TECHNICAL MEMORANDUM

To: Kristen Homel – Oregon Department of Fish and Wildlife

From: Joe Parzych and Josh Epstein - Inter-Fluve

Date: December 2018

Re: Sandy River Delta Chum Project: Year 1 Monitoring Data Summary

Sundial Island – Sandy River delta at the confluence with the Columbia River. Photo by Sam Beebe – EcoTrust

INTRODUCTION

The Oregon Department of Fish and Wildlife contracted Inter-Fluve in 2016 to assess the potential of Sundial Island for supporting a chum spawning channel. Sundial Island is located at the mouth of the Sandy River at the confluence with the Columbia River in Multnomah County, Oregon. This memorandum summarizes Year 1 (2016 - 2017) hydrology monitoring data for the Sandy River Delta Chum Project. A more detailed report will be provided after Year 2 data are collected and analyzed.

FIELD METHODS

A total of eight Hobo U-20L pressure and temperature sensors were deployed at groundwater and surface water monitoring stations in and around Sundial Island between October 2016 and October 2017 (Figure 1). Three sensors were placed in surface water stations in the Sandy River and south side channel (S1, S2, S3). Four sensors were placed in groundwater observation tubes that were installed roughly 12 feet beneath the ground (P1, P2, P3, P4), and one sensor was placed in a tree to correct other sensors for changes in atmospheric pressure. Sensors were surveyed using RTK GPS.

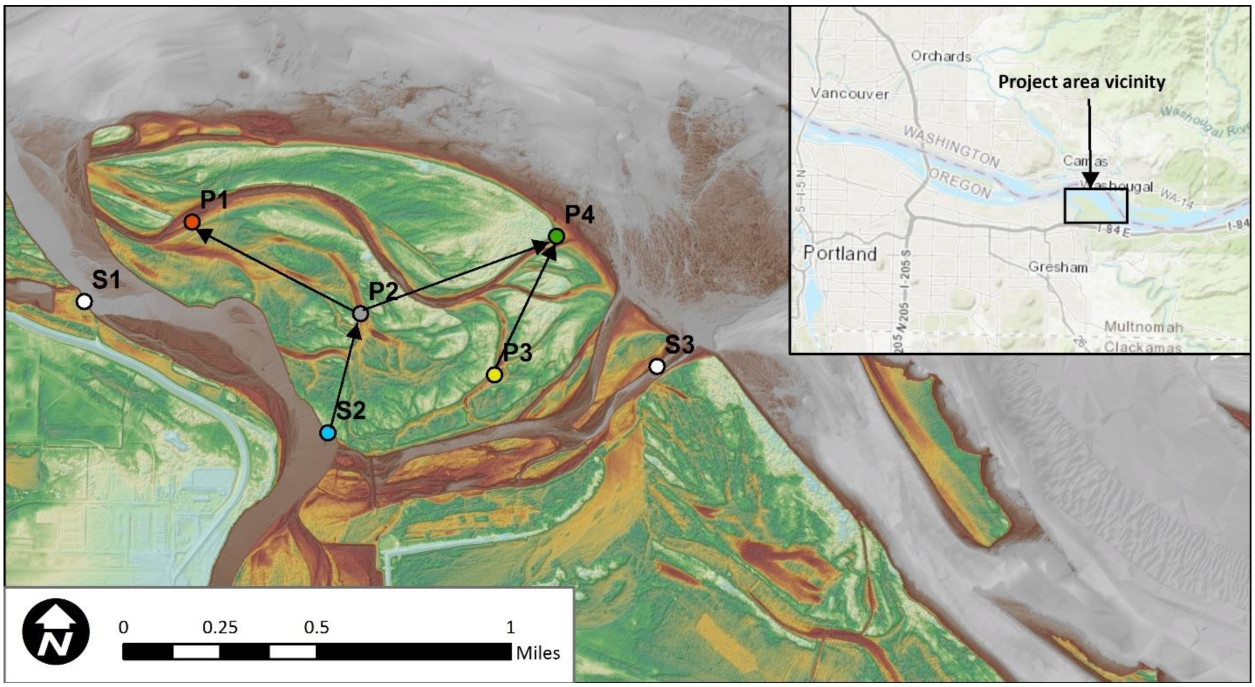


Figure 1. Groundwater and surface water monitoring stations in the study area. Lines between water level sensors were used to calculate water table slope.

Several sensors were either dislodged from their position or stolen during year 1 monitoring (Table 1). These sensors (S1, S3) will be omitted from this analysis, as they were compromised before data were downloaded.

Table 1. Water level sensor installation history. All sensors are currently active as of the writing of this memo.

Sensor name	Sensor start	Sensor end	Notes
S1	10/25/2017	Not downloaded	Relocated on 10/25/2017 due to sedimentation
S2	10/30/2016	6/13/2017	
S3	10/25/2017	Not downloaded	Relocated on 10/25/2017 due to observation tube damage
P1	10/30/2016	6/13/2017	
P2	10/30/2016	6/13/2017	
P3	12/13/2016	6/13/2017	Original sensor (P5) was stolen, replaced with P3 on 12/13/2017
P4	10/30/2016	6/13/2017	

DATA SOURCES

Hydrology data were downloaded from the Columbia River gage at Vancouver (NOAA #9440083) and the Sandy River gage at Bull Run (USGS #14142500). LiDAR data from 2010 were downloaded from the Lower Columbia River Estuary Partnership. Water surface elevation and temperature data were obtained from Hobo U-20L pressure sensors, while RTK GPS were used to survey their location.

RESULTS

The period of interest is November 1 to April 1, which is when chum salmon are likely to be present in the area. Water level data from November 1, 2016 to February 4, 2017 are relatively consistent, fluctuating from 10 to 18 feet, NAVD88, with no particularly high flow events (Figure 2). After February 4, both Columbia River stage and Sandy River discharge increase markedly. Relationships between sensors change during this time, as the Columbia River rises and backwaters the delta.

Temperature data show that Sandy River surface water temperatures are consistently warmer than groundwater temperatures (Figure 3). P1 has the coldest groundwater, followed by P2, P3 and P4. Groundwater sensors with colder temperatures are likely more hydrologically connected to the Sandy River, compared to the Columbia River which is warmer. The following section splits the time series into two periods for analysis.

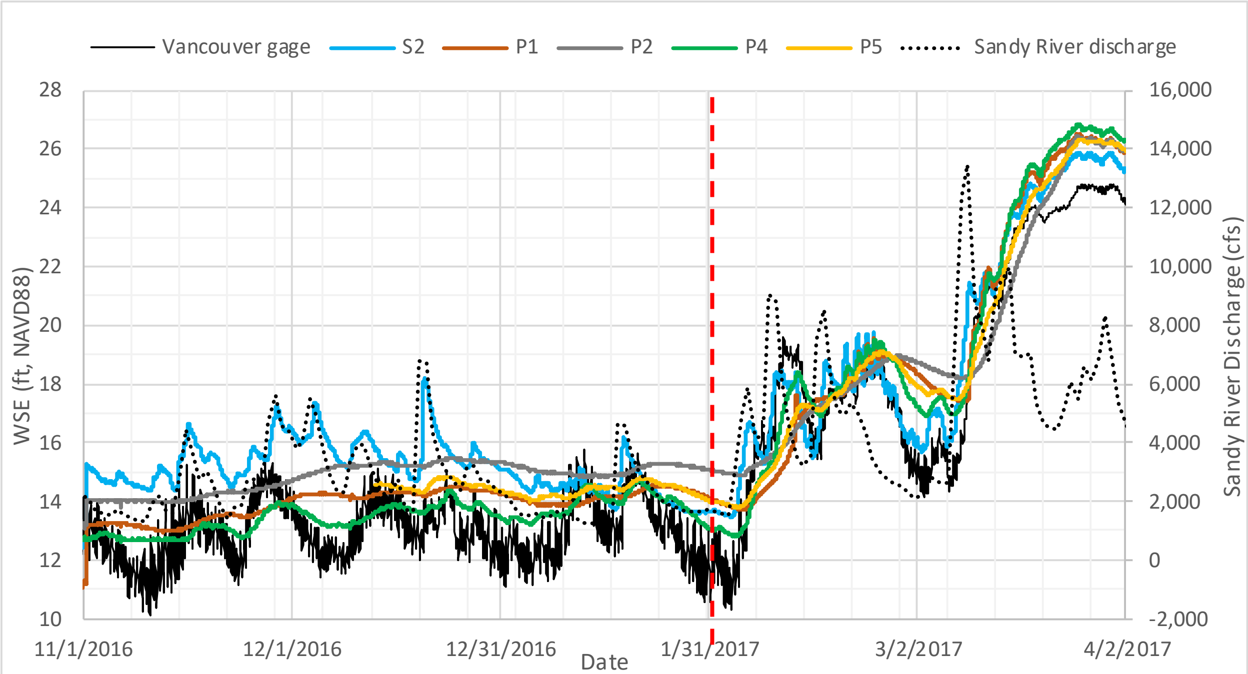


Figure 2. Water level sensor data from November 1, 2016 through April 1, 2017. Red dashed line marks February 4th.

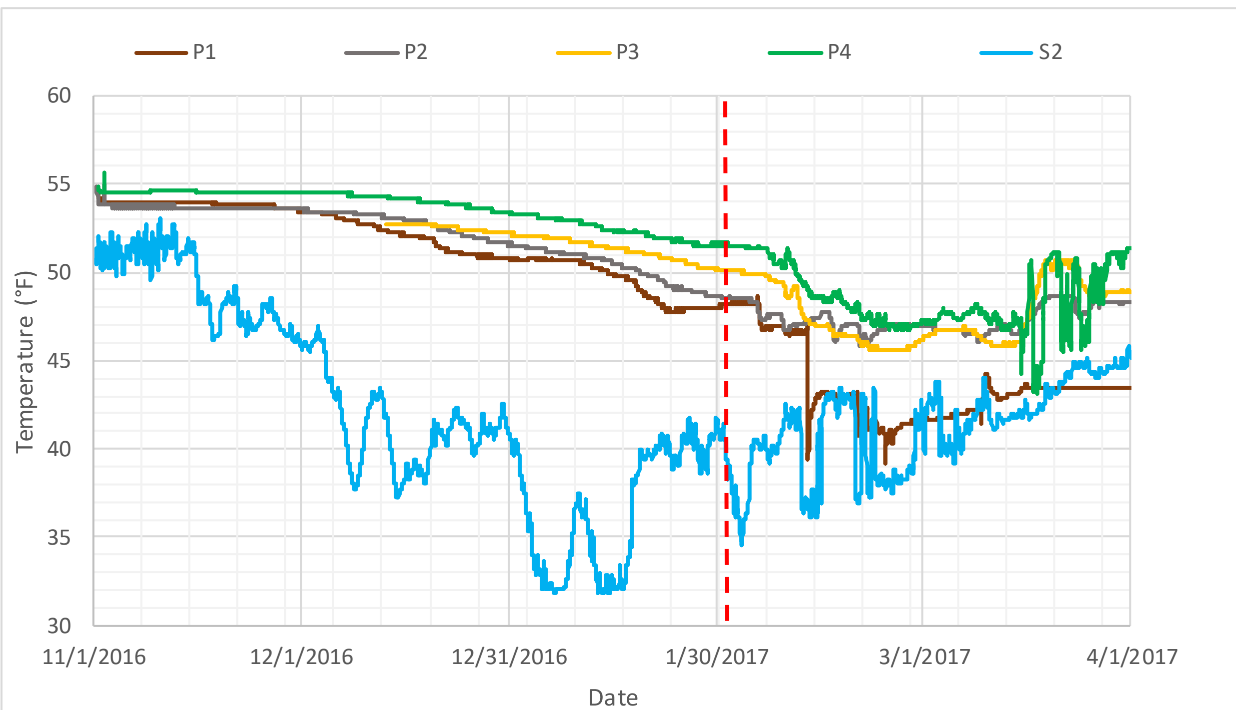
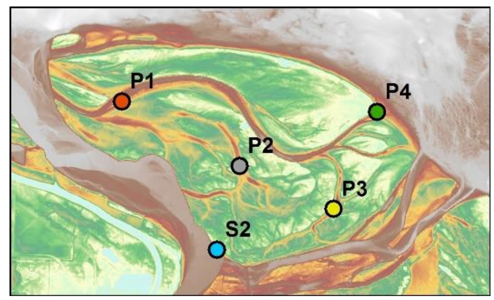


Figure 3. Temperature data from November 1, 2016 through April 1, 2017. Red dashed line marks February 4th. High stages overtopped some groundwater observation tubes in this time series.

November 1, 2016 to February 4, 2017

The first period of interest is during more normal hydrologic conditions between November 1, 2016 and February 1, 2017. S2 has the highest water surface elevations, followed by P2, P3, P1, and finally P4. S2 is primarily influenced by Sandy River discharge, as would be expected given its position in the delta, and relatively moderate Columbia River stages during this time (Figure 4). S2 is almost always at a higher stage than the Columbia River due to inflow from the Sandy River, except during two different time periods in mid-December when Columbia River high tides peaked for a short period of time.

P2 is consistently at a higher stage than other groundwater sensors, and occasionally has a higher stage than S2. Sandy River hyporheic flows travel through Sundial Island, recharging groundwater at P2, which slowly "leaks out" after the peak has passed. P4 has the highest fluctuations of any groundwater sensors, and is most closely related to the Columbia River tidal cycle. This may be due to close proximity to the Columbia River, or due to higher subsurface hydraulic conductivity at P4. P4 has groundwater elevations that are typically lower than P1 because P1 receives more hyporheic flow from the Sandy River. P4 does have higher water surface elevations than P1 during particularly high tidal cycles because of high connectivity to the Columbia.



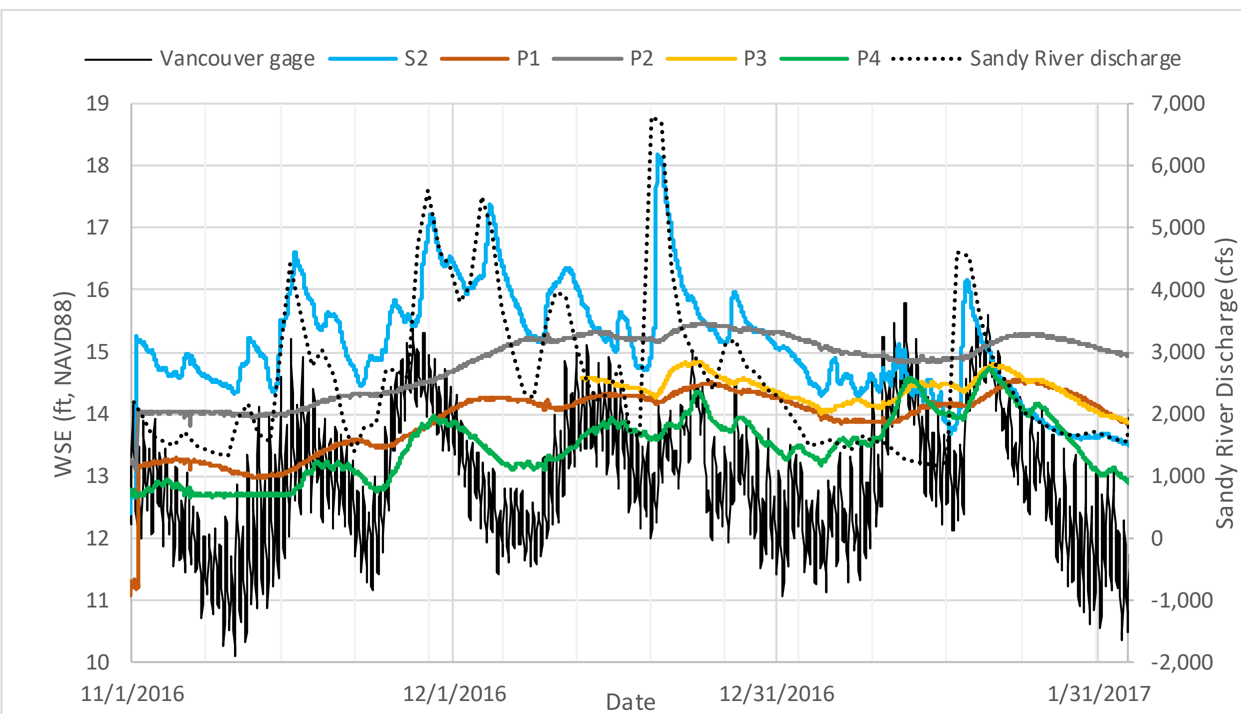
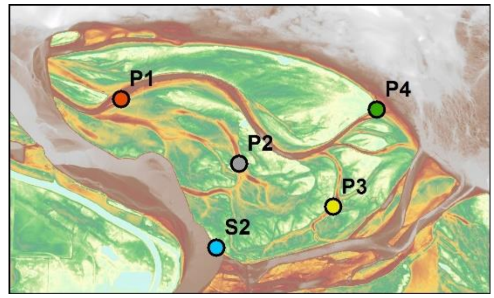


Figure 4. Water level sensor data from November 1, 2016 through February 4, 2017.

Water table slopes between sensors were calculated to evaluate water table dynamics and head gradients in the study area (Figure 5). Slopes between S2 and P2 are most variable, due to high variability in S2 surface water elevations. P2 to P4 slope is consistently high, and is higher than P2 to P1 except when Columbia River stages meet or exceed Sandy River stages. This is because P1 is more strongly connected to Sandy River hyporheic water, while P4 is more heavily influenced by Columbia River. P2 to P1 has consistently high slope, and is generally more consistent than P2 to P4 due to higher connectivity to Sandy River hyporheic flows. P3 to P4 slope fluctuates with a similar shape as P2 to P4, but at a consistently lower slope. Slope between P1 and P4 was analyzed but not shown in figures, and averaged around zero with slopes ranging from -0.04% to 0.02%.



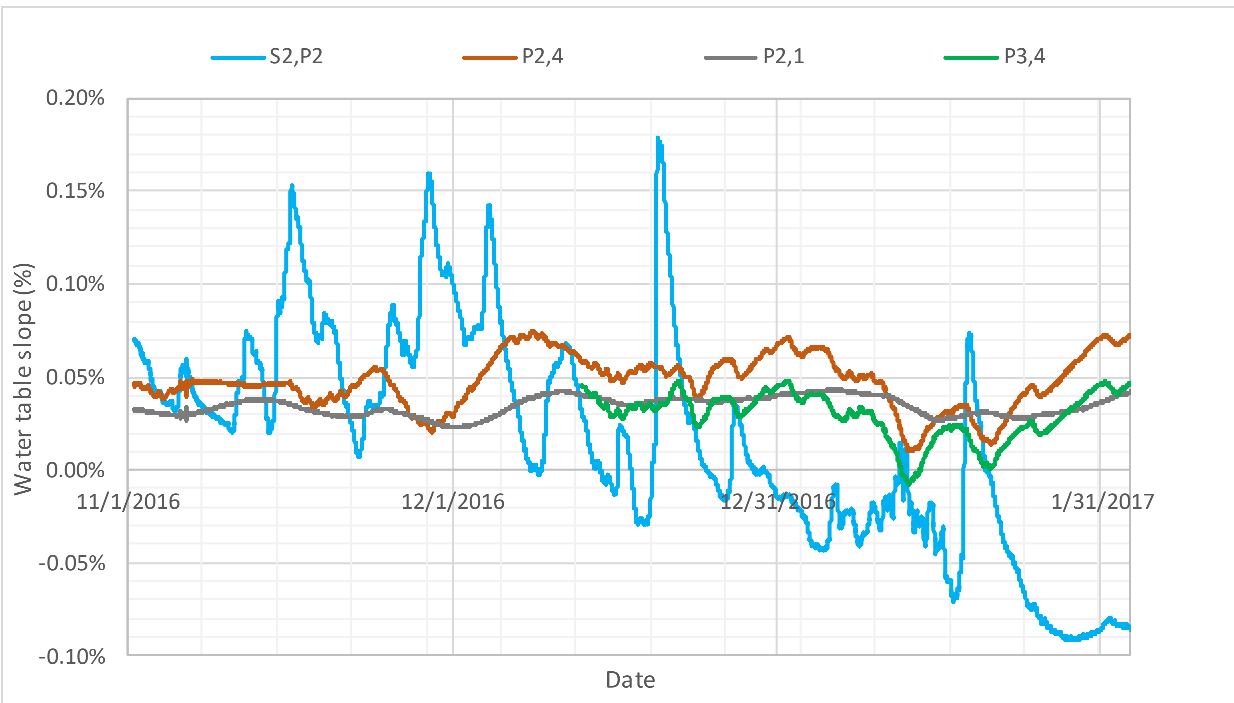
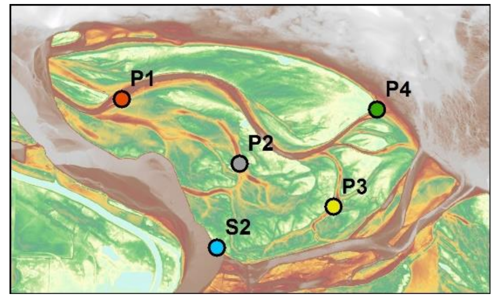


Figure 5. Water table slope between sensor locations from November 1, 2016 through February 4, 2017. Horizontal distance measured on a straight line between points.

February 4, 2017 to April 1, 2017

The second period of interest is during higher flow conditions between February 4, 2017 and April 1, 2017. Water surface elevations during this period are primarily dominated by high Columbia River stage, which reverses the water table gradient observed in the previous period. P4 has the highest elevation, followed by P1, P3, and S2. The relative elevation of P2 is variable, depending on Sandy River discharge and Columbia River stage. P2 appears to be least sensitive to changes in Columbia River stage, as it has the longest lag time relative to changes in the Columbia River. This may be due to lower hydraulic conductivity compared to other sensors.



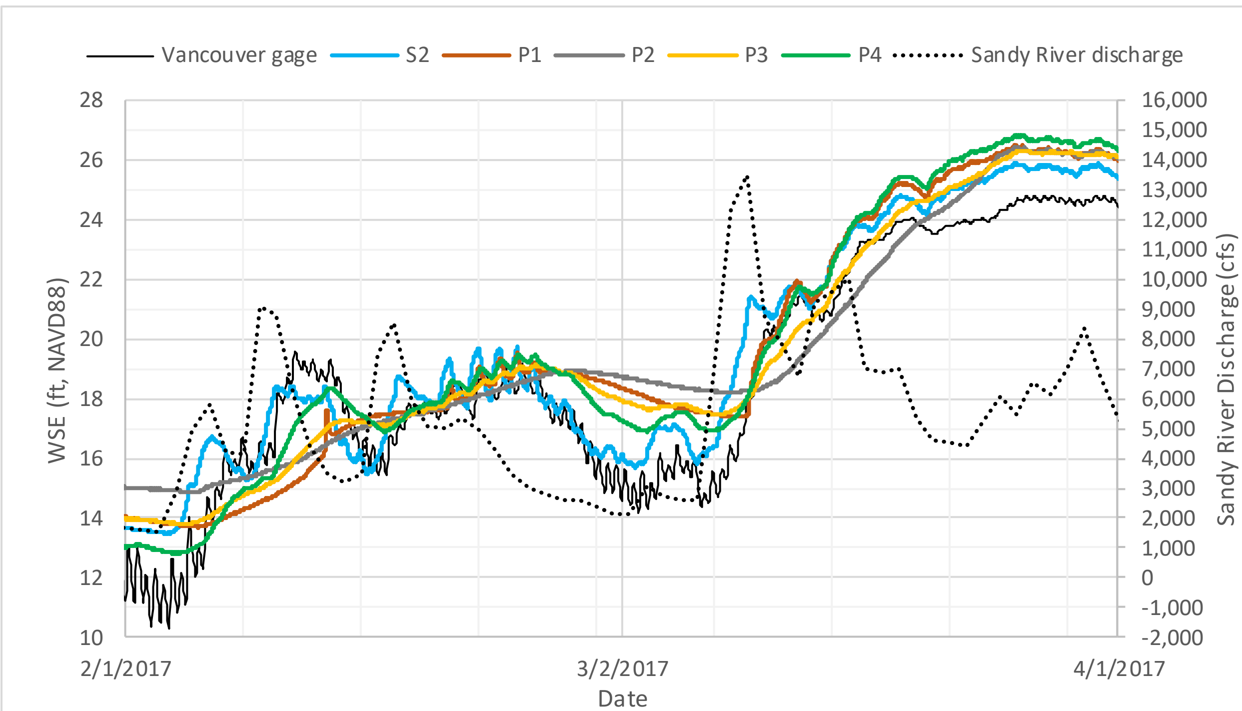
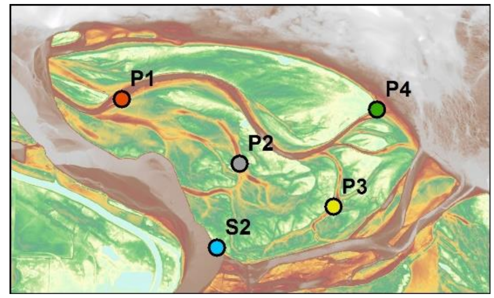


Figure 6. Water level sensor data from February 1, 2017 to April 1, 2017.

Similar to the previous period analyzed, slopes between S2 and P2 are most variable, due to high variability in S2 surface water elevations. P2 to P1 has the most time with a positive slope compared to the other sensors, followed by P2 to P4, then P3 to P4. P4 is strongly connected to Columbia River stage and will reverse the water table slope quickly when stage exceeds that of the Sandy River compared to P1, which is more connected to Sandy River hyporheic flows. Hydraulic conductivity may also be higher at P4, allowing it to respond rapidly to changes in surface water stage.



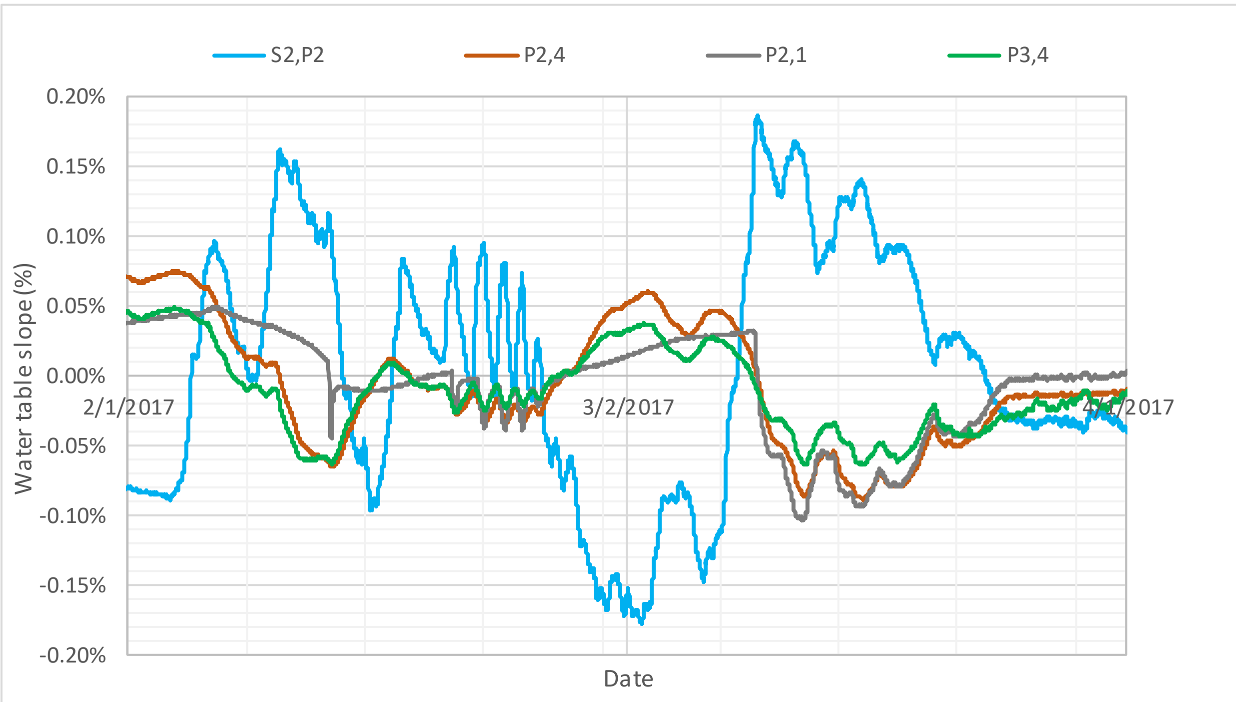


Figure 7. Water table slope between sensor locations from February 1, 2017 through April 1, 2017. Horizontal distance measured on a straight line between points.

CONCLUSIONS

This analysis presents preliminary findings from year 1 surface water and groundwater monitoring at Sundial Island. Local water table slopes between sensors ranged during the period of interest (November through April) from to 0.07% to -0.1%, with the majority of slopes between 0.5% and -0.5%. The water table is sloped in a primarily north-south direction, with groundwater stages controlled by both Sandy River stage and Columbia River stage. Sensors P1 and P2 appear to be most influenced by Sandy River hyporheic water as shown by stage and temperature relationships, while P4 is more strongly regulated by the Columbia River. The groundwater slopes between P2 and P4 were relatively high, and least affected by Columbia River stage compared to other relationships analyzed. This is either due to higher connectivity with Sandy River hyporheic flow, or lower hydraulic conductivity of subsurface material.

A more thorough feasibility analysis of a potential chum spawning channel at the site will be completed following collection of year 2 data. Year 2 analysis will include two more surface water sensors (S1 and S3), along with a comparison of observed Sandy River and Columbia River stages to historical measurements to put these observations in context of "typical" conditions at the site.