WETLANDS AND LAKES OF CHURN CREEK PROTECTED AREA

Vegetation & Hydrology Monitoring

2021

By

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Submitted to:

BC Parks, Regional Operations,
Protected Area Section, Williams Lake

February, 2022

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INTRODUCTION

In Churn Creek Protected Area (CCPA), wetlands are recognized as one of the most critical habitats for a wide range of native species as well as for livestock management (Iverson and Roberts 1999, BC Parks 2000). The management plan for the CCPA (BC Parks 2000) identifies wetlands as high priority ecosystems for inventory, long term monitoring and conservation.

Wetlands are dynamic ecosystems, highly affected by seasonal and annual variations in precipitation, surface runoff, and ground water movement. Dry years and wet years, with corresponding changes in vegetation and wildlife, are a normal part of wetland ecology. However, a drying climate, resulting in long-term sustained reductions in winter precipitation and snowpack and increased evapotranspiration, will result in the long-term disappearance of some wetlands. Understanding which wetlands are most susceptible to climate change and how to minimize the detrimental effects of this change, can inform wetland management practices and range use planning.

The Friends of Churn Creek Protected Area Society (FCCPAS) has initiated a long-term inventory and assessment of wetlands in Churn Creek Protected Area (Steen 2018). The first phase of this study provided a map and reconnaissance level description of all wetlands within the protected area (Steen and Iverson 2021). This second phase has focused on establishing detailed vegetation and hydrological monitoring of selected wetlands and associated riparian ecosystems. In 2021, this included remeasuring long-term monitoring of vegetation plots established in 2020 (four wetlands) and measuring new vegetation plots established in 2021 (eight additional wetlands).

Hydrological characteristics of selected wetlands are being monitored in this project to improve our understanding of annual and seasonal hydrological regimes of wetlands and the factors affecting those regimes within Churn Creek Protected Area. A principal purpose is to elucidate especially those factors affecting surface water depth and duration, as a basis for estimating effects of a changing climate on wetlands in different hydrogeological settings. Hydrological data will support and help to interpret the vegetation data described in the previous section and help to predict long-term effects of a drying climate on vegetation.

The hydrological monitoring portion of this project is being developed and expanded in stages as funding becomes available. This report describes current progress through 2021.

Methods

Wetland Selection

Eleven of the 79 wetlands mapped and described within Churn Creek Protected Area (Steen and Iverson 2021) were selected in 2021 for long-term vegetation and hydrological monitoring (Table 1). A twelfth wetland (Marsh 15), included in the vegetation monitoring portion, was not monitored for water depth or duration in 2021. These wetlands were selected to represent the elevational range of wetlands within grassland landscapes of the Protected Area and the principal wetland ecosystem types which were documented by the wetland inventory (Steen and Iverson 2021). The selected wetlands have a range of hydrological regimes, especially depth and duration of flooding. Monitoring preference was given to wetlands that are relatively easily accessed by vehicle in order to facilitate repeated visitation and installation of monitoring equipment.

Vegetation Monitoring Plot Establishment

A protocol for monitoring wetland characteristics and function was developed by FCCPAS in 2019/2020 following a review of ecosystem monitoring protocols for wetlands in Alberta (Alberta Riparian Habitat Management Program). The Alberta protocols were adapted for use in this project and then briefly tested at two wetlands in CCPA in late summer 2019. Modifications were incorporated in 2019 and 2020 before implementing the FCCPAS protocol in July/August 2020. The protocol assesses hydrological attributes, riparian vegetation, and wetland plant communities and provides a baseline to monitor long-term changes in water, soils, and vegetation.

Our protocol includes permanent vegetation and soil transects, extending from the outer edge of the riparian area into the centre of the wetland. Two or three permanent transects, depending on vegetation variability, were established to represent the dominant vegetation patterns at each wetland. Transects started in the uppermost portion of the riparian zone where a permanent rebar pin was placed in the ground for relocating the start of the transect. Each transect was oriented perpendicular to the edge of the wetland from the outer riparian area to the centre of the wetland or into shallow open water that extended to the wetland centre. A second rebar pin was placed in the ground at the wetland edge to ensure correct transect bearing in future monitoring. The transect is 1 m wide, running along the right-hand side of the line (metre tape) between rebar pins when facing the wetland from the start of the transect. Each transect was subdivided into relatively uniform plant communities ("bands") within the riparian and wetland areas. The start and stop distance of each plant community along the transect was recorded as well as the distance to the outer edge of the wetland, the outer edge of standing water, and water depth at intervals within the wetland. Within each riparian and wetland plant community, we recorded species and percent cover for all plant species with 1% or greater cover.

We remeasured the transects at four wetlands[1] where transects were established in 2020. We established and measured transects at eight additional wetlands in 2021 (Marsh 10, Marsh

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[1] The four wetlands were: Dry Lake [Marsh 2], Coffee Pot [Open water 2 & 2b], Hog Lake South [Marsh 23], and High Lake [Marsh 21]. Names like "Marsh 2" correspond to mapped names of wetlands for Churn Creek Protected Area.

15, Marsh 19, Marsh 39, Marsh 43, Marsh 48, Grasshopper Lake [Marsh 17], and Grouse Lake [Marsh 20]) to better cover the range of wetland types in CCPA. The areas around Grasshopper Lake, Dry Lake, and Marsh 10, including much of their catchment areas burned in a wildfire in August, 2021 and the fire burned right through Marsh 15 and Marsh 48 and severely burned north-facing forests in the catchment area of these wetlands. Marsh 15 and Marsh 48 were monitoring after they had burned; the other wetlands within the fire perimeter were measured prior to burning.

Wetland Bottom Profiles and Estimated Seasonal Water Depth Changes

Wetland bottom profiles of flooded wetlands were described 1) to document the shape of the basin of selected wetlands and 2) as an aid for easily monitoring changes of water levels in the wetlands. Bottom profiles were described in spring (June 13 - 17) by measuring water depths every 2 m along a transect through the middle (assumed deepest or nearly deepest portion) of the wetland. Water depths were translated to elevation of the wetland soil below the point along the transect where above-surface water was first present. That is, water depths were measured from water edge to water edge and used to define the bottom profile, drawn as elevation above the deepest measured point of the wetland. Locations of the reference fixed pins and bearings of each transect are provided in Table 2.

In three wetlands where water depths along the transect became too deep to measure with chest waders, the transect was re-established on the opposite side of the wetland and depths were measured every 2 m back towards the start side of the wetland, leaving a measurement gap in the deepest part of the wetland. In these wetlands, the transect was extended on subsequent dates as the water level dropped and it became possible to measure depths further into the wetland, although not sufficiently to close the measurement gap.

On subsequent dates, as water levels dropped following the initial profile measurement, water depths along the fixed transect were estimated by measuring the distance along the transect to the first above-surface water, or new zero depth distance. The estimated decrease in water depth since the first measurement was determined from the elevation of the measured distance on the wetland basin profile.

The bottom profile of one of the 11 wetlands was not measured because there was no above surface water on the first visitation (June 13). Stranded algal remains suggested that shallow (about 15 cm) above-surface water had been present recently. In future years, this and other wetlands will be measured earlier in the year.

Water depths of each wetland was estimated twice during the season following the initial measurement in June. Many wetlands were dry at one or both of the post-June dates.

Daily Measures of Water Depths

In 2021, water depths and temperatures were measured every eight hours from May 1 to October 6 in three wetlands using Solinst Levelogger 5 data loggers placed in wells established in a deeply flooded area of the wetland, generally 2 - 3 m off the transect. A 2-inch ABS pipe, with several drainage holes, was placed in a 60 to 95 cm deep augered hole. Water level sensors were placed in each well with the sensor approximately 5-10 cm above the bottom of the well. Solinst biofoul screens were placed over each sensor. Above surface water depth at the well was manually measured at the time of installation for calibration purposes. In addition, height of the well head above the sensor, the soil surface, and the water level was recorded in order that depth recorded by the logger could be expressed as depth above or below the soil (wetland bottom) surface.

Water level drops recorded by the data loggers were compared to levels and drops estimated from transects and bottom profiles in the three selected wetlands. The data loggers recorded depth to below surface water tables until the water table dropped below the bottom of the sensors, about 60-70 cm below soil surface.

Snow Cover Imagery

Time lapse cameras were located at three wetlands (those with water depth data loggers) on March 17 in order to indicate duration and extent of snow cover adjacent to the wetlands. Cameras were mounted on posts or trees and positioned to photograph the hydrological collection area portion near the wetland. One image was collected at noon each day at two of the three wetlands until the snow had disappeared. Images were not collected at the third wetland due to a camera setting error. Additional cameras and snow course surveys will be established in 2022.

Weather Monitoring

A weather station (HOBO U30 – 10 channel logger) with a 3m mast on a tripod was established in mid-September on a low ridge (UTM: 10U 546016 E, 5706323 N) near a low elevation, large wetland (Marsh 2; Dry Lake), which is being monitored for vegetation and hydrology. HOBO sensors monitored air temperature, rainfall, wind direction, wind velocity, relative humidity, and surface (15 cm) soil temperature (15-minute intervals). The air temperature sensor was located in a solar radiation shield. Precipitation was measured by a 0.2 mm tipping bucket rain gauge (HOBO E348-S-RGB-M002).

In order to limit animal damage, the wire from the soil temperature sensor was placed in aluminum conduit where it was underground or on the lower portions of the mast. However, the sensor wire higher on the mast was severed in early October, apparently bitten by an animal, and ceased to record soil temperatures.

A HOBO USB Microstation Logger with two temperature sensors was established to measure soil temperatures near but below the low ridge of the weather station (UTM: 10U 546126 E, 5706057 N). Soil temperatures were monitored to estimate date of surface soil thawing, which affects meltwater runoff, in a shallowly eroded gully and adjacent higher area.

RESULTS

Selected Wetlands

The 11 selected wetlands all occur in rolling to strongly rolling terrain with local (collection area) topographic relief ranging from about 30 to nearly 400 m (Table 1). The wetlands all occur within local topographic basins fed by catchment areas ranging from about 4 to nearly 200 ha. It is expected that all have a seasonal perched water table. The wetlands range in areal extent (based on wetland vegetation occurrence) from slightly less than 0.1 ha to 3.6 ha. Marsh 2, the largest of the selected wetlands is also the largest wetland in the protected area that is not part of a lake ecosystem and is also the lowest elevation wetland within the protected area. Snowmelt runoff gullies occur on slopes leading into Marsh 2 and other wetlands, indicating large runoff volumes during spring freshet. None of the selected wetlands are part of or connected to a larger lake, although several of the wetlands are predominantly open water wetlands, usually with an outer band of marsh ecosystems. For example, Open Water 2 wetland has a perimeter band of the Wm11 (*Bolboschoenus maritimus*) marsh ecosystem. Dominant ecosystems of individual wetlands are Wm01 (*Carex utriculata – Carex aquatilis* marsh), Wm04 (*Eleocharis palustris* marsh), Wm05 (*Typha latifolia* marsh), Ww (Typical Shallow Open Water), Wm06 (Bulrush marsh), Wwa (Alkaline Shallow Open Water), Wwx (Non-permanent Shallow Open Water), and WmBolbflu (*Bolboschoenus maritimus x fluviatilis* Marsh) (see Steen and Iverson 2021).

Table 1. Some attributes of wetlands selected for monitoring. Wetlands with bolded numbers are those with daily automated water level measurements in 2021. UTM locations are for the fixed pin at start of the water depth transect.

Wetland #	Wetland Location 10U E	10U N	BGC Subzone	Wetland elevation (m)	Maximum elevation of collection area (m)	Wetland area (ha)	Catchment Area (ha)
Marsh 2 (Dry Lk)	546629	5705947	BGxw	635	840	3.6	196.0
Marsh 10	546761	5705207	BGxw	720	752	0.1	3.7
Open Water 2 (Coffee Pot)	550354	5689495	BGxw	859	1065	0.3	20.2
Marsh 48	548713	5701256	BGxw	877	948	0.1	5.2
Marsh 19	549336	5696800	IDFxm	903	968	0.5	14.0
Marsh 43	548938	5697230	IDFxm	915	1008	0.2	17.6
Marsh 23 (Hog Lk)	549912	5688537	IDFxm	1013	1196	0.9	48.0
Marsh 17 (Grasshopper)	545437	5699573	IDFxm	1040	1225	0.4	72.0
Marsh 39	545550	5689930	IDFxm	1128	1522	0.2	20.5
Marsh 21 (High Lk)	548433	5689216	IDFxm	1215	1248	0.3	4.5
Marsh 20 (Grouse Lk)	547020	5689763	IDFdk	1247	1312	0.8	23.4

Vegetation Monitoring of Selected Wetlands

Permanent soil and vegetation transects were remeasured at four selected wetlands in August 2021. There was substantial upslope movement of the vegetation in all the transects at all four wetlands, consistent with the higher water levels observed in 2021. While water levels were not measured in the spring or summer of 2020, we did observe that water levels had increased in both 2020 and then further in 2021 relative to recent years. Generally, there was greater horizontal shifting on the more gently sloping transects.

At Dry Lake, there was substantial shifting in the location of vegetation bands (Figure 2). In each of the three transects, the wetland plant communities, Wm04 Common spike-rush marsh and *Bolboschoenus maritimus x fluviatilis* marsh moved upslope in 2021. There was a lot of variability in the composition of the riparian plant communities, but less consistent upslope movement.

Figure 1. Transect 1 at Dry Lake in 2020 (left) and 2021 (right).

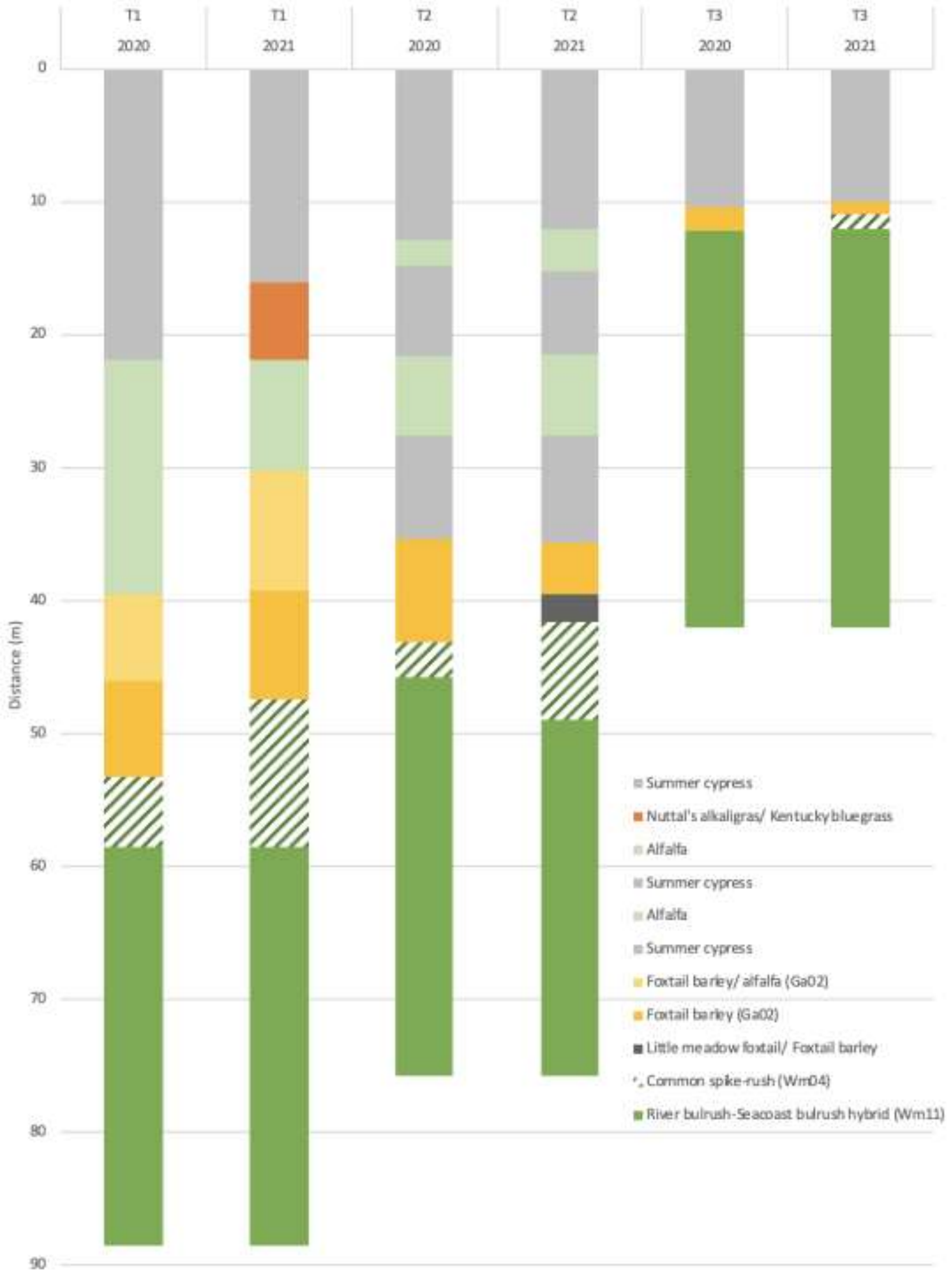

Figure 2. Location of bands of vegetation on transects at Dry Lake in 2020 and 2021. The upper edge of the graph represents the upper edge of the riparian zone; the bottom is the central portion of the wetland. Vegetation bands are named based on the dominant species in each band and the wetland association code (e.g. Wm04) is included where applicable.

Coffee Pot vegetation bands have shifted upslope, particularly the Seacoast bulrush Marsh (Wm11), which has expanded into an area that was occupied by the Wm07 last year (Figure 4). The Ga02 has also expanded upslope. Field observations indicated water levels were higher in 2021 and water persisted longer at Coffee Pot.

Figure 3. Transect 1 at Coffee Pot in 2020 (left) and 2021 (right).

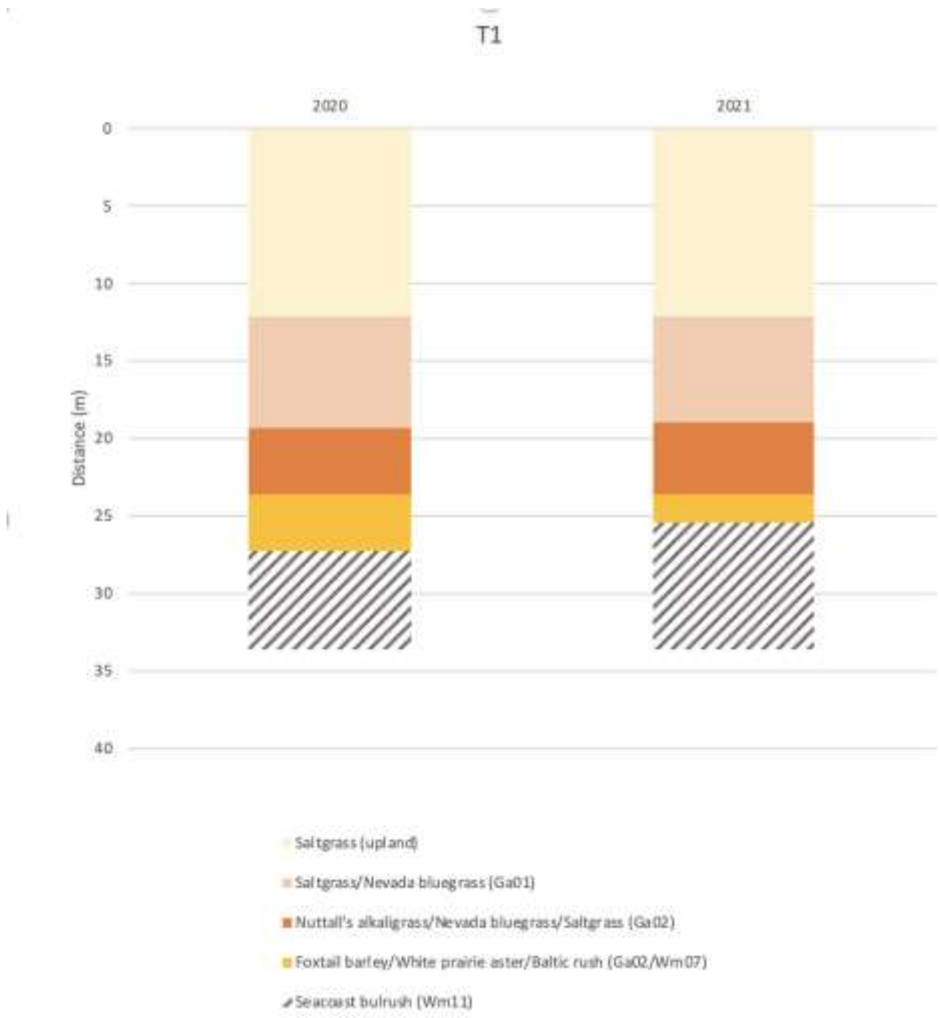

Figure 4. Location of bands of vegetation on transect one (T1) at Coffee Pot marsh. The upper edge of the graph represents the upper edge of the riparian zone; the bottom is the central portion of the wetland. Vegetation bands are named based on the dominant species in each band and the wetland association code (e.g. Wm11) is included where applicable.

At South Hog Lake, portions of the Wm06 Soft-stemmed bulrush marsh, the wetland ecosystem in the deepest part of the marsh, have died back where water has gotten deeper (Figure 5 and Figure 6). Other vegetation bands have shifted substantially upslope. A band of Wm04 Common spike-rush marsh disappeared on transect 3 and was replaced by Wm07 Baltic rush marsh.

Figure 5. Transect 1 at South Hog Lake in 2020 (left) and 2021 (right).

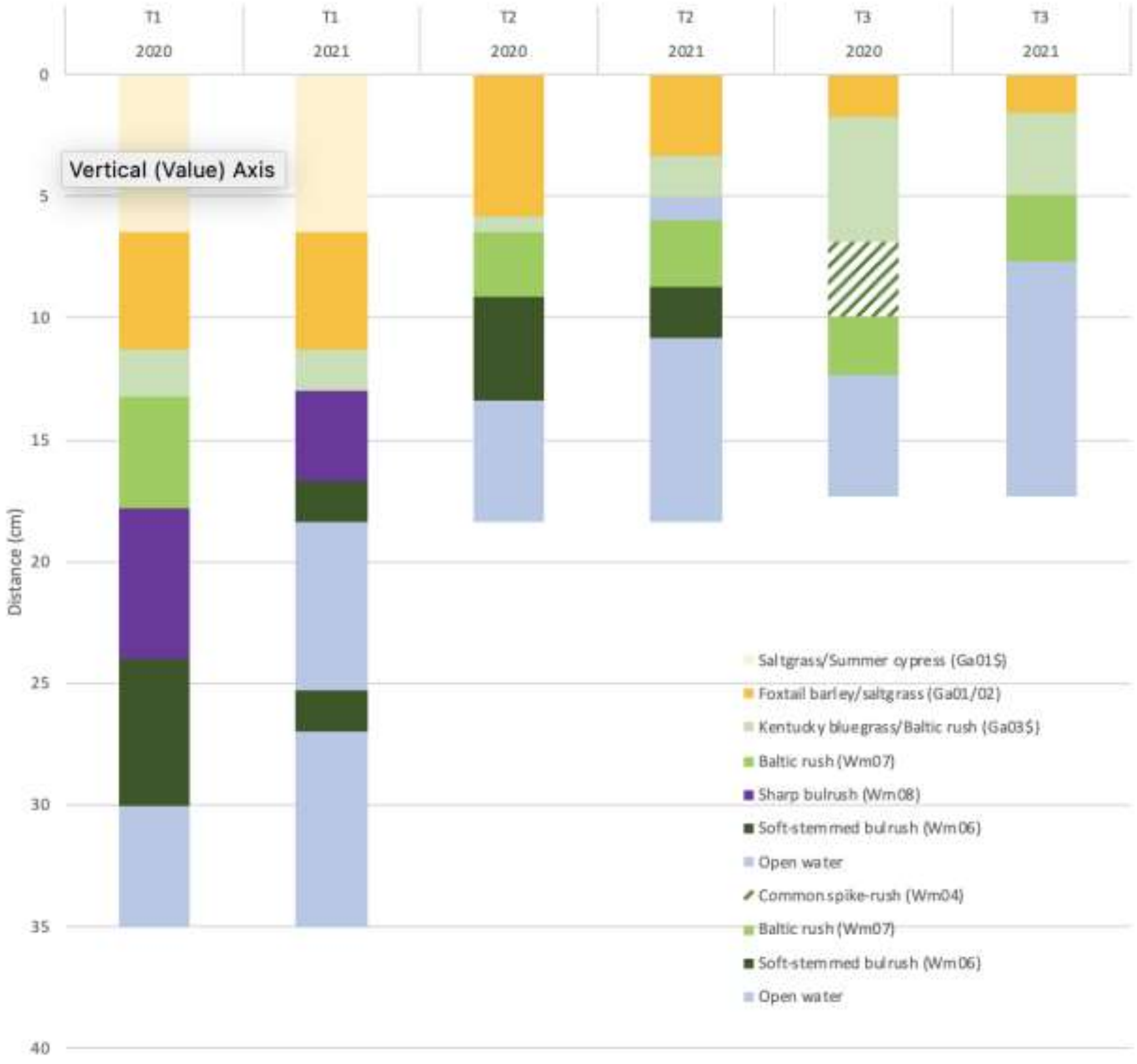

Figure 6. Location of bands of vegetation on transects at South Hog Lake in 2020 and 2021. The upper edge of the graph represents the upper edge of the riparian zone; the bottom is the central portion of the wetland. Vegetation bands are named based on the dominant species in each band.

Marsh 15 and Marsh 48, located on the north side of Airport Flats, burned in August (Figure 7). Monitoring transects were established post-burn in October, although plant cover data was very approximate and it is likely that uncommon species were missed. A significant portion of the catchment area of Marsh 48 is forested and nearly all of the trees were killed by fire. It will be interesting to see how these two wetlands respond post-fire as we expect the loss of tree cover to increase run off into Marsh 48.

Figure 7. Marsh 15 (left) and Marsh 48 (right) in October after they had burned in August.

Water Levels

Water levels, measured in mid-June and estimated later (by measuring distance into bottom profile from a fixed reference pin) on each of the transects in early August and early October are presented in Table 3. Above surface water was not present in mid-June in one wetland (Marsh 48) although stranded debris on vegetation indicated water had been present recently to a depth of about 15 cm earlier in the spring.

Deepest water measured on each transect across ten of the wetlands in mid-June ranged from 32 cm (Marsh 19) to more than 1.4 m (Marsh 20). Deepest water levels measured in Marsh 20 and Marsh 21 were less than deepest actual water levels which were too deep to measure with chest waders. Deepest measured water levels in June and deepest estimated water levels in August and October in each of the wetlands are given in Table 3.

Bottom profiles and recorded water levels in mid-June, early August, and early October for five selected wetlands are shown in Figure 8, Figure 10, Figure 12, Figure 14, and Figure 15. These are selected for illustration purposes. Profiles were also measured for all but one of the other wetlands. Daily water levels recorded by water level sensors are shown for three of the selected wetlands (Marsh 2, Marsh 19, and Marsh 43) in Figure 9, Figure 11, Figure 13.

Mid-June water levels in the 11 wetlands generally increased with increasing elevation of the wetland (Figure 16). In addition, the magnitude of water level decrease during the growing season generally decreased with increasing elevation. Four of six wetlands at elevations below 1000 m asl but none at higher elevations were dry (had no above surface water) by early August (Figure 16).

Table 2. Wetland water depth transects: fixed pin locations, transect bearings, and transect distances to waters edge from fixed pin on three dates (June 13 – 17, August 5 – 8, October 6-7). "n/a" = no surface water present.

Wetland	Fixed pin location (UTM)		Transect bearing	Distance (m) from transect pin to surface water outer edge		
	10U E	10U N		June	August	October
Marsh 2	546493	5705900	48	46.2	59.3	82.5
Marsh 10	546774	5705215	242	6.7	n/a	n/a
Open Water 2	550312	5689457	56	20.7	24.6	25.5
Marsh 48	548739	5701287	228	n/a	n/a	n/a
Marsh 19	549335	5696844	180	9.2	n/a	n/a
Marsh 43	548975	5697230	265	8.9	n/a	n/a
Marsh 23	549869	5688391	92	4.2	5.5	6.0
Marsh 17	545418	5699539	30	9.4	17.6	32.1
Marsh 39	545580	5689946	232	5.4	11.7	24.4
Marsh 21	548404	5689195	50	3.3	4.8	5.8
Marsh 20	547065	5689770	260	3.1	5.1	6.3

Table 3. Maximum water depths recorded in transects across each of the 11 wetlands in mid-June 2021 and estimated from bottom profile in early August and early October. (M = Marsh, OW = Open Water wetland). The deepest water levels along the transects in Marsh 23, Marsh 21, and Marsh 20 were too deep to measure (i.e. values with an asterix are less than actual maximum levels). In these wetlands, August and October values are based on water level drops in a partial bottom profiles (see Figure 14 and Figure 15). Maximum June water level in Marsh 48 was estimated from stranded debris.

Month	M2	M10	OW2	M48	M19	M43	M23	M17	M39	M21	M20
June	86	52	57	(15)	32	49	115*	65	67	138*	130*
August	56	0	39	0	0	0	97*	35	38	123*	110*
October	29	0	30	0	0	0	91*	12	25	113*	99*

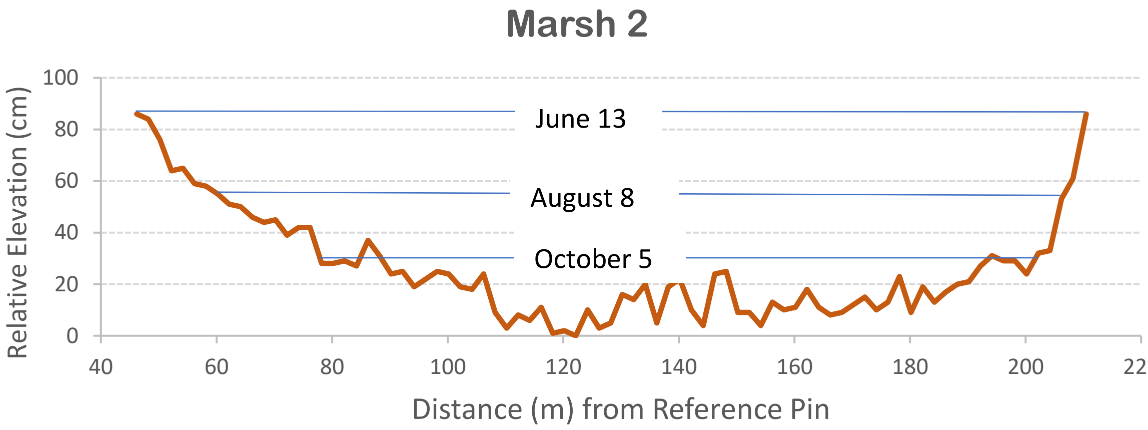

Figure 8. Marsh 2 (Dry Lake) bottom profile and water depths on June 13, September 8, and October 5. Water level decrease from June 13 to October 5 was estimated as 55 cm. The bottom relief is exaggerated due to different scales of the two axes.

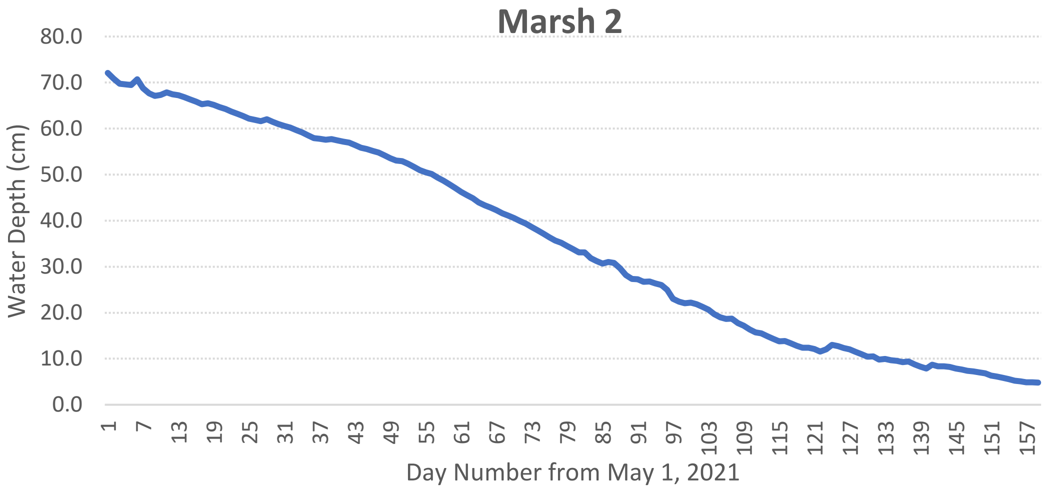

Figure 9. Marsh 2 daily water levels (cm) in monitoring well relative to soil surface. The monitoring well was not at the deepest point of the wetland. Net water level decrease from day 43 (June 13) to day 157 (October 5) was 50 cm.

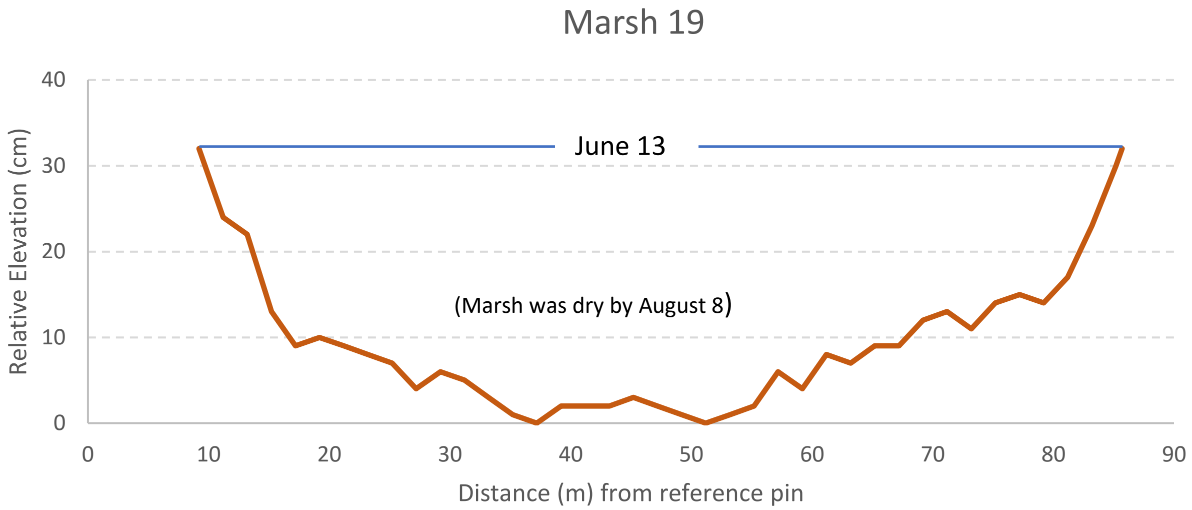

Figure 10. Marsh 19 bottom profile and water depth on June 13. Surface water was absent by August 8.

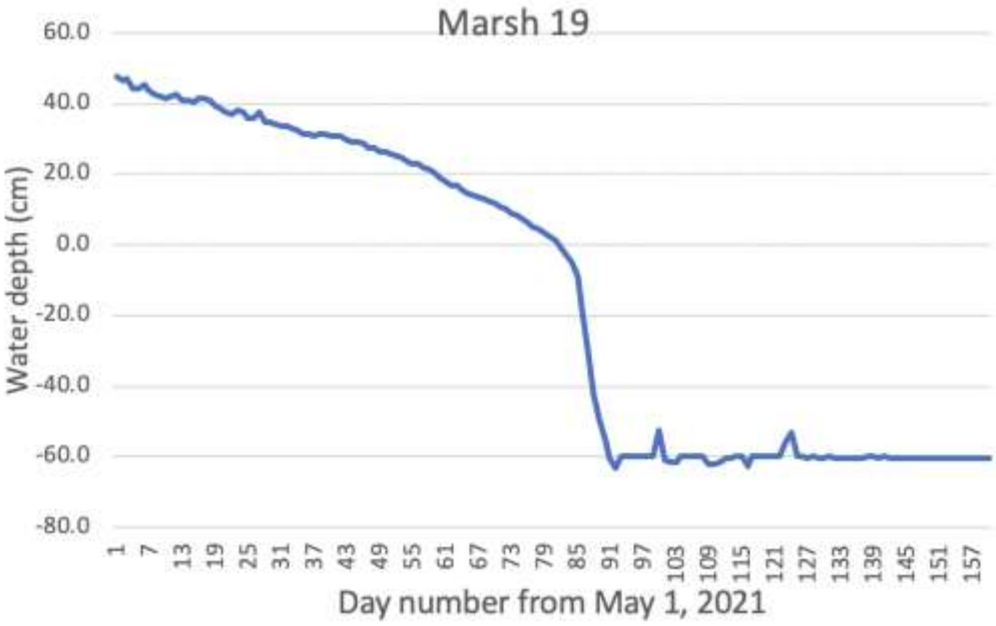

Figure 11. Marsh 19 daily water levels (cm) relative to soil surface in monitoring well. Water level was at the soil surface (0.0 cm) on day 82 (July 21).

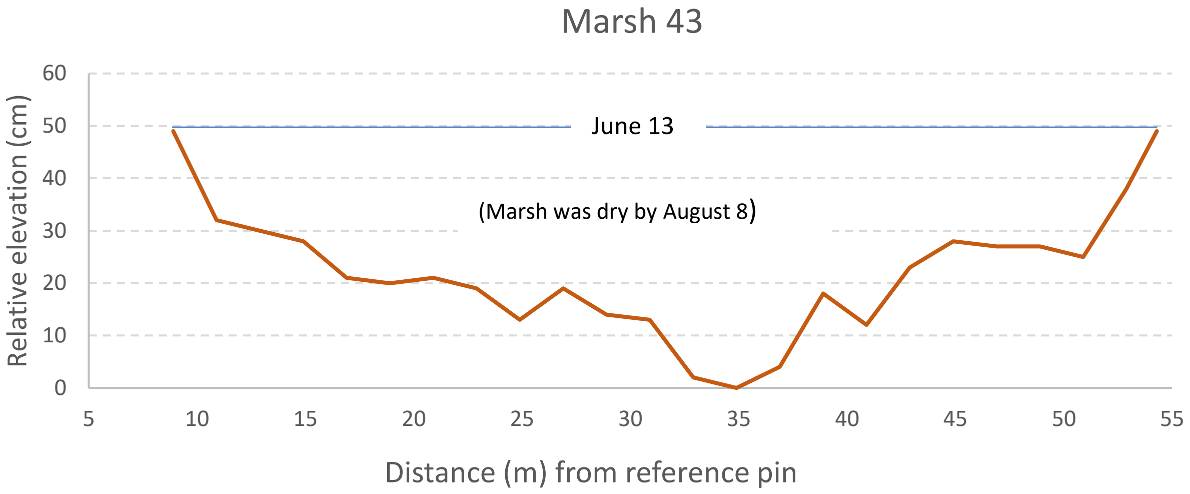

Figure 12. Marsh 43 bottom profile and water depth on June 13. Surface water was absent by August 8.

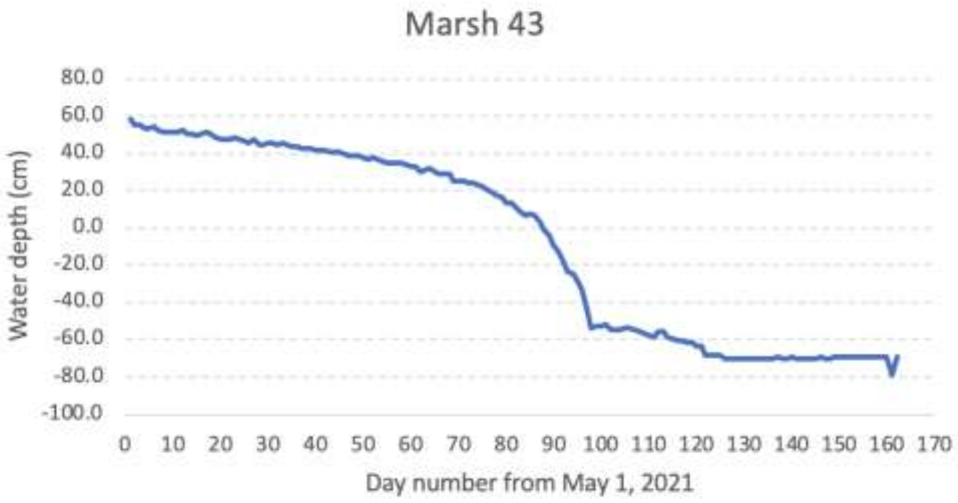

Figure 13. Marsh 43 daily water levels (cm) in monitoring well. Water level was at the soil surface (0.0 cm) on day 87 (July 26).

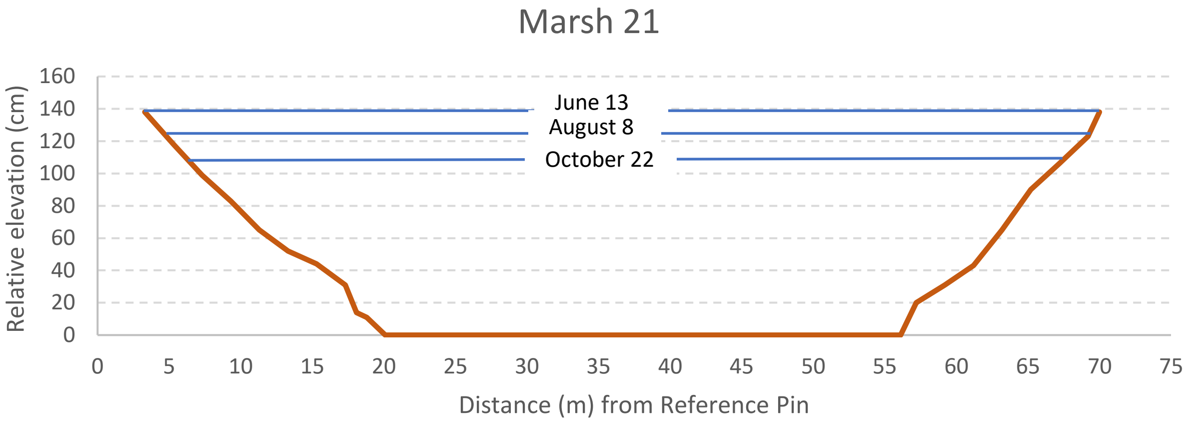

Figure 14. Marsh 21 (High Lake) bottom profile and water depths on June 13, August 8, and October 22, 2021. Bottom profile from 20 to 57 m could not be measured due to very deep water levels. Relief is exaggerated because of axes scale differences. Water level decrease from June 13 to October 22 was estimated as 26 cm.

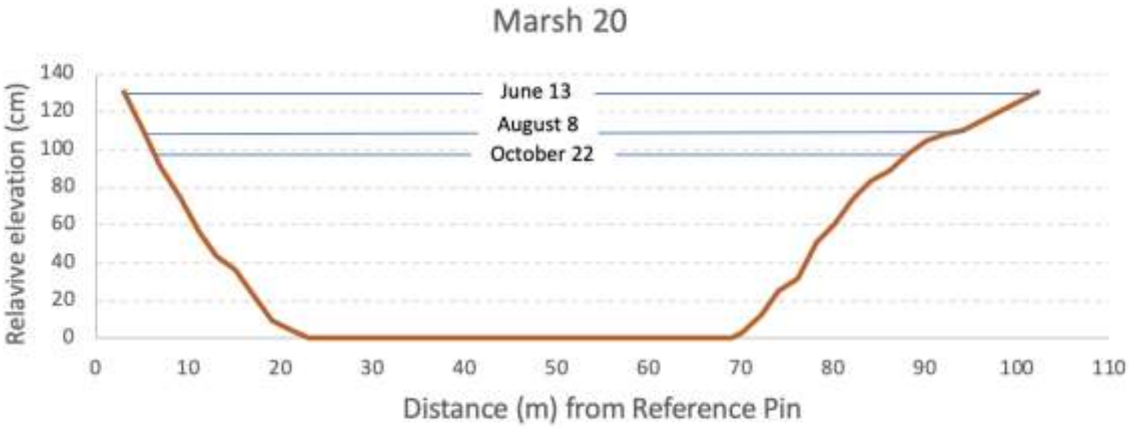

Figure 15. Marsh 20 (Grouse Lake) bottom profile and water depths on June 13, August 8, and October 22, 2021. Bottom profile from 23 to 69 m could not be measured due to very deep water levels. Relief is exaggerated because of axes scale differences. Water level decrease from June 13 to October 22 was estimated as 31 cm.

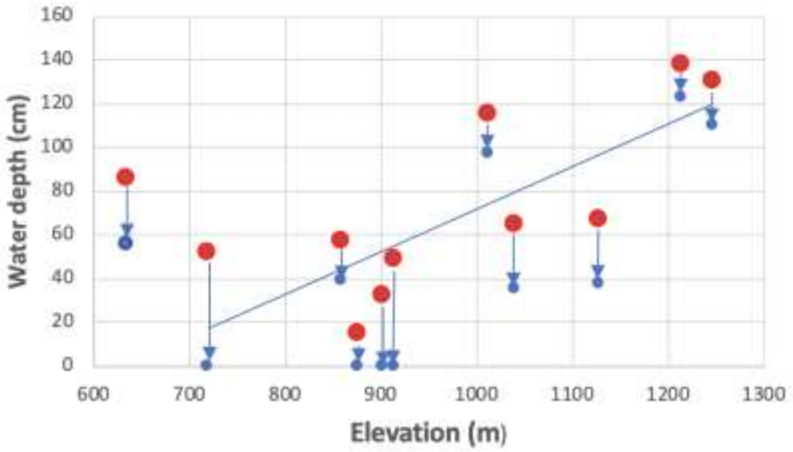

Figure 16. Relationship between water depth and site elevation (m asl) in 11 wetlands in mid-June (red) and early August (blue) (r = 0.77). Depth to below surface water table is not shown. The regression line and correlation coefficient for June data do not include data from the lowest elevation (635 m), outlier wetland (Marsh 2).

DISCUSSION

The wetlands included in this monitoring project have a wide range of water depth and duration. The monitoring system which has been established will allow long term documentation of water level changes which can be related to annual weather variations, snow cover, and vegetation changes. In three of the wetlands, the depth changes estimated from the bottom profile corresponded well to changes measured by a water level sensor in a well.

Depth and duration of above-surface water in the 11 wetlands in 2021 was related to elevation. This relationship was not due primarily to basin relief because the topography surrounding the low elevation wetlands rose well above water levels and thus the basins could have held more water without overflowing. However, the deeper water at high than low elevations may partially reflect slope grades of the basins which tended to be greater at high than low elevations. That is a given volume of water would have a smaller surface area but greater depth as basin side slopes steepen. Further descriptions of the basins are needed. It must also be recognized that landscape elevation likely affects wetland water volumes because of greater winter snow depth and summer precipitation at high elevations, and less water output through evapotranspiration. None of the wetlands had any sign of overland flow out of the wetland. Movement to ground water was not measured in 2021.

Non-elevation related factors also affect wetland hydrology. These include catchment area size, often considered to be related to wetland surface area but, in this survey, also appears to be related to wetland water depth and duration.

Marsh 2, (Dry Lake) the lowest elevation of the 11 wetlands (635 masl) is an outlier in the general relationship between site elevation and early season water depth (Figure 18) among the 11 wetlands. In mid-June, it contained deeper water than any other of the wetlands below 1000 masl and it was still flooded in lowest parts of the basin in early October (Figure 16). This may be due, at least in part, to its relatively large collection area (Table 1), which likely contributes a greater volume of meltwater runoff in the spring and possibly greater shallow ground water flow during the growing season. This wetland also has a dense vegetation cover which may reduce evaporation water loss but increase transpiration water loss during the growing season.

Open Water 2 wetland (Coffee Pot), which is the third lowest (859 masl) of the 11 wetlands, differed from most other low elevation wetlands by having a relatively small water level decrease during the season (Figure 16) and by still being flooded in August and in October. This may be due in part to its larger collection area than other low elevation wetlands which were dry by August (Table 1). In addition, it is a saline-alkaline wetland with little emergent or other rooted vegetation and has an unusually broad, flat bottom of silt deposits. Further studies of wetland soils and ground water movement are needed.

Marsh 23 (Hog Lake), at 1013 masl, had relatively deep water (>115 cm) for its elevation in mid-June and a relatively small water level decrease from June to October (18 cm by August 8 and 25 cm by October 22). Although it is fed by only a moderate sized collection area (Table 1), it is also fed by a spring above the wetland, likely bringing ground water from a nearby deep-water wetland (Marsh 22 in Steen and Iverson 2021).

FUTURE MONITORING

The vegetation transects and water level and duration monitoring of the 11 wetlands will be repeated in 2022.

If funding is available, we hope to better describe the wetland basins and assess shallow ground water flow into selected wetlands through piezometers established above the wetland. We also hope to document snow depths and snow water equivalents within grassland portions of the Protected Area, establish water level sensors in more wetlands than the three monitored in 2021, and document wetland water levels earlier than in 2021 to better estimate amount of water contributed by spring snowmelt runoff.

The collection areas of the 11 wetlands will be described in greater detail, including slope aspects and grades, vegetation cover, and soils.

These data may contribute to better understanding of factors affecting wetland vegetation and hydrology within the Protected Area.

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