Quivira National Wildlife Refuge

Claim of Impairment Inquiry, March 2014

This document is a response from the U.S. Fish & Wildlife Service (Service) to questions posed by the Kansas Division of Water Resources (Chief Engineer's letter dated October 21, 2013) following a formal request for an investigation of impairment. For additional information on Refuge management of water resources and relationships with the larger Rattlesnake Creek Subbasin, examination of the 1998 water resources study by Burns & McDonnell, Consulting Engineers (Burns and McDonnell, Consulting Engineers, 1998), and Kansas Geological Survey Open File Reports 92-6 and 93-7 (Sophocleous & Perkins, 1992), (Sophocleous & Perkins, 1993) is recommended.

Under what circumstances does Quivira claim that impairment has occurred? Examples of specific dates of the past where this has occurred would be helpful.

Quivira claims impairment to Water Right File No. 7571 when streamflow to the Refuge is insufficient to meet management objectives, which often occurs when junior water rights continue to be exercised throughout the Rattlesnake Creek Subbasin. Impairment is most apparent during relatively dry periods, therefore many cases of impairment exist. An example of a specific time period when this occurred is in 2012, when drought conditions in Kansas severely stressed water resources, but irrigators in the Subbasin received concessions (through Drought Term Permits) that allowed them to use more water than authorized. The Refuge had no surface water diversions starting in May through December, when typically some water is needed for irrigation of wetland plants associated with food production for waterbirds and for subsequent flooding of units for use by migrating birds in fall. At the same time, use of water upstream of the Refuge continued over the growing season. Rattlesnake Creek and the groundwater aquifer are hydraulically connected, and the additional stress to the groundwater aquifer caused by pumping for agricultural purposes and other water uses negatively affected streamflow in Rattlesnake Creek to such an extent that there were extended periods of no flow recorded at the USGS Zenith Gage in 2012.

The Quivira National Wildlife Refuge needs water during critical time periods to meet the legislative purposes of the refuge establishment under the 1929 Migratory Bird Conservation and Fish and Wildlife Acts as well as the National Wildlife Refuge System Improvement Act of 1997. For example, a primary purpose of the Refuge is to protect and manage habitat to support migratory birds. Prior to extensive agricultural development in the Subbasin, Refuge water needs were met by annual fluctuation in surface flows and groundwater discharge. However, current stream flows are insufficient to meet Refuge water needs during critical times because maximum irrigation pumping, possibly combined with other water uses in the watershed, often coincide with, or otherwise negatively affect, stream flow entering the Refuge. Water shortages at the Refuge typically occur at periods from late spring/early summer to early fall (before underflow, which begins after most pumping ends), and are most extreme when storage water in Little Salt Marsh is low or depleted. Water cannot be diverted from the Little Salt Marsh unless levels

are above the water control structures, which are not at the lowest elevation of the marsh. Timing of water availability is critical to ensuring:

- Adequate production of wetland plants (seeds, tubers, stems) and aquatic invertebrates that serve as food resources for wildlife, including migratory waterfowl, shorebirds, and other waterbirds that are trust resources of the Service. This often requires dewatering wetlands during spring to stimulate germination of desirable plant species and irrigation during late spring and summer to promote maximum seed production. These practices also facilitate decomposition and cycling of nutrients, which is important for both plant and invertebrate production.
- Appropriate vegetation structure is produced that is required to support breeding and migration of migratory birds and other wildlife. Primary migration periods are spring and fall, whereas breeding occurs in summer.
- Foods and cover that are produced annually can be made available to migratory birds and other wildlife. The range of water depths that provide optimum foraging habitat varies by species, but waterfowl typically forage in water depths less than 15 inches and larger shorebirds forage in water depths less than 4 inches. Providing food resources for waterbirds is most critical during spring, summer, and fall.
- Adequate winter habitat.

Considering the above factors, stacking/storing water in management units directly contradicts the best available scientific information on which refuge management is based. Furthermore, the Refuge doesn't have the capability to store enough water to manage this way. Maintaining flow across the Refuge throughout the year is the best management practice. Management goals, objectives, and associated rationale are described in more detail in the Refuge's Comprehensive Conservation Plan, available later this spring.

Water use has increased in the district over many decades, but Sophocleous and Perkins reported cumulative groundwater rights (vested and appropriated) in Big Bend Groundwater Management District #5 (GMD#5) increased from about 100,000 ac-ft/year in 1965 to about 750,000 in 1990 (Sophocleous M. P., 1993). In 1984, when cumulative groundwater rights were already slightly above 700,000 AFY, Minimum Desirable Streamflow (MDS) criteria at the USGS Zenith gage were developed by the Kansas Division of Water Resources to quantify minimum flows necessary to create and maintain critical habitat without encountering site or system degradation. MDS criteria were developed as achievable minimum flow targets based on the record. The MDS criteria are as follows: January through June is 15 cfs, July is 5 cfs, August through October is 3 cfs, November is 10 cfs, and December is 15 cfs. The Kansas Chief Engineer is required to administer water rights whenever MDS is not met for seven consecutive days at the USGS Zenith gage.

In 1993, the Quivira Partnership (Partnership) was formed as a voluntary cooperative effort to resolve sub-basin issues of aquifer depletion and streamflow impairment without State administration. Partners include the Service, GMD#5, WaterPack, and the Kansas DWR. In June 2000, after six years of Partnership negotiations, the Rattlesnake Creek Subbasin Management Program Proposal (Management Program) was formalized and all members of the Partnership signed the agreement. The Management Program identified specific management strategies for reducing water use, including goals to reduce irrigated acres, improve water conservation, and maintain flows in Rattlesnake Creek. A ten-year average

of 25 cfs in January (mean monthly discharge at the USGS Zenith gage) was determined by the Partnership early on as a benchmark indicator of overall Subbasin health. The 12-year review of Partnership goals concluded that no significant reduction in irrigated acres had occurred and the amount of irrigation water applied per acre had remained generally constant. However, aquifer levels continue to decline, the 10-year January flow is below the target, and streamflow in Rattlesnake Creek has not improved.

Table 1 shows mean monthly discharge at the USGS Zenith gage on Rattlesnake Creek, with average monthly flows less than MDS, highlighted in red. Note the trend of low flows in late summer/early fall, and that in 1991 MDS was not met 100% of the year. Blue highlight indicates years with higher than average precipitation.

Table 1: USGS Mean Monthly Steamflow Data at the Zenith Gage (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973										690.6	184.8	269.8
1974	191.6	140.6	173.5	160.6	105.2	79.8	38.9	45.5	51.6	53.4	66.5	82.4
1975	80.7	86.3	82.1	83	65.2	177.1	131.5	79.5	60.8	32.9	54	57.6
1976	52.4	65.3	55.8	271.9	189.4	69.7	79.1	22.9	33.1	33.2	43.9	61.9
1977	38.1	47.8	52.6	59.7	160.2	146.2	46.2	32.7	43.7	39.2	44.5	49
1978	50.8	57.9	92.2	52.1	120.6	222.7	30.5	11	9.07	11.9	28.2	33.1
1979	27.8	46.1	75.1	57.6	48.7	33.1	24.6	32.6	6.87	6.51	44.3	35.9
1980	40	59.7	93.2	99.1	59.5	49.7	15.2	7.92	2.78	2.37	9.08	23.5
1981	22	21.5	26.7	21.2	46.9	46.2	20.4	8.42	5.48	7.2	34.9	25.2
1982	25.1	47.7	38	26.1	36.2	35.8	21.9	6.5	4.28	5.46	8.53	11.3
1983	14.7	29.1	29	75.5	68.5	88.7	16.7	2.99	2.29	3.04	9.04	8.46
1984	17.3	21.1	61.3	72.5	47.9	20	6.24	1.51	0.855	3.42	3.27	15.7
1985	8.58	23.6	25.9	31.3	46.1	23.9	8.39	9.94	6.01	59.4	22.4	25.9
1986	27.7	28.5	24.6	23.4	16.4	16.4	45.5	14.2	17.9	21.6	20.1	23.4
1987	22.6	29.9	207.4	132.1	61.5	40.3	108	53.5	28.7	23.6	32.4	40.7
1988	46.8	41.2	44.2	60.4	34.4	21.8	9.46	2.65	1.47	2.65	6.61	7.86
1989	11.4	9.3	15.5	11.3	40.4	39.9	27.8	13.8	24.7	8.32	9.07	8.79
1990	16.2	19.9	28.7	34.5	56.1	44	6.35	3.8	2.16	4.17	7.4	6.78
1991	8.28	9.5	11.3	11.2	8.12	10.2	1.54	0.875	0.091	0.046	3.64	5.56
1992	6.48	6.64	7.78	6.47	5.24	37.3	22.2	18.1	4.53	5.44	10.2	21.5
1993	31.8	57.4	86.4	48.2	177.8	595.9	1,099	49.6	30.6	30.5	39	43
1994	41.4	41.7	37.5	40.8	35.3	11.7	7.24	3.65	1.35	5.83	7.16	12.1
1995	14.4	15	18.1	21.5	370.9	100.2	84.7	19.6	6.42	8.05	13	18.6
1996	22.1	22.9	26.9	31	55.1	57.7	10.2	29.8	93.3	70.4	60.4	50.3
1997	45	59.5	54.2	60.4	42.2	49.5	40.3	63.9	35	41.9	49.7	63.3
1998	71	81.5	135.5	131.1	66.2	36.6	28	18.2	4.9	22.9	62.7	37.8
1999	45	71.4	70.1	93.9	64	50.6	110.5	17.2	13.9	17.6	23.1	30.5
2000	37.5	45.6	159.5	80.3	64.5	33.1	56.4	21	4.32	14.4	36.9	25.2
2001	34.3	68.2	65.5	45.5	70	129.4	14.3	6.9	7.45	7.13	11.8	14.7
2002	17.8	23.8	22.9	22.3	18.6	21	6.07	6.32	3.76	14.7	12	13.1
2003	14.7	17.2	48.1	29.5	31.4	14.1	4.51	3	3.26	7.29	6.48	8.71
2004	9.13	8.8	24.5	13.2	15.8	8.85	20.7	21	6.75	11.6	16.5	17.6
2005	15.3	27.9	19.2	20.4	19.6	30	22.4	26.8	9.97	5.81	9.02	12
2006	13.4	16.9	17.6	14.4	9.81	7.7	4.25	8.13	3.04	5.39	6.64	10.4
2007	14.9	13.5	23.8	152.6	399.9	133.1	218.7	30	19	18.1	23.5	53.4
2008	47.8	45.6	40.7	75.3	131.9	46.1	20	18.4	13.9	82.4	40.2	35.5
2009	34.6	37	38.7	187.8	179.9	191.9	38.7	25.7	21.2	26.8	33.2	30
2010	40.7	55.9	55.9	43.9	38	68.6	76.2	61	21.9	15.5	36.7	33.7
2011	30.3	52	37.7	33.4	25.9	12.3	3.06	2.62	0.265	2.28	6.96	8.73
2012	9.05	15.4	18.6	17.9	6.54	3.57	0.195	0.655	0.141	0.665	3.23	3.39

Though MDS criteria were developed for mean daily flows, the red highlights in Table 1 identify months or successive months where mean monthly flow did not surpass MDS. However, a single storm event can often raise mean monthly flow to above MDS level, even though much of the month may not be above

MDS. Therefore, the red highlights in Table 1 represent the worst-case examples and primarily illustrate sustained low-flow conditions.

What quantity of water does Quivira claim it was impaired during these circumstances?

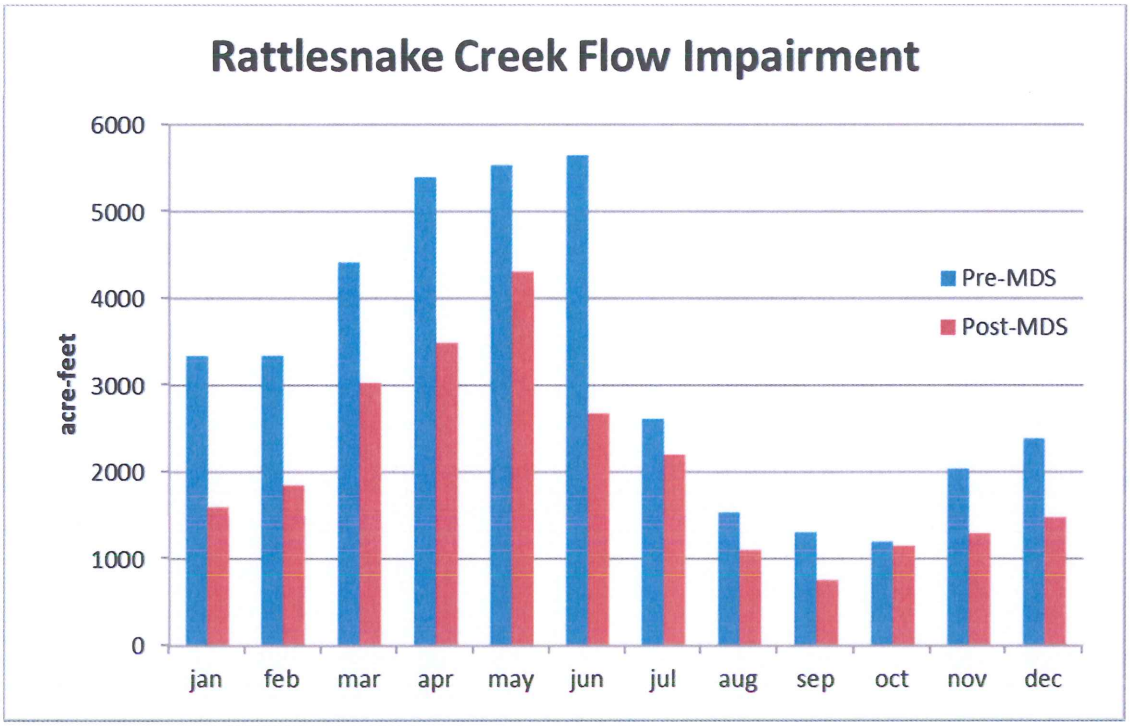


Figure 1: Rattlesnake Creek Flow Impairment

Intense groundwater pumping gained popularity with the advent of improved irrigation design in the mid 1970's. As the use of this technology increased in the Rattlesnake Creek watershed, it is likely that the frequency and magnitude of aquifer depletions and impairment of Rattlesnake Creek streamflow increased, as indicated in several publications (Falk, 2006) (Sophocleous M. P., 1993) (Sophocleous, Koelliker, Govindaraju, Birdie, Ramireddygari, & Perkins, 1999) (Sophocleous M. , 2000). Using MDS data prior to and after 1984 (the year that MDS was established for Rattlesnake Creek) is one quantitative method for determining the extent of impairment to the refuge because it provides a comparison between impacts associated with early groundwater development conditions and current full (or over-appropriated) development conditions. However, this comparison would be expected to provide conservative estimates of impairment given that much of the increase in water use had already occurred by 1984. The average annual streamflow in Rattlesnake Creek from 1974 to 1983 (pre-MDS) was 38,859 acre-feet per year (AFY). From 1984 to 2011 (post-MDS) average annual discharge was 28,442 AFY. Therefore, the average annual impairment to streamflow since MDS inception can be estimated to be 10,417 AFY.

Another method to quantify impairment is to compare the amount of Water Right File No. 7571 that would be fulfilled relative to MDS flows in Rattlesnake Creek. If no flow from Rattlesnake Creek came to the Refuge for the entire year, impairment to Water Right File No. 7571 would be 14,632 acre-feet, the

entire water right. If Rattlesnake Creek flows remained at MDS values all year, impairment to the Refuge would be 7061 acre-feet (14,632 acre-feet minus 7,557 acre-feet), assuming all flow at the USGS Zenith gage enters the Refuge. Note that MDS flows only provide the Refuge with about 50% of its senior water right. Both of the above methods only attempt to quantify the total annual impairment and do not take into account seasonal water needs of the Refuge, which form the basis for ecological management of the Refuge. In addition, impairment to streamflow on the Refuge depends on carry-over storage in the Little Salt Marsh, which is influenced not only by streamflow but also climatic variables (temperature, wind speed, etc.) that influence evaporation. Thus, the seasonal water needs required to meet Refuge purposes need to be assessed.

Evaluation of average monthly MDS values during the period since MDS inception (Figure 1) provides a qualitative assessment of seasonal impairment. This data indicates impairment is greatest in spring and fall, when the Refuge needs water to stimulate germination and growth of food-producing plants, ensure appropriate vegetation structure, and flood wetlands to make these resources available to migratory birds and other wildlife. To better quantify the magnitude of impairment, we developed a Monthly average of Water Needs (AWN) scenario that divides Water Right 7571 into monthly flows. AWN flows for each month were based on average monthly Rattlesnake Creek flows at Zenith from 1984 through 2012. This method is somewhat imprecise because monthly flows during this period do not accurately reflect the influence of water use trends. Mean annual discharge for this period was 27,824 acre feet. AWN values are all less than the mean monthly values from the period; thus, we assume that such flows are feasible. The sum of the differences between the AWN values and average mean monthly flows for the year can be considered a conservative estimate of impairment on an annual basis. It is important to reiterate that water needs can vary drastically within and among years, largely depending on numerous factors including the frequency, timing, and magnitude of precipitation events, temperature, dynamic environmental conditions, and human water use in the Subbasin among others. For example, during months when mean monthly flow exceeds AWN values, there would be no monthly impairment. Therefore, Table 2 shows calculated impairment for selected years when water availability to the Refuge has been limited to illustrate impacts occurring during dry to moderately dry periods.

Table 2: Monthly Impairment for selected years

	1984	1987	1991	1995	2002	2006	2011	2012
Jan	-7.7	-2.4	-16.72	-10.6	-7.2	-11.6	0	-15.95
Feb	-3.9	0	-15.5	-10	-1.2	-8.1	0	-9.6
Mar	0	0	-13.7	-6.9	-2.1	-7.4	0	-6.4
Apr	0	0	-13.8	-3.5	-2.7	-10.6	0	-7.1
May	0	0	-21.88	0	-11.4	-20.19	-4.1	-23.46
Jun	-5	0	-14.8	0	-4	-17.3	-12.7	-21.43
Jul	-3.76	0	-8.46	0	-3.93	-5.75	-6.94	-9.805
Aug	-8.49	0	-9.125	0	-3.68	-1.87	-7.38	-9.345
Sep	-9.145	0	-9.909	-3.58	-6.24	-6.96	-9.735	-9.859
Oct	-11.58	0	-14.954	-6.95	-0.3	-9.61	-12.72	-14.335
Nov	-16.73	0	-16.36	-7	-8	-13.36	-13.04	-16.77
Dec	-9.3	0	-19.44	-6.4	-11.9	-14.6	-16.27	-21.61
sum cfs	-75.6	-2.4	-174.6	-54.9	-62.7	-127.3	-82.9	-165.7
impairment AFY	4498	143	10392	3268	3728	7577	4932	9857

Additional factors to consider in quantifying impairment are storage in Little Salt Marsh, transmission loss, and evaporation and transpiration (ET). Little Salt Marsh holds about 5,000 acre feet of Rattlesnake Creek water. If water needs on the Refuge required the diversion of water from Little Salt Marsh, and subsequent storage depletion, then streamflow in Rattlesnake Creek is used to re-fill the marsh and replenish storage. Transmission losses include infiltration within dry canals and the initial wetting of dry management units. Transmission losses are greatest when lands have been dried. ET losses occur at varying rates, depending on amount of open water, wind speeds, lushness of vegetation, and temperature. The impairment calculations in Table 2 are conservative because they omit flow requirements to replace storage, losses from infiltration, and losses to ET.

What is/are the criteria upon which Quivira bases its impairment complaint?

Studies, observations, Refuge records, and models throughout the years substantiate impairment claims. In 1993, the Service agreed to work with the Partnership to resolve issues of over-drafting on the groundwater aquifers that contribute to streamflow depletions in Rattlesnake Creek. Groundwater use has increased through the 12-year management period, and streamflow conditions have continued to worsen. The Partnership and the Management Program were unable to accomplish goals set in the plan. Consequently, the Service has requested an investigation to resolve impairment to Water Right File No. 7571 through formal processes.

At a minimum, impairment to Water Right File No. 7571 may be based on the following:

- Multiple studies, observations, refuge reports, and models indicate and/or acknowledge water deficiencies in the watershed and impacts to the refuge area (Falk, 2006) (Sophocleous M. P., 1993) (Sophocleous, Koelliker, Govindaraju, Birdie, Ramireddygari, & Perkins, 1999) (Sophocleous M. , 2000);

- Multiple studies and models demonstrate groundwater/surface water connectivity (Falk, 2006) (Sophocleous M. P., 1993) (Sophocleous, Koelliker, Govindaraju, Birdie, Ramireddygari, & Perkins, 1999) (Sophocleous M. , 2000);
- Groundwater use continues to increase;
- Mean annual streamflow at Zenith shows a decreasing trend (USGS, 2014);
- Partners agreed upon the need to reduce water-use in the Rattlesnake Creek Subbasin.

What were the impacts that resulted from the impairment? Can the impacts be quantified? If so, then what are the quantified impacts?

The impact of streamflow impairment to Rattlesnake Creek is readily visible on the Refuge as reduced acres of flooded wetland habitat and reduced wetland quality (e.g., reduced food quantity), but impact of the impairment extends beyond Refuge boundaries. The Refuge is a critical stopover site for migrating birds during the spring and fall as evidenced by the designation of the Refuge as a Ramsar Wetland of International Importance and Western Hemisphere Shorebird Reserve Network site. In addition, the Refuge is designated as critical habitat for the federally endangered whooping crane, which utilize wetland habitats on the Refuge. The operations on the Refuge help to conserve these historic wetland habitats and manage created wetlands necessary to meet the trust obligations of the Service by ensuring water is available to produce foods and cover vegetation, provide open water, and enable safe sanctuary. Impaired streamflow in Rattlesnake Creek directly affects the quality and quantity of managed wetlands, the associated wet meadows on the Refuge, and likely influence some upland habitat as well (e.g., due to decrease in groundwater). The loss of wetland area and/or reduced wetland quality on the Refuge can have negative impacts on regional and continental migratory bird populations as stopover sites are critical for breeding success at more northern latitudes. Evidence of this impact may not be evident for several years.

Aquifer depletions across the Central Flyway, combined with wetland drainage in the northern states, is reducing total wetland habitat from Mexico to Canada. Alternative stopover sites are becoming fewer, and farther between. The reliability of safe sanctuary during the migrations is essential for ensuring the safety and health of the birds. With depleted storage in Little Salt Marsh and reduced streamflow coming into the Refuge, management of critical habitat becomes restricted. Decisions are made concerning priority and effectiveness of managed wetland units.

Are Quivira's operational practices designed to make full use of the water management options that are available to the refuge reasonably ensuring that the water diverted from Rattlesnake Creek is put to beneficial use? For example, are the storage options within the refuge being fully exploited to take advantage of times when there is more water available from Rattlesnake Creek?

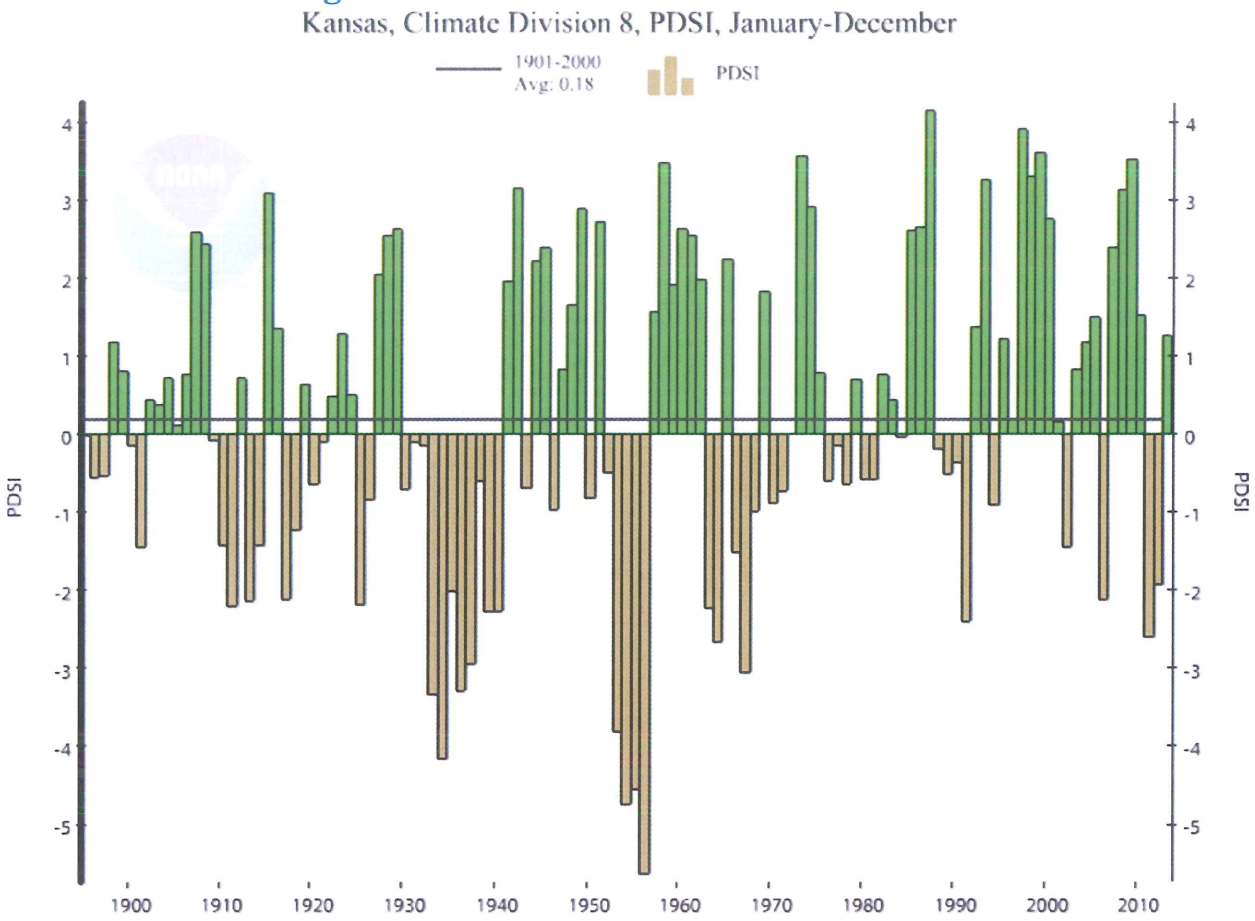
A 1998 study by Burns and McDonnell examined water management options to increase water-use efficiency. Included was an evaluation of storage options, alternatives for the operation of the Refuge water conveyance system, and recommendations. The study was funded through the Service with a special appropriation negotiated by the Partnership. None of the alternatives studied were considered to

have significant impacts, and would not increase wildlife habitat on the Refuge. They conclude that the water available in Rattlesnake Creek (based on post-aquifer development, impaired flows) is insufficient to adequately support the operation of the Refuge.

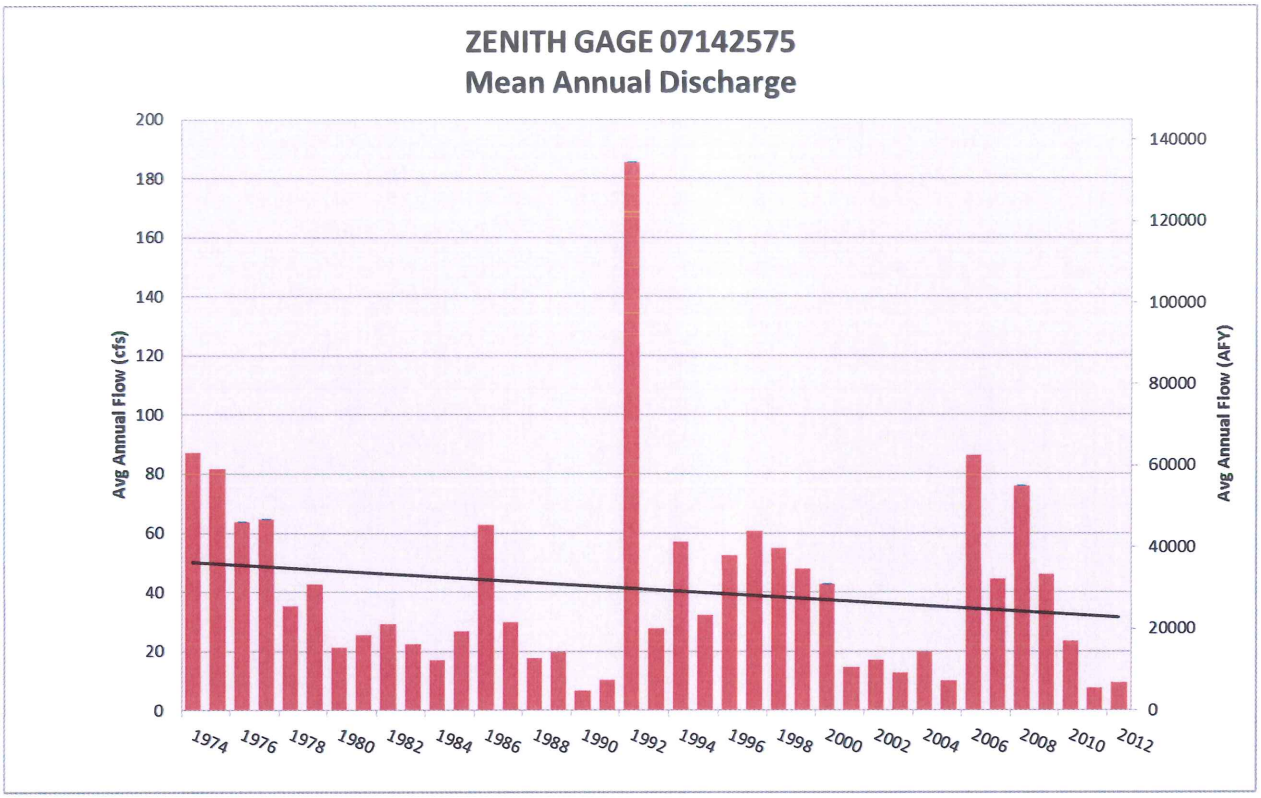
Based on the recommendations in the Burns and McDonnell study (1998), combined with Refuge expertise, the water management and manipulation at the Refuge meets the following criteria:

- Storage is utilized to its full potential, given annual climatic conditions.
- Water control structures are intensively managed for optimum manipulation of water.
- Ineffective or non-productive areas are being reclaimed (e.g., many borrow areas have been re-contoured; hundreds of salt cedar and Russian olive trees have been removed) for more efficient water use.
- Water metering at the points-of-diversion from Rattlesnake Creek is active.
- Area/capacity relationships for 40 wetland units on the Refuge were developed in 2012 using high resolution topographic data derived from LIDAR, and incorporating field-surveyed data. These relationships identified over 6,000 acres of wetlands on the Refuge, which require more than 13,000 acre-feet of water for wildlife habitat at full potential (note that this number is volume only, and excludes the amount of water necessary to offset evapotranspiriation). These volumes represent full pool flooding of the 40 wetland units; full pool flooding is not always the best management practice. But to provide wetland habitat during both spring and fall migration, substantial water volumes are needed during these two time periods. Understanding these relationships, combined with the biological expertise of Refuge staff, enables prioritization of water use.

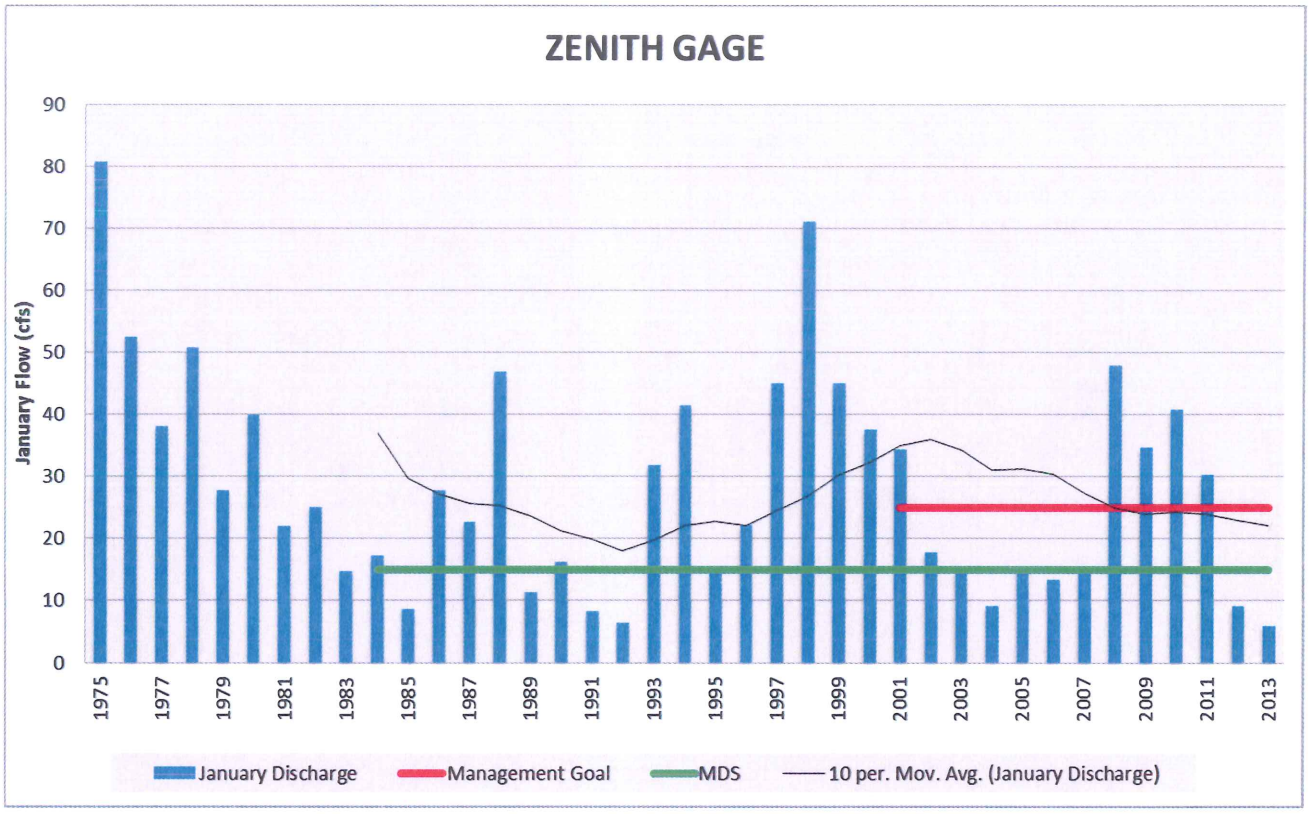
APPENDIX A: Images



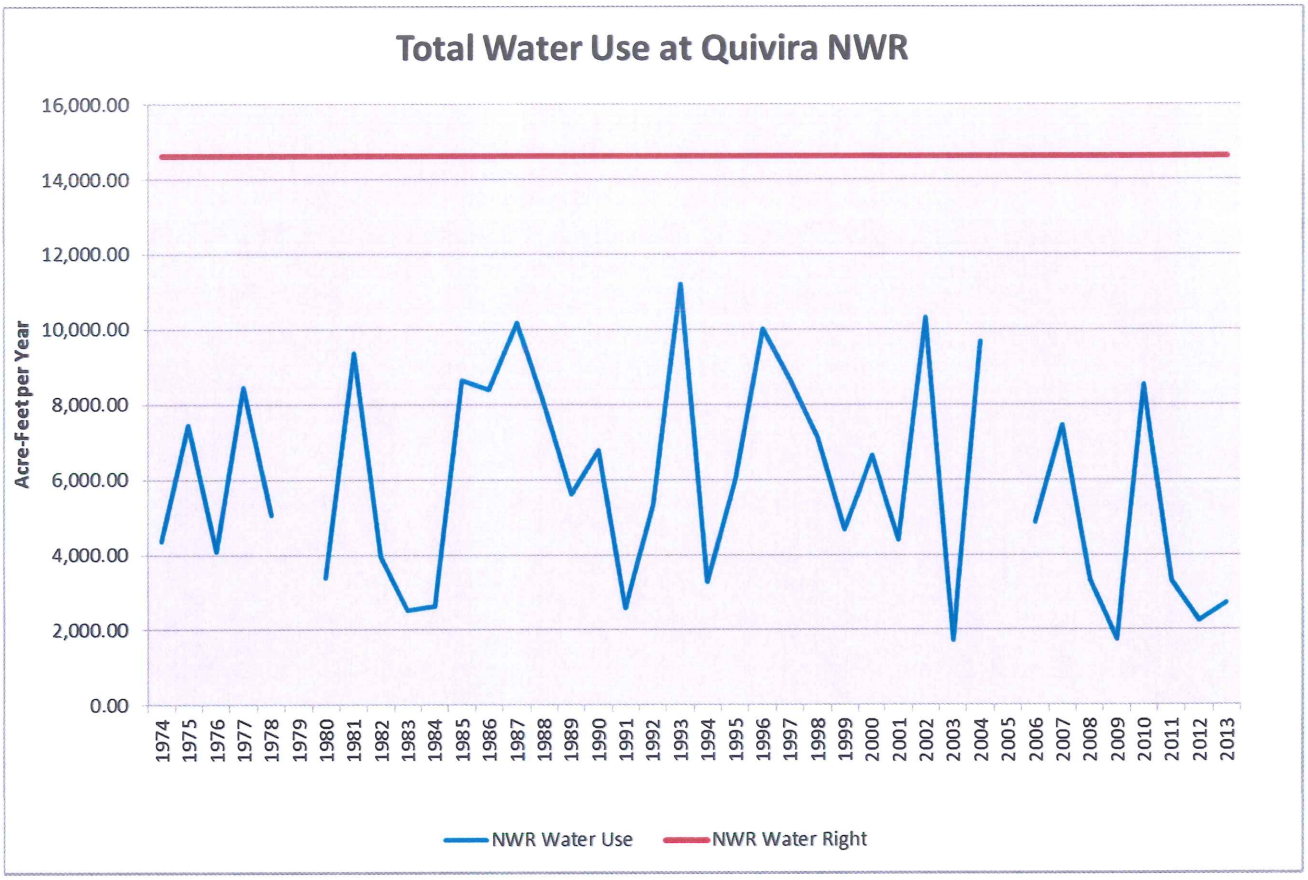
Palmer Drought Severity Index, KS Climate Division 8, 1895 - 2013



Mean Annual Discharge, Zenith, 1973 – 2013



January Discharge at Zenith



Total Water Use at Quivira NWR, measured at the legal Points-of-Diversion, excluding water used to fill and maintain the Little Salt Marsh. Water use in some years is constrained by lack of sufficient water being available throughout the year or at critical times during the year. Following frequent and/or significant precipitation events and when groundwater flows contribute to surface water on the Refuge, the need for the Refuge to divert surface water from Rattlesnake Creek is not always necessary.

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