Fish Springs NWR

Annual Water Management Plan
2015 Water Use Report
2016 Water Use Plan

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Regional Refuge Supervisor Date

Concur: ______________________________ ______________
Chief, Water Resources Division Date

Summary

This Annual Water Management Plan (2015 Water Use Report and 2016 Water Use Plan) is being reported as a stand-alone document from the Annual Habitat Work Plan. Both of these documents report on water management strategies and prescriptions provided in a draft Habitat Management Plan. The 2010 Water Use Report, especially, can be referenced for comprehensive and comparative reporting on historical water use before 2010. A FY2015 Water Delivery System Annual Maintenance Plan and Completion Report is also provided as an appendix within this Annual Water Management Plan.

Harrison Pool – Foraging American Avocet
Courtesy of A. Belt (USFWS volunteer)

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Refuge Spring Water Monitoring

<u>2015 Data Collection</u>

In 2015 spring flow was measured at eight major source springs; this includes Walter Spring which is located on the western boundary of Pintail Unit. Monitoring at Walter Spring began in March 2015 and was conducted in addition to ongoing monitoring of the same seven springs monitored in 2014. Water flow was measured using two methodologies; the first using Parshall flumes (this methodology will be referred to as the historical methodology) and the second using a Global Water FP 11 Flow Pipe Meter. The flumes are located throughout the spring basins where data was collected monthly. Flow measurements using the Flow Pipe Meter were taken at the same time and location as the Historical Measurements.

For each measure, a water depth reading was taken using a static measuring gage mounted next to the flume. For the Historical Measurements, water depth and flume size were then converted to spring flow, i.e. cubic feet per second (CFS), using the TP&S Free-Flow Discharge table. Flow Probe measurements are taken at multiple (3-4 depending on the width of the flume) points at each site for 20-seconds and the average flow rate from those 20-seconds was recorded for each of the 3-4 points. Point measurements are then multiplied by the area at that point and the resulting totals of all points are summed to get "total flow" at that location. Using both methods allows us to compare Pipe Meter measures to our old methodology; both for verification and to possibly improve upon the older method.

For 2015, spring flow readings were conducted monthly (January-December) as close to the third Wednesday of the month as possible (Table 1). Due to weather and staffing limitations, especially throughout the winter months, data collection varied somewhat around this target date. Both measurements were collected throughout the year without interruption.

Five years of historical CFS data (2011-2015) collected using historical methodologies is available for comparison in Figures 1-4. Historical data prior to 2010 can be found in the 2010 Water Use Report. Table 1 includes CFS measures collected using the historical methodology and CFS measures using the Pipe Meter. In order for us to evaluate the effectiveness of these methods to each other, a paired sampled t-test ($n=12$) was conducted comparing the monthly flow values calculated for each measured spring (Table 1). The measures were compared on a spring by spring basis, as different springs have different sized flumes, to determine if flume size influenced methodology success. In 5 of the 8 springs, there was no significant difference found between the historical method and the pipe meter method. House (flume= 6"); Percy (flume = 9") and South (flume = 12") were all found to have significantly different ($p \leq 0.05$) CFS values when measured using both methodologies (Table 1). Although it is possible, we cannot assume that the cause/s behind these differences were the same for all three sites. Possible causes include (but are not limited to): 1) flume not being in alignment for accurate measures to be obtained using the historical method, 2) possible increased backflow pressure on flume outflow caused by obstructed downstream water delivery that affects accuracy of the historical method or 3) inconsistent measures using the flow pipe (*i.e. not consistently holding it at a 90° angle to the water flow*).

At all but one site, Percy spring, the pipe flow method returned a higher mean CFS value across months then using the historical method. Between the results of this year and 2014, we cannot support using these methods interchangeably. As such, we cannot reliably compare current pipe flow CFS measures to CFS measures that have been collected over the years using the historical methodologies. With reduced staffing levels, and the inability to compare the two methods, it is questionable if there is adequate value in continuing to take pipe flow measurements in addition to historical measurements. Due to the ability of historical measurements to be compared with historical data, and the fact this methods limits user bias, it makes sense to continue with this method of data collection alone for 2016. Fish Springs staff will soon be reduced to only two personnel.

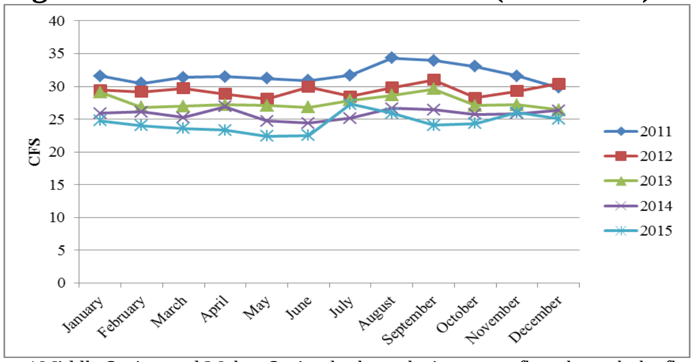
Table 1. 2015 Spring Water Flow Data (CFS) by Month with methodology comparison.

Month Sampled	Spring Name	Historical CFS	Pipe Meter CFS Total	Difference (hist - pipe)	Statistical Significance	
January	House	1.5	1.72	-0.22		
February	House	1.45	1.62	-0.17		
March	House	1.45	1.54	-0.09		
April	House	1.45	1.64	-0.19		
May	House	1.23	1.22	0.01		
June	House	0.87	0.91	-0.04	**n=**	**12**
July	House	0.92	0.86	0.07		
August	House	0.92	0.87	0.05	**Mean**	
September	House	0.92	0.93	-0.01	**Diff. =**	**-0.085**
October	House	0.92	1.05	-0.13		
November	House	1.5	1.56	-0.06	**t-value =**	**2.865**
December	House	1.5	1.72	-0.22	**p-value =**	**0.015**
January	Lost	1.63	1.69	-0.06		
February	Lost	1.78	1.84	-0.06		
March	Lost	1.63	1.73	-0.10		
April	Lost	1.78	1.82	-0.04		
May	Lost	1.78	1.79	-0.01		
June	Lost	2.1	1.88	0.22	**n=**	**12**
July	Lost	1.86	1.73	0.13		
August	Lost	1.78	1.86	-0.08	**Mean**	
September	Lost	1.78	1.86	-0.08	**Diff. =**	**-0.003**
October	Lost	1.7	1.51	0.19		
November	Lost	1.7	1.70	0.00	**t-value =**	**0.930**
December	Lost	1.7	1.85	-0.15	**p-value =**	**0.088**
January	Middle	3.44	3.77	-0.33		
February	Middle	2.57	3.10	-0.53		
March	Middle	2.57	2.62	-0.05		
April	Middle	2.57	2.54	0.03		
May	Middle	1.79	1.77	0.02		
June	Middle	2.57	2.88	-0.31	**n=**	**12**
July	Middle	4.4	4.56	-0.16		
August	Middle	4.4	4.08	0.32	**Mean**	
September	Middle	3.44	3.51	-0.07	**Diff. =**	**-0.067**
October	Middle	3.26	2.80	0.46		
November	Middle	3.44	3.97	-0.53	**t-value =**	**0.711**
December	Middle	3.44	3.10	0.34	**p-value =**	**0.492**
January	North	4.81	5.04	-0.23		
February	North	4.81	5.15	-0.34		
March	North	4.81	5.26	-0.45		
April	North	4.81	5.72	-0.91		
May	North	4.81	4.93	-0.12		
June	North	4.6	4.34	0.26	**n=**	**12**
July	North	4.6	4.73	-0.13		
August	North	4.4	3.98	0.42	**Mean**	
September	North	4.3	4.46	-0.16	**Diff. =**	**-0.240**
October	North	4.4	4.35	0.05		
November	North	4.6	5.18	-0.58	**t-value =**	**2.154**
December	North	4.81	5.51	-0.70	**p-value =**	**0.054**

Table 1. Continued.

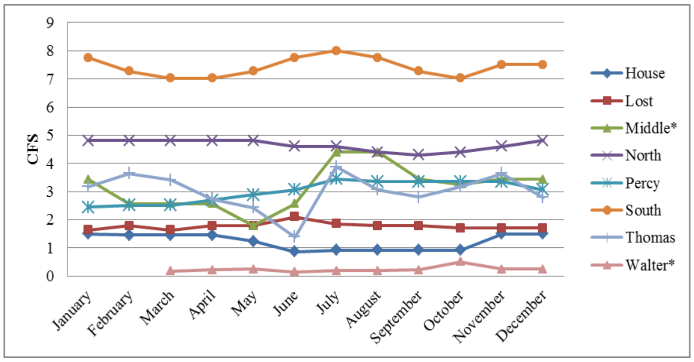
Month Sampled	Spring Name	Historical CFS	Pipe Meter CFS Total	Difference (hist - pipe)	Statistical Significance	Month Sampled
January	Percy	2.44	1.91	0.53		
February	Percy	2.52	1.76	0.76		
March	Percy	2.52	1.90	0.62		
April	Percy	2.7	1.81	0.89		
May	Percy	2.88	1.86	1.02		
June	Percy	3.07	1.91	1.16	**n=**	**12**
July	Percy	3.45	1.92	1.53		
August	Percy	3.36	1.72	1.64	**Mean**	
September	Percy	3.36	1.89	1.47	**Diff. =**	**1.123**
October	Percy	3.36	1.62	1.74		
November	Percy	3.36	2.25	1.11	**t-value =**	**9.785**
December	Percy	3.07	2.06	1.01	**p-value =**	**0.000**
January	South	7.75	8.48	-0.73		
February	South	7.27	8.46	-1.19		
March	South	7.03	7.68	-0.65		
April	South	7.03	7.82	-0.79		
May	South	7.27	6.96	0.31		
June	South	7.75	7.40	0.35	**n=**	**12**
July	South	8	8.40	-0.40		
August	South	7.75	7.55	0.20	**Mean**	
September	South	7.27	7.90	-0.63	**Diff. =**	**-0.413**
October	South	7.03	7.45	-0.42		
November	South	7.51	8.50	-0.99	**t-value =**	**2.774**
December	South	7.51	7.54	-0.03	**p-value =**	**0.018**
January	Thomas	3.18	3.91	-0.73		
February	Thomas	3.64	4.70	-1.06		
March	Thomas	3.41	4.46	-1.05		
April	Thomas	2.74	3.55	-0.81		
May	Thomas	2.43	3.13	-0.70		
June	Thomas	1.39	2.26	-0.87	**n=**	**12**
July	Thomas	3.88	2.11	1.77		
August	Thomas	3.07	2.27	0.80	**Mean**	
September	Thomas	2.8	2.69	0.11	**Diff. =**	**-0.382**
October	Thomas	3.18	3.01	0.17		
November	Thomas	3.64	4.37	-0.73	**t-value =**	**1.428**
December	Thomas	2.79	4.28	-1.49	**p-value =**	**0.181**
January	Walter	N/A	N/A	N/A		
February	Walter	N/A	N/A	N/A		
March	Walter	0.179	0.20	-0.02		
April	Walter	0.222	0.25	-0.03		
May	Walter	0.241	0.21	0.03		
June	Walter	0.154	0.18	-0.03		
July	Walter	0.196	0.19	0.00		
August	Walter	0.196	0.20	-0.01	**n=**	**10**
September	Walter	0.222	0.22	0.00		
October	Walter	0.509	0.32	0.19	**Mean**	
November	Walter	0.241	0.23	0.01	**Diff. =**	**-0.002**
November	Walter	0.241	0.23	0.01		
December	Walter	0.241	0.33	-0.09	**t-value =**	**0.029**
December	Walter	0.241	0.33	-0.09	**p-value =**	**0.978**

Figure 1. Look at 5-Year Historical (2011-2015) Total Annual Spring Flow.



**Middle Spring and Walter Spring both are losing water flow through the flume due to leaks in their respective dikes. These CFS values are artificially lowered due to these leaks and this should be taken into account when interpreting the 2015 data for these springs, as well as the overall annual CFS flow data. Additionally, Walter Spring was added in 2015 from March-December, but was not included in previous years; this must be taken into account when comparing total CFS between years.*

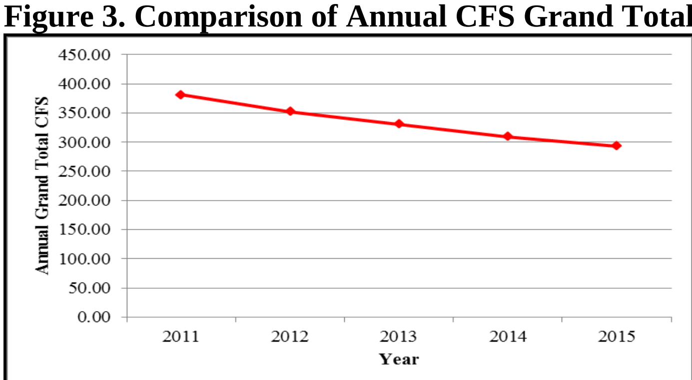
Figure 2. Comparison of 2015 Spring Flow Between all Monitored Springs.



**Middle Spring and Walter Spring both are losing water flow through the flume due to leaks in their respective dikes. These CFS values are artificially lowered due to these leaks and this should be taken into account when interpreting the 2015 data.*

One item of concern is that over the last 5-years, there has been a steady decrease in the annual grand total CFS for all measured springs (Figure 3). When the monthly CFS grand totals across the last 5-years were compared using a one-way ANOVA a significant difference of $p \leq 0.05$ was found [$F(4, 55) = 80.28$, $p = 0.00$]. We cannot clearly state the cause for this decline at this time, or quantify how much may be due to collector bias, dike failure, etc. vs actual decline, but this needs to be closely monitored in upcoming months/years.

Figure 3. Comparison of Annual CFS Grand Totals across all Monitored Springs.



Ave. Mean	31.78	29.38	27.57	25.79	24.44
G. Total CFS	381.38	352.52	330.79	309.51	293.31

The biggest contributor to the overall CFS decline appears to be Middle Spring [F(4, 55) = 96.150, p = 0.00], with the largest decline in mean CFS between year occurring between 2013 and 2014 (difference in mean CFS = 22.5). The only spring to show an increase in mean CFS increase was Percy Spring and the only spring to not show any significant difference was House Spring (Table 2). Since we are aware that there is a muskrat-produced failure in the dike for Middle Spring and we do not know exactly when it occurred, and we also know that Middle Spring demonstrates the largest decline in CFS, we cannot fully calculate any potential grand total annual CFS loss until such time as a repair can be completed.

Table 2. One-way ANOVA results between years (2011-2015) by spring.

	One-way ANOVA Results	Mean CFS Decrease Between Yrs
House	[F(4, 55) = 2.451, p = 0.0567]	0.72
Lost	[F(4, 55) =6.990, p = 0.00]	0.48
Middle	[F(4, 55) =96.150, p = 0.00]	16.56
North	[F(4, 55) =5.956 p = 0.00]	2.05
Percy*	[F(4, 55) =9.782 p = 0.00]	-1.61
South	[F(4, 55) =16.832 p = 0.00]	1.19
Thomas	[F(4, 55) =16.832 p = 0.00]	3.23

**Percy Spring is the only spring that demonstrated a significant CFS increase over the 5-year span.*

Temperature, conductivity, salinity and pH were also collected within nine major springs throughout the Refuge. Data was collected once a month using a YSI meter (Tables 3-5). A spring-by-spring comparative illustration of current (2015) monthly conductivity values to historical average monthly values (1990-1995 and 2010-2014) is provided in Figure 5.

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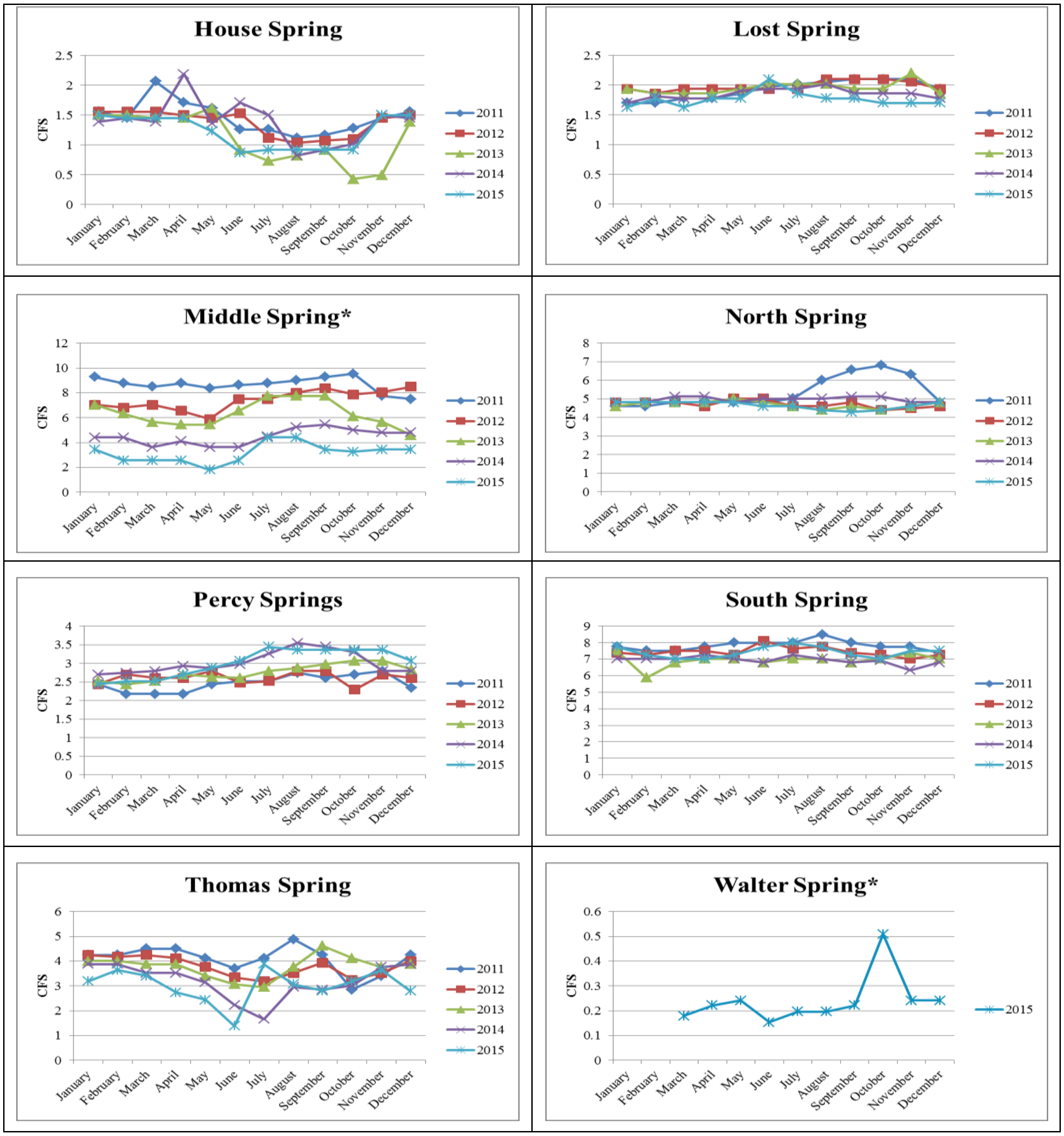
Figure 4. Comparative Spring Water Flows (CFS) by Month *(Historical Methodology)*.



**Middle Spring and Walter Spring both are losing water flow through the flume due to leaks in their respective dikes. These CFS values are artificially lowered due to these leaks and this should be taken into account when interpreting the 2015 data for these springs, as well as the overall annual CFS flow data.*

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Figure 5. Comparative Spring Conductivity Values (µS/cm) by Month.

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Table 3. 2015 Spring Conductivity Data (μS/cm) by Month.

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Deadman	5530	3500	4280	6140	3664	4060	4070	3963	3190	3180	3780	3840
House	3180	3178	3200	3190	3026	3200	3200	3146	3200	3080	2820	3090
Lost	3170	3183	3190	3180	3158	3230	3210	3063	3170	3210	3190	3190
Middle	3180	3161	3180	3160	3101	3190	3200	3132	3190	3160	3170	3170
North	5020	4918	5040	5060	5042	5120	5090	4969	5030	4960	4950	4960
Percy	3230	3217	3250	3240	3201	3210	3230	3168	3240	3210	3200	3220
South	3180	3165	3180	3160	3206	3190	3230	3125	3190	3150	3120	3150
Thomas	3230	3176	3210	3200	3175	3190	3170	3127	3160	3190	3190	3160
Walter	3460	3394	3440	3450	3462	3580	3450	3356	3430	3480	3420	3320
Ave	**3687**	**3432**	**3552**	**3753**	**3448**	**3552**	**3539**	**3450**	**3422**	**3402**	**3427**	**3456**

Table 4. 2015 Spring Conductivity Data (μS/cm) by Month.

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Deadman	7.9	14.27	14.8	12.8	15.66	22.7	21.5	21.87	22	18.3	14.1	10.1
House	25.9	25.91	25.3	25.1	22.98	25.8	25.2	23.74	25	23.3	22.7	22.6
Lost	26.5	25.61	26.3	25.8	26.44	26.6	26	26.69	26.8	26.8	26.8	25.9
Middle	25.9	26.1	27.3	27.1	27.66	28.3	28	26.94	27.9	27.5	26.8	26.1
North	20	20.59	22.2	21.8	21.76	25.1	23.2	23.1	22.8	21	19.9	18.1
Percy	23.2	23.03	23.5	24.2	24.62	25.8	26.1	24.28	25.6	24.5	24.1	23.3
South	23.3	25.12	26.1	27.1	26.78	27.7	27.5	27.42	27.5	27.3	26.9	25.6
Thomas	24.1	25.56	25.9	25.6	26.39	26.6	26.1	25.69	26.1	25.4	23.8	25.5
Walter	14.8	16.89	19.2	19.7	18.73	20.2	20	19.72	19.2	17.5	15.3	12.2
Ave	**21.3**	**22.6**	**23.4**	**23.2**	**23.4**	**25.4**	**24.8**	**24.4**	**24.8**	**23.5**	**22.3**	**21.0**

Table 5. 2015 Spring pH Data by Month.

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Deadman	7.3	7.07	7.6	8.7	6.97	7.7	8	7.38	7.6	7.8	7.8	7.5
House	7.7	7.46	7.7	7.9	7.61	6.9	7.4	7.49	7.4	7.4	7.4	7.6
Lost	7.6	7.53	7.7	7.8	8.04	6.9	7.1	7.84	7.4	7.5	7.3	7.5
Middle	7.5	7.74	7.8	8.3	8.15	6.9	7.1	7.51	7.3	7.2	7.2	7.3
North	7.8	7.89	8.1	8.2	7.56	7.6	8.5	7.57	7.8	7.8	7.5	7.7
Percy	7.6	7.46	7.5	7.8	8.58	6.3	6.9	7.56	7.3	7.4	7.3	7.4
South	7.6	7.58	7.6	8.2	8.4	6.5	7.4	7.91	7.4	7.5	7.3	7.6
Thomas	7.7	7.58	7.8	8	8.15	6.8	7.2	7.39	7.5	7.5	7.4	7.6
Walter	7.6	7.69	7.8	8.5	7.05	7.8	8.8	7.05	7.9	7.8	7.8	8.2
Ave	**7.6**	**7.6**	**7.7**	**8.2**	**7.8**	**7.0**	**7.6**	**7.5**	**7.5**	**7.5**	**7.4**	**7.6**

2015 Data Record Maintenance

Electronic files are now being kept in a designated folder located on a central server. This server undergoes automatic daily and weekly backups. Spring flow data and water quality data are now entered into individual electronic Access databases located on the server at: *I:\BiologyProgram\Databases*. Hardcopy files are being kept in the “Flume CFS Readings” binder.

Other files related to spring flow can be found on the server at the following location: *I:\ BiologyProgram \WildlifeProgram\Water Flow and Quality.*

- 1971-2013_spring_ave_CFS.xls
- ANNUAL_CFS_AVERAGES_TABLE.xls
- OVERALL_CFS DATABASE.xls
- AVERALL_CFS REPORT GRAPHS.xls
- CFS_DATASHEET.xls
- CFS flume READINGS Protocol.doc
- Hydrology_reports
- 2005_2007-2009 spring CFS.xls
- 2010 spring CFS.xls
- 2011 spring CFS.xls
- 2012 spring CFS.xls
- 2013 spring CFS.xls

Maintenance and Monitoring Needs

During the last few years, maintenance priority has shifted to correcting flow issues immediately downstream from the springs in the upstream portion of the impoundment water delivery system. However, severe leakage through a diversion levee was discovered in 2015 within the spring basin of Middle spring. This leak has yet to be repaired and is bypassing water around the spring's flume. The newly installed flume in an impoundment dam at Walter spring also involves a relatively small leak where water bypasses the flume.

Other maintenance priorities listed in earlier Water Use Reports were either changed, accomplished in 2015, or will be completed in 2016:

- Major maintenance and flume installation was not completed for Deadman spring in 2015. A flume has never been installed historically for taking flow measures. This project is being put on hold for 2016.
- In 2016, the diversion levee for the Middle spring basin that is leaking will be repaired, as well as a relatively small leak next to the flume in the first impoundment dam below Walter spring.

Once the above maintenance needs are addressed, other needs within the springs will be pursued, if time permits, including the following:

- Assess all flumes for installation of wing walls to insure full capture of flow by eliminating leakage caused by muskrat activity.
- Assess the condition and performance of water delivery ditches that direct flow between and from the springs; then assess whether all spring flow is accounted for at measuring locations.
- Begin collecting water chemistry data on a periodic basis, such as every 5 years.

Refuge Impoundment System Water Management

<u>2015 Water Use</u>

Water use followed management strategies and prescriptions detailed in the station's draft Habitat Management Plan (DHMP). The DHMP provides for both modest and major changes in water management from guidance provided by the Marsh Management Plan that had been in effect since 1988.

Water management strategy prescriptions involve manipulated water quality, location, depth, and hydroperiod. The DHMP uses an approach that divides the Refuge into major management areas that involve permanent, semi-permanent, seasonal, or intermittent flooding (see Map-1 below). Water level strategies and prescriptions within the managed impoundments involve either semi-permanent or seasonal flooding.

This report provides theoretical hydrographs of planned water use, realized (actual) hydrographs of 2015 water use (measured weekly), conductivity readings (measured monthly), and narrative describing outcomes within each area of specific water management strategy prescription. The responses of wildlife and plants to water management are discussed in Sections III and IV of the AHWP.

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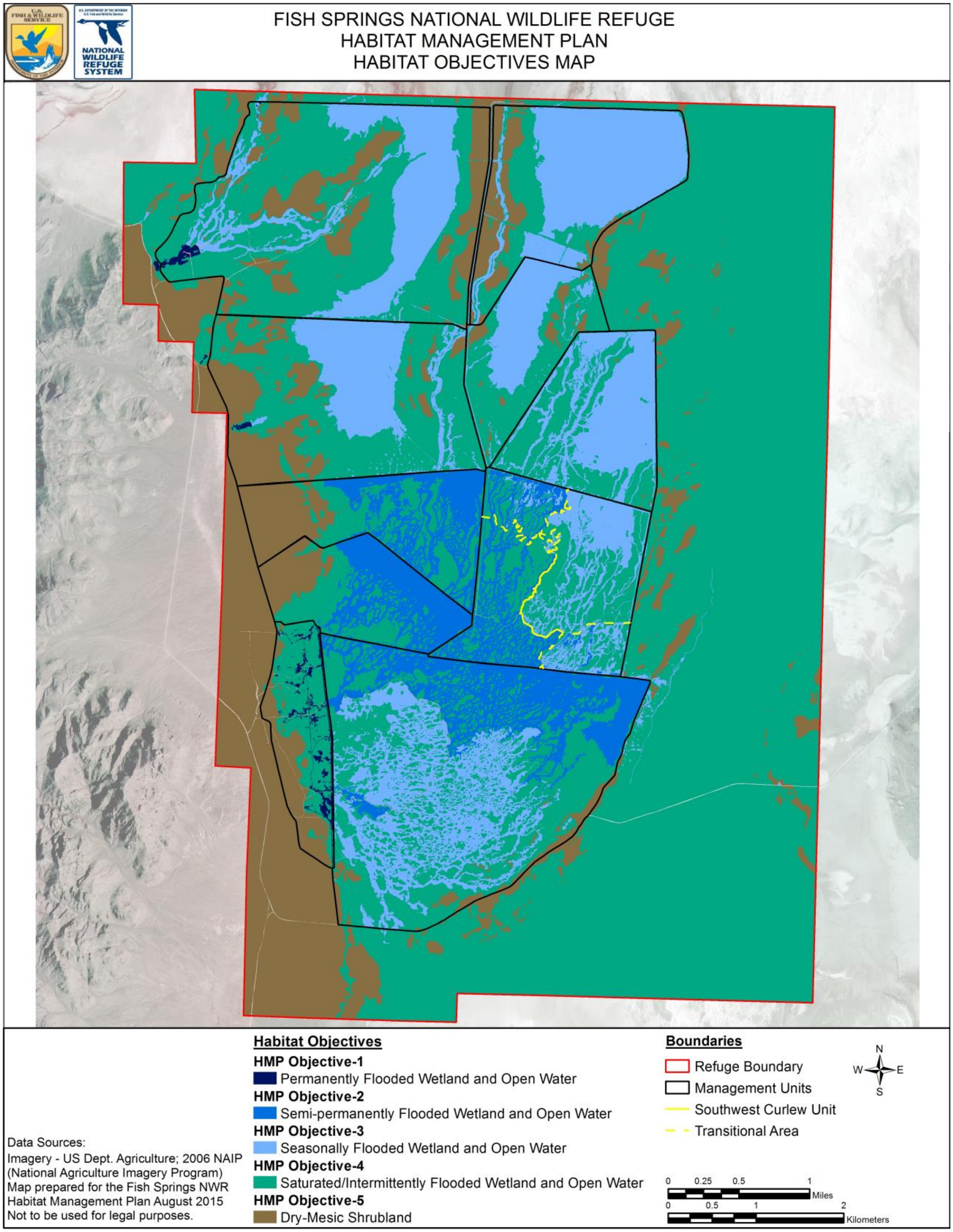
Map-1. Areas of Specific Water Management Strategy Prescription by DHMP Objective.



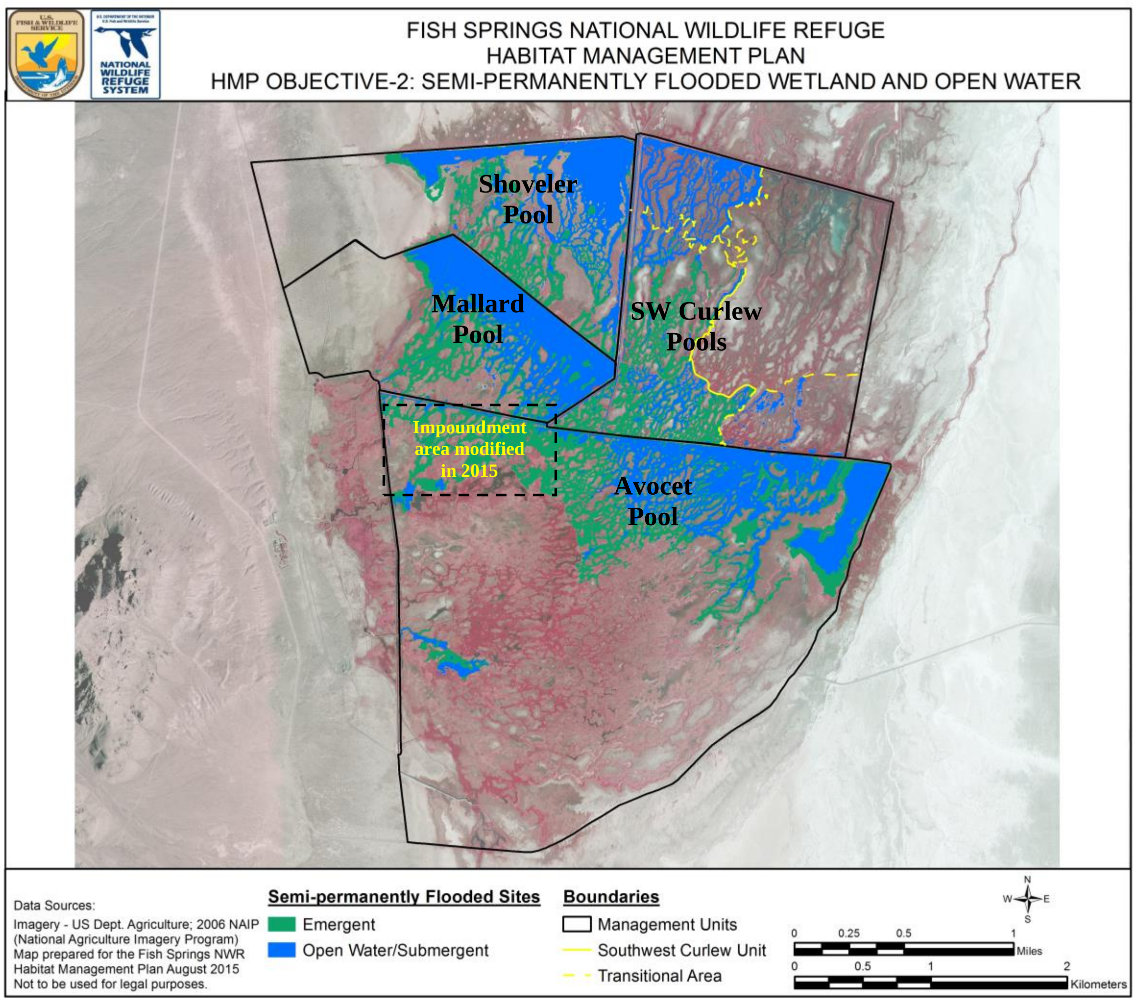
Semi-permanently flooded wetlands (1 and 2 following):

1) Major areas with semi-permanent flooding and 2-8 year (4-year currently preferred) full drawdown rotation:

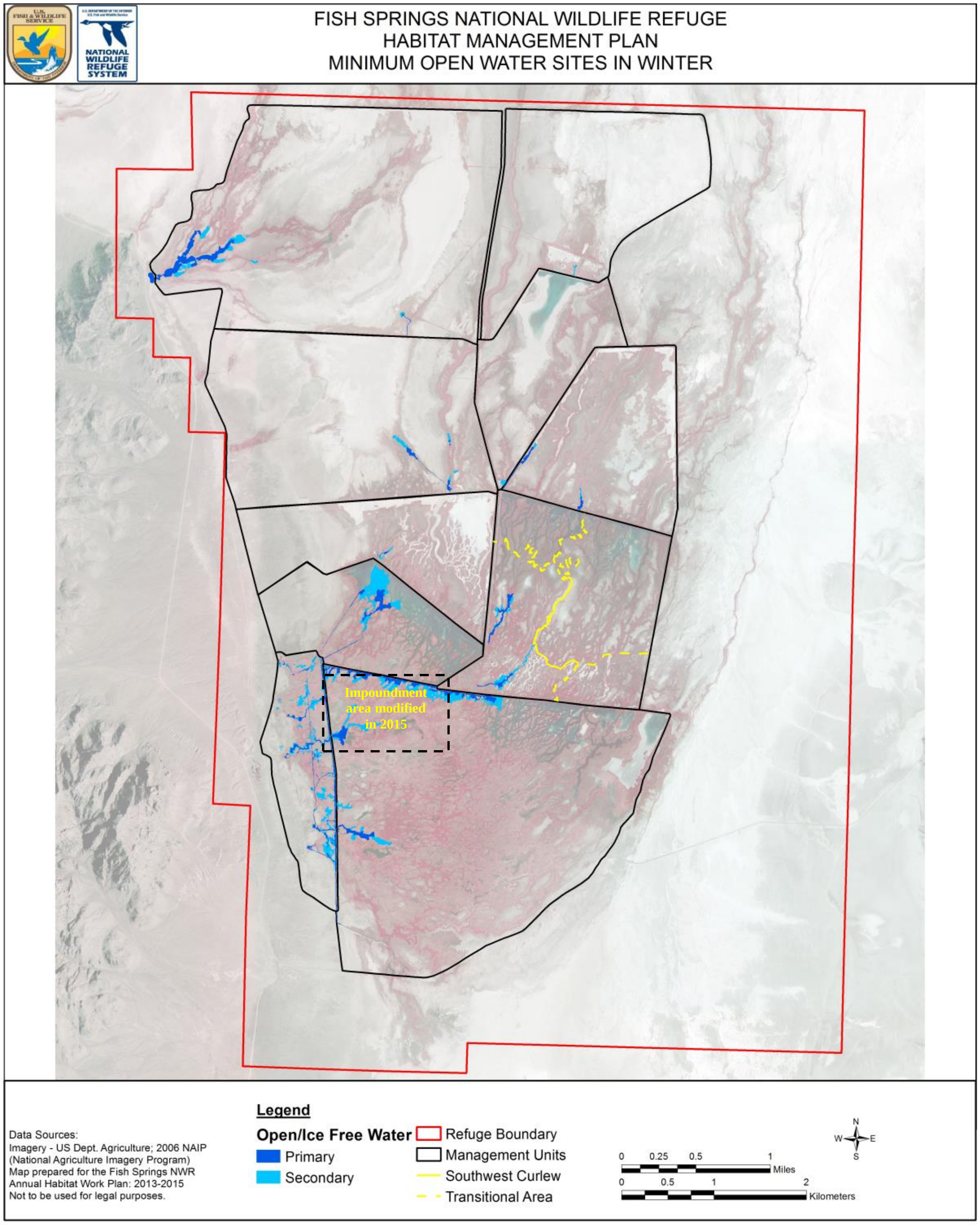
- **Mallard Unit Main Impoundment Pool**
- **Avocet Unit Main Impoundment Pool**
- **Shoveler Unit Impoundment Pools (Main Pool and South Shoveler Pools)**
- **Southwest Curlew Impoundment Pools**

These four major pool areas (Map-2) are continuously impounded except when drawn down by prescription on a 2-8 year rotation schedule, with a 4-year rotation schedule currently preferred. Drawdowns are initiated from late January to March and refilling begins during the same year from September to November. During the growing/nesting season, each impoundment pool level is stabilized at or near long-established "optimum" pool elevations. This water prescription is intended to meet the needs of targeted priority ROC species (see AHWP sections II, III, and IV and DHMP chapters 4 and 5).

Map-2. Areas of semi-permanently flooded wetlands (DHMP objective-2).



Map-3. Typical locations of flooded areas maintained ice-free in winter during the most severe of cold weather conditions. These flooded sites are maintained ice-free with thermal spring flows by consolidating the direction of water flow patterns to targeted sites. As ambient air temperatures fluctuate throughout winter, open water sites can increase substantially form these identified sites, and at times, can include all Refuge waters.



Mallard Unit Main Impoundment Pool:

In 2015, the main impoundment pool of the Mallard Unit was maintained at or near the historic "optimum" water level. During winter, inflows were used to maintain an area of ice-free water near the west end of the pool (see Map-3).

Figure 6. Hydrograph of planned water use during years 2013-16 (4-year water drawdown rotation). Scheduled drawdown in 2013.

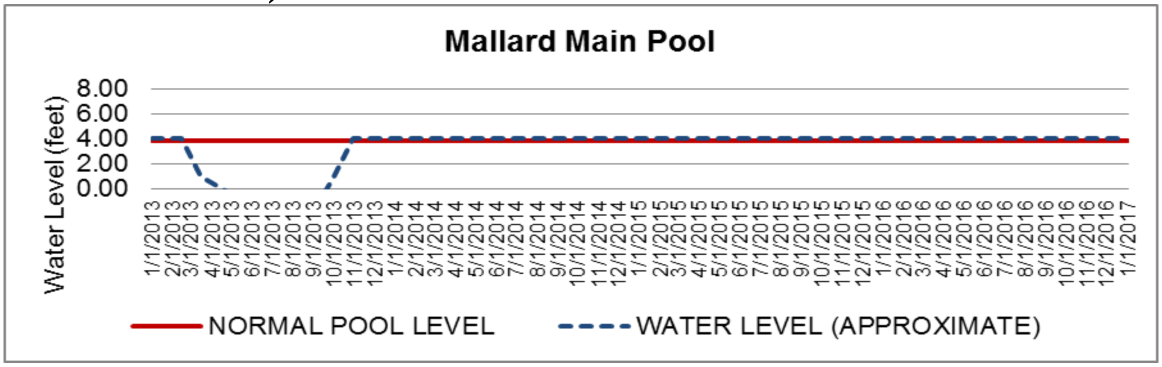
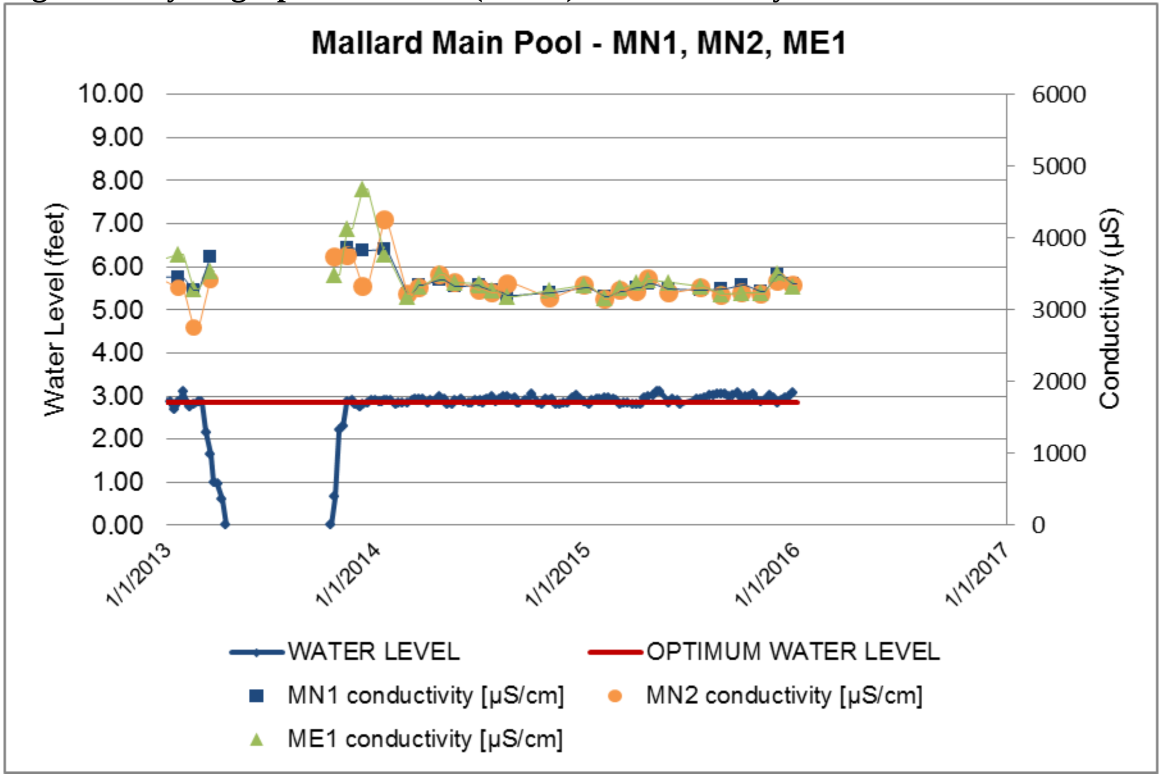


Figure 7. Hydrograph of realized (actual) water use for year 2015.



Avocet Unit Main Impoundment Pool:

In 2015 the main impoundment pool of the Avocet Unit was dewatered as in 2014 for a second consecutive summer in order to support plant control and infrastructure maintenance needs. The full drawdown of the main impoundment pool was intentionally prolonged by allowing sheet water to persist within the large eastern pool areas of the impoundment unit in order to provide for continued bird use. In late November, the pool began being refilled at a slow rate.

Figure 8. Hydrograph of planned water use during years 2013-16 (4-year water drawdown rotation). Scheduled drawdown in 2014.

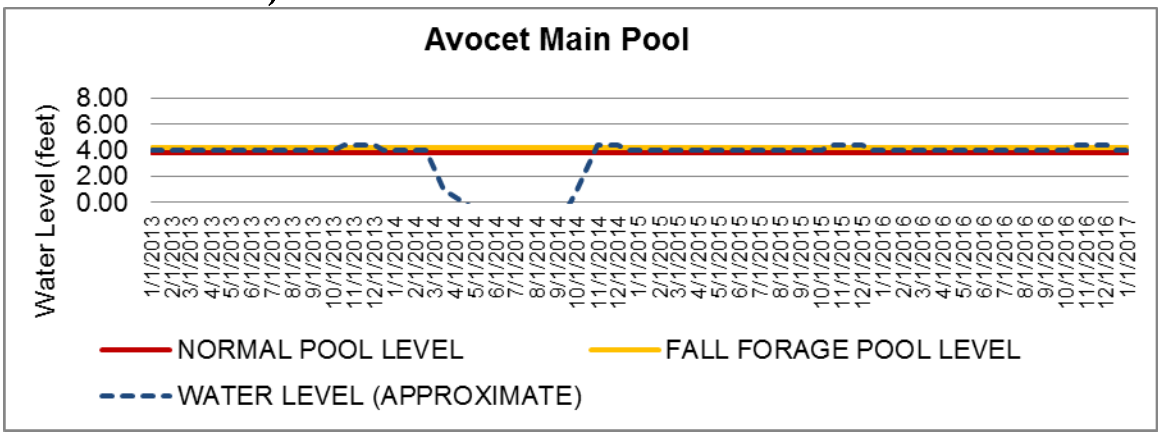
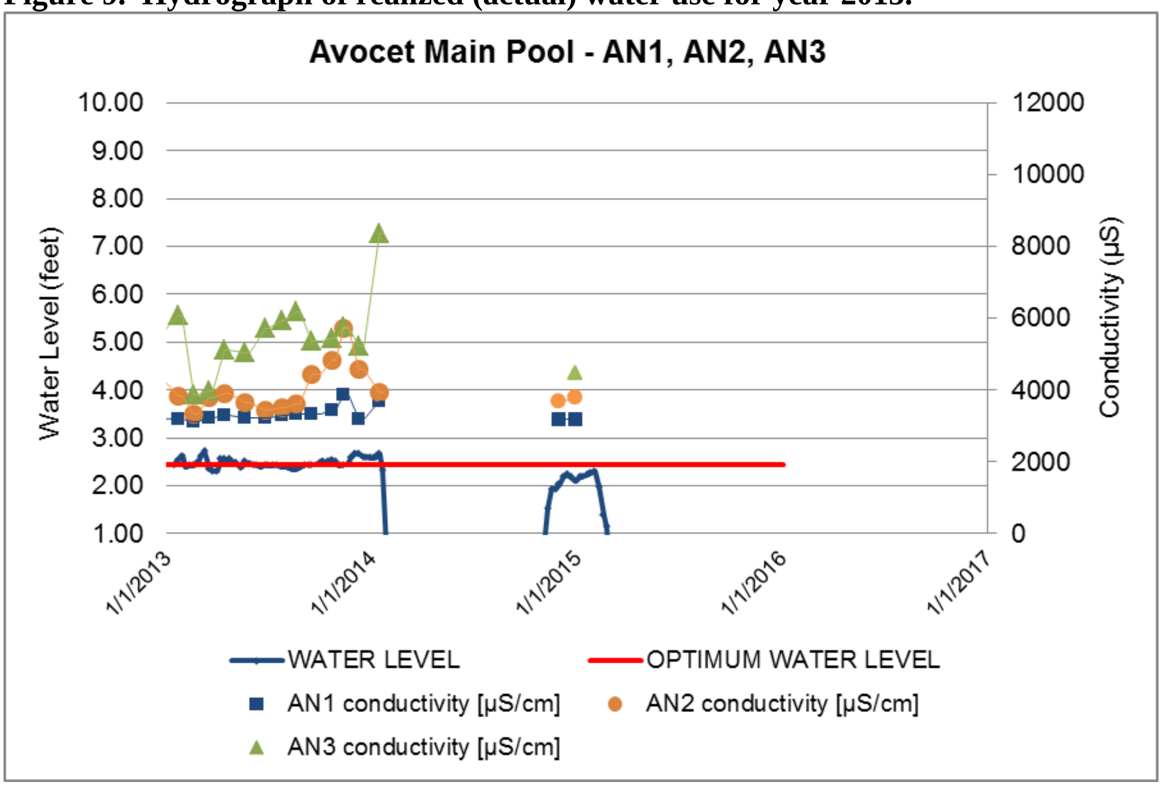


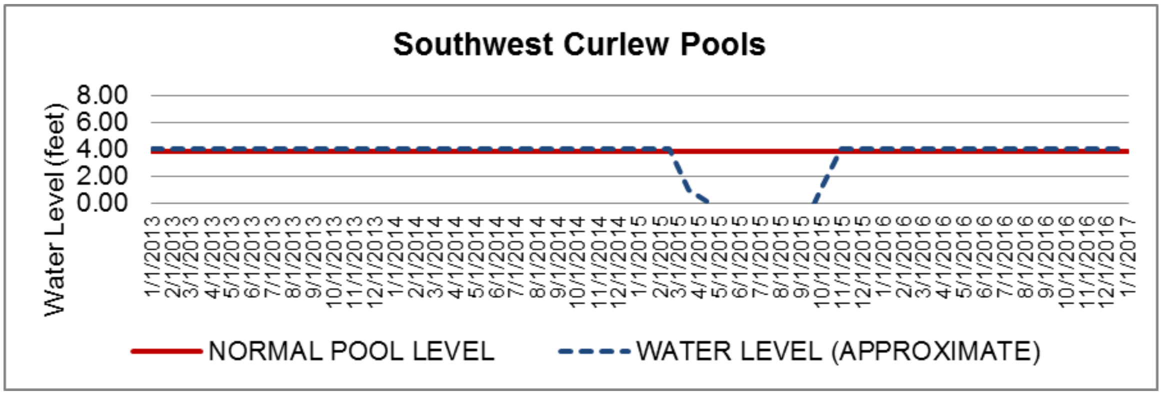
Figure 9. Hydrograph of realized (actual) water use for year 2015.



Southwest Curlew Impoundment Pools:

In 2015, the Southwest Curlew impoundment pools were maintained year round at or near the historic optimum water level. During winter, inflows were used to maintain areas of ice-free water (see Map-3).

Figure 10. Hydrograph of planned water use during years 2013-16 (4-year water drawdown rotation). Scheduled drawdown in 2015 (as reported two years ago) will be delayed to 2016.



Hydrograph of realized water use for year 2015

Data Not Collected – Newly Configured Area with no Staff Gauges

South Curlew (CS2) Conductivity (µS/cm) by Month
(Outflow from the Southern Pool of the Southwest Curlew Pools)

2014	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CS2	3330	4057	3800	4260	3721	4010	3830	3553	3490	3480	3420	3490

West Curlew (CX, not yet officially named) Conductivity (µS/cm) by Month
(Outflow from the Middle-West Pool of Southwest Curlew Pools)

2014	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CX	*	3305	3320	3410	3443	3450	3690	3850	3390	3710	3210	3090

*missing data

West Curlew (CW1) Conductivity (µS/cm) by Month
(Outflow from the Northern-West Pool of Southwest Curlew Pools)

2014	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CW1	3330	3476	3480	3590	3608	3800	4510	5030	3930	4450	3570	2930

Shoveler Unit Impoundment Pools (Main and South Shoveler):

In 2015, the Main and South impoundment pools of the Shoveler Unit were maintained at or near historic "optimum" pool levels. During fall and spring seasons, water level elevations were increased above the "optimum" pool levels in order to provide foraging opportunities for waterfowl and other water birds. During winter, water flows delivered into South Shoveler from WCS MN1 provided for a relatively small area of ice-free water (see Map-3) during periods of extreme cold weather.

Figure 11. Hydrograph of planned water use during years 2013-16 (4-year water drawdown rotation). Scheduled drawdown in 2016 moved to 2017.

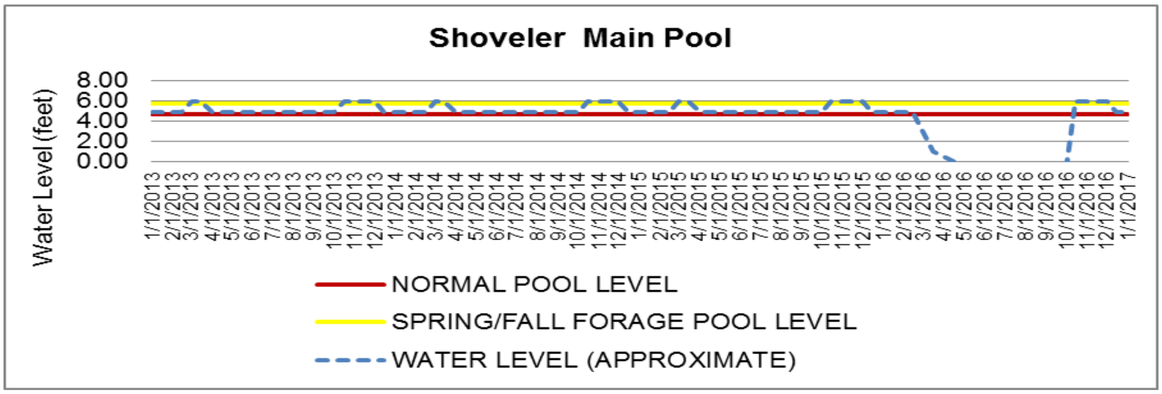
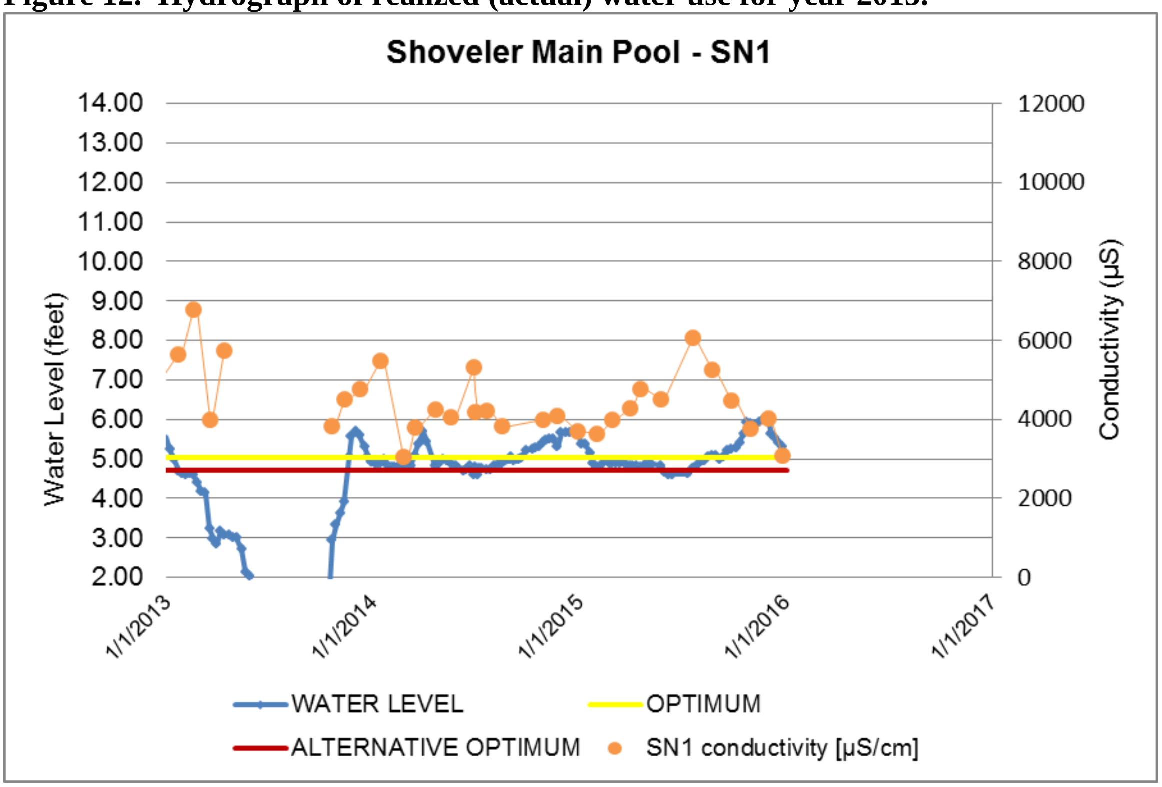


Figure 12. Hydrograph of realized (actual) water use for year 2015.



2) Lesser areas of semi-permanent flooding and 2-8 year drawdown rotation.

- **Special Hunt Area Ponds**
- **Harrison Slough Upper Pond**

In 2015, the Harrison Slough Upper Pond was maintained full year round. During winter, this site received flows sufficient to maintain ice-free areas of water holding submerged aquatic vegetation (SAV) or emergent marsh vegetation to be used by over-wintering waterfowl and other water birds for foraging and other needs (see Map-3). The Harrison Slough Upper Pond's impoundment and water delivery system currently doesn't allow for periodic dewatering and drying. However, plans are to possibly provide that capacity within the next 2-3 years. Therefore, currently, the Harrison Slough Upper Pond is functionally a permanent wetland.

In 2015, the Special Hunt Area Ponds were maintained dry from being dewatered in late March 2014. Plans are to keep the area dry through summer 2016 in order to support common reed and cattail control, and infrastructure work.

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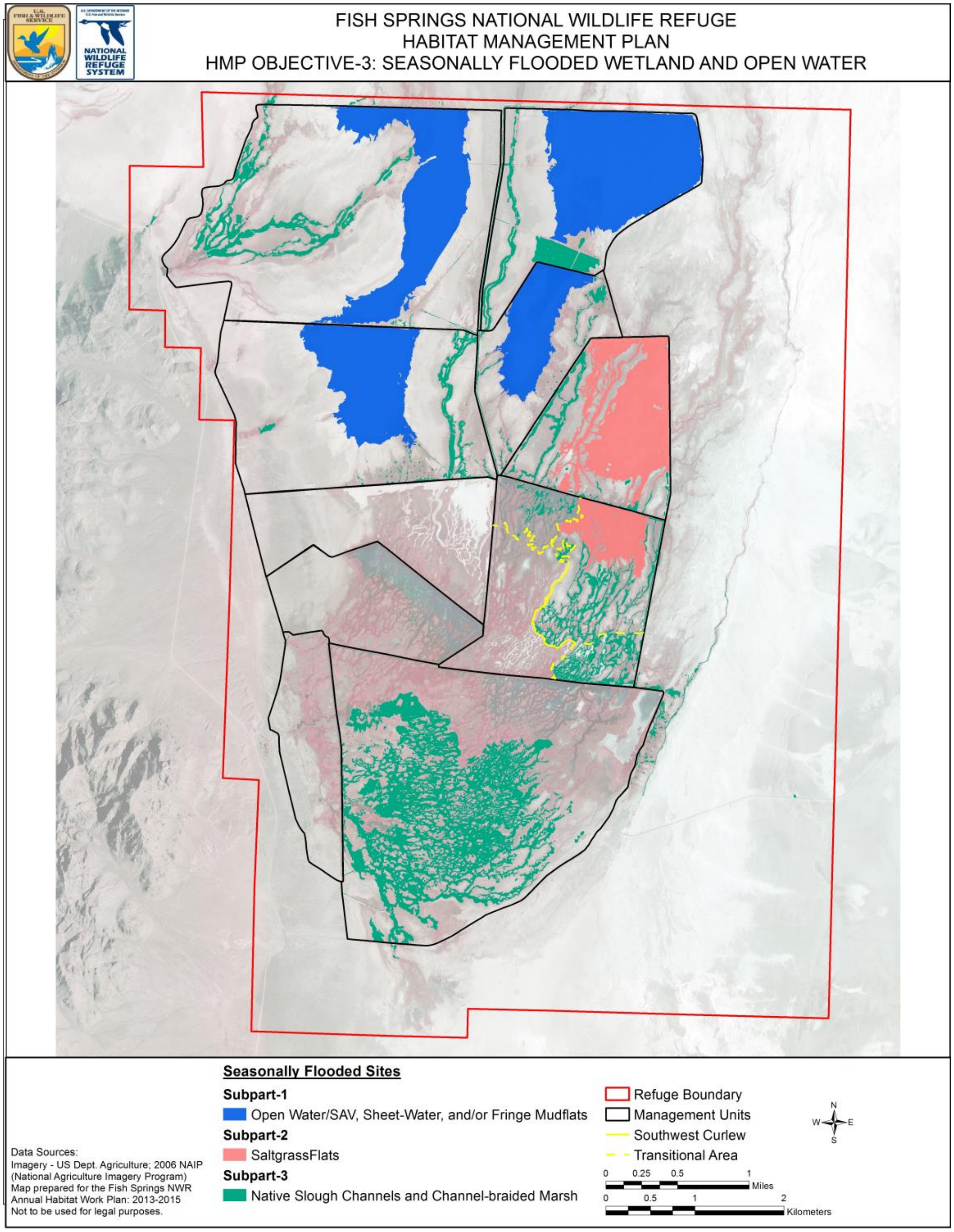
Map-4. Areas of seasonally flooded wetlands (DHMP objective-3).



Seasonally flooded wetlands (1, 2, and 3 following):

Within three distinct areas of seasonal flooding on the Refuge (Map-4), the following site-specific water prescriptions are each intended to meet different needs of targeted priority ROC species (see AHWP sections II, III, and IV and DHMP chapters 4 and 5).

1) Subpart-1: SAV/Open water; shallow pool/sheet-water; fringe mudflat (Map-4)

<u>Harrison Unit Main Impoundment Pool:</u>
In 2015, this water prescription provided "early-season" shallow water and fringe mudflat habitats. The pool began being reduced-down in mid-March and provided shallow water and fringe mudflat habitat by April 1 to the end of August before going fully dry, which was for a longer period than what can normally be maintained.

Figure 13. Hydrograph of planned water use during years 2013-16 (2-year rotation for partial water drawdown). Scheduled early-season partial drawdown in 2013 and 2015.

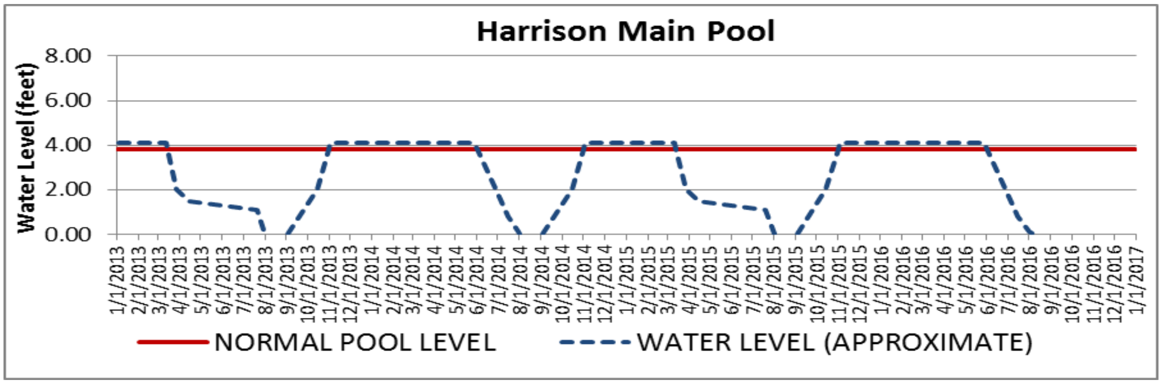
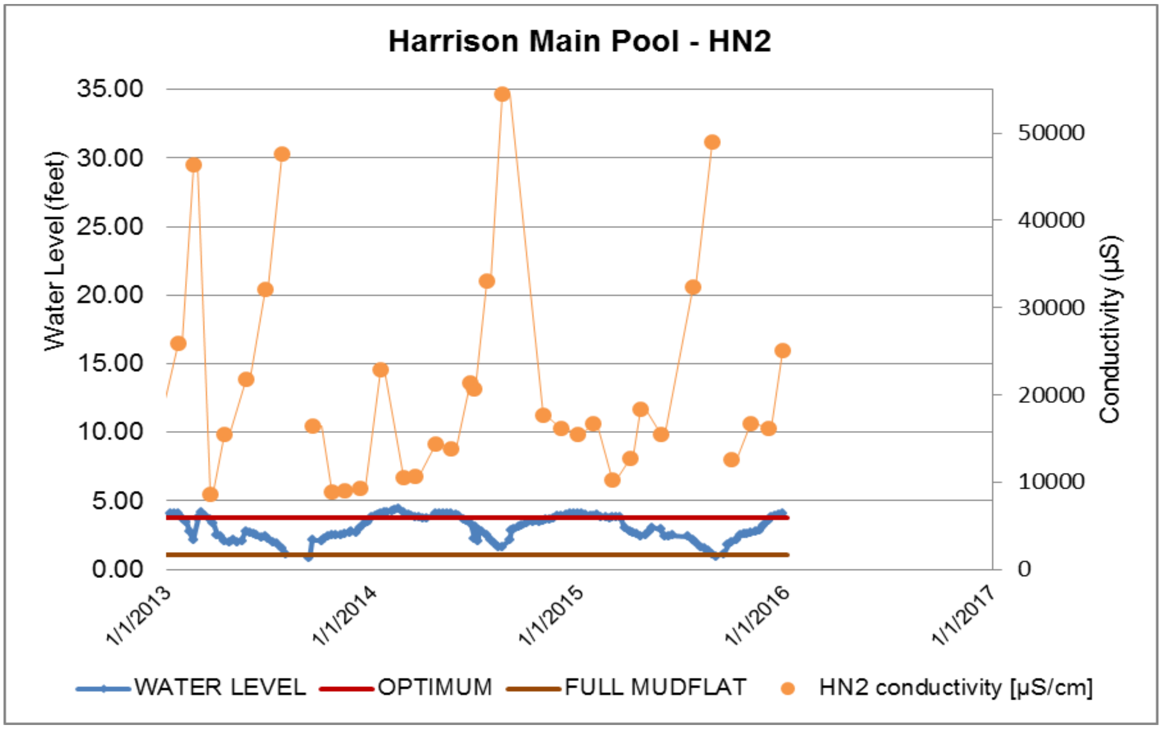


Figure 14. Hydrograph of realized (actual) water use for year 2015.



Pintail Unit Main Impoundment Pool:

In 2015, this water prescription provided “mid to late-season” shallow water and fringe mudflat habitats. The pool was reduced-down beginning in mid-June and provided shallow water and fringe mudflat habitat from the end of June to the end of the Fall season. The maximum extent of pool surface area reduction was approximately half, which was less than by prescription, due to relatively wetter conditions. Flushing flows were used during Fall to lower the pool’s salt concentration and then the pool began being slowly refilled by October and rapidly refilled during December.

Figure 15. Hydrograph of planned water use during years 2013-16 (2-year rotation for partial water drawdown). Scheduled mid-season partial drawdown in 2013 and 2015.

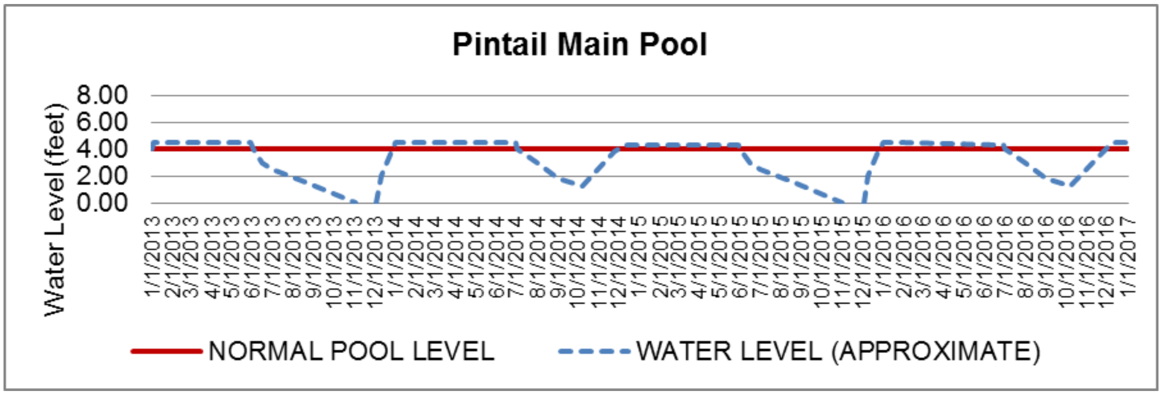
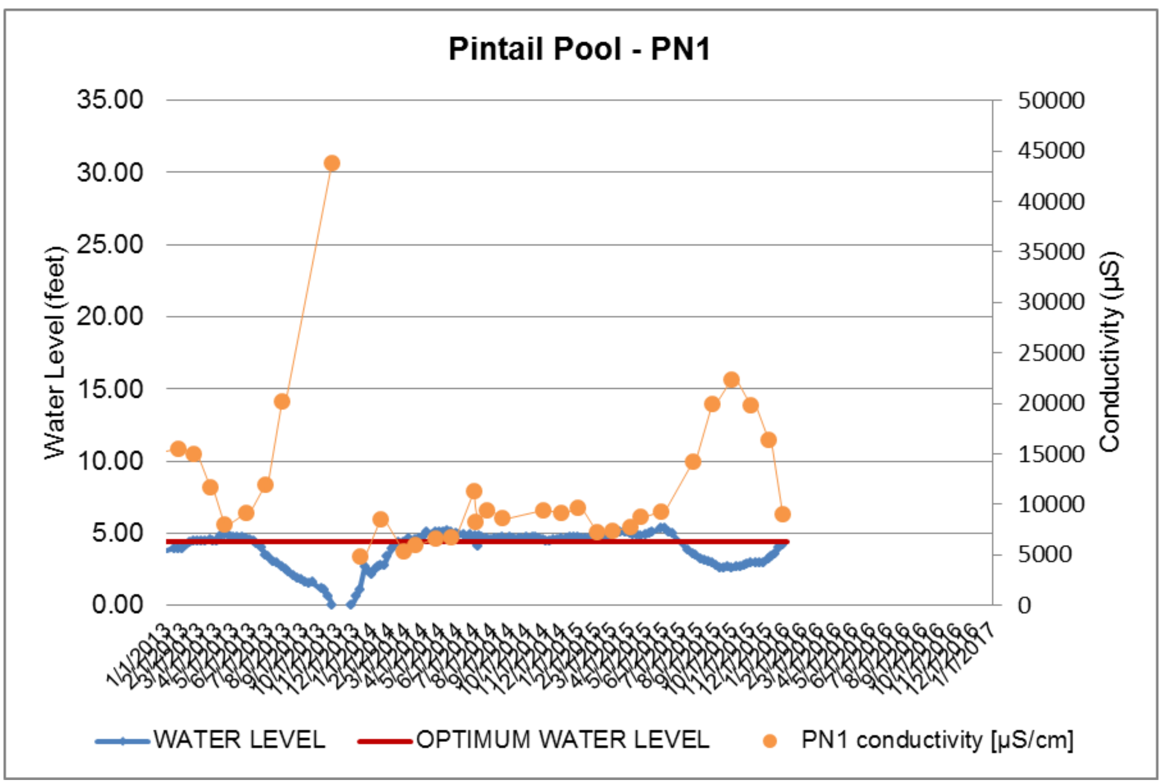


Figure 16. Hydrograph of realized (actual) water use for year 2015.



Gadwall Unit Main Impoundment Pool:

In 2014, the Gadwall Unit Main Impoundment Pool per its water management prescription was refilled during January to just above its historic "optimum" pool level. This pool level was maintained into summer and allowed to partially evaporate down in mid to late summer to provide shallow water and fringe mudflat habitats.

Figure 17. Hydrograph of planned water use during years 2013-16 (2-year rotation for partial water drawdown). Scheduled early-season partial drawdown in 2014 and 2016.

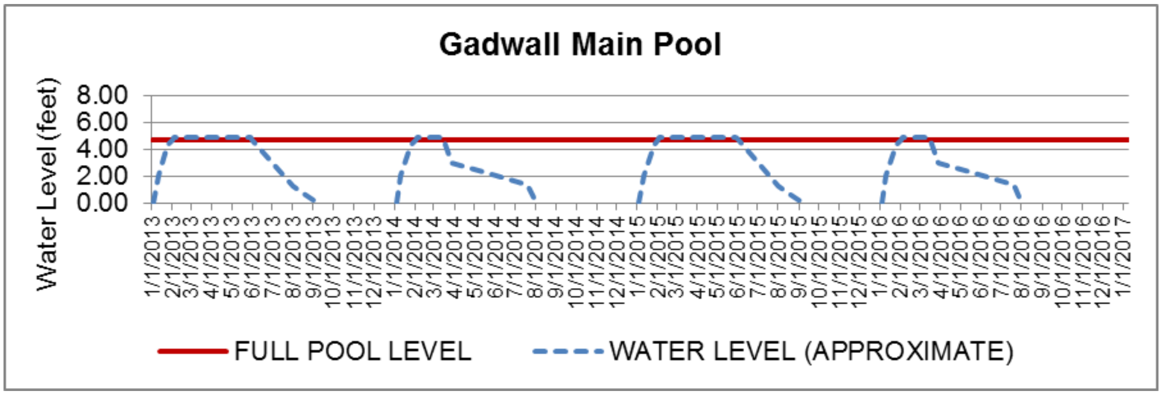
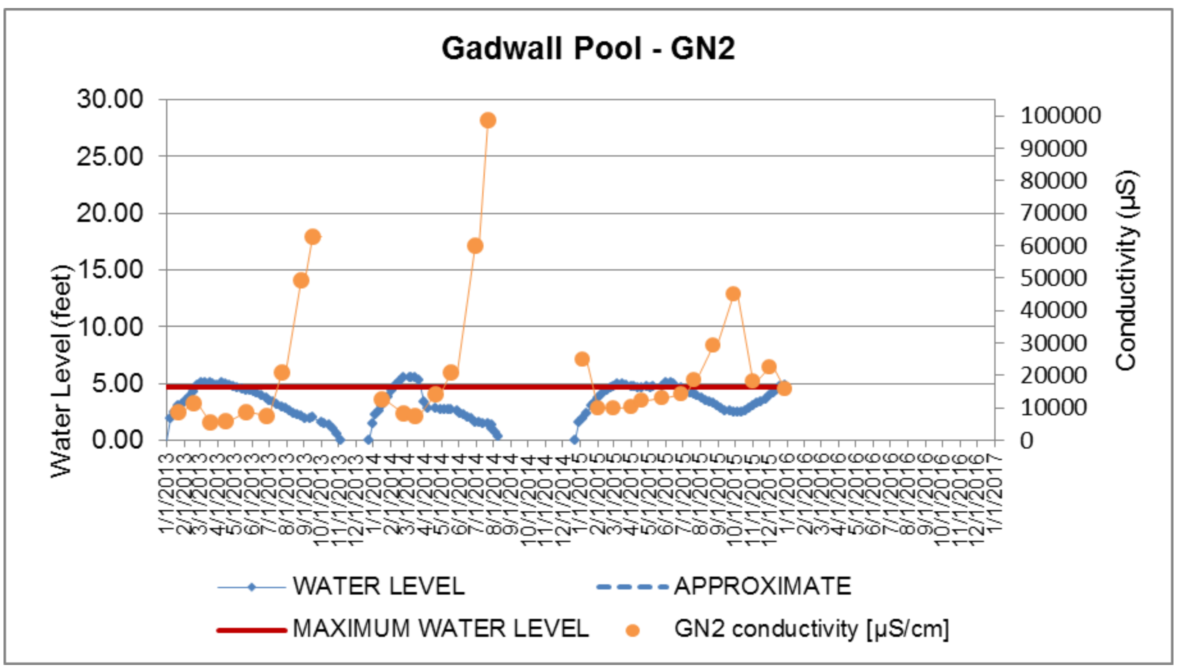


Figure 18. Hydrograph of realized water use for year 2015.



Ibis Unit Main Impoundment Pool:

In 2015, the Ibis Unit Main Impoundment Pool per its water management prescription was maintained year round at or near historic "optimum" pool level in order to provide for SAV production. There was an anticipated drop in pool level during late Summer when water inflows weren't sufficient to maintain its level full.

Figure 19. Hydrograph of planned water use during years 2013-16 (2-year rotation for partial water drawdown). Scheduled mid-season partial drawdown in 2014 and 2016.

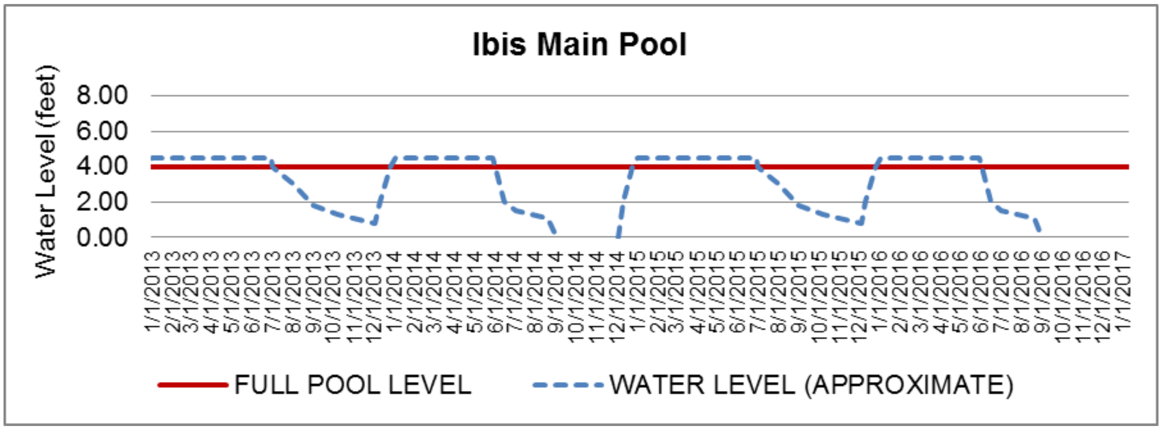
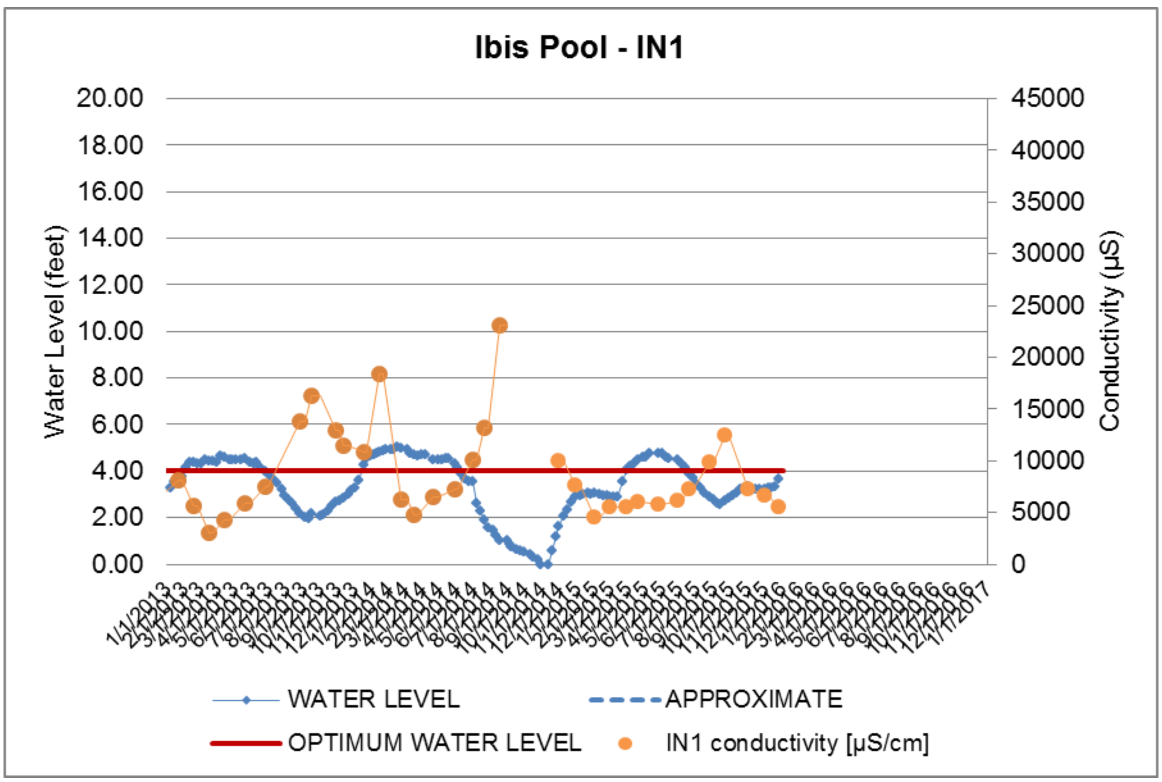


Figure 20. Hydrograph of realized water use for year 2015.



2) Subpart-2: Expansive Saltgrass Flats

Egret Unit Main Impoundment Pool:

In 2015, the Egret Main Pool was maintained above the historic "optimum" pool elevation until late March in order to fully flood and flush expansive flats of salt grass. By early April, a partial drawdown was used to create a reduced pool size. The reduced pool was maintained with areas of non-flooded and flooded salt grass, and then allowed to evaporate dry during summer.

Figure 21. Hydrograph of planned water use during years 2013-16 (annual partial water drawdown).

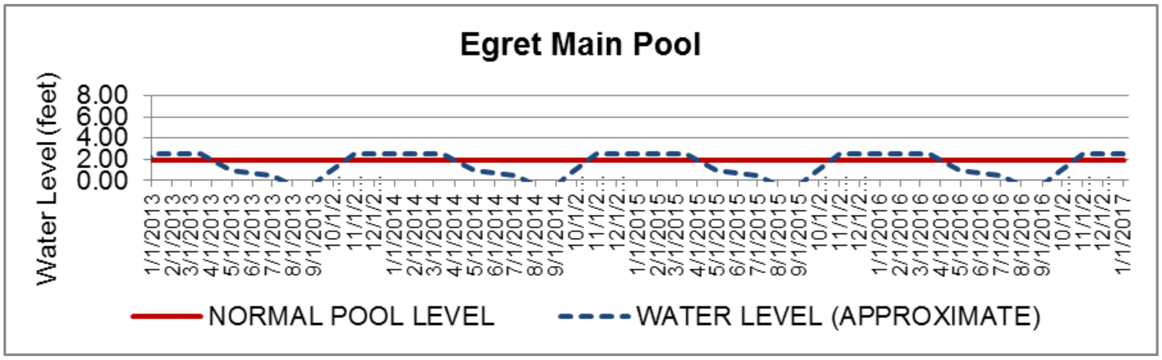
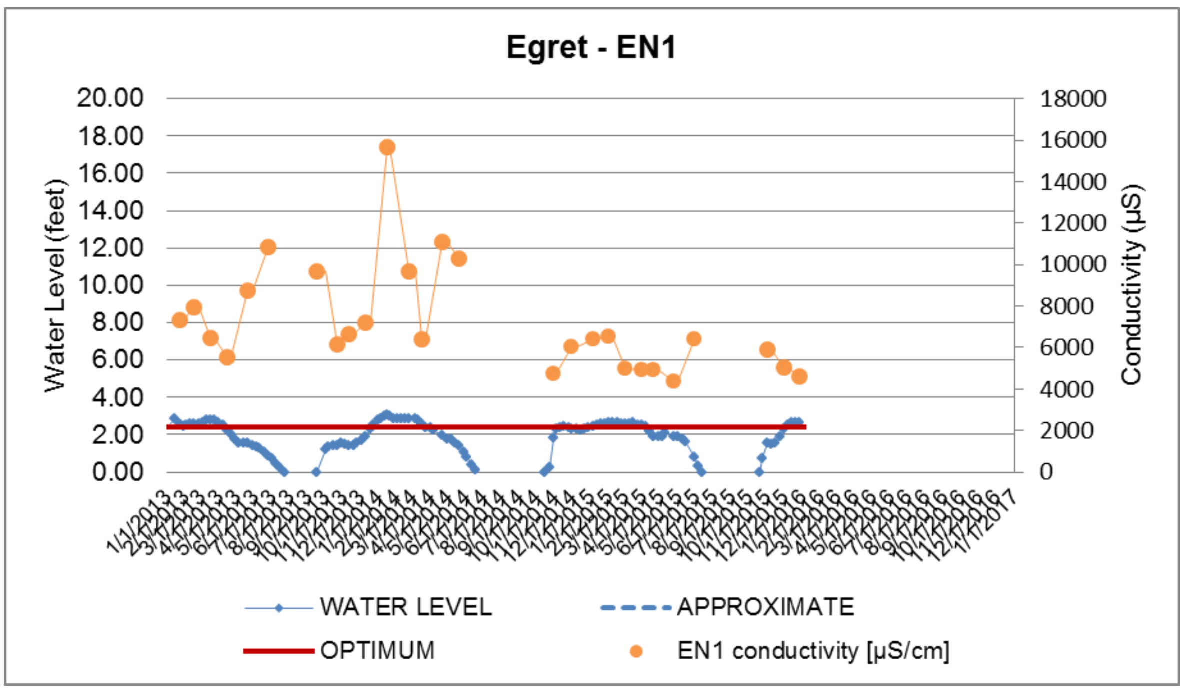


Figure 22. Hydrograph of realized water use for year 2015.



Curlew Unit Main Impoundment Pool:

In 2015, the Curlew Main Pool was maintained near the historic "optimum" pool elevation until late May in order to fully flood expansive flats of salt grass. By early June, a partial drawdown was used to create a reduced pool size. The reduced pool was maintained with areas of un-flooded and flooded salt grass, and then allowed to evaporate down during summer, but it remained higher than anticipated due to relatively wetter conditions, and did not go dry. In September, the pool began being refilled.

Figure 23. Hydrograph of planned water use during years 2013-16 (annual partial water drawdown).

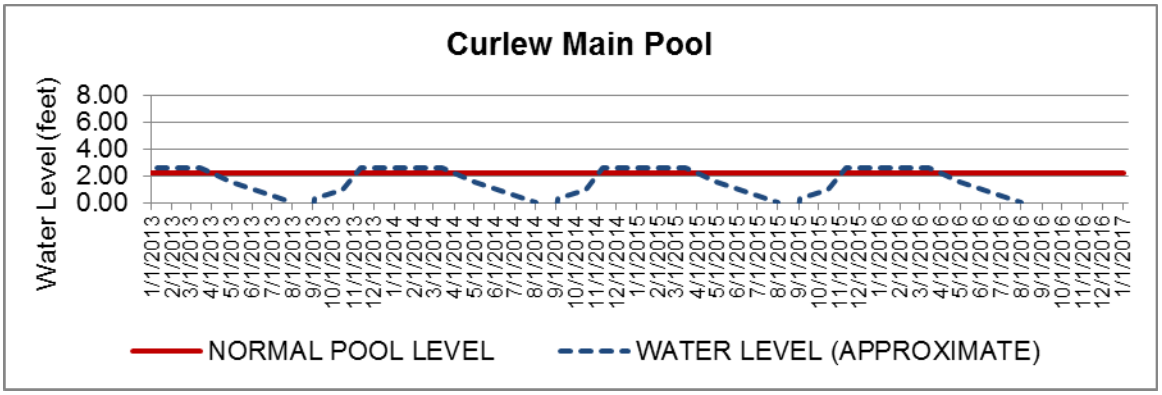
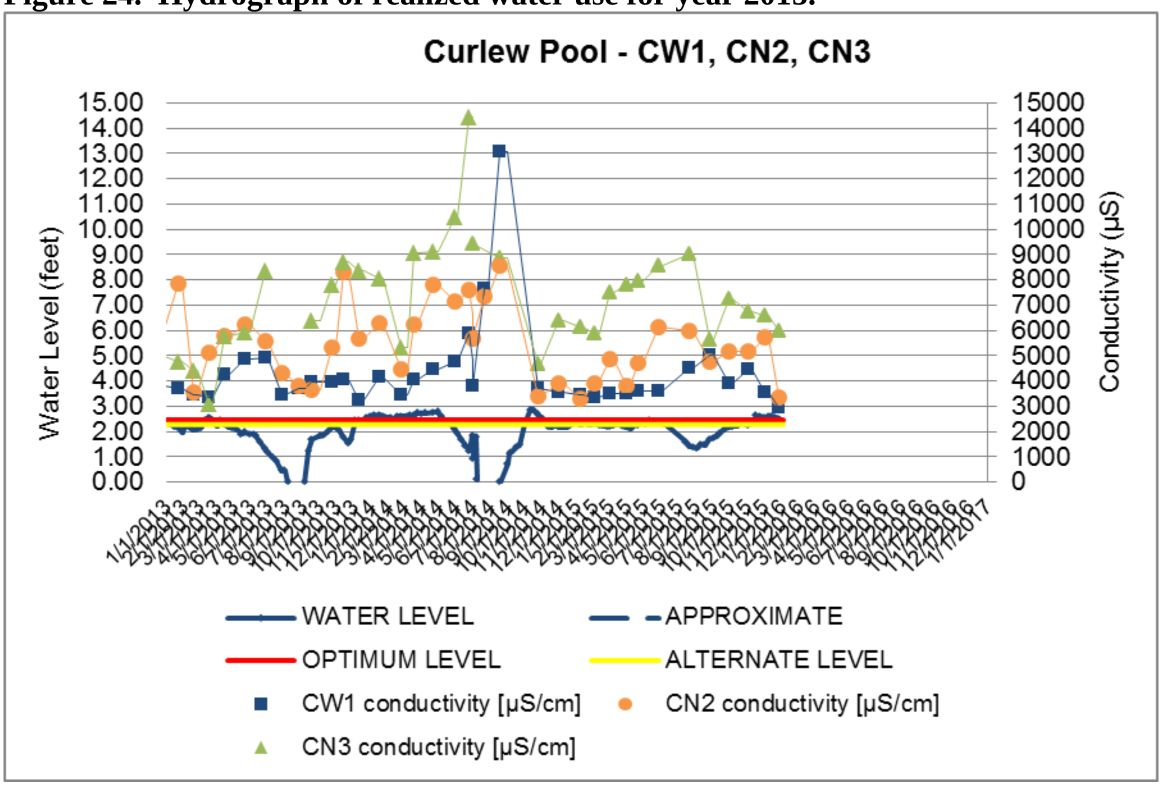


Figure 24. Hydrograph of realized water use for year 2015.



3) Subpart-3: Native Slough Channels and Channel-braided Marsh (Map-4)

These seasonally flooded areas include native channel braids and slough channels outside of the major impoundment footprints. Some of the larger slough channels and braids contain small, within-channel impoundment dams. Delivery of water flows are normally ceased by early June for most sites and allowed to dry down during summer. From October to December, depending on location and other annual influences, all sites normally receive flushing flows and are recharged with water.

2015 Data Record Maintenance

Water level data is collected at least once per week and is entered monthly into a database located on a shared drive on the Refuge's server in "Group Data/B Allen Habitat Mgmt Documents/water management. Backup files are maintained on a common flash drive and the hard drive of the manager's (B Allen) Dell notebook computer (25545076957) in My Documents/Brian's Documents/Biology-Monitoring/Marsh_Water_Database.xls.

Conductivity data is collected monthly by volunteer R. Reitstetter (or substitute) and entered monthly onto his personal computer. Data files are copied each month to the station's server in a shared drive "Group Data" and then backed up on a common flash drive.

2015 Maintenance Activities

Major maintenance was performed within the northwest portion of the Avocet Unit, which was drawn down. For more details on this work, see the appendices directly following.

Future Maintenance and Monitoring Needs

The most urgent maintenance needs completed in 2015 were focused just downstream of the South Springs Complex in the northwest potion of Avocet Unit. In 2016, work is planned within the Special Hunt Blind area of the same unit. Capability of water delivery in this area had become severely diminished, which affects the whole impoundment system, being that it's on the upstream end and includes the main delivery canal. In addition, backed-up water flows within this area result in back pressure on the South Springs Complex spring flumes.

2016 Water Use Plan

Introduction

In 2016, the draft Habitat Management Plan (DHMP) will continue to direct water management strategies and prescriptions. Completion and approval of a final HMP is expected during 2016.

2016 DHMP Water Management

Water Level Management Strategies and Prescriptions by DHMP Objective

- *Permanently Flooded Wetland and Open Water Objective*

Permanently flooded areas on the Refuge include spring basins and wetland areas immediately downstream of springs (Map-1).

- Assess condition of flume wing walls to insure full capture of flow by eliminating leakage bypassing the flume caused by muskrat or other similar activity.
- Assess the alignment of flumes and correct issues with submergence and shifting.
- Assess condition and performance of dams and water delivery diches that direct flow between and from the springs to insure that all spring flow is accounted for at measuring locations; then correct issues when problems found.
- Re-conduct removal treatments of native and nonnative fish to eradicate competitive species in Walter spring.

- *Semi-permanently Flooded Wetland and Open Water Objective*

Semi-permanently flooded areas on the Refuge include the three main impoundment pools nearest the South Springs Complex, including Mallard, Shoveler, and Avocet, as well as individual sub-impoundment areas that collectively make up Southwest Curlew within the Curlew Unit, as well as lesser impoundments within the far western portion of Avocet unit (Map-1 and Map-2).

Maintain all impoundment pools at or near long-established optimum pool levels year round, except when dewatered.

- During the waterbird breeding season, water levels are to be stabilized at optimum pool level.
- During spring and fall migration seasons, water levels can be increased above optimum pool level for intermittent flooding of additional sites to provide additional foraging opportunities.
- During late fall and winter seasons, concentrate water flows within prescribed water delivery patterns and sites in order to maintain those areas ice-free (see Map-3).

Draw down semi-permanent and seasonal impoundment pools in Avocet unit (minus the main impoundment pool supporting flooded saltgrass – see strategies and prescriptions for the seasonally flooded wetland and open water objective).

- Initiate drawdown in January.
- Coordinate a prescribed burn within the dewatered area (also see the fire management strategy prescription section below).
- Additional pool level reduction in the remaining pool area can be extended until as late as late-May to provide for shorebird and other waterbird foraging opportunities during spring migration and the onset of breeding season.

- Coordinate prescribed chemical and mechanical control treatments within the dewatered areas (see the chemical and mechanical management strategy prescription sections, below).

In addition, 1-2 pools (Ibis and/or Pintail) will on occasion provide semi-permanently flooded wetland habitat, as prescribed annually within the seasonally flooded wetlands objective.

- *Seasonally Flooded Wetland and Open Water Objective*

Seasonally flooded areas on the Refuge are depicted in Map-1, as further defined by sub-sections depicted in Map-4, including:

Subpart-1: Open water/SAV, shallow-pool/sheet-water, and/or fringe mudflat
Subpart-2: Expansive saltgrass flats
Subpart-3: Native slough channels and channel-braided marsh

Water level and flow management strategies and prescriptions to be completed 2016:

Subpart-1: Open water/SAV, shallow-pool/sheet-water, and/or fringe mudflat

Seasonally flood the four northern main impoundment pools of Pintail, Harrison, Ibis, and Gadwall at or near 0.5 feet above established optimum pool levels by the end of January each year (Map-1 and Map-4).

- Annually provide seasonal shallow-pool/sheet-water and fringed mudflat habitats during migration and breeding seasons by drawing down three of the four pools from full to reduced pool levels in stepwise order, as prescribed following, and then allow the three reduced pools levels to evaporate down.
    - Initiate early-season partial drawdown (for reduced pool level) between April 1-30 in the Gadwall pool, allowing said pool to eventually evaporate dry.
    - Initiate mid-season partial drawdown (for reduced pool level) between June 1st and July 15th in the Harrison pool, allowing said pool to eventually evaporate dry.
    - Provide late season reduced shallow-pool habitat into September in the Ibis pool, by allowing the pool to evaporate down during mid-summer.
    - Maintain semi-permanent water conditions in the Pintail pool to help flood out encroaching saltgrass and other undesirable vegetation on pool bottoms, as well as to provide SAV habitat growth for avian use during migration and breeding seasons by maintaining the targeted pool at optimum pool levels, or up to 0.5 feet above, for as long as possible into the growing/nesting season, and then into spring of the following year.

Subpart-2: Expansive saltgrass flats

Seasonally flood the two main impoundment pools of Egret and Curlew at or near 0.5 feet above established optimum pool levels by the end of January each year (Map-1 and Map-4).

- Annually provide seasonally flooded saltgrass flats during migration and breeding seasons by drawing down impounded pools from full to reduced pool levels between April 1 and May 15, and then allow the reduced pool levels to evaporate down. Initiate partial drawdown (for reduced pools) at different times among the two pools.
- The prescription will be modified as needed in the main pool of Curlew, due to the rest of that unit being fully dewatered in January.

Subpart-3: Native slough channels and channel-braided marsh

Seasonally flood designated native slough channels and channel-braided marsh by the end of January each year; this includes areas immediately east of the impoundment system by releasing/flushing water from the impoundment system (Map-1). Restrict water inflows by June 1 and allow site water levels to evaporate down.

- The prescription will be modified in the Curlew unit within this area, as it will be fully dewatered in January for prescription burning.

- *Saturated/Intermittently Flooded Wetland Objective*

Water levels for this objective (Map-1) are indirectly managed through the water management strategies and prescriptions of the other wetland objectives.

2016 Monitoring

Water quality monitoring will be maintained as done since 2010. Additional monitoring is under development within the Inventory and Monitoring Plan as part of the HMP development.

APPENDIX A

FY2015 Water Delivery System: Annual Maintenance Plan and Completion Report

<u>Avocet Unit</u>

In 2015, major maintenance work was performed within the northwest section of the Avocet Unit. The impoundment area was modified through rehabilitation, new construction, and removal of a number of small dams and levees located within the project area. Water delivery flows were also modified through channel dredging, small dam/road removal, landscape reconfiguration, and installation of water control structures at new locations. In 2014 and 2015, common reed was chemically treated and later mowed within the project area. Cattail was allowed to dry and desiccate. Much of the projected impoundment area was disked in order to break down dense root-mats of cattail and common reed. Previously, the project area contained the most extensive site of dense common reed and cattail on the Refuge. Flooded open water areas are expected to be dominated by wigeongrass and sago pondweed, and shallow-flooded and shoreline areas are expected to be dominated by tall emergent vegetation. All flooded sites will have high capacity to be maintained ice-free during winter. Previously, water flows into the project area from the main collection canal had become severely restricted.

Map-1. Avocet Unit 2015 Infrastructure Project Area as Newly Modified.