RIPARIAN VEGETATION ESTABLISHMENT AND SURVIVAL ON CAPLES CREEK AND KIRKWOOD CREEK, SUMMER, 2000

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Introduction

In the Project #184 application for new licensing the potential for regulated flows to impair recruitment of riparian vegetation below Caples Lake was discussed. To evaluate this potential effect, a monitoring project was conducted to determine patterns of willow reproduction and recruitment in Caples Meadow and effects of streamflow regulation on it.

Willows present in Caples Meadow include *Salix lemonii* and *Salix lucida ssp. lasiandra.* Both of these are widely distributed throughout the Sierra Nevada (Argus 1997) and are commonly associated with meandering streams. They provide important ecological functions including streambank stabilization and wildlife habitat. Their reproductive behavior has not been studied in detail. Both species flower in May-June, depending on altitude and latitude (Munz and Keck 1973; Weeden 1979). Pollination in willow may be by wind or insects (Sacchi and Price 1988; Douglas 1997). Seed production in willow is generally high (Sacchi and Price 1988; Johnson 1994) but interspecific hybridization, which is common, can produce nonflowering offspring (Mosseller 1990). The interaction between seed dispersal and stream water levels is the process dominating seedling establishment in the Salicaceae (Blom 1999). Seedling establishment depends on soil moisture availability, particularly the effects of spring floods and the rate of flood recession (Rood et al. 1999). Seedling establishment can be extremely variable from year to year (Roelle and Gladwin 1999). Seedlings commonly establish on open sites but some researchers have found greater densities of seedlings on gravel bars with some vegetation cover present (Douglas 1995). First year mortality of seedlings is commonly greater than 90 percent (Sacchi and Price 1992). Studies have shown that specific hydrologic conditions are required for seedling survival, including reduced flooding in the first few years after establishment (McBride and Strahan 1985). Survival rates improve with seedling age (Sacchi arid Price 1992). Local microsite characteristics such as topographic relief and sedimentation can affect survival (Merigliano 1998; Taylor et al. 1999).

Streamflow regulation by dams commonly causes increased recruitment of willows and other pioneer riparian species on alluvial streams (Williams and Wolman 1984; Harris et. al. 1987; Johnson 1994). This is caused by dampening of scouring peak flows and stabilization of low flows, both of which create conditions conducive to survival of seedlings. In the case of Caples Lake, low flows are not just stabilized but they are augmented in late summer and fall. Theoretically, flow augmentation could cause seedling inundation or scouring if at sufficient magnitudes.

Methods

The general hypothesis that we sought to test was whether or not regulated streamflows affect the recruitment and survival of willows on Caples Creek. To test this, data were collected at Caples Creek and a control (unregulated) stream. The data collection spanned the period when recruitment should have been occurring and when flows were both reduced (late spring and summer) and then augmented (early fall) below Caples Lake.

The area affected by regulated flows we studied was the reach of Caples Creek below the confluence of the Caples Lake spillway channel. This reach has experienced significant aggradation due to spillway channel erosion and other causes. The control area was Kirkwood Creek below Highway 88. This area was taken as a control because Kirkwood Creek does not have a major dam on it. Both study areas are grazed to a limited extent by horses passing through. Neither is currently used as a pasture. Both have similar composition of willow species, primarily *Salix lemonii.*

Twenty-four sites were chosen on the two study reaches (see map in accompanying photographic exhibit). These were chosen because they were on or near fluvial deposits where recruitment would be expected or most likely. Nearly all such sites on the two reaches were included.

Permanent photopoints were located at each site. Methods of Platts et. al. (1987) were generally followed. Each site was photographed across, downstream and upstream from the photopoints on three dates. The first date was June 28, 2000 corresponding to the time when seed production should have commenced; the second date was August 15, 2000 corresponding to the time when willow seedlings or sprouts should be present; and the third date was September 11-12, 2000 when Caples Lake was releasing and strearnflow was augmented as compared to natural flows. The study areas were visited on June 21 and July 17 as well and general observations were made.

In addition to the photography at each site, observations were recorded on the following: 1) presence or absence of any form of plant regeneration on fluvial deposits; 2) flowering and fruiting of willows; 3) herbivory; and 4) land user impacts. These observations were recorded either photographically or in field notes.

Results

Strearnflow conditions in Caples Creek for the three sample dates are summarized in Table 1. No strearnflow data are available for Kirkwood Creek:

Table 1: Strearnflow Data for Three Monitoring Dates, 2000

Date	Estimated Natural Flow Average and (Range) (1972-1997) (CFS)	Operational Releases from Caples Lake(2000) (CFS)	Actual Gaged Flows in Caples Creek Below Caples Lake(CFS)
6/28	92.3 (8.7-360.4)	8	75.3
8/15	14.2 (0.9-78.1)	33	32.6

9/12	5.1 (0.3-20.1)	55	56.1

It should be noted that these flow data included contributions from the Caples Lake spillway in June (no spills occurred in August or September) but they did not include the contributions of Kirkwood Creek or the small amount of flow from the spillway in August or September. These amounted to much less than 10 cfs on both dates. These data indicate that in June, Caples Lake was releasing very little water and flows were below estimated natural flows. In August and September, releases from Caples Lake caused flows to exceed average estimated natural flows by up to an order of magnitude. This regulated flow regime was comparable to how the project has operated over its history.

Below, a site by site tabulation is presented. In general, on both Caples Creek and Kirkwood Creek, flowering and seed production by willows was nearly absent this year. The implications of this are that the only potential sources of seed for both places were drift from upstream or wind dispersal from other streams. Neither of these sources was considered a significant source of seed. No willow seedlings were observed in either study area. It is unknown if this was typical or anomalous.

The only willow regeneration that was observed in either study area consisted of root layering from terraces onto terrace banks or into the interface with fluvial deposits. Over the course of this study, less than a dozen instances of layering were observed at both streams combined. The only significant plant recruitment was herbaceous, consisting of annual forbs and grasses, horsetail and sedges. Even this was generally sparse on open sites and tended to concentrate on a few bar littoral edges and in protected areas behind woody debris (see accompanying photographic exhibit).

In August, during the lowest flows, bars were the most exposed on Caples Creek. On Kirkwood Creek, bars gradually exposed as flows receded over the course of the summer. On both streams it is evident that these bars were deposited at much higher flows during the 1997 flood, and at the present time, would only be inundated during bankful or higher discharges. This probably has implications both for accessibility to seed or willow sprouts and moisture availability for establishment.

Field observations indicated that Caples meadow has been subjected to extensive alterations by beaver for many years. At the present time, beaver are active both above and in the study reach. Browsing reduces both the cover and height of willows adjacent to the stream (see accompanying photographic exhibit). There have been no studies of the effects of beaver on the ability of willows to produce flowers and seed. Since seed production is also limited on Kirkwood Creek where beaver are absent, other factors may be at play, including hybridization, inbreeding depression, or absence of pollinators (Sacchi and Price 1988; Mosseller 1990; Douglas 1997).

Finally, both sites are subjected to horse traffic and grazing. Trampling on bars and barren trails are evident (see accompanying photographic exhibit). It did not appear that horses have a significant impact overall on willow recruitment.

Site Comparisons Over Time. The accompanying photographic exhibit shows conditions at each sample site for the three measurement periods. Table 2 summarizes observed conditions.

Table 2: Conditions Observed at Monitoring Sites, Caples Creek and Kirkwood Creek

Sample Site	**Landform and Substrate**	**Willow Seedlings or Sprouts Present?**	**Herbaceous Vegetation Present/Cover**	**Comments**
Caples I	Gravel bar	No	Yes <10 %	None.
Caples 2	Debris bar, sand/silt	No	Yes >50 %	Willow layering on banks above bar.
Caples 3	Gravel-sand bar	No	No	Horse trampling.
Caples 4	Mid-channel bar, sand/silt	No	Yes>80 %	None.
Caples 5	Point bar, gravel	Yes, layering (<10 sprouts)	Yes on back of bar >50 %	Layering at back of bar.
Caples 6	Gravel-sand bar	No	Yes >50 %, less towards water's edge	None
Caples 7	Floodplain, sand/silt	No	Yes >80 %	Adjacent bar had herbaceous recruitment in littoral zone and layering of willows at terrace bank.
Caples 8	Point bar, gravel	No	Negligible	Horsetail recruitment at terrace bank.

Caples 9	Point bar, gravel	Yes, layering (<5 sprouts)	No	Layering at back of bar.
Caples 10	Gravel bar with silt drape	Yes, layering (<5 sprouts)	Yes >20 %	None
Caples 11	Point bar, gravel	No	Yes <10 %	None
Caples 12	Gravel-sand bar	No	Yes <10 %	None
Caples 13	Debris bar, gravel	No	Yes <20 %	Vegetation present in protected area behind debris.
Caples 14	Sand-silt bar	No	Yes >20 %	Adjacent mid-channel bar had limited recruitment of sedges.
Kirkwood 15/16	Gravel bar/floodplain	No, but dense mature willow and sedge	Yes >80 %	Adjacent bars barren.
Kirkwood 17	Gravel bar	No, but dense mature willow and sedge	Yes >80 %	Adjacent bar barren.
Kirkwood 17A	Gravel bar	No	Yes on back of bar >80%	Horsetail dominant.
Kirkwood 18	Floodplain	No, but dense mature willow and sedge	Yes on back of adjacent bar>50 %	Horsetail dominant.
Kirkwood 19	Gravel bar/floodplain	No, but dense willow and sedge	Yes >80 %	Adjacent sand bar barren
Kirkwood 20	Floodplain	No, but dense sedge	Yes >80 %	Adjacent gravel bar barren
Kirkwood 21	Gravel bar	No	No	None
Kirkwood 22	Gravel bar/floodplain	No, but dense mature willow and sedge	Yes >80 %	Adjacent to Site21.
Kirkwood 23/24	Gravel bar/floodplain	No	Yes on floodplain >50 %	None

As may be seen in the accompanying photographic exhibit, exposed fluvial surfaces experienced very little change over the period of study.

Conclusions

This year, willow flowering and seed production were minimal on both the regulated and the control stream. Although we did not put out seed traps to quantify seed rain, we were present on the sites when seed production should have been peaking. Virtually no seed was observed. Willow seed transport by wind or water from upstream or other streams did not appear to be a major factor at these sites. In the absence of natural regeneration, attempts to increase willow recruitment at Caples Creek would have to depend on artificial propagation.

The only willow regeneration observed in either study area was vegetative layering from established plants or plant parts. This amounted to fewer than 20 sprouts. Over time, this regeneration could have some positive effects on channel form recovery at Caples Creek. More rapid recovery could be achieved through artificial propagation.

Exposed bar surfaces generally had little or no recruitment of any kind, probably because of deficiencies in soil moisture. Protected areas behind woody debris, backs of bars, and portions of bars with finer substrate were more likely to have herbaceous recruitment.

At no time did regulated flows inundate higher bars or floodplains on Caples Creek during the period of observation. No mobilization of sediment due to flow augmentation was observed. However, we did not observe the full range of potentially augmented flows. Nevertheless, most instream bars were apparently created during the extreme flow of January 1997 and would only be inundated or mobilized by flows of similar magnitude.

Beaver, especially, and to a much lesser extent, horses, are reducing the cover and extent of existing willows on Caples Creek. Insect herbivory studies have shown significant effects on willow reproduction. There is some evidence that herbivores may selectively feed on male or female plants, thereby changing population sex ratios and seed production. Herbivory also affects susceptibility of willows to drought stress (Bach 1994). If restoration efforts were to implemented at Caples Creek consideration must be given to controlling herbivory.

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