CHANGES TO THE SEEDSKADEE ECOSYSTEM

This study obtained information on contemporary: 1) physical features, 2) land use and management, 3) hydrology, 4) vegetation communities, and 5) fish and wildlife populations of Seedskadee NWR. These data chronicle the history of land and ecosystem changes at and near the refuge from the Presettlement period and provide perspective on when, how, and why alterations have occurred to ecological processes in the NWR and surrounding lands. Data on chronological changes in physical features and land use/management of the region are most available and complete (e.g., from NWR annual narratives, USDA data and records, sequential aerial photographs, hydrology data from the Green River, etc.) while data documenting changes in fish and wildlife populations generally are limited.

SETTLEMENT AND EARLY LAND USE CHANGES

Native people apparently first occupied southwestern Wyoming 10,000 to 12,000 years before the present (BP) (Frison 1978, Miller and Kornfeld 1966). These early people were small groups of hunter-gatherers and had a highly mobile lifestyle that coincided with seasonal availability of resources; they were highly dependent on big game hunting. Native people continued to occupy southwest Wyoming thereafter, but populations apparently were relatively small with localized and often seasonal settlements. Many of these camp sites and population centers were along the Green River because of the more predictable availability of water, wildlife, and shelter (Thompson and Pastor 1995). Inhabitants of the area collected wild plants, hunted large and small animals, and created chipped and ground tools. The Archaic Period (8,000 to 2,000 BP) in North America was drier and warmer than in earlier times and large prey (horse, camel, mammoth, bison) became extinct or smaller and native people shifted to hunt smaller animals (Thompson and Pastor 1995). They also probably made greater use of vegetable foods that apparently occurred during this period; summers may have been spent in mountains and winters were spent in foothills and valleys. Early Archaic subsistence centered around pronghorn, rabbits, and other small animals including fish and birds obtained in the Green River Valley.

By about 2,000 BP, human populations in southwest Wyoming increased and apparently many small villages were established; evidence of early agriculture is found along some waterways. The Shoshone people spread into the Seedskadee region around 700 BP. They were a nomadic tribe that traveled widely and created multiple trails between the Green River floodplain and nearby mountains (USFWS 2002). The Protohistoric Period began when the first European trade goods and people reached the area in the early 1800s and ended with the development of the fur trapping and trade period in the mid-1800s. An important impact on Native American cultures at this time was the use and control of horses, which assisted hunting bison and made transportation easier (Thompson and Pastor 1995).

In 1811, a party of fur traders representing John Jacob Astor's Pacific Fur Company was the first documented Europeans to visit the Green River Basin (Dolin 2010). Donald Mackenzie, a member of this party later joined the British Northwest Company and organized trapping brigades throughout the region and explored crossings of the Green River that would later be used by emigrants. Hundreds of thousands of pioneers crossed the Green River on sections of the Oregon and Mormon Trails through what is now Seedskadee NWR (Fig. 22). The Pony

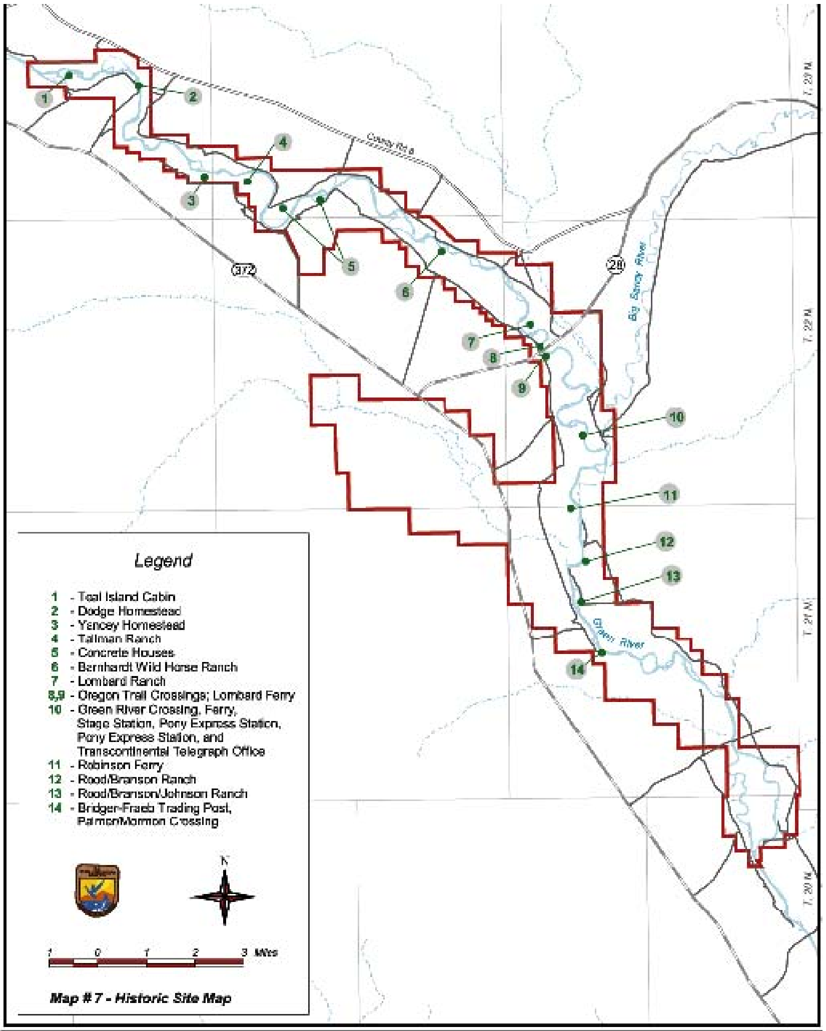

Figure 22. Location of historic sites on Seedskadee National Wildlife Refuge (from USFWS 2002).

Express Trail also crossed the refuge. Jim Bridger and others operated ferries on the Green River in the 1840s and 1850s. The Lombard Ferry, located in the middle part of Seedskadee NWR eventually became the primary crossing of the Green River along the Oregon Trail.

Although the Green River Valley in Wyoming was popular with fur trappers and emigrants, the area offered little attraction for settlers in the mid-1800s because of the remote location, poor soil, and cold climate. Indian uprisings along the Oregon Trail in the 1860s deterred even more settlers. Discovery of gold on South Pass in 1867 stimulated settlement of the area, which was enhanced by the arrival and completion of the Union Pacific Railroad in 1868-69. Soon after, the community of Green River was established. Rock Springs and other towns grew in areas where coal was successfully mined and used to fuel the rail engines. At this time stockmen began to settle the area and by the turn of the century intensive livestock grazing began to degrade and change both riparian and sagebrush steppe communities. Much of the former open range became fenced at this time.

Sweetwater County, that contains Seedskadee NWR, was established in 1865 and is the largest county in Wyoming, covering 10,492 miles^2. The major population centers in the county are Rock Springs and Green River and it currently is the third most populated county in the state. Although the county population is relatively high for Wyoming, much of the county is in public ownership; 68% of the county is public domain administered by the Bureau of Land Management. By the mid-1900s, about 98% of vegetated lands in Sweetwater County were used for livestock grazing. The rich geological formations in the region also led to the development of trona mining and processing, surface coal mining and power generation, oil and gas production, and fertilizer production (Mason and Miller 2005).

CONTEMPORARY LANDSCAPE AND HYDROLOGY CHANGES

The major changes in the Seedskadee NWR ecosystem following more extensive settlement of the region in the late 1800s have been: 1) alterations to distribution, chronology, and abundance of surface and groundwater; 2) alteration of native sagebrush steppe and grassland communities from intensive grazing; 3) reduced and altered riparian woodland; and 4) altered topography including many levees, roads, ditches, borrow areas, and water-control structures on Seedskadee NWR. Additionally, water developments on Seedskadee NWR have impounded many floodplain wetland depressions and created more open water-persistent emergent communities than historically were present.

Agricultural production and extraction of the abundant natural resources in Sweetwater County began to require increasing amounts of water during the mid-1900s (Woolley 1930). Major uses of water in the extraction industry include water used for drilling fluid, secondary recovery of oil, solution mining of trona, and dust control. Water also is used in mine dewatering. Coal bed-methane extraction also required dewatering of coal deposits to release methane gas. The population centers of Green River and Rock Springs obtain water for their use directly from the Green River, while other smaller municipalities in the county rely on groundwater for their public water supply.

Collectively, the attempts to increase agricultural production and supply water for multiple development uses led to the creation of the Seedskadee Project, which was authorized for construction as a part of the 1956 Colorado River Storage Project. The original purpose of the Seedskadee Project was to: 1) divert water from the Green River to deliver irrigation water to 60,720 acres of previously undeveloped desert lands, and 2) develop a wildlife refuge (Seedskadee NWR) to mitigate losses of fish and wildlife habitat (USFWS 2002). Lands proposed for irrigation by the Seedskadee Project were parallel to the Green River and included 51,690 acres of small grain farmlands and 9,030 acres of community pasture. The refuge was to be located along the Green River surrounded by these farm and pasture lands. By 1959, it was determined that a dam and storage reservoir (Fontenelle), as opposed to the originally proposed diversion structure on the Green River, would be required to regulate Green River flows and to deliver irrigation water to farms and the refuge. The 1959 Definite Plan proposed the 18,000-acre Seedskadee NWR with water supplies from irrigation return, Green River, and Fontenelle flows. By the mid-1960s, about 194,000 acres had been withdrawn from public domain, or were acquired by, the Bureau of Reclamation (BOR) for the project and the dam construction and use plans for Fontenelle were modified to include municipal and industrial water storage and use. A stop-order was issued by BOR in 1962 to suspend construction of the originally proposed irrigation delivery canals and infrastructure as it became apparent that the economic feasibility of the original irrigation project was suspect.

Construction of Fontenelle Dam started in 1961 and was completed in 1964. In September 1965, after the reservoir had filled to capacity, water passed through relief cracks in the right abutment, destroyed part of the downstream embankment, and caused high flows and overbank flooding downstream at Seedskadee NWR (Fig. 13). The reservoir was subsequently evacuated and a repair program was completed in 1967. The reservoir was refilled in winter/spring 1967-68 and power generation commenced in May 1968. Total water storage capacity of Fontenelle Reservoir is 345,000 acre-feet that at full pool inundates about 13 miles^2. In 1972, a revised Definite Plan for the Seedskadee Project was prepared that scaled back and phased in acreage that might become irrigated cropland, increased commitments for downstream water for industrial and municipal uses, provided flood control and power generation purposes for Fontenelle Dam, and planed a 34,000 acre-feet annual water supply for Seedskadee NWR. Eventually, the irrigated farm and pasture concept was abandoned as not economically viable for the location and arid climate and because conflicts could arise with successful extraction of underlying and adjacent Green River Basin trona deposits.

Fontenelle Reservoir is managed as part of the extensive Colorado River Reservoir system in accordance with the Colorado River Storage Project Act of 1956, the Colorado River Basin Project Act of 1968, amendments of the Grand Canyon Protection Act of 1992,and the 1944 United States-Mexico Water Treaty. Further, annual operating plans for Fontenelle and other Colorado River Reservoirs are dictated by records of decision (ROD) for the 1996 Glen Canyon Dam ROD, the 1997 Operating Criteria for Glen Canyon Dam, the 1999 Off-stream Storage of Colorado River Water Rule, the 2001 Interim Surplus Guidelines addressing operation of Hoover Dam, the 2006 Flaming Gorge ROD, the 2006 Navajo Dam ROD to implement recommended flows for endangered fish, the 2007 Interim Guidelines for operations of Lake Powell and Lake Mead, and numerous environmental assessments addressing experimental releases from Glen Canyon Dam. Consequently, the BOR, which manages water storage and releases from Fontenelle Reservoir, makes operational decisions annually in response to changing water supply conditions throughout the Colorado River system. The U.S. Congress has charged the Secretary of the Interior with stewardship and responsibility for a wide range of natural, cultural, recreational, and tribal resources within the Colorado River Basin, including the Green River ecosystem at Seedskadee NWR.

Operation of Fontenelle Dam and Reservoir has modified the historical downstream flows of the Green River into and through the Seedskadee NWR and in other downstream Green River floodplain areas. Because the water storage capacity of Fontenelle Reservoir is small relative to inflows from the

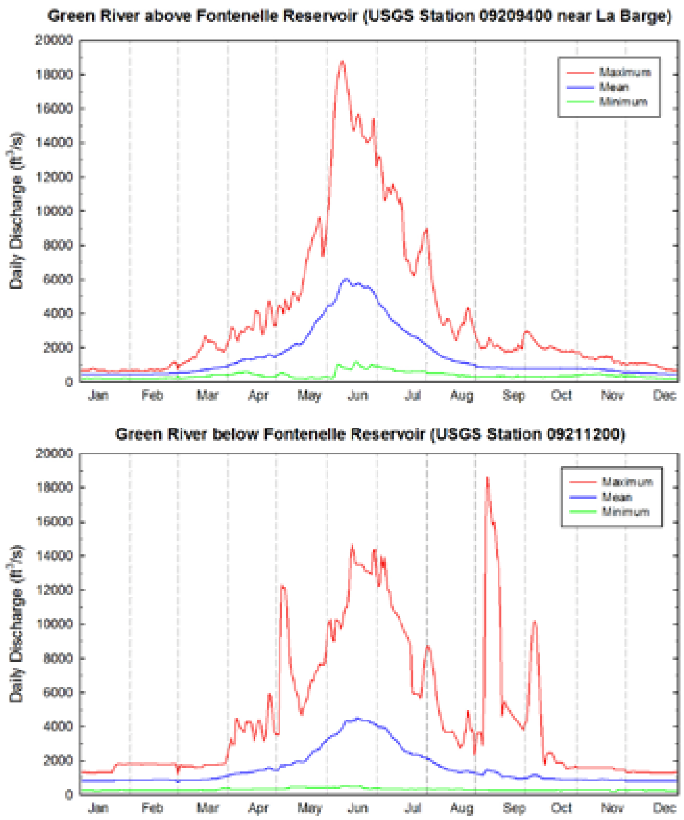

Figure 23. Mean, maximum, and minimum daily discharge (cfs) of the Green River above and below Fontenelle Reservoir, 1964-2009 (data compiled from http://waterdata.usgs.gov/usa/nwis).

Upper Green River Basin, there is limited operational flexibility (USFWS 2002). To accommodate the large spring inflows from snowmelt, reservoir levels are dropped through the winter and early spring to a minimum pool of 93,000 acre-feet by 1 April. Subsequent releases attempt to meet the above mentioned water needs in the Colorado River system. As an example of annual water management, the Fontenelle Reservoir operating plan for 2011 considers the previous year's water supply and downstream flow and storage needs (US BOR 2011). Hydrological conditions in water year 2010 in the Upper Green River Basin were significantly drier than average; inflows to Fontenelle Reservoir from April to July 2010 were only 57% of average because the snow pack conditions in the Upper Green River Basin were only about 65% of average. Further, inflows to Fontenelle Reservoir were below average 9 of the past 10 years and the reservoir did not fill to capacity in water year 2010. In 2010 the reservoir peaked 1.5 feet below spillway level and releases from the reservoir peaked for only 3 days at about 3,050 cfs beginning on 3 July 2010. Releases were then reduced to 1,100 cfs. At the time the 2011 operational plan was written, the BOR estimated that the probable April through July inflow to Fontenelle Reservoir during water year 2011 would be at about 70% of average, which would allow the reservoir to fill and provide slightly higher peak releases in July 2011 compared to July 2010. In actuality, greater late winter and spring snowfall occurred in the Upper Green River Basin in 2011, and peak discharge below Fontenelle Dam was about 8,700 cfs in June 2011.

In general, past operation of Fontenelle Dam has caused water flows in the Green River at Seedskadee NWR to retain a seasonal pattern of increased flows during spring and early summer, but: 1) the spring peak is dampened, 2) occasional high releases, and thus river discharges, occur in fall, and 3) winter flows are somewhat higher than during the pre-reservoir period (Figs. 23,24). Comparing Green River daily discharge during 1964-2009 above Fontenelle Reservoir near La Barge where flows are not affected by Fontenelle Dam to discharges immediately below the dam, the below dam flows had consistently lower June peaks (ca. 14,000 compared to 18,000 cfs), more widely varying discharges, and commonly had a strong September or early October release and high discharge (Fig. 23). From 1952 to 1963, prior to Fontenelle, the mean monthly peak flow in June was 5,466 cfs (Table 5). Post-Fontenelle the mean monthly peak flow in June was 4,518 cfs (Table 9). These flows equated to 325,200 and 268,900 acre-feet of discharge for the same periods, respectively.

Since Fontenelle was constructed, peak flows in the Green River above Fontenelle exceeded 8,000 cfs (a discharge level where at least some minor backwater flooding might occur at Seedskadee NWR) 10 times, but similar discharges of at least 8,000 cfs below the Dam occurred only 3 times (Fig. 24). Since 1966, five flow events above Fontenelle were > 13,000 cfs, while similar flows > 13,000 cfs occurred only three times below the dam (USFWS 2002). From 1971 to 2001, Fontenelle Dam altered natural extremes in seasonal high and low flows, and reduced peak flows in 29 of 38 years (Fig. 25). Long-term data generally indicate that flows in the Green River system have declined from very wet periods in the late 1800s and early 1900s to the present. Discharges at Green River, Wyoming > 20,000 cfs, which would flood most of the Seedskadee NWR floodplain (see earlier Climate and Hydrology section of this report) have not occurred since the 1920s. Flows at the long-term gauge station

Table 9. Monthly and annual streamflow of the Green River after construction of Fontenelle Reservoir 1964-2002 for USGS gauge station #09127000 near Green River, Wyoming (from Mason and Miller 2005).

Month or annual	Water year			Streamflow, in cubic feet per second				Coefficient of variation (unitless)	Percentiles, in cubic feet per second					Mean runoff	
	Begin	End	Total	Maximum	Minimum	Mean	Standard deviation		10th	25th	50th	75th	90th	Acre-feet	Percent of annual
10	1964	2002	39	3,109	279	1,036	497	0.48	510	752	940	1,225	1,413	63,700	5.19
11	1964	2002	39	1,844	281	920	316	.34	484	795	921	1,118	1,261	54,720	4.46
12	1964	2002	39	1,419	272	816	319	.39	408	490	835	1,064	1,210	50,160	4.08
1	1964	2002	39	1,442	266	848	347	.41	367	516	905	1,137	1,257	52,140	4.25
2	1964	2002	39	1,980	267	911	402	.44	380	621	864	1,166	1,340	51,010	4.15
3	1964	2002	39	1,852	350	1,080	418	.39	542	708	1,167	1,365	1,634	66,390	5.41
4	1964	2002	39	3,195	516	1,587	692	.44	782	1,157	1,388	2,007	2,631	94,450	7.69
5	1964	2002	39	5,503	434	2,434	1,395	.57	900	1,298	2,247	3,363	4,480	149,700	12.2
6	1964	2002	39	11,700	414	4,518	2,933	.65	851	2,617	4,151	5,991	8,418	268,900	21.9
7	1964	2002	39	9,416	368	3,310	2,456	.74	798	1,436	2,508	4,820	7,347	203,500	16.6
8	1964	2002	39	3,578	372	1,633	765	.47	611	1,089	1,627	2,100	2,605	100,400	8.18
9	1964	2002	39	7,746	251	1,229	1,140	.93	546	863	1,099	1,261	1,495	73,120	5.95
ANNUAL	1964	2002	39	3,089	576	1,695	657	.39	820	1,204	1,695	2,076	2,454	1,228,000	100

at Green River, Wyoming are affected primarily by the Green River releases at Fontenelle, but also have some contribution from the Big Sandy River. Given this caveat, these flow data from Green River, Wyoming indicate that the frequency and magnitude of Green River flows that would be sufficient to cause at least some overbank and backwater flooding of the Seedskadee NWR floodplain at about 8,000 to 10,000 cfs has been significantly reduced from about once every 2 years to now > 10 years. This reduced early spring and summer flooding has obvious negative consequences of reduced recharge dynamics for floodplain wetlands, drought induced mortality of riparian trees such as cottonwood, and altered nutrient and sediment inputs (Scott et al. 1993, 1999, Mahoney and Rood 1998). In contrast, the operation of Fontenelle Dam has pronounced or exaggerated late summer and early fall discharges compared to historical flows, with potential for occasional flooding, such as occurred in 1970, 1981, 1983, and 1990. This late summer and fall flooding can negatively impact recruitment of riparian and floodplain vegetation by drowning seedlings (Auble et al. 1997).

Comparison of cottonwood stands on aerial photographs from 1965 with 2009 NAIP imagery shows about a

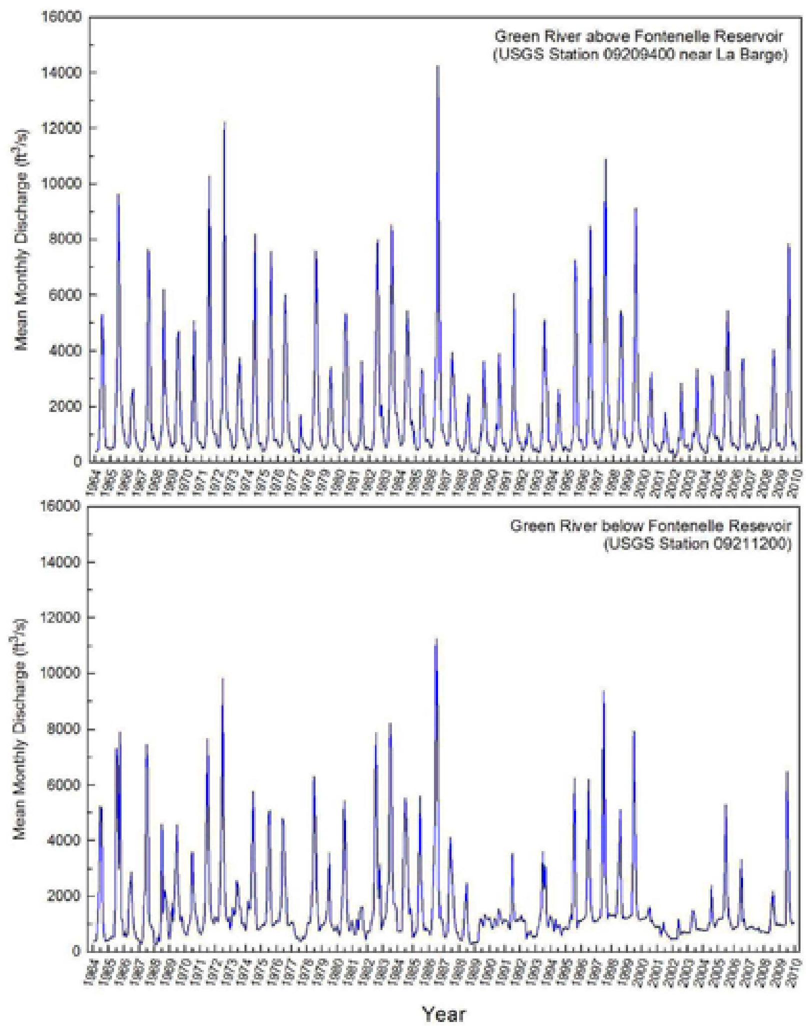

Figure 24. Mean monthly discharge (cfs) of the Green River above and below Fontenelle Reservoir. Long and short marks above year on the x-axis represent 1 January and 30 June, respectively (data compiled from http://waterdata.usgs.gov/usa/nwis).

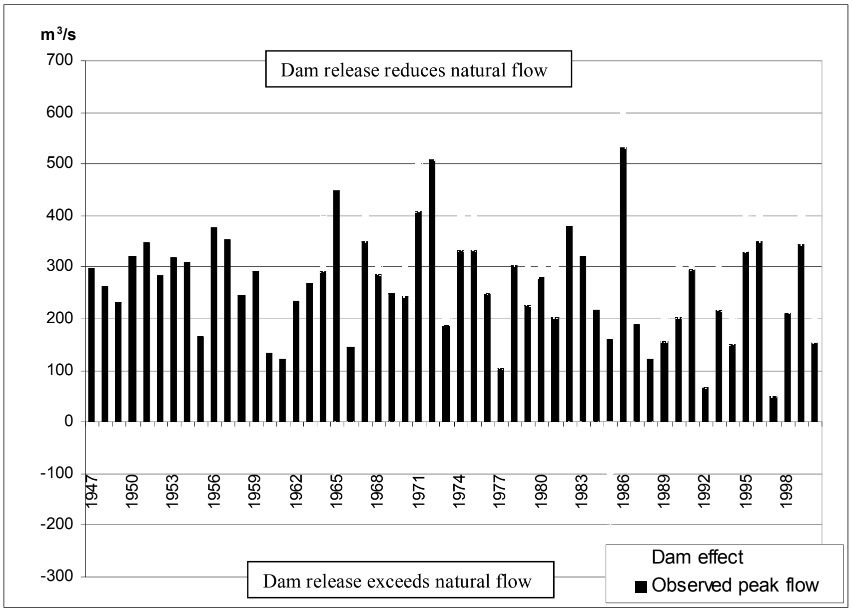

Figure 25. Effects of Fontenelle Dam on peak flows of the Green River 1947-2000. "Dam effect" indicates the difference between inflow and outflow of Fontenelle Reservoir. Negative dam effects indicate that the peak flows below the dam exceeded peak inflows. (from Glass 2002).

60% decrease in area of cottonwood habitats. Habitat mapping based on 1997 color infrared imagery (Fig. 26) also shows a decline in cottonwood areas from the historical extent. Additional analyses of the vegetation radar-return data from the LIDAR flown in 2010 also could be used to provide further information on the current extent of cottonwood and other taller woody and emergent vegetation.

Other realized or potential consequences of Fontenelle Dam to the Seedskadee NWR ecosystem include artificial rapid drops in Green River stage and reduced sediment loads in the river (Glass 2002). Rapid drops in river stage can cause a quick decrease in surface water flooding duration and also a decrease in the groundwater table of floodplains. Rapid declines in, and general lowering of base, groundwater levels in dry summer months have the potential to cause drought stress in riparian cottonwoods as seedling roots become desiccated (Mahoney and Rood 1998). At Seedskadee, relatively rapid decreases in rate-of-fall during summer of > 4 cm/day have become common (Auble et al. 1997). Alteration of alluvial groundwater response to changes in Green River stage at Seedskadee NWR also is apparent (Scott et al. 2008). Reduced sediment loading causes reduced deposition in floodplains and the river channel, which disrupts lateral migration tendencies of the river and causes increased net erosion in the downstream riverbed, often with vertical incision in upstream areas. This incision also has the potential to decrease groundwater levels in floodplains and can "strand" higher elevations, such as natural levees, along the river bank. Evidence for incision of the Green River below Fontenelle Dam is weak, but in contrast, stranding of floodplain "terraces" (point bar ridges and natural levees) which formerly regularly flooded and supported cottonwood recruitment, is apparent (Glass 2002).

ESTABLISHMENT AND MANAGEMENT OF SEEDSKADEE NWR

Seedskadee NWR formally was established in 1965 to partly mitigate the loss of habitat that resulted from construction and subsequent operation of both Fontenelle and Flaming Gorge Reservoirs on the Green River. Acquisition of lands for the refuge began in 1966 and eventually created the 25,970-acre refuge, which had original goals for providing suitable habitat for waterfowl and other waterbirds, along with supporting valuable riverine and riparian habitats. The BOR is responsible for funding land acquisitions and developments to offset loss of wildlife habitats in compliance with Section 8 of the Colorado River Storage Project. Since 1958, the BOR and USFWS have worked cooperatively to mitigate the habitat losses from Fontenelle Reservoir. The original acquisition boundary for Seedskadee NWR was designated in Public Land Order 4834 in 1970 and included 22,112 acres (USFWS 2002). In 1990, the boundary area increased with the purchase of additional lands deemed as "uneconomic remnants." In 1998, additional lands were acquired from BOR withdrawn lands and by 2010, the refuge had expanded to its current acreage. The refuge has water rights that include: 1) irrigation water rights attached to the agricultural lands acquired for the refuge (this water can be used for restoration, enhancement, and management of wetlands); 2) first priority to 5,000 acre-feet of Fontenelle Reservoir storage water under Contract No. 14-06-400-6193; and 3) an allocation of up to

28,000 acre-feet annually, at a rate of 115 cfs, deliverable under BOR Direct Green River Flow Permit (USFWS 2002). Purchase of many tracts of land on the refuge were subject to existing rights-of-way or granted in deeds at the time of purchase and many tracts also contain outstanding reserved subsurface mineral rights. Currently about 2,400 acres of active oil and gas leases occur on the refuge and minerals are privately owned on about 15,000 acres (USFWS 2002).

While the original management purpose and objectives for Seedskadee were to provide habitats for migratory waterbirds, especially waterfowl, overtime the management direction for the refuge has become more holistic (USFWS 2002). For example, the 1987 management plan for the refuge (USFWS 1987) stated objectives as:

1. To develop and maintain wetland habitat (primarily as nesting and brood-rearing habitat for Canada geese and other waterfowl).
2. To preserve habitat conditions for the benefit of native wildlife species thus ensuring wildlife diversity in the area, as well as providing habitat for rare and endangered species which frequent the area.
3. To provide opportunities for interpretation and recreation to the visiting public.

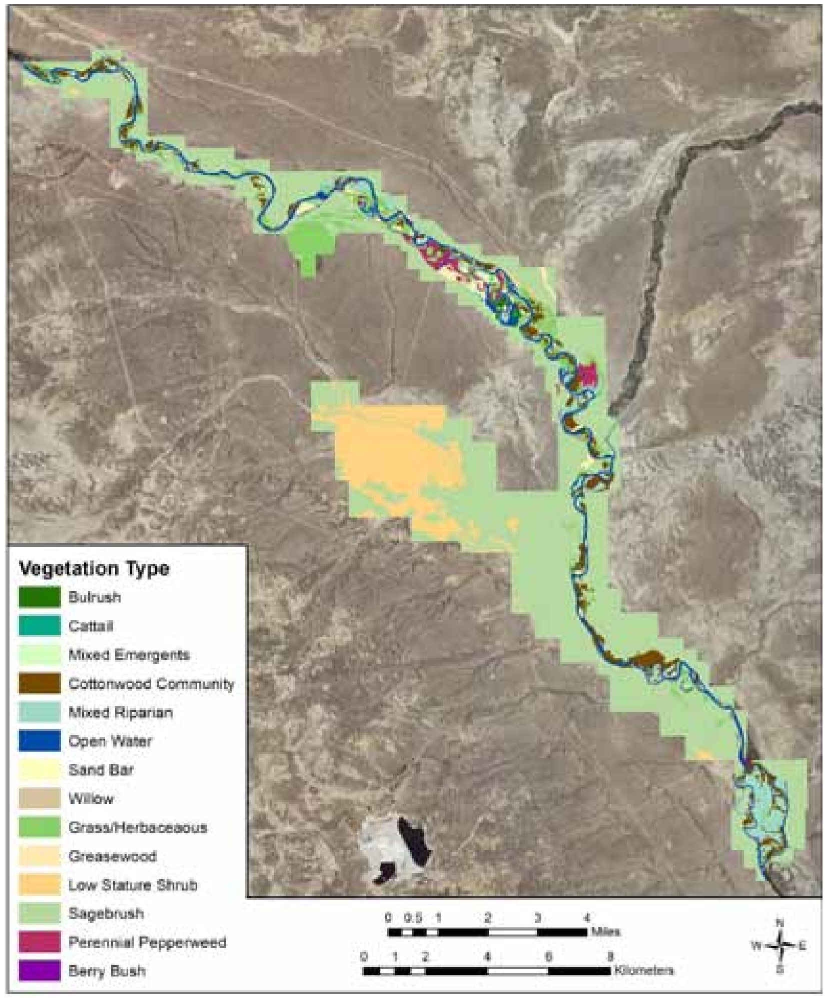

Figure 26. Vegetation communities at Seedskadee National Wildlife Refuge, 1997 (from Berk 1998).

The 2002 CCP for the refuge further broadened the management focus for the refuge with specific goals for wildlife; habitat; and public use, recreation and resource protection. Although the CCP suggested broader ecosystem goals, it maintained specific objectives for key species such as bald eagles, trumpeter swans, whooping cranes, mountain plovers, Ute ladies'-tresses, moose, mule deer, and sage grouse. Further, specific objectives were developed for riparian restoration, management of wetland impoundments, riverine, and sagebrush steppe areas (USFWS 2002). Control of invasive plants also was noted as a management concern and objective. About 20 habitat management areas (units) have been established for the refuge (Fig. 27)

Following establishment of Seedskadee NWR, wetland development activities began on the refuge and have continued to the present (Table 10). The most substantial developments occurred in the 1980s, when the Hamp, Hawley, Lower Hawley, and Dunkle wetland impoundments were rehabilitated or created (Fig. 28). The development of these wetland impoundments included gravity flow diversions from the Green River and a series of ditches, levees, and water-control structures to create the impoundments and to irrigate wet meadow areas. Three key "hard point" rock weir structures built across the Green River channel essentially "dam" the river behind the structure to the top elevation of the rock weir and cause water to flow through a "headgate" into distribution canals that serve the impoundments. Wetland impoundments now total about 1,700 acres and they are subdivided with numerous small levees, ditches, water-control structures, and other infrastructure.

The 55-acre Hamp impoundment is fed by the Hamp No. 1 headgate diversion and water gravity flows into the wetland (Fig. 28). At Green River flows of > 2,000 cfs adequate water exists to maintain the impoundment at full pool. Pool depths range from about 1-5 feet (Fig. 6). The impoundment is subdivided and has 7 water-control structures (mostly drop-board type), however management of individual pools is difficult because they cannot be independently flooded or drained. The Hawley (24 acres), Lower Hawley (147 acres), Sagebrush, and Dunkle (36 acres) impoundments are fed by the Hamp No. 2 headgate diversion point and water gravity flows into the Hawley impoundment first, then into and through the Lower Hawley and Sagebrush impoundments to eventually provide water to the Dunkle impoundment (Fig. 28). At flows > 1,200 cfs, adequate water exists to maintain most of the Hawley impoundment at full pool. At lower discharge levels, water must be rotated between individual pools to maintain adequate head pressure to move water and maintain water levels in the units. Given the “flow through” system of these wetland impoundments, they do not have independent management capability, except for the Hawley impoundment. The Pal management unit contains 73 acres and is supplied by the Superior headgate diversion and the Superior Ditch system. No internal dikes are present in the unit and water flows over low floodplain depressions and into a relict river oxbow. Most of the area functions as a wet meadow and water levels drop in the unit as Green River water levels fall. The Sagebrush Unit (Fig. 28) is a small wetland site located on the west side of the Green River between the Lower Hawley and Dunkle impoundments. Flooding of this unit was accomplished by moving water from the distribution ditch routed to the Dunkle impoundment and management relies on high Green River water flows. In 2004 a dike was built across the Sagebrush unit to subdivide it.

Management of the wetland impoundments and unit areas (excepting Pal Unit) on Seedskadee NWR typically has sought to flood at least some impoundment pools beginning in mid-March after the thaw, and to maintain full pool levels through the fall to provide nesting and brood-rearing

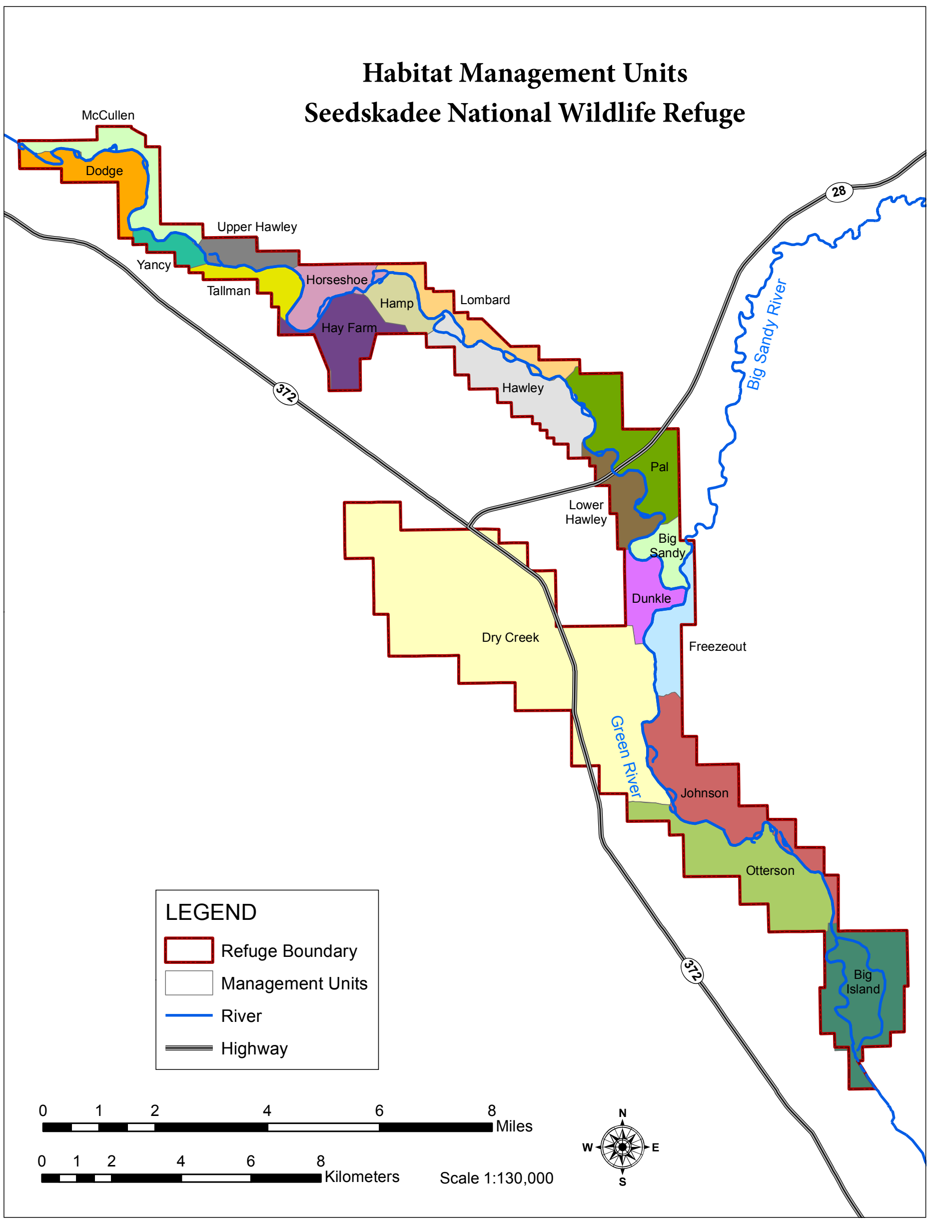

Figure 27. Habitat management units on Seedskadee National Wildlife Refuge (from USFWS 2002).

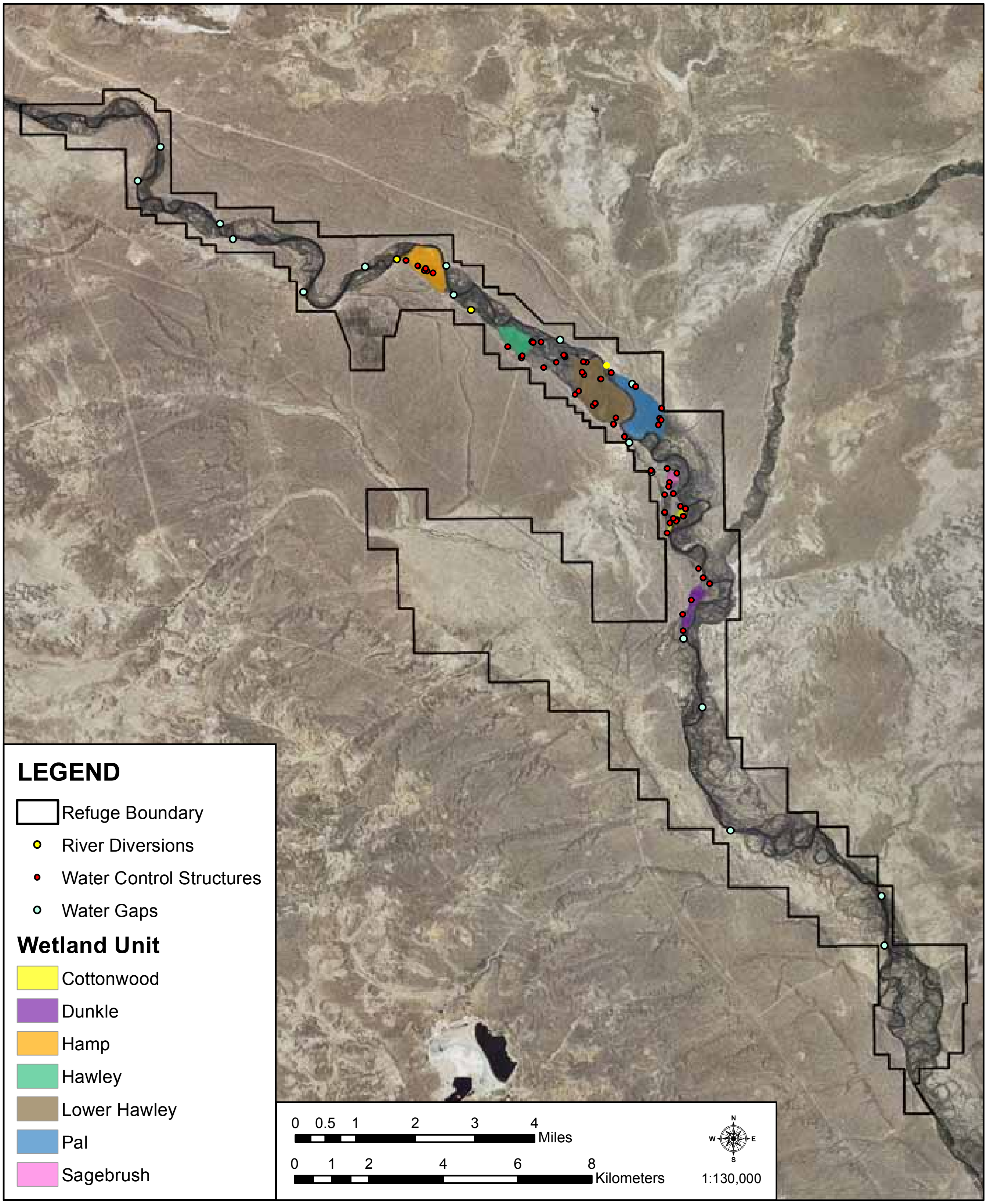

Figure 28. Location of water-control structures and points of diversion for wetland impoundments on Seedskadee National Wildlife Refuge.

Table 10. Chronology of wetland developments on Seedskadee National Wildlife Refuge (compiled from unpublished USFWS annual narratives).

Year	Wetland Development Activities
1956	Refuge authorized by the Colorado River Storage Project.
1961-64	Fontenelle Dam built on the Green River.
1965	Refuge established through a Memorandum of Understanding between U.S. Bureau of Reclamation and U.S. Fish and Wildlife Service.
	Existing irrigation ditches and diversions used as a water supply for wetland management.
1967	Rehabilitated two dikes and one headgate structure in the Hawley Tract.
1968	Completed repairs at Fontenelle Dam.
1968-72	Improved existing infrastructure in the Hawley Unit and Units 6, 8, 9, 10, and 11. Improvements included replacing culverts with concrete water control structures, raising and widening dikes, installing new water control structures and turnouts, and constructing pump ramps, new small dikes, ditches and plugs for better water spreading.
1977	Hawley gravity flow canal and center dike rehabilitated to replace washouts.
1978	Blockhouse Unit constructed.
1980-82	Rehabilitated Hawley Unit dike roads and No. 2 dike, cleaned and rehabilitated Hamp No. 2 ditch, and replaced and reset culverts in Hamp No. 1 ditch.
1982	Installed new headgate and diversion structure.
	Riprapped 800 feet of Refuge channels.
	Riprapped 1400 feet along the Green River.
	Stop log structure with new screw gate built at Hamp No. 2 ditch and Hamp No. 2 lateral junction.
	Low dike rebuilt and lengthened to increase surface area of marsh
1984	Wetland restoration actions completed at Hamp and Hawley Units, including cleaning and constructing 30,624 linear feet of ditch, constructing 9,637 linear feet of dikes, installing 95 control structures and four reinforced concrete pipes, and placing 935 cubic yards of filter blanket and 1,879 cubic yards of riprap.
	Shoreline protection work along 2,350 linear feet of the Green River included clearing and grubbing, removing old car bodies, and placing 3,390 cubic yards of filter blanket and 6,770 cubic yards of riprap along the river bank.
	Roadway for Highway 28 cleared and construction of new bridge started.
1985-86	Wetland restoration actions completed in Lower Hawley and Dunkle Units increasing wetland area to 100 acres. All 6 dikes in the Dunkle and Lower Hawley Units accepted at 1-1.5 feet below specifications.
	Dug Dunkle Ditch as an extension of the Hamp No. 2 ditch.
1987	New CMP flashboard riser water control structure installed in Hamp No. 2 ditch just below inlet of Hawley Pool No. 1.
	Raised level of Dunkle and Lower Hawley dikes to specifications.
1988	Repairs made to Fontenelle Dam.

Table 10 cont'd. Chronology of wetland developments on Seedskadee National Wildlife Refuge (compiled from unpublished USFWS annual narratives).

	Raised and/or widened sections of the Hamp No. 2 ditch road.
	Widened and resurfaced dikes in the Hawley Unit along pools 1, 4, and 6.
	Raised Hay Farm Pond 2 dike 3 feet to more than double effective pool height and installed CMP flash-board riser control structure.
1989	Constructed two new wetland basins in the Hawley Unit with six nesting islands, five dikes, and two flashboard riser control structures.
1990	Created Hay Farm pool 3 by constructing a dam in the drainage below Hay Farm pool 2.
1991	Rock sills placed immediately downstream of the intake of Hamp No. 1 ditch to allow complete filling of Hamp Unit and to restore flow to an old river oxbow on the opposite side of the bank.
	Filter blanket and riprap installed to dissipate energy from the sills.
	Fish walls and fish habitat structures installed to provide habitat for trout and salmon.
1992	Gravel constriction at mouth of Green River at Deer Island Slough cleared several times and a large rock in the river was moved to form a curving jetty resulting in a higher volume of water in the Hamp No. 2 ditch.
1994	Thirteen rock sills constructed on the Big Sandy River to provide cover for juvenile trout and deep water habitat for larger fish.
	Rock sill constructed across the Green River on the McCullen Unit to provide critical winter juvenile trout habitat and to restore flow to an old oxbow to improve riparian vegetation.
1996	Rock placed at three water lanes.
	Twelve additional rock sills constructed on the Big Sandy River near Bone Draw.
1999	Pipeline and water control structure installed in Hamp No. 2 ditch south of the Hawley Unit.
	Small rock diversion structure and four small rock groins constructed in small oxbow near Lower Dodge Bottoms.
2000	Rehabilitated Superior Ditch by replacing 900 feet rock jetty with buried 48-inch pipe, replacing the intake structure, cleaning silt and debris along 4,200 feet of existing ditch, constructing 2,700 feet of new ditch, installing 14 water control structures, and constructing 5,200 feet of service road on the east and west side of ditch berm.
2004	Removed nesting islands from Sagebrush and Cottonwood Units
	Constructed a dike across the Sagebrush Unit to provide better water management.
	Installed two new water control structures along Hamp No. 2 ditch.
	Completed road improvements to the Superior Ditch.
2005	Installed five drop board structures and one culvert in the Cottonwood Units eastern ditch system.
	Installed control structure in Hamp ditch.
	Made emergency repairs to the Hamp No. 2 gabion located on Deer Island channel; plans initiated for replacement of rock gabion with radial gated control structure.
	Installed one water control structure (C8) and replaced four structures (C4, C6, C7 and Hamp 2).
2007	Repaired two control structures at the Pal Unit.

habitat for waterfowl, especially trumpeter swans, and for spring and fall migration habitat. The Pal wet meadow area generally is flooded for 2-3 weeks in spring to provide foraging habitat for shorebirds, cranes, and waterfowl. A consequence of the annual semipermanent to permanent flooding in most impoundments has been an increase in the coverage of persistent emergent vegetation, primarily cattail, in impoundments over time (Berk 1998, Figs. 26,29). Attempts have been made to control the extensive, sometimes monotypic, stands of cattail using drawdowns, prescribed burning, and tillage with a goal of maintaining about 50% of impoundment pools in open water habitat. In the 1980s, many islands also were built in the wetland pools, although some were removed during the mid-2000s. Other past management for nesting waterfowl included construction of predator fences and planting dense nesting cover plots. Active predator control to enhance nesting success of ground-nesting birds also was conducted at times in the past.

Invasive plant species such as perennial pepperweed (*Lepidium latifolium*) and Canada thistle (*Cirsium arvense*) have expanded greatly in many floodplain and some upland areas (Fig. 26). Biological, mechanical, and chemical controls have been used to manage these invasive plants. Most upland sagebrush steppe communities currently are fenced and not grazed, although at times in the past grazing was allowed on some parts of the refuge. For example, the large Dry Creek Unit (Fig. 27) has been fenced and free of grazing by domestic livestock since 1983. Seventeen fenced livestock water access lanes (water gaps) are present on the refuge to allow livestock (from off-refuge grazing lands) access to the water in the Green River (Fig. 28). The historic intense livestock grazing in upland areas plus occasional fire and ground disturbance has altered the community structure of upland sagebrush habitats with the introduction of nonnative annual weeds including halogeton (*Halogeton glomeratus*), Russian knapweed (*Acroptilon repens*), tansy mustard (*Descurainia sophia)*, clasping and perennial pepperweed, Canada thistle, and cheatgrass (*Bromus tectorum*) (Chaney et al. 1990, Fig. 26). By 1990, perennial pepperweed covered over 1,200 acres of the refuge (USFWS, unpublished annual narrative for Seedskadee NWR). Further, the basin big sagebrush component of the community has declined (USFWS 2002).

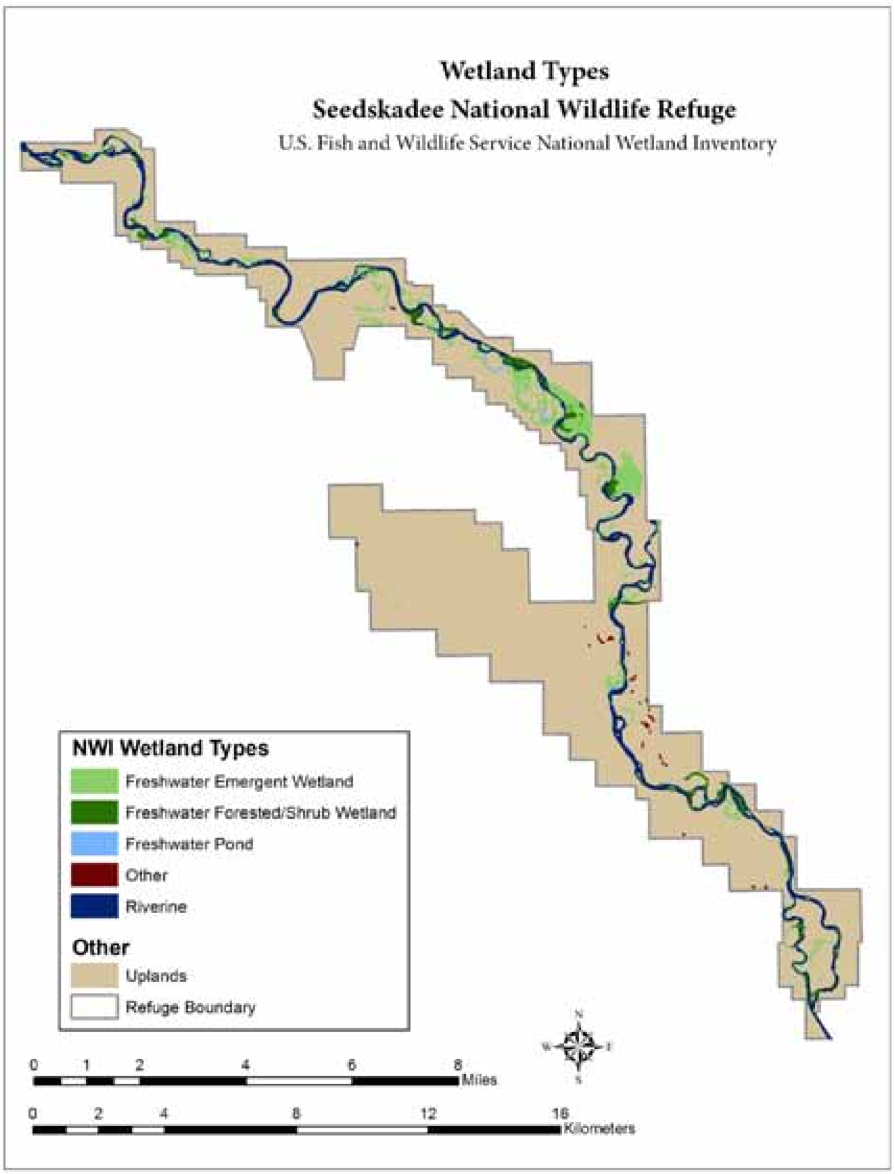

Figure 29. Wetland habitat types on Seedskadee National Wildlife Refuge as classified by the USFWS National Wetland Inventory, based on imagery from the 1980s.

Current riparian woodlands at Seedskadee NWR are aging and not being replaced (Glass 2002). Older cottonwood stands are showing signs of rapid deterioration, and without new recruitment. Alterations to abiotic factors that sustain riparian woodlands are being confounded by high browsing of existing cottonwood and willow by native ungulates and beaver and by higher rates of fire recurrence compared to historical levels (Scott et al. 2008) . Several attempts have been made to restock cottonwood in select riparian sites on the refuge using direct planting and fencing of saplings, but with minimal success (Glass 2002, Scott et al. 2008). Some direct plantings of upland species also have been conducted.

Few long term data are available to document changes in animal abundance and distribution at Seedskadee NWR. Information is best for select waterfowl species, sage grouse, and large ungulates (USFWS 2002). Generally, waterfowl numbers on the refuge have remained relatively stable and numerical changes in migrant numbers reflect continental/regional population dynamics. Trumpeter swans were reintroduced onto the refuge beginning in 1992 and the first successful nesting attempt occurred in 1997 when five cygnets were fledged (USFWS 2002). As many as five pairs of swans have nested on the refuge, but recent recruitment has been low. Mallard, gadwall, and cinnamon teal have been the most common nesting ducks, but nesting density and success currently is relatively low. Numbers of Canada geese (mostly the giant Canada goose subspecies, *Branta canadensis maxima*) nesting on the refuge has increased over time, as have giant Canada goose numbers across the Intermountain West area. Duck and goose production on Seedskadee NWR peaked in 1990 when approximately 1,800 ducklings and 300 Canada goose goslings were produced (USFWS, unpublished annual narratives up to 1999 and open files since). Little data are available on shorebird and wading bird numbers, but species associated with open water and dense stands of emergent vegetation such as American bittern, double-crested cormorant, American pelican, pied-billed grebe, black tern, American coot, and common moorhen may be more abundant than in pre-wetland impoundment periods. Likewise, other bird species associated with these habitats such as marsh wrens and yellow-headed blackbird may have increased over time. Numbers of sage grouse on the refuge appear stable; the status of other sagebrush-associated bird species is unknown.

Seedskadee NWR currently supports about 150 mule deer and 20-40 moose and pronghorns range year-round throughout the region. The refuge lies within the range of the Sublette Antelope herd, which at about 50,000 animals is one of the largest migratory ungulate herds in the lower 48 U.S. states. Many small mammals are abundant on the refuge, although some such as pygmy rabbit, marmot, swift fox, and bats may be declining (USFWS 2002). Black-footed ferret historically was present on Seedskadee NWR lands. A primary prey species, the white-tailed prairie dog currently is present on the refuge, but no known ferrets now are present.

Generally, native fish in the Green River system, including that at Seedskadee NWR, have declined and several species now are threatened or endangered. Many introduced, nonnative species now are present. Rainbow, cutthroat, and brown trout and Kokanee salmon were introduced into the Green River by the Wyoming Game and Fish Department after Fontenelle Reservoir was built. Prior to Fontenelle Dam, the stretch of the Green River at Seedskadee was warmer, more turbid, and had a more sediment-filled streambed. Post-Fontenelle, the river is less turbid, colder, and with a clearer gravel bottom – all of which may be more conducive to the nonnative trout species. In contrast, the turbulent river with turbid and higher temperatures that historically supported the four federally-endangered fish species in the Green River now is not present between Fontenelle and Flaming Gorge Dams.

Karen Kyle

Historical Photos
taken from Seedskadee NWR Annual Narratives