Effects of Reduced Outflow from Prado Dam Water Conservation 2015/2016

Report to

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SECTION 1.0 INTRODUCTION

Water conservation at Prado Dam has been part of the dam design and operation since its construction in 1941. It was constructed and is operated by the US Army Corps of Engineers (Corps). In 1985, a hydrology and water conservation study of Prado Reservoir was prepared. In 1988, an analysis for the operation of Prado Dam for additional water conservation was conducted. In 1990, the water control plan was revised to introduce a buffer pool from elevations 490 to 494 ft. The buffer pool allowed the water control manager to limit releases from Prado Dam and thus to coordinate with Orange County Water District (OCWD) to release water downstream at rates that facilitated OCWD's groundwater recharge activities. In 1993, the current springtime operation for water conservation at Prado Dam was approved which allowed the buffer pool elevation to increase from elevation 494 ft. to elevation 505 ft. during the non-flood season (March 1 to September 30). During the flood season (October 1 to February 28), the buffer pool at Prado Dam was at elevation 494 ft. until 2006 when the allowable winter season level was raised to 498 ft. OCWD is currently working on a Feasibility Study with the Corps and a formal Deviation from normal operations in the interim period to potentially go to elevation 505 ft. year-round for the purposes of water conservation. Permission will also be sought for a reduced minimum required outflow rate since the current rate of 500 cfs routinely exceeds OCWD's recharge capacity.

It is the Corps' policy to balance the use of reservoir resources by conserving as much water as possible consistent with other operational, environmental and fiscal constraints. The Corps regulation entitled Water Control Management states in its policy section (33 CFR 222.7, 6d) that development and execution of water control plans will include appropriate consideration for efficient water management in accordance with the emphasis on water conservation as a national priority. The objectives of efficient water control management are to produce beneficial water savings and improvements in the availability and quality of water resulting from project regulation/operation. The Corps has been extremely cooperative in developing balanced resource use at Prado to conserve as much water as possible while ensuring appropriate focus upon flood control and other priority project functions consistent with Corps Regulations.

Water conservation at Prado Dam maximizes the efficient use of local water resources. To reduce the need for expensive imported water supplies, OCWD has initiated several water management projects to enhance groundwater supplies, including water conservation at Prado Dam. Although the Dam's primary operational function is for flood control, changes have occurred in the operation to allow water from the Santa Ana River to be held back during the flood and non-flood seasons. Slowing the release rates from the dam enables OCWD to recharge the stored flood pool into the groundwater basin downstream.

During the flood season from October 1 through the end of February, water can be impounded behind the dam up to elevation 498 ft. If unfavorable weather is forecast, the water level is drawn down to an elevation of 490 ft. or 494 ft within 24 hours to accommodate anticipated inflow volume and ensure sufficient capacity for flood control purposes. During the non-flood season from March 1 through September 30, the water impoundment level can go to a maximum elevation of 505 ft for water conservation purposes. Generally when there is enough inflow to get to 505 ft, there is significantly more than that and flood control always takes precedence. Getting water to elevation 505 ft and operating for water conservation with outflows well reduced from what they would be for flood control purposes only happens at the tail end of large storm events followed by clear weather with no major storms in the forecast. Also, dam maintenance and construction takes precedence over water conservation unless it can be safely scheduled for a later date.

Early on OCWD recognized major constraints to additional Water Conservation. Chief among them was the operational requirements for flood control. Those times when significant quantities of water were available for conservation always coincided with flood risks. Any water left in the Basin for conservation was dumped within a 24 hr period if a subsequent storm was forecast. However, dam operators became masters at conserving those waters that reasonably could be. The only other operational possibility in terms of additional water conservation in light of flood control precedence was future enhanced forecasting that might allow the pool to be dumped over a longer than 24 hr period of time. This would allow the possibility of a higher pool while accommodating release rates that were less damaging downstream.

SECTION 2.0 PLANNING FOR WATER AND WILDLIFE CONSERVATION

Enhanced water conservation required planning to avoid, minimize, and offset potential environmental damage. Prado Basin contains the single largest forested wetland in coastal Southern California supporting an abundance and diversity of wildlife including many listed and sensitive species. Water on the basin lands caused those wetlands to grow and supports them, but too much water for too long and some of the habitat value is lost for a time. OCWD overcame initial reticence on environmental grounds by proceeding cautiously and in partnering mode with the Resource Agencies, particularly the US Fish and Wildlife Service (FWS). The poster species for the efforts and partnership to achieve simultaneous wildlife and water conservation became the endangered Least Bell's Vireo (*Vireo bellii pusillus*), vireo hereafter, and the story is one of epic success. In 1983 there were 12 vireo territories in Prado Basin and extirpation was imminent; with our management program expanded to the entire watershed by 2010 there were 1,432 vireo territories in the Santa Ana River Watershed including 569 in the Basin. Today, the vireo population on our river remains the single largest in existence.

OCWD first formally committed to vireo management as part of water conservation and operation of the Prado Wetlands in 1989 and 1990 when a Letter Agreement was signed with the Nature Conservancy (TNC) and $70,000 was contributed for vireo monitoring and cowbird control. This was done proactively by OCWD and at a time of crisis on the river for the vireo when no one else, not even the agencies responsible for conservation of the species would step up with funding for the critical management needed to stave off extirpation of this population. This single act set the tone for a mutually beneficial partnership between the FWS and OCWD leading to water conservation that could not have happened otherwise and substantial recovery of the endangered least Bell's vireo on the Santa Ana River. Over time OCWD has continued to strive for simultaneous excellence in water and natural resources management.

In 1991, an emergency water conservation effort was negotiated with a conservation pool to 495 ft; OCWD gave TNC $900,000, half for vireo management and half for habitat restoration focused on 124 ac in the Basin. In 1992 the water conservation pool went to 500 ft for a one-year trial and OCWD contributed another $100,000 to TNC and 40 more acres for restoration. In that same year OCWD installed two rubber dams below Prado to enhance water management downstream; one of many ongoing environmental commitments was the concomitant conservation and protection of water-associated birds nesting on the T and L levees used in the river to slow and train the water released from Prado Dam. In 1993 as per Biological Opinion 1-6-93-F-7 issued by the FWS to the Corps, OCWD would gradually increase the water conservation pool level as habitat developed on OCWD lands set aside for restoration including 228 ac of vireo habitat and 278 ac of wildlife habitat.

In 1995 water conservation was permitted to 505 ft (Biological Opinion 1-6-95-F-28 and Agreements) and OCWD ongoing commitments included: one-time contribution of $1,000,000 to the Conservation Trust Fund for vireo management and habitat restoration; funding of two fulltime vireo monitors; provision of equipped, dedicated office space and vehicles; natural resources management in cooperation with the Corps and Resource Agencies on all OCWD Prado lands; and other logistical support including provision and maintenance of cowbird traps, purchase of bait seed, etc.

In 2000 when changes were made to dam operations for water conservation, OCWD committed to winter cowbird trapping and ongoing support for vireo and wildlife management including the planting of 10,000 native, mostly riparian plants per year at an annual cost of about $50,000 (Biological Opinion 1-6-95-F-75). In 2004 water conservation was approved for the winter season to elevation 498 ft; OCWD committed another $930,000 for vireo management and habitat restoration on 40 ac in the Basin along with $50,000 per year and half of a staff position for native fish and sucker conservation and management (as per Biological Opinion FWS-WRIV-2102.3).

OCWD began participation in Santa Ana Sucker conservation efforts in 1998 and continues today as part of water conservation and routine recharge and wetland operations. Among many other efforts for the sucker, OCWD has and continues to contribute $15,000 - $25,000 per year to the Sucker Conservation Team efforts.

SECTION 3.0 HABITAT DAMAGE ASSESSMENT

Mitigation requirements for habitat damage due to water conservation were based historically upon the expected days of increased inundation of habitat below the pool elevation. So, 15.2 acres were determined to be the mitigation requirement for winter water conservation or 13.8% of the 109.8 acres of habitat still requiring mitigation below 498 ft. The 13.8% is the ratio of average annual increased days of inundation divided by the current number of days of expected inundation, or 4 days/29 days. In 2012, only 94.6 acres remain un-mitigated below 498 ft. This assessment method is not flawless in that the habitat suitability comes and goes and most of the habitat damage is ascribable to much higher and longer inundation associated with flood control. Also, the vireos generally don't nest over standing water unless it pools after the nest is in use but they do routinely forage in emergent vegetation, so the issue is loss of nesting habitat quality and options, not total habitat destruction.

We examined the distribution of vireo territories in the Basin to see if diminished habitat values at the lower elevations had led to reduced use of that habitat based upon number of occupied breeding territories (Table 1). Vireo occupation of the lower elevations fluctuated over time but did not appear to be greatly diminished except in the aftermath of high water years in 2006 and 2012 below elevation 498 ft. Some of the vireos nesting in the lowest elevations use habitat for nest placement that is actually located higher in elevation than what is decipherable in GIS plotting of the territories. The vireos move upslope on the Basin edges, into higher, sometimes more marginal habitat to avoid nesting over the flood or conservation pool.

Table 1: Elevational Distribution of Least Bell's Vireo Territories

Survey Information	1999 Survey	2001 Survey	2002 Survey	2003 Survey	2004 Survey	2005 Survey
Territories at 466-498' (Percent of Total)	57 (18%)	103 (22%)	148 (32%)	86 (21%)	133 (22.5%)	112 (18.7%)
Territories at 498-505' (Percent)	46 (14%)	67 (14%)	62 (13%)	71 (17%)	86 (14.5%)	69 (11.5%)
Territories at 466–505' (Percent)	103 (32%)	170 (36%)	210 (45%)	157 (38%)	219 (37%)	181 (30.2%)
Territories Within 556' Elevation	326	463	463	409	591	594
Total Territories	332	509	513	431	592	600

Survey Information	2006 Survey	2007 Survey	2008 Survey	2009 Survey	2010 Survey	2011 Survey
Territories at 466-498' (Percent of Total)	24 (6%)	42 (10%)	55 (12%)	67 (12%)	55 (10%)	32 (6%)
Territories at 498-505' (Percent)	51 (13%)	59 (14%)	69 (15%)	90 (17%)	97 (17%)	92 (18%)
Territories at 466–505' (Percent)	75 (19%)	101 (24%)	124 (27%)	157 (29%)	152 (27%)	124 (24%)
Territories Within 556' Elevation	390	416	463	538	569	516
Total Territories	394	460	533	538	634	525

Survey Information	2012 Survey	2013 Survey	2014 Survey	2015 Survey	2016 Survey	2017 Survey
Territories at 466-498' (Percent of Total)	68 (15%)	102 (18%)	113 (22%)	109 (20%)	128 (25%)	
Territories at 498-505' (Percent)	97 (22%)	113 (20%)	97 (18%)	106 (19%)	87 (17%)	
Territories at 466–505' (Percent)	165 (37%)	215 (30%)	210 (40%)	215 (40%)	215 (42%)	
Territories Within 556' Elevation	447	560	520	530	510	
Total Territories	451	561	520	532	511	

Reduced nesting cover quality could lead to reduced nesting success but such effects are localized and negligible in that the overall success has resulted in the consistent increase in the Prado population brought about by ongoing management efforts funded in support of the water conservation program.

Prado Dam stops flood waters and sediment. The flood water is eventually released in a controlled manner but much of the heavier grained sediment has built up over time with deposits as deep as 30 ft. or more locally in the Basin. One of the effects of this has been the shrinkage of the acreage in the water conservation pool areas (Table 2). The difference in Basin topography between 1989 and 2008 demonstrates a loss of 349 acres below elevation 505 ft and a net loss of 152 acres to 556 ft (sediment deposition is not uniform). The water conservation pool is shrinking dramatically toward the dam over time due to ongoing sedimentation. Approximately 23% of the acreage and habitat located below elevation 505 ft in 1989 is above that elevation and out of the conservation pool area as of 2008. The outright loss of nesting habitat acreage in the lower Basin dwarfs most other considerations like the subtleties of reproductive success analyses associated with cover quality loss.

Habitat damage occurs at the lower elevations in Prado Basin as a result of prolonged inundation. Mulefat (*Baccharis salicifolia*) appears susceptible to 2 – 3 weeks of inundation. Plants are killed or die back significantly. A high percentage of these sprout from the base but recovery after major dieback is usually not complete enough to provide nesting habitat during the following nesting season. Black willow (*Salix gooddingii)* survival of inundation is very high but if foliage is submerged, it is lost after 3 – 7 days and unavailable for nest placement when the water recedes. Otherwise, the willow foliage nearest the ground is heavily used for vireo nest placement particularly where other shrubby riparian cover is limited.

Quantitatively ascribing habitat damage to water conservation is confounded by the associated, initial prolonged inundation caused by flood control. In the winter of 2010/2011 for example construction activity and facilities protection in and below Prado combined with flood control operations resulted in the highest inundation level on record in the Basin, 529.35 ft on December 23, 2010. The water conservation pool was exceeded for 1 month and 9 days and substantial damage was incurred by mulefat stands on the Basin edge that had never been flooded before, as shown in Figure 1.

Table 2: Prado Acreage in the Conservation Pool Areas and Basin Comparing 1989 Elevations with 2008 Elevation Data

Data Year	Vertical Datum	Data Source	Elevation (FT)	Acreage	Acreage 1989-2008	Percent Lost
1989	NGVD 29	Corps	556	8933	-	
1989	NGVD 29	Corps	505	2201	-	
1989	NGVD 29	Corps	498	1508	-	
2008	NGVD 29	Corps	556	8781	-152	2%
2008	NGVD 29	Corps	505	1852	-349	16%
2008	NGVD 29	Corps	498	1159	-349	23%
2008	NAVD 88	Corps	556	8433	-500	6%
2008	NAVD 88	Corps	505	1610	-591	27%
2008	NAVD 88	Corps	498	9923	-515	34%

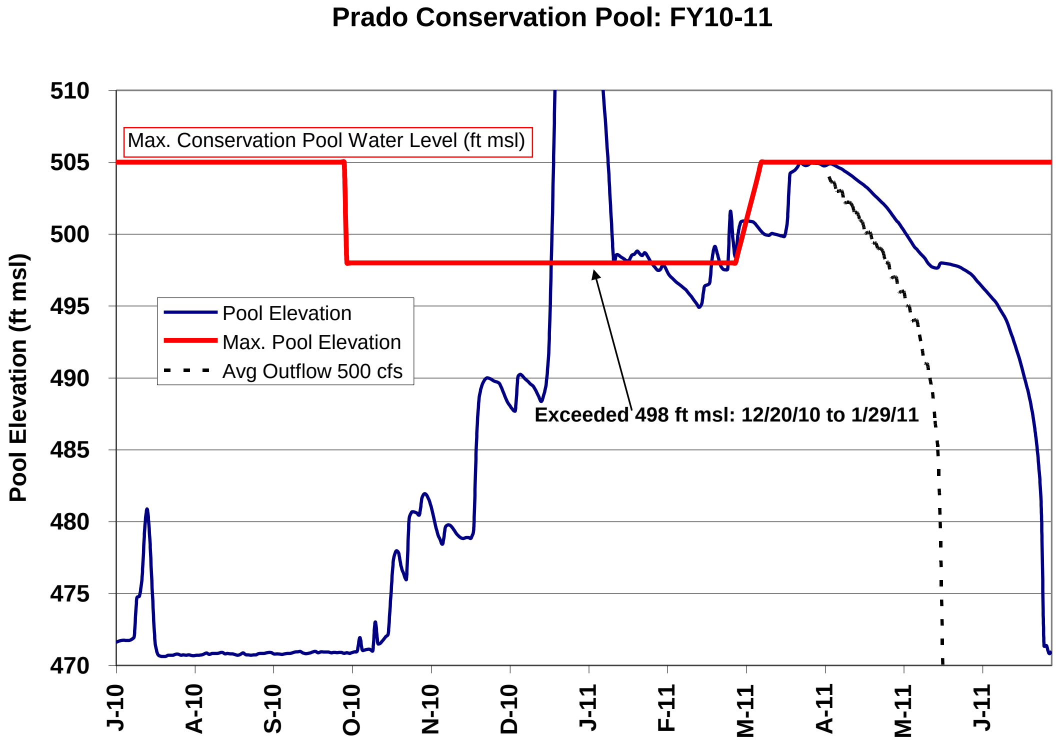


Figure 1: Prado Conservation Pool: FY10-11

The rainy season of 2010-2011 was exceptional in the abundance of big rains in short periods of time that coincided with constraints on flood control that reduced the operational flexibility for large discharges downstream of the dam. Beginning the week of December 19 there was an increased accumulation of water behind Prado Dam that resulted in this all-time record high level (Appendix A & B). Work on the Brine Line below Prado Dam resulted in deviation from normal flood control operations and reduced release rates. A portion of the Brine Line (SARI Line) below Prado Dam had been exposed by erosive flood waters and work continued through this period to protect the line. Water levels did not drop to water conservation levels until January 29, 2011 when the pool elevation leveled off at 498.06. The pool remained at or near 498 ft for a duration of 47 days, the remainder of the winter water conservation operations season which ended February 28. Late season storms brought more water into the Basin with water levels exceeding 505 ft. With no additional storms in the forecast water conservation was implemented and the pool gradually increased reaching elevation 505 ft on March 25, 2011. The pool level gradually decreased to 497.04 on May 31, 2011 and continued to decline into the dry summer months.

SECTION 4.0 PRECIPITATION YEAR 2015-2016

The most recent winter seasons of 2011-16 were characterized by smaller rain events and very little habitat inundation. Rainfall totals at Prado dam for the past five precipitation years (July 1st to June 30th) were 9.09”, 8.00”, 5.42”, 10.95”, and 8.74” respectively. On January 8, 2016 the pool reached a peak elevation of 500.37 ft. The maximum daily mean discharge during this period was 571 cfs recorded on January 15, 2016. Figure 2 displays the discharge rate for the period December 2015 - May 2016 and Figure 3 shows the pool elevation for that same period.

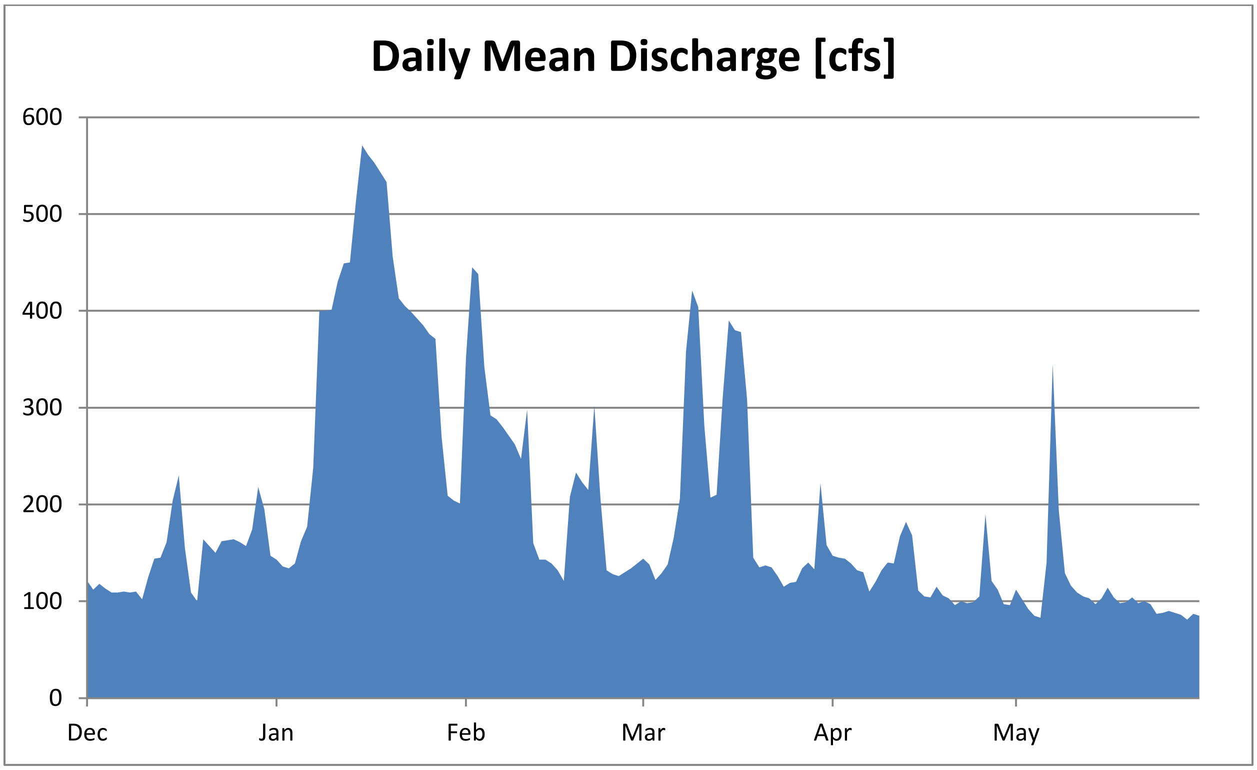


Figure 2: Prado Dam Discharge Rate December 2015- May 2016

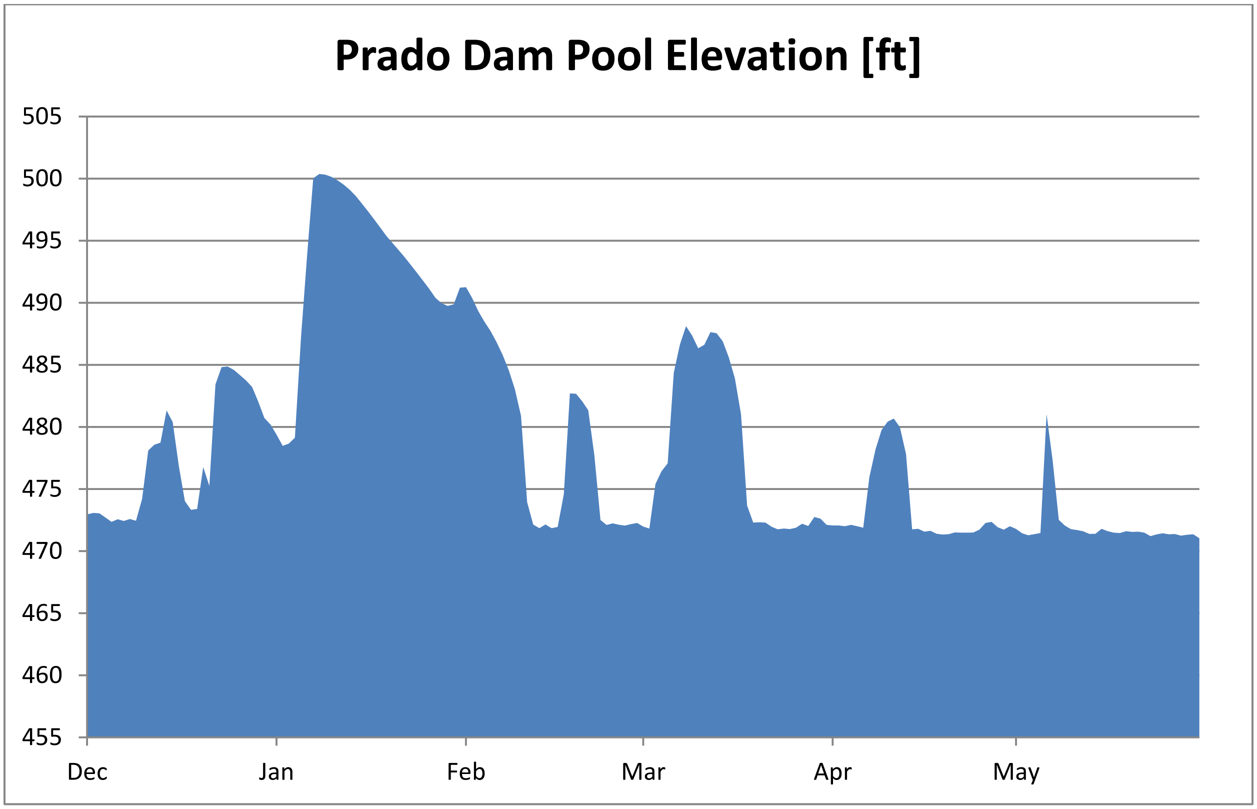


Figure 3: Prado Dam Pool Elevation (ft) December 2015- May 2016

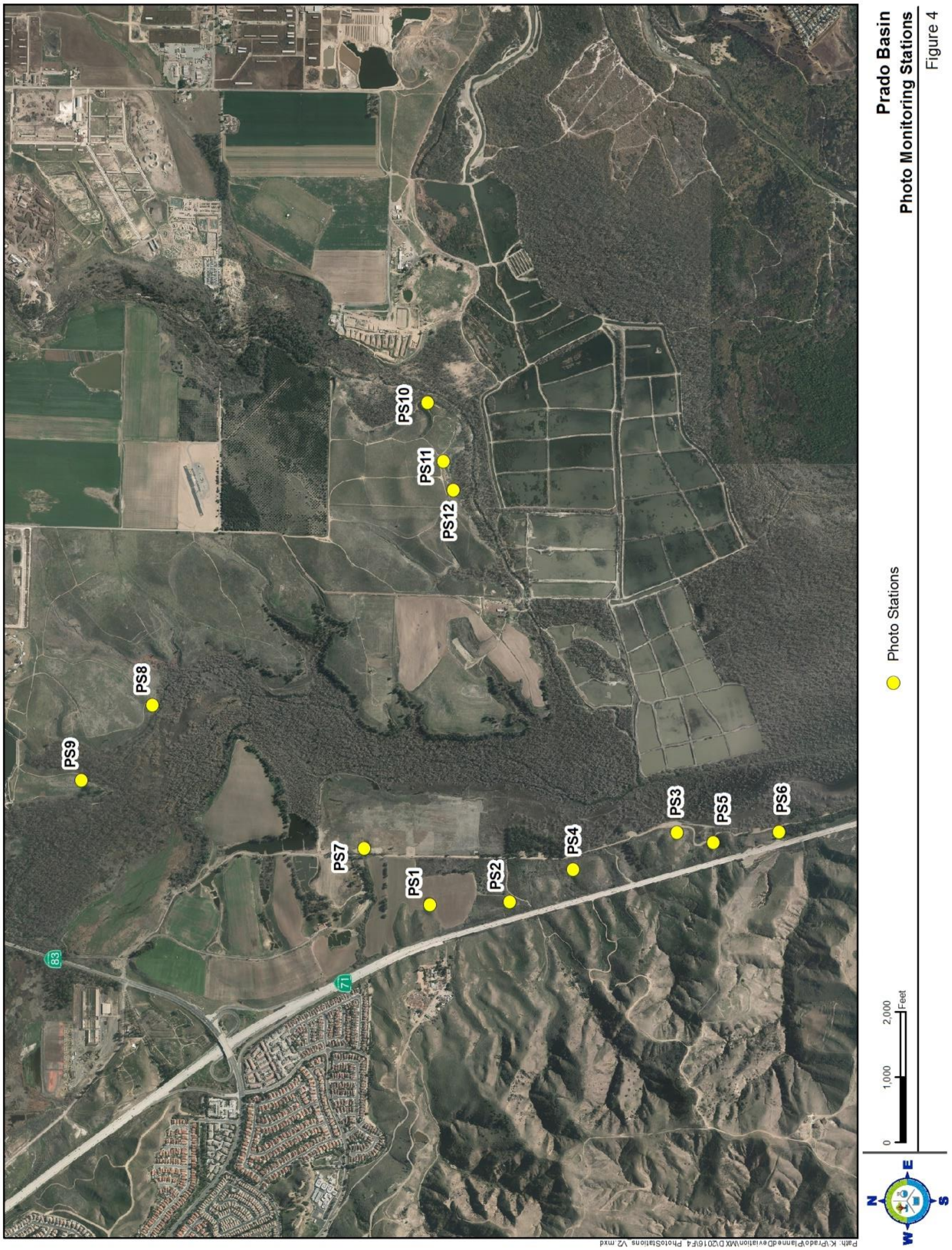
SECTION 5.0 MONITORING THE EFFECTS OF INUNDATION WITH PHOTO STATIONS AND CORPS DATA

A combination of visual aids and Army Corp of Engineer data was used to attempt quantification of habitat degradation due to increased inundation. The Corps data were also utilized to attempt the segregation of the effects of flood control measures from water conservation. The photo stations were located based upon two criteria, elevation and habitat type. Most of the monitoring stations were situated at elevations overlooking habitat that would be inundated due to water conservation. Most sites included habitat of mixed mulefat and black willow riparian woodlands. Mulefat is a perennial evergreen and will not defoliate unless under stress. Black willow is the dominant species of riparian tree in the Basin and is winter deciduous. This species can endure long periods of inundation and may not show signs of degradation for many years, necessitating long term monitoring. Habitat conditions have been documented photographically during unusually wet periods and compared among subsequent seasons and years. The photographs yield visual documentation of conditions over time relative to pool size as it pertains to water conservation and flood control.

Twelve photo stations have been set up in the Basin (Figure 4). At each station stakes were pounded into ground, and a GPS reading was taken to permanently mark the site. Panoramic photos were then taken while standing directly in front of the stake. This panoramic approach differed from previous years when three photos were taken at ninety degrees to one another while standing directly in front of the habitat. The new panoramic approach was adopted following the high water year of 2010-11 when many of the stations were inaccessible except by boat. There are three visits to the photo stations during the year. The first round of photos is taken during January-February to document inundation events if there’s been rain. The second visit happens in spring. This visit is essential since temperatures are usually rising and species such as the Willows are coming out of dormancy. A third visit takes place in late summer when the plants could display lasting adverse effects from the previous winter season or show signs of drought related stress.

Out of an interest to enhance current monitoring efforts, the District is seeking approval from the Federal Aviation Administration to capture aerial imagery via an Unmanned Air Vehicle, or UAV.

Figure 4: Prado Basin Photo Monitoring Stations



The Photo Stations highlighted below (Figures 5-9) were selected for providing the best view of regrowth near the 505 ft elevation area.

Figure 5: Photo Station #7

Photo Station 7 is the only station left over from the previous methodology of photos taken in the cardinal directions. The station's focus is on a single clump of mulefat, but the station elevation of 505 ft is ideal for long term monitoring. This station was completely submerged during the floods of 2010-2011, and has shown good recovery through 2016.

East 1/5/11 Pool Elevation 518 ft South

East 8/22/16 South

Figure 6: Photo Station #8

Mulefat clump in the center photo showing continued significant regrowth into 2016 after inundation.

1/05/11 Pool Elevation 516 ft.

4/14/15

5/11/16

Figure 7: Photo Station #6

This point is located just north of Prado dam and sees regular inundation during the rain year. The habitat in the photos ranges in elevation from 495-498 ft. The Black Willows are in prime condition whereas the mulefat was slow to recover from sustained inundation during 2010-11. Crown sprout and seedling recruit was visible by mid-late summer 2012. Note the drought stress of the Mexican elderberry in the third picture.

5/11/16

8/22/16

Figure 8: Photo Station #1

Overlooking a mitigation site along the 71 Hwy in Chino this site features the Chino Creek riparian belt in the background as well as a mulefat dominated band situated between two agricultural fields. This site often becomes inundated during high water years. The vegetation at this site was thought to be all wiped out by the floods of 2010-11, but has since shown significant regrowth through 2016.

5/11/16

8/22/16

Figure 9: Photo Station #11

This station is located just upslope of Mill Creek. The light green foliage in the immediate foreground of the tree line is mulefat. This part of the creek is affected by the Prado Dam pool. Standing water inundates the habitat in most normal to high water years. Even with the typical inundation the mulefat/black willow habitat has been very healthy through 2016.

5/11/16

8/22/16

SECTION 6.0 SUMMARY

Significant variations occurred from normal operating conditions in 2010-11 due to limitations on outflow release rates caused mostly by the vulnerability of infrastructure downstream of Prado Dam. The pool behind Prado Dam was held above water conservation levels for 40 days, peaking at a record height of 529.35 ft. This had a severe impact on evergreen riparian species, particularly mulefat. Most of the mulefat growing at and below water conservation elevations died back considerably and some patches appeared lost. Some of these patches did begin to recover slowly, but did not reach a stature useful to riparian nesting birds during 2011. Patches of mulefat at or below 505 ft were the slowest to recover and mostly from crown sprout.

Most of the mulefat patches that appeared to have perished during the rainy season of 2010-11 quickly grew back from seedlings or crown sprout. The lack of heavy inundation during the last five rain seasons (2011-2016) allowed for a longer recovery period for these damaged riparian areas. The photo station images in Figures 5-9 reveal continued substantial vegetative growth and recovery of the damaged areas back to pre-2010-11 flood condition.

As in 2015, the riparian communities adjacent to wetted channels or areas located over shallow groundwater remained healthy, but upslope and peripheral stands of vegetation showed little recruitment and poor vigor this past growing season. Black willow recruitment continues to be virtually nonexistent at all sites. In contrast, mulefat fared well over the summer months and continues to show strong recruitment and healthy growth throughout the Basin. Other riparian species exhibiting moderate growth include arroyo willow (*Salix lasiolepis*) and red willow (*Salix laevigata*); these two riparian species are characteristic of more xeric riparian habitat. With the continued drought and reduction in water availability, the total dominance of black willow is being transformed locally to mixed woodland.

The decrease in water availability and plant moisture content was undoubtedly an underlying contributor to the intensity of a wildfire in the Prado Basin that burned over 1,000 acres in April of 2015. The most destructive area of the burn occurred in a large elevated patch of black willow forest mixed with giant reed, *Arundo donax*. The trees in this area showed signs of water stress prior to the fire. The high fatality of mature trees following the burn suggests the willows were in fact stressed from lack of sufficient water compared to mature trees at lower elevations, which had better access to groundwater and survived the fire. Black willows that burned in the hottest areas of the fire have yet to crown sprout, while less damaged trees were able to do so. The new growth provided a much needed benefit to vireo that lost all nesting and foraging habitat in the 2015 fire. The admix of giant reed also helped carry the fire and fuel intensity. OCWD is currently treating 350 acres of Arundo regrowth in the fire footprint.

In both 2015 and 2016, another sign of the prolonged drought is the stunted growth of many non-native species of plants that normally grow well in below average rainfall years. Previous spring and summer growing seasons were characterized by large patches of summer cypress (*Kochia scoparia*), Russian thistle (*Salsola sp.*), pepperweed (*Lepidium latifolium*), black mustard (*Brassica nigra*), poison hemlock (*Conium maculatum*), and European annual grasses. During the past two water years, these species grew marginally with scattered and stunted plants.

In the spring of 2016 the district's biologists observed the Basin's various willow species, especially arroyo and black willow, die off in a patchwork like pattern. The cause of mortality was later confirmed to be a result of the Polyphagous shot hole borer (PSHB) (*Euwallacea* sp.) and *Fusarium* dieback (FD) (*Fusarium euwallaceae*) pest-disease complex. Though PSHB likely arrived prior to the spring of 2016, there was no obvious destruction as observed in the late spring and summer of this year. PSHB have been detected throughout much of the basin, but tree mortality is not occurring as a single, massive die off. Trees that have not died in the most affected areas are showing signs of severe infestation; the heavily infested trees are exhibiting a combination of branch failure, significant staining, and crown sprouting. Surprisingly, the Basin's only stand of Western sycamore (*Platanus racemosa*) is showing no signs of PSHB infestation as of late July 2016.

In conclusion, ascribing impacts to nesting vireos resulting from prolonged inundation due to water conservation in the Prado Basin is greatly confounded by: flood control operations with higher inundation levels that precede water conservation and are of a longer duration at certain elevations; sedimentation that has diminished the acreage of habitat at and below the 505 ft contour by at least 348.8 acres; vireos that continue to nest in the lower elevations in spite of inundation effects; and an overall Basin vireo population that has increased to 4 times its original size since the current water conservation program was instituted in 1993. Segregating impacts of water conservation versus flood control was particularly difficult in 2010-11 because of the deviation from normal operating conditions to protect the SARI line downstream. On the other hand the last five seasons (2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016) were dry enough years such that the permission granted to reduce outflows of water conserved in the spring was never able to be used. The biggest effects on Prado riparian habitat over the past rainfall year was the cumulative effects of on-going drought and the PSHB/FD pest-disease complex.

Appendix A:
Prado Reservoir Inundation Levels and Discharge Rates, Dec 2015 – May 2016

Date	Midnight WSE NGVD [ft]	Daily Mean Discharge [cfs]
01Dec15	472.95	121
02Dec15	473.07	112
03Dec15	473.04	118
04Dec15	472.7	113
05Dec15	472.35	109
06Dec15	472.56	109
07Dec15	472.42	110
08Dec15	472.58	109
09Dec15	472.44	110
10Dec15	474.21	102
11Dec15	478.1	125
12Dec15	478.56	144
13Dec15	478.73	145
14Dec15	481.32	161
15Dec15	480.39	204
16Dec15	476.87	230
17Dec15	474.02	155
18Dec15	473.32	109
19Dec15	473.39	100
20Dec15	476.76	164
21Dec15	475.24	157
22Dec15	483.42	150
23Dec15	484.81	162
24Dec15	484.86	163
25Dec15	484.59	164
26Dec15	484.17	161
27Dec15	483.74	157
28Dec15	483.21	174
29Dec15	482.04	218
30Dec15	480.72	195
31Dec15	480.19	147
01Jan16	479.37	143
02Jan16	478.47	136
03Jan16	478.65	134
04Jan16	479.13	139
05Jan16	487.2	162
06Jan16	493.84	177
07Jan16	500.02	238
08Jan16	500.37	400
09Jan16	500.31	400
10Jan16	500.13	401
11Jan16	499.85	430
12Jan16	499.5	449
13Jan16	499.08	450
14Jan16	498.57	514
15Jan16	497.96	571

Date	Midnight WSE NGVD [ft]	Daily Mean Discharge [cfs]
16Jan16	497.34	561
17Jan16	496.69	553
18Jan16	496.03	543
19Jan16	495.36	533
20Jan16	494.79	456
21Jan16	494.22	413
22Jan16	493.64	405
23Jan16	493.02	399
24Jan16	492.39	392
25Jan16	491.75	385
26Jan16	491.1	376
27Jan16	490.39	371
28Jan16	489.96	270
29Jan16	489.74	209
30Jan16	489.87	204
31Jan16	491.21	201
01Feb16	491.25	352
02Feb16	490.38	445
03Feb16	489.33	438
04Feb16	488.48	342
05Feb16	487.73	292
06Feb16	486.82	288
07Feb16	485.79	280
08Feb16	484.56	271
09Feb16	483.03	262
10Feb16	480.89	247
11Feb16	473.93	298
12Feb16	472.13	160
13Feb16	471.84	143
14Feb16	472.14	143
15Feb16	471.84	139
16Feb16	471.94	132
17Feb16	474.57	121
18Feb16	482.69	208
19Feb16	482.67	233
20Feb16	482.07	223
21Feb16	481.34	215
22Feb16	477.73	302
23Feb16	472.5	206
24Feb16	472.1	132
25Feb16	472.23	128
26Feb16	472.12	126
27Feb16	472.05	130
28Feb16	472.17	134
29Feb16	472.26	139
01Mar16	471.97	144
02Mar16	471.81	138

Date	Midnight WSE NGVD [ft]	Daily Mean Discharge [cfs]
03Mar16	475.4	122
04Mar16	476.43	129
05Mar16	477.06	138
06Mar16	484.36	166
07Mar16	486.63	206
08Mar16	488.11	358
09Mar16	487.35	421
10Mar16	486.33	404
11Mar16	486.61	281
12Mar16	487.63	207
13Mar16	487.54	210
14Mar16	486.9	310
15Mar16	485.6	390
16Mar16	483.9	380
17Mar16	481.02	378
18Mar16	473.66	308
19Mar16	472.29	145
20Mar16	472.32	135
21Mar16	472.29	137
22Mar16	471.96	135
23Mar16	471.75	126
24Mar16	471.81	115
25Mar16	471.77	119
26Mar16	471.88	120
27Mar16	472.2	134
28Mar16	472.02	140
29Mar16	472.74	133
30Mar16	472.61	222
31Mar16	472.11	158
01Apr16	472.06	147
02Apr16	472.06	145
03Apr16	472	144
04Apr16	472.11	139
05Apr16	472	132
06Apr16	471.88	130
07Apr16	475.94	110
08Apr16	478.17	120
09Apr16	479.75	132
10Apr16	480.42	140
11Apr16	480.67	139
12Apr16	479.97	167
13Apr16	477.81	182
14Apr16	471.75	168
15Apr16	471.79	111
16Apr16	471.56	105
17Apr16	471.63	104
18Apr16	471.39	115

Date	Midnight WSE NGVD [ft]	Daily Mean Discharge [cfs]
19Apr16	471.33	106
20Apr16	471.36	103
21Apr16	471.5	96
22Apr16	471.48	100
23Apr16	471.48	98
24Apr16	471.49	99
25Apr16	471.72	105
26Apr16	472.26	190
27Apr16	472.35	121
28Apr16	471.92	112
29Apr16	471.72	97
30Apr16	472	96
01May16	471.78	112
02May16	471.43	102
03May16	471.27	92
04May16	471.36	85
05May16	471.45	83
06May16	481.02	140
07May16	477.27	345
08May16	472.51	194
09May16	472.05	129
10May16	471.76	116
11May16	471.69	109
12May16	471.59	105
13May16	471.38	103
14May16	471.39	97
15May16	471.79	103
16May16	471.6	114
17May16	471.48	104
18May16	471.45	98
19May16	471.6	99
20May16	471.54	104
21May16	471.56	98
22May16	471.48	100
23May16	471.2	97
24May16	471.34	87
25May16	471.43	88
26May16	471.35	90
27May16	471.37	88
28May16	471.24	86
29May16	471.31	81
30May16	471.35	87
31May16	471.03	85

Appendix B:
Prado Dam Rainfall Totals From 2003 to Present (compiled by USACE)

Precipitation Year (July 1 to June 30)	
2016	8.74”
2015	10.95”
2014	4.56”
2013	8.00"
2012	9.09"
2011	21.80"
2010	18.12"
2009	11.53"
2008	9.41"
2007	3.03"
2006	11.36"
2005	33.86"
2004	10.14"
2003	15.99"
Water Year (Oct. 1 to Sept 30)	
2016	5.97”
2015	12.94”
2014	5.24”
2013	7.93"
2012	8.71"
2011	22.35"
2010	18.12"
2009	11.53"
2008	9.07"
2007	3.37"
2006	11.28"
2005	33.94"
2004	10.04"
2003	16.09"