NATIONAL WETLAND INVENTORY REPORT FOR THE UINTA BASIN, UTAH

by

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Prepared for U.S. Fish and Wildlife Service

UTAH DNR GEOLOGICAL SURVEY

UTAH GEOLOGICAL SURVEY

a division of

UTAH DEPARTMENT OF NATURAL RESOURCES

2020

PROJECT INFORMATION

Project ID: R06Y17P03

Project Title and Area: Uinta Basin

The project area was defined by several watershed boundaries (HUC10) and all wetlands within the Pelican Lake-Green River, Walker Hollow-Green River, Lower Ashley Creek, and Twelvemile Wash watersheds (HUCs 1406001012, 1406001011, 1406001009, and 1406001010) were mapped. These watersheds were chosen through coordination with local stakeholders to identify areas of greatest mapping concern within the greater Uinta Basin. The project area covers 388,604 acres of the Uinta Basin and includes the communities of Vernal, Naples, Jensen, and Ouray, as well as the Ouray National Wildlife Refuge (ONWR).

This project overlaps several U.S. Geological Survey (USGS) 7.5-minute quadrangles. Table 1 identifies these quadrangles, the acres of overlap between a quadrangle and the project area, and whether the existing wetland mapping within the quadrangles was partially or completely revised.

Table 1. Summary of mapped quadrangles.

Quadrangle	**Location**	**Acres of Overlap**	**Revised Mapping**
Dry Fork	Q1437	5611.3	Partial
Steinaker Reservoir	Q1438	18,350.4	Partial
Donkey Flat	Q1439	8846.1	Partial
Lapoint	Q1536	2621.8	Partial
Vernal NW	Q1537	35,371.4	Partial
Vernal Ne	Q1538	36,375.5	Complete
Naples	Q1539	27,618.1	Partial
Dinosaur Quarry	Q1540	2360.7	Partial
Fort Duchesne	Q1636	1387.9	Partial
Vernal SW	Q1637	29,785.7	Partial
Vernal Se	Q1638	36,444.0	Complete
Rasmussen Hollow	Q1639	36,443.7	Complete
Jensen	Q1640	31,941.5	Partial
Cliff Ridge	Q1641	2092.6	Partial
Pelican Lake	Q1737	23,160.0	Partial
Brennan Basin	Q1738	36,340.3	Partial
Red Wash NW	Q1739	23,457.1	Partial
Red Wash	Q1740	15,868.1	Partial
Dinosaur NW	Q1741	2375.4	Partial
Ouray	Q1837	5561.5	Partial
Ouray SE	Q1838	6591.2	Partial

Project Area Description

Geography

The project area is in the Uinta Basin of northeastern Utah (figure 1). The Uinta Basin is a semi-closed basin that extends from the southern slopes of the Uinta Mountains south to the edge of the Tavaputs Plateau and from the eastern slopes of the Wasatch Range east to mesas and ridges near Rangeley, Colorado. The entire project area falls within the Colorado Plateau Level III Ecoregion and within three Level IV Ecoregions: Northern Uinta Basin Slopes, Semiarid Benchlands and Canyonlands, and the Uinta Basin Floor (Woods and others, 2001). The project area is entirely within Uintah County, Utah, and contains several towns and cities, including Ouray, Maeser, Vernal, and Jensen, and parts of the Uinta and Ouray Reservation.

The Green River flows through the project area, entering near Jensen below the confluence with Cliff Creek and exiting near Ouray above the White River confluence. All terrain in the project area eventually drains toward the Green River or its floodplain, and much of the project area consists of semiarid benches dissected by temporarily or intermittently flooded washes that flow directly into the Green River. Terrain in Ashley Valley drains to Ashley Creek, which flows south from the Uinta Mountains and enters the project area north of Maeser before flowing into the Green River at the Stewart Lake Waterfowl Management Area.

The project area contains few perennial waterbodies, the largest of which is the Green River. Other perennial waterbodies include the Steinaker and Brough Reservoirs, Pelican Lake, and Ashley Creek. These perennial waterbodies support and are supported by a network of canals that provide irrigation water to agricultural lands in the Ashley Valley, areas near Pelican Lake, and along the Green River floodplain.

Climate

The project area has a cool desert climate. Summer temperatures at the Vernal Airport reach above an average maximum of 89.9°F and winter temperatures reach below an average minimum of 4.9°F. Average annual precipitation is 8.31 inches. Most of the precipitation falls as rain in two distinct periods, a spring period from May to June and a fall period from October to November (Western Regional Climate Center, 2019). Average temperatures and precipitation vary within the project area. Parts of the project area northwest of Vernal that are more centrally located in the Northern Uinta Basin Slopes ecoregion are cooler and wetter than Ouray which is more centrally located in the Uinta Basin Floor ecoregion.

Land Use

Human presence in the Uinta Basin extends to the Paleoindian era (roughly 10,000 to 8,000 years ago) and continues through the Archaic and Fremont eras to the modern Utes (Ashley National Forest, undated). Prior to European settlement, dominant land uses included dispersed hunting, gathering, and limited maize cultivation. Wetlands were largely unaffected until the arrival of European settlers in the 1870s. Since the 1870s, much of the land in the Ashley Valley has been converted to agriculture or pasture and a network of impoundments, ditches, and natural stream channels has been created to carry irrigation water throughout the valley. Additional agricultural conversions have occurred near Pelican Lake and along the floodplain of the Green River. Urban development has also occurred extensively in the Ashley Valley, typically during oil, gas, and gilsonite mining booms. Across the project area, numerous small impoundments were built across washes to capture intermittent flows and develop water sources for livestock grazing on the rangeland. Similarly, many natural springs have been excavated to improve water sources for livestock.

DATA USED

Source Imagery

The mapping was conducted using National Agriculture Imagery Program (NAIP) imagery collected during 2016 and 2018 (table 2). Most mapping was conducted using the 2016 NAIP imagery because it better captured seasonal high-water conditions during an average water year, as opposed to the 2018 NAIP imagery which captured seasonally low water conditions during a historical drought. However, 2018 NAIP imagery was used to map the ONWR because recent changes in management practices after 2016 altered the water regimes and vegetation communities of many wetlands on the ONWR. The 2018 imagery was only used to map parts of the ONWR above the Green River banks; all wetlands between the banks including sandbars, islands, and the Green River itself were mapped using 2016 NAIP imagery.

Table 2. Source imagery.

Dataset	Description	Source	Relevant Date(s)
NAIP 2016	1-meter resolution, 4-band aerial imagery collected during the summer of 2016	USDA NAIP	06/27/2016 to 07/07/2016
NAIP 2018	0.6-meter resolution, 4-band aerial imagery collected during the summer of 2018	USDA NAIP	09/10/2018 to 09/21/2018

Supporting Data

Spatial Data

All wetland boundaries were mapped to features visible in the source imagery, but several other spatial datasets were reviewed in conjunction with the 2016 and 2018 NAIP imagery to support mapping wetland boundaries, types, and water regimes. These spatial datasets included historical and recent imagery, high-resolution light detecting and ranging (lidar) data, existing wetland and hydrography mapping, soil surveys, and water-related land use information (table 3).

Table 3. Supporting spatial data.

Dataset	Description	Source	Relevant Date(s)
Imagery			
Historic Orthophotos	1-meter resolution, historical black and white orthophotos collected in the summer of 1997.	Utah AGRC	Summer 1997
NAIP 2011	1-meter resolution, 4-band aerial imagery collected during the summer of 2011.	USDA NAIP	06/25/11 to 08/21/2011
NAIP 2014	1-meter resolution, 4-band aerial imagery collected during the summer of 2014.	USDA NAIP	08/02/2014 to 09/11/2014
Utah Imagery	15-centimeter resolution, true color imagery collected through partnership between State of Utah and Google Imagery services.	Utah AGRC	June 2015
Google Earth Imagery	Publicly available, true-color imagery from several years and sources. Imagery available in the project area includes NAIP imagery, Landsat imagery, and imagery collected by Google Imagery services. Imagery was collected over several years, usually during the growing season, but one leaf-off dataset was collected in March of 2012.	Google Earth	Various
ESRI World Imagery	30-centimeter, true color imagery available as an ESRI service. Imagery mosaiced from several sources and collection dates, but much of the project area collected in 2017.	ESRI	Various
Lidar			

Green River lidar	0.5-meter resolution, first return and bare earth lidar data of the Green River and floodplain collected during low flows (<5,000 cfs).	Utah AGRC	Fall 2015
Uinta Basin lidar	1-meter resolution, bare earth lidar data of the northern Uinta Basin collected during the spring, summer, and fall of 2018.	Utah AGRC	2018
Existing Mapping			
National Wetland Inventory (NWI) Mapping	Existing wetland mapping included in the NWI dataset.	USFWS	Summer 1983
National Hydrography Dataset Flowlines	Centerlines of ephemeral, intermittent, seasonal, and perennial channels identified in the NHD.	USGS	2016
Uintah County Soil Survey (UT 047)	Soil map units, including hydric component ratings, as identified in the Uintah County Soil Survey.	NRCS	2003
Land Use			
Water Related Land Use	Land use data showing the extent and type of irrigated crops, urban areas, and relatively natural landscapes.	Utah Division of Water Resources	2017
Water Points of Diversion	Agricultural irrigation and other diversion points along water features identifying wells, stock ponds, and springs.	Utah Division of Water Resources	Spring 2019

Non-spatial Data

In addition to the spatial datasets described above, mappers reviewed other data including historical precipitation data for Vernal, Ouray, and Jensen and USGS stream gaging records for the Green River and Ashley Creek. These data helped mappers better understand precipitation, runoff, and flooding patterns in the project area, and were used to corroborate the broad use of the intermittently flooded water regime and distinguish between riparian areas and temporarily flooded wetlands along the Green River and Ashley Creek.

Field Data

Field reconnaissance surveys were conducted to view problematic wetland mapping situations and correlate wetland vegetation types and water regimes to aerial imagery signatures. Reconnaissance surveys also focused on understanding the general distribution of wetlands within the project area, understanding landscape features likely to support wetlands, and distinguishing between riparian areas, wetlands, and surrounding uplands.

Reconnaissance surveys consisted of visiting pre-identified sites that were either (1) representative of typical wetlands, (2) difficult to map based on aerial imagery alone, (3) located in a unique landscape or feature, or (4) had a unique aerial imagery signature. All sites were either located on public land or easily viewed from public roads. For each site the most appropriate wetland type and water regime were recorded along with a representative photograph and GPS location using Collector Classic running on an Apple iPad Air 2 tablet. If access and conditions allowed, additional information about the wetland hydrology indicators, hydric soil indicators, and the dominant herbaceous and woody vegetation species present at each site were collected. These field data and photographs were invaluable throughout the mapping, but particularly useful in determining wetland boundaries in actively irrigated pastures in the Ashley Valley.

Wetland types were determined based on the current condition as visible in the field—presence of wetland vegetation, vegetation growth forms, and evidence of modification. Water regimes, as well as distinctions between wetlands, riparian areas, and uplands, were determined based on current conditions and discussion of likely conditions throughout the year. Current conditions assessed included features visible in the field (presence of standing water or saturation, extent of flooding and saturation, general vegetation communities) whereas discussion of likely conditions throughout the year focused on landscape position, possible hydrology sources, and seasonal water patterns. All these discussions helped mappers understand likely hydrology sources, whether the site was flooded, saturated, or both, and the duration and frequency of flooding or saturation.

Field reconnaissance surveys were conducted during two visits from April 30 to May 2, 2019, and May 20 to May 23, 2019, by the Utah Geological Survey mappers, Pete Goodwin and Lydia Keenan, who were accompanied on part of the second trip by the NWI Western U.S. Coordinator, John Swords. John Swords accompanied the surveys to visit the project area and provide guidance on applying the Cowardin codes and water regimes to wetlands on the landscape. Field reconnaissance surveys were conducted during a historically wet spring and coincided with large rainstorms (0.88 and 1.68 inches of total precipitation) that each deposited more than one-tenth of the average annual precipitation for the region (Western Regional Climate Center, 2019). As a result, many wetlands visited during the reconnaissance surveys were flooded for longer and to a greater extent than average. The above-average flooding conditions were considered when discussing likely water regimes.

WETLAND AND RIPARIAN MAPPING

General Methods

Mapping for this project was accomplished with "heads up" interpretation of 2016 and 2018 NAIP imagery by Utah Geological Survey wetland mappers Lydia Keenan and Pete Goodwin in 2019. All mapping was completed by hand-digitizing polygons in ArcGIS 10.6 to establish boundaries and assign a wetland or riparian type according to U.S. Fish and Wildlife Service (USFWS) guidelines (Dahl and others, 2015; USFWS, 2019). John Swords provided several clarifications and mapping reviews.

Wetland and riparian mapping were conducted concurrently, and all features were mapped at 1:3000 scale. Wetlands were mapped to a target mapping unit (TMU) of 0.1 acres (roughly 400 square meters), whereas riparian areas were mapped to a TMU of 0.5 acres (roughly 2000 square meters). This TMU difference arose from likely applications of the wetland and riparian mapping dataset. The wetland mapping is commonly used as initial mapping for aquatic resource delineations or to identify small, dispersed habitats such as springs or ponds, applications where fine-scale mapping is required. The riparian mapping is often used for broader applications—selecting treatment areas for tamarisk control, identifying habitats for nesting birds, evaluating the presence and extent of riparian buffer around a stream or wetland, or some other purpose looking to identify broad vegetation communities. Due to the finer TMU and greater use, wetlands were mapped with precedence over riparian areas and often "burned" through stretches of riparian vegetation.

The 2016 NAIP imagery and the 2018 NAIP imagery on the ONWR were the source imagery for all wetland and riparian mapping, and all wetlands and riparian areas were delineated and classified based on features visible in the source imagery. Supporting data were used to determine water regimes and map approximate boundaries if boundaries were indistinct in the source imagery.

Water regimes were determined by reviewing imagery collected across several years and considering several factors for each feature including (1) presence of water across several years, (2) likely water sources, (3) if water was present as surface inundation or saturation, (4) extent of flooding or saturation and any changes in extent, (5) timing of imagery, and (6) landscape position. Along the Green River floodplain, the 0.5-meter resolution Green River lidar was used to compare elevations of various floodplain features relative to the river and map features variously as riparian or A regime wetlands. Generally, features 1.5–2 meters above the river were considered above average peak flows and mapped as riparian features. The Green River lidar first return data were also used to help distinguish between emergent, shrubby, and forested areas along the river.

Wetland and riparian boundaries were largely drawn based on vegetation, hydrology, and topographic differences readily visible in the source imagery. For features with less apparent boundaries where canopy vegetation, grazing, or crop production obscured vegetation or topography, mappers reviewed supporting data when drawing boundaries including 1-meter lidar, leaf-off imagery collected in March 2012, and existing spring, stream, and wetland mapping. These supporting datasets were most often used when mapping wetlands in the Ashley Valley where widespread and variable irrigation blurs vegetation signatures and where distinguishing between existing wetlands, wetlands created by irrigation, and temporarily irrigated areas supporting healthy vegetation is difficult. Supporting data to identify depressional areas, canals or other constructed features, consistently wet areas, and known locations of streams, springs, or historical wetlands were helpful when determining if and how to map a feature. Elsewhere in the project area, lidar data were used to identify small impoundments and stream channels through discontinuous reaches and dense riparian vegetation.

Wetland Specific Conventions

The project area contained several features where the extent and duration of flooding or saturation varies widely between years, including the Green River, irrigated wetlands in the Ashley Valley, large reservoirs, and heavily managed wetlands on the ONWR. To consistently map these wetlands, several project-specific conventions were developed. They include:

- Wash mapping
  - Riverine wetlands were mapped along washes identified in the NHD Flowline dataset, with the centerlines adjusted to current streambed positions. Riverine features that appeared to flow every year but were not included in the NHD Flowline dataset were also mapped.
  - Water regimes in washes were determined based on landscape position, with larger washes meandering along valley bottoms mapped as R4SBA wetlands and smaller washes in narrow, confined arroyos mapped as R4SBJ wetlands.
  - Riverine wetlands were mapped through small, discontinuous reaches without clearly visible bed or bank features to show landscape hydrologic connectivity. However, the headwaters of many washes contain long reaches without visible channel features; riverine wetlands were mapped to the point where those features disappeared. Similarly, several washes flowing onto the Green River floodplain terminate in alluvial fans without connecting to the river itself.
  - Washes and other features were mapped through riparian areas. Available lidar data were used to identify the channel in dense canopies.

- Riverine bars, shores, and islands
    - Unvegetated bars and shores along the Green River and Ashley Creek were mapped as Unconsolidated or Rocky Shore features with a C water regime.
    - All of the Green River and the features between its banks were mapped using 2016 NAIP imagery, including the part of the river that flows through the ONWR.
- Farmed and irrigated wetlands
    - The f modifier was solely used to identify existing wetlands that have soil disturbance associated with agricultural crop production.
    - Wetlands where agriculture had replaced the vegetation with something that could not be considered emergent (corn, wheat, alfalfa, etc.) were mapped as Pf with no class or water regime.
    - Features that were created from irrigation and would likely return to upland if irrigation were to stop were not mapped as wetlands unless field data or other supporting data confirmed persistent hydric soils or other wetland characteristics.
    - Wetland features that appeared to be receiving additional water from irrigation were mapped as a wetland without an f modifier. Generally, this meant mapping the core or consistently wet part of an irrigated landscape through reviewing several years of imagery.
- Pioneering annuals
    - Vegetation in large lacustrine areas mapped having an A or J water regime was assumed to be dominated by pioneering annuals and was not mapped as a vegetated wetland even if cover exceeded 30 percent. These areas were instead mapped as L2USA or L2USJ features.
    - Vegetation in small, isolated ponds having an A or J regime was treated conservatively and not assumed to be dominated by pioneering annuals. These features were mapped as vegetated wetlands if vegetation cover exceeded 30 percent.
- Aquatic beds
    - Aquatic bed features were mapped if visible cover of surface plants exceeded 30 percent, or if a feature had a water regime of F, G, or H and was actively managed for waterfowl.
- Forested wetlands
    - Forested wetlands were not mapped in the project area. Cottonwood stands were considered riparian areas and mapped as such.

    - Woody species like tamarisk (*Tamarix* sp.) or Russian olive (*Elaeagnus angustifolia*) capable of reaching heights of 20 feet were considered as scrub-shrub species and mapped as scrub-shrub wetlands.
- Changing management on the ONWR
    - ONWR has been breaching and removing select impoundments in Leota and Sheppard's Bottoms to better connect those areas to the Green River and re-create a more typical riparian overbank flooding hydrology. Many of these breaches occurred between 2016 and 2018, and the resulting water regime and vegetation changes were captured by mapping wetlands on the ONWR using the 2018 NAIP imagery.
    - The part of the Green River flowing through the ONWR, and all features between its banks, were mapped using the 2016 NAIP imagery to preserve connectivity along these features.
- Distinctions between C, A, and J water regimes for unvegetated features
    - J regimes were applied to features that were not expected to flood every year or appeared to flood in less than half of the available imagery. J regimes were applied to dry washes, isolated impoundments, and to large depressions on the Green River floodplain that were infrequently flooded but, when flooded, would remain flooded for much of the growing season.
    - A regimes were applied to features that were expected to flood most years for a short period. A regimes were applied to larger washes, isolated impoundments and ponds, and other features that looked to have minimal retention and connection to other wetland features. These features appeared to be obviously drying in some imagery.
    - C regimes were applied to features that were expected to flood most years for a longer period. C regimes were applied to impoundments and ponds, large floodplain wetlands, and other features that were well connected to other wetland features.
- B regimes for spring and seep features
    - B regimes were applied to features that were known to be springs or seeps based on supporting data, field data, or landscape position. B regimes were also applied to several wetlands in Ashley Valley that did not appear to be receiving irrigation water via canals or flooding from Ashley Creek.
- K regimes for artificial features
    - K regimes were applied to several created features where water had been diverted, pumped, and stored in excavated features. These features include wastewater treatment

ponds, fish hatchery ponds, and two artificial springs created by pumping water from the Green River to the top of the Deadman Bench area.

- Managed wetlands
    - The m modifier was used to identify ponds, lakes and vegetated wetlands managed to create desirable habitat for waterfowl. The m modifier was only used on properties like the ONWR or Stewart Lake Wildlife Management Area where creating waterfowl habitat was a known priority. There may be additional areas managed for waterfowl that are not identified in this mapping.
    - The m modifier was not applied to adjacent tamarisk thickets and drier emergent wetlands within the same impounding feature, as these wetlands or riparian areas were not considered desired waterfowl habitat.

Riparian Specific Conventions

Riparian mapping posed a challenge in the project area, particularly in the Ashley Valley where moderately high groundwater tables allowed woody species like Russian olive, tamarisk, and cottonwoods (*Populus fremontii*) to establish in areas far from any waterbody or wetland. Additionally, extensive irrigation for pasture has resulted in the creation of several areas that are indistinguishable from riparian emergent areas and often contain the same assemblage of mesic grass species. To help mappers distinguish riparian areas from patches of vegetation with similar signatures, riparian areas were mapped using a functional approach which evaluated the likelihood of a given patch of vegetation to provide key riparian functions such as sediment and pollutant trapping, slowing surface flows, or shading. This approach was premised on the idea that one of the main interests in riparian areas is their ability to protect downstream water quality and habitats. Areas providing a greater degree of riparian functions were more likely to protect downstream waters and were mapped as riparian areas.

Mappers assessed the potential riparian functions of a given patch of vegetation by considering (1) proximity to a wetland or waterbody, (2) vegetation density, (3) patch size, and (4) landscape position. In general, riparian functions were considered to diminish with decreasing vegetation density, decreasing patch size, and increasing distance from a waterbody. Riparian functions were expected to be greater along active floodplains and within confined channels, but mappers also considered the presence of roads, development, or intervening bands of upland vegetation when considering the landscape position.

Riparian areas were mapped along the Green River, Ashley Creek, reservoirs and lakes, and some ponds, streams, canals, and washes. In general, features were mapped along active floodplains, confined channels, and adjacent to waterbodies in locations where riparian vegetation could be expected to reduce surface flow velocities, shade flowing water, and intercept sediments or other pollutants before they could enter surface waters.

Similar to wetland mapping, several riparian mapping conventions were established to consistently identify riparian areas. These conventions include:

- TMU
    - Riparian areas were mapped with a 0.5-acre TMU, and most mapped riparian areas are 0.5 acres or larger. However, riparian areas smaller than 0.5 acres were mapped if they were part of a distinct patch of riparian vegetation that had been split by a mapped wetland or were distinctly different from surrounding areas such as a small sandbar supporting riparian vegetation.
- Classification level
    - Riparian areas were classified to the class level, and riparian areas dominated by tamarisk were not distinguished from areas dominated by willow (*Salix* sp.), birch (*Betula* sp.), or Russian olive.
- Distinguishing between forested and scrub-shrub classes
    - Due to the lack of reliable canopy height data, scrub-shrub and forested areas were distinguished by the dominant woody species. Russian olive, tamarisk, willows, and water birch (*Betula occidentalis*) were considered shrub species, and areas dominated by the species were mapped as scrub-shrub areas. Cottonwoods were considered tree species, and cottonwood stands were mapped as forested areas.
- Features supporting riparian areas
    - Emergent riparian emergent areas were only mapped along the Green River and Ashley Creek.
    - Forested and scrub-shrub riparian areas were mapped along all features that could support riparian areas.
    - Riparian areas were not mapped along washes assigned a J regime.
- Minimum width
    - Linear stretches of riparian vegetation less than 20 feet wide were not mapped.
- Riparian emergent areas
    - Emergent riparian areas were nearly indistinguishable from irrigated pastures and were only mapped in areas that were clearly not irrigated.

MAPPING COMPARISON

This 2019 mapping project replaces existing mapping from a 1995 mapping project which used black and white imagery from 1983 as the source imagery (USFWS, 1995). Wetland extents and distributions have changed in the 33 years between the source imagery collection dates, but so have mapping conventions and guidelines over the past 24 years. These changing guidelines complicate comparisons between the 1995 mapping and the 2019 mapping, because the exact attribute for each wetland or riparian area type may not be the same between datasets. Additionally, several revisions to the mapping guidelines have allowed modern mappers to map (1) non-riverine wetlands with the intermittently flooded water regime, (2) use the farmed modifier to identify wetlands affected by crop production, (3) discontinue the use of the unknown perennial river subclass, and (4) map riparian areas along floodplains and other waterbodies. These changes have affected how several features in the project area were mapped. Despite these changes, comparisons between the 2019 mapping and the 1995 mapping are possible when wetland and riparian types are viewed at a more general level. Table 4 summarizes the two mapping datasets by broad wetland and riparian categories and also provides a crosswalk to detailed Cowardin codes.

Table 4. Summary of 1995 and 2019 Mapping.

Broad Wetland Type	2019 Mapping			1995 Mapping		
	Cowardin Codes	**Features**	**Acres**	**Cowardin Codes**	**Features**	**Acres**
Lacustrine Systems						
Deep Water	L1UBH, L1UBHh	3	1100.7	L1UBHh	2	756.0
Aquatic Bed	L2ABF, L2ABFm	2	166.1	L2ABF, L2ABFh, L2ABFx, L2ABG, L2ABGh	9	2029.2
Shallow Water	L2UBF, L2UBFh, L2UBH	7	671.4	L2UBFx	1	17.1
Lacustrine Shore	L2USJh, L2USJ, L2USC, L2USCm, L2USJm, L2USCh	39	2639.6	L2USA, L2USAh, L2USAx, L2USC, L2USCh	33	545.4
Artificially Flooded	-	-	-	L2USK	1	868.2
Lacustrine Total		**51**	**4577.8**		**46**	**4215.9**
Palustrine Systems						
Aquatic Bed	PABFm, PABFx, PABFh, PABF, PABGx, PABGh, PABHh	66	70.0	PABF, PABFh, PABFx	217	214.2
Emergent Meadow	PEM1Jh, PEM1Ah, PEM1K, PEM1A, PEM1C, PEM1B, PEM1Cm, PEM1J, PEM1Ax, PEM1Am, PEM1Ch, PEM1Bx, PEM1Cx, PEM1Ad	821	3069.9	PEM1A, PEM1Ah, PEM1B, PEM1C, PEM1Ch, PEM1Cx, PEM1K, PEM1Kx	811	5923.0
Emergent Marsh	PEM1F, PEM1Fh, PEM1Fm, PEM1Fx	33	488.3	PEM1F, PEM1Fh	91	660.5
Farmed	Pf	44	226.4	-	-	-
Forested	-	-	-	PFOA, PFOAx	54	591.0
Scrub-shrub	PSS1K, PSS1A, PSS1Ah, PSS2Jh, PSS2A, PSS1Fh, PSS2J, PSS1C, PSS1Am, PSS1J, PSS2C, PSS1Ch, PSS1B	245	774.1	PSSA, PSSAh, PSSAx, PSSB, PSSCh, PSSCx, PSSC	210	1151.6

Table 4 cont.

Broad Wetland Type	2019 Mapping			1995 Mapping		
	Cowardin Codes	**Features**	**Acres**	**Cowardin Codes**	**Features**	**Acres**
Permanent Pond	PUBFx, PUBFh, PUBHx, PUBF, PUBGh, PUBGx	126	97.1	PUBF, PUBFx	37	19.0
Seasonal Pond	PUSJh, PUSAh, PUSCh, PUSJx, PUSAm, PUSAx, PUSJ, PUSCm, PUSCx, PUSC, PUSA	259	267.6	PUSA, PUSAh, PUSAx, PUSC, PUSCh, PUSCx	164	217.5
Artificially Flooded	PUBKx	72	75.0	PABKx, PUSK	11	52.1
Palustrine Total	-	**1666**	**5068.5**		**1595**	**8828.9**
Riverine Systems						
Lower Perennial	R2USC, R2UBF, R2UBH, R2UBG	260	4383.6	R2UBF, R2UBFx, R2UBG, R2USA, R2USC, R2UBH	250	4403.9
Upper Perennial	R3RSC, R3RBF, R3RBFx, R3USA, R3USC, R3RBG	87	119.7	R3UBF, R3UBH, R3USA, R3USC	178	365.8
Intermittent Streambed	R4SBJ, R4SBAx, R4SBCx, R4SBA, R4SBJx, R4SBC	695	3420.5	R4SBC, R4SBCx, R4SBJ, R4SBJx	814	3398.8
Unknown Perennial		-	-	R5UBFx, R5UBH	275	78.9
Riverine Total		**1042**	**7923.7**		**1517**	**8247.5**
Riparian Systems						
Riparian Emergent	Rp1EM	159	1124.5	-	-	-
Riparian Forested	Rp1FO, Rp2FO	304	2779.6	-	-	-
Riparian Scrub-shrub	Rp1SS, Rp2SS	573	3314.5	-	-	-
Riparian Total		**1036**	**7218.6**	-	-	-
Total Mapping		**3795**	**24,788.6**		**3158**	**21,292.3**

There are several differences between the 1995 and 2019 mapping. Excluding riparian areas, the 2019 mapping identified fewer wetland features and less total acreage. The reduction in number of wetland features largely stems from different mapping conventions handling riverine wetlands. The 2019 mapping emphasized wash connectivity and many washes were mapped as single, highly branched R4SBJ features whereas the 1995 effort mapped many of these same washes as disconnected features, often separated by a few feet. Similarly, the 1995 mapping identified backchannels along the Green River and Ashley Creek as separate R5 features; the 2019 mapping identified these backchannels as part of the main channel and typically did not map them as separate features. The reduction in wetland acreage largely results from changes in the amount of mapped palustrine features, particularly palustrine emergent features. The 2019 mapping identified similar numbers of palustrine emergent features as the 1995 mapping, but these features tended to be smaller or mapped to more exact boundaries. Reduced palustrine feature acreage is most apparent in Ashley Valley, where large palustrine emergent features identified in the 1995 mapping are either not mapped or have been greatly reduced in the 2019 mapping. Two factors could influence this reduction. The first could be that mappers in 2019 followed a stricter mapping convention and excluded many areas as irrigation-created wetlands that were mapped in the 1995 mapping. The second factor could be a shift in irrigation practices that result in less water being applied to the landscape. Regardless, many areas in Ashley Valley previously identified as wetlands are no longer mapped as wetlands in the 2019 mapping. The 2019 mapping identified a greater number and acreage of seasonal and permanent ponds than the 1995 mapping. This discrepancy could result from the high-resolution imagery and small TMU used in the 2019 mapping, but also could result from the increased collection of irrigation returns in downstream impoundments.

Riparian mapping guidelines were created in 1997, and the 1995 mapping did not identify any riparian areas. However, many palustrine scrub-shrub and palustrine forested wetlands identified in the 1995 mapping were mapped as riparian areas in the 2019 mapping. Most of the riparian remapping occurred along the Green River, where almost all features identified in the 1995 mapping have been remapped as riparian areas in the 2019 mapping. In addition to the remapping, the 2019 mapping identifies extensive riparian areas along the Green River and Ashley Creek where occasional flooding and elevated water tables support dense riparian vegetation.

ACKNOWLEDGMENTS

This mapping project was made possible through funding from the Environmental Protection Agency Wetland Program Development Grant (CD-96851101-2). Several individuals aided throughout this project and I would like to thank them all. John Swords explained intricacies of the NWI mapping and provided valuable feedback during several reviews. Ryhan Sempler and Sara Owen of the Montana Natural Heritage program shared their wetland mapping expertise throughout the project. Dan Schadd of the ONWR allowed access to the refuge and shared changing management strategies. Diane Menuz of UGS provided administrative support as well as invaluable technical expertise and reviews throughout the project. Lydia Keenan assisted with all of the fieldwork, planning, and mapping; I am especially grateful for her help throughout the project. Stephanie Carney, Hugh Hurlow, Mike Hylland, and Bill Keach provided careful review of this report.

REFERENCES

Ashley National Forest, undated, Paleoindian to late prehistoric eras—Overview of northeastern Utah history before European arrival: Online, https://www.fs.usda.gov/detail/ashley/learning/history-culture/?cid=fsm9_002413, accessed November 2019.

Dahl, T.E., J. Dick, J. Swords, and B.O. Wilen, 2015, Data collection requirements and procedures for mapping wetland, deepwater and related habitats of the United States (version 2): Madison, Wisconsin, U.S. Fish and Wildlife Service Division of Habitat and Resource Conservation, National Standards and Support Team, 92 p.

Western Regional Climate Center, 2019, Utah climate summaries: Online, https://wrcc.dri.edu/summary/climsmut.html, accessed November 2019.

U.S. Fish and Wildlife Service (USFWS), 2019, A system for mapping riparian areas in the western United States: Falls Church, Virginia, U.S. Fish and Wildlife Service Ecological Services, 36 p.

U.S. Fish and Wildlife Service (USFWS), 1995, National Wetlands Inventory map report for northeast Utah, Colorado Plateau, and Rocky Mountain forest province: Denver, Colorado, U.S. Fish and Wildlife Service, 23 p.

Woods, A.J., Lammers, D.A., Bryce, S.A., Omernik, J.M., Denton, R.L., Domeier, M., and Comstock, J.A., 2001, Ecoregions of Utah (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,175,000).