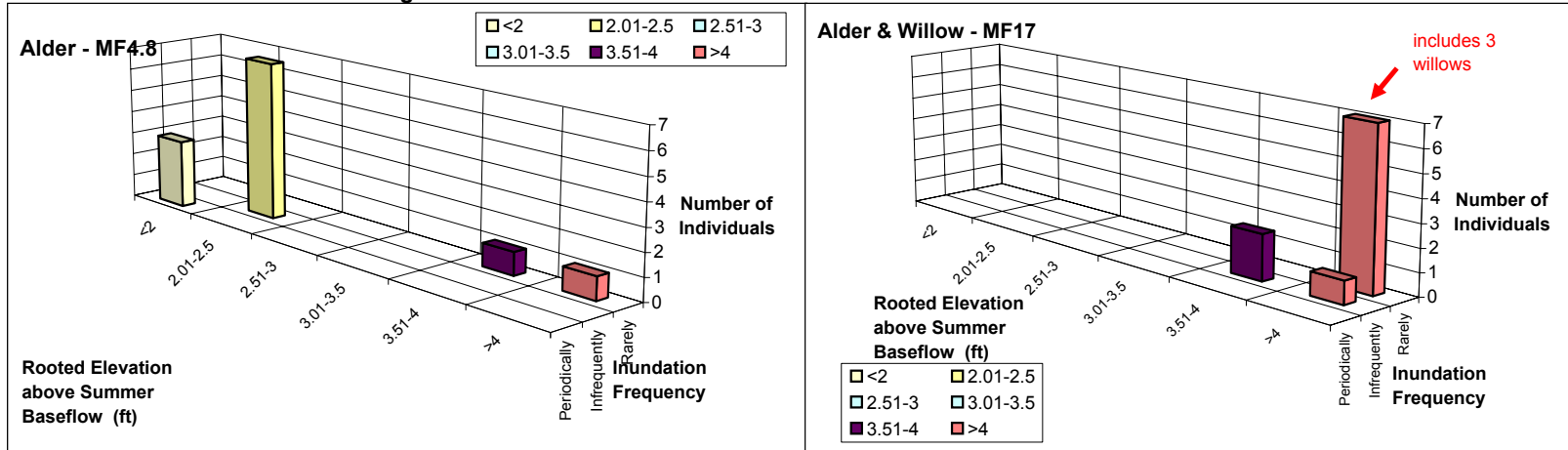
**Figure G-5. Relationship Between Rooted Elevation of Dated Trees Above Summer Baseflow and Inundation Frequency on the Middle Fork American River, Rubicon River, and Comparison Rivers for All Water Year Types (1975-2007)<sup>1</sup>.**

**Middle Fork American River - Bypass Reach**



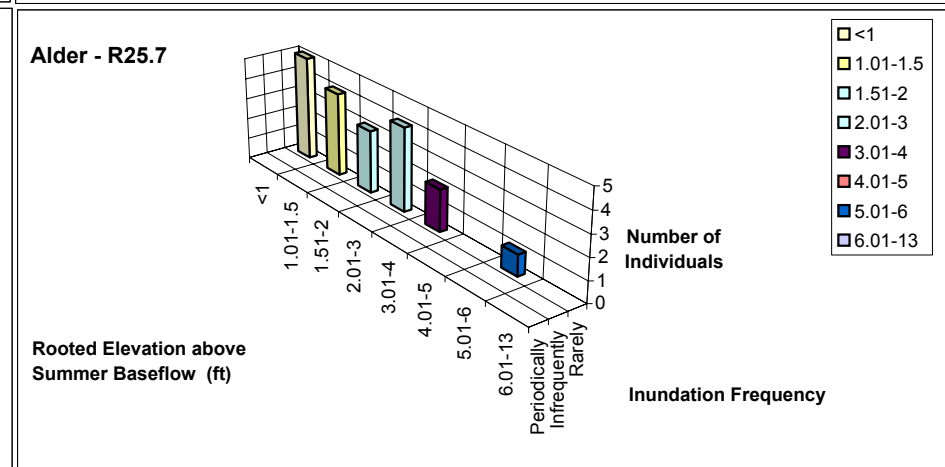
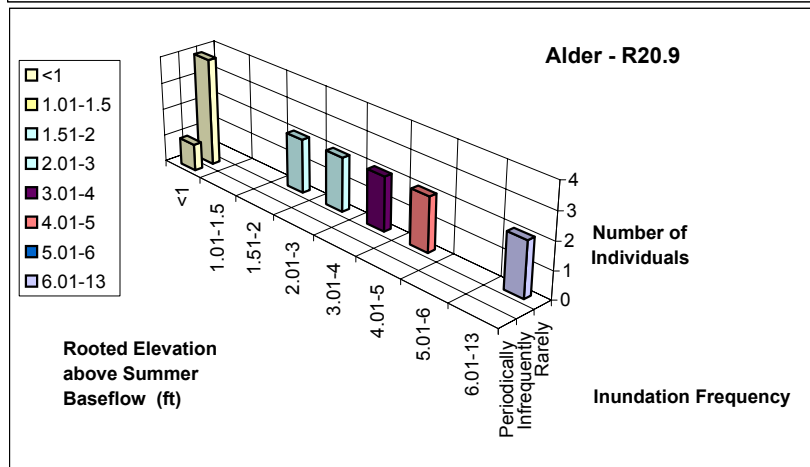
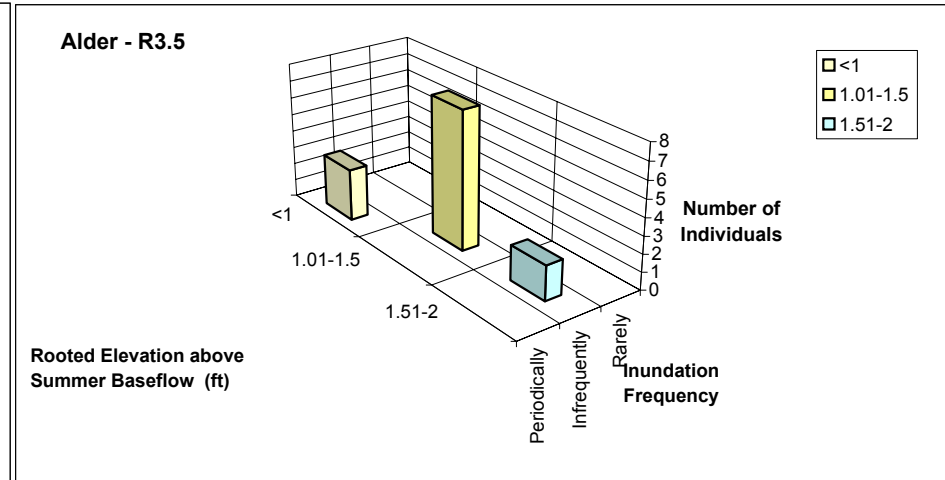
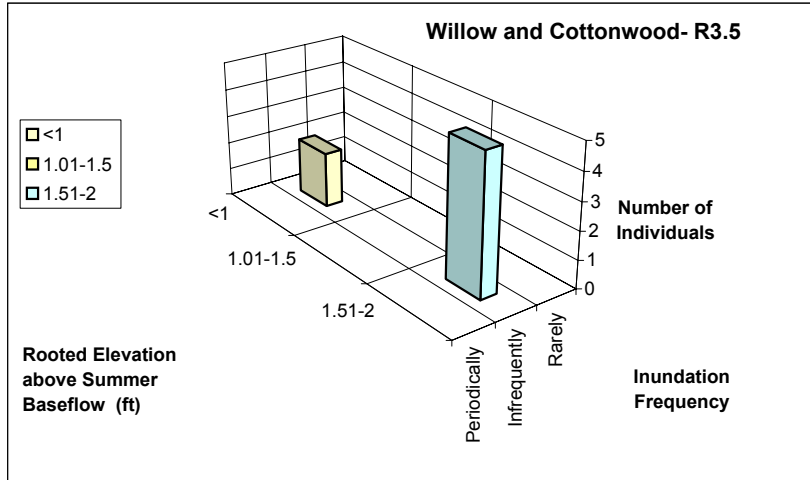
**Figure G-5. Relationship Between Rooted Elevation of Dated Trees Above Summer Baseflow and Inundation Frequency on the Middle Fork American River, Rubicon River, and Comparison Rivers for All Water Year Types (1975-2007) (continued).**

**Middle Fork American River Peaking Reach**



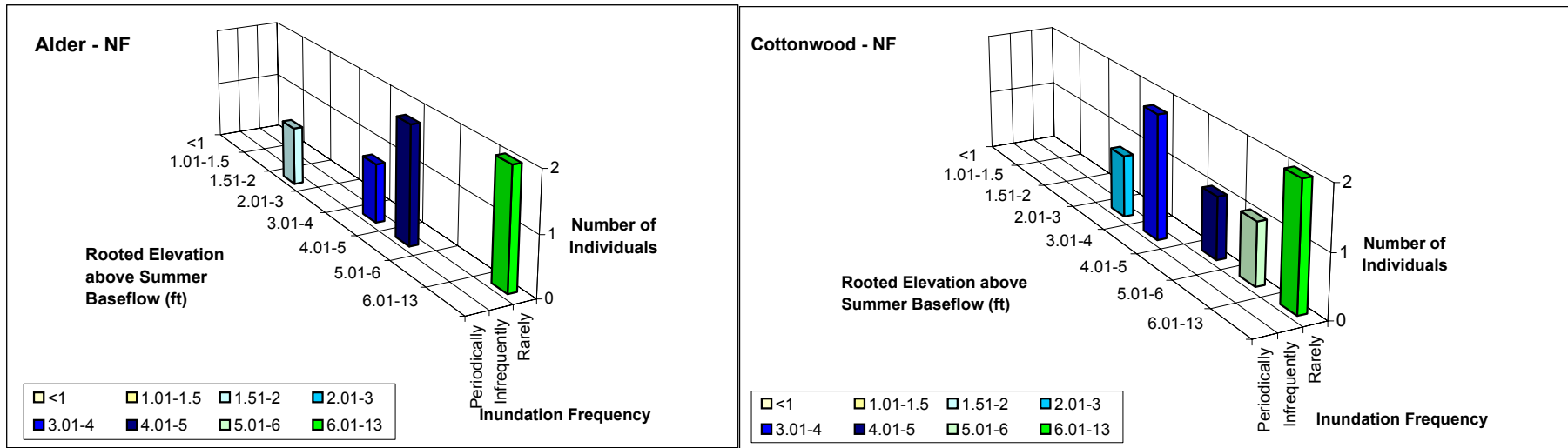
**Figure G-5. Relationship Between Rooted Elevation of Dated Trees Above Summer Baseflow and Inundation Frequency on the Middle Fork American River, Rubicon River, and Comparison Rivers for All Water Year Types (1975-2007) (continued).**

**Rubicon River**

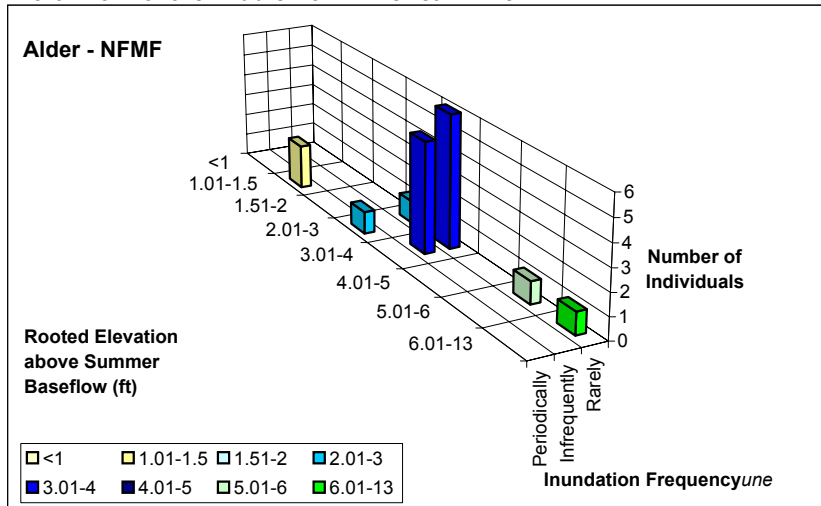


**Figure G-5. Relationship Between Rooted Elevation of Dated Trees Above Summer Baseflow and Inundation Frequency on the Middle Fork American River, Rubicon River, and Comparison Rivers for All Water Year Types (1975-2007) (continued).**

**North Fork American River**



**North Fork of the Middle Fork American River**



<sup>1</sup> Inundation Frequency: Rarely (<5% of year); Infrequently (5-25% of year); Periodically (25-75% of year); Frequently (>75% of year)