2010 ANNUAL SELF-MONITORING REPORT

South Bay Salt Pond Restoration Project - Phase 1

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LIST OF ACRONYMS AND ABREVIATIONS

Acronym or Abbreviation	Full Phrase
BOD	Biological Oxygen Demand
CCM	Continuous Circulation Monitoring
CDFG	California Department of Fish and Game
CSUS	California State University Sacramento
DO	Dissolved Oxygen
FWS	United States Fish and Wildlife Service
GPS	Global Positioning System
IRP	Initial Release Period
ISP	Initial Stewardship Plan
mg/L	Milligrams per Liter
mS/cm	MilliSiemens per Centimeter
MLLW	Mean Lower Low Water
NMFS	National Marine Fisheries Service
PAR	Photosynthetically Active Radiation
PSS	Practical Salinity Scale
Refuge	Don Edwards San Francisco Bay National Wildlife Refuge
Service	United States Fish and Wildlife Service
SMP	Self-Monitoring Program
SOD	Sediment Oxygen Demand
South Bay	South San Francisco Bay
USGS	United States Geological Survey
Water Board	California Regional Water Quality Control Board

SECTION 1
REPORT OVERVIEW

1.1 INTRODUCTION

This annual self-monitoring report provides the results of the 2010 water quality monitoring and applied studies conducted at the Alviso Ponds in Santa Clara County, California. The report also provides updates of South Bay Salt Pond Restoration Project (Project) Phase 1 activities and Phase 2 planning efforts. In previous years, this annual report has been submitted to the California Regional Water Quality Control Board (Water Board) to comply with the Self-Monitoring Program (SMP) as described in the Final Order (No. R2-2008-0078). This year, the report will also be submitted to NOAA's National Marine Fisheries Service (NMFS) because we have included additional fisheries monitoring conducted as part of the Science Program's Applied Studies, which are intended to fill the most important gaps in our knowledge about South San Francisco Bay (South Bay) ecosystem

It is anticipated that both water quality and fisheries information will help the Water Board and NMFS: 1) provide guidance to the Project on future applied studies and monitoring; and 2) assist in identifying emerging key uncertainties and management decisions required to keep the Project on track toward its restoration objectives.

1.2 WATER QUALITY MONITORING FOR ALVISO PONDS

This report summarizes 2010 water quality sampling conducted at the Alviso Ponds in Santa Clara County, California, which are part of the South Bay Low Salinity Salt Ponds. Operations occurred from June through October 2010. Sampling was performed on a continuous, weekly, monthly, or bi-monthly schedule as required by the Water Board Order, as modified in a letter dated June 29, 2010. Sampling was performed by the United States Geological Survey (USGS) on behalf of the United States Fish and Wildlife Service (Service) in accordance with the waste discharge requirements.

The Final Order for the South Bay Low Salinity Salt Ponds concerned 15,100 acres of ponds in Alameda, Santa Clara, and San Mateo Counties. The area encompasses the Alviso Pond Complex (Figure 1-1).

This report covers the following pond systems within the complex: A2W, A3W, A7, A14, and A16. The systems are operated by the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) in Santa Clara County. The California Department of Fish and Game (CDFG) will submit a report for the Eden Landing (Baumberg) Ponds under a separate cover.

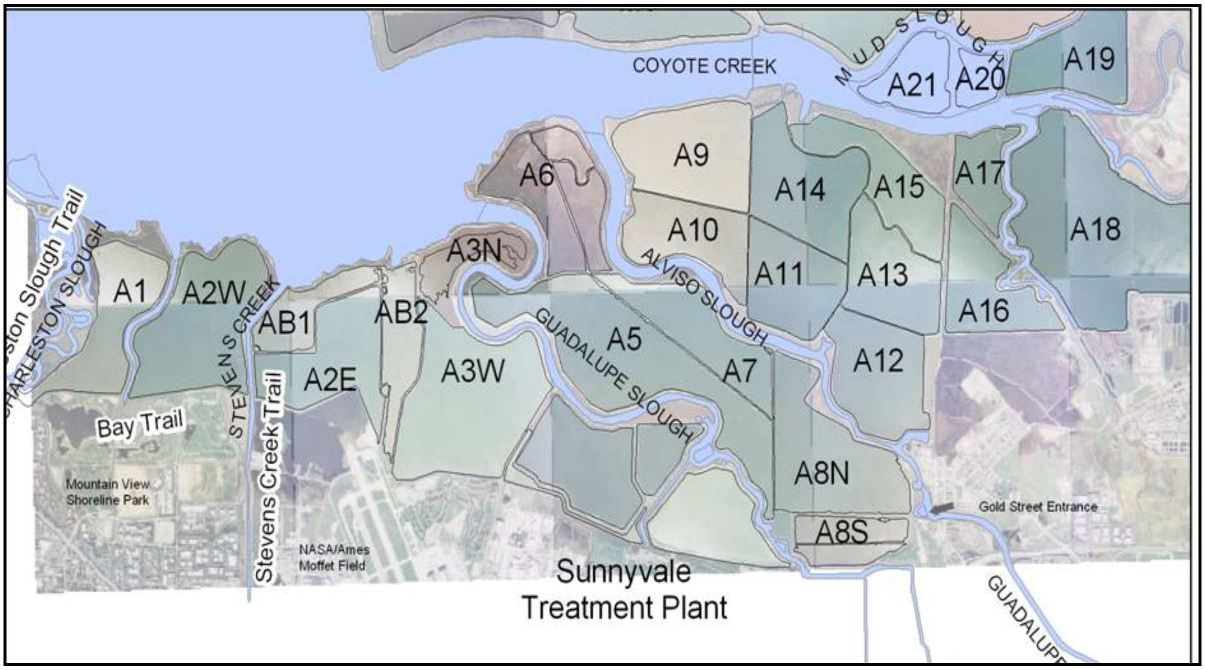

Figure 1-1: Alviso Pond Complex

The ponds are generally being operated as flow-through systems with Bay or slough water entering an intake pond within each pond system at high tides through a tide gate, passing through one or more ponds, and exiting the particular system's discharge pond to either a tidal slough or the Bay at low tides. The ponds only discharge at low tides for about 6 or 8 hours per day. Two ponds in the A3W and A7 systems, Ponds A3N and A8, respectively, were operated as seasonal ponds during 2010 and were not connected to this flow-through system. Also, Ponds A12, A13, and A15, part of the A14 pond system, are designed as batch ponds. Discharge occurs from Pond A15 to Pond A16 when salinity reaches over 130 parts per thousand (ppt); it was not discharged on a batch basis in 2010.

The Final Order recognized two periods of discharges from the ponds. The first covered the Initial Release Period (IRP) when salinity levels would decrease from the initial levels in the ponds. The second period is the Continuous Circulation Monitoring (CCM) period after salinities went below the 44 ppt salinity discharge limit. Different monitoring plans were identified in the Final Order by Water Board and revised in 2005, and 2008.

In 2010, the Service submitted a monitoring proposal to direct Service resources towards a more robust Applied Study of Pond A3W to better understand the causal factors of low dissolved oxygen (DO) in managed ponds. The Water Board modified the Self-Monitoring Program (SMP) in a letter, dated June 29, 2010, so that it was consistent with the Service's proposal to focus efforts on Pond A3W. To accommodate this shift in resources, the Water Board no longer requires the Service conduct continuous monitoring at Pond A7.

1.3 APPLIED STUDIES FOR POND A3W

Over the past two years, the Service conducted Applied Studies in pond systems A3W, A14, and A16. These studies have shown that water quality, in particular DO, exhibits significant spatial and temporal variation within each pond. To develop a better understanding of the causal factors of this variability, the Service proposed to focus its limited resources on Pond A3W. This is, in part, because Pond A3W is expected to remain a managed pond in any long-term restoration scenario. By focusing on Pond A3W, this will allow the Service to conduct more monitoring for porewater filters (sediment oxygen demand), chlorophyll (a), nitrogen components, and to deploy up to six continuous datasondes within the pond to monitor for DO, pH, salinity, and temperature. This will provide a more robust data set from which to evaluate causal factors of low DO. To complement the Applied Study monitoring requirements for Pond A3W, USGS has submitted two separate reports that address DO budget and nutrients.

SECTION 2
WATER QUALITY MONITORING METHODOLOGY

This section summarizes the monitoring methodology used to perform monitoring conducted during the 2010 calendar year at the Alviso Pond Complex to comply with the Order.

2.1 CONTINUOUS POND DISCHARGE SAMPLING - POND A3W

In June 2010, the Water Board revised the SMP in response the Service's request to focus resources towards a more robust Applied Study of Pond A3W to better understand the causal factors of low DO in managed ponds. As a result, the Service will no longer conduct continuous monitoring at Pond A7. However, continuous monitoring will continue as part of the Applied Study requirement for Pond A3W.

USGS installed one continuous monitoring datasonde (Hydrolab-Hach Company, Loveland, CO) at the Alviso Pond A3W discharge location during the 2010 water quality monitoring season. This datasonde began logging data on 1 June 2010 and continued logging data through 31 October 2010. The datasonde at the discharge location was installed inside Pond A3W on the water control structure, where it could measure water quality at the outflow of the discharge into the slough and/or San Francisco Bay. It was secured within a submerged perforated ABS tube attached to the water control structure to allow for free water circulation around the sensors. The device was installed at a depth of at least 25 centimeters to ensure that the sensors were submerged, and the depth was monitored and adjusted to maintain constant submersion as the pond water level fluctuated.

Salinity, pH, temperature, and DO were collected at 15-minute intervals with a sensor and circulator warm-up period of 2 minutes. Data were downloaded weekly and the datasonde was serviced to check battery voltage and data consistency. A recently calibrated Hydrolab minisonde (Hydrolab-Hach Company, Loveland, CO) was placed next to the datasonde in the pond at the same depth, and readings of the two instruments were compared. Any problems detected with the datasonde were corrected through calibration or replacement of parts or instruments. The sensors on the datasonde were calibrated prior to deployment into the pond and were calibrated and cleaned on a biweekly schedule unless otherwise noted in Service records. During the cleaning and calibration procedure, simultaneous readings were collected with a recently calibrated minisonde to confirm data consistency throughout the procedure (initial, de-fouled, and post-calibration). The initial and de-fouled readings were also used to detect shifts in the data due to accumulation of biomaterials and sediment on the sensors.

2.2 Dissolved Oxygen Investigations - Pond A3W

To complement the continuous monitoring and weekly discharge sampling efforts (discussed in section 2.3), USGS conducted intensive in-pond DO investigations in Alviso Pond A3W from 1 June 2010 through 31 October 2010. In addition to the datasonde located at the discharge location, five additional datasondes were deployed in Pond A3W during this time frame. All six datasondes were left in these locations for the length of the study period, with the exception of cleaning and/or maintenance. In most cases these recorded salinity, pH, temperature, and DO at 15-minute intervals, with the exception of instrumentation failures.

These six datasondes began logging data on 1 June 2010 and continued logging data through 31 October 2010. Datasonde locations were chosen with the intent of obtaining an overall representation of the spatial variability within Pond A3W. One datasonde was deployed at each of the following six locations:

1. Discharge – datasonde deployed at the discharge structure,

2. Intake – datasonde deployed at the intake structure,

3. Algal – datasonde deployed adjacent to a floating algal mat,

4. Deep – datasonde deployed within an internal pond channel with a depth greater than one meter,

5. Shallow #1 - datasonde deployed at a shallow location where the datasonde was stationary yet floating near the water surface, and

6. Shallow #2 - datasonde deployed at a shallow location in which the datasonde was deployed on the pond bottom in water less than one meter in depth.

The datasonde at the discharge location was installed inside Pond A3W on the water control structure, as described in Section 2.1. The remaining five datasondes were secured inside a cage-like structure made from PVC pipe. This PVC cage ensured a secure, free-standing deployment and allowed for free water circulation around the datasonde's multiple sensors.

As part of the in-pond DO investigations, additional sampling of Pond A3W was conducted from July 2010 to September 2010. These investigations included the following sample types listed below:

- <u>Pressure Transducer</u> – A Solinst barologger was installed near the discharge structure of Pond A3W to record barometric pressure data. This data was used in conjunction with a Solinst levelogger, installed adjacent to the discharge datasonde, to determine water depths in Pond A3W.

- Nutrients – To examine spatial variability across Pond A3W, representative nutrient samples were collected weekly in the vicinity of the five shallow water datasonde locations. Sample collection at the deep water datasonde location was excluded due to logistical concerns and the likelihood that this shallow, well-mixed pond would exhibit similar concentrations at shallow site #1, residing just above the deep datasonde. From July through September 2010, two samples were collected from just below the water surface. These samples were stored on wet ice and transported to a 40°F freezer for storage until they could be analyzed for ammonia, nitrate, nitrite, dissolved inorganic nitrogen (a sum of ammonia, nitrate and nitrite), orthophosphate (biologically available form of phosphate), silica and trace metals.

- Chlorophyll a – To examine spatial variability across Pond A3W, water samples were collected monthly for chlorophyll a analysis. Samples were collected just below the water surface at each of the five shallow water datasonde locations using a light excluding Nalgene container. A Van Dorn water sampler was used to collect a water sample at the deep datasonde location. These samples were then chilled on wet ice until they were filtered. Filtration took place on site and the resulting retentates were stored in a light excluding container which was then placed in a cooler of dry ice. Samples were transported the same day to a -80 °C freezer for storage until they could be analyzed for chlorophyll a and phaeopigments. Surficial sediment (that is, the top 0.5 centimeters of lakebed material) were collected from Ekman grabs, and analyzed spectrophotometrically for benthic chlorophyll a and phaeopigments.

- Porewater Profilers: Oxygen, Dissolved Organic Carbon, Nutrients and Trace Metals – Non-metallic porewater profilers were deployed in Pond A3W each month from July to September 2010. Profilers were deployed in triplicate at two sites: (1) a shallow site (< 1 meter deep) which was close in proximity to the intake datasonde location, and (2) a deep site (>2 meters deep) which was adjacent to the datasonde at the deep location. Glass syringes were used to collect DO samples. The concentration difference between the overlying water and the porewater can be used to determine an estimate of diffusive (i.e. passive, not including bioturbation) flux of oxygen into the sediment. Acid-washed polyethylene syringes were used to collect dissolved (i.e., 0.2 micron filtered) porewater samples, which were analyzed for dissolved nutrients (ammonia, nitrate, nitrite, orthophosphate, and silica), dissolved organic carbon and dissolved trace metals. Again, the concentration gradient can be used to determine diffusive flux estimates.

- Sediment Oxygen Demand – Acrylic tubes were used to sample sediment cores, approximately 10 centimeters deep, from which overlying water was iteratively sampled and analyzed for DO. The rate at which oxygen decreases in the overlying water can be used to calculate an estimate of sediment oxygen demand (SOD) (i.e., total consumption of oxygen by the sediment – most likely due to respiring bacteria consuming labile organic material).

- Biological Oxygen Demand – Biological oxygen demand (BOD) samples were collected from six locations in the pond, corresponding to the location of the six deployed water quality datasondes. Triplicate samples were collected in 3-liter bottles from each location on 1 July, 19 August, and 22 September 2010. A Van Dorn water sampler was used to collect a water sample at the location of the deep datasonde. Any obvious macrophytes were excluded from the samples at the time of collection. The samples were stored on ice and transported to the California State

University-Sacramento (CSUS) campus. Analysis for BOD_5 was started within eight hours of sample collection. Sample analysis was provided by Dr. John Johnston and August Smarkel, Office of Water Programs, CSUS, using the standard five-day test (Standard Methods 5210B; APHA 1998[1]). Dilution water used for the test was artificial seawater adjusted to the salinity of the collected samples. Reported BOD_5 values represent the mean of the three triplicate samples for each location.

- Discharge (flow) – Inflow to and outflow from the pond were measured with a 1,200 kHz acoustic Doppler current profiler (ADCP, R.D. Instruments) fitted into a buoyant sled. The sled was pulled back and forth across the channel upstream of the inflow culvert from Pond AB2 and the discharge culvert to Guadalupe Slough to measure water velocities and compute flow rates through the culverts. The water surface elevations in each pond (AB2 and A3W) were recorded at the time of measurements from staff gauges located near each culvert. The flow from Pond A3W into Guadalupe Slough is tidally controlled, so discharge measurements must be collected over a period of hours to capture the relationship between outflow and tide height in the slough. Further details of the measurement details can be found in Shellenbarger et al. (2007)[2]. Flow measurements were collected on 18 August and 3 November 2010.

- Meteorological Measurements – A portable weather station was installed on Pond A3W which was used to collect meteorological data. Wind speed and direction, air temperature, relative humidity, rainfall, photosynthetically active radiation (PAR), and solar radiation were collected at 15-minute intervals during each sample period.

2.3 Discharge Sampling – Ponds A2W, A3W, A7, A14, and A16

In addition to the continuous monitoring datasonde used at Alviso Pond A3W, weekly spot monitoring was conducted at the discharge structures for Alviso Ponds A2W, A3W, A7, A14, and A16 using a Hydrolab minisonde. From 1 June 2010 to 31 October 2010 Ponds A7, A14, and A16 were monitored for compliance by sampling the discharge waters for a total of thirteen consecutive minutes each week. Pond A2W was monitored from 1 July 2010 to 31 October 2010 using the same sampling methods. This weekly spot monitoring was conducted in the morning hours since DO values are generally lowest due to nightly respiration and the lack of available PAR (photosynthetically active radiation).

2.4 Receiving Water Sampling – Ponds A3W, A7, A14, and A16

Beginning 4 June 2010, samples were collected monthly from Pond A3W receiving water (Guadalupe Slough, 8 sites), A7 receiving water (Alviso Slough, 7 sites), A16 receiving water (Artesian Slough, 5-6 sites) and A14 (3 sites) through October 2010. Slough sampling sites were accessed via boat from San Francisco Bay. A boat-mounted global positioning system (GPS) unit was used to navigate to sampling

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[1] American Public Health Association. 1998. Standard methods for the examination of water and wastewater, 20th ed., Washington D.C.

[2] Shellenbarger, G.G., D.H. Schoellhamer, and M.A. Lionberger. 2007. PONDCALC—a tool to estimate discharge from the Alviso Salt Ponds, South San Francisco Bay, California. US Geological Survey Scientific Investigations Report 2007–5005, 12 pages. http://pubs.usgs.gov/sir/2007/5005/pdf/sir_2007-5005.pdf

locations. When the boat was approximately 50 to 25 meters from the site, the engine would be cut or reduced which would then allow the boat to drift (by current and wind) to the site location. Every effort was made to ensure that the sample reading was collected from the center of the slough. A recently calibrated Hydrolab minisonde was used to measure salinity, pH, temperature, and DO at each location. Samples were collected from the near-bottom of the water column in addition to the near-surface (25 centimeters) at each sampling location. Depth readings for sample locations were collected at the completion of each minisonde measurement to account for drift during the reading equilibration period. The specific gravity of each site was measured with a hydrometer (Ertco, West Paterson, New Jersey) scaled for the appropriate range. This sample was collected concurrently with the near-surface minisonde measurement. The majority of the samples were collected on the rising or high tide in order to gain access to the sampling sites, which were not accessible at tides less than 3.0 feet mean lower low water (MLLW). Standard observations collected at each site included:

A. observance of floating and suspended materials of waste origin;

B. description of water condition including discoloration and turbidity;

C. odor (presence or absence, characterization, source and wind direction);

D. evidence of beneficial use, presence of wildlife, fisherpeople and other recreational activities;

E. hydrographic conditions (time and height of tides, and depth of water column and sampling depths); and

F. weather conditions (air temperature, wind direction and velocity, and precipitation).

Observations A, B, C, D and E were recorded at each sampling location. Observation F was recorded at the beginning and ending of each slough, unless it had changed significantly.

2.5 CALIBRATION AND MAINTENANCE

All the instruments used for sampling as part of the South Bay Salt Pond Initial Stewardship Plan's (ISP) Self-Monitoring Program were calibrated and maintained according to the USGS standard procedures. Datasondes were calibrated pre-deployment and maintained on a biweekly cleaning and calibration schedule unless they required additional maintenance. The problem of biofouling and sediment accumulation interfering with the moving parts, such as on the self-cleaning brush and circulator, was improved with the use of a copper mesh held in place by nylon stockings. This allowed for maximum water flow past the sensors while helping to reduce biological growth and debris from interfering with sensor performance. USGS performed a biweekly fouling check to detect shifts in data due to the accumulation of biomaterial and sediment on the sensors. A calibration and maintenance log was maintained for each pond.

SECTION 3
WATER QUALITY MONITORING RESULTS

3.1 CONTINUOUS CIRCULATION MONITORING - POND A3W

During the 2010 monitoring season, only Pond A3W was continuously monitored for discharge since this pond has typically shown low DO throughout the summer months. Data collected at discharge waters for Pond A3W in 2010 were compared to water quality data collected in previous years (2005-2009) during the same period and at the same location. Following the pattern observed in 2005 and 2006, salinity levels of discharge waters for Pond A3W generally increased from June through October 2010. There was a slight, short-lived decrease in the salinity of discharge waters for Pond A3W in early July and early October 2010. However, after these small decreases, salinity values once again continue on an upward trend for the remainder of the 2010 study period. Salinity values recorded early this year were higher than values seen in 2005 and 2006 but are generally lower than salinity values recorded in 2007 and 2009 (Appendix A, Figure A-1). In 2010, pH averages for discharge waters in Pond A3W were variable, as they were in all other monitoring years, but there was an obvious downward trend from mid-July until mid-September. Monitoring years 2008 and 2009 also show an obvious decrease in pH values around this same time frame (Appendix A, Figure A-2). Temperatures recorded this year are consistent with data collected during all other years with temperatures gradually increasing from June through August then decreasing from August through October (Appendix A, Figure A-4). This year, as well as all previous years of continuous monitoring, DO values has been highly variable for discharge waters within Pond A3W. During the first few months of the 2010 monitoring season, June and July, daily DO averages were primarily above the 3.33 mg/L threshold excluding the daily average on June 5th when the DO average fell to 2.44 mg/L. After late August, daily DO averages primarily fell below the threshold and continued to straddle this 3.33 mg/L limit until late October when daily averages once again rose above the 3.33mg/L mark (Appendix A, Figure A-3). All weekly 10th percentile values for DO in 2010 fell below 3.33 mg/L except for a few weeks in June and July when 10th percentile values hovered slightly above this limit (Table 3.1). Although these weekly 10th percentile values for DO were primarily below the 3.33mg/L limit in 2010, this is not an unusual pattern. Weekly 10th percentiles values for DO in years 2007, 2008, and 2009 also primarily fell below the threshold of 3.33 mg/L (Appendix A, Figure A-5).

Table 3.1: 10th Percentiles for Dissolved Oxygen During Discharge in Pond A3W, 2010

Start Date	End Date	2010 data (mg/L)	2009 data (mg/L)	2008 data (mg/L)	2007 data (mg/L)	2006 data (mg/L)	2005 data (mg/L)	2004 data (mg/L)
23-Apr	30-Apr	n/a	n/a	n/a	1.7	4.7	5.1	n/a
1-May	5-May	n/a	n/a	n/a	2.7	4.2	3.5	n/a
6-May	12-May	n/a	n/a	n/a	3.1	4.3	3.8	n/a
13-May	19-May	n/a	n/a	n/a	2.6	3.2	4.4	n/a
20-May	26-May	n/a	n/a	n/a	1.7	5.2	3.8	n/a
27-May	2-Jun	2.8	n/a	n/a	0	5.4	3.6	n/a
3-Jun	9-Jun	2.2	2.2	n/a	0	5	3.8	n/a
10-Jun	16-Jun	3.2	0.7	n/a	0.2	3.5	3.5	n/a
17-Jun	23-Jun	2.7	2	n/a	1.6	2.7	3.9	n/a
24-Jun	30-Jun	3.3	2.5	n/a	1.6	2.3	3.6	n/a
1-Jul	7-Jul	4.3	1.2	n/a	1.6	2.7	3.7	n/a
8-Jul	14-Jul	4.0	0.3	n/a	0.6	2.7	4.5	n/a
15-Jul	21-Jul	2.5	1	n/a	0.4	2.3	1.7	0.1
22-Jul	28-Jul	4.2	0.2	n/a	0.7	0.5	1.9	0.7
29-Jul	4-Aug	2.1	0.6	0.1	0.8	2.6	2.6	0.1
5-Aug	11-Aug	2.7	1.7	0.1	1.3	2.9	3.6	0.4
12-Aug	18-Aug	2.0	1.1	0.3	0.8	2.9	3.5	0.1
19-Aug	25-Aug	2.2	1	0.5	0.2	3.4	3.6	0.1
26-Aug	1-Sep	1.1	0	0.1	0.4	2.5	1.9	0.1
2-Sep	8-Sep	0.7	0	0.8	0.3	1.9	0.6	0.1
9-Sep	15-Sep	0.2	0.9	0.4	0.7	2.5	3.6	0.1
16-Sep	22-Sep	0.7	0.9	0.1	1.1	4.7	2.2	0.1
23-Sep	29-Sep	0.5	0.1	0.1	1.3	3.2	3.8	0.1
30-Sep	6-Oct	0.1	0.5	0.3	2.1	2.8	1.4	0.1
7-Oct	13-Oct	0.2	1.3	0.3	2	4	4	0.1
14-Oct	20-Oct	0.1	0.1	n/a	3.4	4.6	4	1
21-Oct	27-Oct	1.4	0.1	n/a	2.7	2.8	3.5	2
28-Oct	3-Nov	0.2	3.1	n/a	3.4	5.7	5.6	2.5
4-Nov	10-Nov	n/a	n/a	n/a	4.9	n/a	5.2	4.2
11-Nov	13-Nov	n/a	n/a	n/a	7	n/a	n/a	n/a

3.2 POND A3W IN-POND SAMPLING

Datasondes were deployed at six locations within Pond A3W during the study period (Figure 3.2). We found that DO concentrations were highest in June and July and lowest in September and October. Following this trend, pH concentrations and temperatures of Pond A3W were highest during June and July and lowest in September and October. In contrast, salinity levels of Pond A3W were lowest during June and July and highest during September and October (Table 3.2).

When comparing monthly averages, DO levels were highest at the intake location (Table 3.2). Lowest monthly averages for DO were most often recorded by the datasonde at the shallow #2 location (Table 3.2). Generally, DO was lower in the deep compared with the shallow #1 location, indicating probable vertical stratification of Do concentrations within the water column of this pond.

Figure 3.2: Datasonde Locations in Pond A3Wduring 2010.

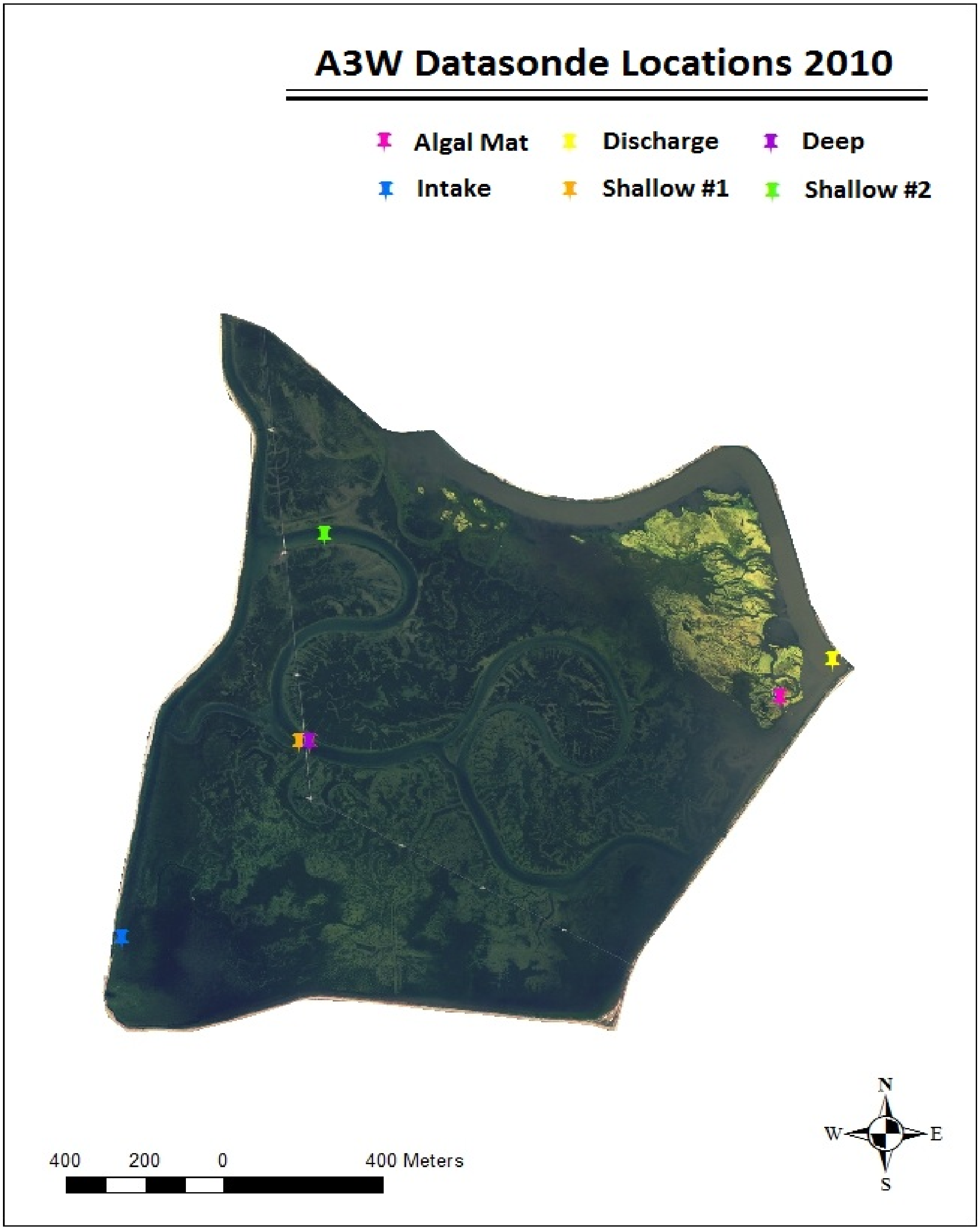


Table 3.2: Pond A3W summarized water quality values (mean ± standard deviation) by month in 2010.

Pond	Month	Dissolved Oxygen (mg/L)	pH (Units)	Specific Conductivity (mS/cm)	Temperature (°C)	Salinity
A3W	**June**					
	Overall	6.09 ± 3.34	9.17 ± 0.50	33.74 ± 3.42	22.16 ± 2.35	21.33 ± 2.30
	Discharge	4.90 ± 2.00	8.62 ± 0.42	28.16 ± 3.90	21.97 ± 1.81	18.37 ± 3.40
	Intake	6.94 ± 2.45	8.79 ± 0.08	34.47 ± 1.52	22.47 ± 2.42	21.66 ± 1.06
	Algal	5.37 ± 4.14	9.53 ± 0.35	34.43 ± 2.55	22.70 ± 2.58	21.63 ± 1.78
	Shallow #1	6.80 ± 2.23	9.54 ± 0.17	34.35 ± 2.02	22.55 ± 1.92	21.64 ± 1.58
	Shallow #2	5.63 ± 4.83	8.83 ± 0.25	35.51 ± 2.50	21.13 ± 2.82	22.40 ± 1.75
	Deep	6.76 ± 2.55	9.60 ± 0.18	34.72 ± 2.06	22.19 ± 1.91	21.84 ± 1.44
	July					
	Overall	5.22 ± 2.85	9.01 ± 0.33	37.54 ± 2.61	22.66 ± 1.83	23.78 ±1.85
	Discharge	5.03 ± 1.52	8.76 ± 0.27	33.27 ± 2.58	22.87 ± 1.59	20.83 ± 1.79
	Intake	6.52 ± 2.27	8.90 ± 0.06	37.97 ± 0.69	22.93 ± 1.87	24.12 ± 0.49
	Algal	4.58 ± 2.94	8.94 ± 0.33	36.20 ± 2.44	23.20 ± 1.73	22.88 ± 1.71
	Shallow #1	6.33 ± 2.36	9.28 ± 0.16	38.94 ± 0.87	22.99 ± 1.49	24.60 ± 1.07
	Shallow #2	**2.98** ± 3.15	8.92 ± 0.47	39.58 ± 0.81	21.11 ± 1.74	25.26 ± 0.58
	Deep	6.06 ± 2.60	9.26 ± 0.11	38.78 ± 0.94	22.98 ± 1.56	24.70 ± 0.67
	August					
	Overall	4.30 ± 3.08	8.62 ± 0.39	39.23 ± 2.43	22.03 ± 1.82	25.02 ± 1.72
	Discharge	4.24 ± 1.89	8.55 ± 0.22	35.04 ± 2.43	21.93 ± 1.67	22.06 ± 1.70
	Intake	5.81 ± 3.18	8.74 ± 0.15	39.67 ± 0.55	22.29 ± 1.96	25.33 ± 0.39
	Algal	4.05 ± 2.95	8.69 ± 0.23	38.69 ± 1.70	22.19 ± 1.86	24.64 ± 1.21
	Shallow #1	5.14 ± 3.02	8.84 ± 0.37	40.58 ± 0.56	22.38 ± 1.64	25.98 ± 0.40
	Shallow #2	**1.98** ± 2.63	7.86 ± 0.23	40.94 ± 0.19	21.51 ± 1.99	26.24 ± 0.13
	Shallow #2 Backup	**1.50** ± 1.85	8.55 ± 0.12	41.03 ± 0.26	21.77 ± 2.10	26.30 ± 0.18
	Deep	5.72 ± 2.77	8.97 ± 0.24	40.63 ± 0.40	21.94 ± 1.42	26.02 ± 0.29
	September					
	Overall	**2.98** ± 3.04	8.32 ± 0.27	39.44 ± 2.10	21.92 ± 1.99	25.17 ± 1.49
	Discharge	**3.16** ± 2.86	8.30 ± 0.25	35.98 ± 2.26	21.56 ± 1.76	22.72 ± 1.59
	Intake	3.65 ± 3.16	8.28 ± 0.12	40.19 ± 0.38	22.56 ± 2.12	25.70 ± 0.27
	Algal	**3.10** ± 2.98	8.39 ± 0.18	38.97 ± 1.57	21.84 ± 1.96	24.84 ± 1.11
	Shallow #1	**3.11** ± 2.81	8.33 ± 0.17	40.47 ± 0.36	22.37 ± 1.75	25.90 ± 0.26
	Shallow #2	**2.62** ± 2.97	8.05 ± 0.29	40.78 ± 0.36	21.35 ± 2.06	26.12 ± 0.26
	Deep	**3.01** ± 3.59	8.61 ± 0.17	40.37 ± 0.39	22.39 ± 1.92	25.83 ± 0.28
	October					
	Overall	3.92 ± 3.35	8.31 ± 0.15	39.26 ± 1.05	18.86 ± 2.53	25.04 ± 0.74
	Discharge	3.64 ± 3.72	8.39 ± 0.15	37.63 ± 2.28	18.55 ± 3.04	23.89 ± 1.61
	Intake	5.55 ± 3.56	8.27 ± 0.16	39.33 ± 0.40	18.55 ± 2.57	25.09 ± 0.29
	Algal	4.33 ± 3.58	8.28 ± 0.11	38.71 ± 0.80	20.13 ± 1.97	24.65 ± 0.57
	Shallow #1	4.79 ± 3.02	8.31 ± 0.15	39.66 ± 0.22	18.70 ± 2.50	25.32 ± 0.15
	Shallow #2	**2.09** ± 2.05	8.32 ± 0.13	39.59 ± 0.31	19.07 ± 2.27	25.28 ± 0.22
	Deep	**2.74** ± 2.75	8.32 ± 0.13	39.72 ± 0.15	18.62 ± 2.47	25.37 ± 0.10

3.2.1 Dissolved Oxygen

Throughout the study period, 1 June to 31 October, DO concentrations had a strong cyclical pattern in all datasonde locations, likely following both diurnal and tidal cycles (Figures 3.2.1-1 through 3.2.1-22). The recorded values differed at each of the six datasonde locations and were generally most variable at the discharge location.

Overall, the shallow #2 location had the lowest average DO values which were most frequently recorded early in the morning and during low tides. At this location, the datasonde rested on the bottom of a narrow, shallow channel. Situated on either side of this channel was the pond's former plateau, and was covered by aquatic vegetation (which also covered the channel) throughout the study period.

From the very start of the study, overnight DO concentrations at this location were very low but recovered to levels above 3.2.13 mg/L around mid-day (Figures 3.2.1-1 through 3.2.1-22) After June, all monthly averages for DO at this location fell below the 3.33 mg/L threshold (Table 3.2). In early August, DO concentrations at this location fell and did not recover even after mid-day; however, this may have been due to an equipment failure. This datasonde was serviced, calibrated, and redeployed at the shallow #2 location after passing all calibration checks. As a precaution, a second datasonde was deployed at this location to monitor data collected by the original datasonde. For the first few days, both datasondes at this location logged very low DO values that did not appear to be influenced by diurnal or tidal cycling. However, this apparent equipment issue seemed to be corrected after calibrations and the subsequent data appears to correspond with data collected throughout the pond. It should be noted that overnight DO levels remained very low at this location as well as all other shallow datasonde locations. Then again, these locations with extremely low DO concentrations at night experienced the highest DO concentrations during the day (Figures 3.2.1-1 through 3.2.1-22). As with the shallow #2 site, the algal mat datasonde was submerged in fairly shallow water and surrounded by aquatic vegetation. This may partially explain the similarities in data recorded at these two locations. The algal mat datasonde was initially deployed adjacent to a floating algal mat but this mat, as well as all other visible algal mats, disappeared (and most likely sunk) in late August.

After late August, all locations within Pond A3W experience extreme overnight DO lows that were recorded throughout the pond (Figure 3.2.1-13). Daytime, pond-wide DO concentrations also dropped around this same time frame but appeared to experience a small increase again in early September (Figures 3.2.1-11 through 3.2.1-15). Overnight DO concentrations decreased again from 3-7 September which corresponded with decreased daytime concentrations (Figure 3.2.1-15). Around mid-September, DO concentrations began to increase both day and night (Figures 3.2.1-15 and 3.2.1-16). In late September, overnight DO levels fell again pond-wide (Figures 3.2.1-17 and 3.2.1-18). DO concentrations increased in early October yet dropped again mid-October (Figures 3.2-18 through 3.2-22). It should be noted that these events appear to cycle around our maintenance schedules and may have been, in part, related to biofouling. As stated previously, locations with large amounts of aquatic vegetation (algal mat, shallow #2, and deep), consistently logged nightly DO values lower than locations with less vegetation (Figures 3.2.1-1 through 3.2.1-22).

DO concentrations were highest during the first few weeks of the study (Table 3.2 and Figures 3.2-1 through 3.2-5). We logged the highest mean DO value (6.94 mg/L) at the intake datasonde location during the month of June (Table 3.2). In June, monthly mean DO levels at all locations were above the 3.33 mg/L limit. Not only were PAR light values largest in June, wind speeds were also highest during this month. Increased wind-driven water mixing and increased amount of photosynthetically active radiation, may, in part, explain the high DO concentrations recorded in June (Table 3.2 and weather table).

After these initial high DO concentrations, monthly DO averages decline after June through September then increased slightly from September to October (Table 3.2). Although monthly DO concentrations declined after June, they remained above 3.33 mg/L except for the month of September when the monthly mean fell to 2.98 mg/L (Table 3.2).

The intake location logged the highest DO concentrations across months. All monthly averages for this location were above the 3.33 mg/L threshold, even during September when all other locations had averages that fell below this threshold (Table 3.2). Excluding September, most locations within Pond A3W had monthly averages above the 3.33 mg/L boundary. The few exceptions were the shallow #2 and deep locations, both of which had monthly averages below 3.33 mg/L in October. The shallow #2 location also had a mean monthly DO value below 3.33 mg/L for all months, excluding June. Irregular spikes in DO concentrations occur throughout the study period and at locations throughout Pond A3W. There were no obvious equipment-related explanations and therefore, are thought to be pond related.

Figure 3.2.1-1: Pond A3W DO values at 6 pond locations during 1 June – 6 June

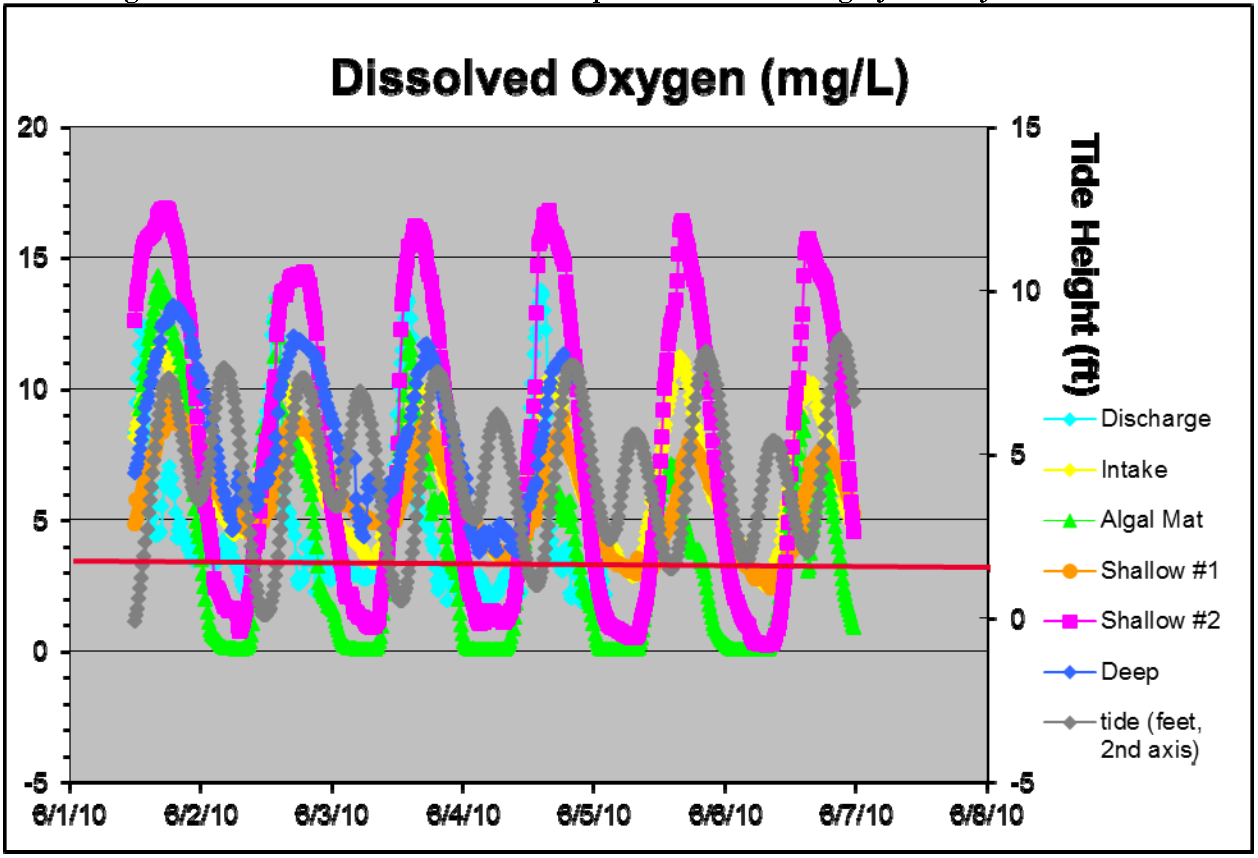


Figure 3.2.1-2: Pond A3W DO values at 6 pond locations during 7 June – 13 June

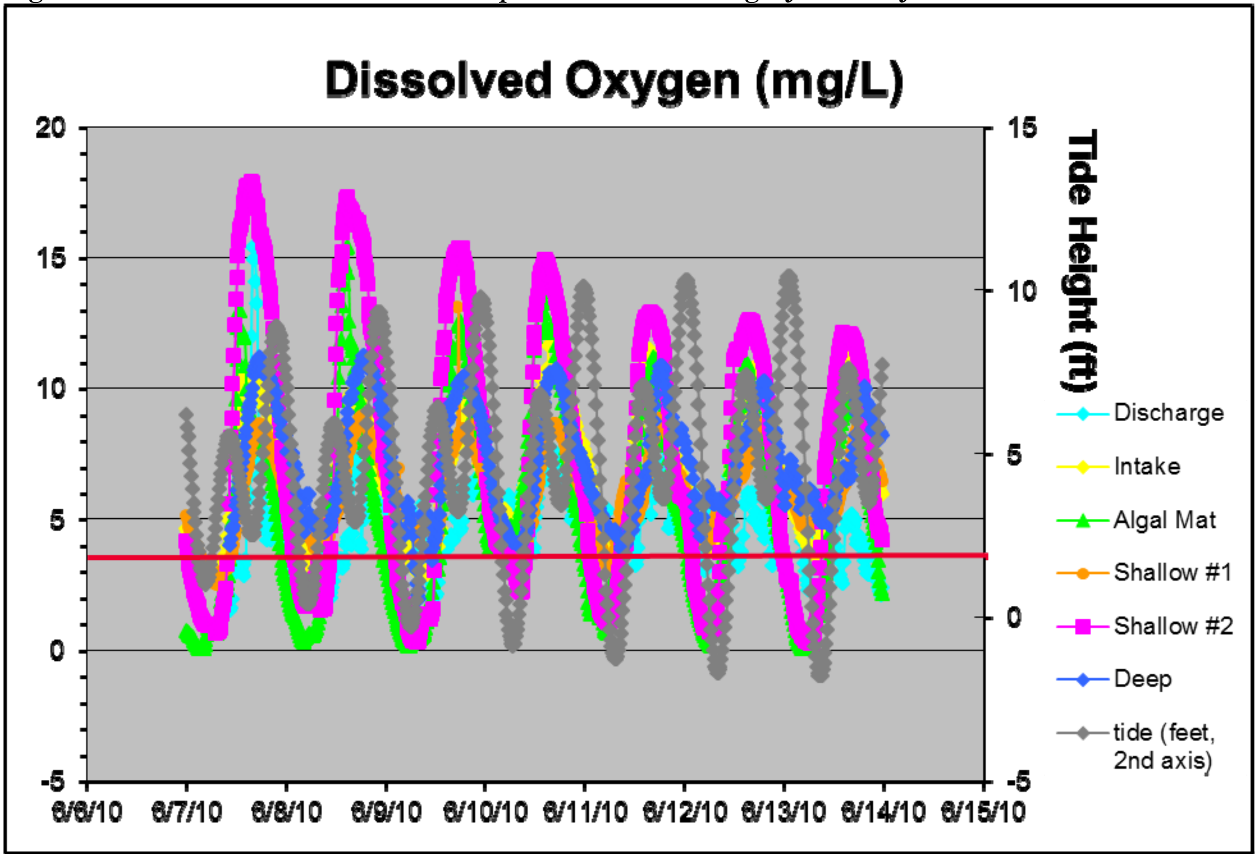


Figure 3.2.1-3: A3W DO values at 6 pond locations during 14 June – 20 June

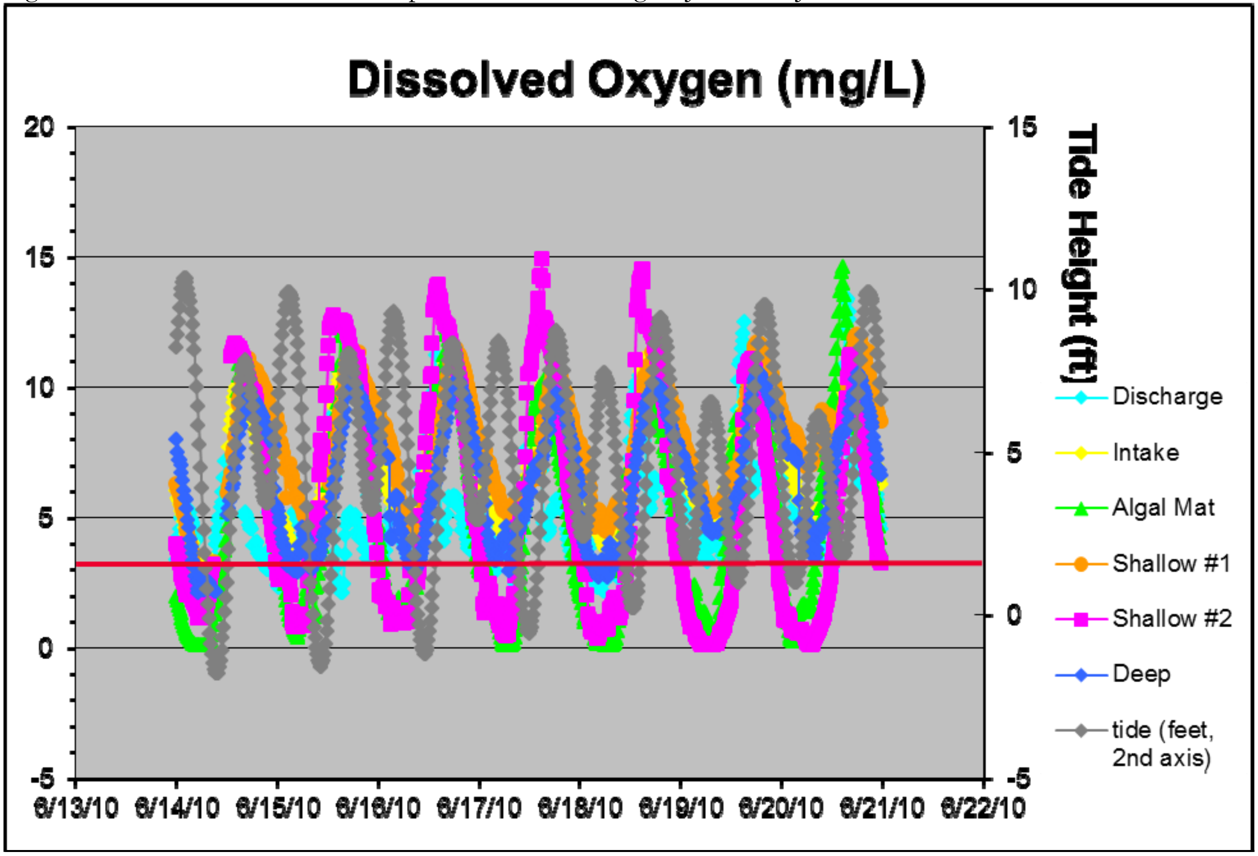


Figure 3.2.1-4: Pond A3W DO values at 6 pond locations during 21 June – 27 June

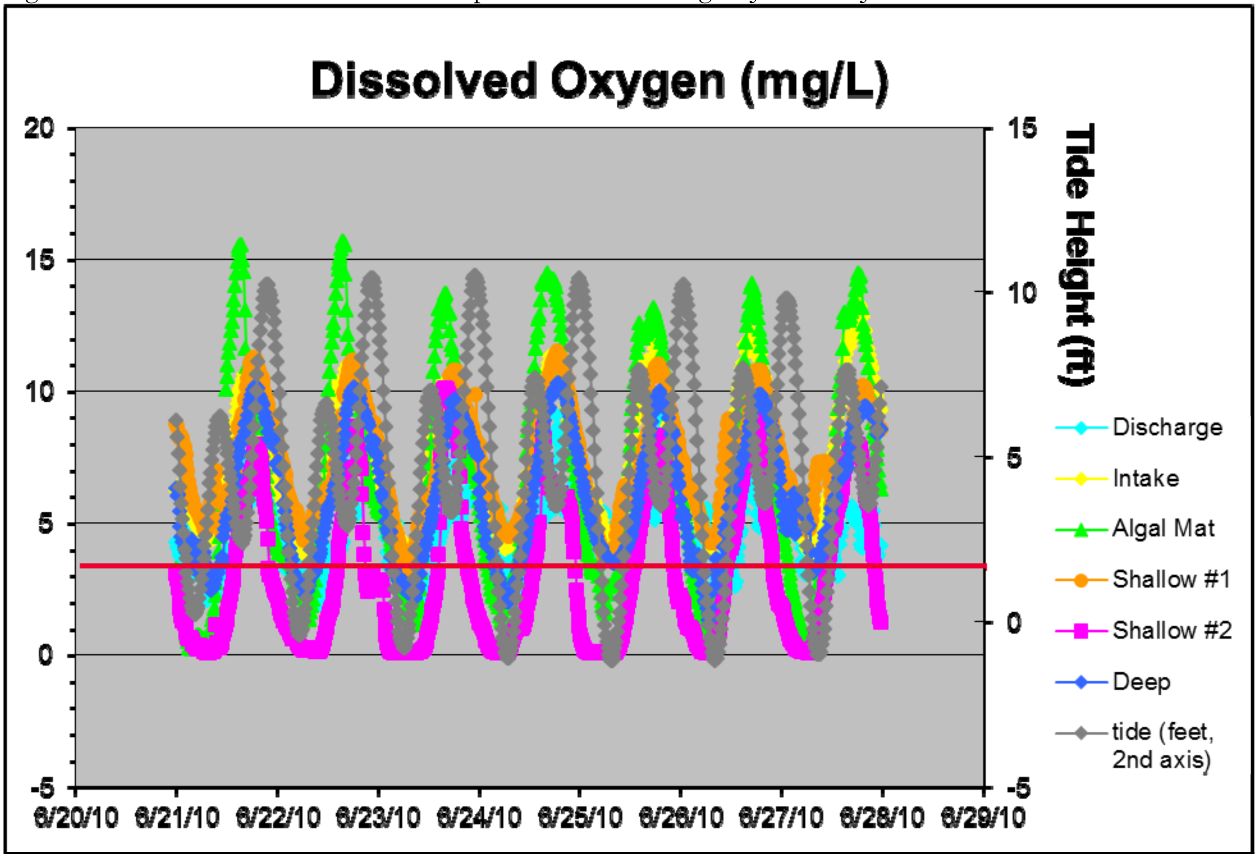


Figure 3.2.1-5: Pond A3W DO values at 6 pond locations during 28 June – 4 July

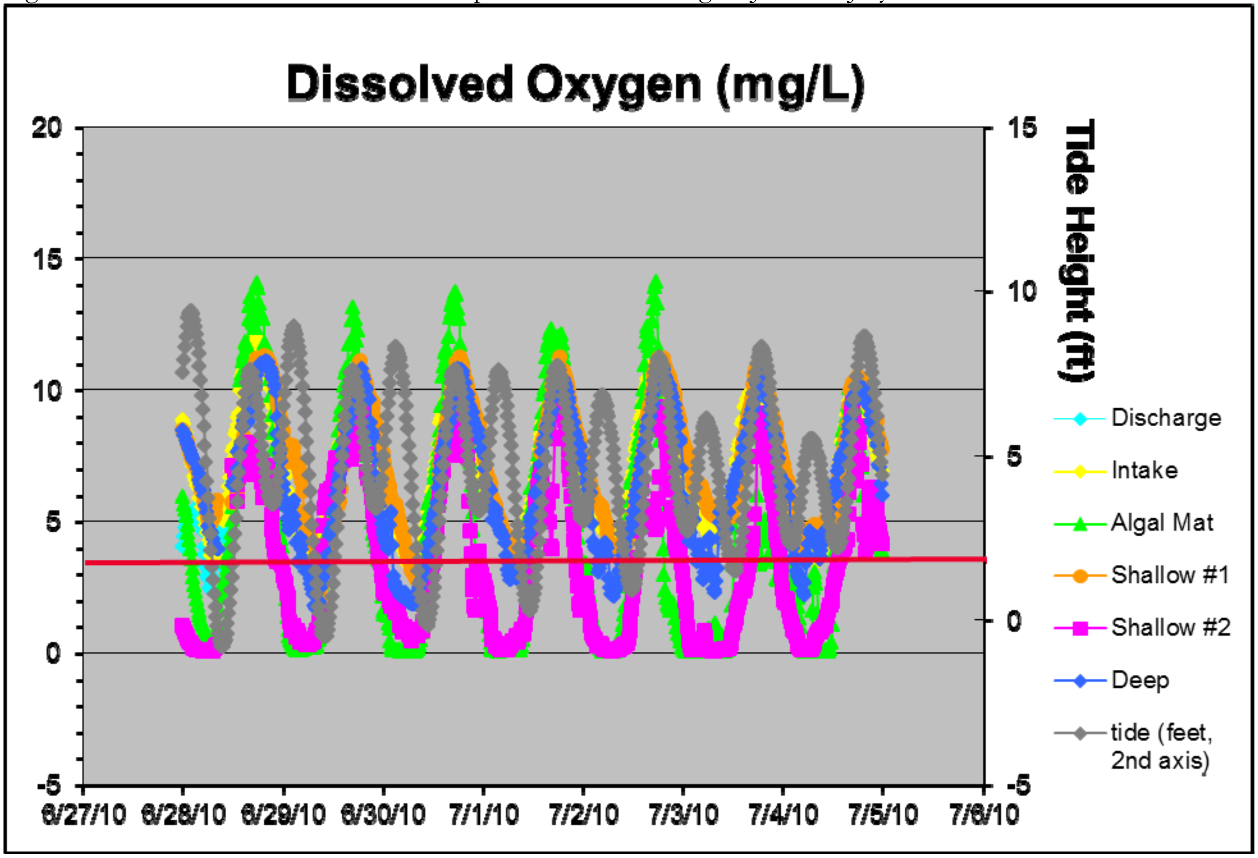


Figure 3.2.1-6: Pond A3W DO values at 6 pond locations during 5 July – 11 July

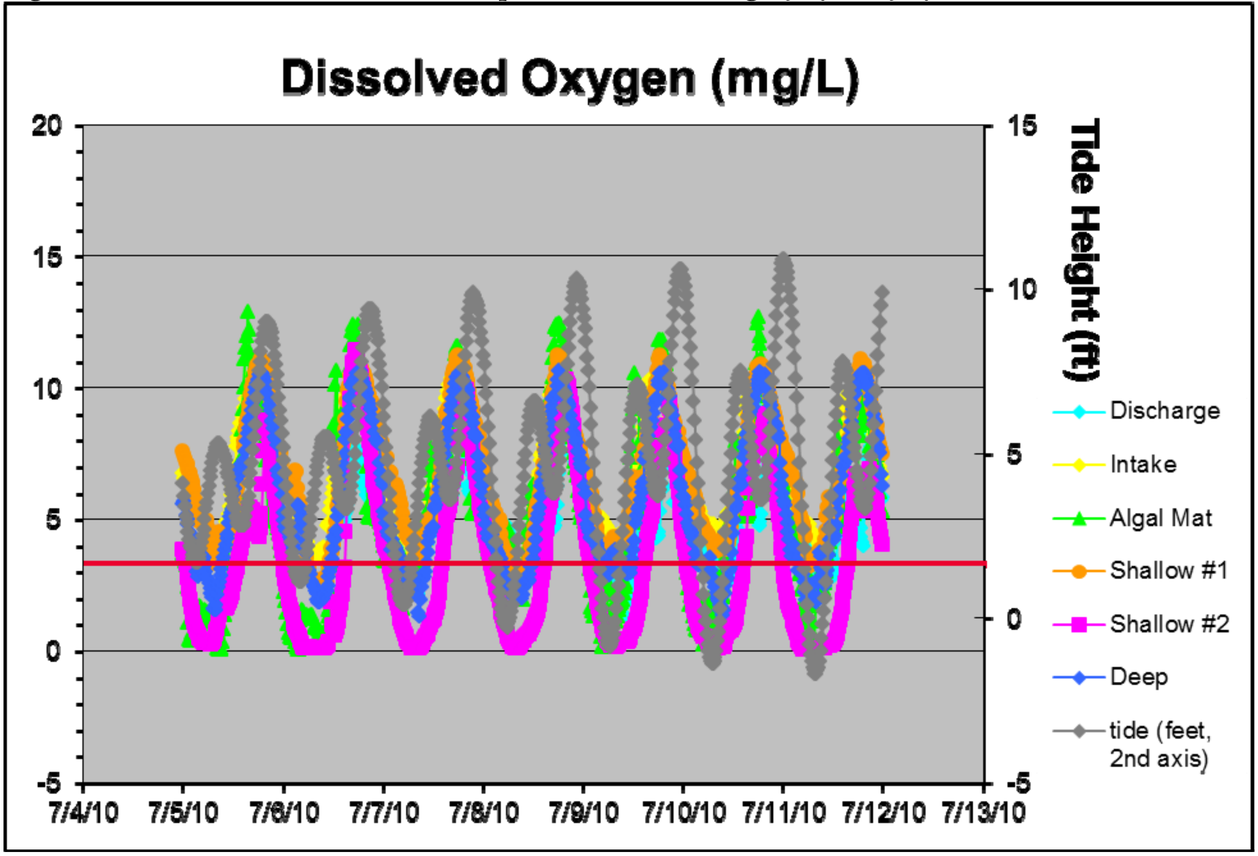


Figure 3.2.1-7: Pond A3W DO values at 6 pond locations during 12 July – 18 July

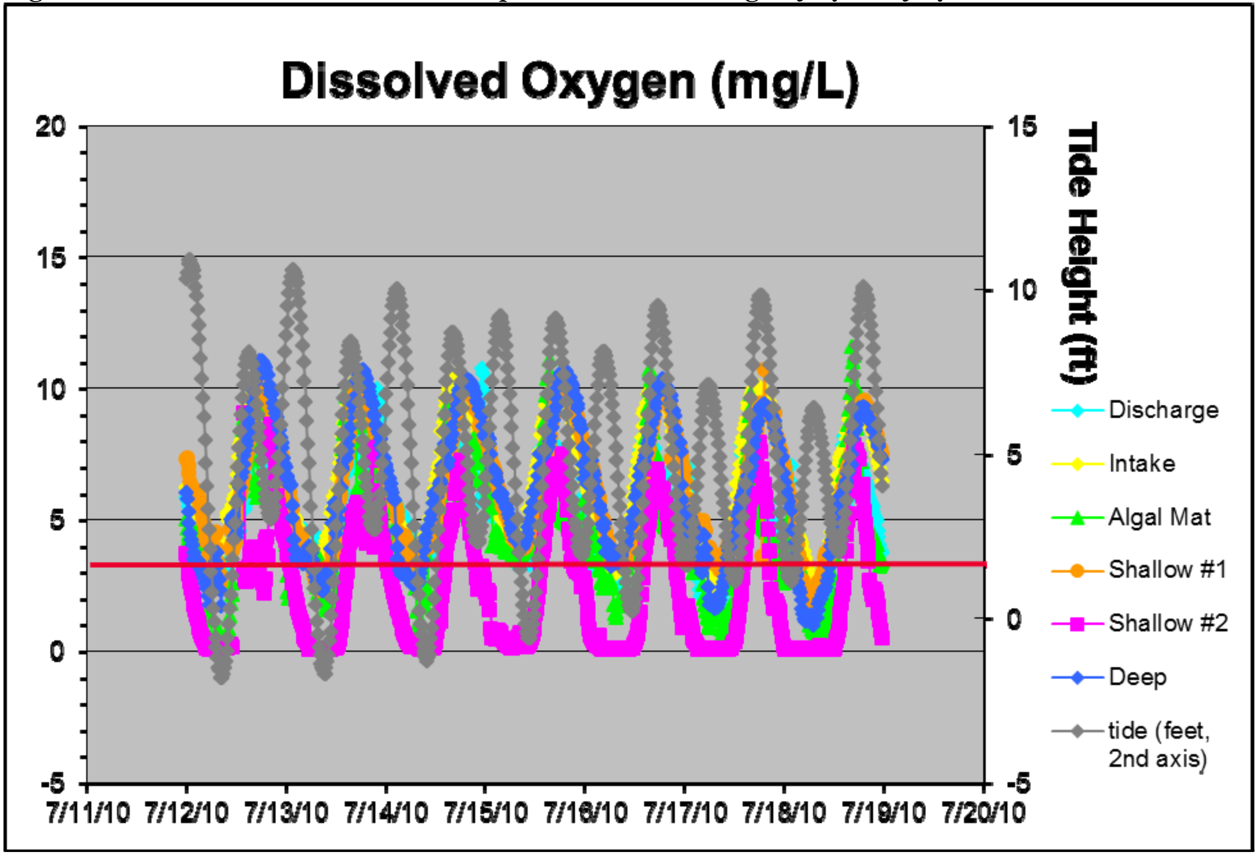


Figure 3.2.1-8: Pond A3W DO values at 6 pond locations during 19 July – 25 July

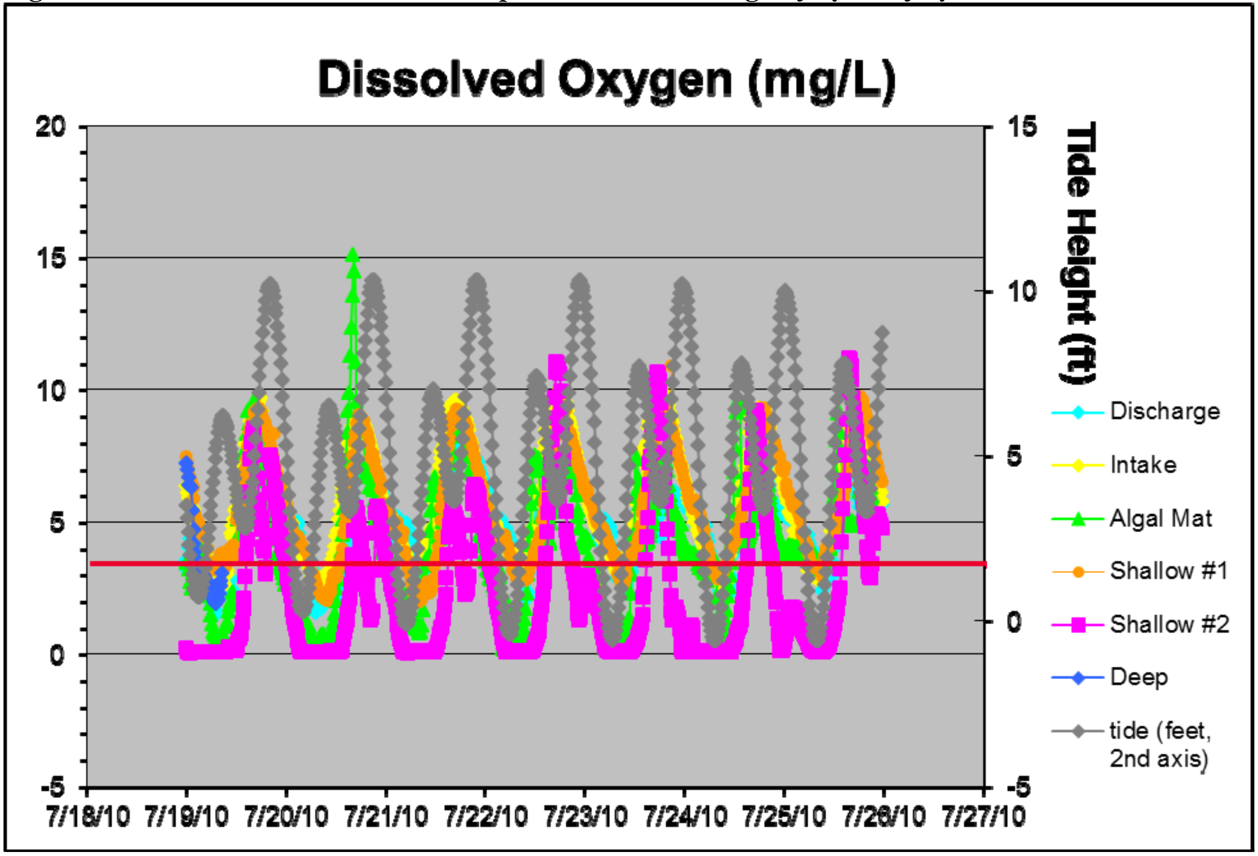


Figure 3.2.1-9: Pond A3W DO values at 6 pond locations during 26 July – 1 August

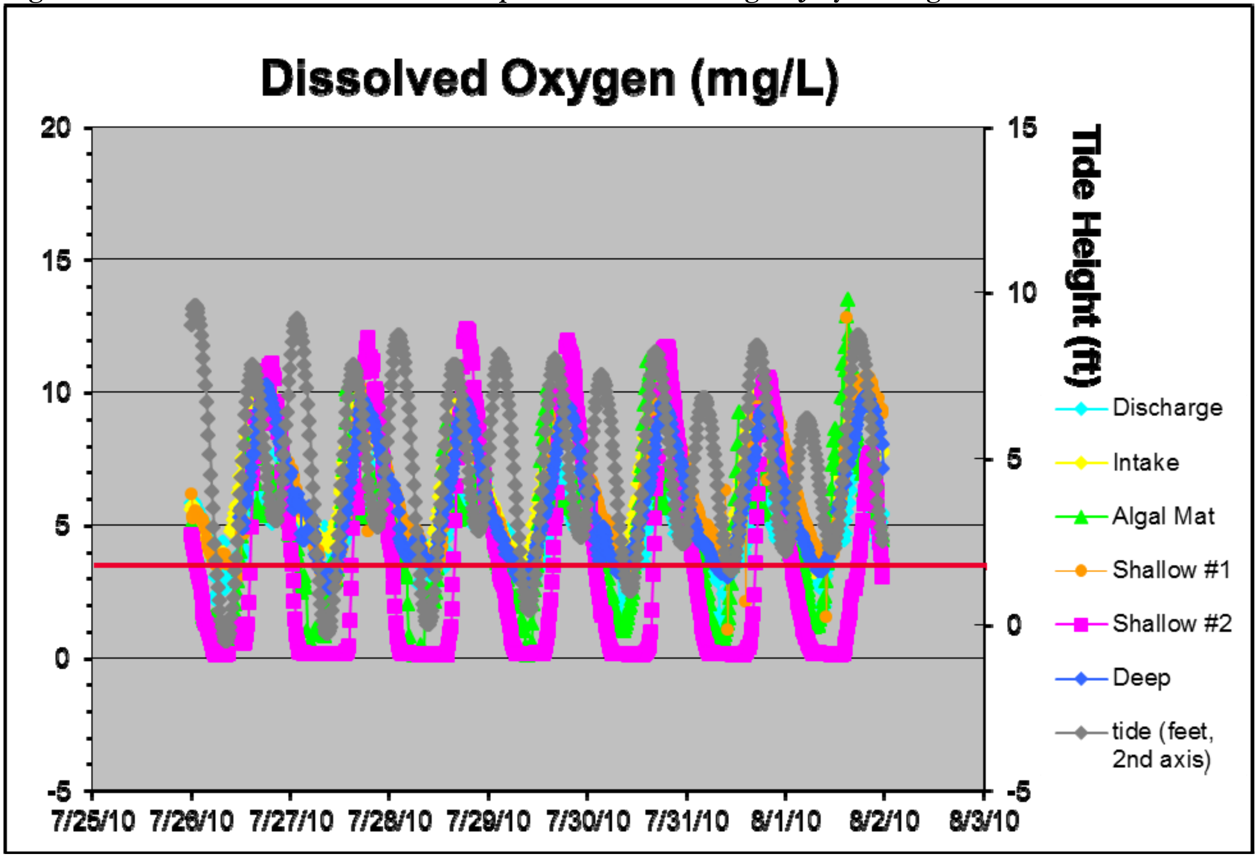


Figure 3.2.1-10: Pond A3W DO values at 6 pond locations during 2 August – 8 August

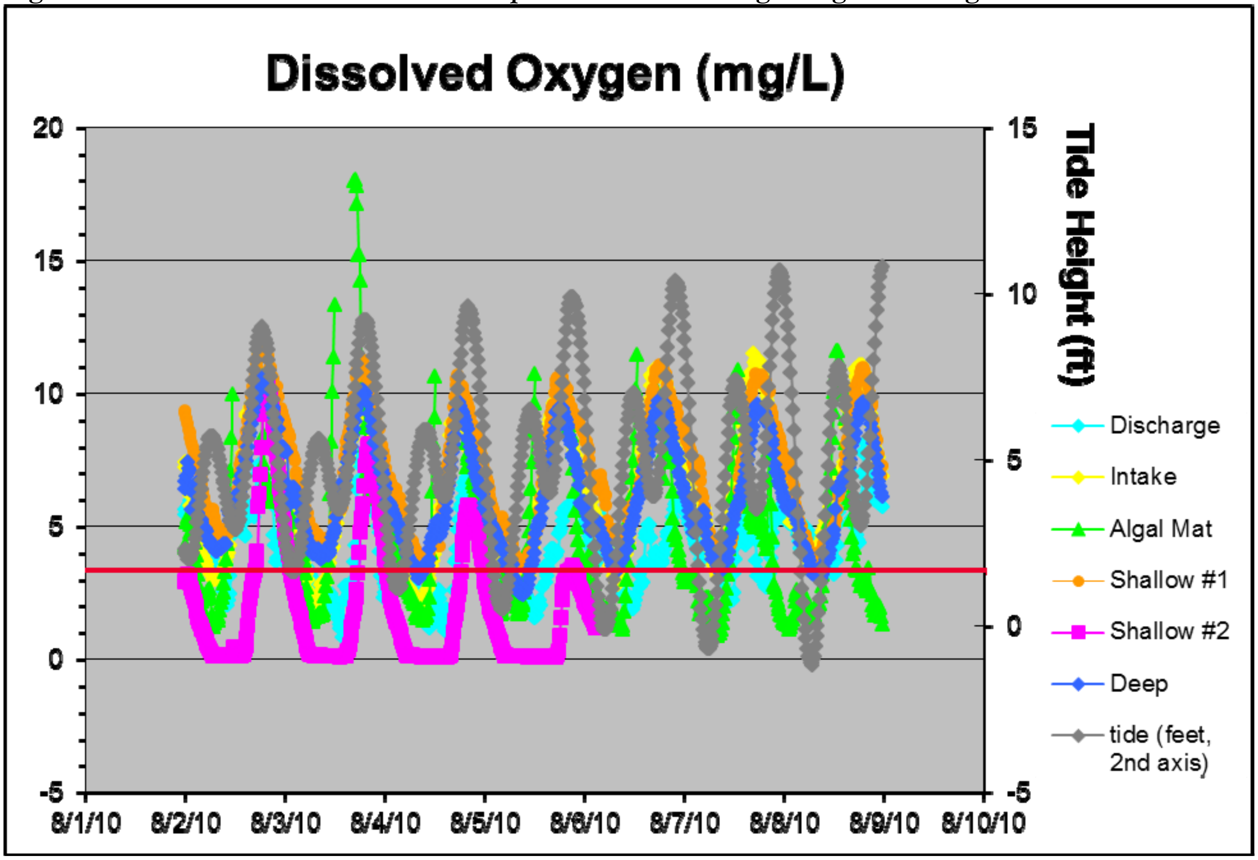


Figure 3.2.1-11: Pond A3W DO values at 6 pond locations during 9 August – 15 August

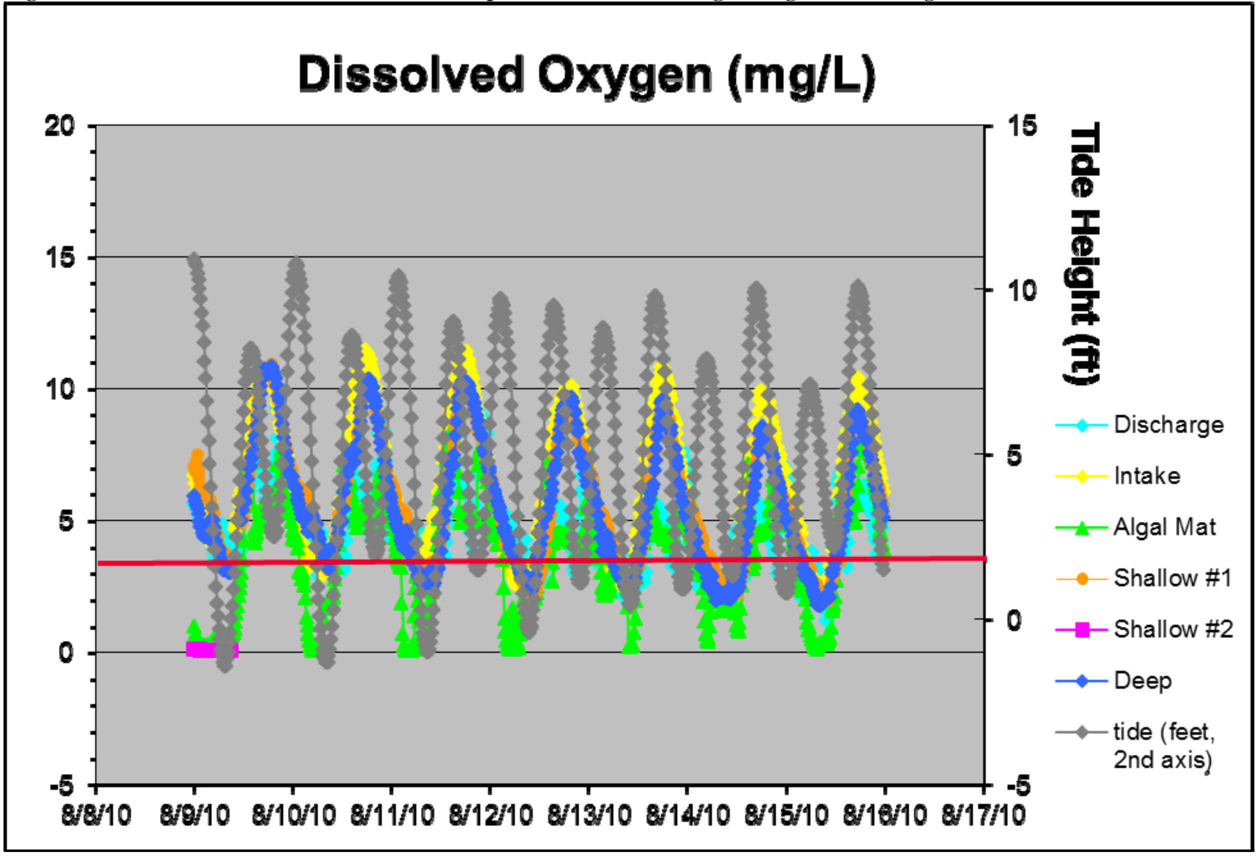


Figure 3.2.1-12: Pond A3W DO values at 6 pond locations during 16 August – 22 August

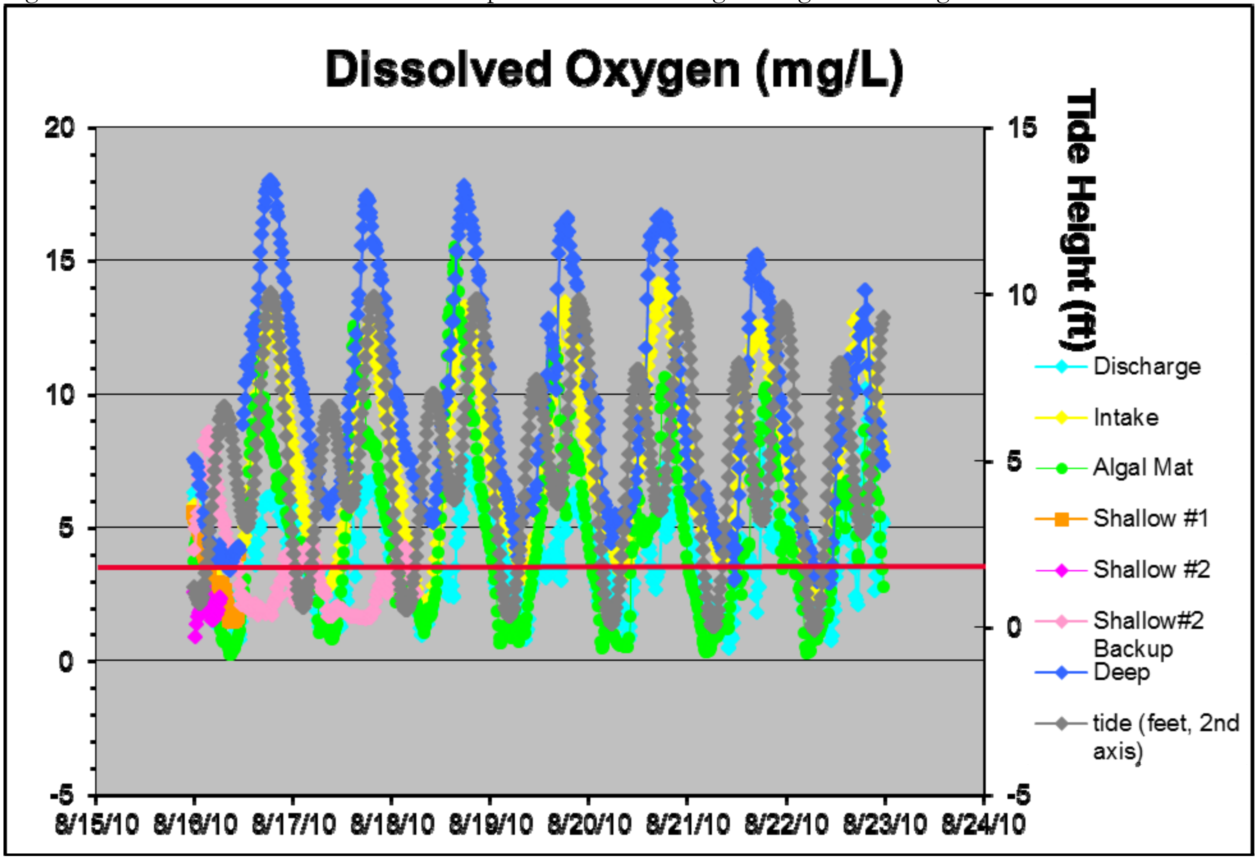


Figure 3.2.1-13: Pond A3W DO values at 6 pond locations during 23 August – 29 August

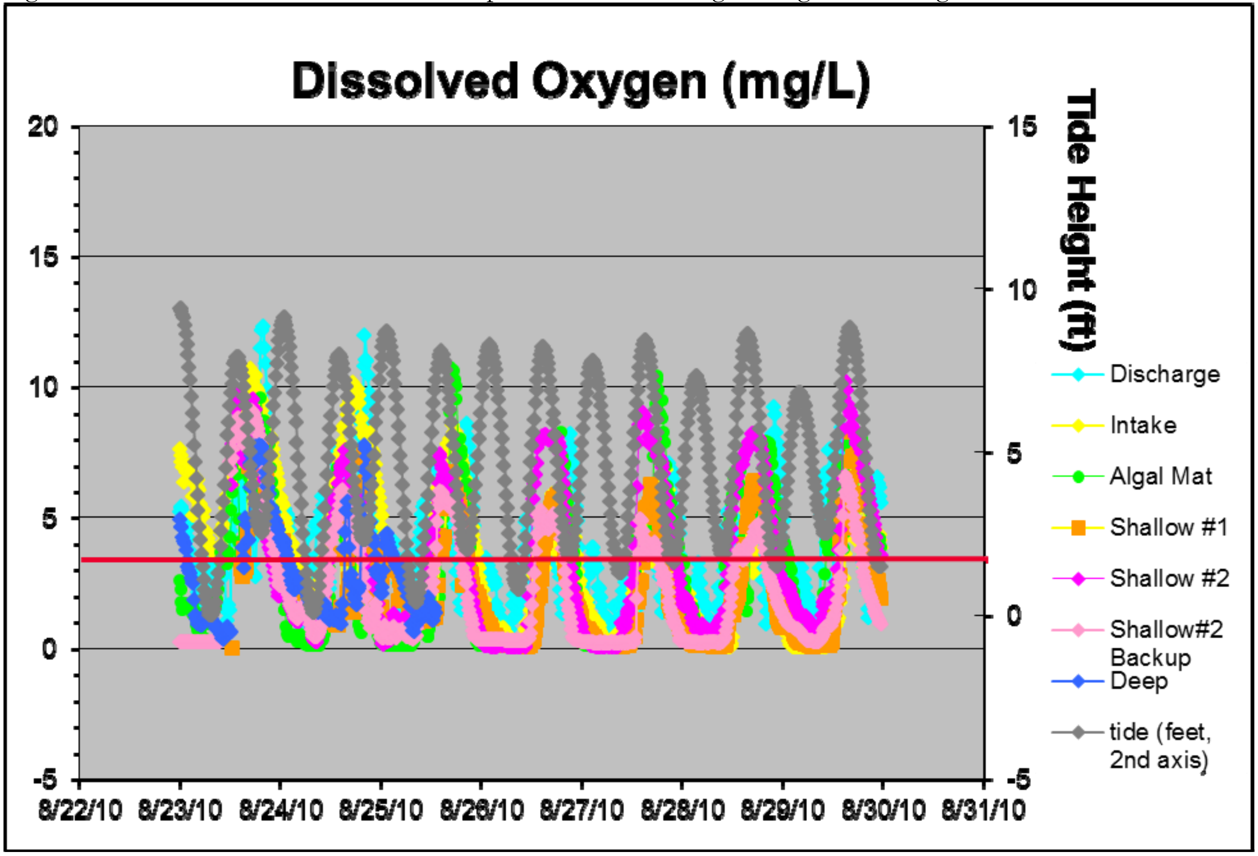


Figure 3.2.1-14: Pond A3W DO values at 6 pond locations during 30 August – 5 September

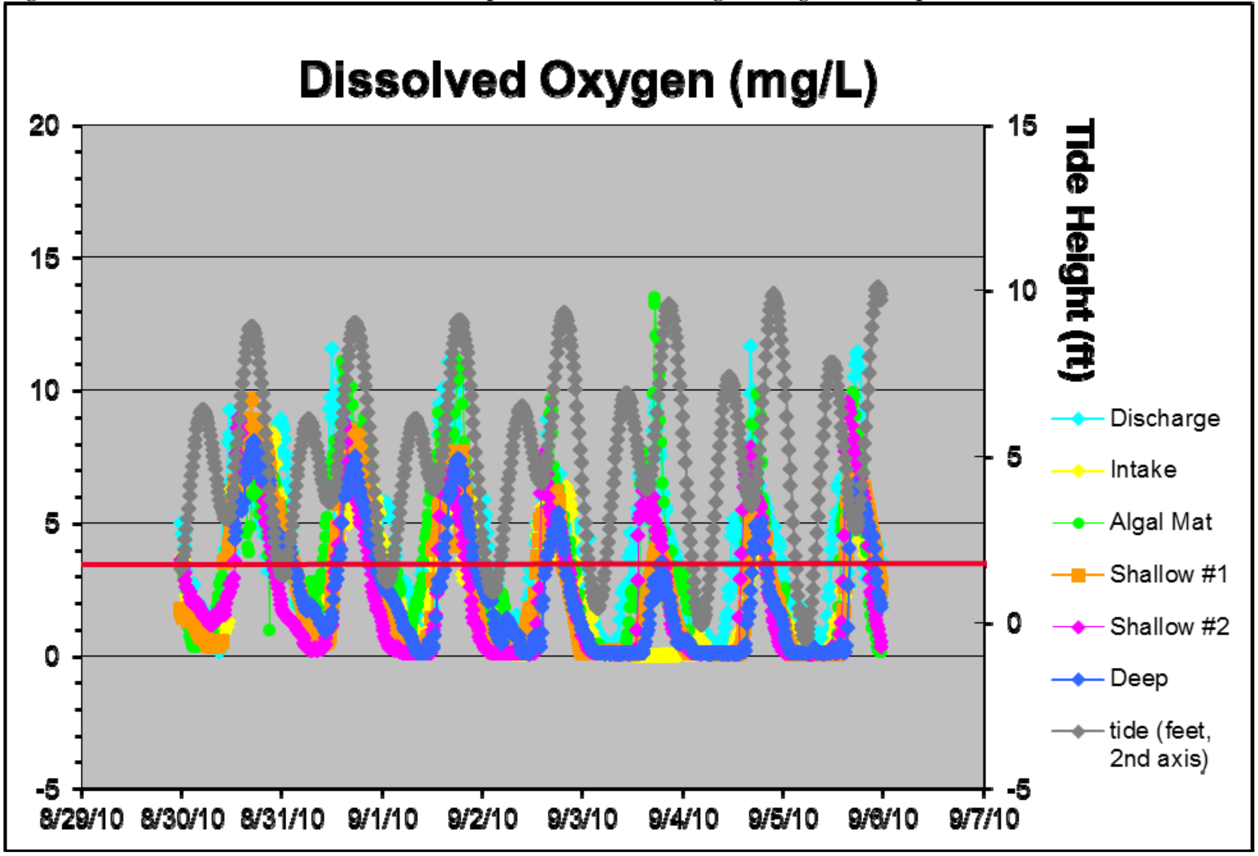


Figure 3.2.1-15: Pond A3W DO values at 6 pond locations during 6 September – 12 September

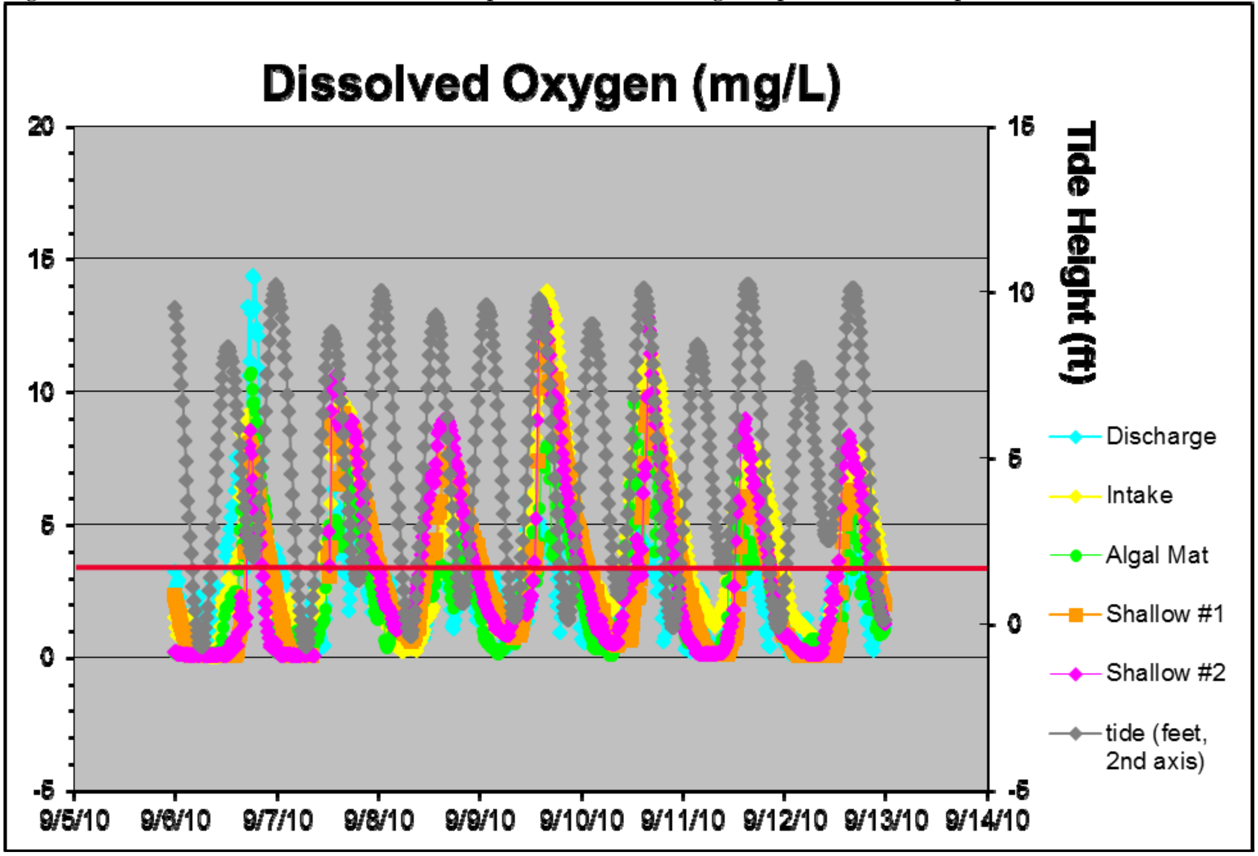


Figure 3.2.1-16: Pond A3W DO values at 6 pond locations during 13 September – 19 September

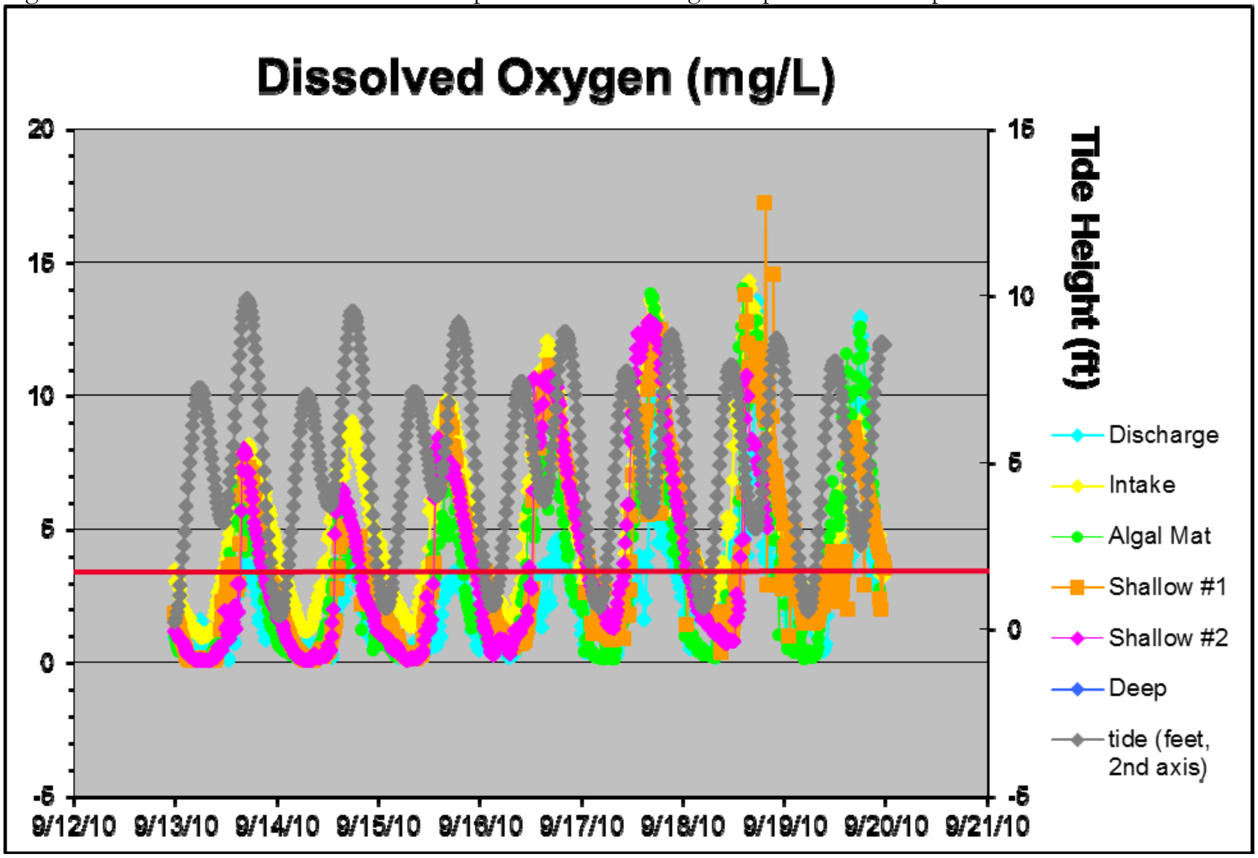


Figure 3.2.1-17: Pond A3W DO values at 6 pond locations during 20 September – 26 September

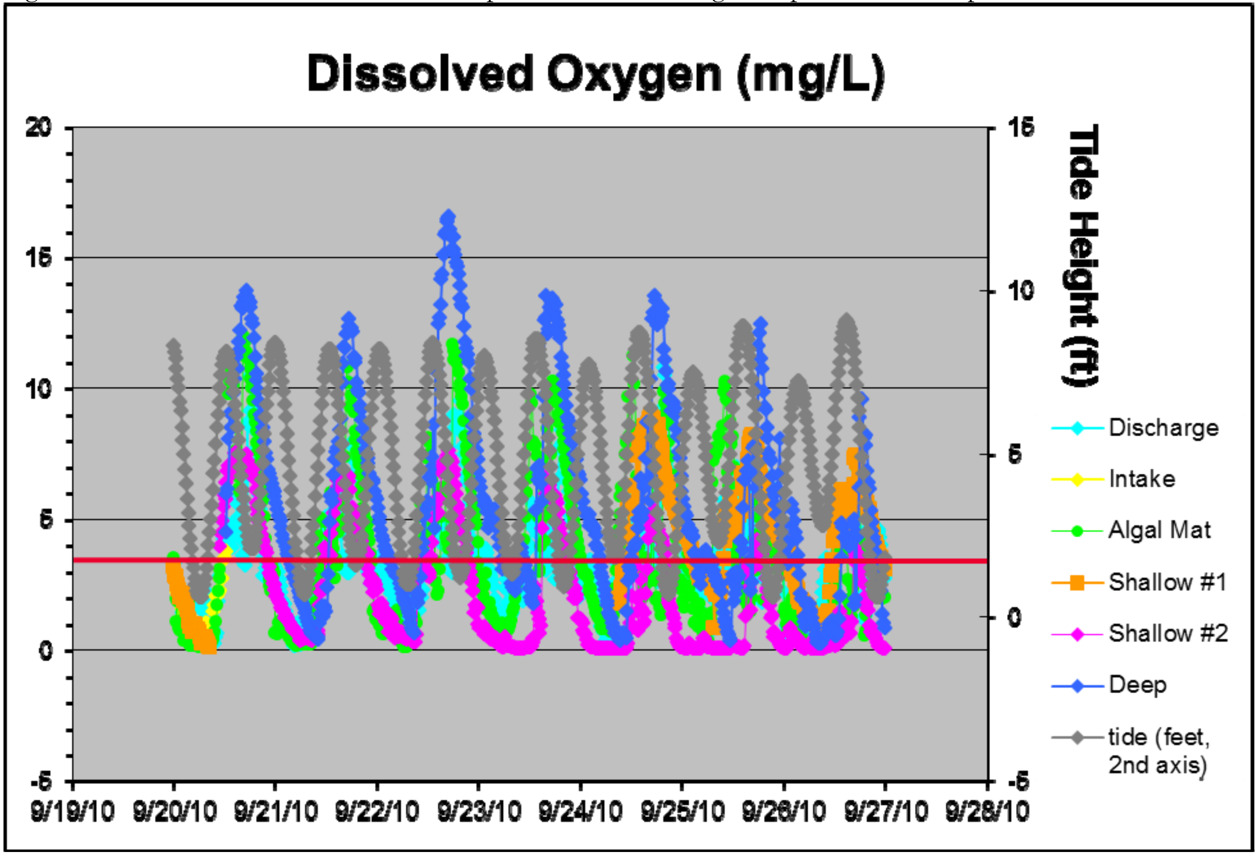


Figure 3.2.1-18: Pond A3W DO values at 6 pond locations during 27 September – 3 October

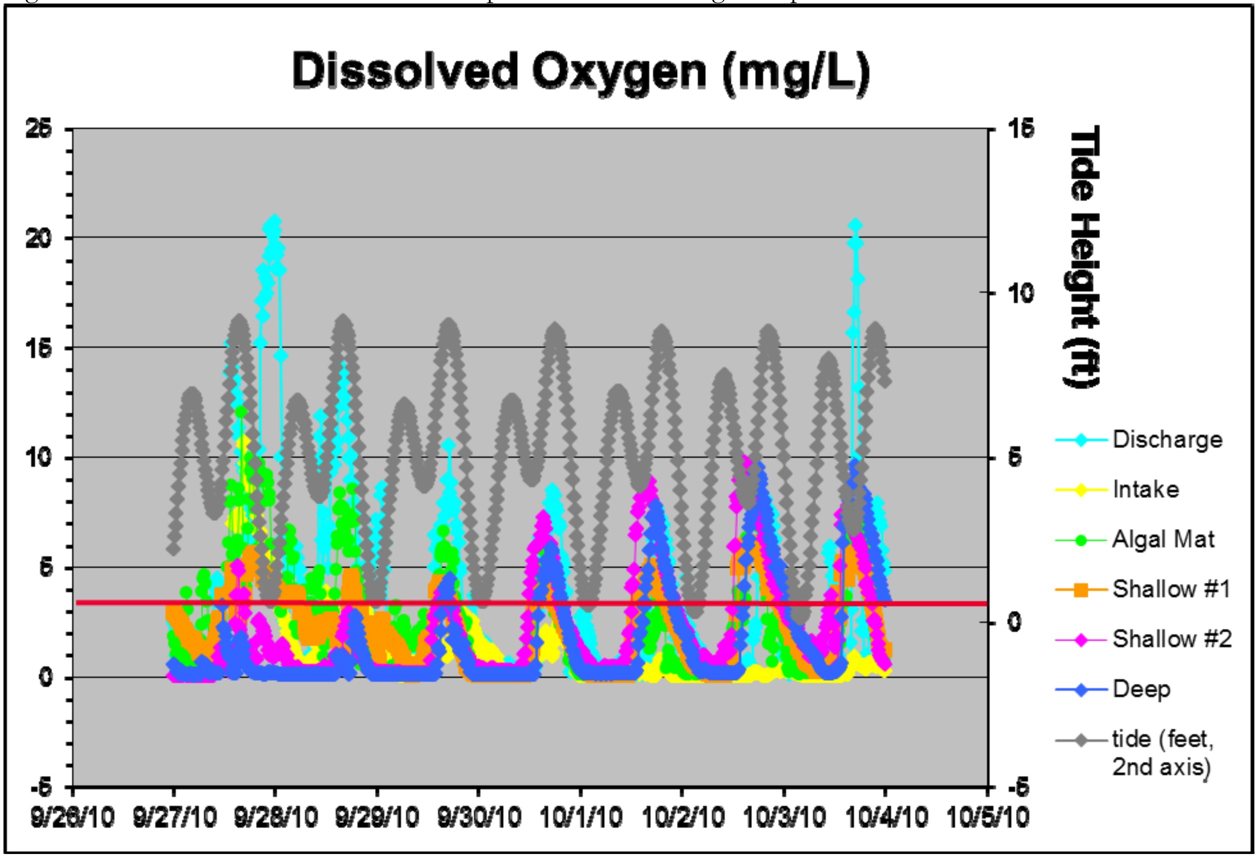


Figure 3.2.1-19: Pond A3W DO values at 6 pond locations during 4 October – 10 October

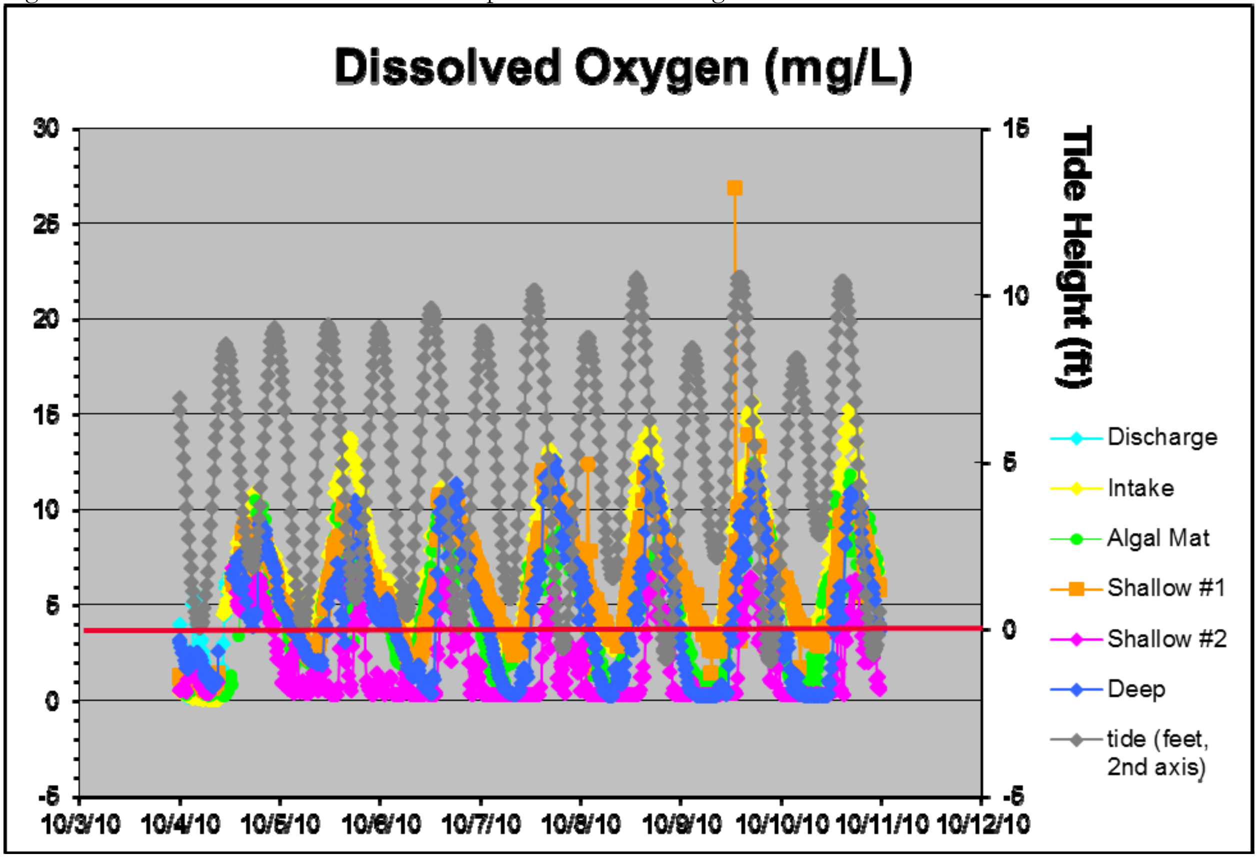


Figure 3.2.1-20: Pond A3W DO values at 6 pond locations during 11 October – 17 October

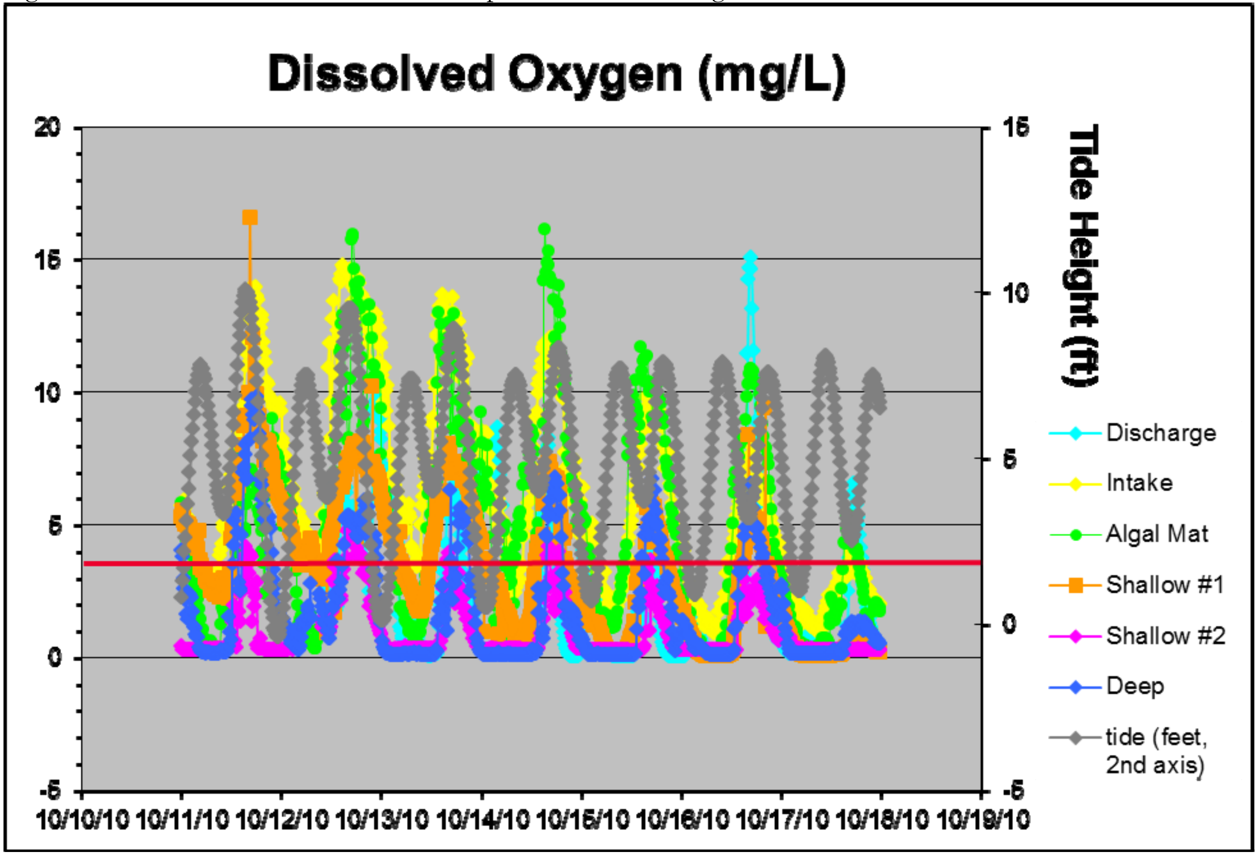


Figure 3.2.1-21: Pond A3W DO values at 6 pond locations during 18 October – 24 October

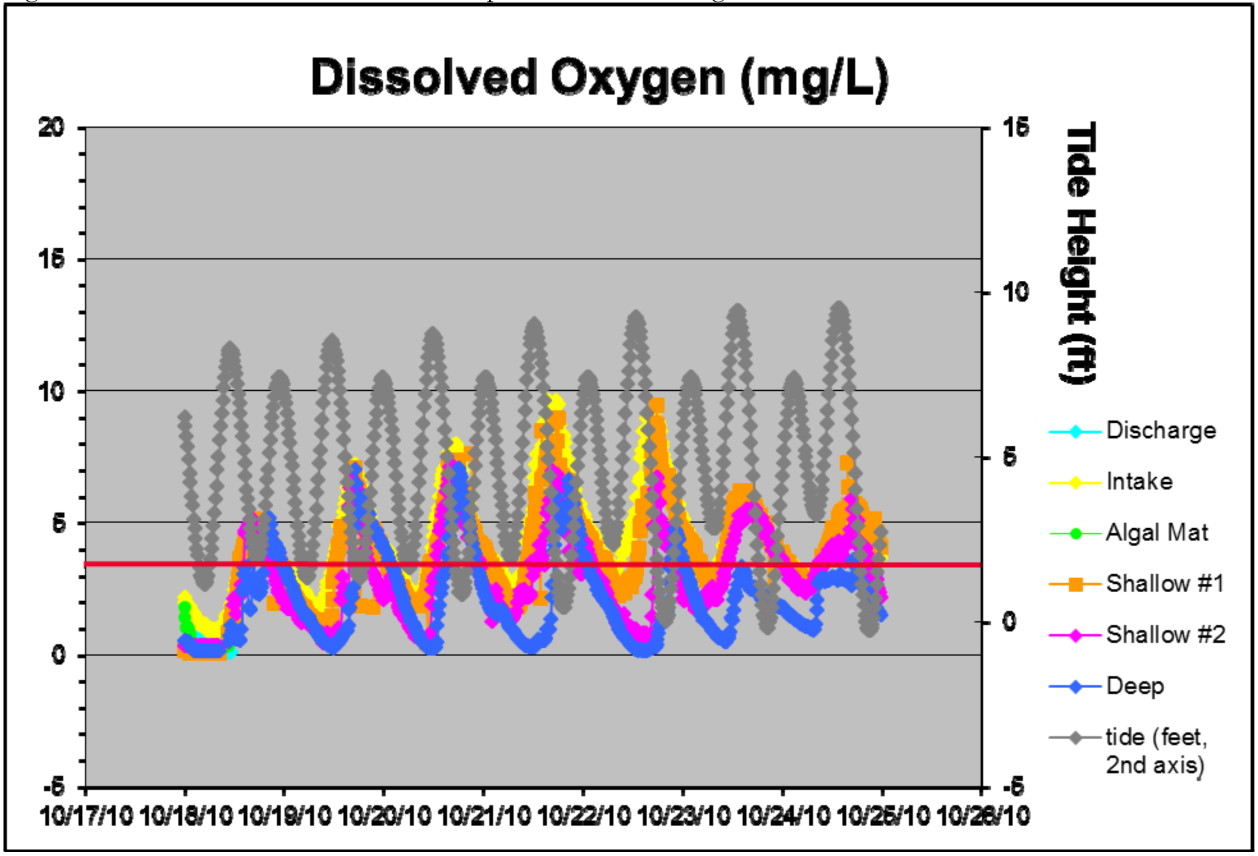
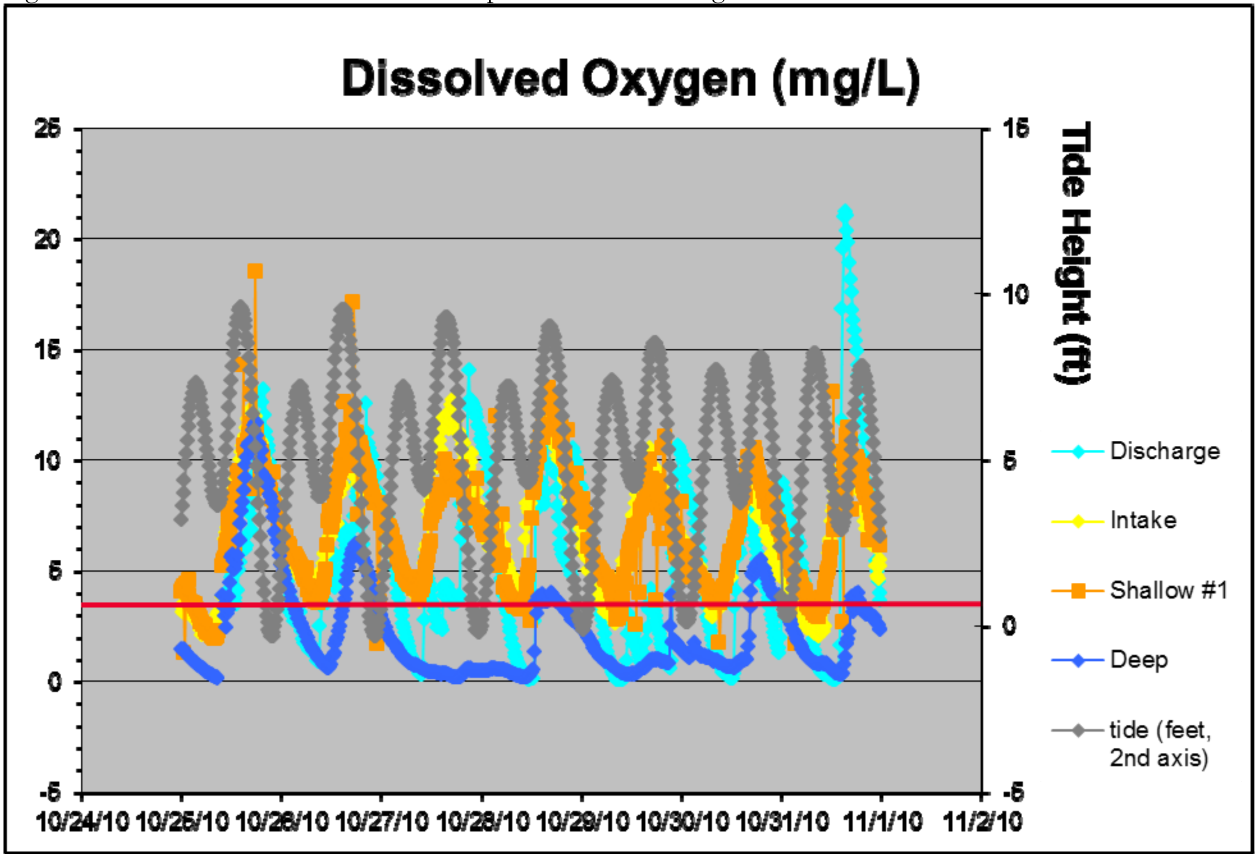


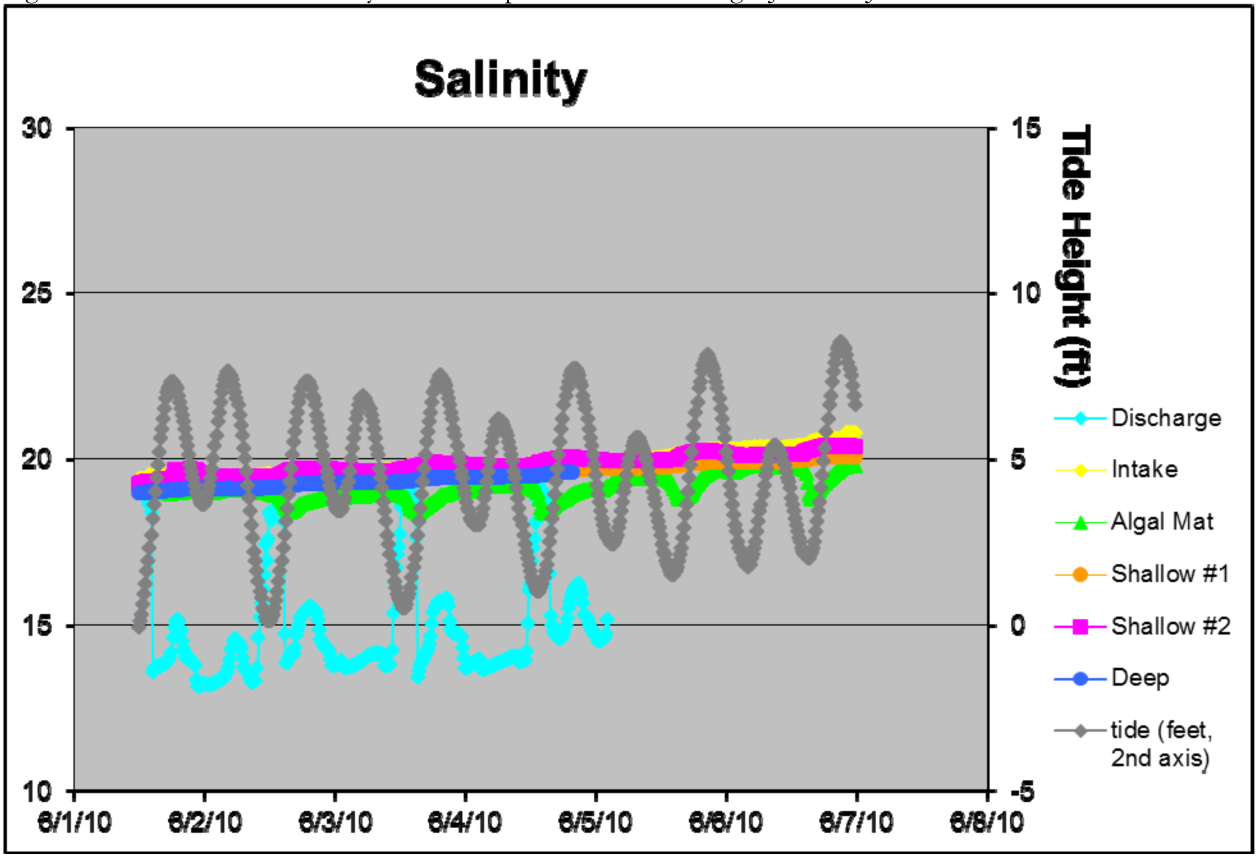
Figure 3.2.1-22: Pond A3W DO values at 6 pond locations during 25 October – 31 October



3.2.2 Salinity

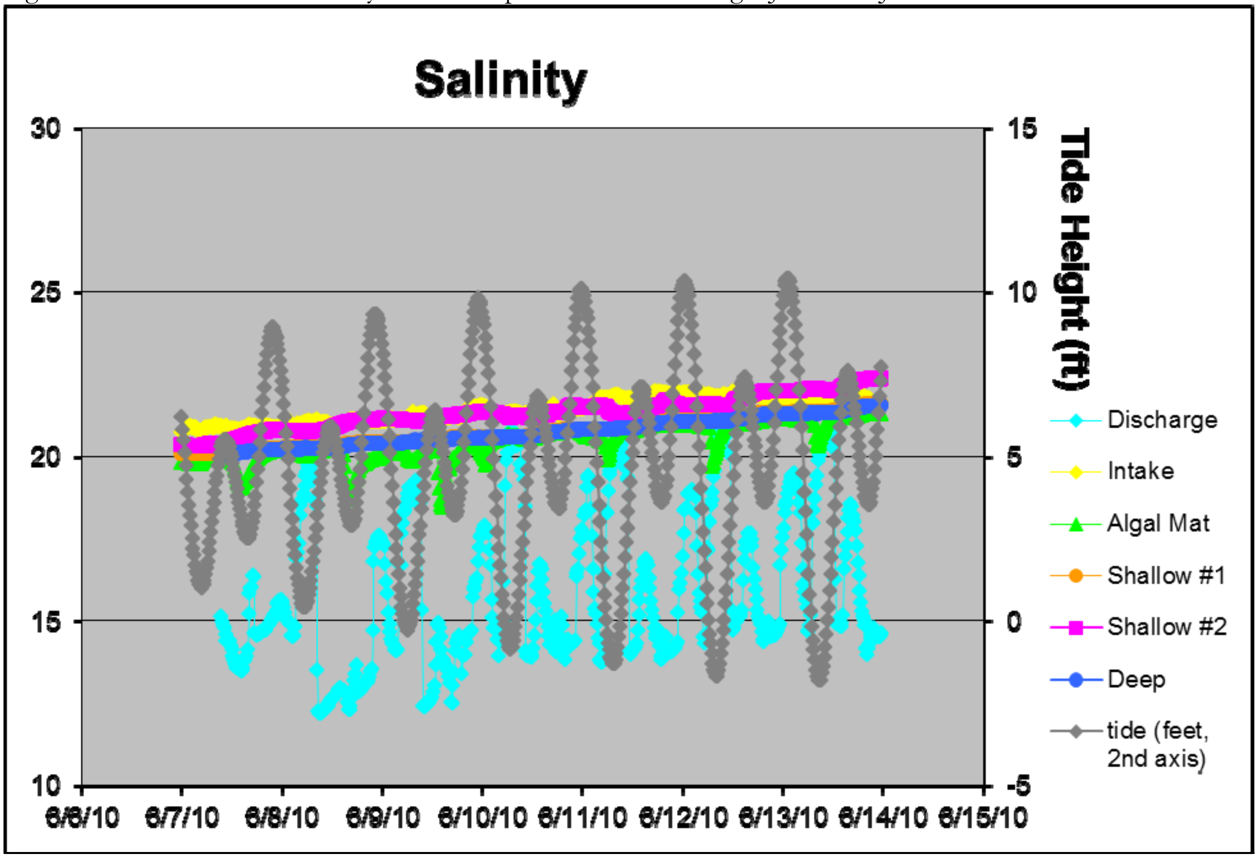
The discharge and algal datasondes had overall lower salinity and greater variation in salinity over the study period compared with the four other datasondes located in Pond A3W (Figures 3.2.2-1 through 3.2.2-22). Perhaps the greater variation seen at these two locations was due to greater tidal influence as both of these locations were closest to the discharge structure and thus, experienced greater influx than internal pond locations. For the majority of the study period, salinity levels at interior locations within Pond A3W did not seem to be influenced by tidal cycles (Figures 3.2.2-1 through 3.2.2-22). However, salinity values began to show a cyclic pattern at the shallow #2 location around 19 June (Figures 3.2.2-3 and 3.2.2-4). Starting on the 28 June, salinity levels at the shallow #1 also seemed to be influenced by tidal cycling (Figure 3.2.2-5). After early July, salinity levels logged at both shallow locations stabilized and for the remainder of the study period, showed no tidal influence (Figures 3.2.2-6 through 3.2.2-22). Salinity levels of Pond A3W did not appear to be vertically stratified since the shallow and deep locations logged similar salinity levels. Throughout Pond A3W, salinity levels increased from June through September followed by a very small decrease from September to October (Figures 3.2.2-1 through 3.2.2-22).

Figure 3.2.2-1: Pond A3W salinity values at 6 pond locations during 1 June – 6 June



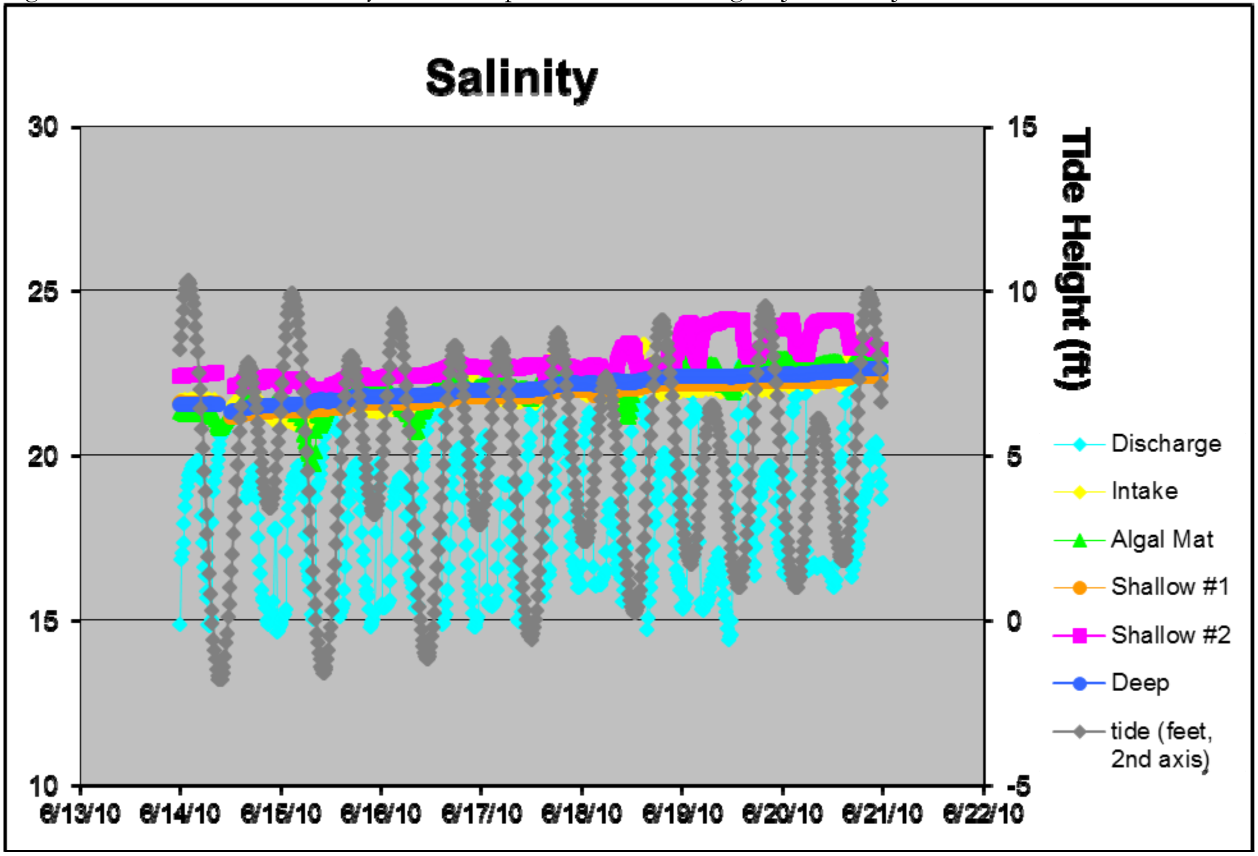
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-2: Pond A3W salinity values at 6 pond locations during 7 June – 13 June



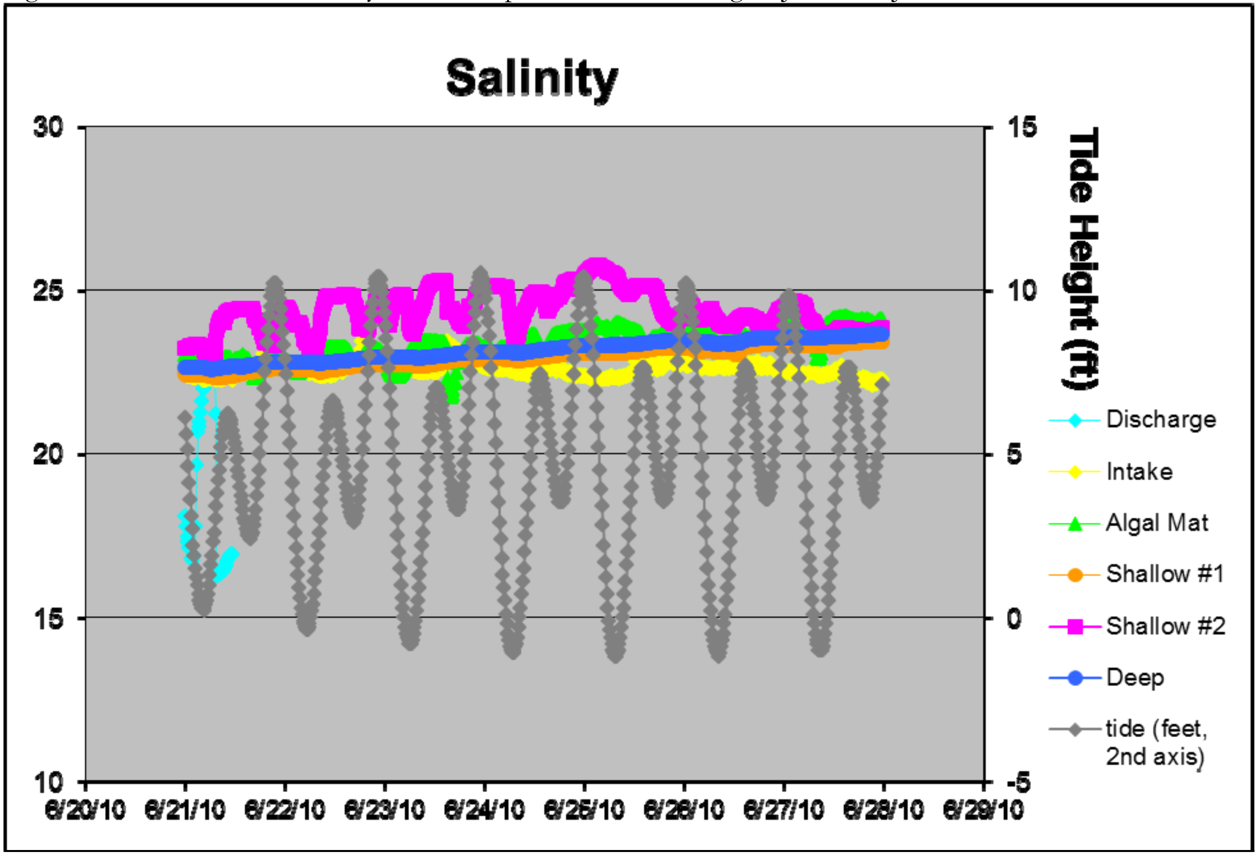
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-3: Pond A3W salinity values at 6 pond locations during 14 June – 20 June



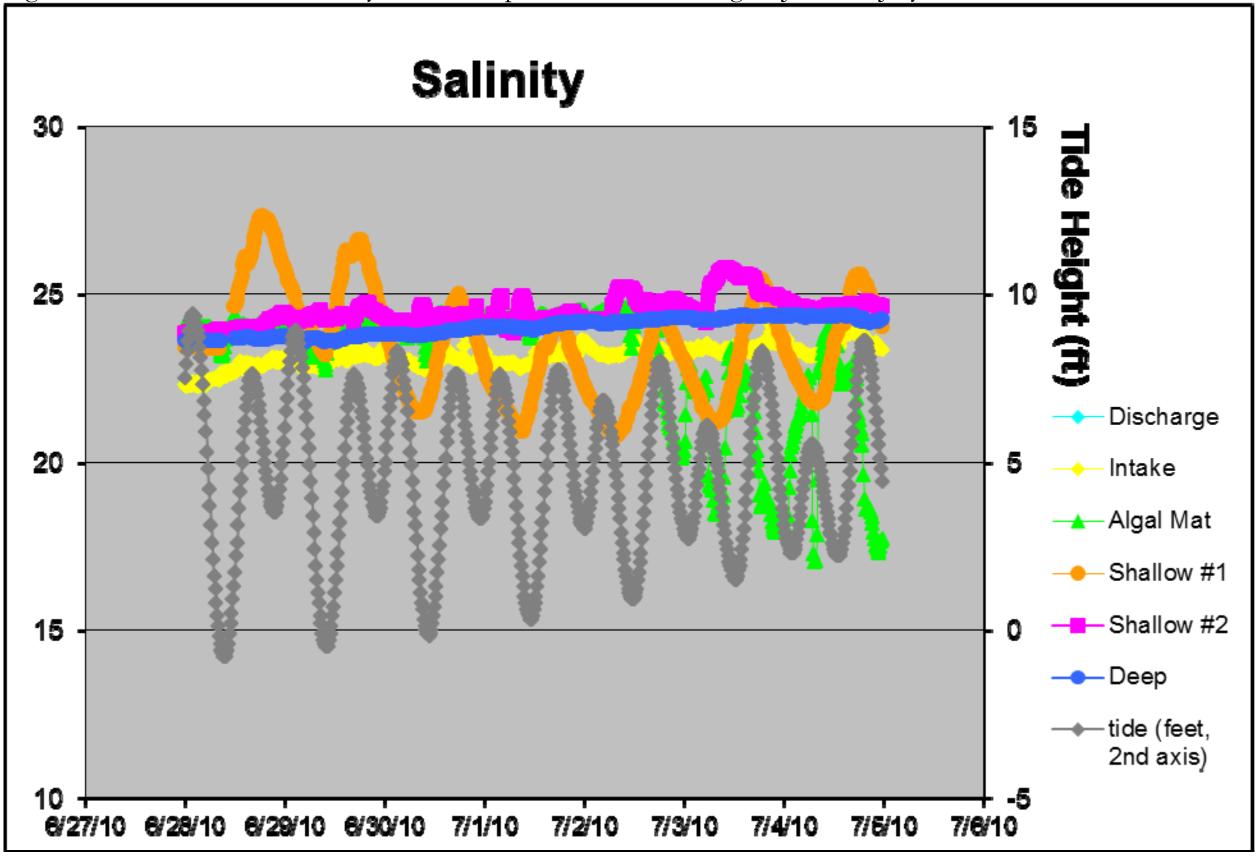
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-4: Pond A3W salinity values at 6 pond locations during 21 June – 27 June



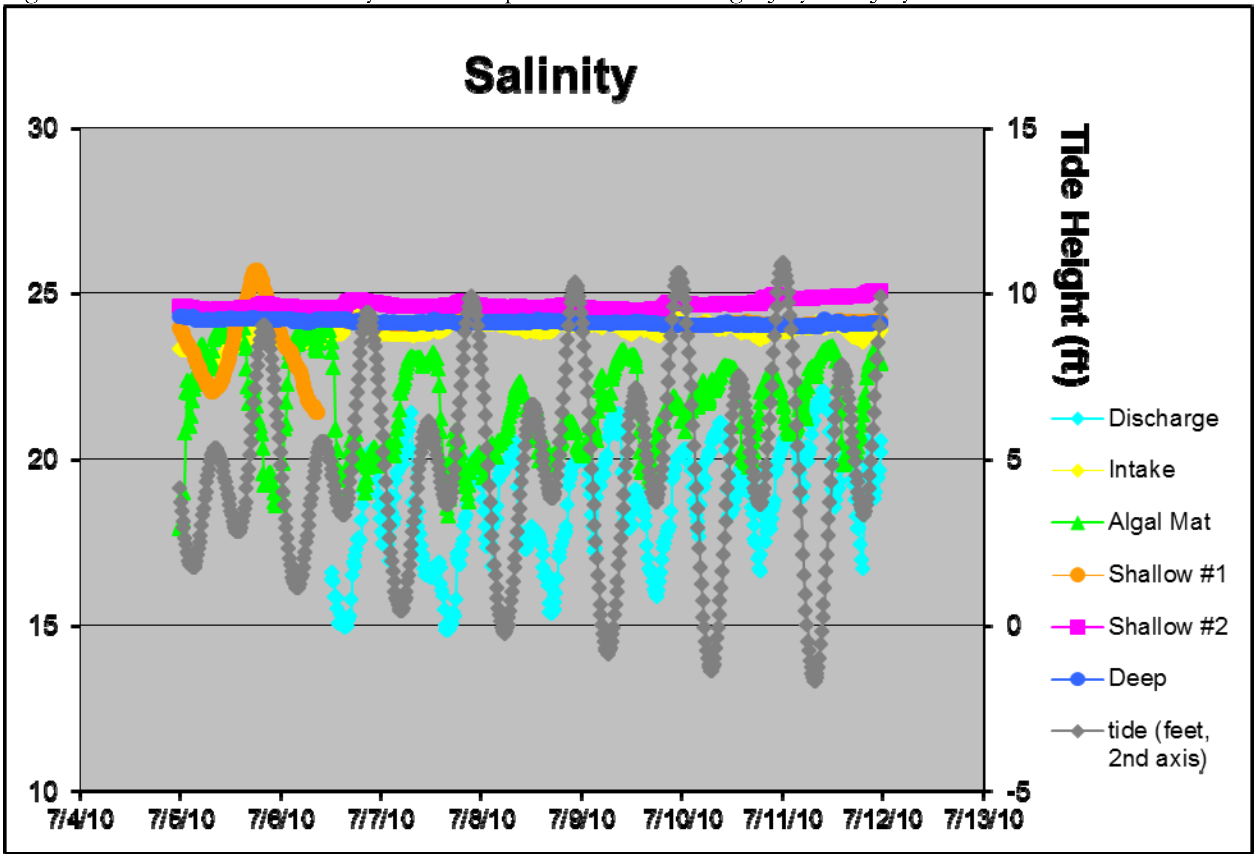
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-5: Pond A3W salinity values at 6 pond locations during 28 June – 4 July



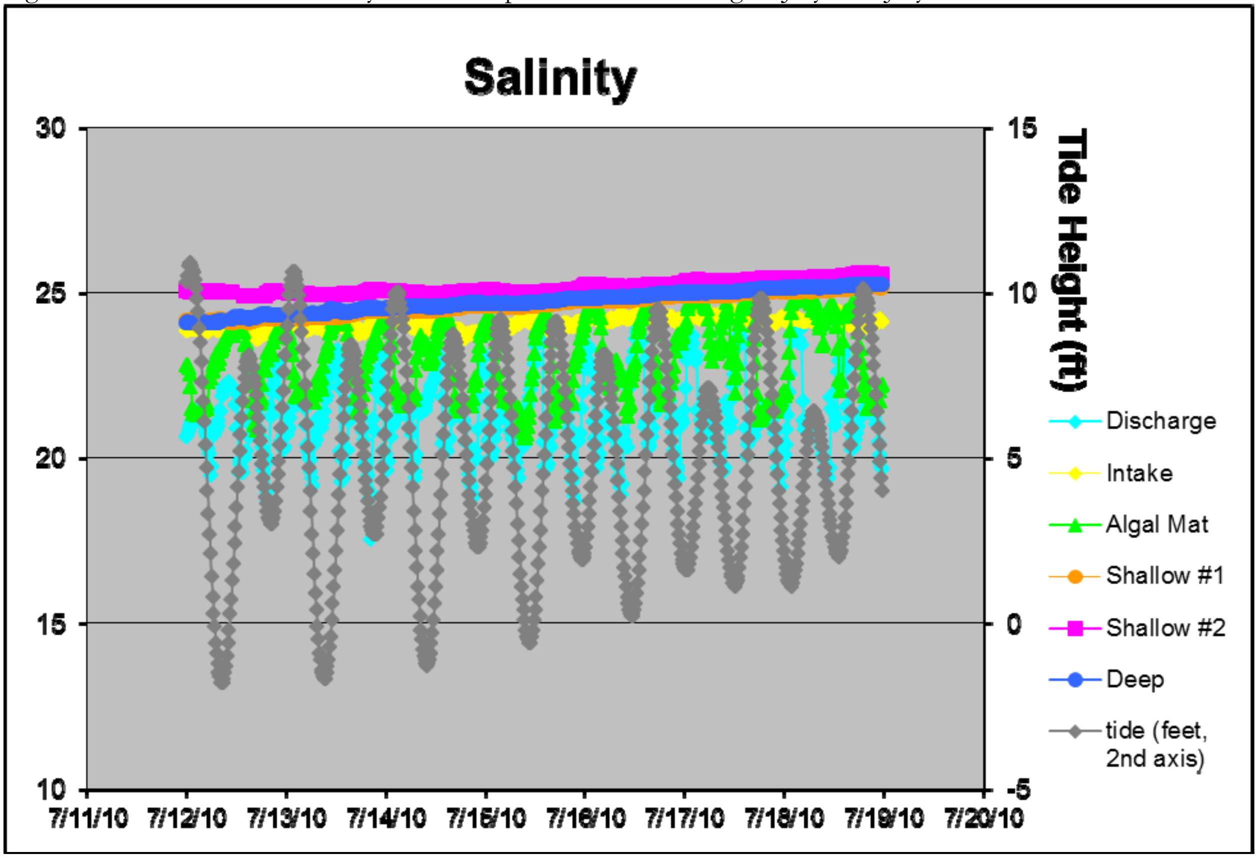
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-6: Pond A3W salinity values at 6 pond locations during 5 July – 11 July



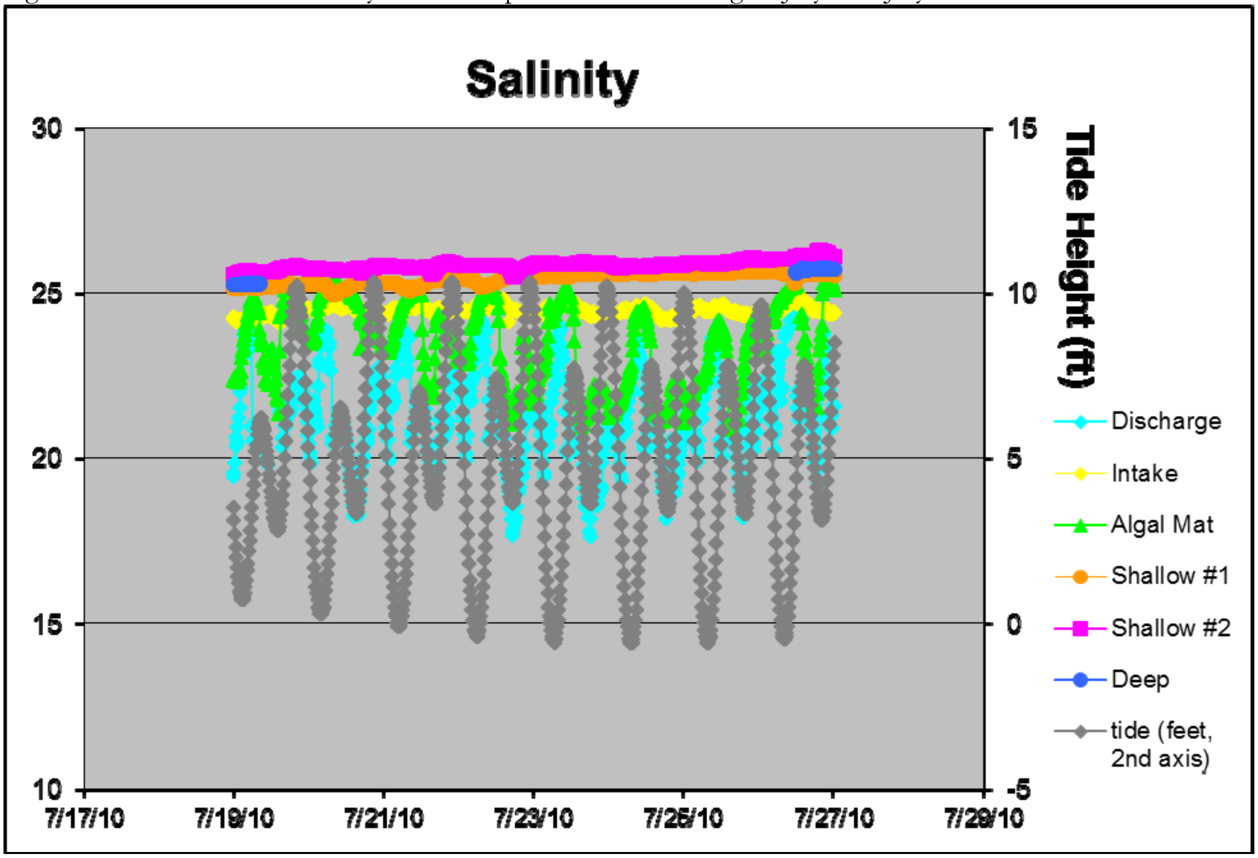
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-7: Pond A3W salinity values at 6 pond locations during 12 July – 18 July



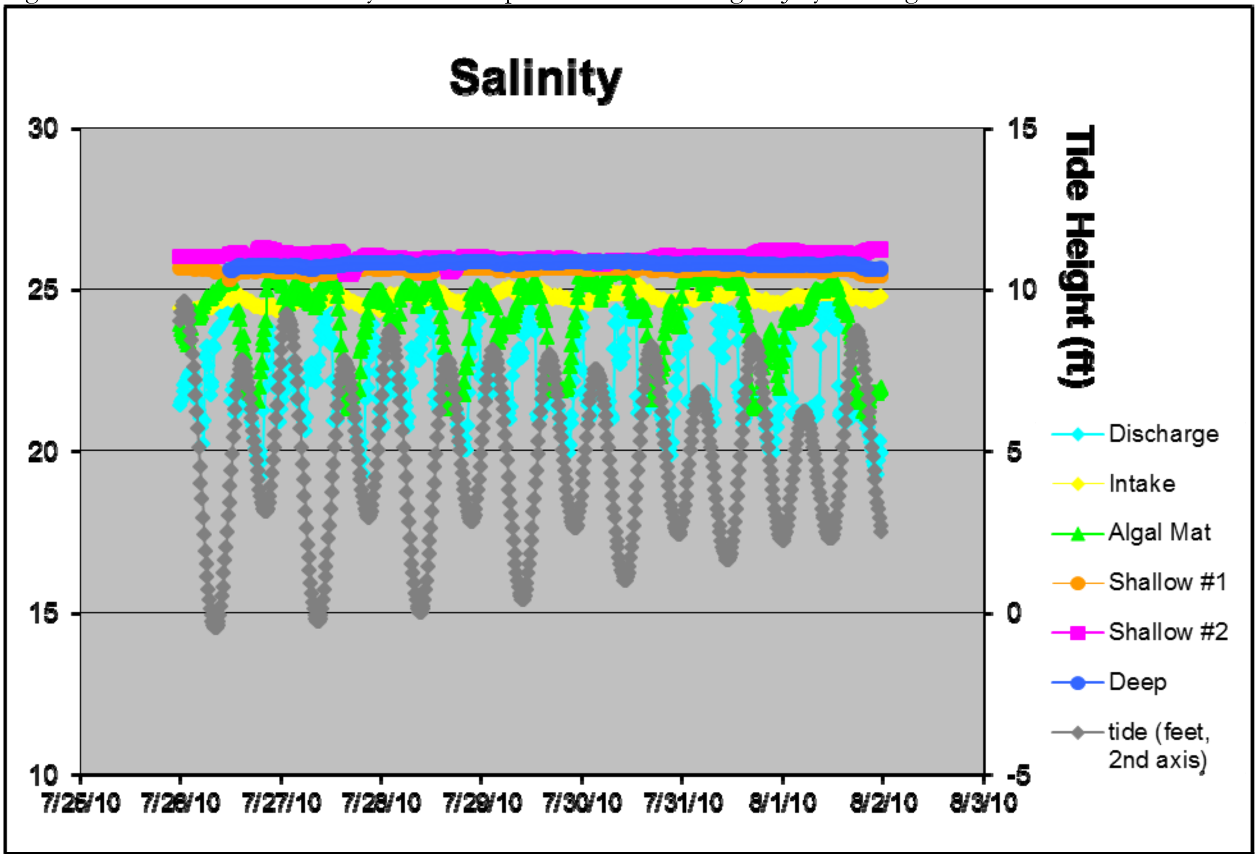
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-8: Pond A3W salinity values at 6 pond locations during 19 July – 25 July



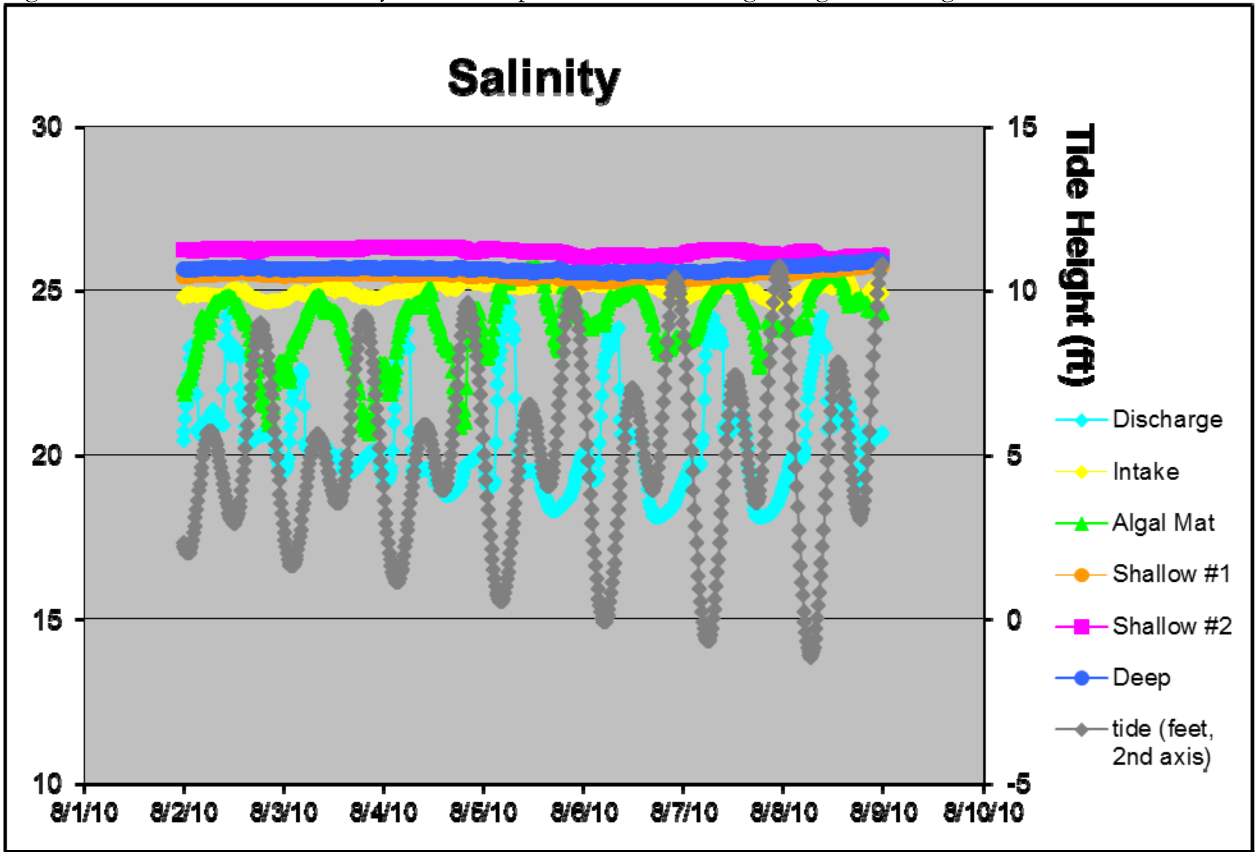
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-9: Pond A3W salinity values at 6 pond locations during 26 July – 1 August



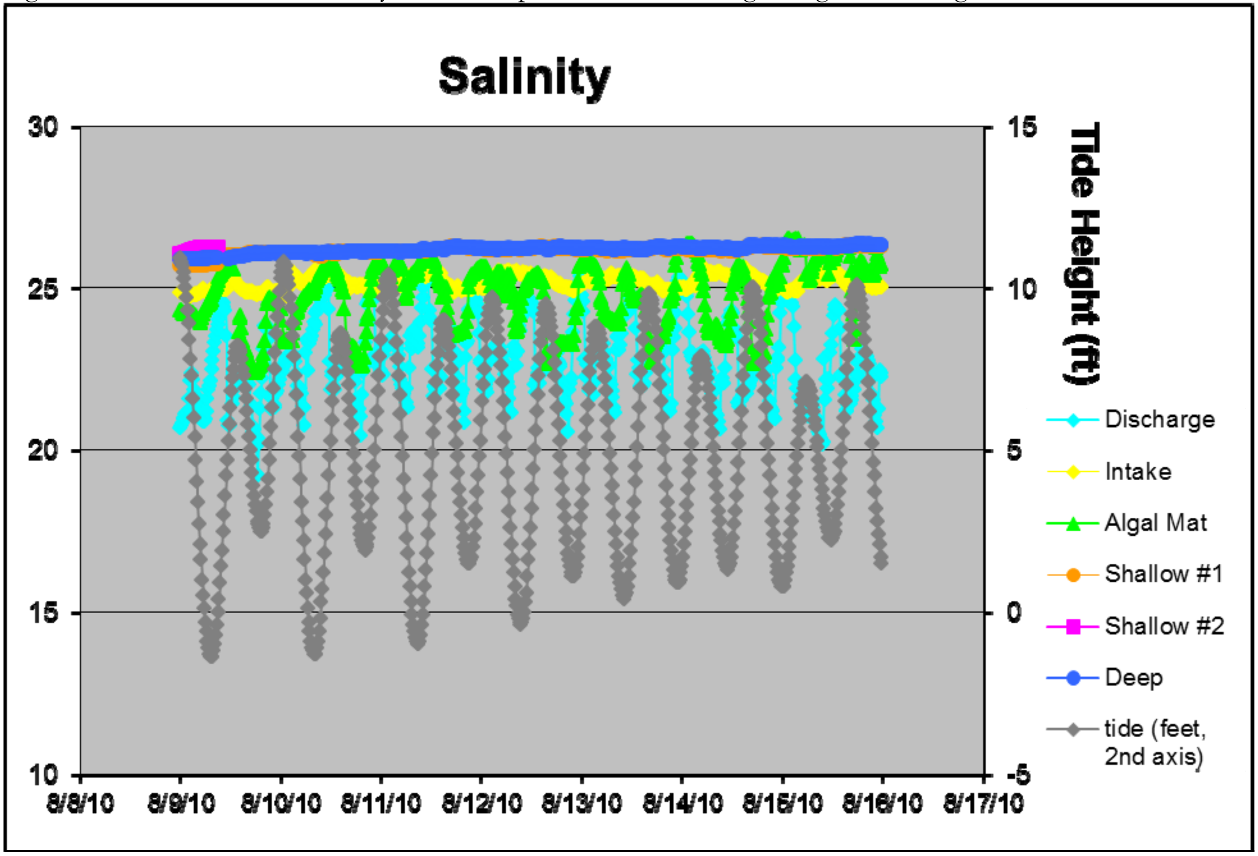
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-10: Pond A3W salinity values at 6 pond locations during 2 August – 8 August



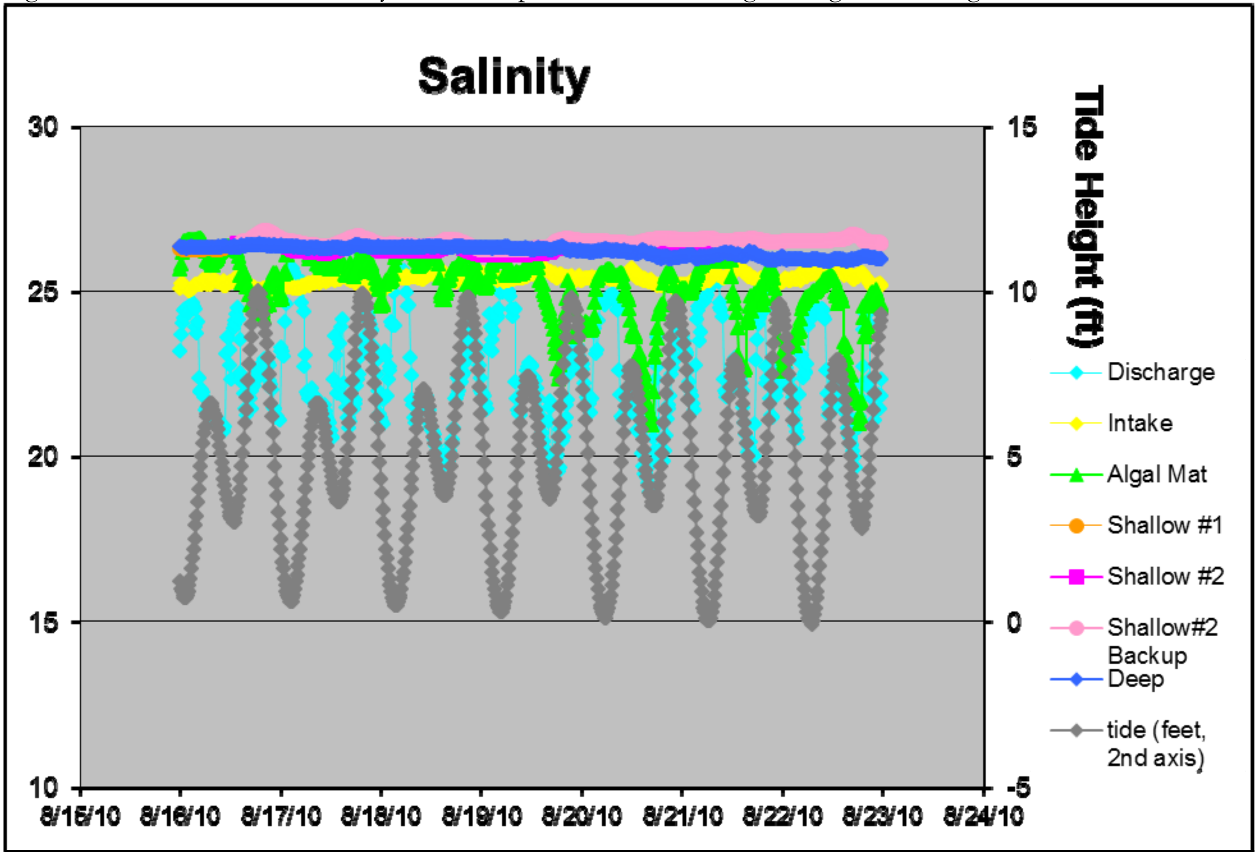
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-11: Pond A3W salinity values at 6 pond locations during 9 August – 15 August



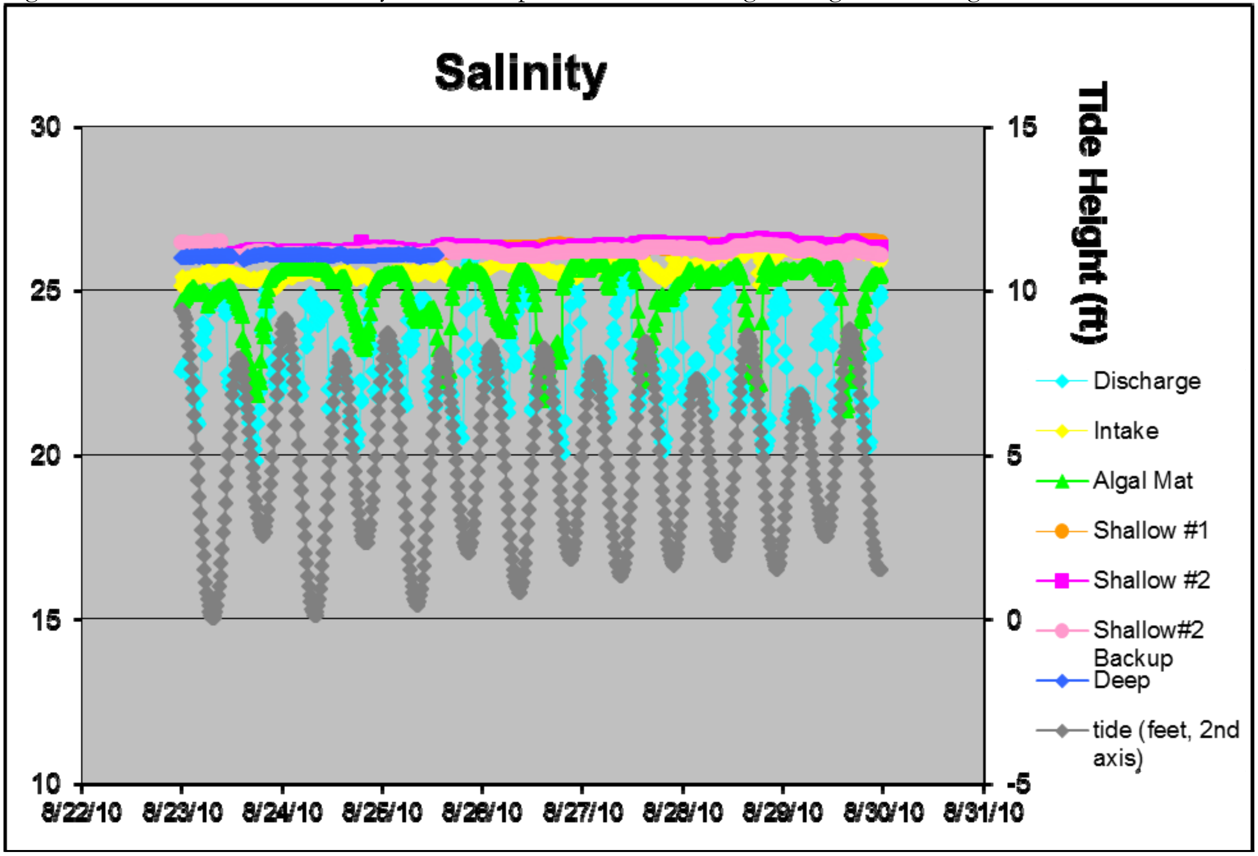
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-12: Pond A3W salinity values at 6 pond locations during 16 August – 22 August



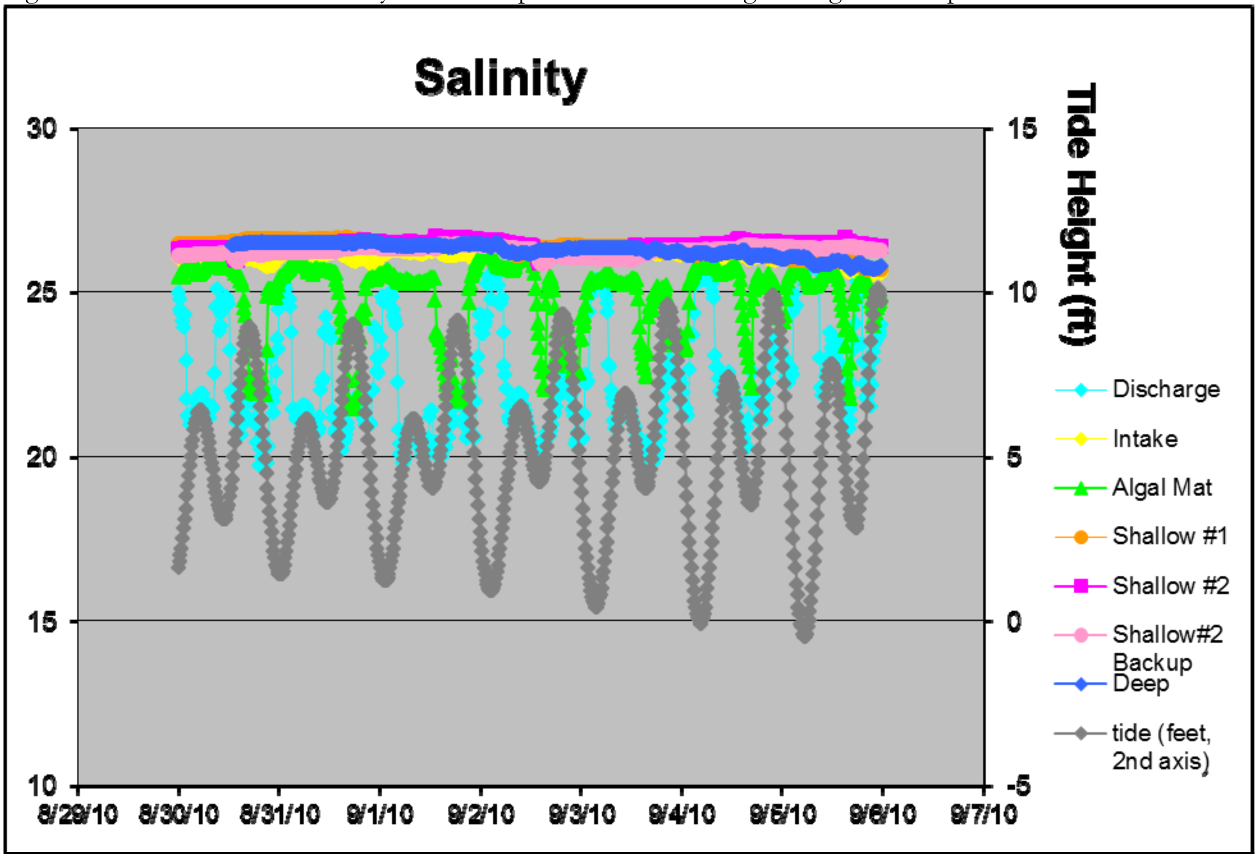
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-13: Pond A3W salinity values at 6 pond locations during 23 August – 29 August



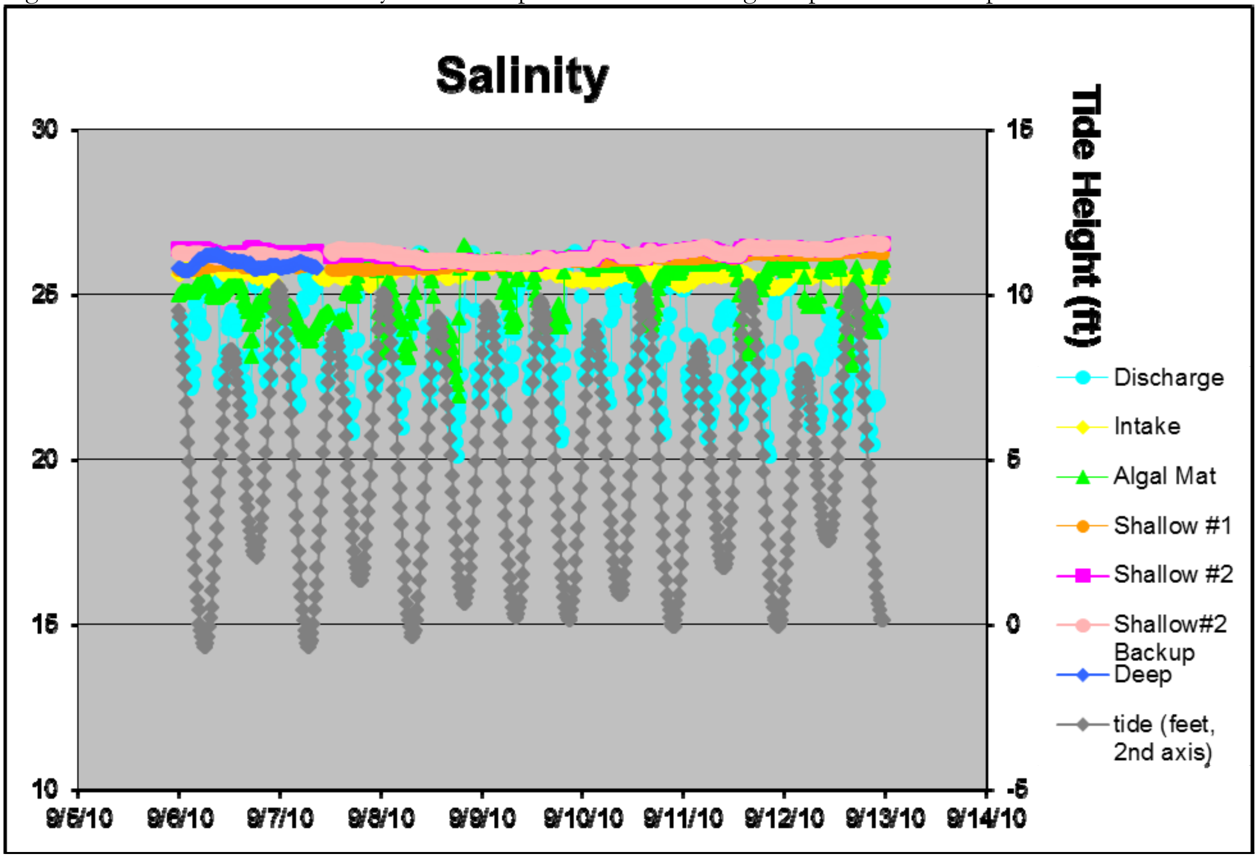
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-14: Pond A3W salinity values at 6 pond locations during 30 August – 5 September



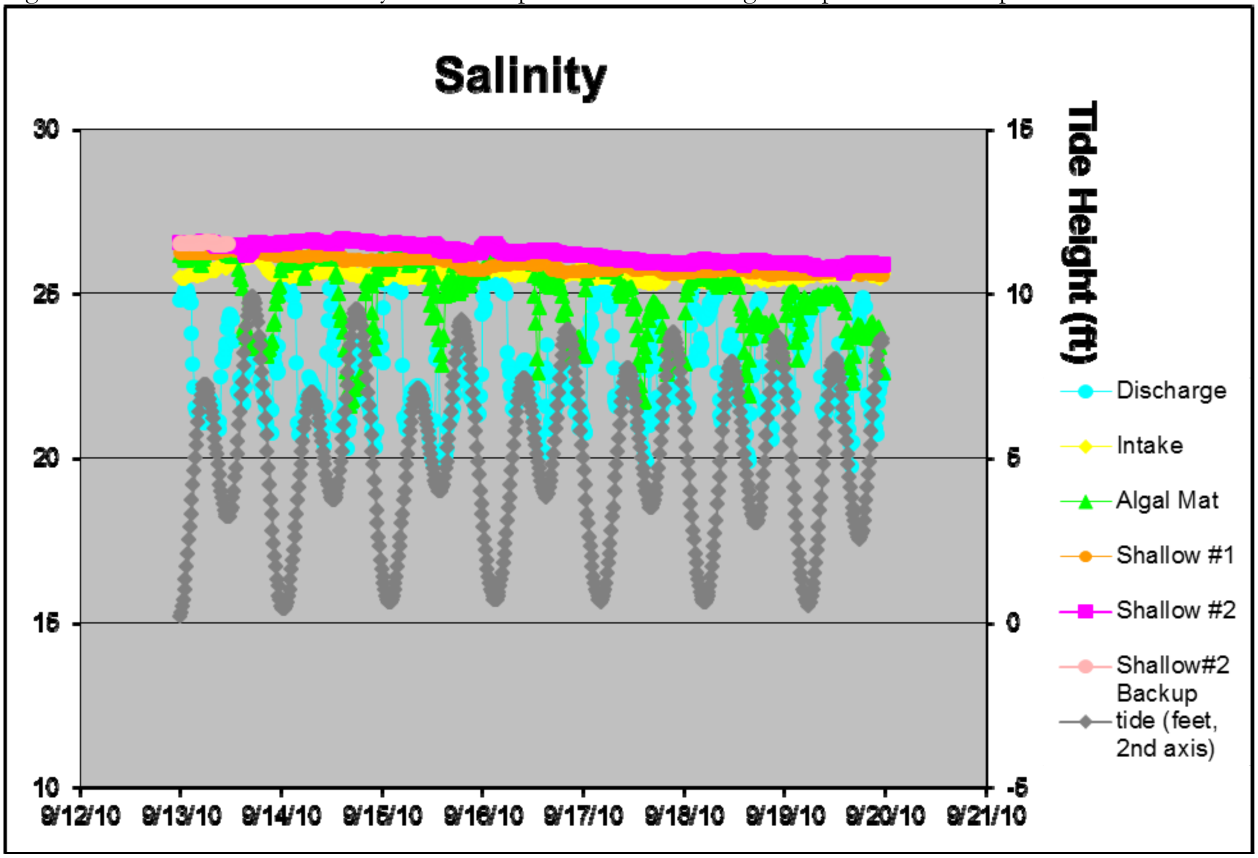
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-15: Pond A3W salinity values at 6 pond locations during 6 September – 12 September



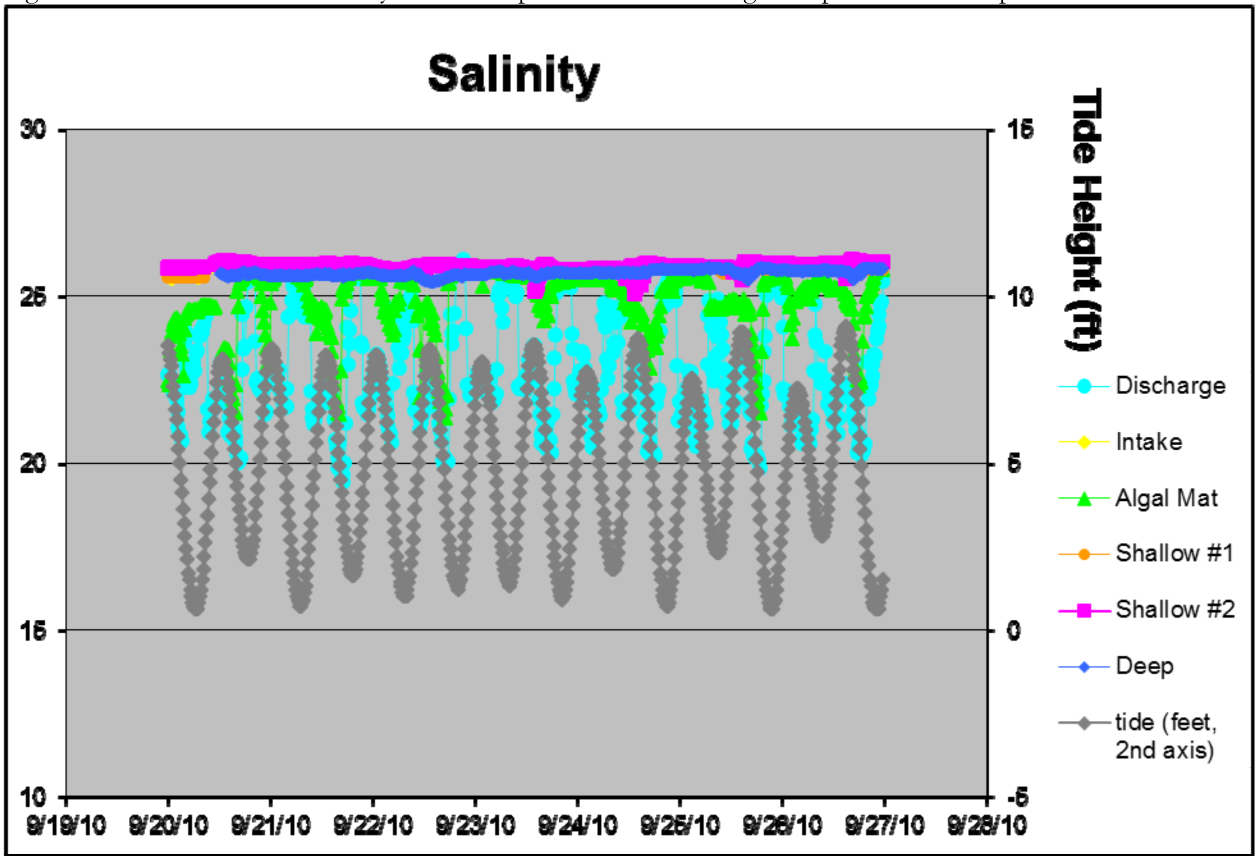
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-16: Pond A3W salinity values at 6 pond locations during 13 September – 19 September



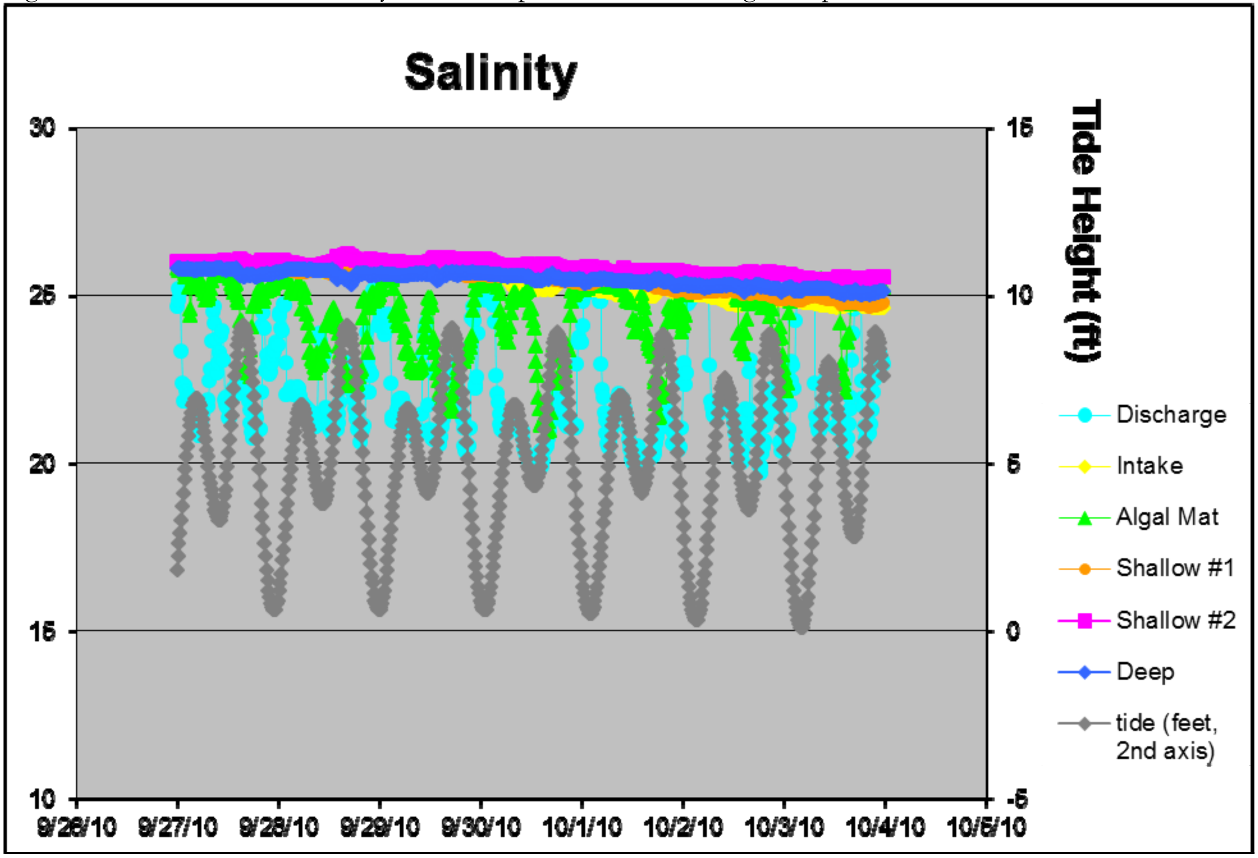
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-17: Pond A3W salinity values at 6 pond locations during 20 September – 26 September



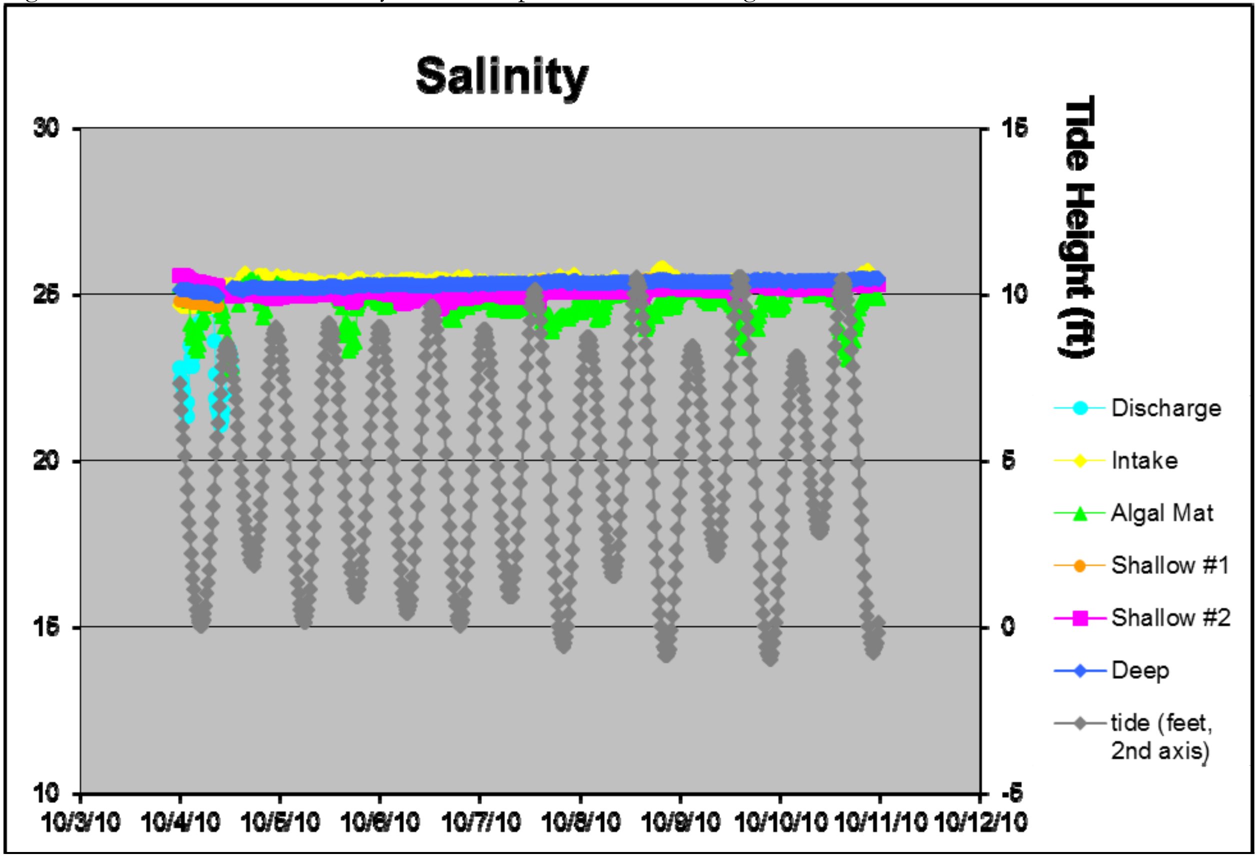
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-18: Pond A3W salinity values at 6 pond locations during 27 September – 3 October



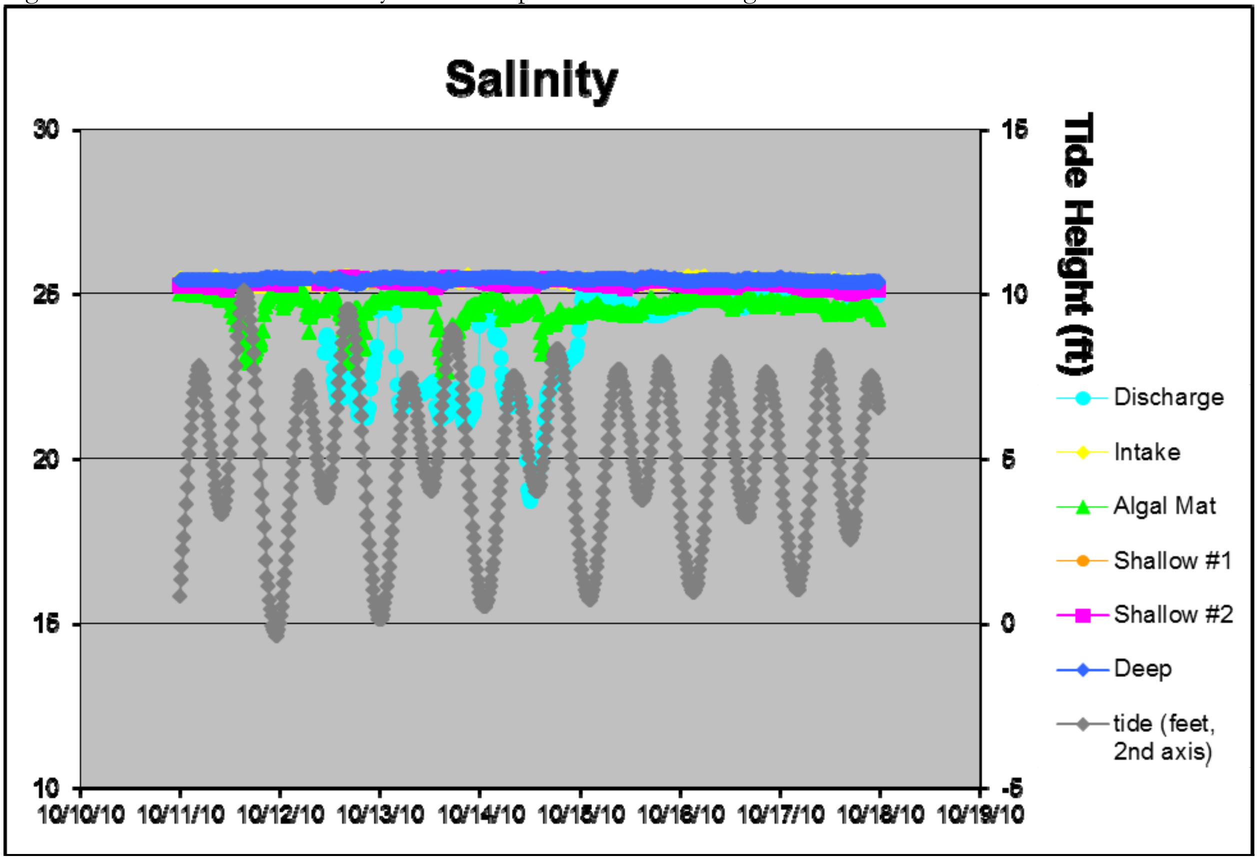
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-19: Pond A3W salinity values at 6 pond locations during 4 October – 10 October



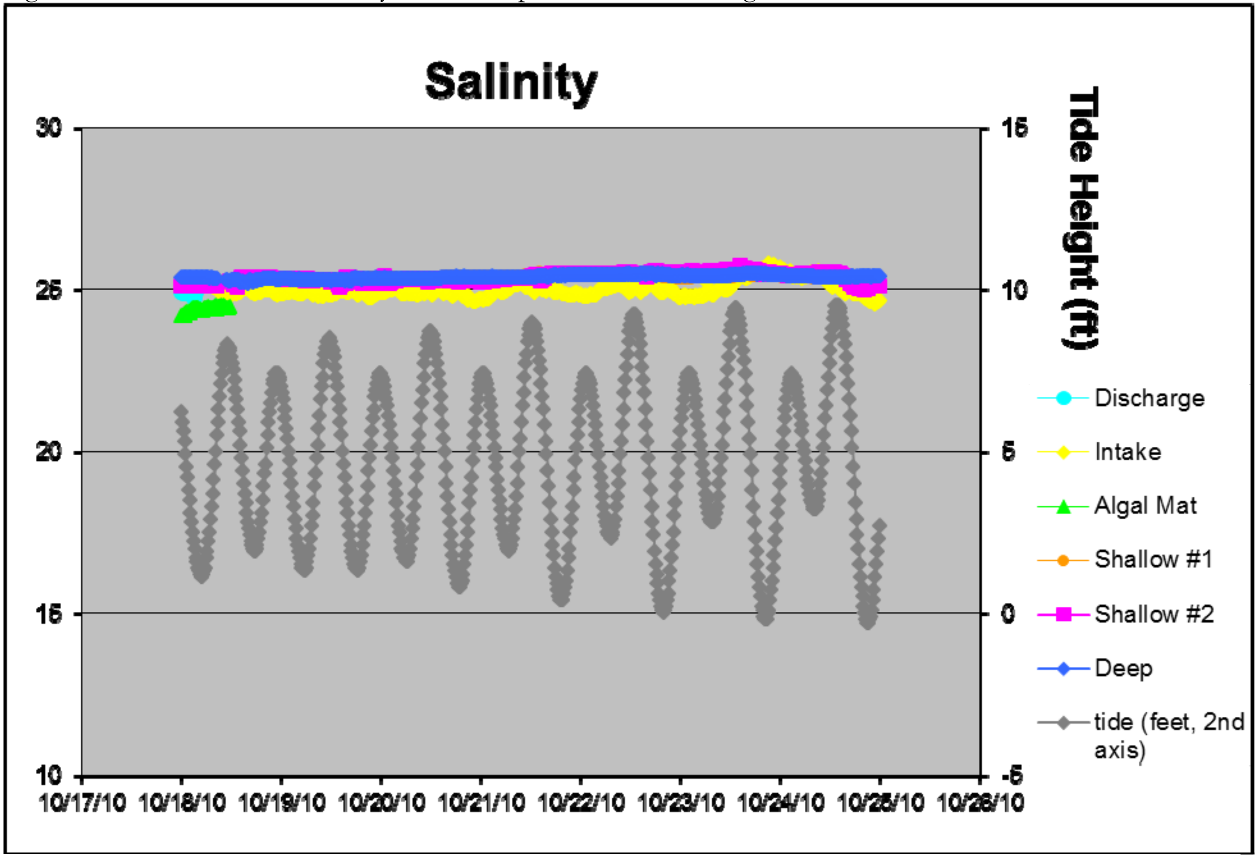
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-20: Pond A3W salinity values at 6 pond locations during 11 October – 17 October



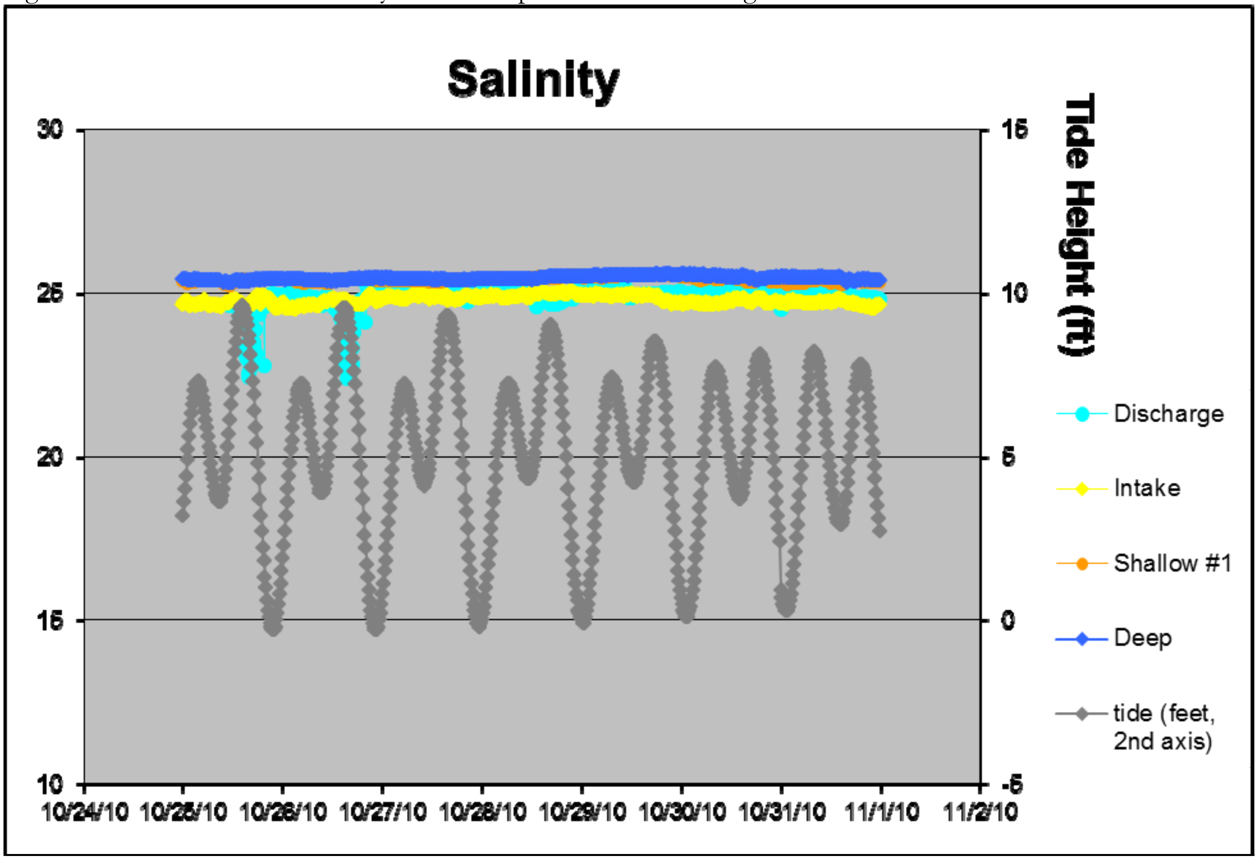
*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-21: Pond A3W salinity values at 6 pond locations during 18 October – 24 October



*Note: Salinity is reported using the Practical Salinity Scale (PSS)

Figure 3.2.2-22: Pond A3W salinity values at 6 pond locations during 25 October – 31 October



*Note: Salinity is reported using the Practical Salinity Scale (PSS)

3.2.3 pH

Recorded pH values within Pond A3W also seemed to be influenced by a muted tidal cycles with greatest variation over time observed in the discharge datasonde. Variation of pH levels within Pond A3W was greatest during the first few months of the study and at locations closest to the discharge structure, and least at the intake location. The pH varied by datasonde location, with lowest recorded pH values at the discharge location and the shallow #2 location. Highest pH values were recorded at the algal location. Within Pond A3W, pH ranged from 7.64, recorded at the discharge location, to 10.10, recorded at the algal location (Figures 3.2.3-1 through 3.2.3-22). From June to October, pH concentrations within Pond A3W decreased steadily (Table 3.2 and Figures 3.2.3-1 through 3.2.3-22).

Equipment issues were encountered during the 5-month study and these problems were documented upon occurrence. After July 26th, the shallow #1 datasonde failed the upper limit for pH calibrations for the remainder of the study period. Despite the calibration failures for the upper pH limit, the datasonde at the shallow #1 location continued to log pH data similar to the pH data recorded at the deep location until late September. These two datasondes were deployed at the same location and differed only by depth, of about one meter, which allowed for pH-sensor performance checks of the shallow #1 datasonde. After 20 September, pH levels at the shallow #1 datasonde decline and depart from pH values recorded at the deep location (Figure 3.2.3-17 and 3.2.3-18). After 4 October, data collected at the shallow #1 location once again mimicked pH values recorded at the deep location (Figures 3.2.3-19 through 3.2.3-22)

Throughout the study, the datasonde at the shallow #2 location failed the upper limit for pH calibrations and data from this datasonde were questionable, for example, from July 26th through August 9th (Figures 3.2.3-9 through 3.2.3-11). Although the datasonde at the shallow #2 location experienced pH calibrations failures throughout the monitoring period, the pH data recorded at this location seemed consistent with data recorded at other locations within Pond A3W until 26 July. After this date, pH levels recorded at the shallow #2 location plummet and do not appear to agree with data recorded at other locations. A backup or replacement datasonde was deployed at this location on 16 August. Data recorded by this backup datasonde closely resembled pH data collected throughout Pond A3W. Unfortunately, after 5 September, this backup datasonde encountered problems related to the DO sensor and was therefore pulled from Pond A3W. Due to limitations of equipment availability, the original datasonde for this shallow #2 location was redeployed for the remainder of the 2010 study period. As noted previously, this datasonde had known pH sensor problems yet the recorded pH levels for this location were very similar to data recorded throughout Pond A3W (Figures 3.2.3-1 through 3.2.3-22).

Figure 3.2.3-1: Pond A3W pH values at 6 pond locations during 1 June – 6June

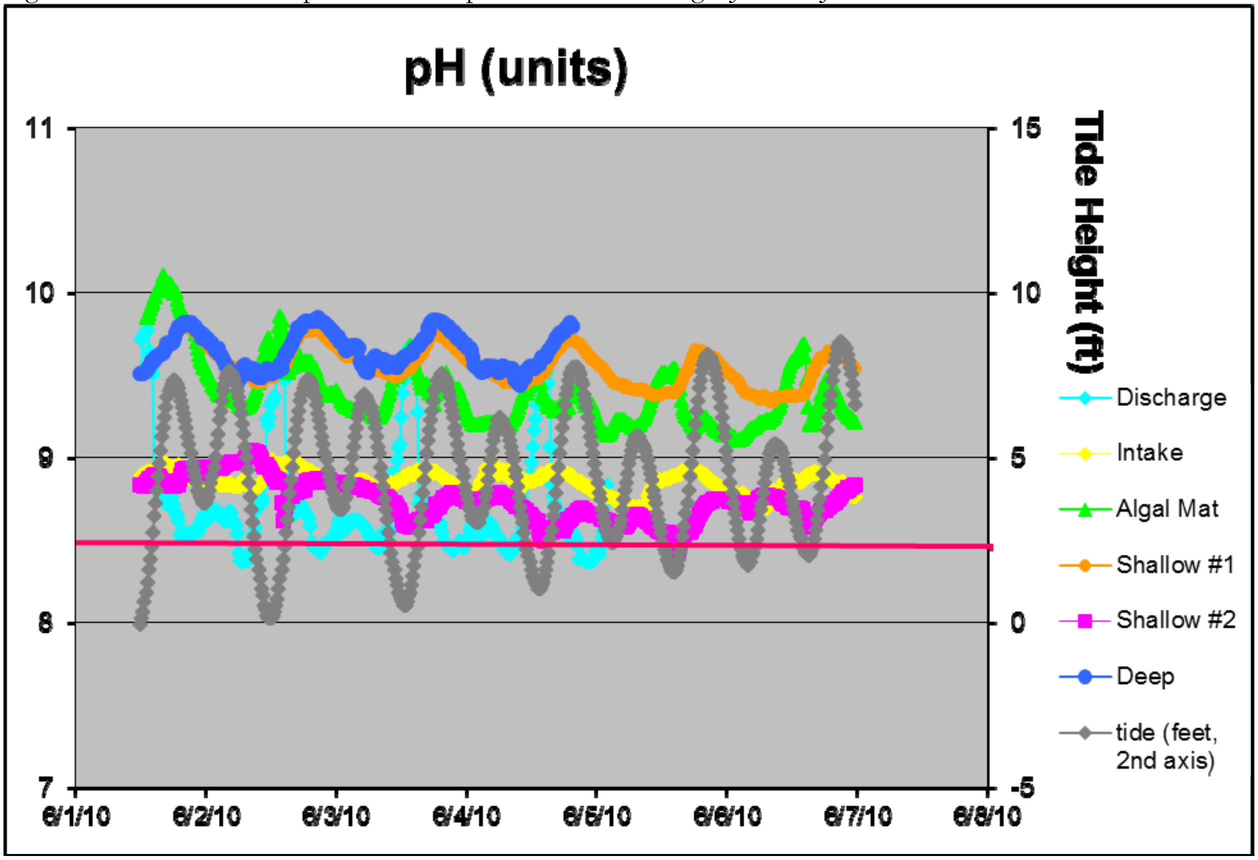


Figure 3.2.3-2: Pond A3W pH values at 6 pond locations during 7 June – 13 June

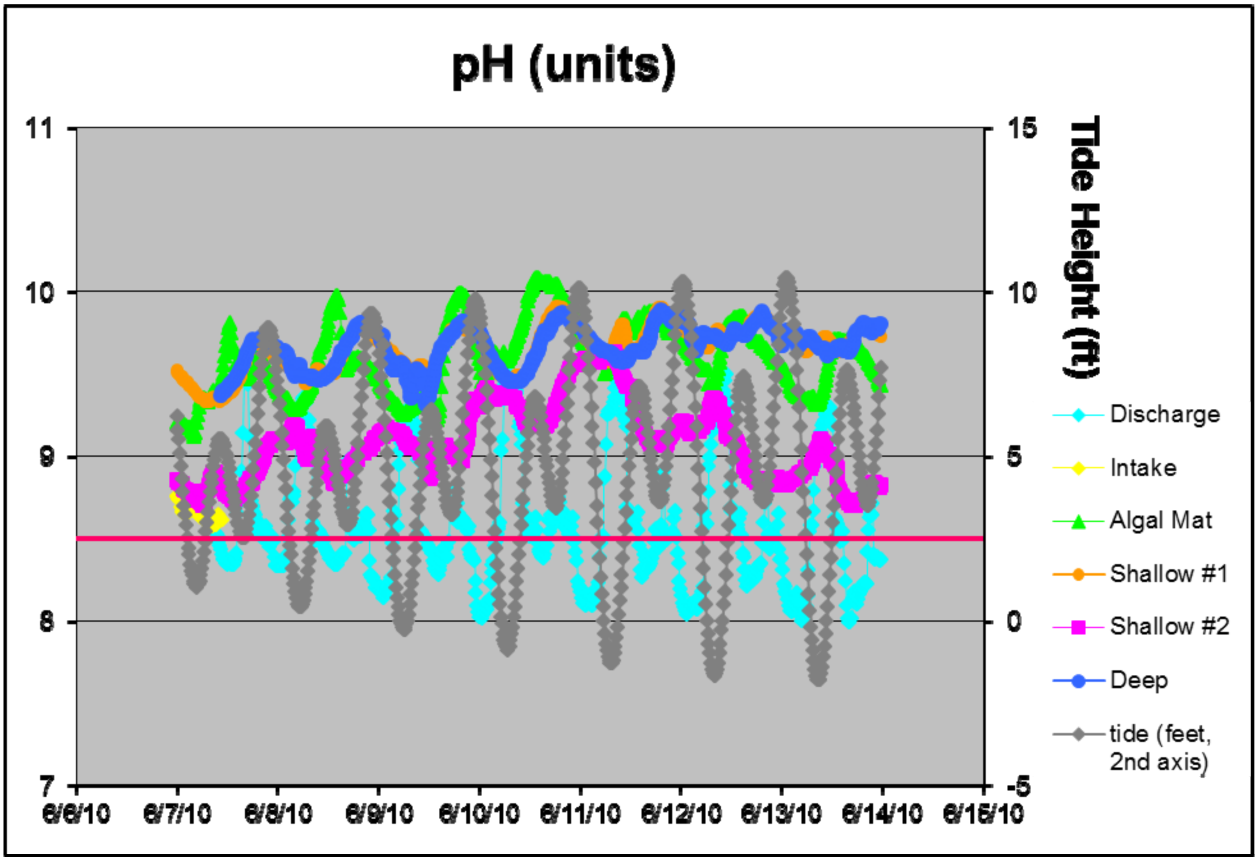


Figure 3.2.3-3: Pond A3W pH values at 6 pond locations during 14 June – 20 June

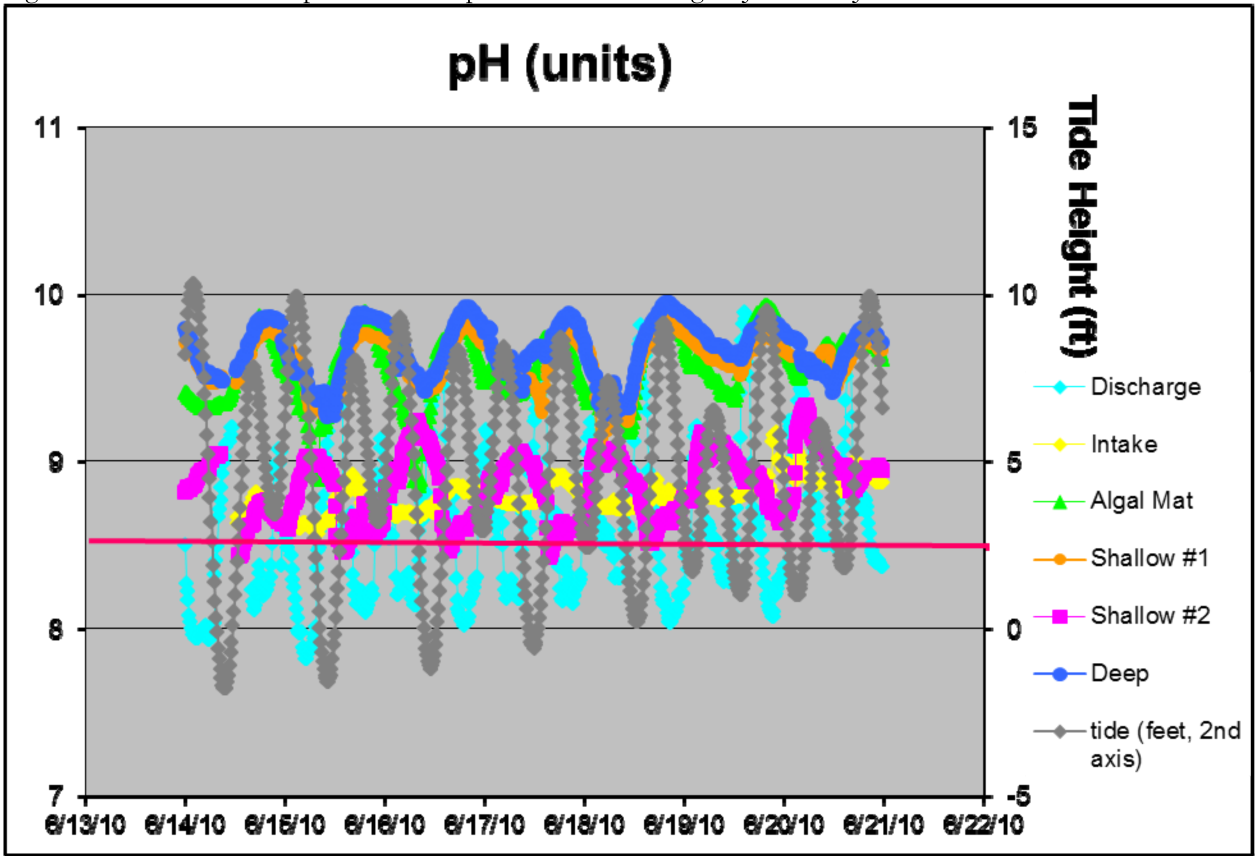


Figure 3.2.3-4: Pond A3W pH values at 6 pond locations during 21 June – 27 June

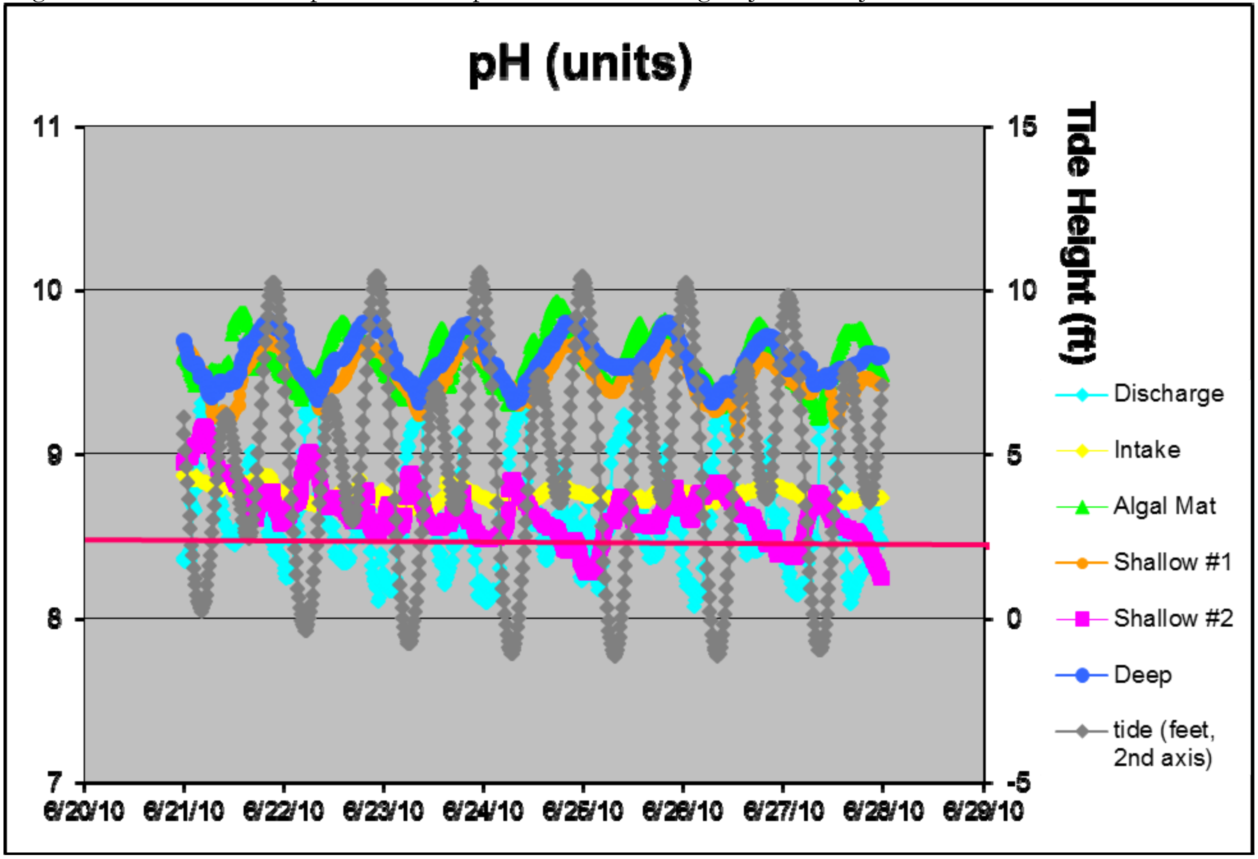


Figure 3.2.3-5: Pond A3W pH values at 6 pond locations during 28 June – 4 July

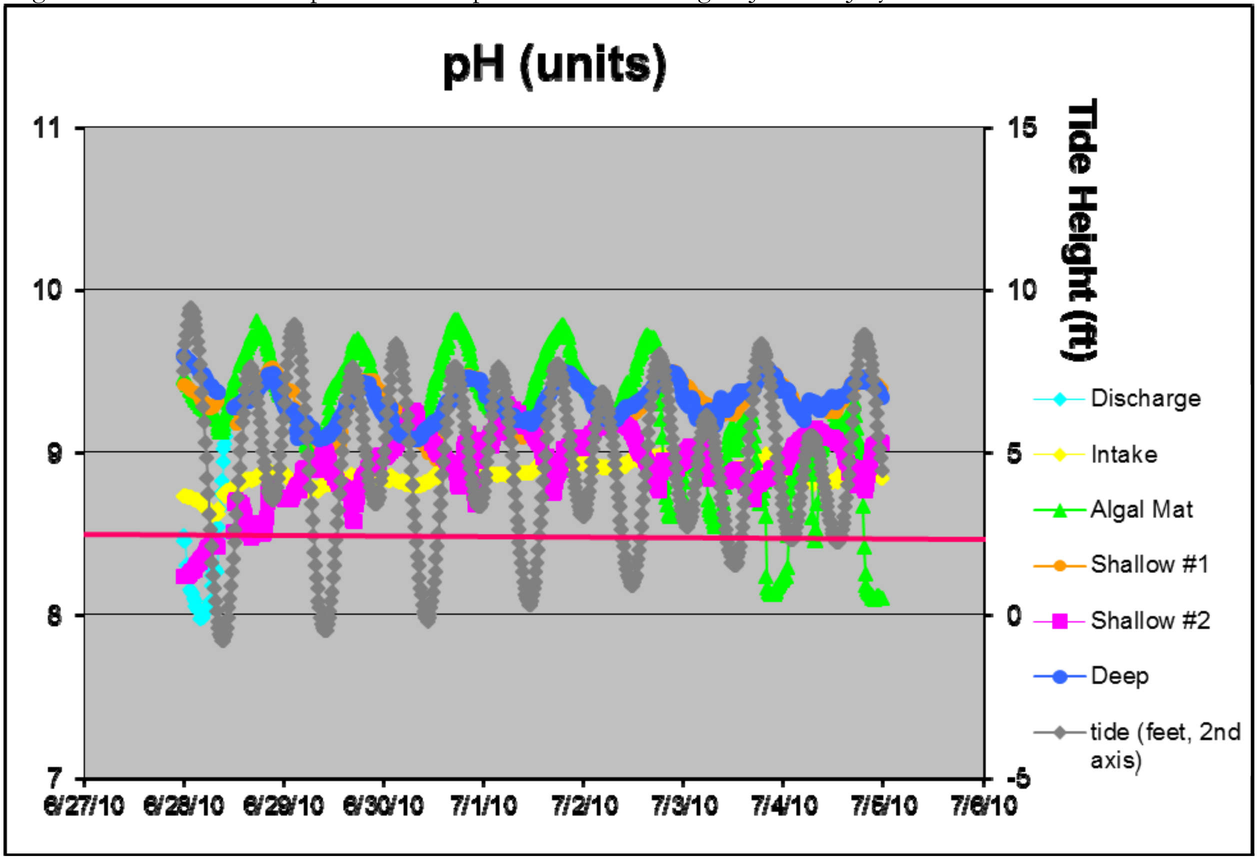


Figure 3.2.3-6: Pond A3W pH values at 6 pond locations during 5 July – 11 July

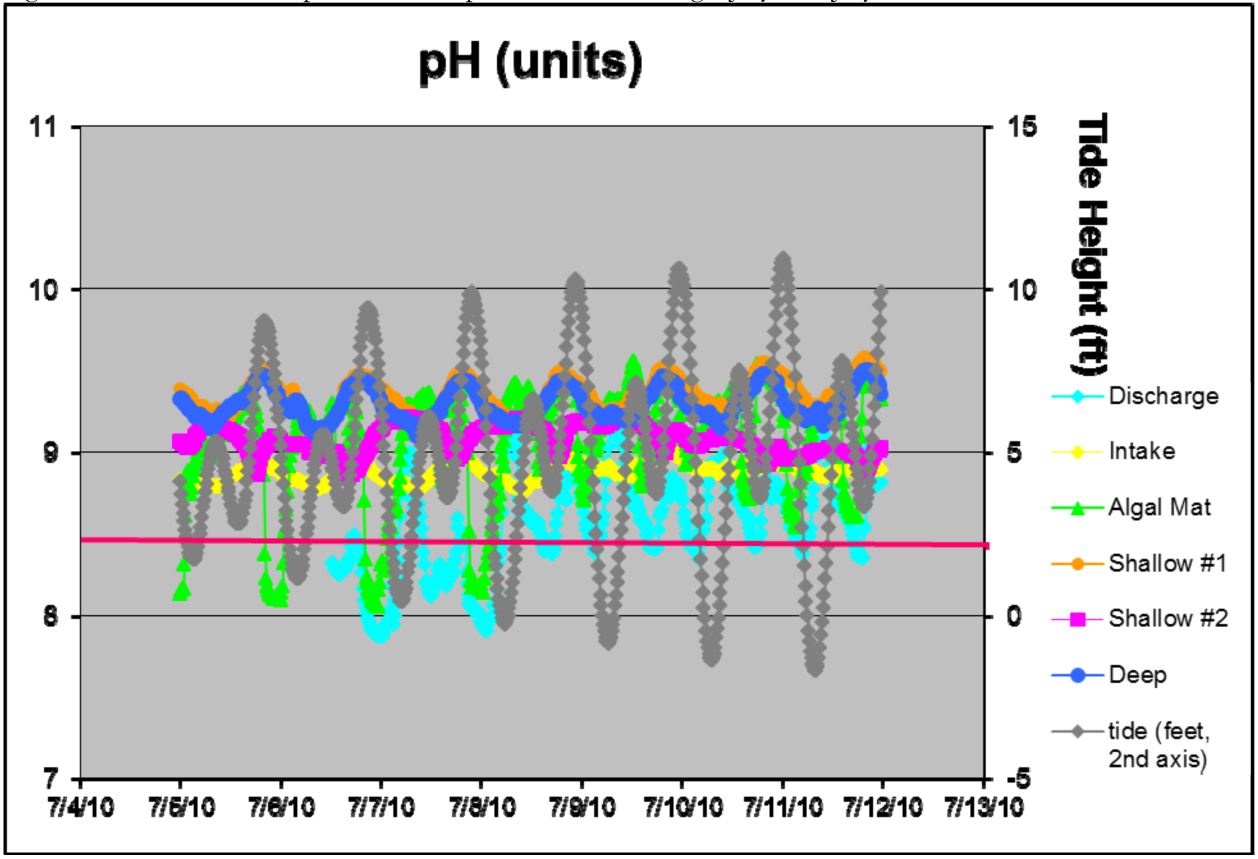


Figure 3.2.3-7: Pond A3W pH values at 6 pond locations during 12 July – 18 July

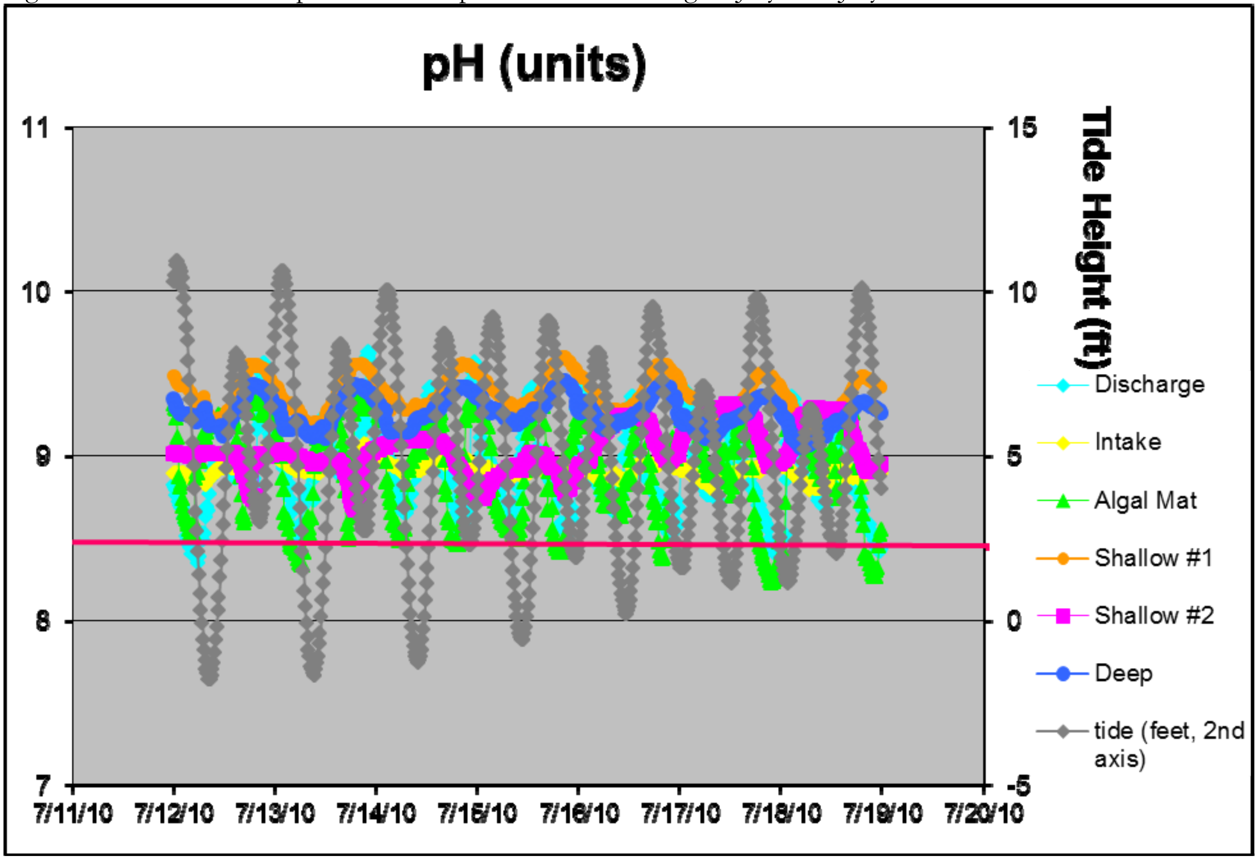


Figure 3.2.3-8: Pond A3W pH values at 6 pond locations during 19 July – 25 July

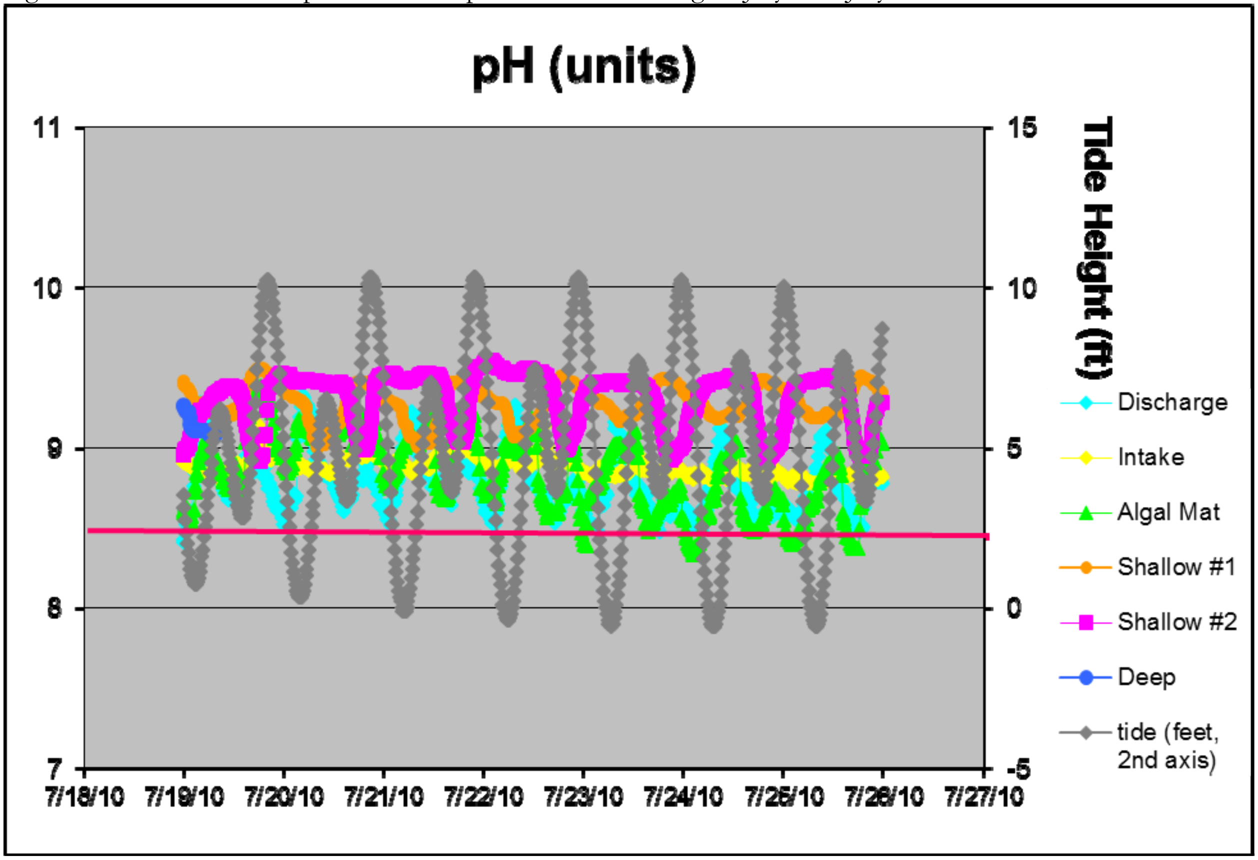


Figure 3.2.3-9: Pond A3W pH values at 6 pond locations during 26 July – 1 August

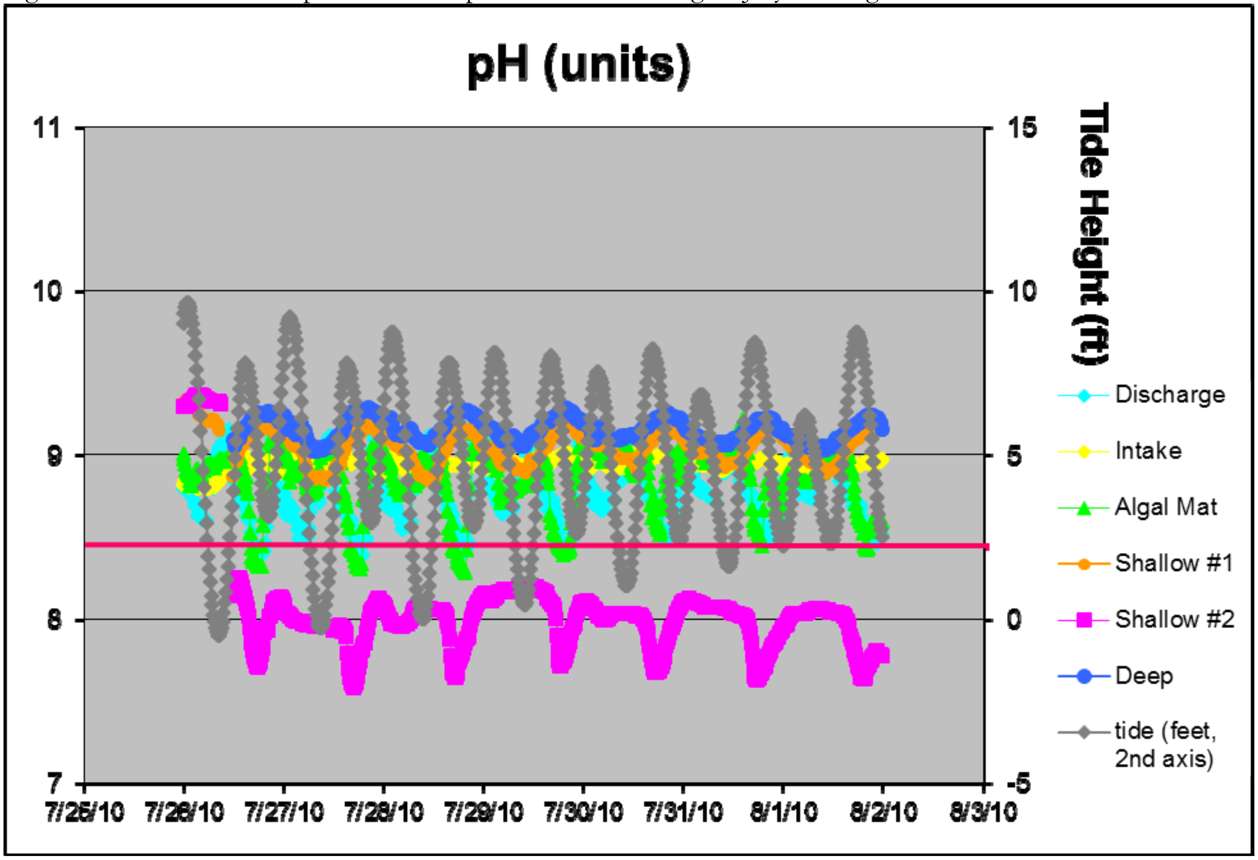


Figure 3.2.3-10: Pond A3W pH values at 6 pond locations during 2 August – 8 August

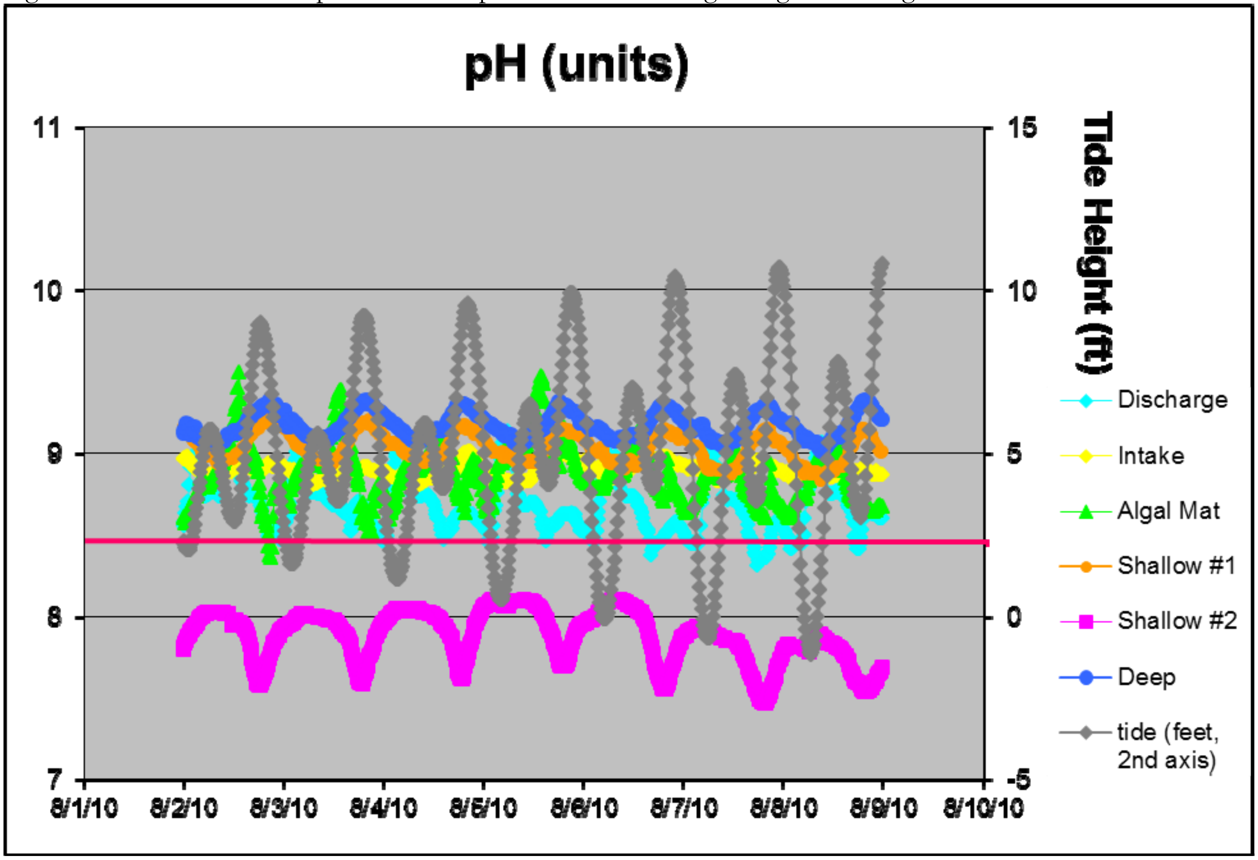


Figure 3.2.3-11: Pond A3W pH values at 6 pond locations during 9 August- 15 August

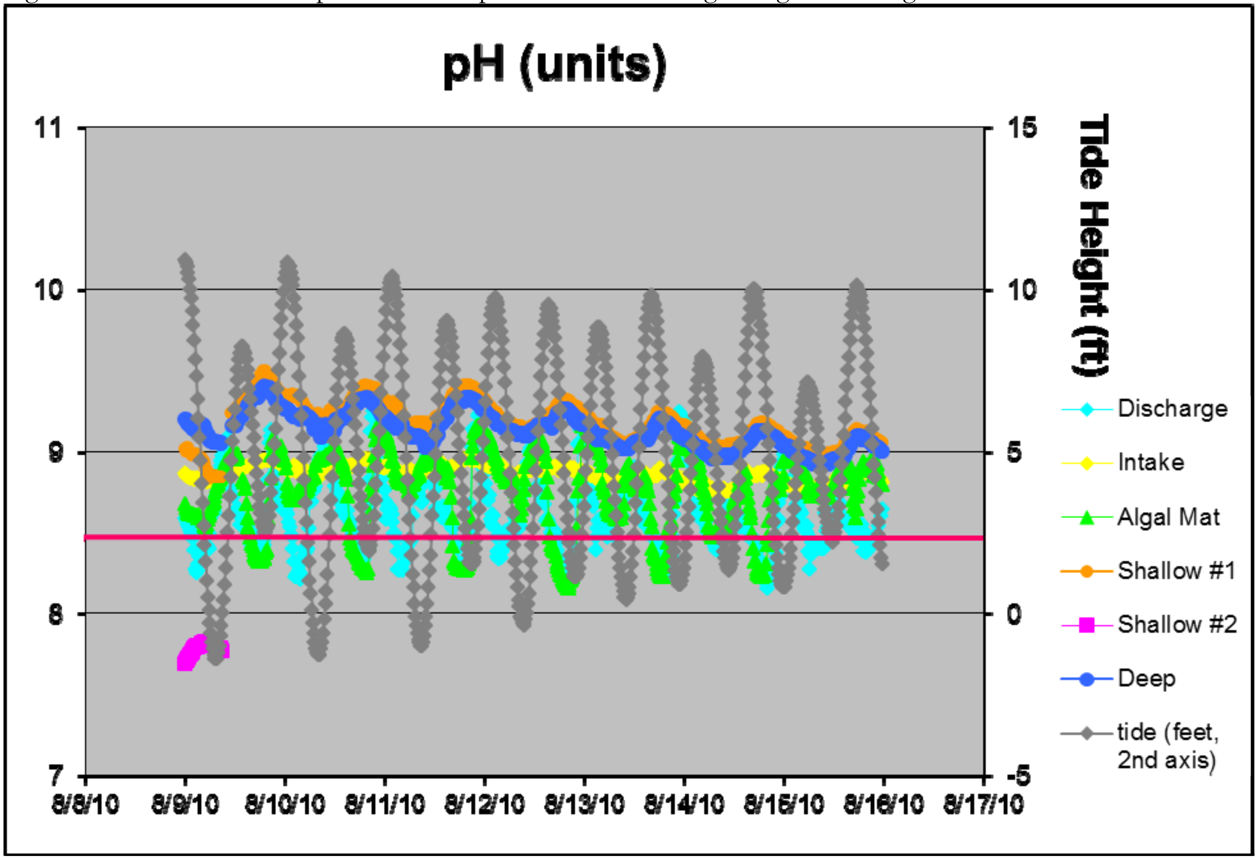


Figure 3.2.3-12: Pond A3W pH values at 6 pond locations during 16 August – 22 August

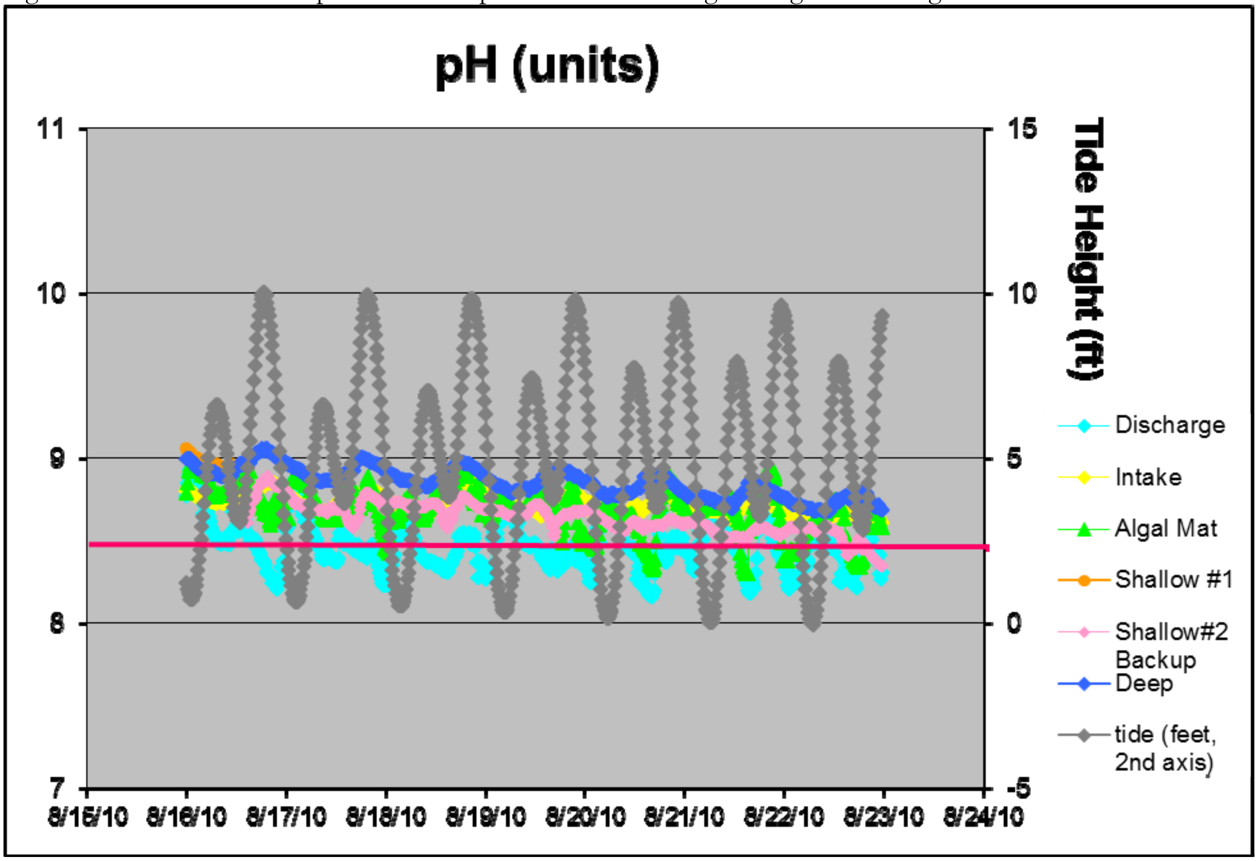


Figure 3.2.3-13: Pond A3W pH values at 6 pond locations during 23 August – 29 August

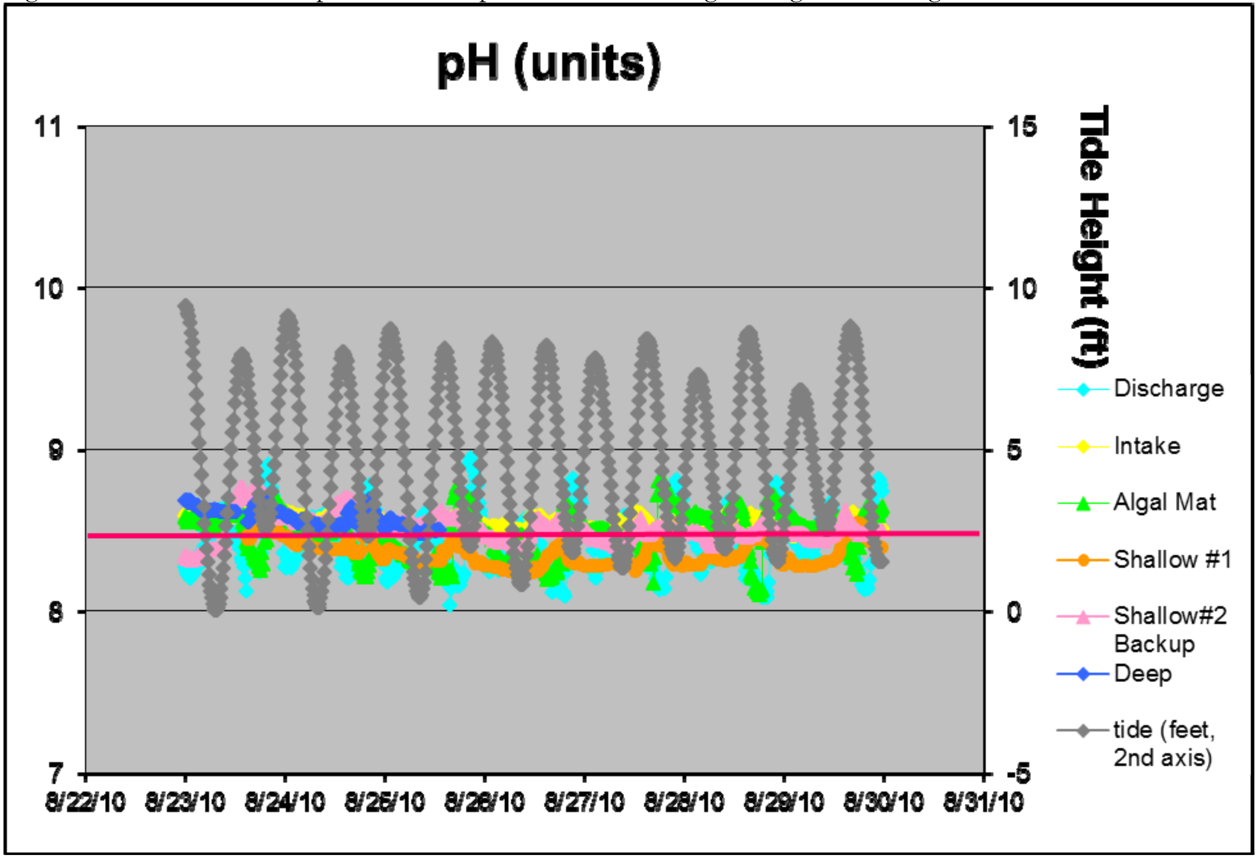


Figure 3.2.3-14: Pond A3W pH values at 6 pond locations during 30 August – 5 September

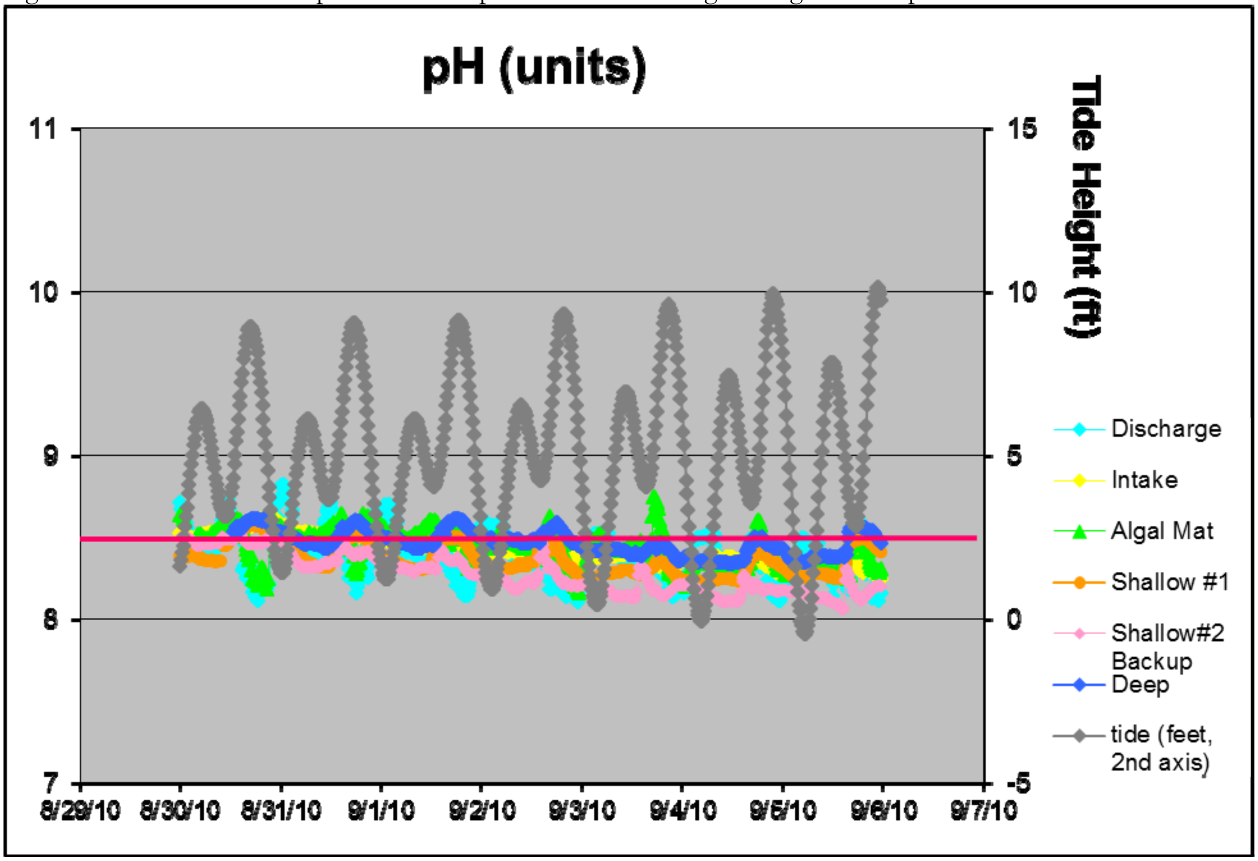


Figure 3.2.3-15: Pond A3W pH values at 6 pond locations during 6 September – 12 September

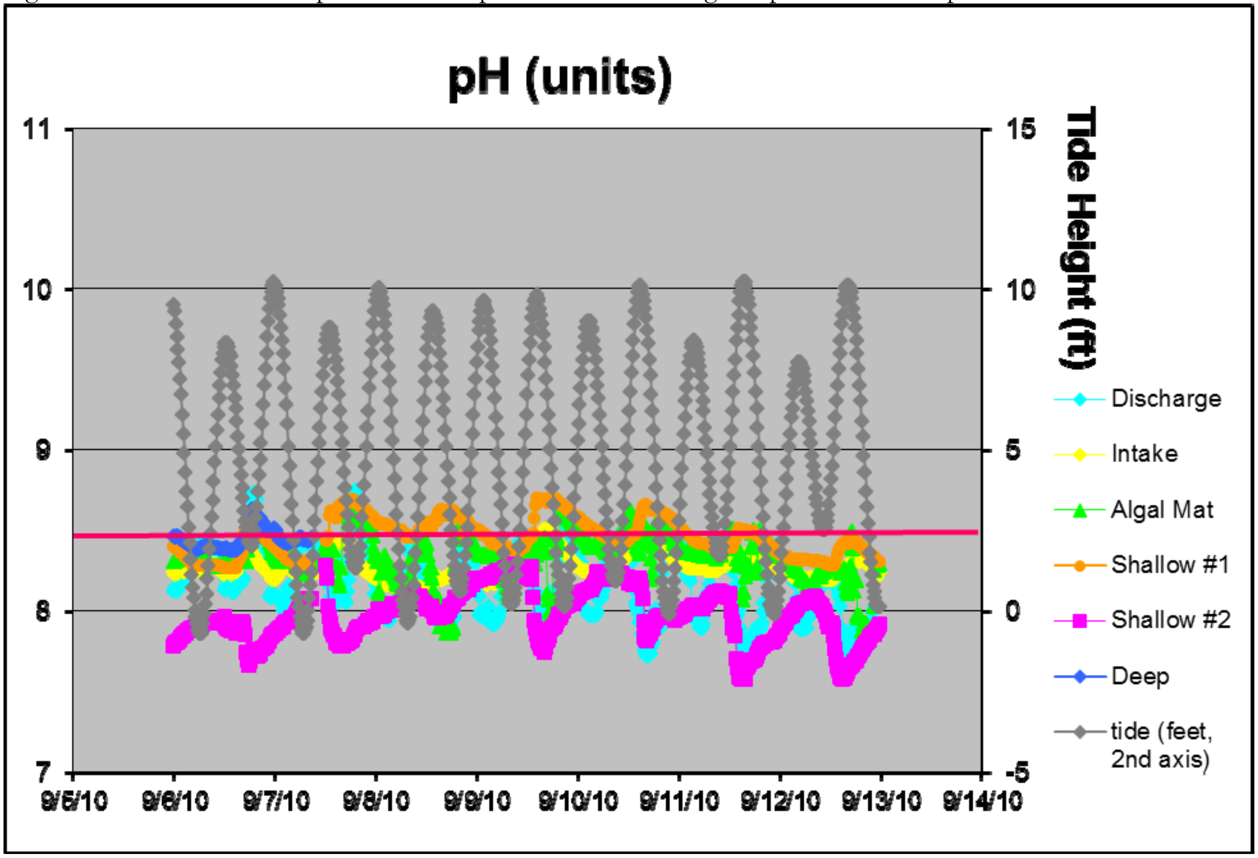


Figure 3.2.3-16: Pond A3W pH values at 6 pond locations during 13 September – 19 September

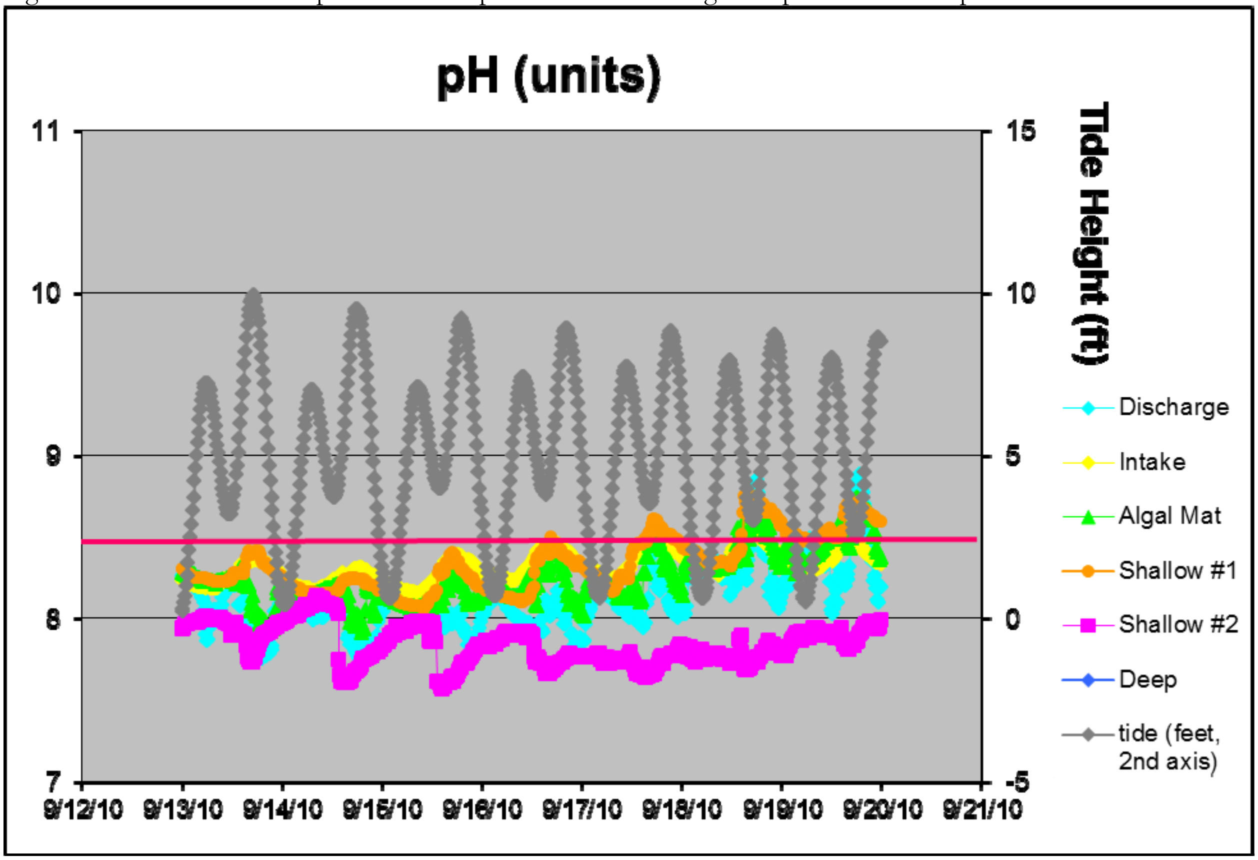


Figure 3.2.3-17: Pond A3W pH values at 6 pond locations during 20 September – 26 September

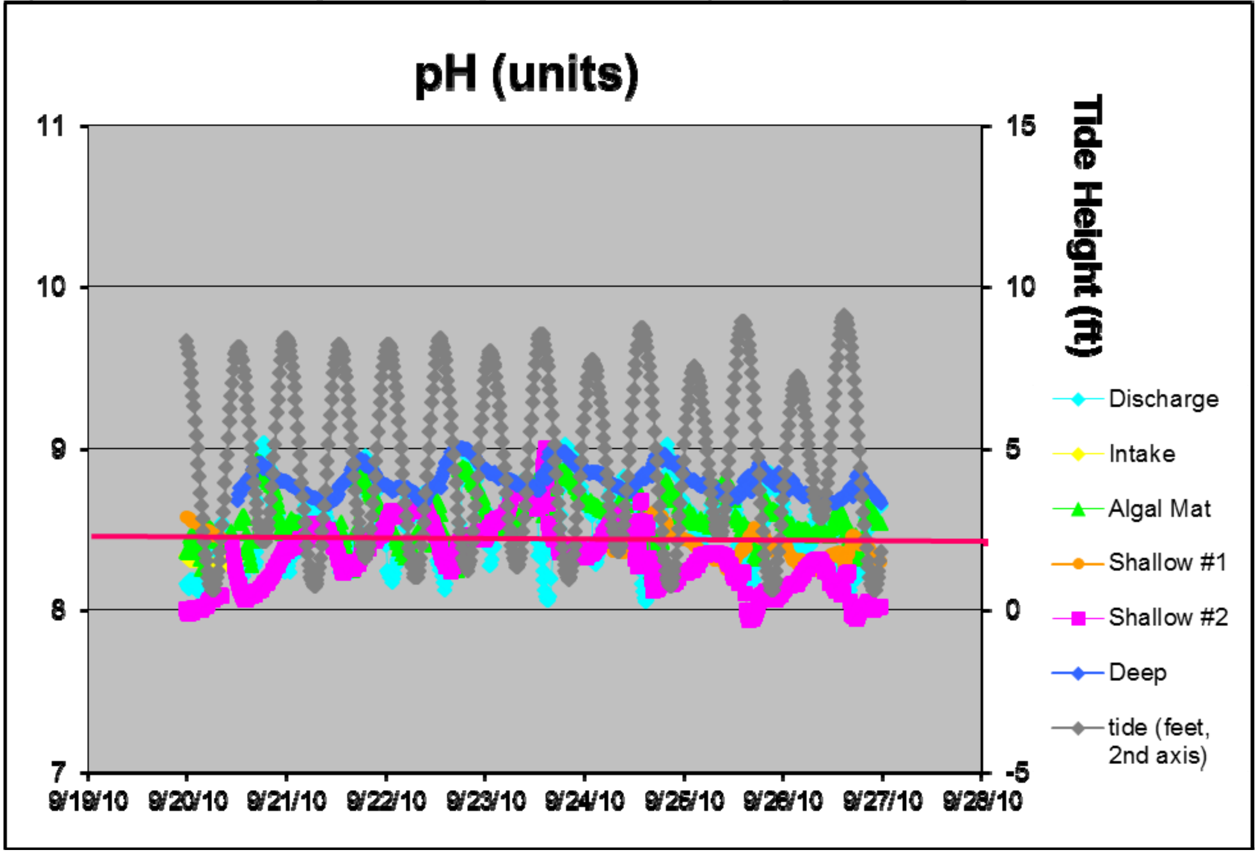


Figure 3.2.3-18: Pond A3W pH values at 6 pond locations during 27 September – 3 October

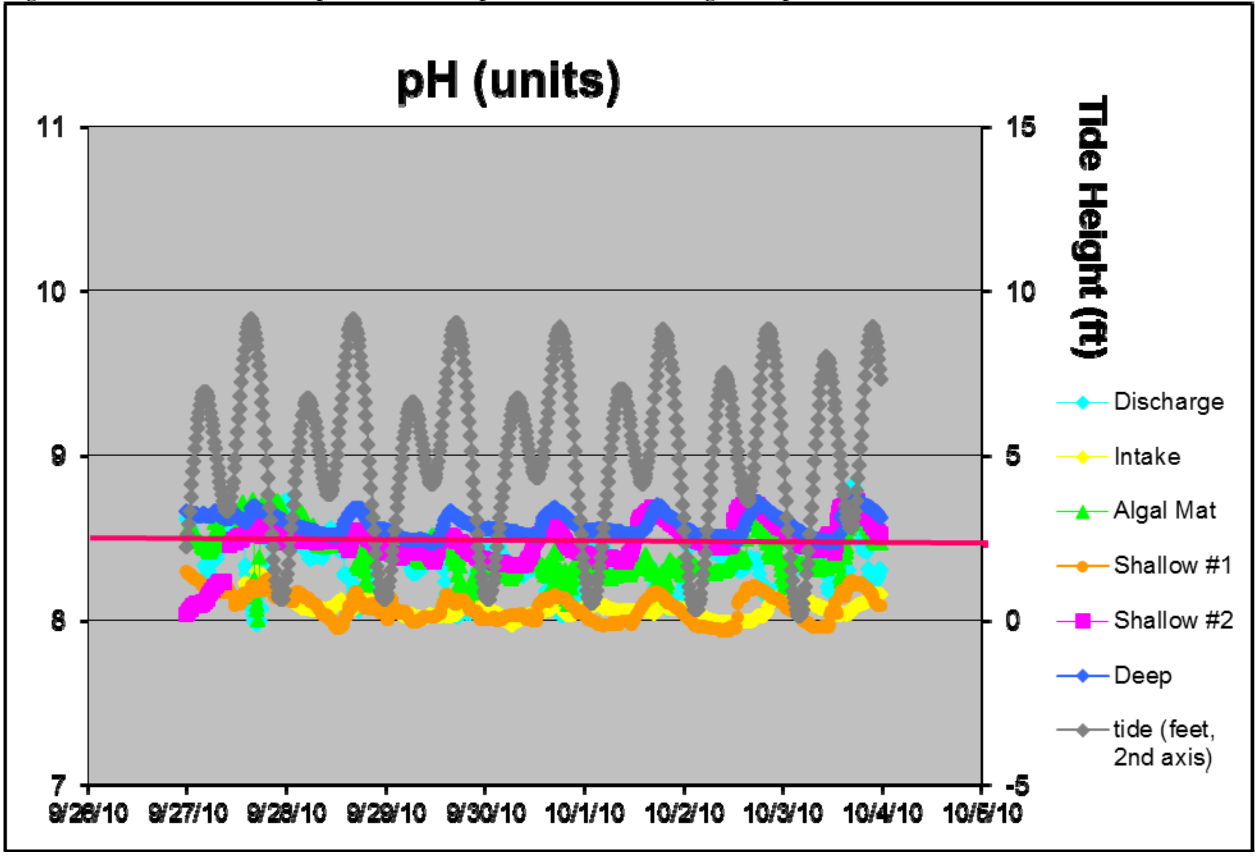


Figure 3.2.3-19: Pond A3W pH values at 6 pond locations during 4 October – 10 October

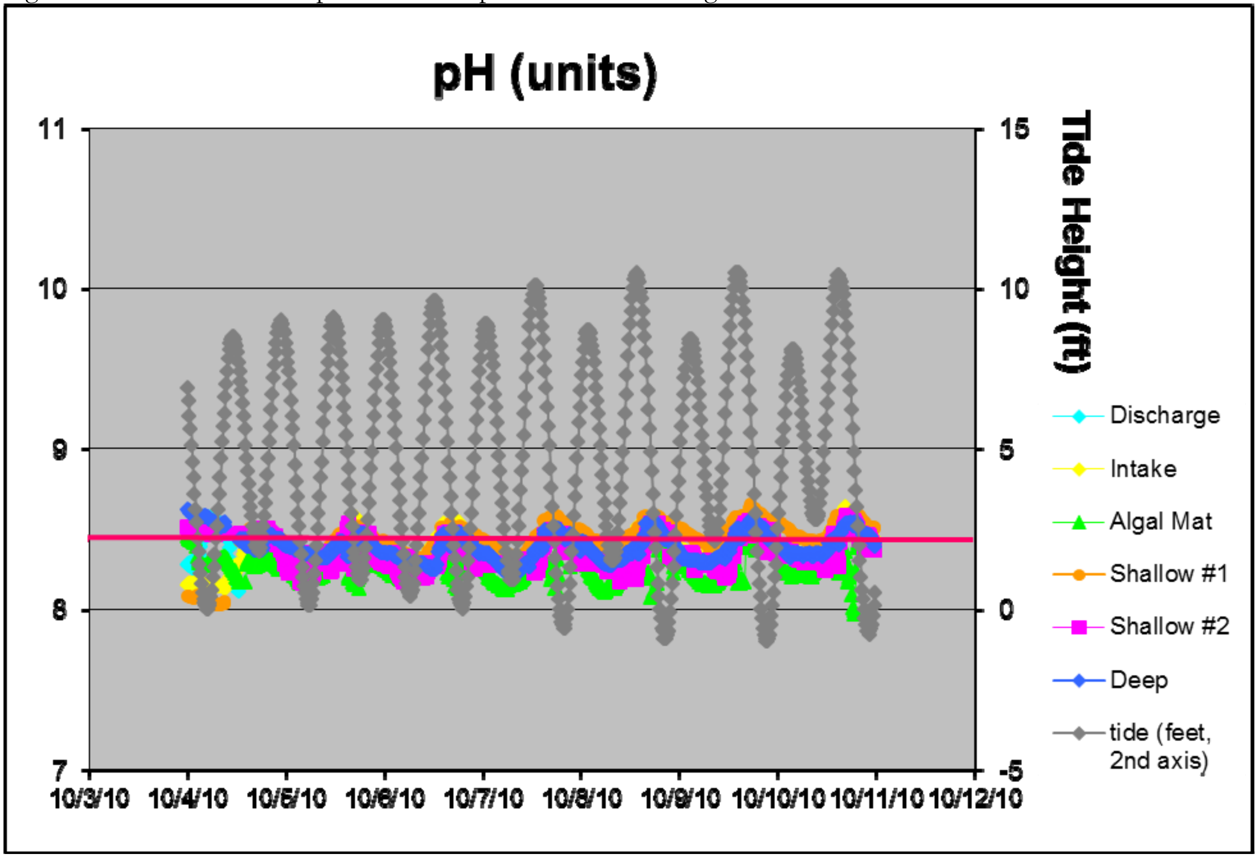


Figure 3.2.3-20: Pond A3W pH values at 6 pond locations during 11 October – 17 October

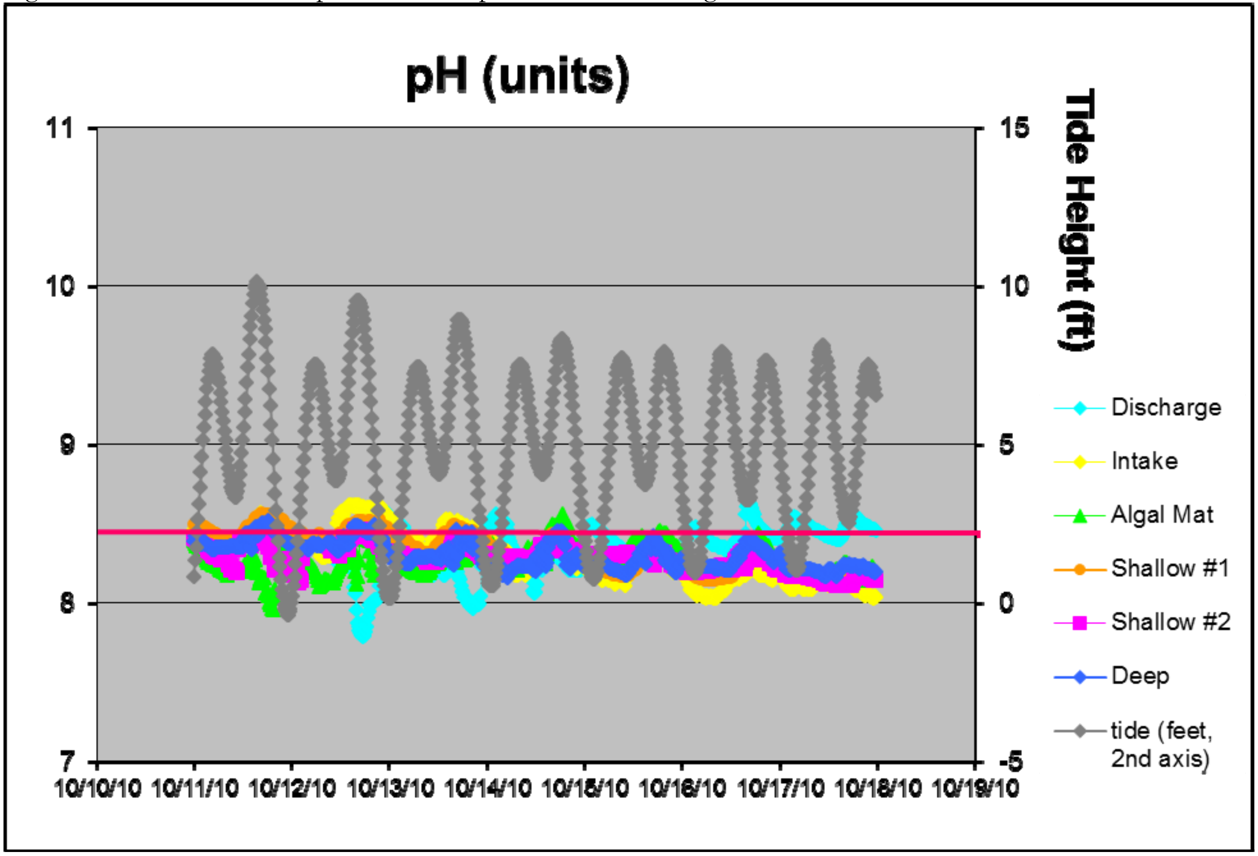


Figure 3.2.3-21: Pond A3W pH values at 6 pond locations during 18 October – 24 October

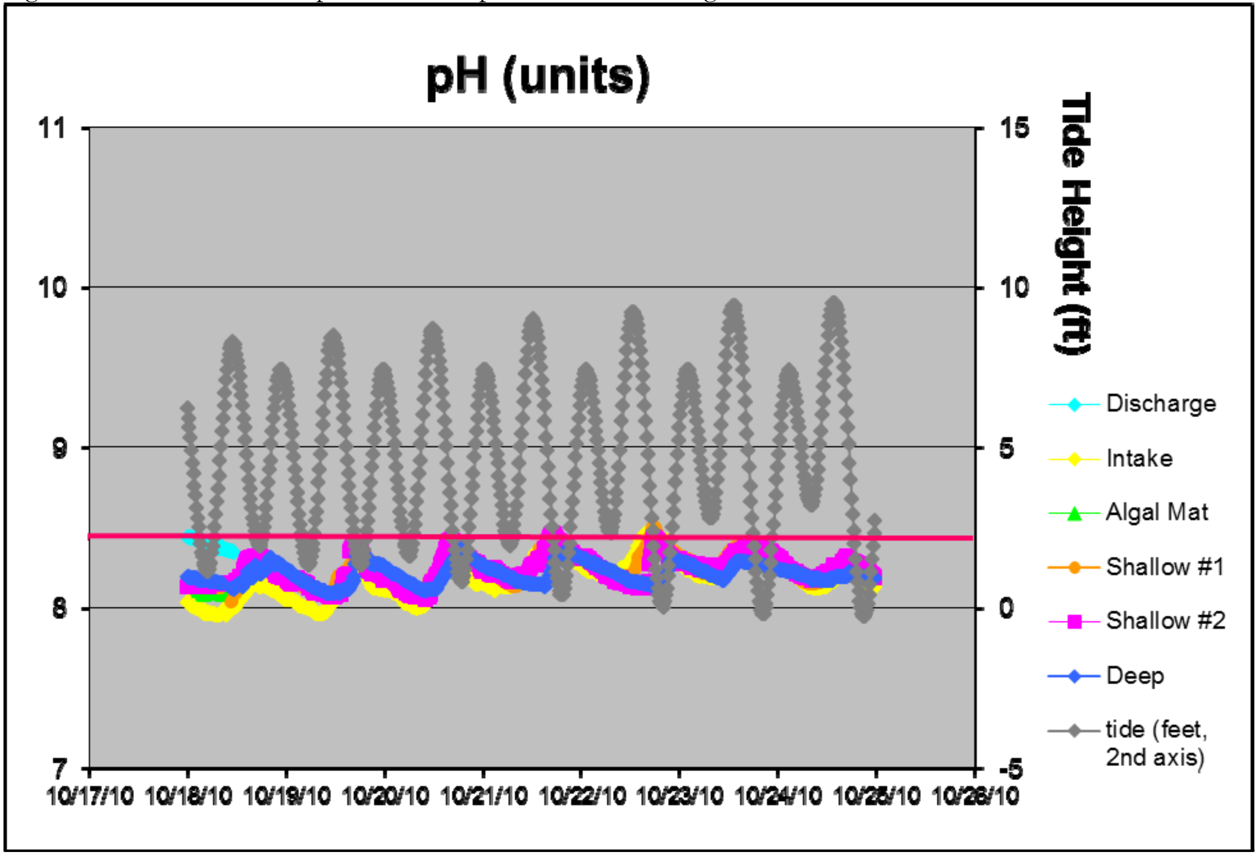
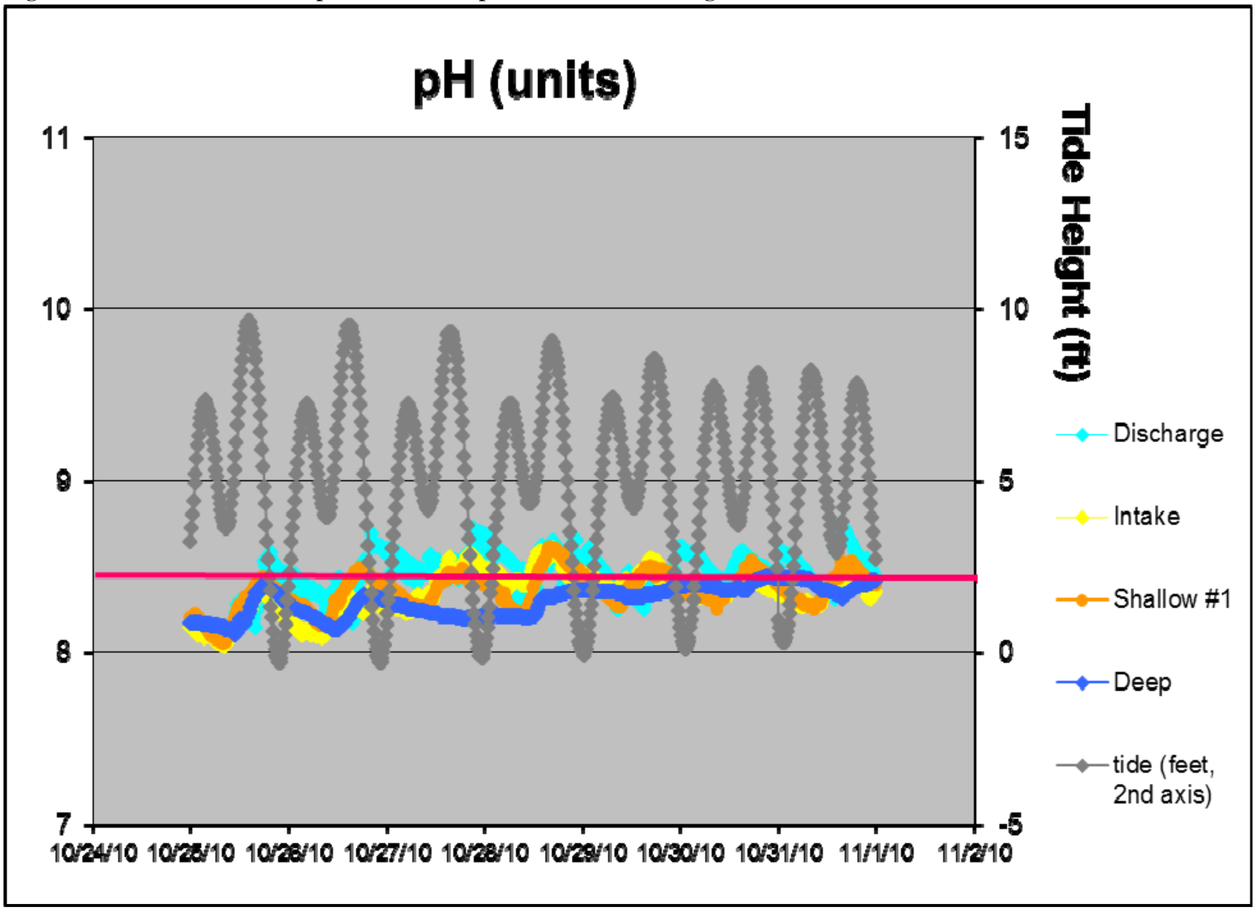


Figure 3.2.3-22: Pond A3W pH values at 6 pond locations during 25 October – 31 October



3.2.4 Temperature

Water temperature within Pond A3W showed a strong cyclic pattern, likely due to both the tidal and diurnal cycles (Figures 3.2.4-1 through 3.2.4-22). From June through July 2010, these tidal influences were variable according to datasonde location. These influences were most noticeable at the shallow #2 location where daily minima and maxima were slightly more pronounced than at other locations within Pond A3W (Figures 3.2.4-1 through 3.2.4-9) This location also logged the lowest monthly mean temperatures values from June to September (Table 3.2). Temperatures logged after August are similar for all datasonde locations (Figures 3.2.4-9 through 3.2.4-22). Monthly mean water temperatures of Pond A3W show a small increase from June to July then continuously decrease from July to October (Table 3.2).

Figure 3.2.4-1: Pond A3W temperature values at 6 pond locations during 1 June – 6 June

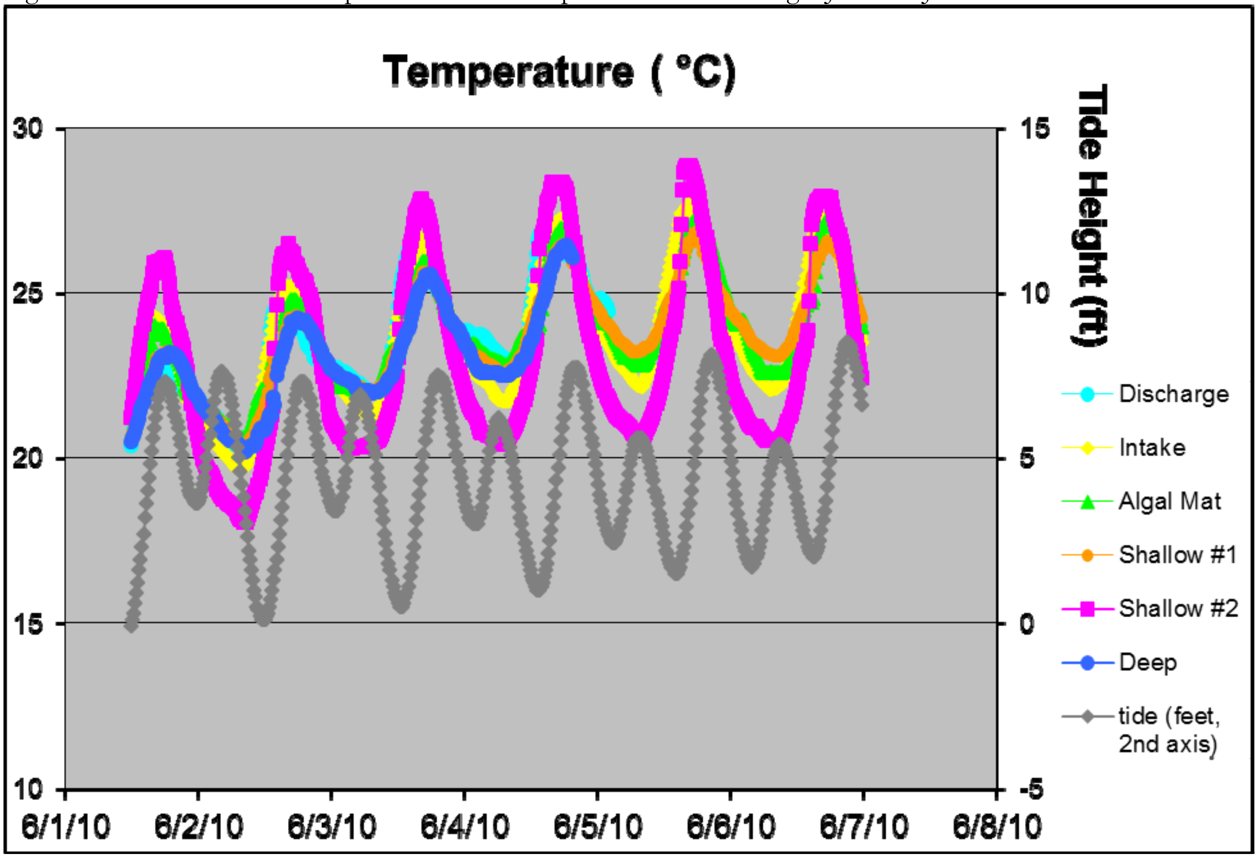


Figure 3.2.4-2: Pond A3W temperature values at 6 pond locations during 7 June – 13 June

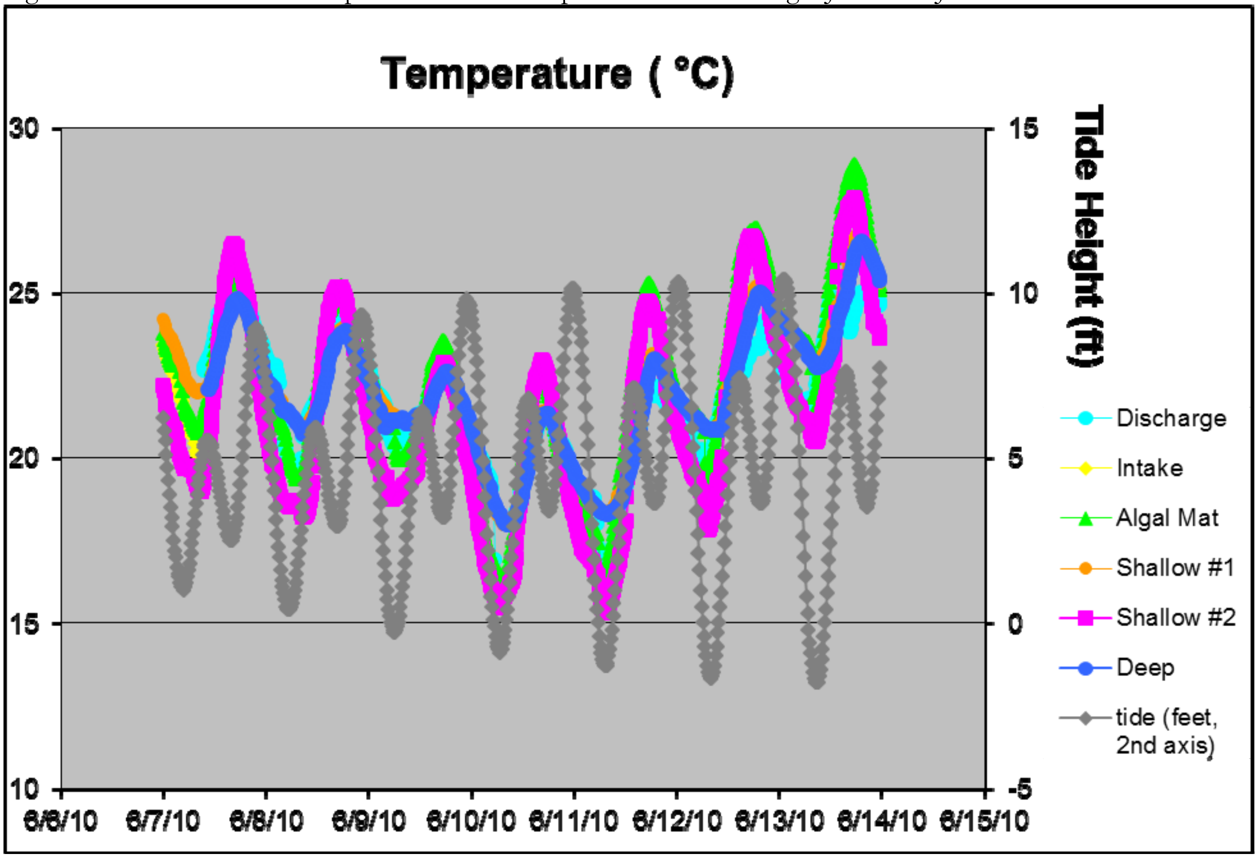


Figure 3.2.4-3: Pond A3W temperature values at 6 pond locations during 14 June – 20 June

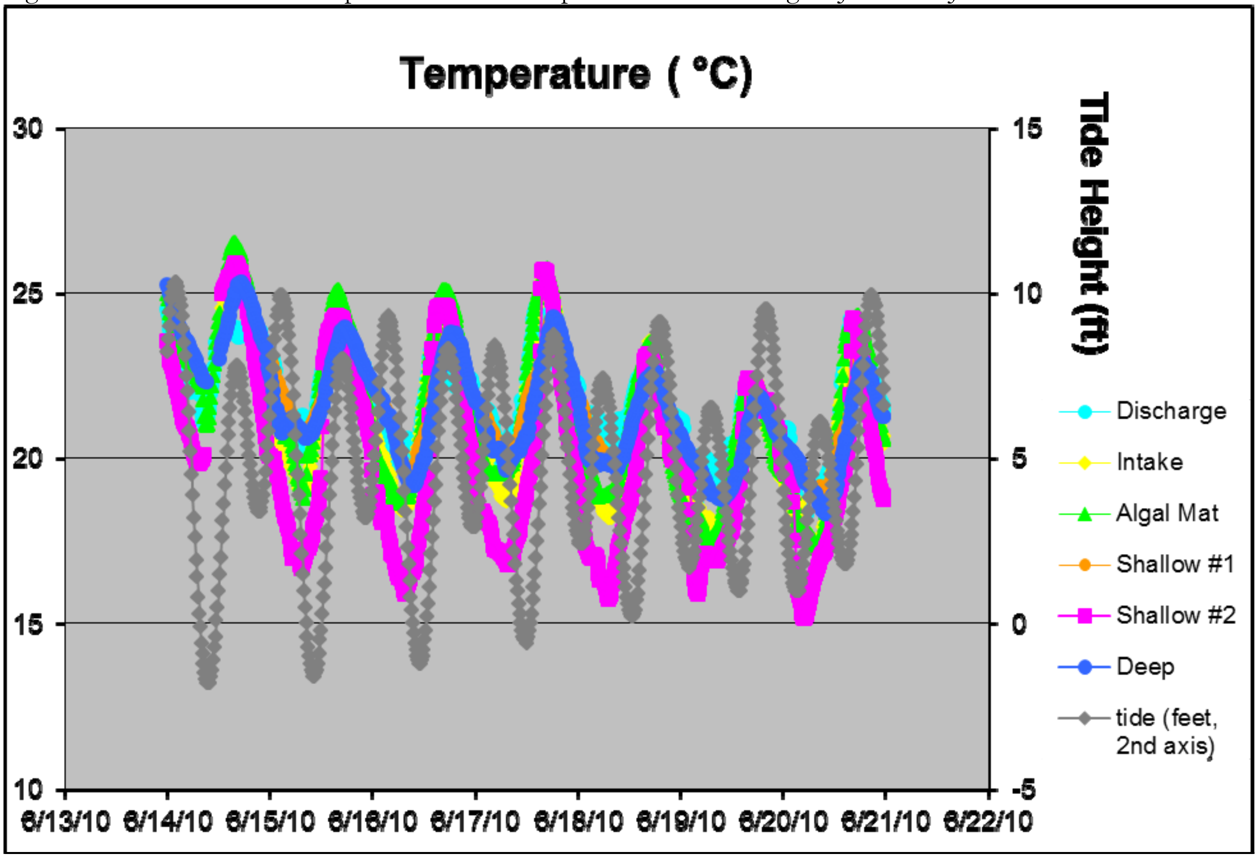


Figure 3.2.4-4: Pond A3W temperature values at 6 pond locations during 21 June – 27 June

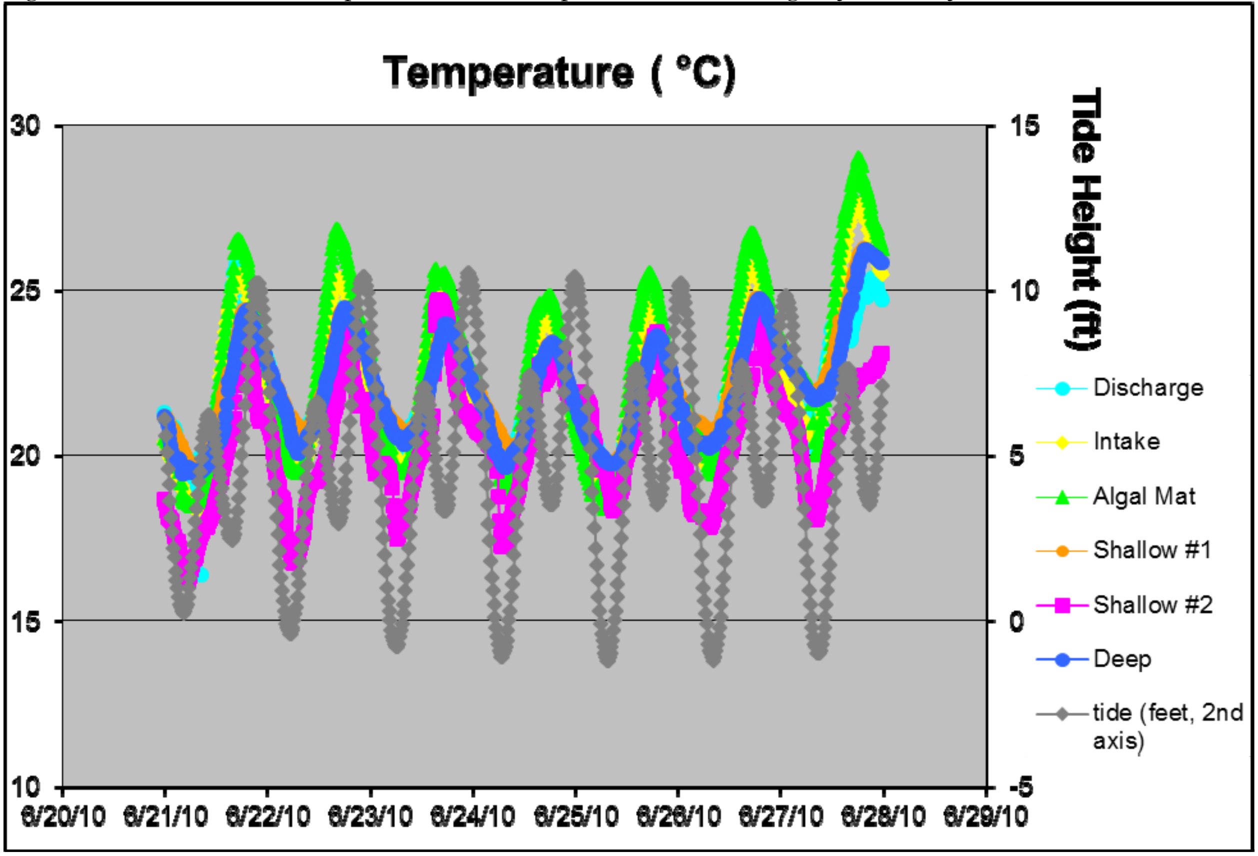


Figure 3.2.4-5: Pond A3W temperature values at 6 pond locations during 28 June – 4 July

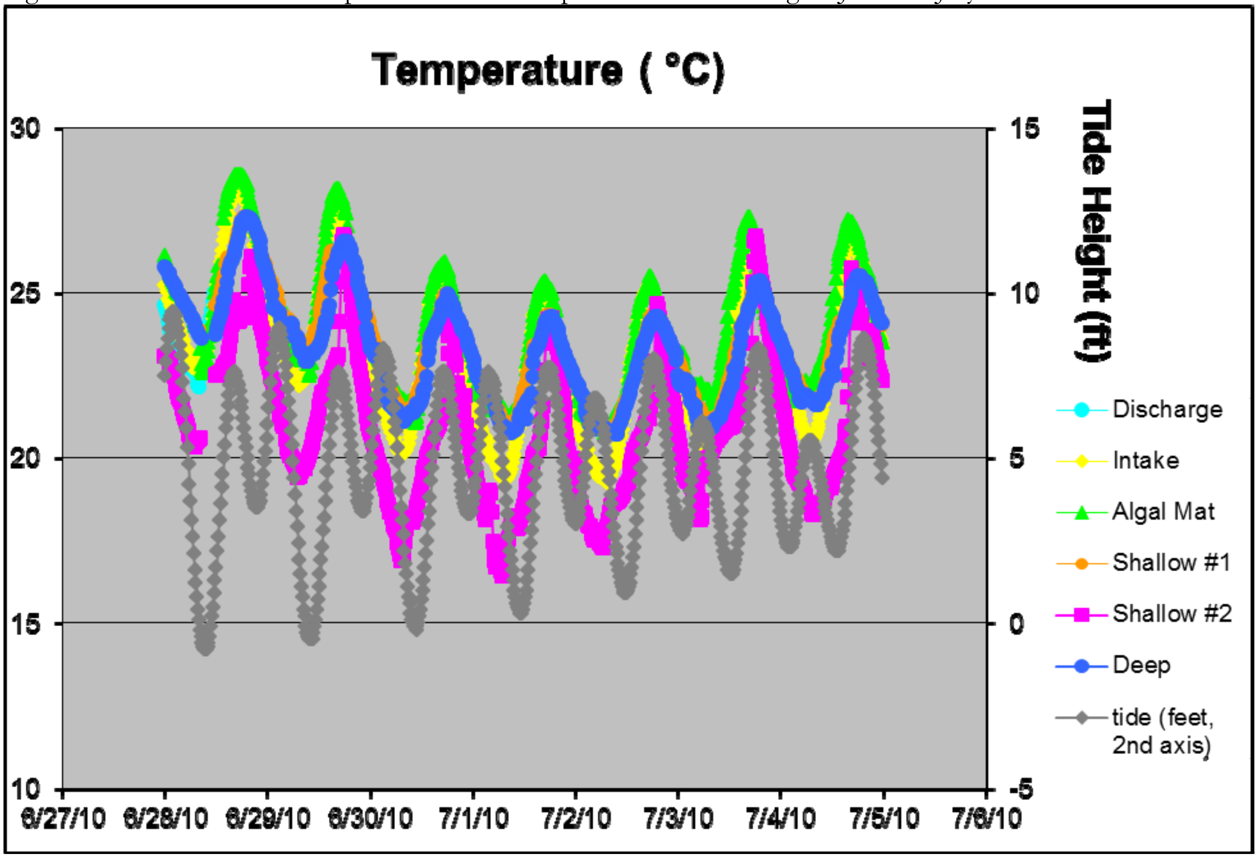


Figure 3.2.4-6: Pond A3W temperature values at 6 pond locations during 5 July – 11 July

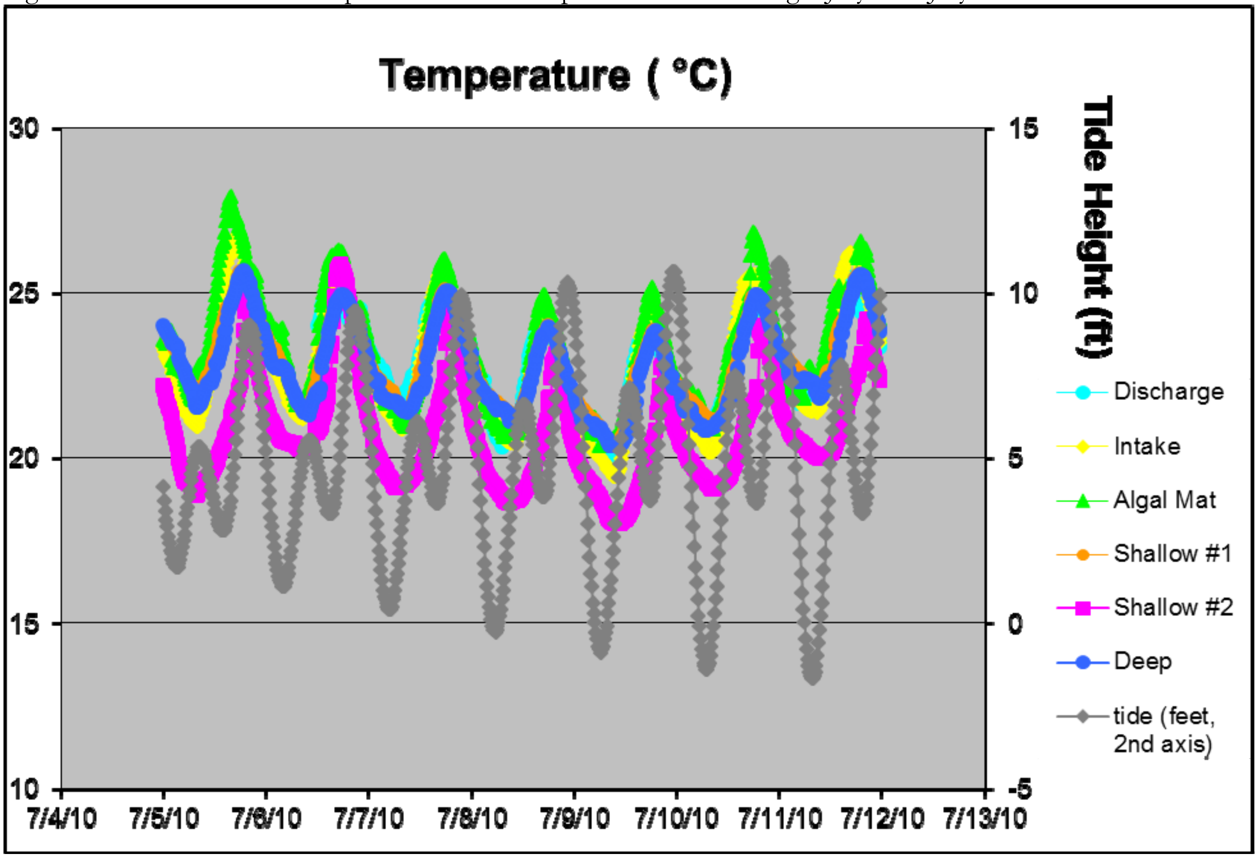


Figure 3.2.4-7: Pond A3W temperature values at 6 pond locations during 12 July – 18 July

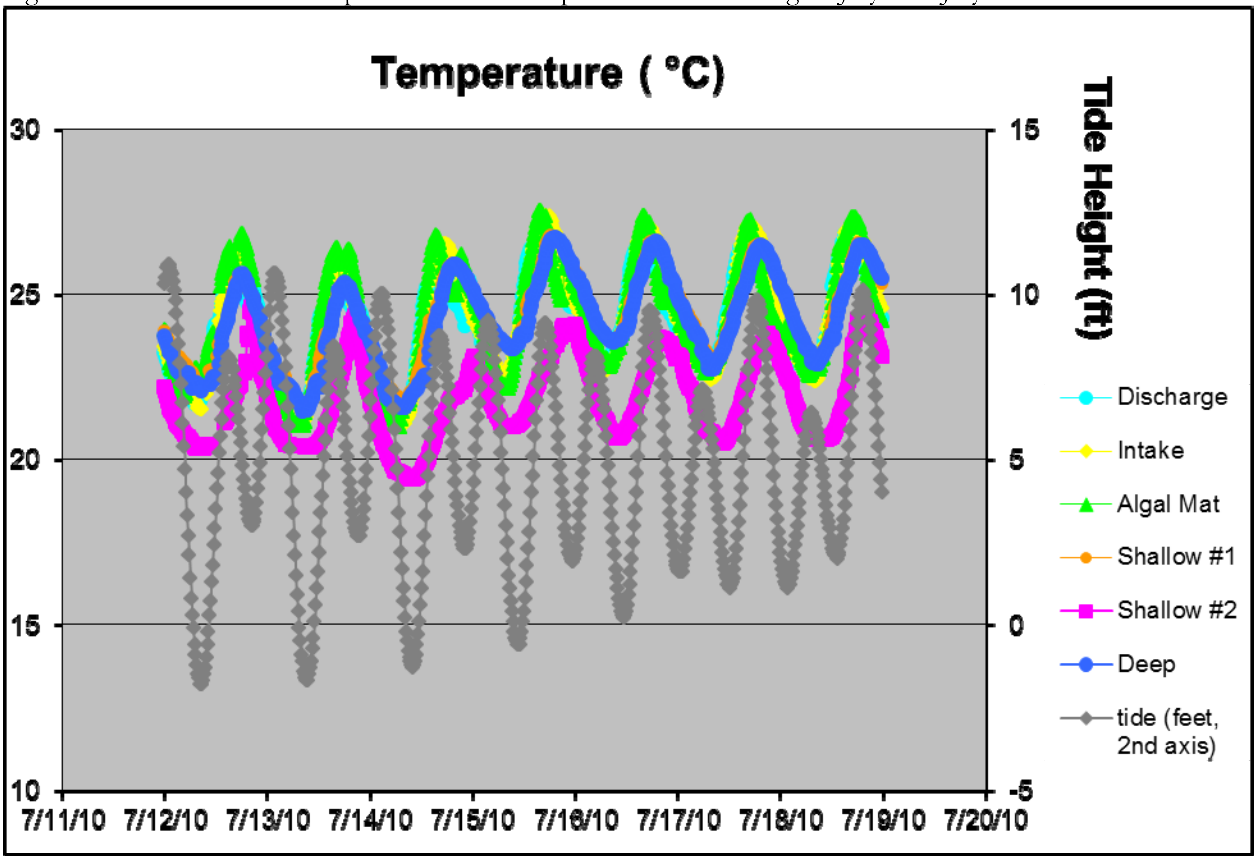


Figure 3.2.4-8: Pond A3W temperature values at 6 pond locations during 19 July – 25 July

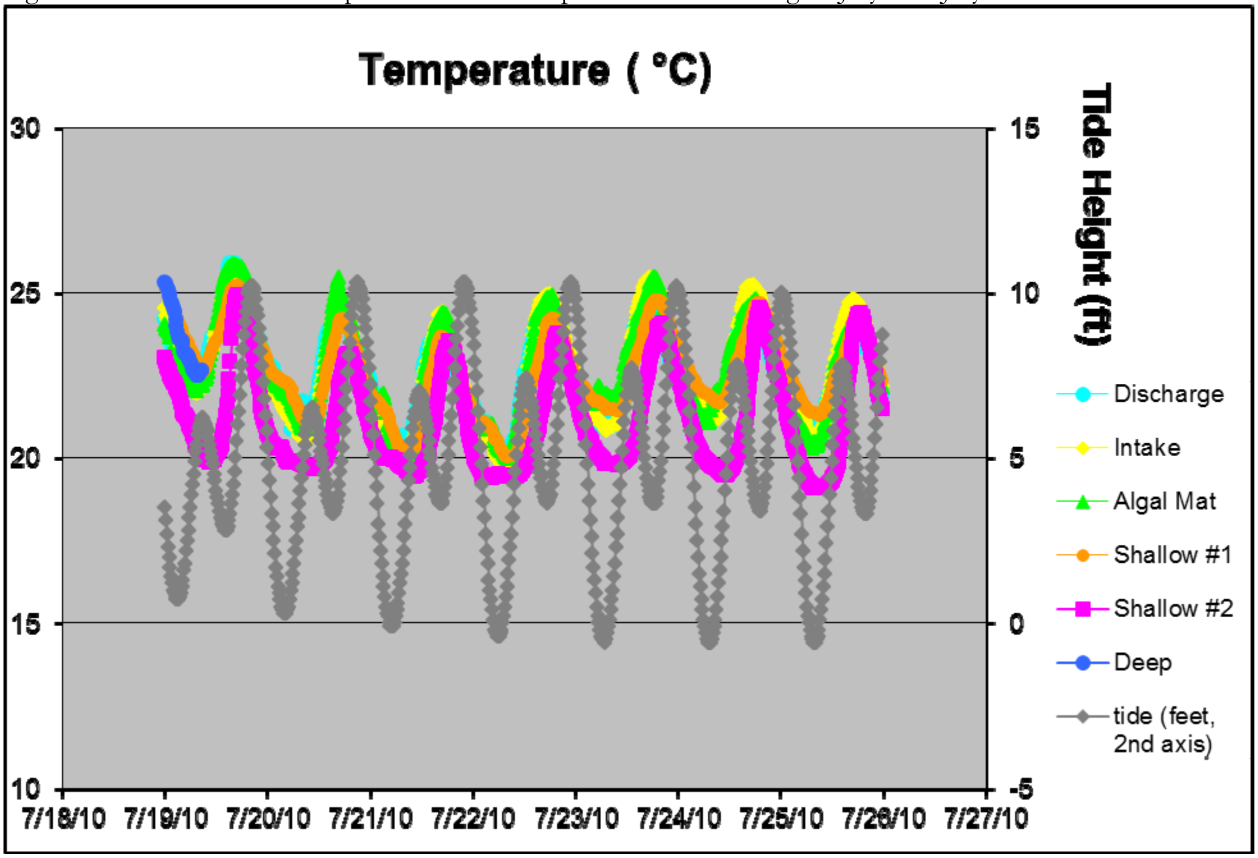


Figure 3.2.4-9: Pond A3W temperature values at 6 pond locations during 26 July – 1 August

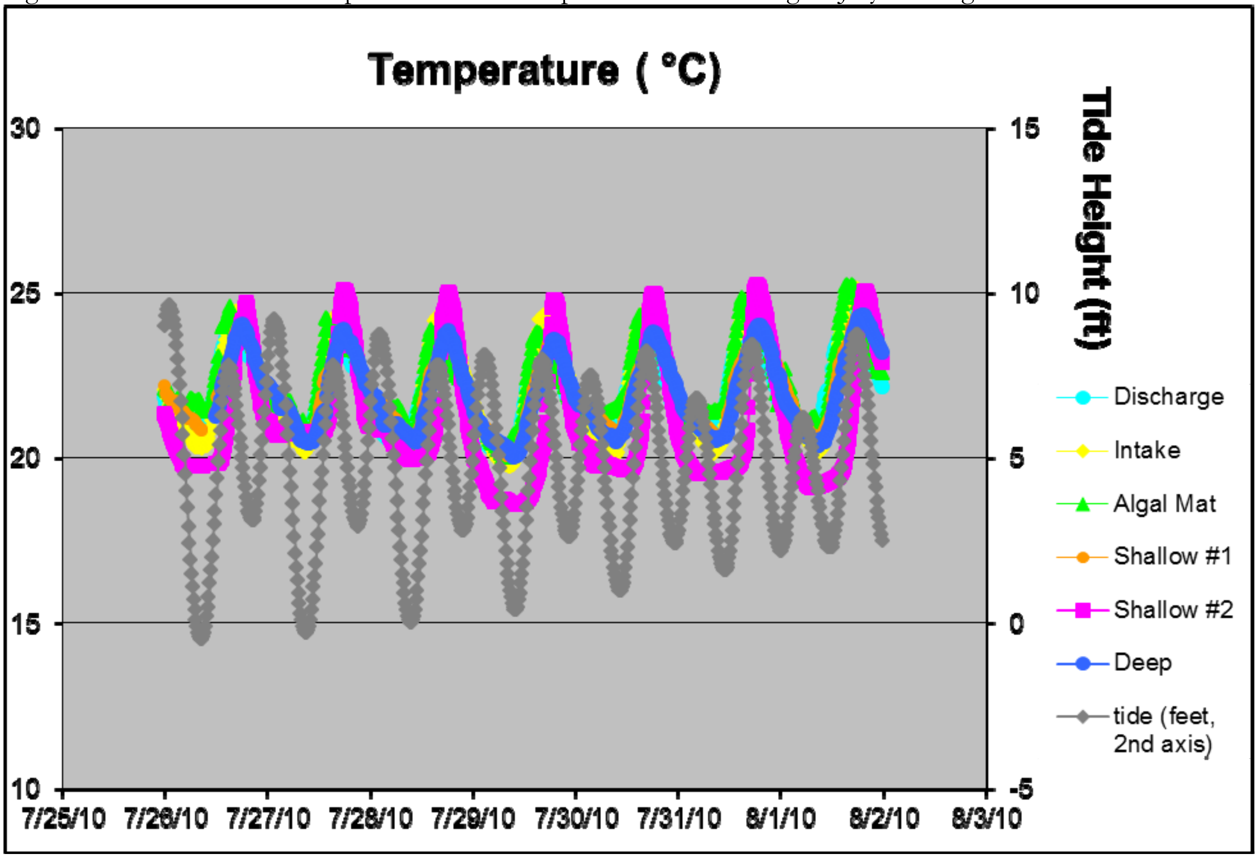


Figure 3.2.4-10: Pond A3W temperature values at 6 pond locations during 2 August – 8 August

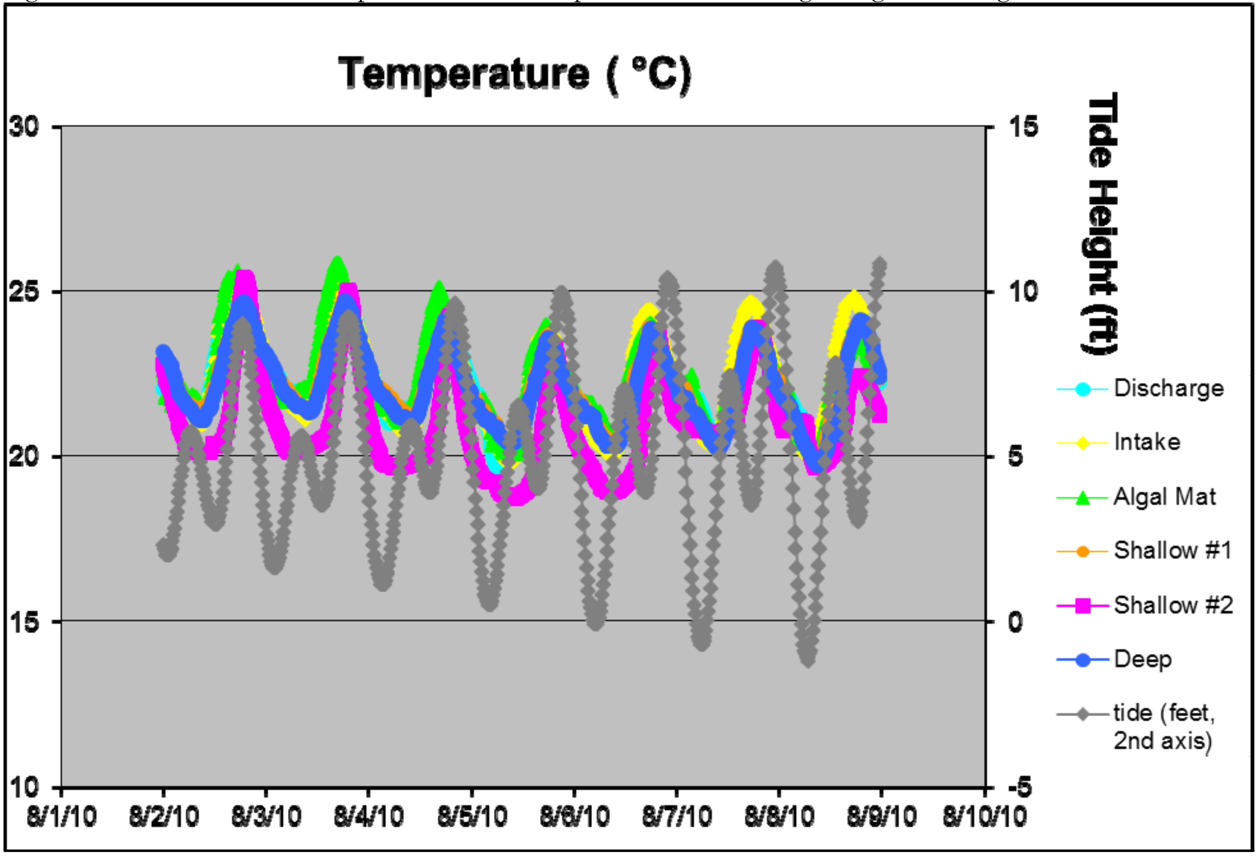


Figure 3.2.4-11: Pond A3W temperature values at 6 pond locations during 9 August – 15 August

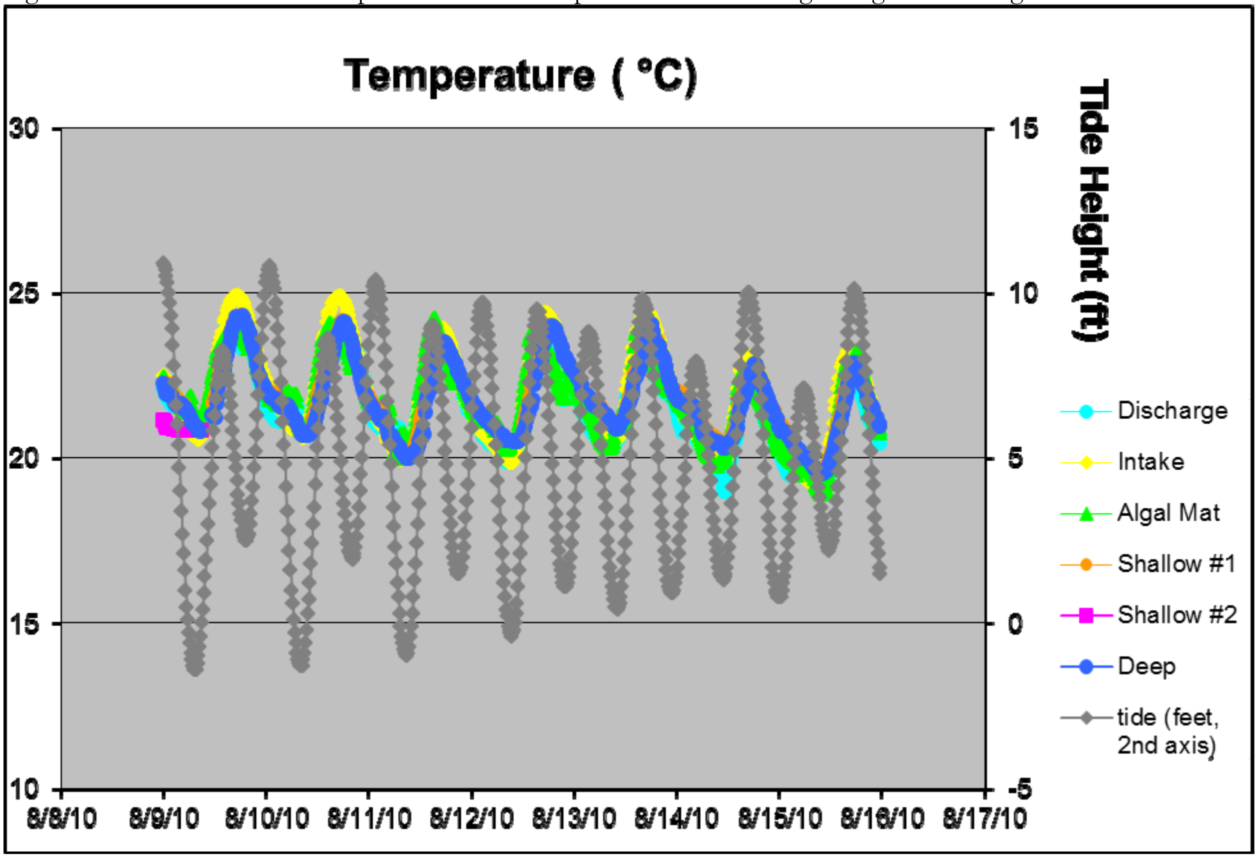


Figure 3.2.4-12: Pond A3W temperature values at 6 pond locations during 16 August – 22 August

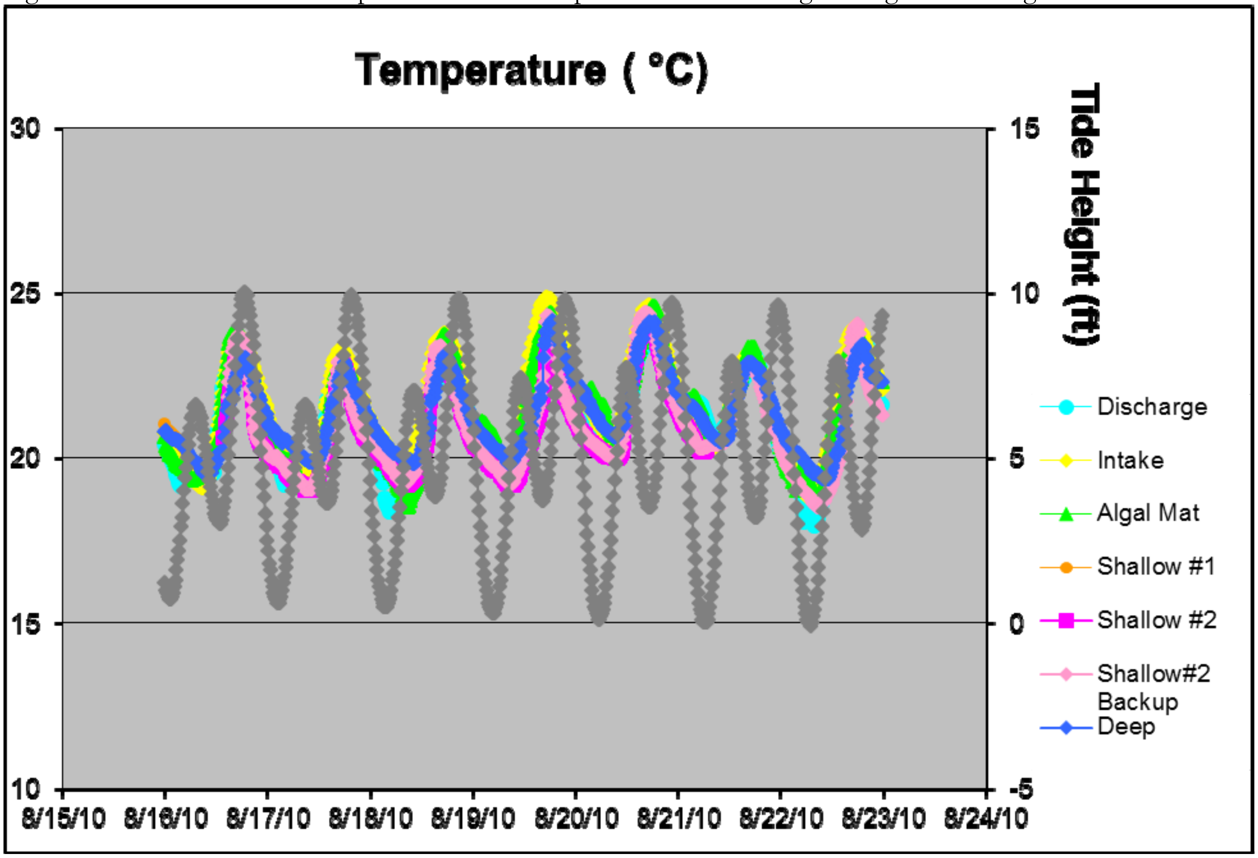


Figure 3.2.4-13: Pond A3W temperature values at 6 pond locations during 23 August – 29 August

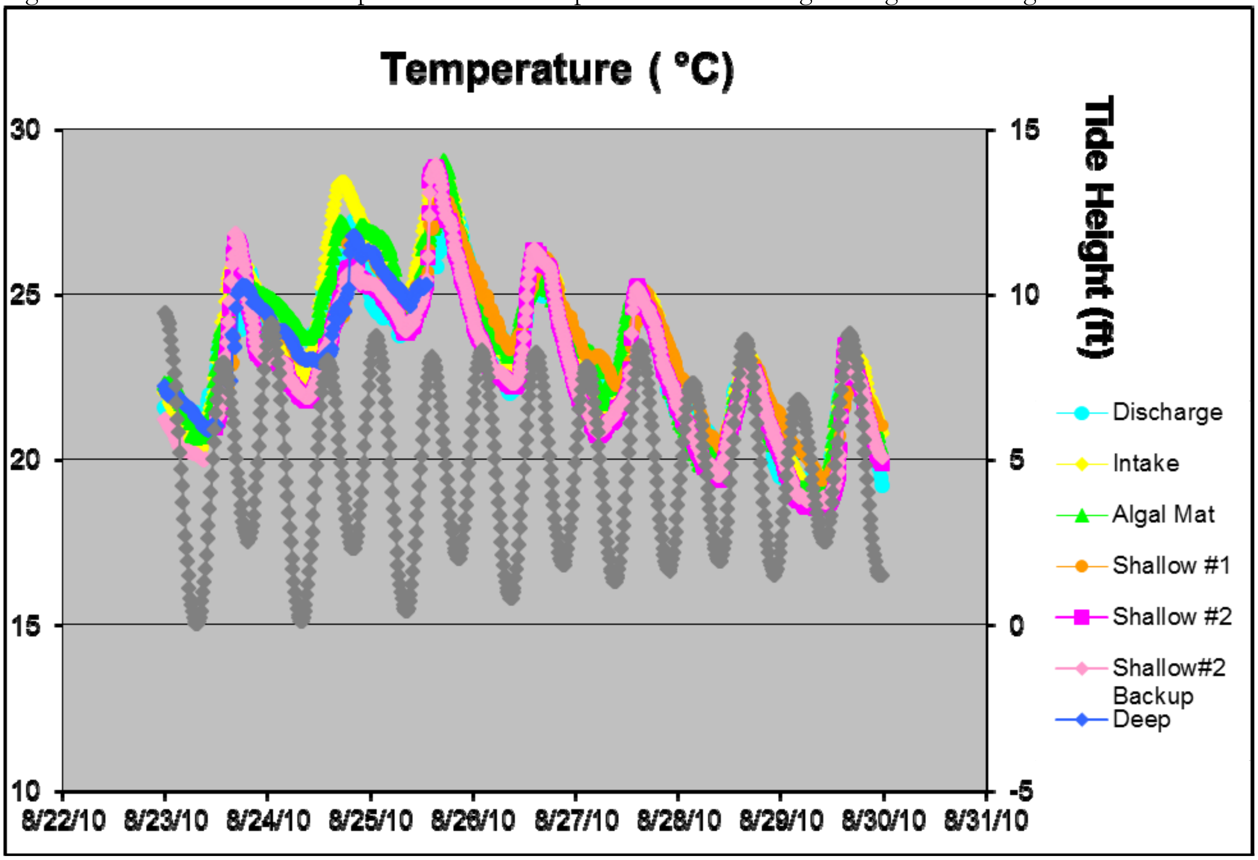


Figure 3.2.4-14: Pond A3W temperature values at 6 pond locations during 30 August –5 September

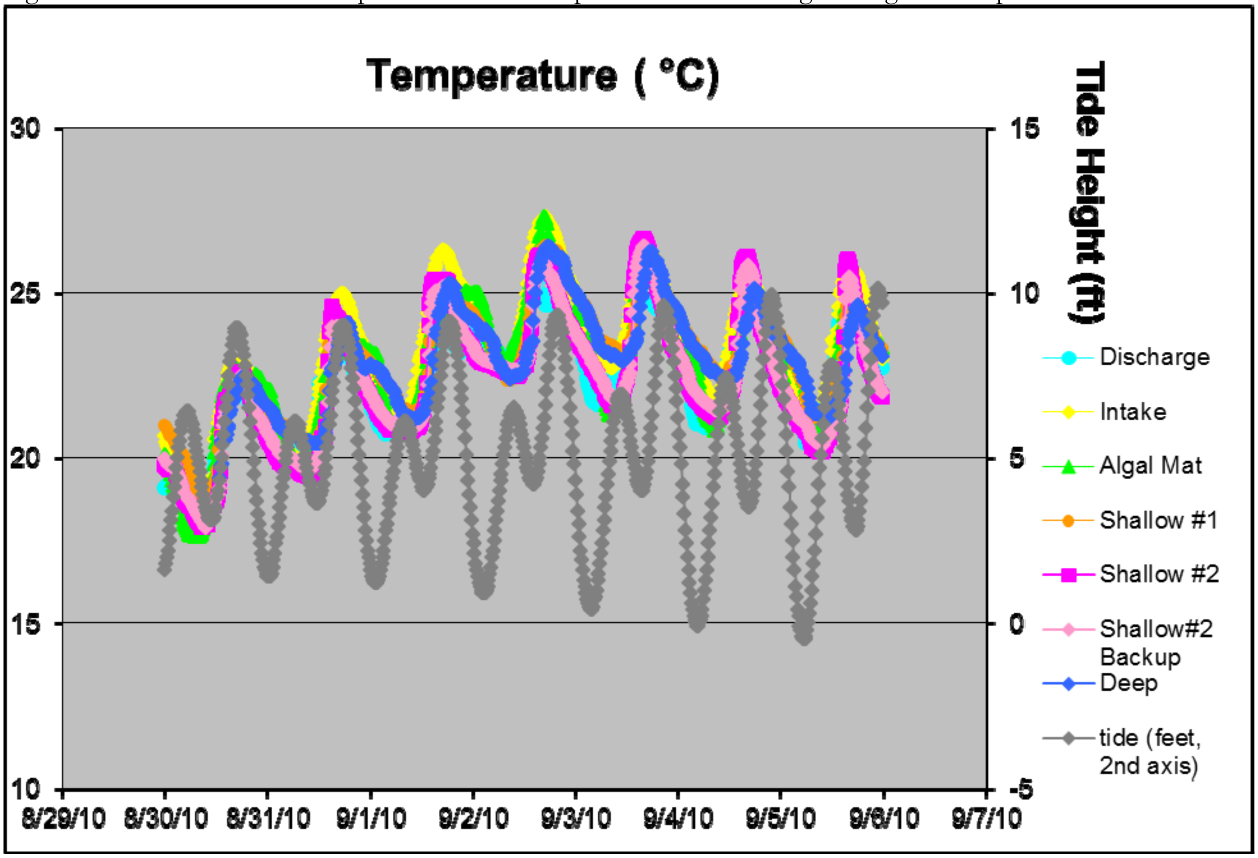


Figure 3.2.4-15: Pond A3W temperature values at 6 pond locations during 6 September – 12 September

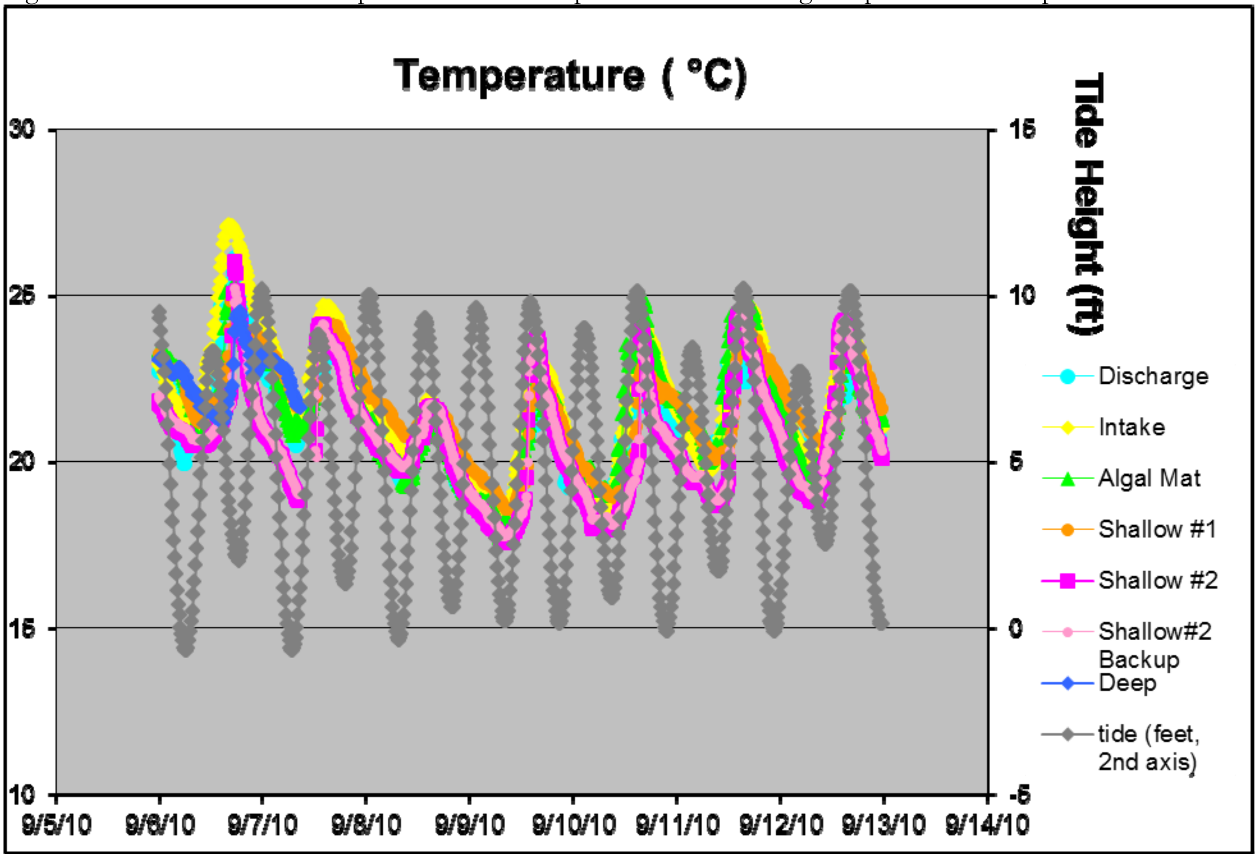


Figure 3.2.4-16: Pond A3W temperature values at 6 pond locations during 13 September – 19 September

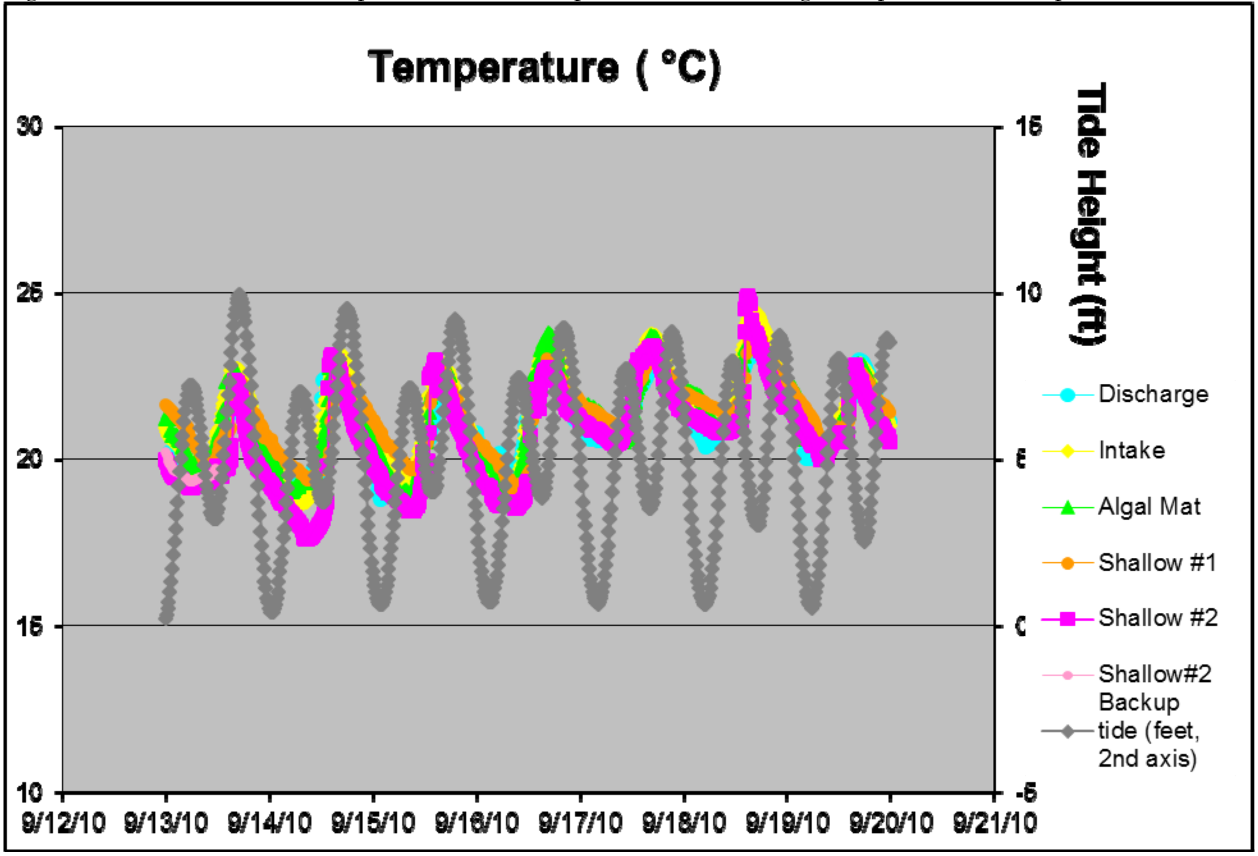


Figure 3.2.4-17: Pond A3W temperature values at 6 pond locations during 20 September – 26 September

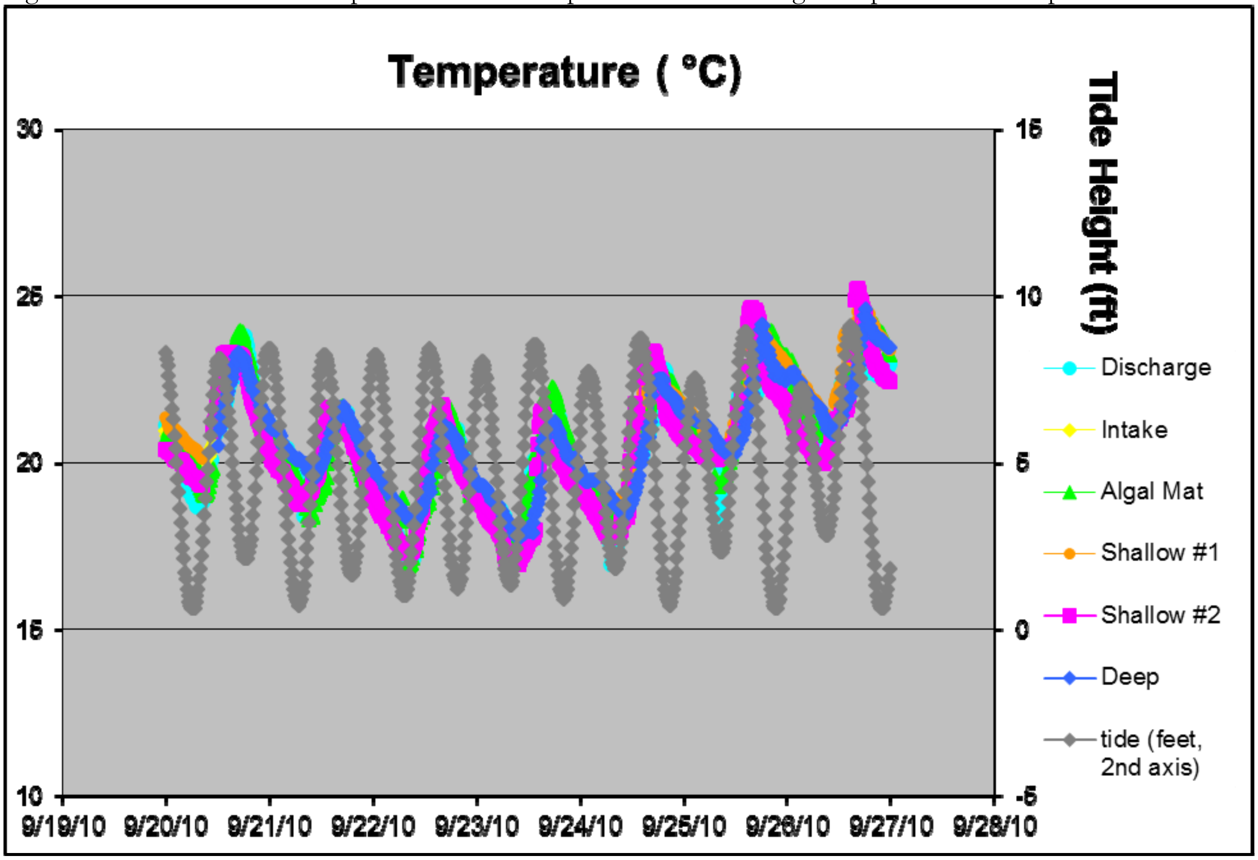


Figure 3.2.4-18: Pond A3W temperature values at 6 pond locations during 27 September – 3 October

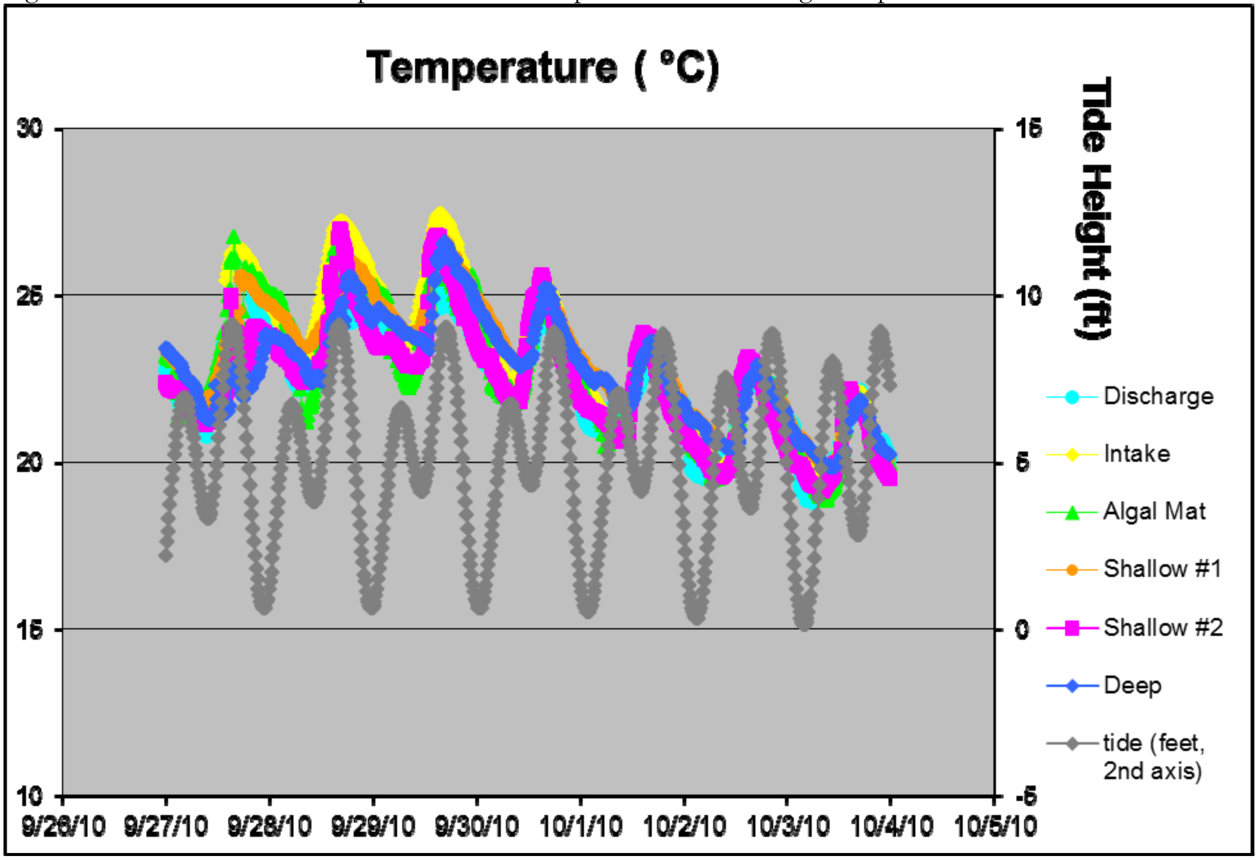


Figure 3.2.4-19: Pond A3W temperature values at 6 pond locations during 4 October – 10 October

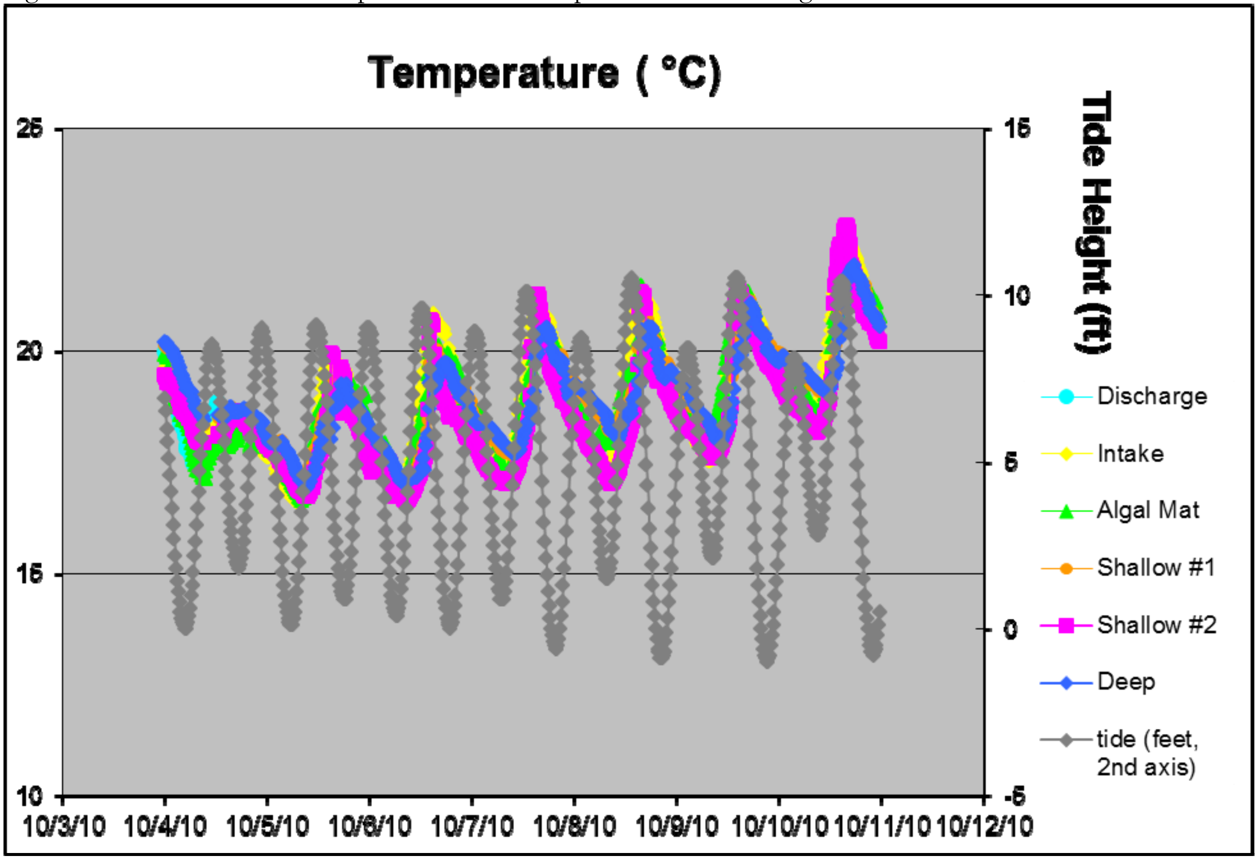


Figure 3.2.4-20: Pond A3W temperature values at 6 pond locations during 11 October – 17 October

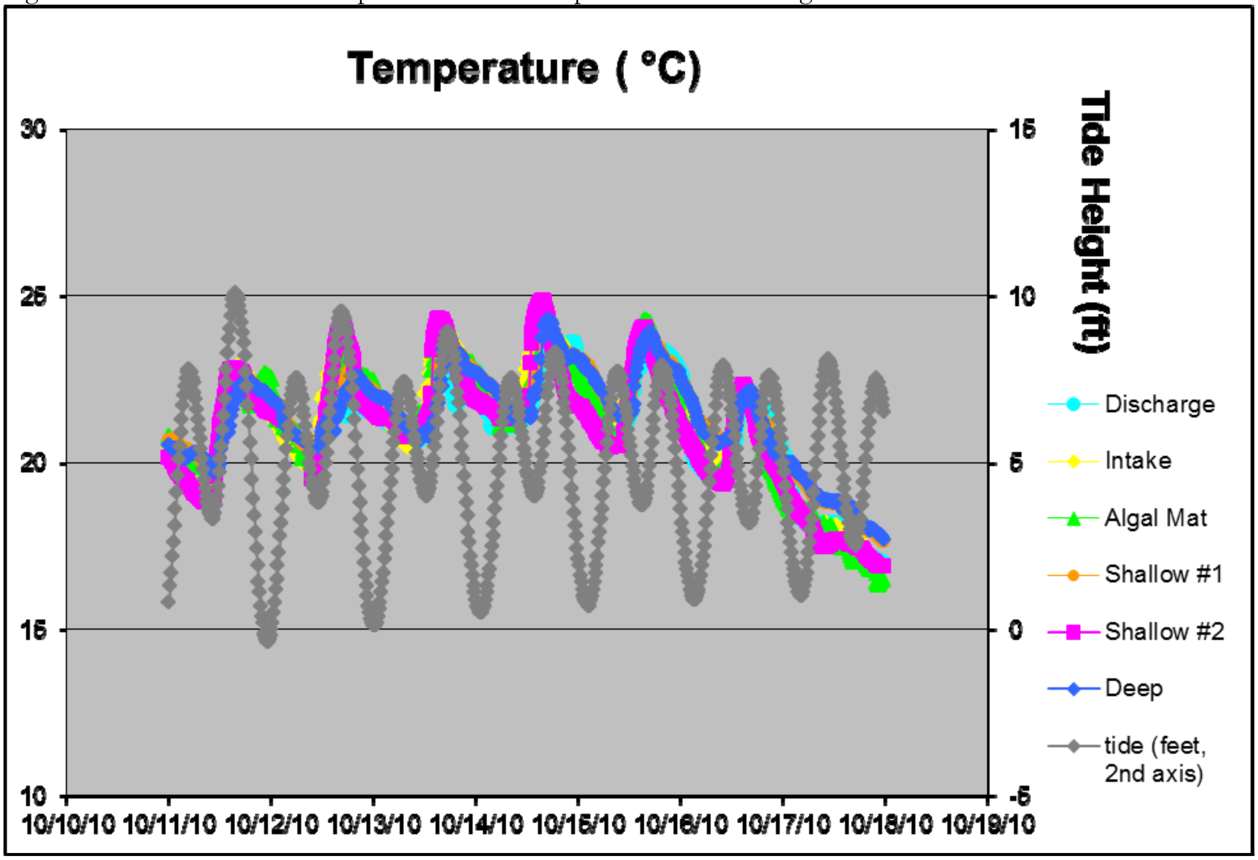


Figure 3.2.4-21: Pond A3W temperature values at 6 pond locations during 18 October – 24 October

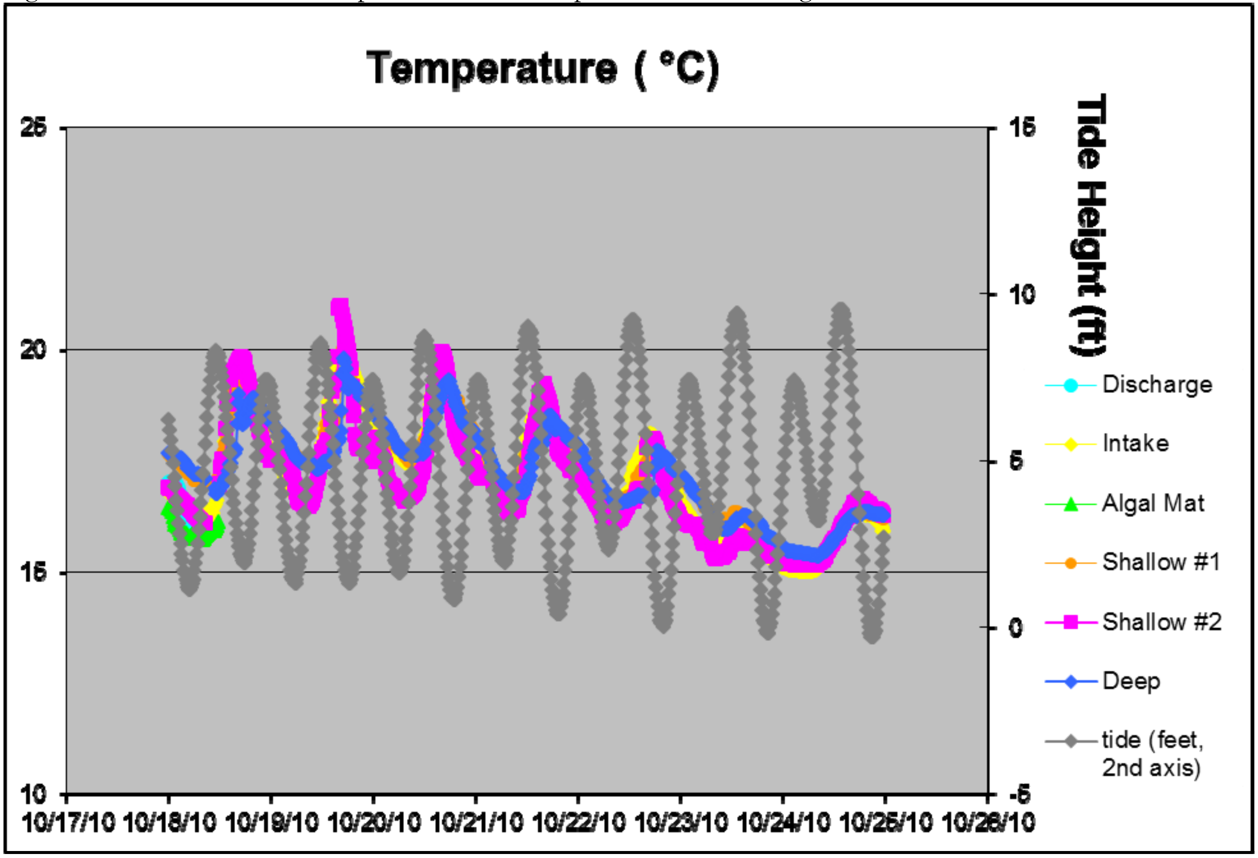
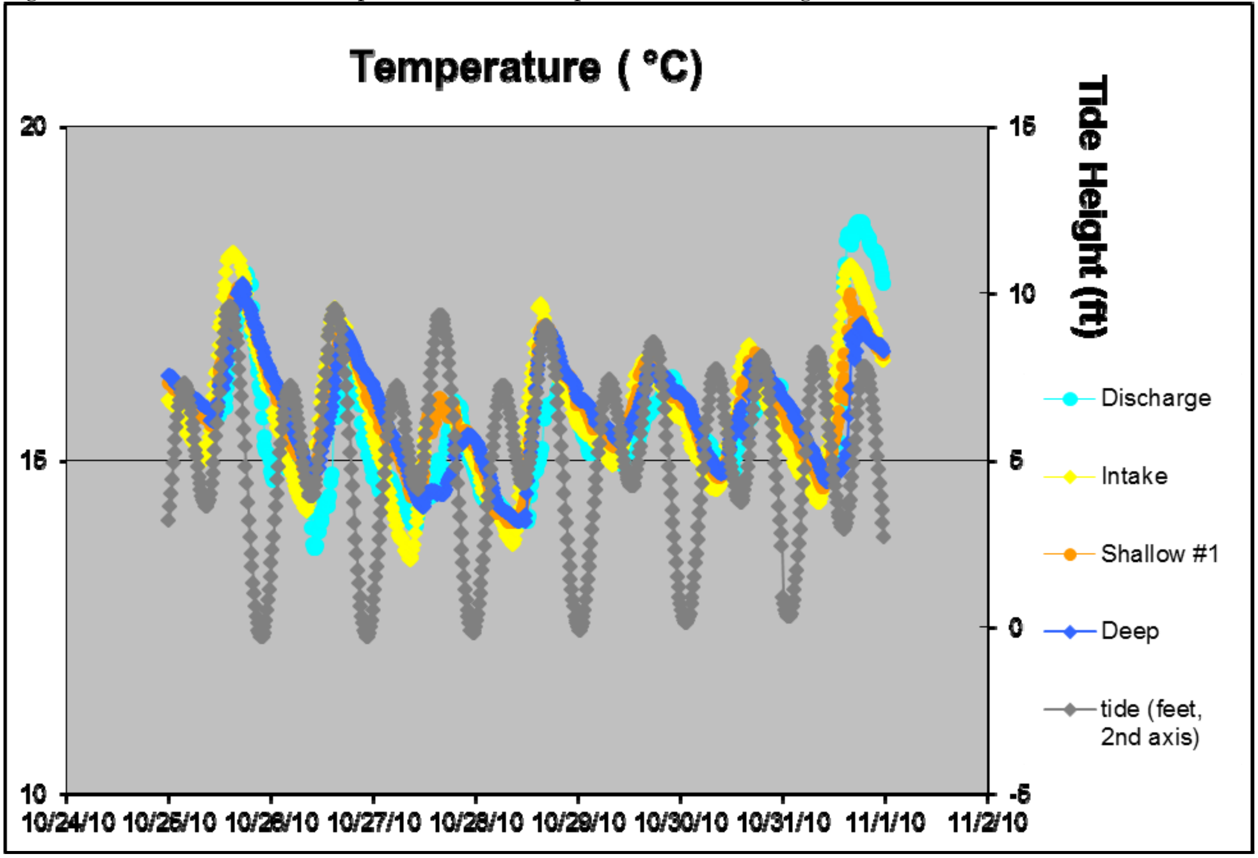


Figure 3.2.4-22: Pond A3W temperature values at 6 pond locations during 25 October – 31 October



3.2.5 Meteorological Measurements

Meteorological data were relatively consistent during the study period (Table 3.2.5-1). Winds were primarily from the south or the south-southwest and averages ranged from 3.5 to 7 miles per hour (mph) with gusts as high as 32 mph (Table 3.2.5-1). Relative humidity remained fairly consistent throughout the study period, from 73.65 – 78.70 percent, with no occurrence of precipitation events during the 5-month study. Monthly mean temperatures were also pretty consistent and ranged from 16.53 °C to 18.94 °C. Photosynthetically active radiation and solar radiation were variable during the study period, but varied largely due to diurnal cycles (Table 3.2.5-1).

Table 3.2.5-1: 2010 Summarized weather values (mean ± standard deviation) for all ponds by month.

Month	Temp (°C)	Relative Humidity (%)	Rainfall (cm)	Primary Wind Direction	Wind Speed (mph)	PAR Light (uM/m^2s)	Solar Radiation (wat/m2)
June	17.64 ± 3.61	74.40 ± 13.80	0.00 ± 0.0	Northeast	7.03 ± 5.70	1192.10 ± 778.70 Max: 2649	496.90 ± 336.11 Max: 1128
July	17.50 ± 3.00	78.70 ± 11.20	0.00 ± 0.0	South - Southwest	5.90 ± 5.00	1150.20 ± 782.80 Max: 2241	478.90 ± 340.80 Max: 965
August	17.40 ± 3.80	78.60 ± 13.82	0.00 ± 0.0	South	5.24 ± 5.00	1075.93 ± 739.00 Max: 2145	451.10 ± 328.90 Max: 945
September	18.94 ± 4.00	73.65 ± 15.40	0.00 ± 0.0	South - Southwest	4.20 ± 4.54	975.70 ± 634.90 Max: 2126	412.0 ± 286.10 Max: 913
October	16.53 ± 3.50	75.32 ± 16.72	0.00 ± 0.0	South	3.50 ± 3.90	693.30 ± 524.30 Max: 1706	294.70 ± 232.50 Max: 750

SECTION 4
APPLIED STUDIES FOR POND A3W

The initial intent of the ISP was to prevent the buildup of salts and resulting ecological problems by promoting circulation of bay waters into the pond during an interim management period. Since first being opened to circulation in 2004-2005, salinity reduction has been successful. However, monitored discharge ponds have experienced substantial periods of low DO, which is likely a continuation of a long-term condition. The initial management response to this low DO issue was to increase the DO concentration of the incoming flow using baffles and solar aerators. In 2007, USGS investigated the effects of low DO incoming water on receiving waters (Shellenbarger et al. 2008). The results of this study suggested that the pond water was alternately a source and sink for slough oxygen concentrations.

Because the focus has recently shifted to long-term DO management concerns, the Water Board expressed concern, in a 2008 letter to the Service, that low DO conditions in ponds may make them ecologically unsustainable for the long term. Because several ponds are proposed to be retained as managed ponds for bird habitat, it is important to understand the pond characteristics that create low DO conditions in order to better manage them.

In general, ponds and other low exchange water bodies can exhibit low DO concentrations due to a combination of biological oxygen demand (BOD, within the water-column) and sediment oxygen demand (SOD). During the summer of 2008, a directed study on oxygen dynamics was conducted by USGS in Alviso Ponds A3W, A14, and A16. The study focused on spatial heterogeneity within selected salt ponds and examined several parameters including flow, benthic flux of dissolved oxygen in sediments, nutrient and chlorophyll concentrations, and weather conditions. Both BOD and SOD appeared to be significant sinks for DO. We felt that modifications and extensions to the study could lead to a better understanding of DO behavior in the ponds, and the implications for the ability of management actions to control DO concentrations. Because Pond A3W is proposed to be retained as a managed pond, it is important to understand the pond characteristics that create low DO.

Therefore, the Service and USGS proposed to focus studies on Pond A3W during the 2010 season to help us understand what is driving changes in the ponds throughout the season. Based on previous year's DO transects, it appears that DO is variable both spatially and temporally within the ponds. Therefore, DO transects were eliminated and locations for datasondes and other parameters were established using information learned from the previous year's DO transects, with the goal to design a better A3W directed study.

During the summer of 2010, a directed study on oxygen dynamics was conducted by USGS in Pond A3W. This study builds on the results of a previous study conducted by USGS in 2008 in Ponds A3W, A14, and A16. The details of the sampling can be found in Appendix B (Shellenbarger 2011) and Appendix C (Topping *et al.* 2011). Appendix B presents a preliminary analysis of different sources and sinks of dissolved oxygen. Appendix C reinforces the findings of the 2008 report that sediment oxygen demand, largely from bacterial respiration, is a significant and likely persistent sink for DO in the system. Additionally, previous nutrient monitoring (N, P) was discontinued, and USGS conducted nutrient studies on ammonium, nitrate, DIN, and trace metals, as proposed by Brent Topping and James Kuwabara. Low DO in the system can affect the redox (reduction-oxidation) conditions at the sediment water interface. This can potentially affect the flux of nutrients from the sediment, which in turn can affect the primary productivity within the pond.(Appendix C).

SECTION 5
FUTURE ACTIONS

5.1 CORRECTIVE ACTIONS

Maintaining adequate DO levels in the Alviso Ponds has been the major water quality challenge for the Service. A number of corrective actions have been identified in the pond operations plans and implemented in previous years to raise DO in the ponds, such as:

- Pond A2W - Increased the flows in the pond system by opening the inlet further. If increased flows were not possible, the Service fully opened the discharge gate to allow the pond to become a muted tidal system until pond DO levels revert to levels at or above conditions in the Bay or slough.

- Pond A3W - Set in a series of flow diversion baffles at the pond discharge for directing the water from more suitable DO water levels to achieve maximum oxygen uptake.

- Pond A7 - Installed solar aerators used to circulate waters

- Pond A14 - Closed discharge gates completely until DO levels met standards

- Pond A16 - Closed discharge gates completely for a period of time each month when low tides occured primarily at night when DO levels are typically at their lowest

- Discontinued nighttime discharges due to diurnal pattern. This was a daily operation of discharge gates, closing the discharge gates at night (when the DO is typically at the lowest) and then opening them in the morning when the DO levels have reverted to higher levels. However, this was not a feasible long term solution for resolving DO issues.

- Another method discussed was to mechanically harvest dead algae. Mechanically harvesting algae would be very difficult and expensive considering how large the ponds are. This might work on a very limited basis such as removing the dead algae from around the discharge structure, but it is difficult to find a place to dry and dispose of the harvested algae in our highly urban environment. The algae would smell and the local landfills do not want us to bring our salt laden dead algae into their green waste disposal systems

Some of these actions improved DO levels, and some did not. Based on the previous lessons learned, the Service has been operating the ponds as continuous flow-through systems to try and reduce the water resident time as much as possible.

Pond System A2W

The objectives for the Pond A2W system is to maintain full tidal circulation through ponds A1 and A2W while maintaining discharge salinities to the Bay at less than 40 ppt and meet the other water quality requirements in the Water Board's Waste Discharge Permit. Through trial and error, the gates will need to be adjusted to find equilibrium of water in-flow and discharge to account for evaporation during the summer. The back portions of the Ponds A1 and Pond A2W will need to be monitored closely when warmer weather patterns occur. The 2011 Operation Plan for Pond A2W is included in Appendix D.

Pond System A3W

The objectives for the Pond A3W system are to: 1) maintain full tidal circulation through ponds AB1, AB2, A2E, and A3W while maintaining discharge salinities to Guadalupe Slough at less than 40 ppt and meet the other water quality requirements in the Water Board's Waste Discharge Permit; 2) maintain pond A3N as a seasonal pond; and 3) maintain water surface levels lower in winter to reduce potential overtopping of A3W levee adjacent to Moffett Field. Water levels in Pond AB1 and Pond AB2 of Pond A3W system may be temporarily lowered during the summer to improve shorebird nesting and foraging habitat. The 2011 Operation Plan for Pond A3W is included in Appendix E.

Pond System A7/A8

The Phase 1 action at Pond A7/A8 is one of the initial actions for implementation under the Project. Pond A8 is identified as tidal habitat in the long-term programmatic restoration of the SBSP Restoration Project. The Pond A7/A8 system will be operated to maintain muted tidal circulation through ponds A5, A7, A8N and A8S while maintaining discharge salinities to the Bay at less than 40 ppt and meet the other water quality requirements in the Water Board's Waste Discharge Permit. The 2011 Operation Plan for Pond A8 is included in Appendix F.

Pond System A14

The objectives of the Pond A14 systems are to: 1) maintain full tidal circulation through ponds A9, A10, A11 and A14, while maintaining discharge salinities to Coyote Creek at less than 40 parts per thousand (ppt) and meet the other water quality requirements in the Water Board's Waste Discharge Permit; 2) maintain pond A12, A13 and A15 as batch ponds. Operate batch ponds at a higher salinity (80 – 120 ppt) during summer to favor brine shrimp; 3) minimize entrainment of salmonids by limiting inflows during winter; and 4) maintain water surface levels lower in winter to reduce potential overtopping. During the winter, Pond A9 and Pond A14 intakes will not be open due to possible fish entrainment. The 2011 Operation Plan for Pond A14 is included in Appendix G.

Pond System A16

The objectives for the Pond A16 system are to: 1) maintain full tidal circulation through ponds A17 and A16 while maintaining discharge salinities to the Artesian Slough lower than 40 ppt and meet the other water quality requirements in the Water Board's Waste Discharge Permit; and 2) minimize entrainment of salmonids by closing the A17 intake during winter, or reversing of intake and outlet flow during winter. The 2011 Operation Plan for Pond A16 is included in Appendix H.

5.2 PROPOSED 2011 MONITORING APPROACH

In April 2011, the Service, California State Coastal Conservancy (CSCC), and USGS will meet to discuss what monitoring and applied studies would be proposed to the Water Board for the 2011 season. Initial topics to be discussed will include:

1. Will monitoring need to occur for the next 50 years of the Project to comply with the Water Board Order, or would focused experiments and studies be more beneficial to the Project to make management decisions? Could focused experiments and studies satisfy Water Board requirements?

2. When the Water Quality Self-Monitoring Program was written, the DO limits were established by the Water Board based on east coast and Artesian Slough DO information. The Water Board indicated that they specifically wrote that those limits could be changed if scientific evidence suggested different values. Sampling by USGS a few years ago showed low DO occurred in sloughs not in the restoration program. Is it possible to change the regulatory limits based on scientific data for the South Bay showing the restoration doesn't increase impairment of South Bay waters?

Once the Service has a recommended approach for 2011 monitoring, we will schedule a meeting between the Service, CSCC, USGS, and the Water Board to identify monitoring and studies that will move science in direction of better understanding the ecological implications of water quality issues in managed ponds.

SECTION 6
SOUTH BAY SALT POND RESTORATION PROJECT - PHASE 1 ACTIVITIES AND PHASE 2 PLANNING

6.1 PHASE 1 ACTIVITIES

The largest wetlands restoration project on the West Coast of the U.S., the Project encompasses about 15,100 acres of former salt ponds located around the edge of South San Francisco Bay bordering Silicon Valley. Its mission is to restore and enhance wetlands in South San Francisco Bay as habitat for federally endangered species and migratory birds while providing for flood management and wildlife-oriented public access and recreation.

Project Partners include the California State Coastal Conservancy, California Department of Fish and Game, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, NOAA's National Marine Fisheries Service, U.S. Geological Survey, Santa Clara Valley Water District, Alameda County Flood Control and Water Conservation District, Hewlett, Packard, and Moore Foundations and the Goldman Fund.

Restoration of the South Bay Salt Ponds is expected to occur over decades. The first step, of developing the Project long-term restoration plan, was completed and permitted in 2008-2009. The Project is now in its first phases of restoration and public access construction.

6.1.1 PHASE 1 CONSTRUCTION

<u>Alviso Pond A8 to be Opened this Year</u>

Crews have finished preparing 1,400 acres of ponds near Alviso for the influx of Bay waters to create shallow tidal habitat. Water will be introduced this spring to Ponds A8, A7 and A5. Construction, managed by the Santa Clara Valley Water District, included installation of a 40-foot levee notch, which will allow managers to control and limit the tidal flows in what is called a "muted tidal" system. The notch will also allow for the pond to be closed off, if sediment and flow dynamics between the ponds and sloughs threaten to cause methylmercury problems. Mercury in area sediments is a legacy of the Gold Rush-era New Almaden mine upstream from the site. Scientists will be monitoring mercury levels in water, sediments and key species once the ponds are opened. We expect to open the specially-constructed tide gates at an event in June 2011. Project managers have allowed enough water into the system to cover the dry bottom of the pond in order to prevent Burrowing owls from nesting there. Ultimately the pond will provide shallow water habitat for pelicans, cormorants and ducks. The Operation Plan for Pond A8 is included in Appendix I.

Alviso Pond A6 Breached in December 2010

Levees were breached to restore tidal marsh at the 330-acre Pond A6 in Alviso, a duck's head-shaped area located far from populated areas in the Bay between Guadalupe and Alviso sloughs. Excavators began breaching the levee that surrounds the dry pond in the morning and water from the upcoming tide poured in across the surface of the pond bottom. Pond A6, also known as the Knapp Tract, sits far away from the Bay shoreline, making views of this dramatic levee breach visible only from the air. Fortunately photographer Judy Irving of Pelican Media braved the levees with a few other staff and snapped the photo you see here. Although Pond A6 has subsided over the years, sedimentation studies in the area indicate that new marsh could be established at this site within 5 to 10 years. The restoration will immediately provide habitat for fish and birds, and ultimately for marsh dependent species such as the endangered Salt marsh harvest mouse.

Ravenswood Pond SF2

In September 2010, U.S. Senator Dianne Feinstein and a crowd of supporters helped celebrate the completion of a carefully managed 240-acre complex of shallow pond, nesting islands and dry land designed to draw and support families of shorebirds and threatened Western snowy plovers. Just south of the Dumbarton Bridge, the Ravenswood Pond SF2 includes 30 islands for nesting birds, protected by a carefully designed shallow water system, as well as 85 acres of dry flats, which are prime nesting habitat for snowy plovers. Project managers plan to replicate the nesting island system at other ponds, with the aim of hosting dense populations of shorebirds.

So far, water levels in the pond seem to be operating as designed, with shallow foraging habitat throughout cells 1 & 2. Many species of birds are now using Pond SF2 for foraging and roosting, but is too early to tell if target birds will nest on the 30 islands this year. During summer operations, four of the five intake water control structures are fully open to provide maximum water flow input, but in order to reduce algae blooms, the fifth intake may be open to further reduce residence time. Winter operations is from February 1 through May 31, and is operated as the same as summer and also having 1 intake and 1 discharge culvert open for muted tidal to prevent migrating salmon entrainment.

The Operation Plan for Pond SF2 is being developed by the Service and will be submitted to the Water Board once we determine the best way to manage water control structures.

Rethinking the A16/A17 Restoration Design

The final Phase 1 project in the Alviso Complex is the reconfigured pond at A16. This action was delayed due to engineering constraints related to the ecological sustainability of maintaining A16/17 as a managed pond system. The Project Management Team is in the process of refining the revised restoration concepts. The new design will likely include a reduction in the number nesting islands, and the addition of tidal wetland restoration along Coyote Creek in Pond A17. This new tidal restoration component will also mean that changes will be occurring to the trail alignment, both temporarily during construction, as well as over the long-term. When the project is complete, an improved but shorter loop trail will remain with a spur trail out to the edge of Coyote Creek. A new overlook structure and interpretive features will be added to the trail however to make it more accessible and useful for visitors. The project partners are in the process of setting up meetings with the community to discuss these potential changes.

6.1.2 PUBLIC ACCESS

In 2010 Project Partners opened a key 2.2-mile segment of the Bay Trail, between the cities of Mountain View and Sunnyvale and adjacent to NASA's Moffett Field. Walkers and cyclists can now travel from Mountain View all the way to Sunnyvale directly along the edge of the Bay. Opening the segment required a transfer of land from Cargill to NASA, involving multiple levels of review and approval in Washington DC. The trail includes a rest stop with benches, interpretive signs and a pair of mounted binoculars for bird watching.

A 0.7-mile length of bayside trail and two viewing platforms opened near the Dumbarton Bridge at Ravenswood Pond SF2. One of the platforms includes a set of ADA-accessible binoculars for bird viewing.

Interpretive signs have risen at a scenic viewpoint on the hillside at Menlo Park's Bedwell Bayfront Park, just north of the Dumbarton Bridge.

The Project restarted its volunteer docent program, conducting a spring training program and launching the docents into action in the fall. The goal of the docent program is to allow community members to develop and present their own programs on their favorite topics to the public. Offerings this season include bike rides, bird photography, the science of tides and the post-Gold Rush history of the San Francisco Bay.

6.1.3 FLOOD PROTECTION

Portions of the Restoration Project cannot be completed unless flood control levees are in place to protect low-lying parts of the South Bay shoreline. Since its inception he Project has been planned and implemented in close coordination with a related but separate effort, the Congressionally-authorized South San Francisco Bay Shoreline

Study. The Shoreline Study is a U.S. Army Corps of Engineers feasibility study to identify and recommend for federal funding flood risk management, ecosystem restoration, and other projects. The Project and the Santa Clara Valley Water District are local partners with the Corps. A major goal of this effort is to provide flood protection in Silicon Valley for, in Santa Clara County alone, roughly 42,800 acres, 7,400 homes and businesses.

In 2010 The Corps of Engineers completed a "Without Project" baseline for the Shoreline Study, which will quantify the flood risks, both now, and 50 years in the future, accounting for sea level rise. Preliminary mapping indicates that the areas with the highest damages from future flooding in the South Bay include: Matadero Creek to Barron Creek; Barron Creek to Adobe Creek; Stevens Creek to Sunnyvale West Creek; and Guadalupe Creek to Coyote Creek. As a result, the Army Corps of Engineers is considering a new, phased approach to completing the Study focusing on these four areas first.

6.2 SCIENCE PROGRAM

Adaptive management and ongoing scientific investigation is an integral part of the Project. Because of many scientific uncertainties related to issues such as sediment dynamics, methylmercury contamination in the environment from Gold Rush-era activities, and wildlife use of changing habitats, Adaptive management involves measuring and analyzing changes on the ground and folding that new information back into management decisions.

During Phase 1, the Science Program's focus is collecting baseline data - a "before" picture. Studies will continue to collect data as construction proceeds.

Third Science Symposium - A Great Success

Approximately 200 people attended the third South Bay Salt Pond Restoration Science Symposium on February 3, at the U.S. Geological Survey campus in Menlo Park. The entire symposium was broadcast live on the web, and is now available on the SBSP website (http://www.southbayrestoration.org/index.html) along with copies of the agenda, presentations, posters, and abstracts.

SBSP Lead Scientist Laura Valoppi and Executive Project Manager John Bourgeois provided an overview of the Salt Pond Restoration Project and the key scientific uncertainties inherent in a wetland restoration project of this size and scope. These uncertainties create the framework for the Project's Adaptive Management Program. Under the guidance of the Project Management Team, researchers from state, federal and local agencies as well as universities and private consultants are collecting data designed to adjust and improve the restoration process as it happens. As Lead Scientist Valoppi explains, "We are conducting a large experiment in restoration by measuring the effect the restoration is having on the South Bay ecosystem and then adjusting our management actions accordingly." So far we are finding:

- **The natural movement of sediment will feed and grow the new tidal marshes –** preliminary data is indicating there is sufficient sediment to support marsh restoration for the life of the project.

- **Loss of mudflat habitat is still a concern**, as researchers don't fully understand how sedimentation processes on the mudflats are connected to sedimentation in the ponds.
- **Wildlife are returning to restored habitats** – already we have found 30 species of fish using the newly restored ponds, including Longfin smelt and anchovy that are of regional importance. Almost all of the fish species found are native.
- **Shorebird and dabbling duck populations have generally increased**, while diving duck populations have stayed the same.
- **Questions remain regarding habitat for nesting waterbirds**. The project continues to offset the loss of pond habitats by creating managed ponds and nesting islands for these birds. However, we are still monitoring how different species respond to these new habitats. We are also continuing to monitor the mercury impacts associated with restoration, as well as California gull predation on waterbird nests and chicks.
- **Western snowy plover hatching success has decreased between 2004 and 2010**, while depredation of chicks and eggs has increased. It is not clear that altering plover habitat by using shell enhancement is an effective means to decrease depredation. USFWS is developing a gull management plan to help decrease the impacts of California Gull on plovers and other waterbirds.
- **Decreases in California clapper rail survival are correlated to high tide events in winter**. Researchers believe that the lack of high water refugia and increased predation during high water events are responsible for the decreased survival of these endangered birds.

6.2.1 APPLIED STUDY–FISH ASSEMBLAGES

During the Project's planning phase, the Science Team with participation of other participants determined the most important gaps in knowledge about South Bay ecosystem functioning or restoration that may hinder our ability to achieve the Project objectives. One of the key Project uncertainties identified was effects on non-avian species, especially the extent to which restoration and management will affect fish in the South Bay ecosystem.

The proposal titled "Monitoring the Response of Fish Assemblages to Restoration in the South Bay Salt Ponds" by James Hobbs (UC Davis) was accepted by the Project as part of the 2008 Request for Proposal Awards for Phase 1 Selected Monitoring and Applied Studies (see proposal at: http://www.southbayrestoration.org/rfq-rfp/2008-rfp-awards/Hobbs_7.pdf). The study goals are to: 1) document fish species and communities associated with newly restored salt marsh habitat; 2) document fish species and communities associated with adjacent habitats (i.e. sloughs and creeks) within the South Bay Salt Pond complex; and 3) develop indicators of sentinel species population health to assess the effects of the restoration.

The 2010 Semi-Annual Report (Appendix I) provides an update of sampling efforts conducted in Alviso Slough, Coyote Creek, the Island Ponds (A19, A20, A21), Mt. Eden Creek, Old Alameda Creek, Steinburger Slough, outer Bair Island and Redwood Creek.

6.3 PHASE 2 PLANNING

The Project Management Team is currently considering specific actions for the next phase of restoration. As most readers know, we broke ground on Phase 1 of restoration in 2008 and have completed a large part of the work outlined for that phase. We will base our decisions about what construction and restoration activities to pursue in Phase 2 of the project in part, on the evaluation of adaptive management information collected to date. The overarching guiding principles for the selection of Phase 2 actions are first, to "do no harm" relative to flood impacts, and second, not to deviate significantly from the goal of creating at least 50 percent managed ponds and 50 percent tidal marsh at the restoration site. Until adaptive management results supply us with significant data to the contrary, our plan is to build upon decisions made in previous planning processes.

We outlined the Initial concepts for Phase 2 in an August 2010 memo (http://www.southbayrestoration.org/planning/phase2/), and then took those ideas to the public for initial feedback and brainstorming. The Project Management Team will consider the input we received at the Stakeholder Forum meeting, as well as at the Alviso and Ravenswood Working Group meetings in making its final selection of Phase 2 actions. The public can also provide input on Phase 2 actions at the upcoming Eden Landing Working Group or via the website (http://www.southbayrestoration.org/index.html). We anticipate making a decision in late Spring 2011, with a Request for Services for design, permitting and environmental review to follow in the summer of 2011.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay National Wildlife Refuge Complex
9500 Thornton Avenue
Newark, California 94560

March 15, 2011

Mr. Bruce Wolfe, Executive Officer
California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, California 94612

Subject: 2010 Annual Self-Monitoring Report for South Bay Salt Pond Restoration Project, Phase 1 (Order No. R2-2008-0078, WDID No. 2 019438001)

Dear Mr. Wolfe:

This letter transmits the U.S. Fish and Wildlife Service's (Service) 2010 Annual Self-Monitoring Report, as identified in the California Regional Water Quality Control Board (Water Board) Order No. R2-2008-0078 (WDID No. 2 019438001). We have also included the 2011 Operations Plans for the Alviso Salt Ponds in Santa Clara County, California. The California Department of Fish and Game will be submitting a separate report covering the Eden Landing Ecological Reserve salt ponds in Alameda County, California.

The report provides information on the main parameters of concern within the Alviso ponds including salinity, dissolved oxygen (DO), pH, and temperature. This report summarizes water quality monitoring and applied studies for the 2010 season. Additional information regarding South Bay Salt Pond Restoration Project, Phase 1 accomplishments and Phase 2 planning efforts has been included as well.

If you have any questions regarding the report, please contact me at Eric_Mruz@fws.gov, (510) 792-0222 (ext. 125) or Melisa Helton (melisa_helton@fws.gov), (510) 792-0222 (ext. 124).

"I certify under penalty of law that this document and all attachments have been prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. The information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

Sincerely,

Eric C. Mruz

Eric Mruz
Refuge Manager
Don Edwards San Francisco Bay
National Wildlife Refuge

Enclosure
2010 Annual Self-Monitoring Report

cc:
Gary Stern, NOAA's National Marine Fisheries Service, Santa Rosa, California

Appendix B

Preliminary Analysis of 2010 Dissolved Oxygen Sources and Sinks for Alviso Pond A3W

Preliminary analysis of 2010 dissolved oxygen sources and sinks for Alviso pond A3W

Greg Shellenbarger, USGS, CAWSC, Sacramento, CA

Background

During the summer of 2010, a directed study on oxygen dynamics was conducted by the USGS in Alviso pond A3W. The pond was instrumented June-October using water quality sondes that measured temperature, salinity, and dissolved oxygen concentrations on a 15-minute interval. In addition, pond inflow and out-flow rates were periodically measured, and benthic oxygen and nutrient flux profilers were deployed for one 24-hour period in July, August, and September. This study builds on the results of a previous study conducted by the USGS in 2008 in Alviso ponds A3W, A14, and A16 (Mruz *et al*. 2010). The details of the sampling can be found in the main body of this report to the Regional Water Control Board and Topping *et al.* (2011). Presented here is a preliminary analysis of different sources and sinks of dissolved oxygen.

Methods for quantifying dissolved oxygen sources and sinks

Numerous methods exist for computing dissolved oxygen (DO) budgets in the environment. We have selected to use a technique detailed in Thébault *et al.* (2008), which they successfully applied to Alviso pond A18 in their 2006 study. This technique utilizes the time-series of measured dissolved oxygen concentrations (Figure 1), along with a variety of measured physical parameters, to compute net ecosystem metabolism as the difference between the calculated photosynthetic and respiration rates in the pond. The general equation for the change in dissolved oxygen in the system through time is:

$dC/dt = P-R+D$ Equation 1

where dC/dt is the change in dissolved oxygen concentration in the pond per unit of time, P is the photosynthetic rate, R is the respiratory rate, and D is the diffusion rate of oxygen moving into and out of the water from the atmosphere. The terms in this equation have units of mass of dissolved oxygen per unit water volume per unit time. This equation can be rewritten as:

$P-R=dC/dt-D$

The terms dC/dt and D can be computed from measured parameters (water and air temperatures, salinity, wind speed, atmospheric pressure, average pond depth, and dissolved oxygen concentration). This result can be used to calculate P-R (the difference between the photosynthetic and respiratory rates). During the night, when there is no solar radiation, P=0, so R=-dC/dt+D. Using the averaged hourly R values calculated during the night (and assuming that R is constant throughout a 24-hour period), P can be computed as P=dC/dt-D+R.

The equations required for the solution to the above equation are detailed at the end of this report. This form of the dissolved oxygen equation ignores advective fluxes of dissolved oxygen from water moving into and out of the pond (*i.e.,* inflow and discharge). We feel that initially this is a valid assumption, because the volume of the pond is large relative to the volume of inflow and discharge. Therefore, dissolved oxygen that enters or leaves the pond as a result of flow will contribute minimally to the overall sources and sinks of oxygen.

The values for pond temperature, salinity, and dissolved oxygen concentrations that were used for the computations were an average of data from up to six sondes deployed in a variety of locations (intake, discharge, three shallow, and one deep locations). Wind velocity, air temperature, and solar irradiance values were measured with a weather station deployed adjacent to the Alviso ponds by USGS-BRD. Atmospheric pressure values were obtained from a NOAA weather station located in the Port of Redwood City via the NOAA National Data Buoy Center website (station RTYC1, http://www.ndbc.noaa.gov/). Biochemical oxygen demand (BOD) samples were analyzed by Dr. John Johnston at California State University-Sacramento following standard methods for BOD_5 analysis.

Results

Dissolved oxygen concentrations in A3W during the study exhibit strong diurnal and some seasonal variability (Figure 1), as was expected. The pond showed the lowest DO concentrations during the nighttime and early morning hours, with highest values during the afternoon when light and photosynthetic rates were highest. Some of the daily variability in DO concentration relates to the solar irradiance (Figure 2) and daily Photosynthetically Active Radiation (PAR, data not shown), but it can also be related to specific ecosystem changes that were not quantified (*e.g.*, changes in the populations of organisms in the pond).

Estimates of the daily rates of P and R in A3W are presented in Figure 2. Overall, the P and R rates are reasonably balanced, as would be expected for a balanced ecosystem. The pond exhibits generally decreasing P and R rates over the study period, concurrent with decreasing solar irradiance and decreasing temperatures. Sharp decreases in solar irradiance occur on overcast days, which lead to decreases in photosynthesis. Examples of this can be seen with sharp decreases in solar irradiance and P on 30 June, 8 September, and 17 October. However, factors other than solar irradiance can also affect P and R rates. For example, on 28 September, rates of P and R dramatically decrease with a pond water temperature increase and no dramatic change in solar irradiance, and solar irradiance dramatically decreased on 4 October without a strong decrease in P or R. The cause of the sustained increases in P and R for periods in September and October is not readily apparent and will require integration with the chlorophyll and nutrient data to better understand. Table 1 presents monthly-averaged P and R rates for the ponds and the associated dissolved oxygen loads. The loads appear balanced each month, suggesting that productivity and respiration are balanced in the ecosystem.

A comparison of the measured rates of Biochemical Oxygen Demand (BOD) of the water column and benthic oxygen demand from core incubations (Sediment Oxygen Demand, SOD; data from Topping *et al.* (2011)) are presented in Table 2. Note that BOD is presented first as a volumetric rate and SOD as an areal rate, so only the daily load values (expressed in kg/day) of BOD and SOD should be directly compared. Overall, BOD increased from July through September, while the SOD remained reasonably constant. This results in increasing BOD:SOD through the summer, ranging from 4% in July to 9% in August and 17% in September.

Discussion

<u>Comparison of results to pond A18 study (Thébault *et al.* (2008))</u>

Dissolved oxygen concentrations in the pond during the summer of 2010 exhibit periods of suboxic conditions (Figure 1), similar to what has been measured in Alviso ponds in the past. These DO concentrations are similar to those reported for pond A18 in 2006 by Thébault *et al.* (2008). The P and R rates presented here are up to about ten times higher than those reported by Thébault *et al.* (2008) for pond A18. It is difficult to determine exactly why this is the case. Numerous differences exist between pond A18 and A3W. Pond A18 was managed as a muted-tidal pond and received regular pulses of water directly from Artesian Slough and Coyote Creek, whereas ponds A3W was a discharge pond operated as part of flow-through pond system (there was limited slough inflow from Guadalupe Slough to pond A3W at higher tides). Thébault *et al.* (2008) report that pond A18 contained no vascular plants, macroalgae, or benthic microalgae (P is only from phytoplankton photosynthesis), in contrast to A3W in the current study that does contain at significant quantities of at least macroalgae. The presence of macroalgae in the pond can greatly increase the P and R rates relative to ponds without macroalgae, so this could be the main factor that explains differences in the two studies.

<u>Comparison of A3W 2008 and 2010 results</u>

Dissolved oxygen concentrations in A3W appear to be similar in 2010 to the concentrations measured during the 2008 A3W study periods (Mruz *et al.*, 2010), although the 2010 data suggest slightly higher concentrations and greater diurnal variability. Rates of P and R are also similar in the 2008 and 2010 studies, with total daily oxygen productive and consumptive loads between 200,000 – 300,000 kg of oxygen per day. The BOD values in September are comparable for the two years (0.0025 gO_2/L-day in 2008 and 0.0023 gO_2/L-day in 2010). BOD rates were lower in the early summer in 2010, but no BOD samples were collected in A3W early in the summer of 2008 for comparison. Overall, this suggests that dissolved oxygen dynamics were similar in 2008 and 2010. Given similar results between two different hydrologic years, it can be assumed that oxygen cycling in the pond is fairly similar from year to year. One major difference between the 2008 and 2010 results is the ten-fold increase in estimates of SOD in 2010. 2008 results calculated SOD as 0.5 gO_2/L-day (Topping *et al.*, 2009), while 2010 results are about 5 gO_2/L-day (Table 2). This difference is due solely to a change in SOD measurement techniques, where the 2010 results are derived from the more sensitive core incubation technique than the benthic oxygen flux technique used in 2008 (Topping, 2011). Whereas the 2008 results showed BOD loads as double those of the SOD loads, the improved results in 2010 show that BOD loads are actually <20% of the SOD loads. Results from the less accurate benthic oxygen flux technique were similar in 2008 and 2010. These new results suggest that the sediments in pond A3W are a significantly stronger sink for dissolved oxygen than the water column.

<u>Comparison to other results reported in San Francisco Bay</u>

Peterson (1979) reported a value of 5.5×10^{-6} gO_2/L-day as a bay average planktonic respiration rate (*i.e.*, water column oxygen demand). Rudek and Cloern (1996) report a range of 4.5×10^{-5} to 8.2×10^{-4} gO_2/L-day, and Caffrey *et al.* (1998) report a range of 8×10^{-5} to 9.2×10^{-4} gO_2/L-day for south San

Francisco Bay. This compares to the range of $6x10^{-4}$ to $2.3x10^{-3}$ gO_2/L-day for this study (BOD, Table 2), which are about one order of magnitude higher than reported from the bay. The higher water column oxygen demand in the pond versus the bay waters is not surprising. Primary productivity in the bay is generally considered to be light-limited, because of high suspended-sediment concentrations. The pond has lower sediment concentrations than the bay, and is less light limited. Therefore, productivity would be expected to be higher in the pond than the bay, and the water column oxygen demand would also be higher.

Benthic respiration rates for the bay have been reported in previous studies, and these rates can be compared to the SOD results reported here. Caffrey *et al.* (1998) report a benthic respiration rate range of 0.003 to 1.1 gO_2/m^2-day in south San Francisco Bay, while Grenz *et al.* (2000) report rates that range from 0.02 to 1.5 gO_2/m^2-day for South Bay. The SOD results reported by Topping (2011) for this study (Table 2) are higher, but of the same order of magnitude as the high estimates from the other two studies. A likely explanation for higher values in A3W is because of higher overall rates of productivity in the warmer, shallow, clear pond. This would lead more organic material to settle on the bottom of the pond to be remineralized.

Respiration rates in the ponds are a function of BOD, SOD, and respiration due to organisms not captured in BOD or SOD samples (*e.g.*, macroalgae and fish). BOD and SOD are only two components of R, but the expectation for this pond is that BOD and SOD would be the major components of R. However, the Thébault *et al.* (2008) method produces respiration rates that are about one order of magnitude greater than the sum of BOD and SOD (Tables 1 and 2). The BOD and SOD tests are conducted over a small spatial scale (on the order of meters for each set of SOD replicates) or using small volumes of water (BOD samples) that cannot capture all of the conditions that exist in the pond (such as the presence of fish or macroalgae). The methodology used by Thébault *et al.* (2008), as applied here, integrates all of the conditions in the pond that affect DO at the six measurement locations in each pond. As such, the small spatial scale of the BOD and SOD sampling may not adequately represent average conditions in the ponds, because these techniques exclude the impacts of macroalgae and other large producers and consumers in the system. Therefore, the different methods have different sensitivities and likely do not produce comparable results. For this reason, we do not offer a direct comparison of the values presented in Tables 1 and 2.

Continuing work with this dataset will include calculation of an oxygen budget for A3W from July-September 2010. In addition, we will integrate the results reported here with the nutrient and chlorophyll data analyzed by J. Kuwabara and B. Topping to better understand factors that are driving dissolved oxygen dynamics in the pond.

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Table 1. Comparison of the monthly-averaged dissolved oxygen production (P, photosynthesis) or demand (R, respiration) for the 2010 study in A3W. Respiration is one process that removes dissolved oxygen from the system. The P and R values are daily-averages averaged over each month for the entire pond.

Study Month	**P** $g\ O_2/L/day$	**R** $g\ O_2/L/day$	**P** $kg\ O_2/day$	**R** $kg\ O_2/day$
June	0.33	0.34	286,000	295,000
July	0.31	0.31	268,000	268,000
August	0.27	0.27	233,000	237,000
September	0.26	0.26	224,000	227,000
October	0.24	0.24	212,000	209,000

Table 2. The dissolved oxygen demand by the water column (BOD, in volume concentration) and sediments (SOD, in areal concentration) in concentration and load of oxygen per day for 2010. Both BOD and SOD are sinks that remove dissolved oxygen from the pond system.
[+]BOD values are averages of up to 18 samples collected during each of the benthic flux profiler deployments.
[*]SOD values are from the prefered core incubation technique. Values reported here are an average of the two fluxes per deployment reported by Topping *et al.* (2011).

Collection Date	**BOD**[+] $g\ O_2/L/day$	**SOD**[*] $g\ O_2/m^2/day$	**BOD**[+] $kg\ O_2/day$	**SOD**[*] $kg\ O_2/day$
30 Jun.-1 Jul.	0.0006	5.5	500	12,600
18-19 Aug.	0.0011	4.5	970	10,300
21-22 Sept.	0.0023	5.2	2,010	11,900

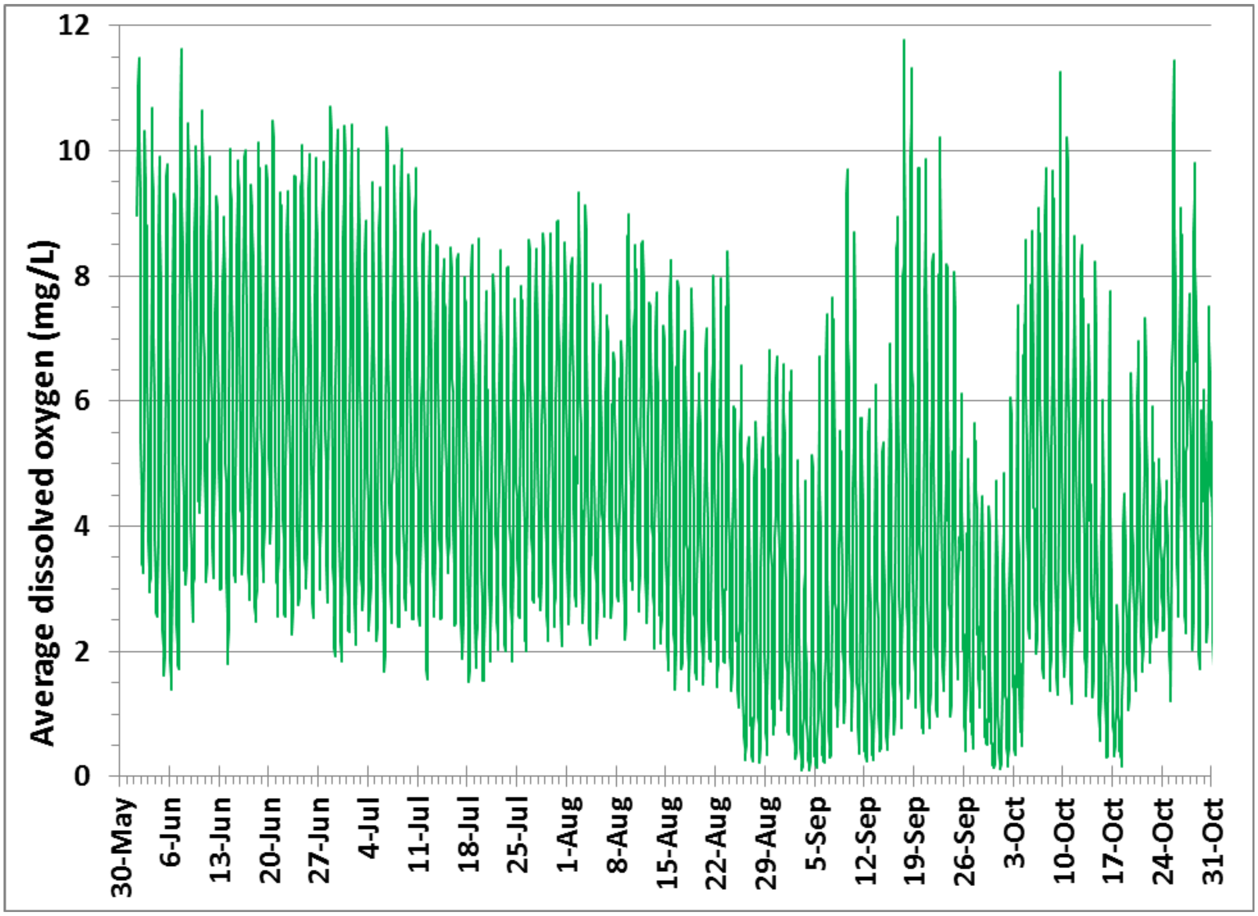

Figure 1. Hourly-averaged dissolved oxygen concentrations in A3W during the period of study in 2010. These values are an average of data from up to six water quality sondes deployed in the pond.

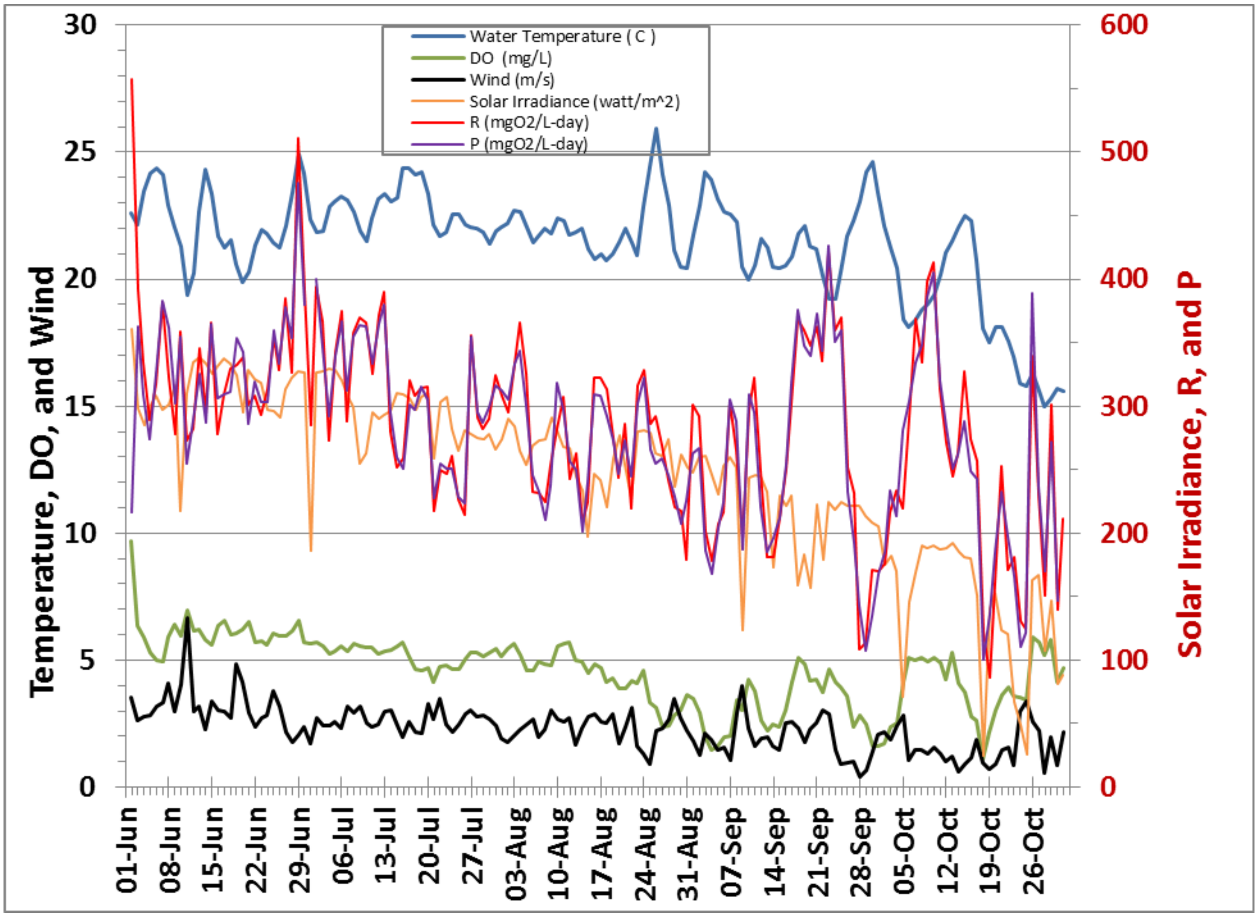

Figure 2. Comparison of the computed daily oxygen production/consumption rates of photosynthesis (P) and respiration (R) and solar irradiance for A3W during summer 2010 (right-hand y-axis). In addition, daily averages of pond water temperature, wind speed, and dissolved oxygen concentration are displayed (left-hand y-axis). Respiration is one process that removes dissolved oxygen from the system.

Equations and data sources for DO calculations using Thébault *et al.* (2008) techniques

<u>Rate of dissolved oxygen concentration change:</u> (Thébault *et al.* (2008), Eqn. 1)
$dC/dt=P-R+D$
or when rewritten:
$P-R=dC/dt-D$,
where dC/dt is the rate of change of dissolved oxygen in the pond (measured, mgO_2/L-hour), D is the rate of diffusion across the water surface (computed using the below equations, mgO_2/L-hour), and P and R are the photosynthetic and respiratory rates in the water column, respectively (computed, mgO_2/L-hour).

<u>Rate of oxygen uptake of pond by diffusion:</u> (Thébault *et al.* (2008), Eqn. 2)
$D=k_a(C_s-C)$
where C is the oxygen concentration in the pond (measured, mg/L), C_s is saturation oxygen concentration in water for given conditions (computed, see below), and k_a is the volumetric reaeration coefficient (computed, see below, 1/hour)

<u>Dissolved oxygen saturation concentration:</u> (Thébault *et al.* (2008), Eqn. 3)
$lnC_s=-135.29996+1.572288*10^5*T^{-1}-6.637149*10^7*T^{-2}+1.243678*10^{10}*T^{-3}-8.621061*10^{11}*T^{-4}-(0.020573-12.142*T^{-1}+2363.1*T^{-2})*S$
where T is the water temperature (measured, K) and S the salinity (measured)

This term needs to be in the correct units and can be converted using Thébault *et al.* (2008), Eqn. 4
C_s (mg O_2/L) = C_s (μmol O_2/kg) $*\rho_w*31.9988*10^{-6}$
where ρ_w is the density of water (computed, see below, kg/m^3)

<u>Volumetric reaeration coefficient:</u> (Thébault *et al.* (2008), Eqn. A11)
$k_a = (1/24)*(K_L/H)$
where K_L the oxygen mass transfer coefficient (computed, see below, m/day), and H is the average water depth (estimated from staff gauge readings and pond stage:area:volume relationships, m)

<u>Oxygen mass transfer coefficient:</u> (Thébault *et al.* (2008), Eqn. A10)
$K_L=0.24*170.6*(D_w/\nu_w)^{0.5}*(\rho_a/\rho_w)^{0.5}*U_{10}^{1.81}$
where D_w is the diffusivity of oxygen in water (computed, see below, m^2/s), ν_w is the kinematic viscosity of water (computed, see below, m^2/s), ρ_a and ρ_w are the density of air and water respectively (computed, see below, kg/m^3), and U_{10} is the wind speed at 10 meters above the surface (computed, see below, m/s)

<u>Wind speed at 10 m:</u> (Thébault *et al.* (2008), Eqn. A8)
$U_{10}=U_z*(ln(10/z_0)/ln(z/z_0))$
where z is the height of the anemometer (measured, m), z_0 the length scale for surface roughness (estimated at 10^{-5} m for smooth water), and U_z is the wind velocity (measured, m/s).

<u>Density of seawater</u>: (code from Phil Morgan, CSIRO, 1992 using the UNESCO 1983 Equation of State polynomial for seawater at atmospheric pressure)

The standard polynomial is too complex to reproduce here. It is computed based on the water temperature and salinity (measured, kg/m^3).

Density of air: (Thébault *et al.* (2008), Eqn. A6)
$\rho_a=(P_{atm}-P_v)/(R_d T_{air})+(P_v/(R_v T_{air}))$
where P_{atm} is the air pressure (measured, Pa) P_v is the saturation vapor pressure of water (computed, see below, Pa) R_d is the gas constant for dry air (287.05 J/kgK), R_v is the gas constant for water vapor (461.495 J/kgK), T_{air} is the air temperature (measured, K).

Kinematic viscosity: (Thébault *et al.* (2008), Eqn. A2)
$\nu_w=\mu_w/\rho_w$
where μ_w is the dynamic viscosity of water (computed, see below, kg/m-s), ρ_w the water density (computed, see above, kg/m^3).

Dynamic viscosity of water: (Thébault *et al.* (2008), Eqn. A3)
$\mu_w=\mu_{pw}*(1+(5.185*10^{-5}*T+1.0675*10^{-4})*(\rho_w*S/1806.55)^{0.5}+(3.3*10^{-5}*T+2.591*10^{-3})*(\rho_w*S/1806.55))$
where T is the water temperature (measured, C), S is the salinity (measured), ρ_w is the water density (computed, see above, kg/m^3), and is the dynamic viscosity of pure water (computed, see below, kg/m-s)

Dynamic viscosity of pure water: (Thébault *et al.* (2008), Eqn. A4)
$\mu_{pw}=1.002*10^{-3}*10$^$(1.1709*(20-T)-1.827*10^{-3}*(T-20)^2)/(T+89.93))$
where T is the water temperature (measured, C), and S is the salinity (measured)

Diffusivity of O_2 in water: (developed from data in Table 6.2 from Denny (1993), which is reprinted from Armstrong (1980))
$D_w=5.59x10^{-11}*T+9.86x10^{-10}$
where T is water temperature (measured, C).

Saturation water vapor pressure: (Flatau *et al.*, (1992))
$P_v= a_1+a_2*T+a_3*T^2+a_4*T^3+a_5*T^4+a_6*T^5+a_7*T^6$
where T is water temperature (measured, C) and a_{1-7} are constants (see reference Table 3 for constants)

Average pond depth: (determined by measured pond stage and pond stage:area:volume relationships)
A3W = 0.38 m

Appendix C
Internal Nutrient Sources, Weekly Nutrient Distributions, and Sediment Oxygen Demand for Alviso Pond A3W

Internal Nutrient Sources and Weekly Nutrient Distributions in Alviso Pond A3W

Brent R. Topping, including analysis from L. Arriana Brand, Sara L. Piotter and James Kuwabara.

Background

With the implementation of the South Bay Restoration Program in 2004, water quality in the Alviso Salt Ponds has been monitored to document the effects of changing hydrologic connections between the ponds and the adjacent estuary. Such water quality monitoring provides managers with confirmation or management focus on ability of these evolving ecosystems to support the desired terrestrial-wildlife, water-column and benthic communities. To complement ongoing water-column monitoring in the ponds, pore-water profilers have been deployed in 2008 and 2010 to provide the first and only measurements of oxygen, macronutrient, micronutrient and dissolved organic carbon fluxes across the sediment-water interface associated with the pond benthos. These measurements are critical to pond restoration because they quantify a major, but often neglected, nutrient source available to the base of the pond food web. That food-web base also represents the highest, most intense step of biological accumulation for particle reactive solutes (e.g. mercury, certain macronutrients, herbicides and pharmaceuticals). Furthermore, anoxic waters, consistently near the sediment-water interface (Topping et al., 2009), are unsuitable for survival of many aquatic organisms spanning all trophic levels, and can lead to massive fish die-offs.

Methods:

Sampling and analytical methods for the proposed work are briefly described and referenced below.

1. **Benthic-flux measurements:** A non-metallic pore-water profiler was used to determine a vertical concentration gradient near the sediment-water interface, from which a diffusive solute flux was determined using Fick's Law (Kuwabara et al., 2009; Topping et al., 2009). The benthic flux (J_i in units of micromoles of solute i per square meter per hour), assuming diffusion-controlled transport (i.e., a conservative estimate) may be calculated by the equation:

   $J_i = D_{i,T}(\varphi)(dC/dz)$, where

   $D_{i,T}$ is the diffusion coefficient of solute i at temperature T in units of centimeter squared per second,

   φ is the sediment porosity in dimensionless units, and

   dC_i/dz is the concentration gradient for solute i in the vertical (or z) direction in units of micrograms per liter per centimeter, and calculated flux values are converted to meter and hour units.

2. **Sediment oxygen demand:** Acrylic tubes were used to sample sediment cores, approximately 10 cm deep, from which overlying water was iteratively sampled and analyzed for dissolved oxygen (Topping et al., 2004)

3. **Dissolved nutrients:** Dissolved (0.2-micron filtered) nutrient concentrations in both water-column and pore-water samples were determined by low-volume, batch-spectrophotometric methods (Kuwabara et al., 2009).
4. **Oxygen (DO):** Dissolved samples from glass syringes were analyzed for DO using a 0.9-mL flow-through cell fitted with a microelectrode (Topping et al., 2009).
5. **Water-column chlorophyll:** Samples were taken just below the surface and collected onto glass-fiber filters, and analyzed by fluorometry (Parsons et al., 1984).
6. **Benthic chlorophyll:** Surficial sediment (that is, the top 0.5 centimeters of lakebed material) were collected from Ekman grabs, and analyzed spectrophotometrically for benthic chlorophyll (Franson, 1985).
7. **Dissolved organic carbon (DOC):** Dissolved samples from syringes underwent dissolved organic carbon analysis by high-temperature combustion (Qian and Mopper, 1996).

Results

1. **Initial Measurements of Benthic Nutrient Sources in Pond A3W**

On June 30, August 18 and September 21, 2010, porewater profilers were deployed in triplicate at two contrasting sites in Pond A3W ("Inlet", near the inflow, and "Deep", near the middle of the pond) to provide the first measurements of the diffusive flux of nutrients across the interface between the pond bed and water column (i.e., benthic nutrient flux). These fluxes are critical to understand in all pond restoration efforts because they typically represent a major (if not the greatest) source of nutrients to the water column for ponds and other lentic systems. Measurements of benthic flux described herein assume that molecular diffusion regulates the transport of solutes across that interface. Given that other processes may enhance diffusive flux (Kuwabara et al., 2009), these measurements provide a conservative estimate of benthic flux to identify the relative importance of this nutrient source. For soluble reactive phosphorus (SRP, the most biologically available form in solution), benthic flux was consistently positive (i.e., out of the sediment into the water column) and greater at Deep than Inlet for both the June (14.9 ± 9.5 μmoles-m^{-2}-h^{-1} at Inlet; 69.9 ± 3.3 μmoles-m^{-2}-h^{-1} at Deep) and September (14.1 ± 7.3 μmoles-m^{-2}-h^{-1} at Inlet; 46.9 ± 27.6 μmoles-m^{-2}-h^{-1} at Deep) sampling periods. In contrast, all flux measurements made in August, near the peak of the summer algal-growth period, were either negligible or negative (i.e., into the sediment consumed from the water column; -0.2 ± 0.1 μmoles-m^{-2}-h^{-1} at Inlet and -0.2 ± 0.2 μmoles-m^{-2}-h^{-1} at Deep). That is, primary productivity is so intense during parts of the summer, that benthic sources may be depleted and water-column sources are scavenged. In the adjacent estuary, Topping et al. (2001) reported consistently positive SRP benthic fluxes for South San Francisco Bay ranging from 2.3 to 6.8 μmoles-m^{-2}-h^{-1} using core-incubation measurements that incorporate bioturbation and bioirrigation effects. There is much greater temporal variability in SRP flux in the pond than reported for the lower estuary.

For dissolved ammonia, benthic flux was consistently positive on all three sampling trips, and similar to SRP, the fluxes at Deep (from an average of 136 ± 10 μmoles-m^{-2}-h^{-1} in September to 177 ± 69 μmoles-m^{-2}-h^{-1} in June) were consistently greater than those at Inlet (from an average of 0.1 ± 0.2 μmoles-m^{-2}-h^{-1} in August to 35 ± 7 μmoles-m^{-2}-h^{-1} in September). These pond values bracket those reported for South San Francisco Bay by Topping et al. (2001) for dissolved ammonia (range of 15 to 92 μmoles-m^{-2}-h^{-1}). Once again, greater variability in the pond than observed in adjacent South San Francisco Bay.

With the absence of any measurable concentration gradient, dissolved-nitrate fluxes were consistently negligible (<0.2 µmoles-m^{-2}-h^{-1}) in the pond. In contrast, consistently positive nitrate fluxes have been previously reported for South San Francisco Bay (Topping et al., 2001).

Silica fluxes are often used to represent sediment diagenetic processes that biogeochemically cycle silica (an important algal macronutrient) between biogenic and inorganic phases (Fanning and Pilson, 1974; Emerson et al., 1984), and for South San Francisco Bay, those values are consistently positive from core-incubation experiments (ranged of 75 to 294 µmoles-m^{-2}-h^{-1}; Topping et al., 2001). In Pond A3W, dissolved-silica fluxes ranged from 43 $\pm$ 3 to 193 $\pm$ 83 µmoles-m^{-2}-h^{-1} at Inlet and were much higher at Deep with a range of 527 $\pm$ 236 to 862 $\pm$ 466 µmoles-m^{-2}-h^{-1}, similar to the spatially varibility observed for SRP and dissolved ammonia. An elevated silica flux can stimulate diatom production and subsequent eutrophication effects. Variability in these silica fluxes are consistent with season patterns in pond primary productivity.

In summary, the initial benthic-flux values reported here for Pond A3W for macronutrients are particularly impressive in magnitude, particular if one considers the fact, as previously mentioned, that diffusive flux of dissolved solutes based on porewater profiles provides a conservative determination that may be enhanced by other biogeochemical processes. These enhancement processes include bioturbation, bioirrigation, wind resuspension, and potential groundwater inflows, some of which are captured in core-incubation experiments (Kuwabara et al., 2009). Hence, the values reported herein represent lower bounds to indicate the potential importance of such internal solute sources. The elevated diffusive fluxes for nutrients in the pond relative to the adjacent estuary indicate that vertical nutrient transport between the pond bed and water column is consistently an important (and at times the most important) sources of nutrients that stimulate phytoplankton growth in the water column. One might therefore reasonably hypothesize that this benthic transport of biologically reactive solutes (both nutrients and toxicants) represents the most important step at the base of the food web for trophic transfer of biomagnifying solutes like mercury.

2. **Macronutrient Distributions in the Water Column of Pond A3W (Weekly sampling frequency)**

In addition to benthic-flux measurements for nutrients, weekly samples of the upper water-column (0.5 m depth) were also taken from June 30, 2010 through Sep 27, 2010 at five sites in pond A3W. Besides Inlet and Deep, one of the other sites is near the outflow of the pond (hereafter referred to as "Discharge"). Since the pond's major inflow occurs at Inlet, and the sole outflow occurs at Discharge, comparing concentrations of nutrients at these sites on the same dates suggest nutrient sources and losses in the pond (part of a so called "nutrient budget"). In other words, the difference will indicate whether nutrients increased or decreased while the water flows through the pond. For ammonia, Discharge was 0.1 mg/L higher, on average, than Inlet. For nitrate, Discharge was 0.3 mg/L higher, on average, than Inlet. For silica, Discharge was 4.0 mg/L higher, on average, than Inlet. Lastly, for SRP, Discharge was 0.2 mg/L lower, on average, than Inlet. These data suggest that the pond acts as a net source of ammonia, nitrate and silica, and as a net sink for SRP.

These two observations are counterintuitive given that the N:P molar ratio is 1.1$\pm$ 0.6 for the 140 samples. For reference the molar ratio of N:P in phytoplankton is approximately 16:1 (the "Redfield" ratio). The ratio of 1.1$\pm$ 0.6 for the pond is about 15 times lower, which indicates there is an abundance of P relative to N. Since the shallow depth of the pond likely rules out light-limitation, this low value suggests N-limitation of primary productivity. Both the southern and northern components of San Francisco Bay also exhibit this. If the algal community is dominated by nitrogenfixing (able to sequester nitrogen from atmospheric N_2) cyanobacterium, however, N would not be considered the limiting nutrient. Identification of the algal community is unknown at this time.

Ammonia concentrations at some sites went from detectable in July/early August, to non-detectable in mid/late August, and returned to higher levels in September. Although high-frequency (weekly) chlorophyll measurements were not available to corroborate, this suggests that the peak algal bloom occurred in mid to late August, with a resultant crash evident by early September.

3. **Methodological Comparison of Benthic Oxygen Demand in Pond A3W**

Topping et al. (2009) measured diffusive oxygen flux of -1.33 mmoles-m^{-2}-h^{-1} (the negative value indicates oxygen consumption by the sediment) at the Inlet site in A3W and suggested that this was likely an underestimate due to other processes (e.g., bioturbation, bioirrigation and wind mixing) that enhance diffuse flux. In 2010, diffusive flux measurements were again made using the same porewater profilers, while sediment oxygen demand experiments using core incubations were performed concurrently. The diffusive flux estimates averaged -0.39 mmoles-m^{-2}-h^{-1} over all sites and dates, while core-incubation measurements yielded an average of -6.63 mmoles-m^{-2}-h^{-1} over all sites and dates (Table 1). Topping et al. (2004) reported similar SOD measurements for South San Francisco Bay (-2.5 $\pm$ 2.3 to -5.0 $\pm$ 2.4 mmoles-m^{-2}-h^{-1}) from similar core-incubation experiments. It appears that for this sediment, diffusive flux estimates, as expected, result in a significant underestimation of true sediment oxygen demand.

Using the estimated pond surface area of 2.27 square kilometers, -6.63 mmoles-m^{-2}-h^{-1} can be converted to -5780 kg/day. In Topping et al. (2009), estimates of oxygen diffusion from the atmosphere into the pond were calculated. For A3W, the average estimate was 1630 kg/ day. Comparing this value of 1,630 kilograms of oxygen each day diffusing into the water each day, to the 5780 kilograms we estimate is being consumed by the sediment each day, it's clear that oxygen depletion is likely in the water-column. Photosynthetic oxygen production during the daytime likely mitigates the depletion, but during the night, the combination of sediment oxygen demand and algal respiration causes regular depletion. Figures in Topping et al. (2009) show this regular diurnal fluctuation.

Table 1. Dissolved Oxygen Flux

Site Averages

Diffusive technique		**(mmoles/m2-h)**
A3W Inlet	6/30/2010	**-0.01**
A3W Deep	6/30/2010	**-0.36**
A3W Inlet	8/18/2010	**-0.01**
A3W Deep	8/18/2010	**-1.55**
A3W Inlet	9/21/2010	**-0.04**
A3W Deep	9/21/2010	**-0.38**
	overall avg	**-0.39**

SOD (core technique)		**(mmoles/m2-h)**
A3W Inlet	6/30/2010	**-7.34**
A3W Deep	6/30/2010	**-7.04**
A3W Inlet	8/18/2010	**-4.87**
A3W Deep	8/18/2010	**-6.93**
A3W Inlet	9/21/2010	**-7.39**
A3W Deep	9/21/2010	**-6.21**
	overall avg	**-6.63**

4. **Chlorophyll in the water-column and benthos of Pond A3W**

During all three of the deployments of porewater profilers, water-column and benthic chlorophyll samples were also taken. Benthic chlorophyll is an indicator of settled algal material which is sometimes still photosynthetically active, but sometimes is only organic material being degraded by bacteria. This bacterial degradation consumes oxygen. Benthic chlorophyll was highest at both the Inlet and Deep sites on June 30, 2010 (9.5 and 8.3 $ug\text{-}cm^{-2}$, respectively) and much lower on Sept 21, 2010 (2.6 and 1.0 $ug\text{-}cm^{-2}$, respectively). In the water-column, chlorophyll concentrations exhibit a dramatic increase as the season progressed. Samples, taken from five sites, range from 4.6 to 14.7 $ug\text{-}L^{-1}$ on June 30, 2010, from 9.8 to 18.9 $ug\text{-}L^{-1}$ on August 18, 2010, and from 46.6 to 197.7 $ug\text{-}L^{-1}$ on September 21, 2010. These data suggest that a bloom was on-going in late September, contrary to the suggestion from the weekly nutrient data above. Higher resolution sampling of chlorophyll would be required to gain an understanding of the timing of the bloom or blooms within the pond. If the timing of large bloom periods can be identified, the subsequent crash can be monitored for likely depletion of the oxygen in the water-column. This may help identify when anoxic conditions could be present or threatening, and could allow managers to attempt to prevent fish kills.

Management Implications and Recommendations for 2011

Benthic flux is largely generated by natural or anthropogenic processes that accumulate surface-reactive solutes (i.e., certain organic and inorganic nutrients and toxicants) in bed sediment over annual to decadal time scales. It is likely that long-term improvements in water quality within the pond will eventually lead to decreases in contaminant porewater gradients. However, such decreases are expected to lag in both time and magnitude relative to any surface-water regulatory improvements.

There are engineering steps that could be taken to help mitigate the dissolved oxygen depletion. Managers could mechanically aerate waters at the pond outflow during low-DO summer periods so that advective transport through the pond could be maximized without compromising receiving water quality. Similarly, if flows can be managed according to diurnal patterns, it would be useful to maximize flow during the day (i.e., high DO periods), while also mechanically aerating the pond water column at the inflow and outflow during the night. Inflow water can also be baffled to create turbulence near the inflow, outflow, or both to increase atmospheric oxygen diffusion (i.e., increased surface area and mixing).

Given the magnitude and variability, both spatially and temporally, of nutrient benthic sources described above for 2010, it would be prudent to complete the second and final year of the study to quantify that variability at least over annual time scales, to track transitional benthic processes occurring as a result of any new hydrologic connections or flow management alterations. Also, the 2010 summer was widely considered to be unseasonably cool (News Link), so it may have poorly represented summer conditions in the region. Furthermore, benthic-flux measurements of nutrients and metals, as well as sediment oxygen demand are recommended at other sites within the pond to quantify large-scale (between-site) spatial variability. The "Discharge" site would be a logical site to include because, based on initial 2010 nutrient sampling, it appears to integrate the pond due to both flow and wind dynamics. It does not appear necessary to continue diffusive flux estimates for oxygen, however, as they have consistently demonstrated the significant magnitude of oxygen consumption in all three Alviso Salt ponds thus far tested (Topping et al., 2009), and also because more resource intensive core-incubation measurements indicate a enhancement of diffusive flux. As described above, diffusive-flux determinations provide conservative screening measurements to: (1) identify "hot spots" of concern for more intensive habitat monitoring, and (2) provide a quantitative measure of nutrients and toxicants that remobilize in the pond benthos to exchange with the flowing water column.

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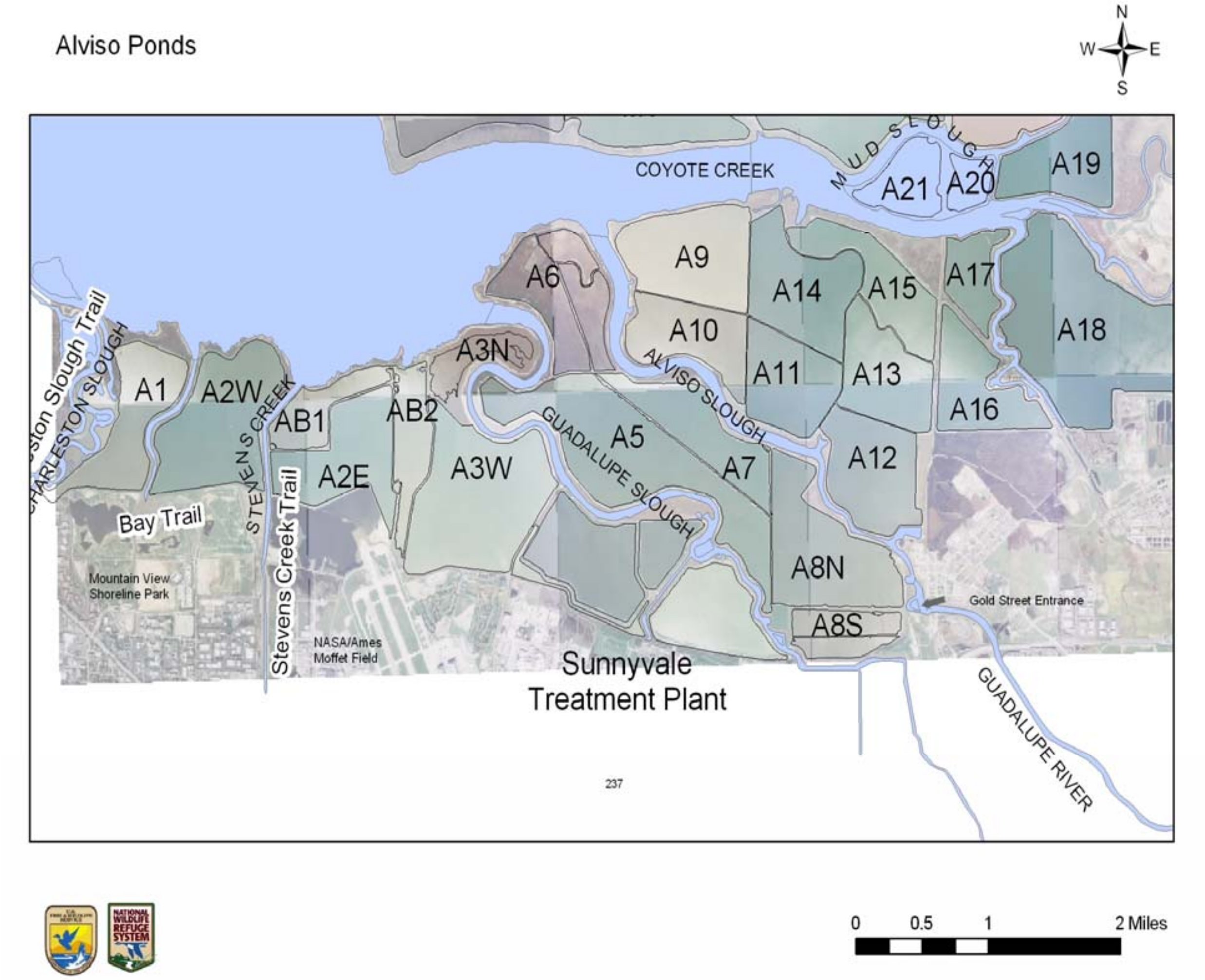
APPENDIX D
ALVISO POND A2W OPERATION PLAN

Pond System A2W Water Management Operation Plan – Alviso System 2011



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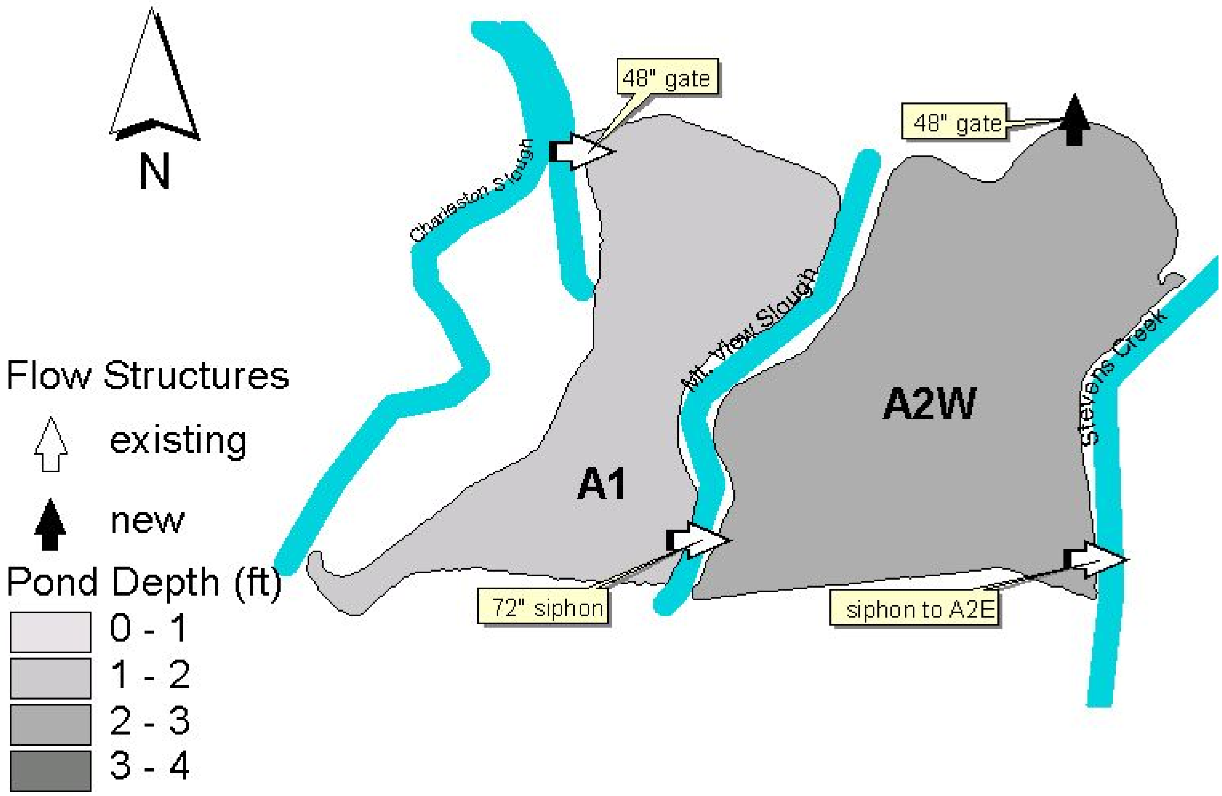


Objectives

Maintain full tidal circulation through ponds A1 and A2W while maintaining discharge salinities to the Bay at less than 40 ppt and meet the other water quality requirements in the Water Board's Waste Discharge Permit. This program will also include monitoring for pH, dissolved oxygen, temperature, avian botulism, and potential for inorganic mobilization.

Structures

The A2W system includes the following structures needed for water circulation in the ponds:

- Existing 48" gate intake at A1 from lower Charleston Slough
- New NGVD gauge at A1
- Existing 72" siphon under Mountain View Slough between A1 and A2W
- Existing staff gauge (no datum) at A1
- New 48" gate outlet structure with 24' weir box at A2W to the Bay
- New NGVD gauge at A2W
- Note that existing siphon to A2E should be closed

System Description

The intake for the A2W system is located at the northwest end of pond A1 and includes one 48” gate from lower Charleston Slough near the Bay. The system outlet is located at the north end of pond A2W, with one 48” gate to the Bay. The flow through the system proceeds from the intake at A1 though the 72” siphon under Mountain View Slough to A2W. An existing siphon under Stevens Creek to Pond A2E was used for salt pond operations. It should remain closed for normal operations, though it is available for unforeseen circumstances.

Operations of the A2W system should require little active management of gate openings to maintain appropriate flows. Summer and winter operations are described below to indicate predicted operating levels during the dry and wet seasons. The system will discharge when the tide is below 3.6 ft. MLLW.

Summer Operation

The summer operation is intended to provide circulation flow to make up for evaporation during the summer season. The average total circulation inflow is approximately 19 cfs, or 38 acre-feet/day, with an outlet flow of about 14 cfs (28 acre-feet/day). The summer operation would normally extend from May through October.

Summer Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A1	277	-1.8	-0.4	2.0
A2W	429	-2.4	-0.5	NA

Summer Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A1 intakes	50	19
A2W	100	48
Weir	-1.2 ft NGVD	6 boards

Water Level Control

The water level in A2W is the primary control for the pond system. The outlet at A2W includes both a control gate and control weir. Either may be used to limit flow through the system. The system flow is limited by the outlet capacity. Normal operation would have the outlet gates fully open, and the weir set at elevation -1.2 ft NGVD, approximately 0.7 feet below the normal water level. The normal water level in A2W should be at -0.5 ft NGVD in summer. The level may vary by 0.2 due to the influence of weak and strong tides.

The A1 intake gate can be adjusted to control the overall flow though the system. The maximum water level in either A1 or A2W should generally be less than 1.2 ft NGVD. This is to maintain freeboard on the internal levees, limit wind wave erosion, and to preserve existing islands within the system used by nesting birds.

<u>Design Water Level Ranges</u>

Pond	Design Water Level Elev. (ft, NGVD)	Maximum Water Elev. (ft, NGVD)	Maximum Water Level (ft, Staff Gage)	Minimum Water Elev. (ft, NGVD)	Minimum Water Level (ft, Staff Gage)
A1	-0.4	1.2	3.6	-0.6	1.8
A2W	-0.5	1.1	NA	-0.7	NA

The minimum and maximum water levels are based on our observations in the ponds for the period 2005.

There is no existing staff gage in pond A2W. Therefore, there is no record of existing minimums and maximums. Based on system hydraulics, pond A2W would typically be about 0.1 feet below pond A1.

<u>100 Percent Coverage Water Level</u>

Pond	Design Water Level Elev. (ft, NGVD)	100 % Coverage Water Elev. (ft, NGVD)	100 % Coverage Water Level (ft, Staff Gage)
A1	-0.4	-0.7	1.7
A2W	-0.5	NA	NA

The 100 percent coverage values represent the estimated water level which begins to expose part of the pond bottom area. Lower water levels would expose large areas of the pond bottom to drying and may cause odor problems.

Salinity Control

The summer salinity in the system will increase from the intake at A1 to the outlet at A2W, due to evaporation within the system. The design maximum salinity for the discharge at A2W is 40 ppt. The intake flow at A1 should be increased when the salinity in A2W is close to 35 ppt. If the gate at A1 is fully open, the flow can be increased by lowering the weir elevation at the A2W outlet structure. Increased flow will increase the water level in A2W. Water levels above elevation 1.1 ft NGVD should be avoided as they may increase wave erosion of the levees.

Dissolved Oxygen and pH Control

If summer monitoring shows that DO levels in discharges from the Pond A2W fall below a 10th percentile of 3.3 mg/L (calculated on a calendar weekly basis), the FWS will conduct within-pond monitoring and notify and consult with the Water Board as to which Best Management Practices described below for increasing dissolved oxygen levels in discharge water should be implemented:

1. Increase the flows in the system by opening the A1 inlet further. If increased flows are not possible, open the A2W gate to allow the pond to become fully muted or partially muted tidal system until pond DO levels revert to levels at or above conditions in the Creek.

2. Set in a series of flow diversion baffles at the pond discharge for directing the water from more suitable DO water levels to achieve maximum oxygen uptake.

3. Cease nighttime discharges due to diurnal pattern.

4. Close discharge gates completely until DO levels meet standards.

5. Close discharge gates completely for a period of time each month when low tides occur primarily at night.

6. Mechanically harvest dead algae.

To help minimize significant downtime on continuous monitoring devices used for DO and pH, the FWS will:

1. Have an extra monitor on hand, in case there is a break down.
2. Get a loaner unit through Hydrolab (within a week), if the extra monitor is being used.
3. Work with Hydrolab to insure a quick repair of monitors (within 2 weeks).

Avian botulism

Avian botulism outbreaks most typically occur in late summer/early fall when warm temperatures and an abundance of decaying organic matter (vegetation and invertebrates) combine to present ideal conditions for the anaerobic soil bacterium *Clostridium botulism* along water bodies. If summer monitoring shows that DO levels in the pond drop the BMPs listed under the section on Dissolved Oxygen and pH Control will be implemented to increase the DO. Monitoring of weather for long periods of hot, dry, windless days during late August and early September will trigger on the ground monitoring for any signs of botulism. FWS will be in contact with the adjacent landowners such as the San Jose and Sunnyvale Treatment plants to determine if botulism is occurring on their ponds. Additionally, if any bird carcasses in the ponds or nearby receiving waters are observed, they will be promptly collected and disposed of.

Winter Operation

The winter operation is intended to provide less circulation flow than the summer operation. Evaporation is normally minimal during the winter. The winter operation is intended to limit large inflows during storm tide periods and to allow rain water to drain from the system.

The average total circulation inflow is approximately 9 cfs, or 18 acre-feet/day, with an outlet flow of about 9 cfs (18 acre-feet/day). The winter operation period would normally extend from November through April. The proposed gate settings are intended to limit the intake flow, and flow within the system.

Winter Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A1	277	-1.8	-0.6	1.8
A2W	429	-2.4	-0.6	NA

Winter Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A1 intakes	30	12
A2W	100	48
Weir	-1.2 ft NGVD	6 boards

Water Level Control

The water level in A2W is the primary control for the pond system. The system flow is limited by the both the intake and outlet capacities. Normal winter operation would have the intake gate partially open to reduce inflow during extreme storm tides. Water levels in the ponds are controlled by the outlet weir setting. The normal winter water level in A2W should be at -0.6 ft NGVD, approximately 0.6 ft above the outlet weir. The pond water level may vary by 0.2 ft due to the influence of weak and strong tides, and over 0.5 ft due to storms

During winter operations, the water levels should not fall below the outlet weir elevation. If the elevation does decrease in April, it may be necessary to begin summer operation in April instead of May.

During winter operations, if the water levels exceed approximately 1.2 ft NGVD, the A1 intake should be closed to allow the excess water to drain. Note that without rainfall or inflow, it will take approximately 3 weeks to drain 1.0 ft from the ponds.

Salinity Control

The winter salinity in the system may decrease from the intake at A1 to the outlet at A2W, due to rainfall inflows within the system, which may exceed winter evaporation. During very wet winters, the intake salinities and system salinities may decrease to as low as 11 ppt.

Monitoring

The system monitoring will require weekly site visits to record pond and intake readings. The monitoring parameters are listed below.

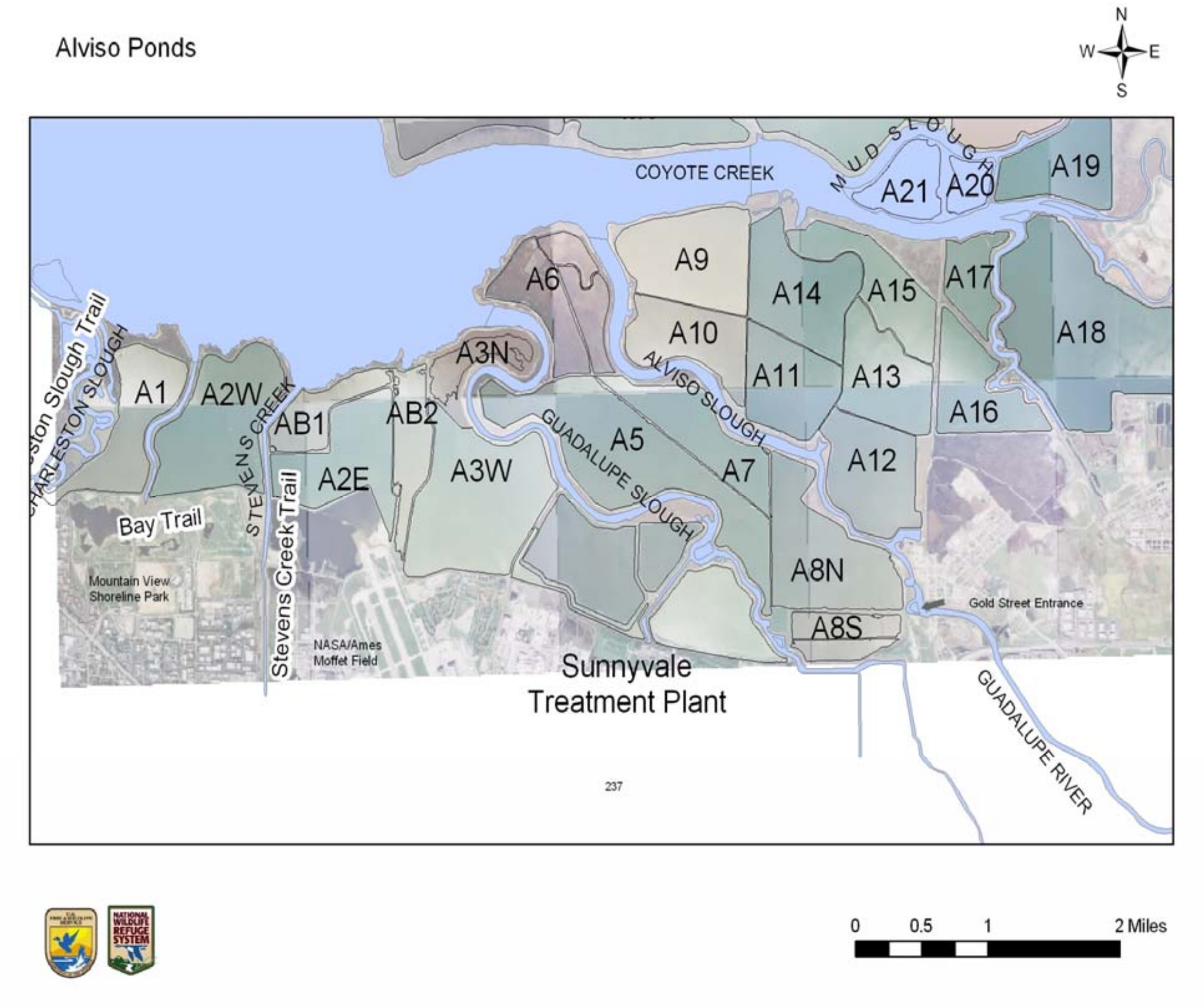
Weekly Monitoring Program

Location	Parameter
A1 intakes	Salinity
A1	Depth, Salinity, Observations
A2W	Depth, Salinity, Observations

The weekly monitoring program will include visual pond observations to locate potential algae buildup or signs of avian botulism, as well as visual inspections of water control structures, siphons and levees. This program will also include supplementary DO monitoring when problems are identified in the formal monitoring listed below.

APPENDIX E
2010 ALVISO POND A3W OPERATION PLAN

Pond System A3W Water Management
Operation Plan – Alviso System
2010



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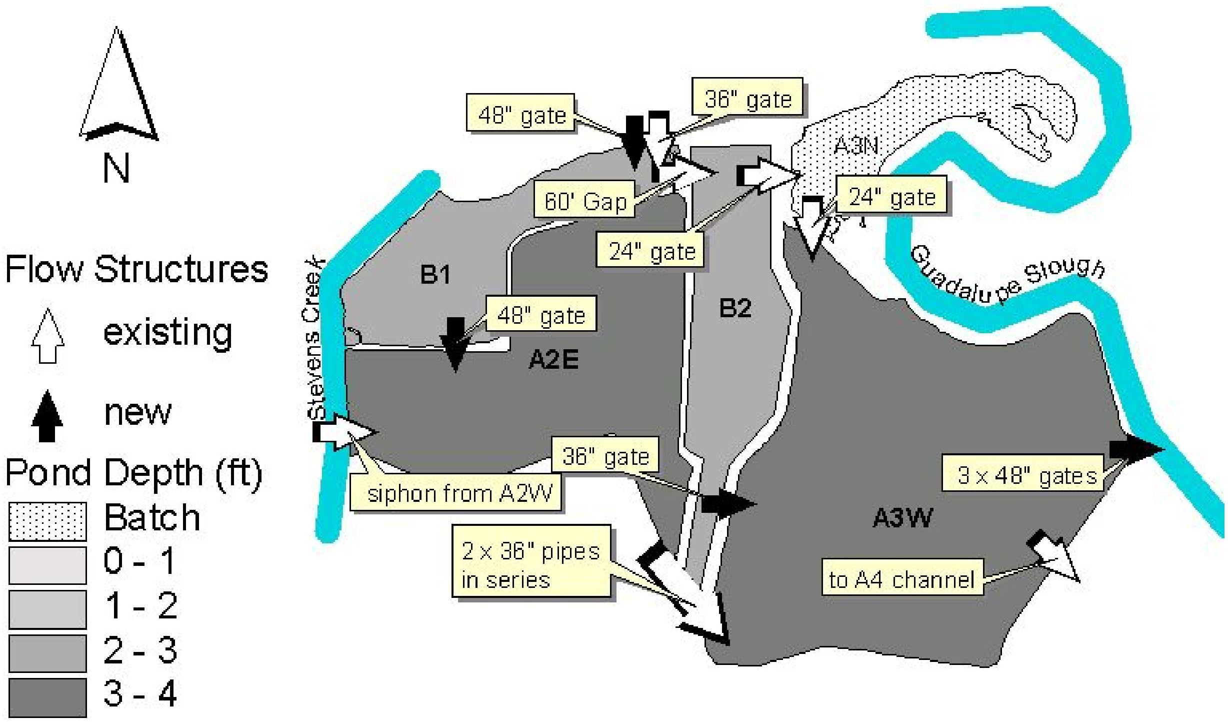


Objectives

1. Maintain full tidal circulation through ponds B1, B2, A2E, and A3W while maintaining discharge salinities to Guadalupe Slough at less than 40 parts per thousand (ppt) and meet the other water quality requirements in the Water Board's Waste Discharge Permit. This program will also include monitoring for pH, dissolved oxygen (DO), temperature, avian botulism, and potential for inorganic mobilization.

2. Maintain pond A3N as a seasonal pond. If results of wildlife population monitoring indicate the need, operate pond A3N as a batch pond (i.e., at higher salinities).

3. Maintain water surface levels lower in winter to reduce potential overtopping of A3W levee adjacent to Moffett Field.

Structures

The A3W system includes the following structures needed for water circulation in the ponds:

- Existing 36" gate intake structure from the Bay at B1
- New 48" gate intake from the Bay at B1
- New 48" gate between B1 and A2E

- Existing 2x36” pipes in series between A2E and A3W (no gates).
- New 36” gate between B2 and A3W
- Existing gap between B1 and B2
- Existing 24” gate between B2 and A3N
- Existing 24” gate between A3N and A3W
- New 3x48” gate outlet at A3W to Guadalupe Slough. Two are outlet only, and one allows both inflow and outflow, no weir.
- Existing staff gauges at all ponds and new NGVD gauges at all ponds
- Existing siphon from A2W is closed, but available if needed

System Description

The intake for the A3W system is located at the northeast end of pond B1 and includes one 48” gate and one 36” gate from the bay. The system outlet is located at the eastern end of pond A3W, with three 48” gates into Guadalupe Slough. The normal flow through the system follows two parallel routes. One route is from B1 to A2E and then to A3W. The second route is from B1 to B2 and then to A3W. Flow through the two routes is controlled by gates from B1 to A2E, and from B2 to A3W. There is an uncontrolled gap between ponds B1 and B2. Due to the size of pond A2E, the majority of the flow should be through A2E, with only minimal circulation flow through B2. Because of the flap gates and the relative elevation of the tides and pond levels, all gravity intake flow would occur at high tide, and all outflows would occur when the tide is below 3.1 ft. MLLW.

Pond A3N is a seasonal pond. Therefore, for the ISP period, the pond will be drained, and left to partially fill with rain water during the winter and to evaporate completely during the summer. However, if wildlife population monitoring during this period indicates the need for additional higher salinity habitats or if mercury monitoring indicates an increase in methylation due to reduction in water levels, Pond A3N could be operated as a batch pond.

Summer Operation

The summer operation is intended to provide circulation flow to makeup for evaporation during the summer season. The average total circulation inflow is approximately 35 cfs, or 70 acre-feet/day. The summer operation would normally extend from May through October.

Summer Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
B1	142	-0.8	0.4	1.3
B2	170	-0.6	0.4	1.3
A2E	310	-3.1	-0.5	3.0
A3W	560	-3.2	-1.4	2.1
A3N	163	-1.4	NA	NA

* Pond B1 and B2 will be operated at lower water levels on an experimental basis in an attempt to improve shorebird nesting and foraging habitat. If water quality or operations are jeopardized from lower water levels in Ponds B1 or B2, the system will be reverted back to normal operating levels.

Summer Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
B1 west intake	100	36
B1 east intake	90	39
B1 – A2E	38	14
A2E – A3W	NA	NA
B2 – A3W	41	12
A3W outlets	100	48
A3W intake	0	0
B2 – A3N	0	0
A3N – A3W	0	0

Water Level Control

The water level in A3W is the primary control for the pond system. The system flow is limited by the outlet capacity. Normal operation would have the outlet gates fully open. Water levels are controlled by the intake gate settings. The normal water level in A3W should be at -1.4 ft NGVD (2.1 ft gage). The level may vary by 0.2 due to the influence of weak and strong tides.

The flow through B2 to A3W is only required to maintain circulation through B2. This circulation prevents local stagnant areas which may create areas of higher salinity or algal blooms. The gate can be set to a standard opening and would not require frequent adjustment.

The flow through A2E is controlled by the gates from B1 to A2E. The partial gate opening is to maintain the water level differences between A2E and B1. Again, the setting should not require frequent adjustment. There are no gates on the culverts between A2E and A3W, therefore the water levels in those two ponds should be similar.

The B1 intake gates should be adjusted to control the overall flow though the system. The water levels in B1 (and therefore B2) will change due to the change in inflow. The maximum water level should be less than 1.6 ft NGVD (2.5 ft gage). This is to maintain freeboard on the internal levees and limit wind wave erosion.

Water levels in Pond AB1 and Pond AB2 of Pond A3W system will be lowered during the summer to improve shorebird nesting and foraging habitat

Design Water Level Ranges

Pond	Design Water Level Elev. (ft, NGVD)	Maximum Water Elev. (ft, NGVD)	Maximum Water Level (ft, Staff Gage)	Minimum Water Elev. (ft, NGVD)	Minimum Water Level (ft, Staff Gage)
B1	0.4	1.6	2.5	-0.2	0.7
B2	0.4	1.6	2.5	-0.2	0.7
A2E	-0.5	-0.2	3.3	-2.0	1.5
A3W	-1.4	-0.2	3.3	-2.0	1.5
A3N	NA	NA	2.6	NA	NA

The minimum and maximum water levels are based on our observations in the ponds for the period 2005.

100 Percent Coverage Water Level

Pond	Design Water Level Elev. (ft, NGVD)	100 % Coverage Water Elev. (ft, NGVD)	100 % Coverage Water Level (ft, Staff Gage)
B1	0.4	-0.8	0.1
B2	0.4	-0.8	0.1
A2E	-0.5	-2.2	1.3
A3W	-1.4	-2.7	0.8
A3N	NA	NA	NA

The 100 percent coverage values represent the estimated water level which begins to expose part of the pond bottom area. Lower water levels would expose large areas of the pond bottom to drying and may cause odor problems.

Salinity Control

The summer salinity in the system will increase from the intake at B1 to the outlet at A3W, due to evaporation within the system. The design maximum salinity for the discharge at A3W is 40 ppt. The intake flow at B1 should be increased when the salinity in A3W is close to 35 ppt. Increased flow will increase the water level in A3W. Water levels in pond A3W above elevation -0.2 ft NGVD (3.3 ft gauge) should be avoided as they may increase wave erosion of the levees.

Dissolved Oxygen and pH Control

If summer monitoring shows that DO levels in discharges from the Pond A3W fall below a 10th percentile of 3.3 mg/L (calculated on a calendar weekly basis), the FWS will accelerate receiving water monitoring to weekly, conduct within-pond monitoring and notify and consult with the

Water Board as to which Best Management Practices described below for increasing dissolved oxygen levels in discharge water should be implemented:

1. Increase the flows in the system by opening the B1 inlet further. If increased flows are not possible, open A3W gate to allow the pond to become fully muted tidal or partially muted tidal system until pond DO levels revert to levels at or above conditions in the slough.

2. Set in a series of flow diversion baffles at the pond discharge for directing the water from more suitable DO water levels to achieve maximum oxygen uptake.

3. Cease nighttime discharges due to diurnal pattern.

4. Close discharge gates completely until DO levels meet standards.

5. Close discharge gates completely for a period of time each month when low tides occur primarily at night.

6. Mechanically harvest dead algae.
.

The pH of the discharge is related to the DO of the discharge. If the pH of the discharge falls outside the range of 6.5 – 8.5, an analysis of the impact of discharging pH on the receiving waters will be performed. If it is determined that discharge is impacting receiving water pH outside the range of 6.5 – 8.5, ammonia monitoring in the receiving water will be done to document potential toxicity affects associated with unionized ammonia.

To help minimize significant downtime on continuous monitoring devices used for DO and pH, the FWS will:

1. Have an extra monitor on hand, in case there is a break down.

2. Get a loaner unit through Hydrolab (within a week), if the extra monitor is being used.

3. Work with Hydrolab to insure a quick repair of monitors (within 2 weeks).

Avian botulism

Avian botulism outbreaks most typically occur in late summer/early fall when warm temperatures and an abundance of decaying organic matter (vegetation and invertebrates) combine to present ideal conditions for the anaerobic soil bacterium *Clostridium botulism* along water bodies. If summer monitoring shows that DO levels in the pond drop the BMPs listed under the section on Dissolved Oxygen and pH Control will be implemented to increase the DO. Monitoring of weather for long periods of hot, dry, windless days during late August and early September will trigger on the ground monitoring for any signs of botulism. FWS will be in contact with the adjacent landowners such as the San Jose and Sunnyvale Treatment plants to determine if botulism is occurring on their ponds. Additionally, if any bird carcasses in the ponds or nearby receiving waters are observed, they will be promptly collected and disposed of.

Winter Operation

The winter operation is intended to provide less circulation flow than the summer operation. Evaporation is normally minimal during the winter. The winter operation is intended to limit large inflows during storm tide periods and to allow rain water to drain from the system.

The average total circulation inflow is approximately 16 cfs, or 32 acre-feet/day, with an average outflow of approximately 18 cfs (36 acre-feet per day). The winter operation period would normally extend from November through April. The proposed gate settings are intended to limit the intake flow, and flow within the system.

Winter Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
B1	142	-0.8	0.9	1.8
B2	170	-0.6	0.9	1.8
A2E	310	-3.1	-1.8	1.7
A3W	560	-3.2	-1.8	1.7
A3N	163	-1.4	NA	NA

Winter Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
B1 west intake	34	10
B1 east intake	25	10
B1 – A2E	16	6
A2E – A3W	NA	NA
B2 – A3W	21	6
A3W outlets	100	48
A3W intake	0	0
B2 – A3N	0	0
A3N – A3W	0	0

Water Level Control

The water level in A3W is the primary control for the pond system. The system flow is limited by the outlet capacity. Normal winter operation would have the A3W outlet gates fully open. Water levels are controlled by the intake gate settings. The normal water level in A3W should be near -1.8 ft NGVD (1.7 ft gage). The level may vary by 0.2 due to the influence of weak and strong tides, storm tides, and rainfall inflows.

The water levels in A3W are important to prevent levee overtopping. The south levee separates the pond from the Moffit Field drainage ditch. The levee is low, and subject to erosion with high water levels. If the water level in A3W exceeds -0.6 ft NGVD (2.9 ft gage), the intake gate openings at B1 should be reduced or closed. The internal gates from B1 and B2 would also require adjustment. If the water level in A3W exceeds -0.2 ft NGVD (3.3 ft gauge), the intake gates and all internal gates should be closed until the water level in A3W is back to normal. This may take one to two weeks depending on the weather. The water levels in the upper ponds (B1, B2, and A2E) may increase due to rainfall during this period, but are less sensitive to higher water levels. The historic high elevation in pond A3W has been -0.2 ft NGVD (3.3 ft gauge).

Whenever possible, the system intake at B1 should be closed in anticipation of heavy winter rains and high tides. When the system intake gates are closed, the internal gates from B1 to A2E and from B2 to A3W should also be closed to keep water in the upper ponds (B1 and B2).

There is no gate between A2E and A3W. During winter operations with reduced flows through the system, the A2E water level will be similar to the A3W water level. During the summer, the higher flows will establish approximately 0.9 ft difference due to the head loss through the two pipes in series which connect the ponds.

Salinity Control

The winter salinity in the system may decrease from the intake at B1 to the outlet at A3W, due to rainfall inflows within the system, which may exceed winter evaporation. During very wet winters, the intake salinities and system salinities may decrease to as low as 10 ppt.

Monitoring

The system monitoring will require weekly site visits to record pond and intake readings, as well as to inspect water control structures, siphons and levees. The monitoring parameters are listed below.

Weekly Monitoring Program

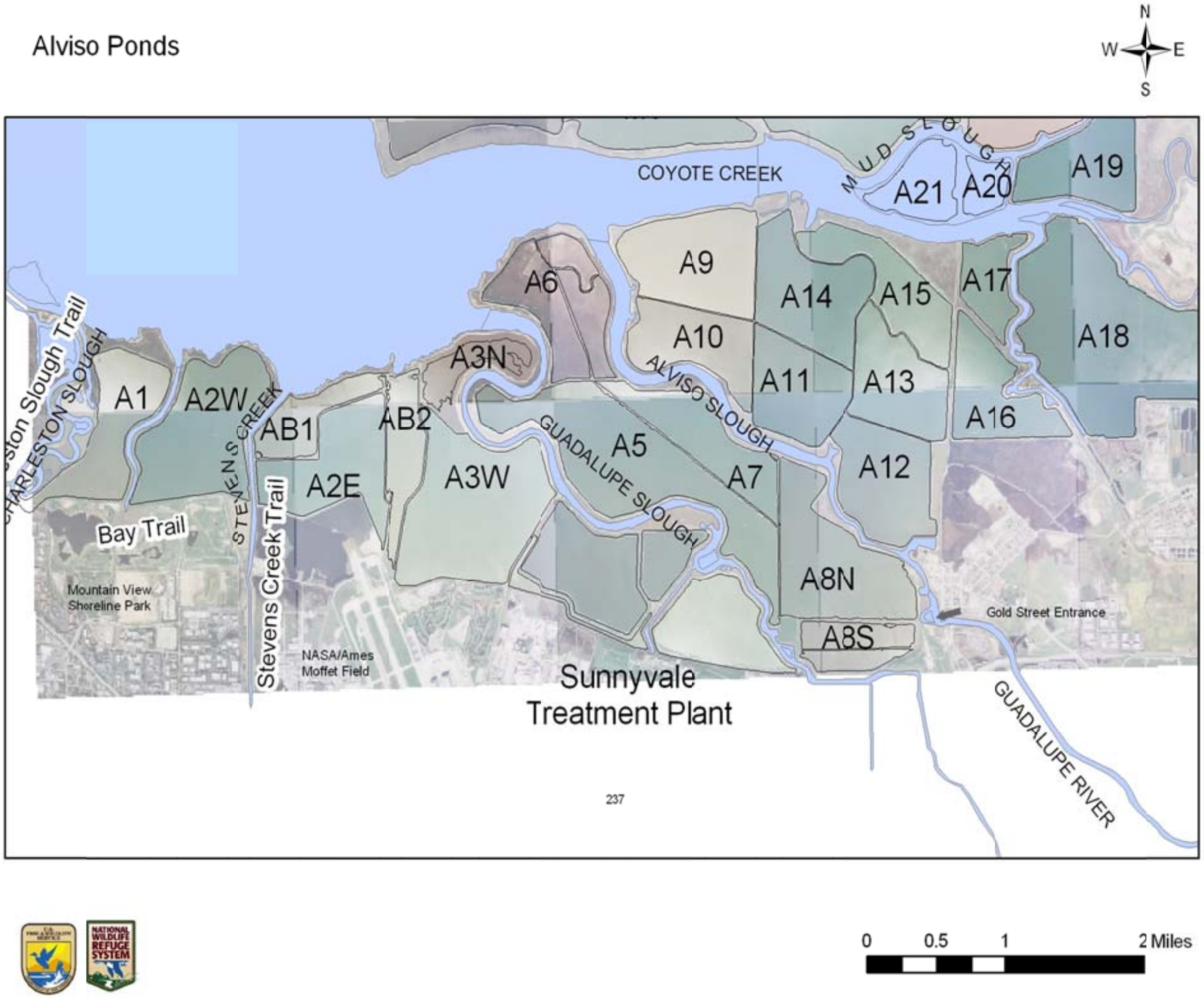
Location	Parameter
B1 intakes	Salinity
B1	Depth, Salinity, Observations
B2	Depth, Salinity, Observations
A2E	Depth, Salinity, Observations
A3W	Depth, Salinity, Observations
A3N	Depth, Salinity, Observations

The weekly monitoring program will include visual pond observations to locate potential algae buildup or signs of avian botulism, as well as visual inspections of water control structures, siphons and levees. This program will also include supplementary DO monitoring when problems are identified in the formal monitoring listed below.

Location	**Frequency**	**Parameters**
A3W(discharge)	Continuous (May-Oct)	DO, pH, Temp., Salinity
Guadalupe.Sl.	Monthly (July –Oct)	DO, pH, Temp., Salinity

Appendix F
2011 Alviso Pond A8 Operation Plan

Pond System A8 Water Management Operation Plan – 2011



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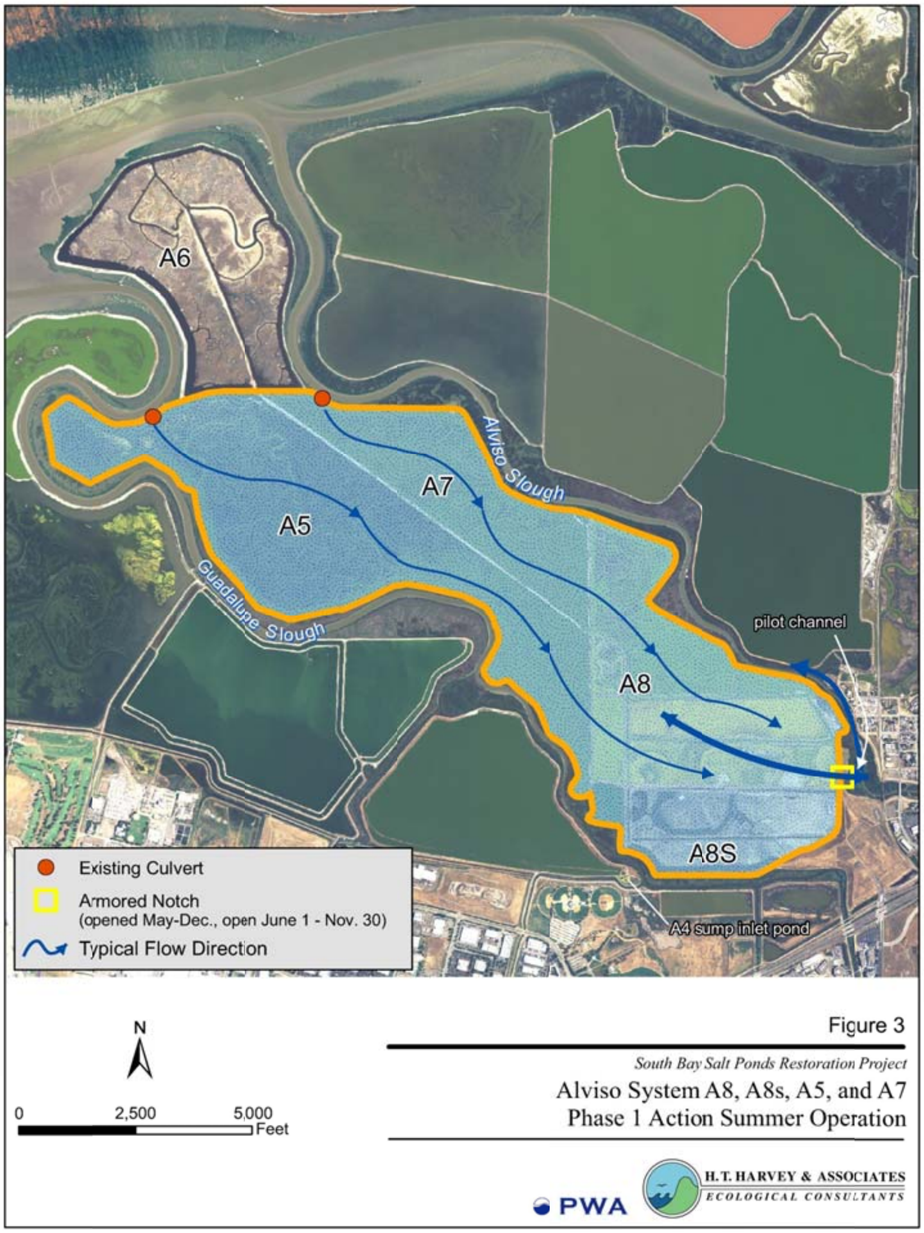

Map provided by Philip Williams and Associates (PWA)

Goals

The Phase 1 action at Pond A8 is one of the initial actions for implementation under the larger South Bay Salt Pond (SBSP) Restoration Project. Pond A8 is identified as tidal habitat in the long-term programmatic restoration of the SBSP Restoration Project, which would contribute to achieving the overarching project goal of restoring wetland habitat while providing for flood management and wildlife-oriented public access and recreation (U.S. Fish and Wildlife Service et al. 2007). The Pond A8 system will be operated to maintain muted tidal circulation through ponds A5, A7, A8N and A8S while maintaining discharge salinities to the Bay at less than 40 ppt. Other water quality requirements in the Regional Water Quality Control Board's (RWQCB's) Waste Discharge Requirements (Order No. R2-2008-078) include monitoring for pH, dissolved oxygen, temperature, avian botulism, and mercury methylation.

Pond A8 is located within the Alviso pond complex between Alviso and Guadalupe Sloughs in South San Francisco Bay. The pond was historically part of a larger tidal marsh, which was diked in the mid-1900s for salt production. Perimeter levees separate the pond from Alviso Slough to the northeast and Guadalupe Slough to the southwest. Internal levees separate Pond A8 from adjacent Ponds A5 and A7 and divide Pond A8 into Ponds A8N and A8S. Deeper borrow ditches surround the ponds along the inboard side of the levees (PWA et al. 2008).

This Phase 1 action would introduce muted tidal exchange to create approximately 400 acres of muted tidal habitat within Pond A8, and modify water depths in approximately 1,000 additional acres of existing shallow water habitat in Ponds A5 and A7. Restoration of tidal action at Pond A8 is designed to be adaptable and reversible so that in the event that unacceptable environmental impacts begin to occur, tidal exchange to Pond A8 can be modified or eliminated to prevent long-term adverse impacts. If needed, water management at Ponds A5 and A7 can revert to ISP operations. Adaptive management experiments associated with the Phase 1 action will study the effects of increased mercury exposure on the food web of the South Bay. The mercury study will monitor bioaccumulation across a variety of estuarine and managed pond habitats to assess potential impacts of restoration and management actions on wildlife (PWA et al. 2008).

The following goals have been identified to guide the design of the Phase 1 action at Pond A8 (PWA et al. 2008).

- Enlarge the Alviso Slough channel in a way that can be sustained by natural tidal flows. Do not increase peak water levels or erode levees along Alviso Slough, particularly those along the east side of the slough.

- Provide a cost-effective project that reflects the expected 10 -50 year lifecycle expected of notch structure. The goal is that in 10 or 15 years the SBSP Restoration Project would have direction on whether to pursue full tidal restoration of Pond A8 or to maintain ISP or other pond management operations. Both directions entail the permanent removal of Phase 1 structures. Channel enlargement through tidal scour is a central component of the SBSP sustainable flood management approach and will provide public access improvements for small craft navigation along Alviso Slough

- To the extent possible given other goals, encourage conversion of tall-form brackish marsh vegetation to short-form salt marsh vegetation by increasing salinities along Alviso Slough. Vegetation conversion would enhance public access (small craft navigation).

There are three vertical datums mentioned in this plan. The FWS currently uses NGVD29 in the ponds to calculate water levels. To correlate the different data sets, use the following relationships:

NAVD88 = NGVD29 + 2.7 feet
MLLW = NAVD88 + 1.97 feet

Structures

The A8 system includes the following structures needed for water circulation in the ponds:

- Existing 2x48” gate intake at A5 from Guadalupe Slough.
- Existing 2x48” gate inlet with two 24’ weir boxes at A7 from Alviso Slough.
- Existing staff gages in ponds; Existing NGVD gages at A5 and A7 structures (see Figure 2).
- Existing 36” gate between A7 and A8N.
- Existing siphon between A4 to A5 will generally be closed, this siphon is pump driven rather than gravity fed.
- New 40 ft. armored notch with multiple bays that can be opened and closed independently.

Figure 2: Water Level Gauge Locations

2.1 Weir Structure

Under existing conditions, the Alviso Slough channel does not have the capacity to convey the 100-yr design storm of 18,300 cfs (at the UPRR Bridge) to the Bay (Santa Clara Valley Water District 2001). Therefore, a portion of the levee adjacent to Pond A8 was reconfigured as part of the Lower Guadalupe River Flood Protection Project (LGRFPP) to act as an overflow weir and take advantage of the off-line storage provided by the Pond A8 system. The LGRFPP was constructed by the Santa Clara Valley Water District (SCVWD) on the Guadalupe River/Alviso Slough between Highway 101 and Alviso Marina County Park. The focus of the LGRFPP was primarily to address the Guadalupe River contribution to flood conditions in the area. In addition to the Pond A8 overflow weir, project work included: construction of floodwalls or raising levees along the river banks; replacement of the Highway 237 eastbound bridge; modification of storm drain outfalls; improvement and construction of maintenance roads and under-crossings; improvement of the west perimeter levee around Alviso and construction of grade-control weirs (gradual drops in the stream elevation) (Santa Clara Valley Water District 2001).
The 1,000-ft long overflow weir at Pond A8 allows high flood flows to exit Alviso Slough when water levels reach approximately 10.5 ft NAVD88. Due to the relatively low elevation of interior

pond levees, flood water stored in Pond A8 would spill into Pond A8S (at 2.5 ft NAVD88), Pond A5 (at 3.25 ft NAVD88), Pond A7 (4.0 ft NAVD88), and eventually Pond A6 (at 10.0 ft NAVD88), (PWA et al. 2008).

2.2 A4 Siphon

The SCVWD may request to pump water from Pond A4 into Pond A5. At that time, SCVWD will provide monitoring data from Ponds A3W, A4 and A5 twice weekly, in accordance with the Pond A4 Water Management Operations Plan (December 2005) to assure that A8 discharges will remain below RWQCB permit limits. The Fish and Wildlife Service (USFWS) may also desire to pump water from Pond A4 into Pond A5 and may request SCVWD to do so. Operations of the A4 siphon will be consistent with the A4 MOU agreement between SCVWD and USFWS which was established in 2005.

2.3 Notch / Bridge Structure

The armored notch provides a muted-tidal connection between Pond A8 and upper Alviso Slough. Earth excavated to construct the notch has been placed within Pond A8 and covered by clean sediment. The notch width is adjustable up to approximately 40 ft. The depth of the notch (invert at 0.5 ft NAVD88) is approximately one foot above the average bed elevation (-0.5 ft NAVD88). The size of this structure was to maximize the volume of water exchanged between the slough and the pond while controlling water levels within the pond. The notch consists of multiple ‘bays’ that can be opened and closed independently. This allows for adjustments to the amount of tidal exchange between Pond A8 and Alviso Slough based on monitoring data. Initially, the notch is to be operated with only one bay open. Additional bays may be opened if monitoring data confirm that slough widening does not threaten downstream levees, in particular the levees along the east side of Alviso Slough (perimeter levees to Ponds A11 and A12). Flow through the notch occurs during both flood and ebb tides. Concrete armoring is to prevent unintentional widening and/or deepening of the notch. Vehicle access over the notch for maintenance of the overflow weir and management of flashboards is provided by a bridge that spans the 40-ft notch (PWA et al. 2008). The FWS at its own expense operates and maintains the notch, bridge, and access levees and insures that the notch remains fully functional. As part of the preventive maintenance, the FWS performs weekly monitoring for the notch, bridge, channels, weir boards, and access levees to document areas for repair. FWS staff will be monitoring for erosion, cracks, missing or defective pieces, vandalism, or any normal and/or abnormal wear that was not part of the original construction. Once these repair items have been identified, FWS staff will inform Refuge Manager of repairs needed to keep these improvements in fully functioning condition.

3. System Description

The Pond A8 project consists of a variety of elements that allow for a muted-tidal connection from adjacent slough to Ponds A8, A5 and A7. The notch can be closed if there is evidence of adverse environmental impact. Water exchange through this connection is limited and the tidal range within the ponds is muted. With a fully open notch, water level fluctuations in the ponds over a tidal cycle were predicted to be small (0.5 to 1 ft) compared to the range of tidal change in Alviso Slough (over 8 ft). Initially, water level fluctuations in the ponds are predicted to be less as the notch is to be only partially open. Water levels in Pond A8 were predicted to exceed elevations of internal levees, spill into adjacent Ponds A8S, A5 and A7 and modify the existing hydrologic regime in these ponds as well. Water levels were predicted to fluctuate over the tidal cycle evenly across the area of all the ponds, and depths vary due to differences in bed elevations. Depths were predicted to exceed those at which the ponds were managed under the ISP (<1 foot). Typical summer water levels are shown in Table 1.

A notch with multiple bays adds operational flexibility, and the operation of the notch is informed by on-going monitoring activities. Initially, the notch will be operated with one (5 ft) bay open during the dry season (summer and fall) in order to avoid excessive channel widening and possible erosion of perimeter levees along Alviso Slough and the former salt ponds (e.g., the A12 levee at the A8 'Bulge'). Depending on the actual channel widening observed and the amount of fringing marsh remaining, the notch width may gradually be increased up to its full 40-ft width. If monitoring indicates a substantial risk to the structural integrity of perimeter pond levees, additional channel scour could be halted by reducing the restored tidal prism. Closing one or more of the multiple bays provides this flexibility.

Table 1. Summer Pond Water Levels

Pond	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A5	-0.9	1.4	2.9
A7	-0.8	1.4	2.8
A8N	-3.6	1.4	NA
A8S	-3.5	1.4	NA

The intakes for the A8 system are located at the northwest end of pond A5 (two 48-inch gated culverts from lower Guadalupe Slough and at the northeast end of pond A7 (two 48-inch gated culverts from Alviso Slough. The discharge point is located at the east end of Pond A8 with a 40 foot notch which has adjustable independent bays that allows flood and ebb flow. In normal operations, the flow through the system starts at the intakes of A5 and A7, and then muted tidal at the notch in Pond A8. Because of the flap gates and the relative elevation of the tides and pond levels, all gravity intake flow occurs at high tide, and all outflows occurs when the tide is below 8.12 ft. MLLW. The standard summer operation gate settings are shown in Table 2.

Table 2. Summer Gate Settings

Gate	Setting (% open)	# of gates and size
A5 intakes	100	2 X 48"
A7 intakes	100	2 X 48"
Notch	1 bay of boards to begin	1 of 8 bays

3.1 Water Level Control

The water level in A8 is the primary control for the pond system. The 40 foot notch at Pond A8 includes multiple bays that can be adjusted to reach desired pond depth. The intake gate settings or notch may be used to limit flow through the system. The system flow is limited by the outlet capacity. Normal operation is to have the intake gates fully open, and the initial notch setting is to have one bay fully open. The normal water level in A8 will normally be at 1.4 ft NGVD in summer (see Table 3). The level may vary by 0.2 feet due to the influence of weak and strong tides.

The A5 and A7 intake gates can be adjusted to control the overall flow though the system. The maximum water level in A5, A7, and A8 is to be less than 1.6 ft NGVD. This is to maintain freeboard on the external levees, limit wind wave erosion, and to preserve remnant lengths of islands within the system occupied by nesting birds. If future monitoring efforts result in re-evaluating the maximum level, the FWS will verbally consult with the SCVWD to determine appropriate water levels. Additionally, the extent of tidal exchange needs to be adjustable such than corrective actions can be taken if needed to avoid increases in flood hazards to the community of Alviso.

Table 3. Design Water Level Ranges

Pond	Design Water Level Elev. (ft, NGVD)	Maximum Water Elev. (ft, NGVD)	Maximum Water Level (ft, Staff Gage)	Minimum Water Elev. (ft, NGVD)	Minimum Water Level (ft, Staff Gage)
A5	1.4	1.6	3.1	0.9	2.2
A7	1.4	1.6	3.0	0.9	2.1
A8	1.4	1.6	NA	0.9	NA

Table 4. 100 Percent Coverage Water Level

Pond	Design Water Level Elev. (ft, NGVD)	100 % Coverage Water Elev. (ft, NGVD)	100 % Coverage Water Level (ft, Staff Gage)
A5	1.4	0.2	1.4
A7	1.4	0.2	1.4
A8	1.4	-2.5	NA

Table 4 shows the water elevation needed to cover the pond bottom. The 100 percent coverage values represent the estimated water level which begins to expose part of the pond bottom area. Lower water levels would expose large areas of the pond bottom to drying and may cause odor problems.

3.2 Channel Erosion along Alviso Slough

Restoration of muted tidal action at Pond A8 is expected to deepen and widen the channel along the upper
(landward) portion of Alviso Slough due to substantial increases in the slough tidal prism. The magnitude of tidal current velocities and associated slough scour would be related to the size of the notch opening, with less deepening and widening occurring with fewer open bays. These potential changes would increase the ability of the slough channel to convey flood flows and lower water levels associated with large rainfall-runoff events on the Guadalupe River. However, restoration of muted tides in Ponds A8, A7 and A5 during the rainy season would also reduce the amount of flood storage provided by these ponds and possibly result in higher maximum water elevations along Guadalupe Slough. The Phase 1 action at Pond A8 would provide an opportunity to assess the changing flood conveyance along Alviso Slough and determine if flood hazards are decreased over both the short- and long-term. Monitoring data of slough scour and tidal regime would provide the necessary information to examine changes to baseline flood hazards. If it is determined that changes in channel conveyance always compensate for losses of flood storage, seasonal management of the Phase 1 notch could be modified (PWA et al. 2008).

3.3 Water Quality Monitoring

Water quality monitoring is conducted as stated in Attachment D of the RWQCB Order No. R2-2008-078. A continuous monitor at the notch location records several water quality parameters. Weekly checks are made to clean and download data from the monitor. Monthly grab samples are conducted in the receiving waters to record if any impacts are occurring. The monitoring season is conducted from May through October each year with an annual report provided to the RWQCB.

3.4 Avian botulism

Avian botulism outbreaks most typically occur in late summer/early fall when warm temperatures and an abundance of decaying organic matter (vegetation and invertebrates) combine to present ideal conditions for the anaerobic soil bacterium *Clostridium botulinum* along water bodies. Monitoring of weather for long periods of hot, dry, windless days during late August and early September will trigger on the ground monitoring for any signs of botulism. FWS will be in contact with the adjacent landowners such as the San Jose and Sunnyvale Treatment plants to determine if botulism is occurring on their ponds. Additionally, if any bird carcasses in the ponds or nearby receiving waters are observed, they will be promptly collected and disposed of. Historically, Ponds A5 and A7 were susceptible to botulism outbreaks due to a shallow water depth and pond dynamics. At A8, the raised waters levels within the system should reduce potential botulism outbreaks.

3.5 Winter Operation

The notch is closed during winter months (December – May) to prevent entrapment of migrating salmonids. During these winter months, Pond A8 system is operated by closing the inlets at A5 and A7 and allowing them to discharge only until waters levels within Ponds A5 and A7 are at or below 0.6 NGVD. The gate between A7 and A8 is also opened to lower water levels in A8. Once the winter operation target level is reached at Pond A5, both A5 and A7 is operated as muted tidal as part of the FWS permit requirements stated in National Marine Fisheries Service (NMFS) biological opinion (NMFS et al. 2009). Table 5 shows the target water levels for winter operation. During winter operations, if the water levels exceed approximately 0.6 ft NGVD, the A5 intake will be closed to allow the excess water to drain. Note that without pumping, rainfall or inflow, it will take approximately 3 weeks to drain 1.0 ft from the ponds. If water levels exceed the capacity of Pond A8, SCVWD will use pumps to remove excess water at various locations stated in the Pond A8 Floodwater Evacuation Plan (2006). With the pumping described in the 2006 plan, the pond should be returned to the beginning winter operations water level within 40 days.

Winter operation provides less circulation flow than the summer operation. Evaporation is normally minimal during the winter. Winter operation is to limit large inflows during storm tide periods to allow rain water to drain from the system, and maintain flood storage for the Guadalupe River. The Pond A8 system (Ponds A5, A6, A7, and A8) currently provides flood overflow storage and conveyance of Guadalupe River/Alviso Slough flows via the Pond A8 overflow weir along Alviso Slough. The Phase 1 action must maintain or improve current levels of flood protection. This includes avoiding unintentional breaching of downstream perimeter levees due to channel widening. Table 6 shows the winter gate settings which are based on visual observations of water elevations that provide enough water in the ponds to prevent mud flats from occurring, and not yet too high to overtop internal levees.

Table 5. Winter Pond Water Levels

Pond	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A5	-0.9	0.6	1.8
A7	-0.8	0.6	NA
A8N	-3.6	NA	NA
A8S	-3.5		

Table 6. Winter Gate Settings

Gate	Setting (% open)	# of gates and size
A5	100	2 X 48”
A7	100	2 X 48”
A8 Notch	Closed	Closed

4. Monitoring

The system monitoring requires weekly site visits to record pond and intake readings. The monitoring parameters are listed below in Table 7.

Table 7. Weekly Monitoring by Refuge staff

Location	Parameter
A5	Depth, Observations
A7	Depth, Observations
A8	Depth, Salinity, Observations

The weekly monitoring program includes visual pond observations to locate potential algae buildup or signs of avian botulism, as well as visual inspections of water control structures, siphons and levees. This program also includes supplementary DO monitoring when problems are identified in the formal monitoring listed below in Table 8.

Table 8. Additional Refuge monitoring required by the RWQCB discharge requirements

Location	Frequency	Parameters
A8 notch (discharge)	Continuous (May-Oct)	DO, pH, Temp., Salinity
Alviso Slough	Monthly (May –Oct)	DO, pH, Temp., Salinity

4.1 Mercury

Sediments in some parts of Pond A8, particularly in and along Alviso Slough, contain elevated levels of mercury contamination. Re-mobilization of mercury-contaminated sediments into the water column, either directly (e.g., during excavation of pilot channels) or indirectly (through increased sediment scour after the pond is opened to tidal action), could result in adverse effects on South Bay biota.

South Baylands Mercury Project started in 2006 to assess the risks associated with restoring pond A8 to tidal action and to collect baseline data prior to breaching. This study established baseline mercury levels in the sediment, water column, and various sentinel species (song sparrows, brine flies, long jawed mud suckers, silver sides, stickleback, killi fish, and yellow fin gobies); bioavailability of inorganic mercury in sediments; mercury methylation across salinity gradients in managed ponds, marshes, and other habitat types. These baseline data may be influenced by direction and/or future requirements imposed by regulatory agencies (including the RWQCB), as well as findings from other applied studies or scientific research. These baseline data will be used to inform management decisions to further minimize mercury exposure. Specifically, exceedence beyond the baseline levels will be cause for changing management of the armored notch.

Future mercury monitoring projects will be developed to advance the understanding of uncertainties faced by the project. If the change in operation of the pond by opening the notch results in a negative effect on the local environment, the notch may be operated differently or closed following the process described in the Memorandum of Agreement between FWS and the SCVWD. Alternatively, if there is not a negative effect or the benefits of tidal restoration appear to outweigh any negative effect, the FWS will consider beginning the planning process for full tidal restoration of Pond A8.

4.2 Alviso Slough Channel Scour and Effects on Downstream Levees

The SCVWD will monitor scour effects in Alviso Slough, as specified in the Memorandum of Agreement between FWS and the SCVWD. Monitoring will consist of taking cross-sections at two points in the slough annually to assess potential impacts to the FWS-owned levee bordering Pond A12 and the District-owned levee upstream (see Figure 2). The purpose for these inspections is to determine if operations of the notch have produced undesired scour or other undesired conditions, as described below. The District will provide results of its monitoring in an annual report to the FWS. If undesired scour of either levee occurs or other undesired condition is observed, the FWS will close the notch and promptly notify all the members of the SBSP Restoration Project Management Team (PMT), in writing. A meeting of the PMT will be convened to discuss and determine Adaptive Management actions as soon as possible to determine the appropriate course of action regarding the operation of the Armored Notch (e.g., changing Armored Notch operation).

As part of the regular monitoring conducted by FWS, FWS staff will visually inspect the levees downstream of the armored notch. Any of the following is considered to be an undesired condition:

1. Sloughing, scarps, or bulges in the levee slope
2. Ruts, rills, and erosion on the levee slope.
3. Cracks - transverse, longitudinal, or diagonal crack anywhere on the levee
4. Seepage- water emerging on slope, at toe, or beyond the toe of the levee
5. Sinkholes and/or animal burrows anywhere on the levee

4.3 Fish Entrapment

The notch is closed seasonally from December 1 through May 31 to prevent migrating salmonids from swimming up current into Pond A8 and becoming entrapped. An applied study will be developed to address the potential for fish entrapment. The exact timing and study design will be based on timing of the availability of funding. If future studies performed pursuant to the NMFS biological opinion demonstrate no impact to salmonids, i.e., entrapment of smolts and adults within the pond, the notch may be allowed to remain open during winter months of December 1 through May 31, pending approval from NMFS.

4.4 Flood Storage Capacity

The Pond A8 system (Ponds A5, A6, A7, and A8) currently provides flood overflow storage and conveyance of Guadalupe River/Alviso Slough flows via the Pond A8 overflow weir along

Alviso Slough. The Phase 1 action must maintain or improve current levels of flood protection. It is predicted by Phillip Williams and Associates (PWA) that the water surface elevation will decrease with the notch fully open. If future studies such as Mercury, channel scour, and fish entrapment prove to show no unacceptable risks, the notch can be operated fully open year round. Until the notch is fully open year round, winter operations (refer to winter operations 3.5) will be followed to maintain existing flood storage capacity.

Figure 3. Monitoring locations of Alviso Slough for erosion

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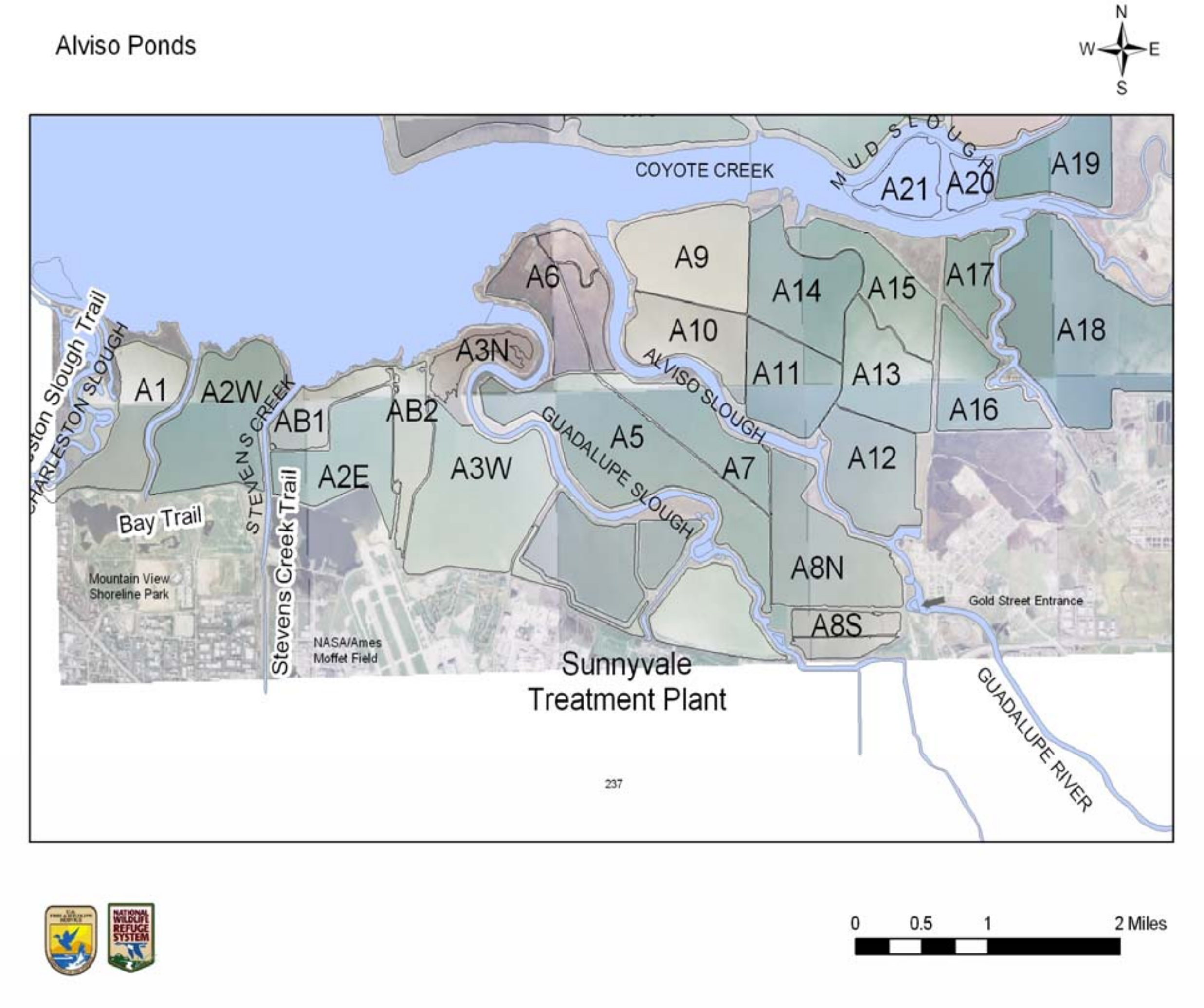
APPENDIX G
ALVISO POND A14 OPERATION PLAN

Pond System A14 Water Management Operation Plan – Alviso System 2010



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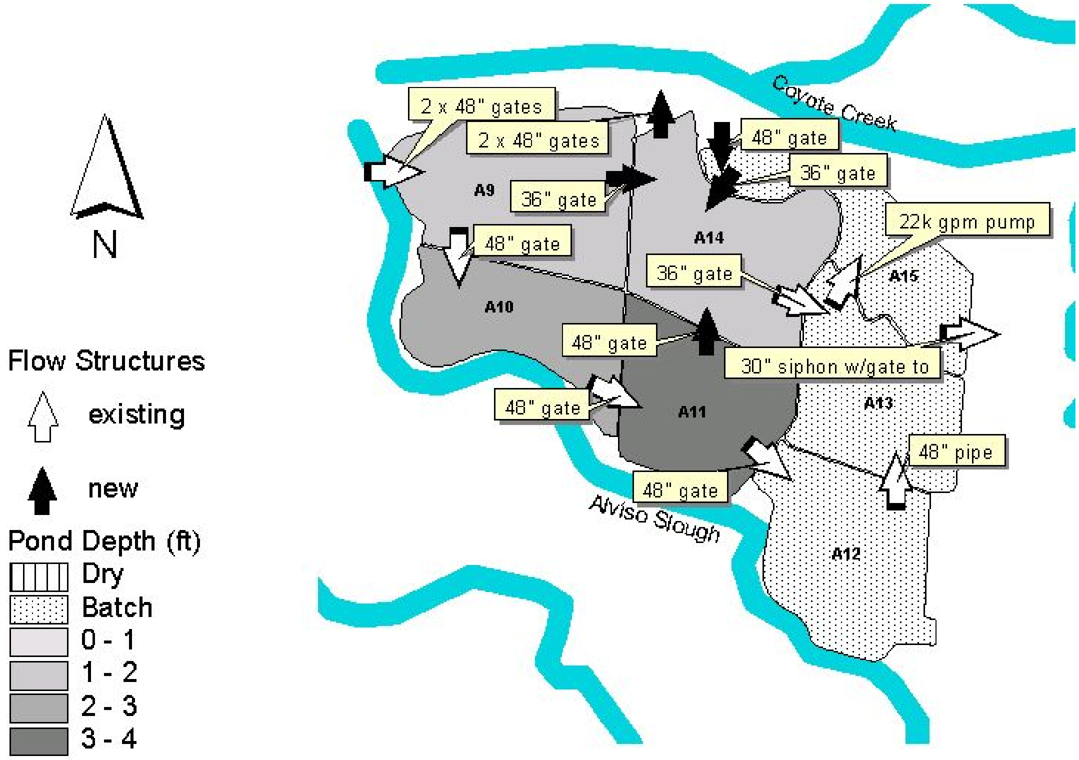


Objectives

1. Maintain full tidal circulation through ponds A9, A10, A11 and A14, while maintaining discharge salinities to Coyote Creek at less than 40 parts per thousand (ppt) and meet the other water quality requirements in the Water Board's Waste Discharge Permit. This program will also include monitoring for pH, dissolved oxygen (DO), temperature, avian botulism, and potential for inorganic mobilization.

2. Maintain pond A12, A13 and A15 as batch ponds. Operate batch ponds at a higher salinity (80 – 120 ppt) during summer to favor brine shrimp.

3. Minimize entrainment of salmonids by limiting inflows during winter.

4. Maintain water surface levels lower in winter to reduce potential overtopping.

Structures

The A14 system includes the following structures needed for water circulation in the ponds:

- Existing 2 x 48" gate intake at A9 from Alviso Slough
- Existing 48" gate between A9 and A10
- New 48" gate between A9 and A14
- Existing 48" gate between A10 and A11
- New 48" gate between A11 and A14
- Existing 48" gate between A11 and A12
- Existing 48" gate between A12 and A13
- Existing 36" gate between A14 and A13
- Existing siphon from A15 to A16
- Existing 36" gate between A15 and A14
- Existing 22,000 gpm pump from A13 to A15
- New 48" gate intake at A15 from Coyote Creek
- New 2 x 48" gate outlet at A14 into Coyote Creek
- Existing staff gages at all ponds and new NGVD gages at all pond

System Description

The intake for the A14 system is located at the northwest end of pond A9 and includes two 48" gates from Alviso slough near the Bay. The system outlet is located at the northerly end of A14, with two 48" gates into Coyote Creek. The normal flow through the system proceeds from the intake at A9, then flow through A10 and A11 to the outlet at A14. Because of the flap gates and the relative elevation of the tides and pond levels, all gravity intake flow would occur at high tide, and all outflows would occur when the tide is below 6.2 ft. MLLW.

Ponds A12, A13, and A15 will be operated as batch ponds to control the individual pond volumes and salinities.

Operations of the A14 system should require little active management of gate openings to maintain appropriate circulation flows. Summer and winter operations are described below to indicate predicted operating levels during the dry and wet seasons.

Summer Operation

The summer operation is intended to provide circulation flow to makeup for evaporation during the summer season. The average total circulation inflow is approximately 38 cfs, or 17,000 gpm. The summer operation would normally extend from May through October.

Summer Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A9	385	-0.2	2.0	3.3
A10	249	-0.8	1.8	3.0
A11	263	-1.8	1.3	2.5
A14	341	-0.0	0.9	2.3
A12	309	-2.0	1.2	2.5
A13	269	-1.1	1.1	2.6
A15	249	0.7	2.8	4.1

Summer Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A9 north intake	100	48
A9 south intake	100	48
A9 – A10	100	48
A10 – A11	100	48
A11 – A14	100	48
A14 west outlet	100	48
A14 east outlet	100	48
A9 – A14	0	0
A11 – A12	0	0
A12 – A13	0	0
A13 – A15	0	0
A14 – A13	0	0
A15 – A14	0	0
A15 intake	0	0
A14 weir	0.0 ft NGVD	

Water Level Control

The water level in A14 is the primary control for the pond system. The system flow is limited by the inlet capacity at A9. Normal operation would have the outlet gates fully open. Water levels are controlled by the weir elevation at A14. The A14 weir should be at approximately 0.0 ft NGVD to maintain the summer water level in A14 at 0.9 ft NGVD (2.3ft gage). The level may vary by 0.2 due to the influence of weak and strong tides.

The route of flow through this system will be from A9 to A10 to A11 to A14. The partial gate opening is to maintain the water level differences between the ponds. Again, the setting should not require frequent adjustment.

The A9 intake gates should be adjusted to control the overall flow though the system. The water levels in A9 will change due to the change in inflow. The maximum water level should be less than 2.5 ft NGVD (3.8 ft gage). This is to maintain freeboard on the internal levees and limit wind wave erosion.

<u>100 Percent Coverage Water Level</u>

Pond	Design Water Level Elev. (ft, NGVD)	100 % Coverage Water Elev. (ft, NGVD)	100 % Coverage Water Level (ft, Staff Gage)
A9	2.0	1.6	3.0
A10	1.8	-0.2	1.0
A11	1.3	-0.2	1.0
A14	0.9	0.8	2.2
A12	NA	-0.3	1.0
A13	NA	-0.3	1.2
A15	NA	0.7	2.0

The 100 percent coverage values represent the estimated water level which begins to expose part of the pond bottom area. Lower water levels would expose large areas of the pond bottom to drying and may cause odor problems. The 100 percent coverage water levels are intended for information purposes only. Operating the ponds at or near minimum depths will interfere with circulation through the ponds and may cause significant increases in pond salinity during the summer evaporation season.

Pond A14 has an estimated average bottom elevation at 0.0 ft NGVD, but portions of the pond bottom are at 0.8 ft NGVD, very near the design water level. The proposed A14 water level may need to be adjusted to maintain circulation through the pond.

Salinity Control

The summer salinity in the system will increase from the intake at A9 to the outlet at A14, due to evaporation within the system. The design maximum salinity for the discharge at A14 is 40 ppt. The intake flow at A9 should be increased when the salinity in A14 is close to 35 ppt. Increased flow may increase the water level in A14. The inflow at A9 is constrained by the tide level in Alviso Slough since the intake gates would be fully open. The inflow can be increased by partially opening the gate from A9 to A14 to lower the water level in A9 and increase the gravity inflow. This would increase the flow through A9 and A14, but reduce the flow through A10 and A11. Water levels in pond A14 above elevation 2.0 ft NGVD (3.4 ft gage) should be avoided as they may increase wave erosion of the levees.

Batch Ponds A12, A13, and A15 summer salinity levels should be between 80 and 120 ppt, to provide habitat for brine shrimp and wildlife which feeds on brine shrimp. Salinity control for the batch ponds will require both inflows to replace evaporation losses, and outflows to reduce the salt mass in the ponds and create space for lower salinity inflows. Ponds A12 and A13 would operate as a single unit, with inflow from pond A11 and outflows to either A14 or A15. The water levels in A12 and A13 would generally be between the elevations in A11 (higher than A12) and A14 (lower than A13). Therefore inflows from A11 and outflows to A14 would be by gravity. Outflows from A13 can also be pumped to A15. Water can also be pumped from A13 to A14 if the water levels are low in A13. Pond A15 would operate as a separate batch pond at a higher elevation than A13 or A14. Inflows to A15 would be pumped from A13, or by gravity from Coyote Creek with the supplemental intake at A15. Outflows from A15 would be by gravity to either A14 or A16.

The batch pond operation will require the outflow of approximately 0.5 to 0.7 ft of water from the batch ponds each month. This represents approximately 25 percent of the pond volumes. Because the A14 and A17 system have no circulation inflows from Coyote Creek for dilution from December through April, the outflow would normally occur during the evaporation season. The preferred operation would be to maintain the pond salinities near 100 ppt as much as possible, with consistent small outflows during the month from A13 to A14 and from A15 to A16. These gates should only be open approximately 10 percent, depending on the pond water levels. The inflows would be on a batch basis to add approximately 0.5 ft to the batch ponds about every other week.

If the salinity levels are high in A14 or A16, it may be necessary to reduce or suspend outflows from the batch ponds and allow the batch pond salinity to increase until later in the season. The salinity in a batch pond will increase by approximately 10 ppt per month during the peak evaporation months. If the batch pond salinities are high at the end of the circulation season, it may be necessary to continue to operate the A16 system with reverse flow during the winter continue to dilute the batch pond outflows until a reasonable salinity level is reached to start the next evaporation season.

Dissolved Oxygen and pH Control

If summer monitoring shows that DO levels in discharges from the Pond A14 fall below a 10^{th} percentile of 3.3 mg/L (calculated on a calendar weekly basis), the FWS will accelerate receiving water monitoring to weekly, conduct within-pond monitoring and notify and consult with the Water Board as to which Best Management Practices described below for increasing dissolved oxygen levels in discharge water should be implemented:

1. Increase the flows in the system by opening the A9 inlet further. If increased flows are not possible, open A14 gates to allow the ponds to become fully muted

tidal or partially muted tidal systems until pond DO levels revert to levels at or above conditions in the Creek.

2. Set in a series of flow diversion baffles at the pond discharge for directing the water from more suitable DO water levels to achieve maximum oxygen uptake.

3. Cease nighttime discharges due to diurnal pattern.

4. Close discharge gates completely until DO levels meet standards.

5. Close discharge gates completely for a period of time each month when low tides occur primarily at night.

6. Mechanically harvest dead algae.

7. Install solar aeration circulators.

The pH of the discharge is related to the DO of the discharge. If the pH of the discharge falls outside the range of 6.5 – 8.5, an analysis of the impact of discharging pH on the receiving waters will be performed. If it is determined that discharge is impacting receiving water pH outside the range of 6.5 – 8.5, ammonia monitoring in the receiving water will be done to document potential toxicity affects associated with unionized ammonia. To help minimize significant downtime on continuous monitoring devices used for DO and pH, the FWS will:

1. Have an extra monitor on hand, in case there is a break down.

2. Get a loaner unit through Hydrolab (within a week), if the extra monitor is being used.

3. Work with Hydrolab to insure a quick repair of monitors (within 2 weeks).

Avian botulism

Avian botulism outbreaks most typically occur in late summer/early fall when warm temperatures and an abundance of decaying organic matter (vegetation and invertebrates) combine to present ideal conditions for the anaerobic soil bacterium *Clostridium botulism* along water bodies. If summer monitoring shows that DO levels in the pond drop the BMPs listed under the section on Dissolved Oxygen and pH Control will be implemented to increase the DO. Monitoring of weather for long periods of hot, dry, windless days during late August and early September will trigger on the ground monitoring for any signs of botulism. FWS will be in contact with the adjacent landowners such as the San Jose and Sunnyvale Treatment plants to determine if botulism is occurring on their ponds. Additionally, if any bird carcasses in the ponds or nearby receiving waters are observed, they will be promptly collected and disposed of.

Winter Operation

During the winter season, the A9 intake will be closed to prevent entrainment of migrating salmonids. The winter operation period would normally extend from December through May 31. During the winter, rainfall would tend to increase the water levels in the ponds. The water levels in the ponds would be set by a weir at the outfall or adjustment of the control gates to avoid flooding of the existing internal levees or wave damage to the levees. The gates from A9, A10, and A11 will be partially open to allow rainfall to drain to A14. Excess water from rainfall would be drained from the system after larger storms and will require additional active management to adjust the interior control gates.

Winter Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A9 north intake	0	0
A9 south intake	0	0
A9 – A10	100	48
A10 – A11	100	48
A11 – A14	100	48
A14 west outlet	0	0
A14 east outlet	100	48
A9 – A14	0	0
A11 – A12	0	0
A12 – A13	0	0
A13 – A15	0	0
A14 – A13	0	0
A15 – A14	0	0
A15 intake	0	0

Winter Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A9	385	-0.2	1.5	2.8
A10	249	-0.8	1.5	2.7
A11	263	-1.8	1.4	2.6
A14	341	-0.0	1.3	2.7
A12	309	-2.0	1.4	2.7
A13	269	-1.1	1.2	2.7
A15	249	0.7	2.8	4.1

Salinity Control

The winter salinity in the system may decrease from the intake at A9 to the outlet at A14, due to rainfall inflows within the system, which may exceed winter evaporation. During very wet winters, the intake salinities and system salinities may decrease to as low as 11 ppt.

Monitoring

The system monitoring will require weekly site visits to record pond and intake readings, as well as to inspect water control structures, siphons and levees. The monitoring parameters are listed below.

Weekly Monitoring Program

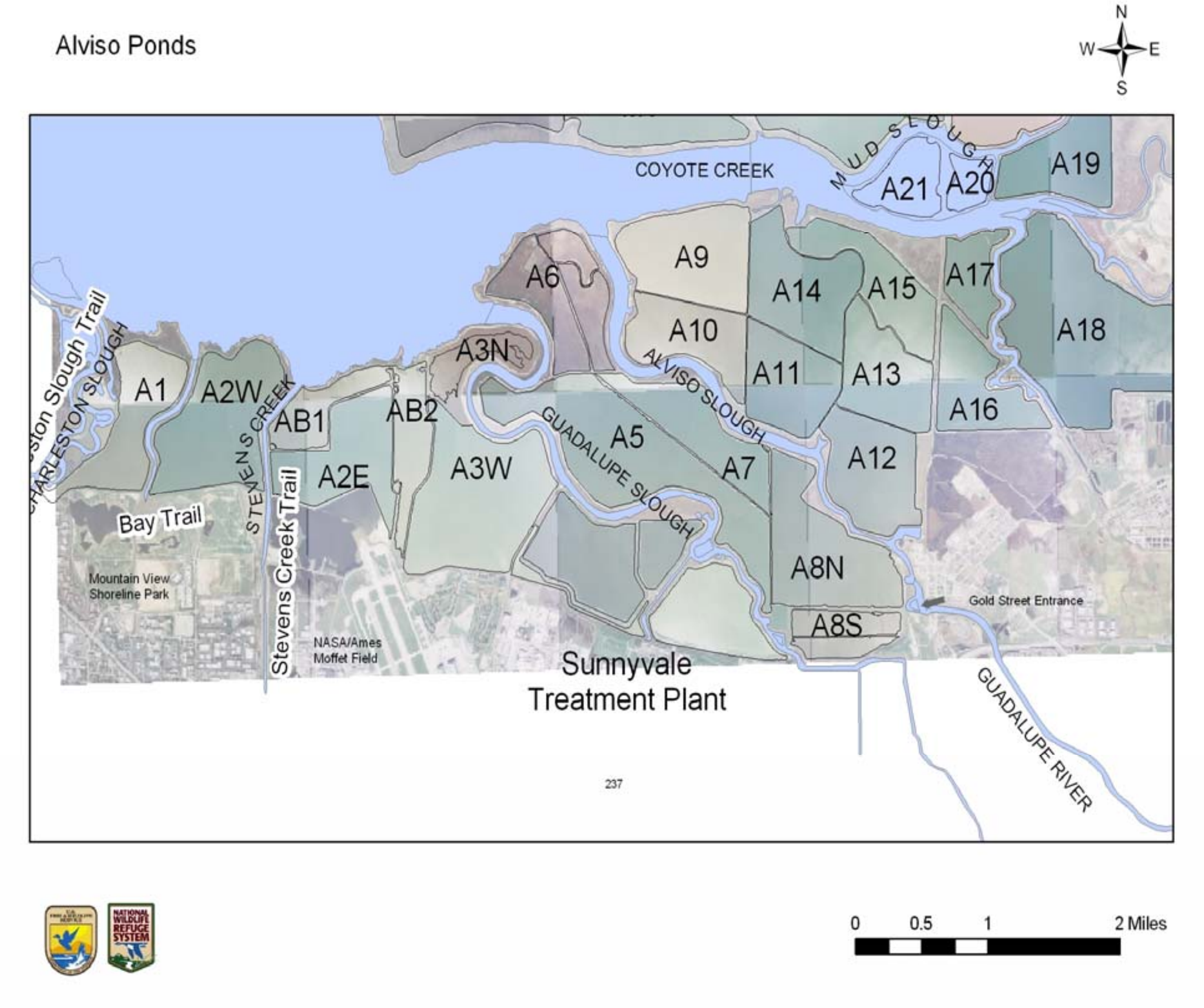
Location	Parameter
A9 intakes	Salinity
A10	Depth, Salinity, Observations
A11	Depth, Salinity, Observations
A14	Depth, Salinity, Observations
A12	Depth, Salinity, Observations
A13	Depth, Salinity, Observations
A15	Depth, Salinity, Observations

The weekly monitoring program will include visual pond observations to locate potential algae buildup or signs of avian botulism, as well as visual inspections of water control structures, siphons and levees. This program will also include supplementary DO monitoring when problems are identified in the formal monitoring listed below.

Location	**Frequency**	**Parameters**
Coyote Creek	Monthly (May –Oct)	DO, pH, Temp., Salinity

APPENDIX H
ALVISO POND A16 OPERATION PLAN

Pond System A16 Water Management Operation Plan – Alviso System 2010



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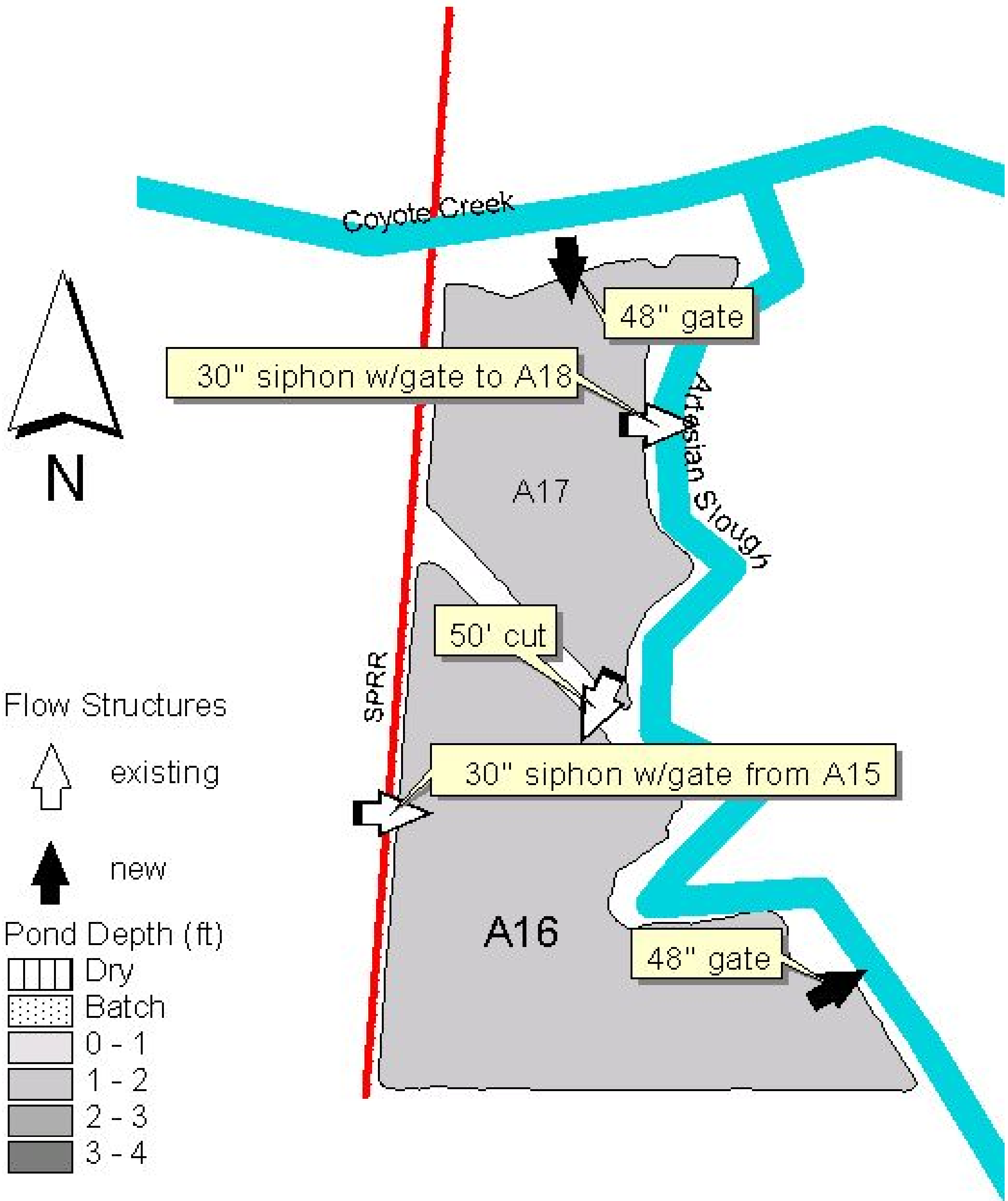

Objectives

1. Maintain full tidal circulation through ponds A17 and A16 while maintaining discharge salinities to the Artesian Slough lower than 40 parts per thousand (ppt) and meet the other water quality requirements in the Water Board's Waste Discharge Permit. This program will also include monitoring for pH, dissolved oxygen (DO), temperature, avian botulism, mercury methylation, and potential for inorganic mobilization.

2. Minimize entrainment of salmonids by:
    - Close A17 intake during winter, or
    - Reverse of intake and outlet flow during winter.

Structures

The A16 system includes the following structures needed for water circulation in the ponds:

- New 48” gate intake at A17 from Coyote Creek
- New 48” gate outlet structure at A16 into Artesian Slough
- Existing siphon between A15 (from system A14) to A16
- Existing gap between A17 and A16
- Existing siphon between A17 and A18
- Existing staff gauges (no datum) , plus new NGVD gauges to be installed

System Description

The intake for the A16 system is located at the northern end of pond A17 and includes one 48” gate from lower Coyote Creek. The system outlet is located at the southeast end of pond A16, with one 48” gate to the Artesian Slough. The flow through the system proceeds from the intake at A17 though a 50’ cut in the levee between A17 and A16, then through the 48” gate at the outlet A16. An existing siphon from A15 to A16 will be used to release excess water from ponds A12, A13, and A15 on a batch basis. The existing siphon between A17 and A18 will not be used for system circulation, and may be sealed in the future. A18 will be owned and operated by the City of San Jose.

Operations of the A16 system should require limited active management of gate openings to maintain appropriate flows. Because of the flap gates and the relative elevation of the tides and pond levels, all gravity intake flow would occur at high tide, and all outflows would occur when the tide is below 7.2 ft. MLLW. Summer and winter operations are described below to indicate predicted operating levels during the dry and wet seasons.

Summer Operation

The summer operation is intended to provide circulation flow to compensate for evaporation during the summer season. The average total circulation inflow is approximately 15 cfs, or 6,800 gpm, with an outlet flow of about 12 cfs (5,400 gpm). The summer operation would normally extend from May through October.

Summer Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A17	131	1.1	2.3	1.3
A16	243	0.6	2.3	0.7

Summer Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A17 intake	100	48
A16 outlet	100	48
A16 weir	1.9 ft NGVD	

Water Level Control

The water level in A16 is the primary control for the pond system. The system flow is limited by the outlet capacity. Normal operation would have the outlet gates fully open, and the water level in A16 would be controlled by the elevation of the outlet weir at A16. The estimated weir elevation would be 1.9 ft NGVD to maintain the pond water level at 2.3 ft NGVD in summer. The level may vary by 0.2 feet during a month due to the influence of weak and strong tides.

The A17 intake gate can be adjusted to control the overall flow though the system. The maximum water level in either A17 or A16 should generally be less than 3.0 ft NGVD during the summer. This is to maintain freeboard on the internal levees and limit wind wave erosion. The maximum historic water level in A16 and A17 has been 3.8 ft NGVD during the winter.

100 Percent Coverage Water Level

Pond	Design Water Level Elev. (ft, NGVD)	100 % Coverage Water Elev. (ft, NGVD)	100 % Coverage Water Level (ft, Staff Gage)
A17	2.3	1.1	0.1
A16	2.3	1.6	0.1

The 100 percent coverage values represent the estimated water level which begins to expose part of the pond bottom area. Lower water levels would expose large areas of the pond bottom to drying and may cause odor problems. The 100 percent coverage water levels are intended for information purposes only. Operating the ponds at or near minimum depths will interfere with circulation through the ponds and may cause significant increases in pond salinity during the summer evaporation season.

Salinity Control

The summer salinity in the system will increase from the intake at A17 to the outlet at A16 due to evaporation within the system. The design maximum salinity for the discharge at A16 is 40 ppt. The discharge permit requires that the discharge salinity not exceed 44 ppt.

The system circulation flow should be increased when the salinity in A16 reaches approximately 35 ppt during the summer. There are two operational measures available to increase the circulation flow. First, the level of the outlet weir can be lowered to lower the pond water level and the gravity inflow to the system. The weir structure includes weir boards on three sides of the structure. In general, the overall weir elevation should not be lowered more than 0.5 ft, but it may be more practical to lower one side by 1.0 ft or less.

The second operational measure to increase the circulation flow would be to adjust the intake gate at the A16 outlet structure to allow inflow from Artesian Slough at high tide. With the A16 intake gate fully open, the overall circulation flow would be approximately double the flow with A17 alone. In addition, the salinity in Artesian Slough at high tide is lower than in Coyote Creek and would directly lower the salinity in A16. The weir level at A16 should be adjusted to increase the outflow from A16 to account for the increased inflow.

The A16 system is intended to be the discharge for flows from pond A15 in the A14 system. A15 is a batch pond with operating salinities in the range of 80 to 120 ppt. Water will be transferred from A15 to A16 to lower the water levels in A15 and provide capacity for lower salinity inflows control the batch pond salinity. The intention is to dilute the higher salinity water with the pond A16 circulation. The siphon from A15 should be approximately 10 to 25 percent open, and the 22,000 gpm pump from A13 to A15 should operate approximately two to 3 days per month. The pump can add approximately 0.4 ft of water to A15 in one day.

Dissolved Oxygen and pH Control

If summer monitoring shows that DO levels in discharges from the Pond A16 fall below a 10th percentile of 3.3 mg/L (calculated on a calendar weekly basis), the FWS will accelerate receiving water monitoring to weekly, conduct within-pond monitoring and notify and consult with the Water Board as to which Best Management Practices described below for increasing dissolved oxygen levels in discharge water should be implemented:

1. Increase the flows in the system by opening the A17 inlet further. If increased flows are not possible, open both the A17 and A16 gates to allow the ponds to become fully muted tidal or partially muted tidal systems until pond DO levels revert to levels at or above conditions in the Creek.

2. Set in a series of flow diversion baffles at the pond discharge for directing the water from more suitable DO water levels to achieve maximum oxygen uptake.

3. Cease nighttime discharges due to diurnal pattern.

4. Close discharge gates completely until DO levels meet standards.

5. Close discharge gates completely for a period of time each month when low tides occur primarily at night.

6. Mechanically harvest dead algae.

7. Install solar aeration circulators.

The pH of the discharge is related to the DO of the discharge. If the pH of the discharge falls outside the range of 6.5 – 8.5, an analysis of the impact of discharging pH on the receiving waters will be performed. If it is determined that discharge is impacting receiving water pH outside the range of 6.5 – 8.5, ammonia monitoring in the receiving water will be done to document potential toxicity affects associated with unionized ammonia.

To help minimize significant downtime on continuous monitoring devices used for DO and pH, the FWS will:

1. Have an extra monitor on hand, in case there is a break down.

2. Get a loaner unit through Hydrolab (within a week), if the extra monitor is being used.

3. Work with Hydrolab to insure a quick repair of monitors (within 2 weeks).

Avian botulism

Avian botulism outbreaks most typically occur in late summer/early fall when warm temperatures and an abundance of decaying organic matter (vegetation and invertebrates) combine to present ideal conditions for the anaerobic soil bacterium *Clostridium botulism* along water bodies. If summer monitoring shows that DO levels in the pond drop the BMPs listed under the section on DO and pH Control will be implemented to increase the DO. Monitoring of weather for long periods of hot, dry, windless days during late August and early September will trigger on the ground monitoring for any signs of botulism. FWS will be in contact with the adjacent landowners such as the San Jose and Sunnyvale Treatment plants to determine if botulism is occurring on their ponds. Additionally, if any bird carcasses in the ponds or nearby receiving waters are observed, they will be promptly collected and disposed of.

Winter Operation

During the winter season, the A17 intake will be closed to prevent entrainment of migrating salmonids in Coyote Creek. The winter operation period would normally extend from November through April. During the winter, rainfall would tend to increase the water levels in the ponds. The inflow and outflow direction of the system will be reversed, where intake at A16 from Artesian Slough during the winter to minimize potential entrapment of migrating salmonids in Coyote Creek. The outlet at A17 includes both a control gate and control weir. Either may be used to limit flow through the system. The water levels in the ponds would be set by a weir at the outfall of A17 or adjustment of the control gates to avoid flooding of the existing internal levees or wave damage to the levees. The winter operation is intended to provide less circulation flow than the summer operation. Evaporation is normally minimal during the winter.

Winter Pond Water Levels

Pond	Area (Acres)	Bottom Elev. (ft, NGVD)	Water Level (ft, NGVD)	Water Level (ft, Staff Gage)
A17	131	1.1	2.2	1.2
A16	243	0.6	2.2	0.6

Winter Gate Settings

Gate	Setting (% open)	Setting (in, gate open)
A17 intake	0	0
A16	25	12
Weir	2.1 ft NGVD	

Water Level Control

The water level in A17 is the primary control for the pond system. The A17 water level is controlled by the outlet weir structure. Normal winter operation would have the A16 intake gate partially open to reduce inflow during extreme storm tides. Water levels in the ponds are controlled by the outlet weir setting. The normal winter water level in A17 should be at 2.2 ft NGVD, approximately 0.1 ft above the outlet weir. The pond water level may vary by 0.2 ft due to the influence of weak and strong tides, and over 0.5 ft due to storms. During winter operations, the water levels should not fall below the outlet weir elevation. During winter operations, if the water levels exceed approximately 3.0ft NGVD, the A16 gate should be closed to allow the excess water to drain. Note that without rainfall or inflow, it will take approximately 3 weeks to drain 1.0 ft from the ponds.

Salinity Control

The winter salinity in the system may decrease from the intake at A16 to the outlet at A17, due to rainfall inflows within the system, which may exceed winter evaporation. During very wet winters, the intake salinities and system salinities may decrease to as low as 5 ppt.

Monitoring

The system monitoring will require weekly site visits to record pond and intake readings. The monitoring parameters are listed below.

<u>Weekly Monitoring Program</u>

Location	Parameter
A17 intake	Salinity
A17	Depth, Salinity, Observations
A16	Depth, Salinity, Observations

The weekly monitoring program will include visual pond observations to locate potential algae buildup or signs of avian botulism, as well as visual inspections of water control structures, siphons and levees. This program will also include supplementary DO monitoring when problems are identified in the formal monitoring listed below.

Location	**Frequency**	**Parameters**
Artesian Slough	Monthly (May - Oct)	DO, pH, Temp., Salinity

Appendix I
Monitoring the Response of Fish Assemblages to Restoration in the South Bay Salt Ponds

Monitoring the Response of Fish Assemblages to Restoration in the South Bay Salt Ponds

Semi-Annual Report 2010

Prepared for:

South Bay Salt Pond Restoration Project Science Program
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PROJECT GOALS

The goals of the study are to:

1. document fish species and communities associated with newly restored salt marsh habitat,
2. document fish species and communities associated with adjacent habitats (i.e. sloughs and creeks) within the South Bay Salt Pond (SBSP) complex, and
3. develop indicators of sentinel species population health to assess the effects of the restoration.

Project Activities during Quarters 1 and 2

Prior to sampling, considerable effort was invested in repair and preparation of boats and sampling gear, including purchasing traps, a side scanning sonar unit, modifying trawl decking, calibrating water quality meters, and updating safety equipment. In addition two scouting trips were made to evaluate slough conditions for otter trawling and launch access identification.

Project Goals 1 and 2

Field sampling for fishes began in July 2010. Since the sampling schedule for the final SOW had May as the first sampling period, we supplemented the schedule with a sampling period in August to account for the missed sampling period. Initial sampling of fish communities within sloughs adjacent to restoration ponds and within breached ponds (A19-21) was conducted utilizing a four-seam otter trawl. Shallow pounded and salt marsh habitat s was sampled with baited clover and minnow traps. Replicate otter trawls were conducted in Alviso Slough, Coyote Creek, the Island Ponds (A19, A20, A21), Mt. Eden Creek, Old Alameda Creek, Steinburger Slough, outer Bair Island and Redwood Creek (Figure 1).

For the first two quarters of this study we sampled in 4 survey months at 4 marsh sites (Eden Landing, Alviso, SF2, and Bair Island) (Table 1). In total we have collected 3,307 fishes of 30 different species by otter trawl, a majority of which were native to the San Francisco Estuary. We have collected 348 fishes from 7 different species via minnow and clover traps. The Northern anchovy and three-spine stickleback were the most common species found in each of the sites sampled with the otter trawl (Figure 3), and the sentinel species the longjaw mudsucker was the most common fish found in minnow and clover traps (Table 3).

Overall fish abundance was greater during the summer surveys (July and Aug) and decreased in October, when water temperatures dropped below 20 °C. Northern anchovy and three-spine stickleback were the most abundant species found throughout the South Bay. (Figure 2 &3). In December the catches of many of the abundance fish species during summer declined and a suite of new species arrived, including Pacific herring, longfin smelt and two species of shad (Figure 4).

Fish were most abundant in Alviso Slough (Northern anchovy, three-spine stickleback), while catches were similar among Eden Landing, Coyote Creek and Bair Island sloughs (Figure 5). In

Coyote Creek fish abundance for most species was similar among island ponds A19-21 compared to adjacent slough sites except for northern anchovy and three-spine stickleback, which were much more abundant inside the island ponds relative to adjacent slough sites (Figure 6).

Water quality parameters varied across the first 4 survey months and among the 4 sites. In October 2010, we observed decreases in temperature, salinity and dissolved oxygen among all 3 sites sampled for all months of the survey (Fig 6-8). The decrease in temperature and salinity was due to increased runoff from local watersheds, as well as the decreasing temperature of San Francisco Bay consistent with local rain showers. Coincident with the shift in abiotic factors, there were several changes to the fish assemblages in the restoration areas; northern anchovy catches declined by 90%, threespine stickleback catches decreased in ponds and sloughs, while topsmelt increased in both size and relative abundance. In addition to these overarching trends, a mortality event was documented in the upper reaches of both Coyote Creek and Alviso Slough which had the lowest dissolved oxygen levels (Figure 7). The fish kill was most likely due to the influx of urban runoff from storm drains. The dissolved oxygen content was less than 2 mg/L in both upper Alviso Slough and in Coyote Creek during this period.

Project Goal 3: Develop indicators of sentinel species population health to assess the effects of the restoration.

Collection of possible sentinel species (longjaw mudsucker, Pacific staghorn sculpin, yellowfin goby) has been accomplished using minnow traps, clover traps and otter trawls. Lengths and catch per unit effort have been collected for these species. In addition, captured fish were inspected for the presence of any morphological deformities. Because the longjaw mudsucker has been used successfully as a sentinel species elsewhere in the San Francisco Bay Estuary, it is the preferred sentinel species for this project. Data on other species is being collected in the event that longjaw mudsuckers are not abundant enough at one or more sites to be used in that context.

Longjaw mudsucker populations were collected in the marshes surrounding Alviso Slough (A6) and within the salt ponds of Eden Landing (E8, E8X and E9). However, minnow trapping and otter trawling has failed to show the presence of mudsucker at Bair Island (Inner Bair along Corkscrew Slough, Middle and Outer Bair). In spite of the lack of success at Bair Island, efforts will continue into the spring. Should longjaw mudsuckers fail to be abundant at Bair Island, a concerted effort will be made to explain their dearth and one of the alternatives will be used at the sentinel species.

Longjaw mudsucker were most abundant at Alviso Slough fringing marsh along pond A6, with the highest recorded catches in San Francisco Bay occurring in August (Figure 9). The abundance of longjaw mudsuckers declined in October along with declining water temperatures and the onset of breeding season. This seasonal trend is similar to patterns found in marsh sites in Central and North San Francisco Bay and Tomales Bay. Longjaw mudsuckers were consistently larger at the Eden Landing pond sites compared to Alviso Slough sites (Figure 10). This observation is likely due to the ponding of water in Eden Landing ponds compared to more tidal conditions at the Alviso Slough sites. Otoliths have been collected and are currently being processed to more accurately measure growth differences among collections sites.

Hook and line angling surveys were conducted at three locations during each survey (Coyote Creek at Ponds A19-21 outlets, Alviso Slough adjacent to the future breach location, and in Corkscrew Slough adjacent to the recently breached outer Bair Island outlet. Angling took place during outgoing tides for one hour, using live and dead bait (live yellowfin goby and freshly dead Northern anchovie). At least 4 anglers using similar gear were used. Fish species landed was recorded, lengths measured and sex determine when possible. Only two species were collected via hook and line, leopard shark and bat rays. Catch per unit of effort was greatest at outlets to the Island ponds A19-21, and was slightly lower at Corkscrew Slough in Bair Island. No fish were encountered at the site in Alviso Slough adjacent to the future breach site of pond A6.

Overall fish were found to be relatively abundant among all sites sampled during the first four surveys of this study. The species composition appears to be changing with the seasonal change freshwater flow and decreased water temperatures. It is noteworthy to mention that during the December survey the threatened longfin smelt was observed at several sites within the Alviso-Coyote Creek complex including inside the island ponds and the newly breached pond A6. Overall species abundance was similar between the island ponds and adjacent sloughs suggesting fishes are capable of recolonizing these habitats shortly after breaching as observed with several species is found in the newly opened pond A6 only a few days post breaching. Thus far the restoration of salt pond habitats does appear to harbor fish species with no adverse effects observed.

PROGRESS TOWARDS MILESTONES

Thus far we have completed the first 5 surveys, including the ongoing survey in February. The monitoring of newly restored SF2 and pond A6 began in December and a baseline of fish abundance and condition at Eden Landing was collected and archived for later analysis. We have successfully provided a quarterly report to the Resource Legacy Fund and the South Bay Salt Pond Restoration Program and have given presentations at the Calfed-Delta Science Program Conference in Oct 2010 and the South Bay Salt Pond Restoration annual meeting in February of 2011.

ENVIRONMENTAL OUTCOMES

The most interesting environmental observation thus far was the low dissolved oxygen event that occurred a few days prior to our sampling in October 2010. The upper reaches of Coyote and Alviso sloughs had dissolved oxygen concentrations near lethal for most fish species. Conversations with local fisherman at the Alviso boar ramp revealed that approximately 100 dead striped bass were observed upstream of the launch near the inlet for pond A8. Conditions in the island pond appear to be progressing successfully, with considerable pickleweed marsh plants beginning to grow in the northern section of pond A21, and considerable sediment deposition above the gypsum flats in all three island ponds. Lastly we have observed considerable freshwater input from the San Jose wastewater treatment facility in Artisan Slough and measure water temperature several degrees above temperatures in adjacent sloughs and a mile downstream of the discharge point. It is likely that treated outflow has some environmental impact on the biota of artisan slough and the adjacent areas.

PROBLEMS ENCOUNTERED AND RESOLUTIONS

Primary challenges that we have encounter thus far is safe travel across the bay from the Bair Island boat launch to Eden Landing to otter trawl slough sites. Wind and the tides can create steep whitecap conditions and make transit across the bay unsafe, thus on two sampling occasions we were unsuccessful at conducting trawl sampling outside Eden Landing. Efforts have been made to minimize this obstacle by launching earlier in the morning, planning around weather forcasts and looking for alternative launch sites. It would be extremely useful if in future planning for Eden Landing that a cemented boat launch be established; potentially where the future kayak launch site is planned to occur.

ACTIVITIES PLANNED FOR NEXT QUARTER

Next sampling period will be February 17-21. Alviso Complex, Bair Island and Eden Landing slough sites will be sampled with the addition of shallow water trawls in newly opened pond A6. These trawls will be augmented with clover traps and minnow traps where necessary. In addition experimental gill nets will be deployed inside restored pond habitats to sample for larger predator fish that are not often collected via otter trawling. Due to the extensive restoration work at Eden Landing we will suspend trapping inside any pond containing water till construction is complete in spring.

We will be developing techniques for measure very low level concentrations of Hg and Se in blood, muscle tissue, and otoliths of sentinel species longjaw mudsucker and staghorn sculping. Using inductively coupled plasma mass spectrometry, we will measure blood and muscle to the ppb level, while using a couple laser system, we will measure concentrations deposited in the time resolved growth bands deposited in otoliths. If successful this technique would provide for a time record of contaminant exposure, and would be the first stuydy of its kind conducted anywhere.

In order to monitor the population health of longjaw mudsuckers in restoration areas, mark and recapture of mudsuckers will be initiated in April of 2010. This aspect of the project was deferred till spring as catches typically decline during the winter months due to the reproductive cycle and the burrowing nature of this species during this time. In addition to population level studies, individual health is currently being investigated. To this end, one third of captured longjaw mudsuckers were retained for use as reference specimens, against which the observed effects of restoration will be compared. Otoliths from the retained longjaw mudsuckers will be used to attain the age and growth rates. Otoliths have been extracted and mounted. We will be purchasing a new microscope camera for digital imaging and aging of the otoliths.

CONCLUSION

Overall, our methods appear to successfully capture fish inside restored ponds and adjacent habitats in the Alviso complex. Fish appeared to be relatively abundant during the first quarter of the study, and did not have any apparent health issues bases on simple external morphological investigations. However, the fish kill in October raises some real concern for the restoration efforts, as this event occurred immediately upstream of ponds A19-21 in Coyote Creek and adjacent to pond A8 in Alviso Slough. Urban runoff may ultimately nullify any benefit of salt pond restoration for fishes in South Bay. We recommend conducting a comprehensive screening of fish collected and archived during this period for contaminant effects. We have been consulting with Dr. Swee Teh of the Aquatic Toxicology program at UC Davis regarding different biomarkers he has developed to identify effects of different classes of chemical contaminants.

FIGURES

Figure 1: Satellite imagery showing the location of otter trawl stations in the South Bay.

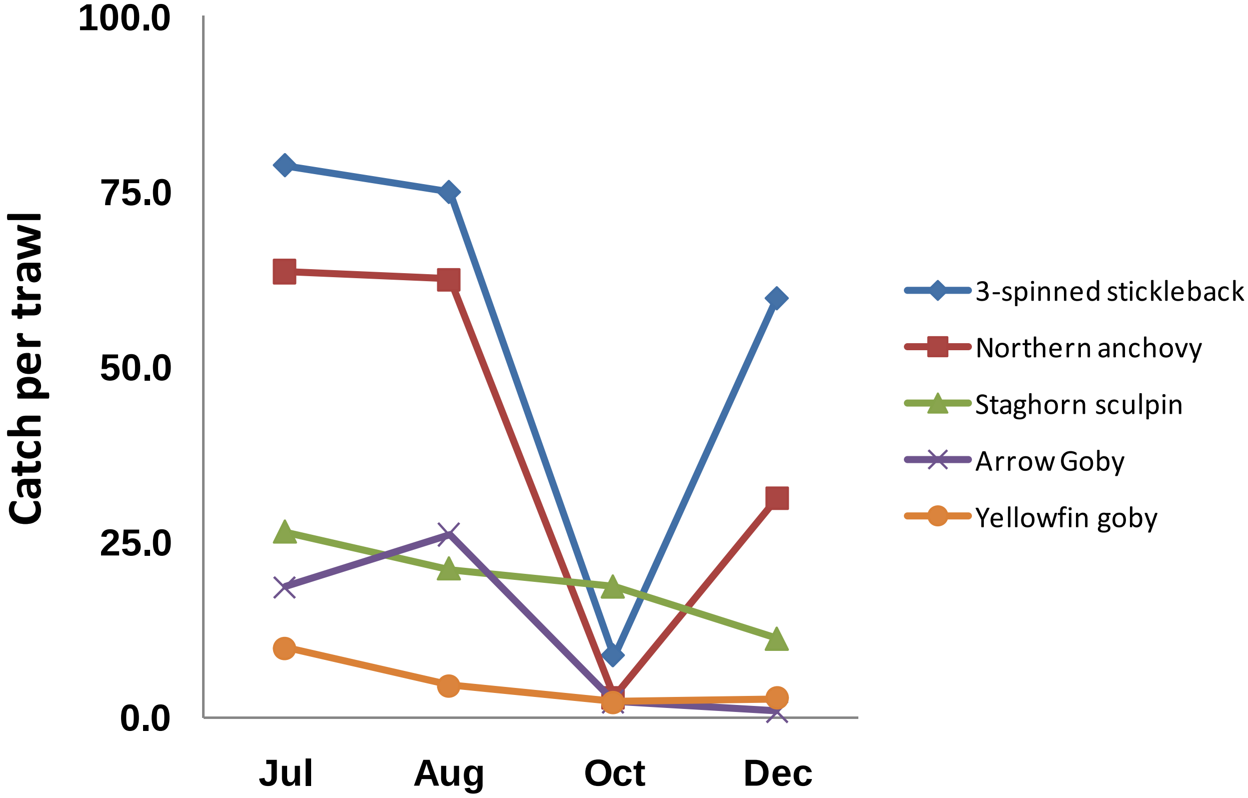

Figure 2: Mean Catch per trawl for the top 5 abundant fish species from all sites across the 4 months of the survey.

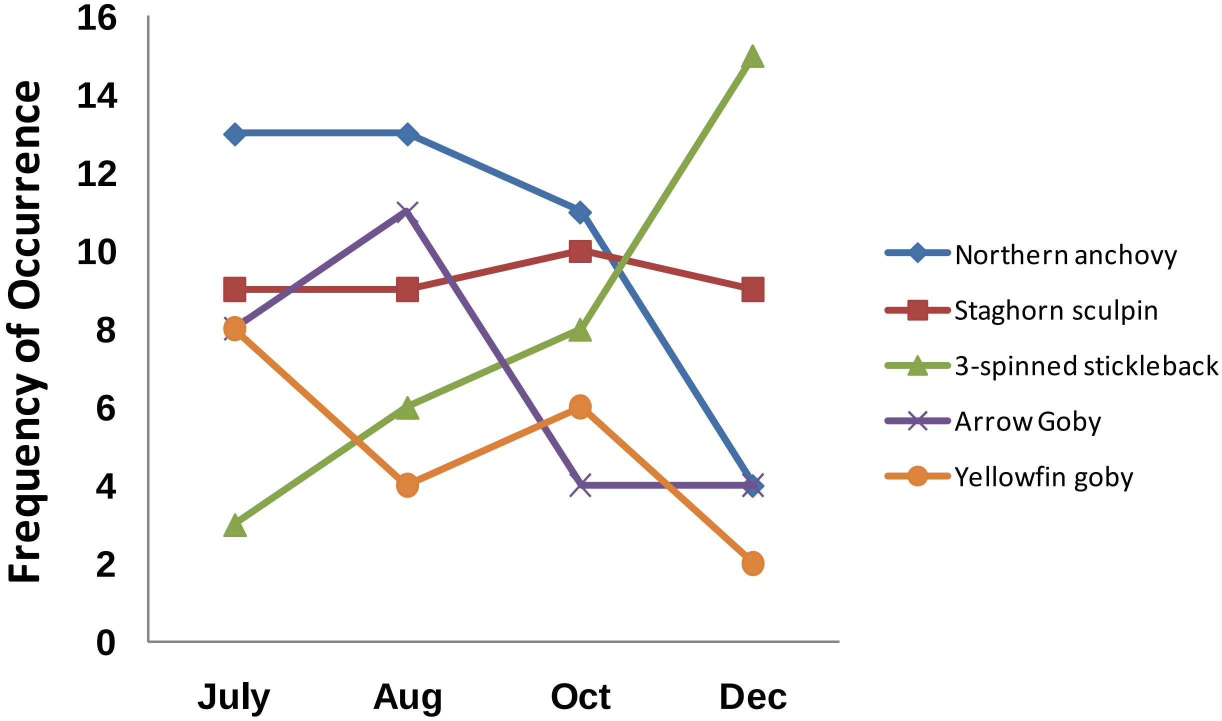

Figure 3:. Frequency of occurrence for the top 5 species from all sites.

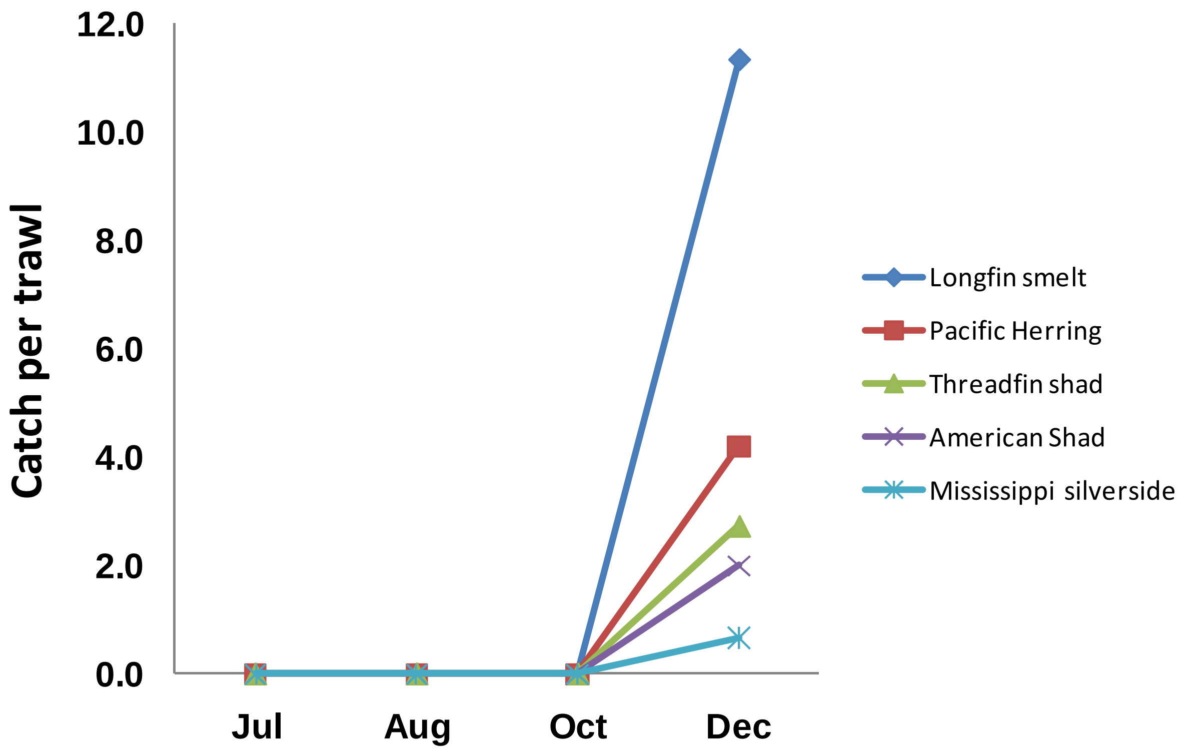

Figure 4: Mean catch per trawl of the winter fish assemblage from all sites.

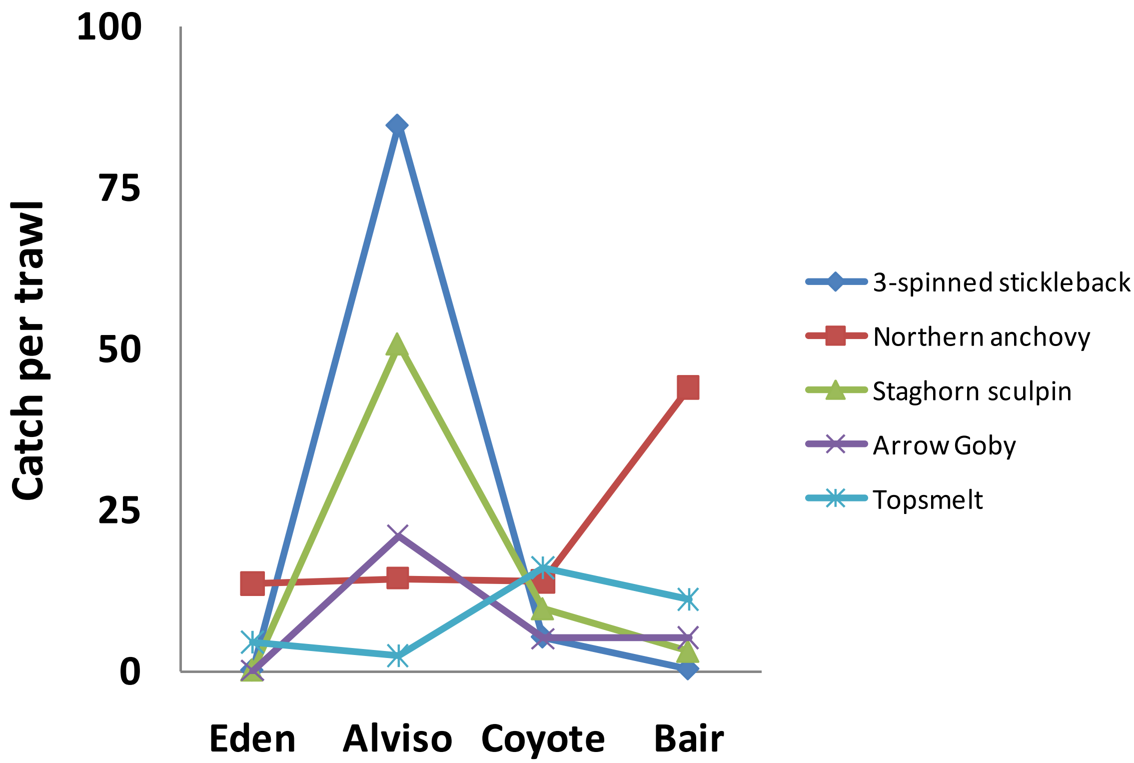

Figure 5: Mean catch per trawl for the 4 sites, averaged across the 4 months for the top 5 species.

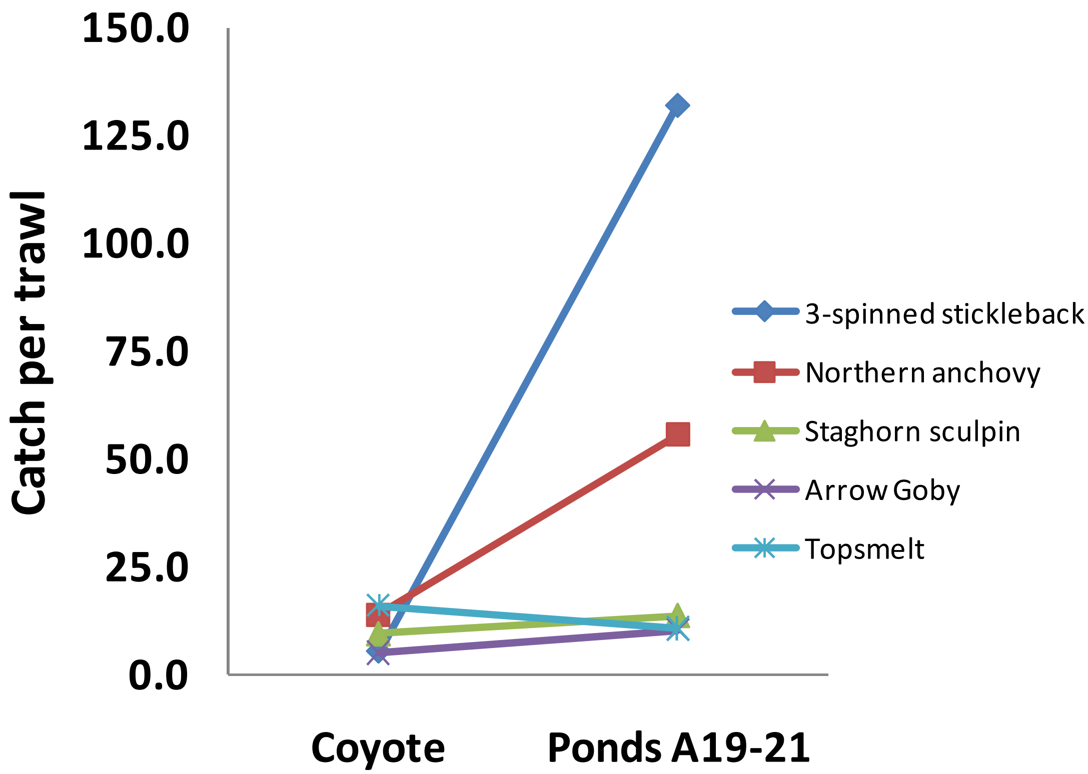

Figure 6: Mean catch per trawl of the top 5 species comparing island ponds to adjacent sloughs.

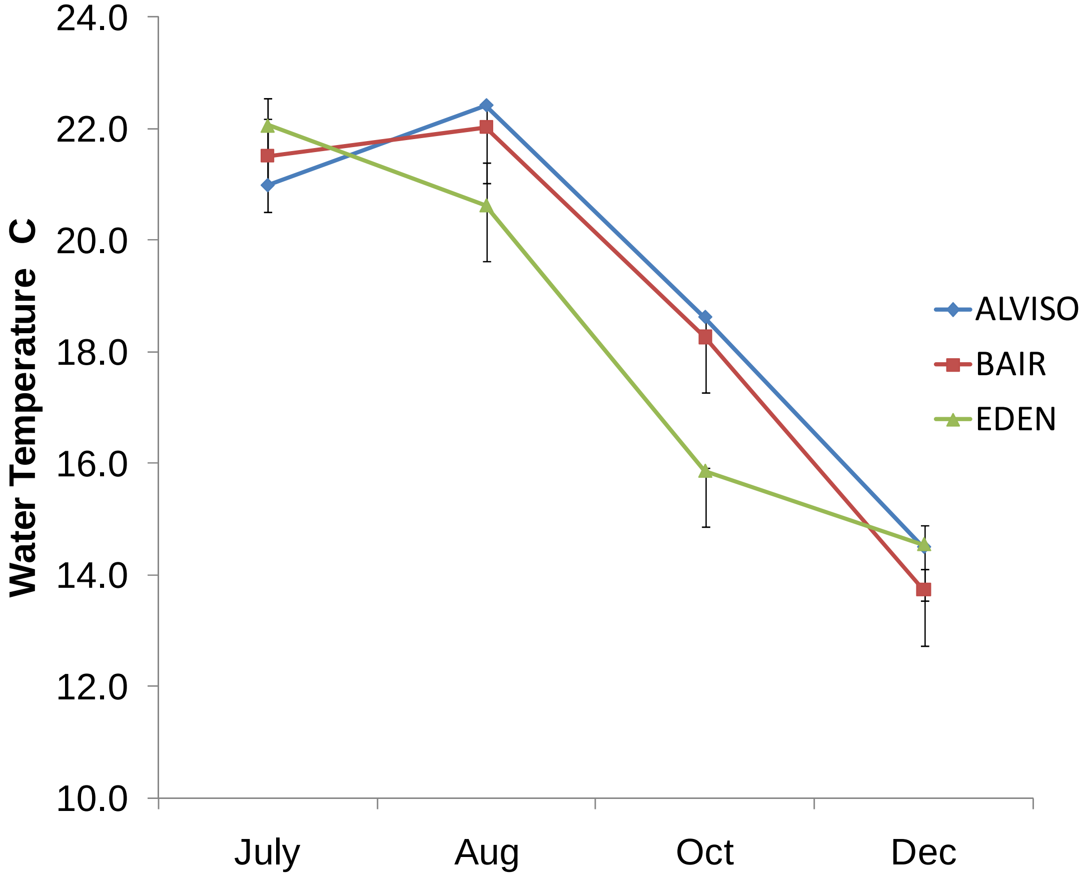

Figure 6: Mean monthly water temperature from slough sites.

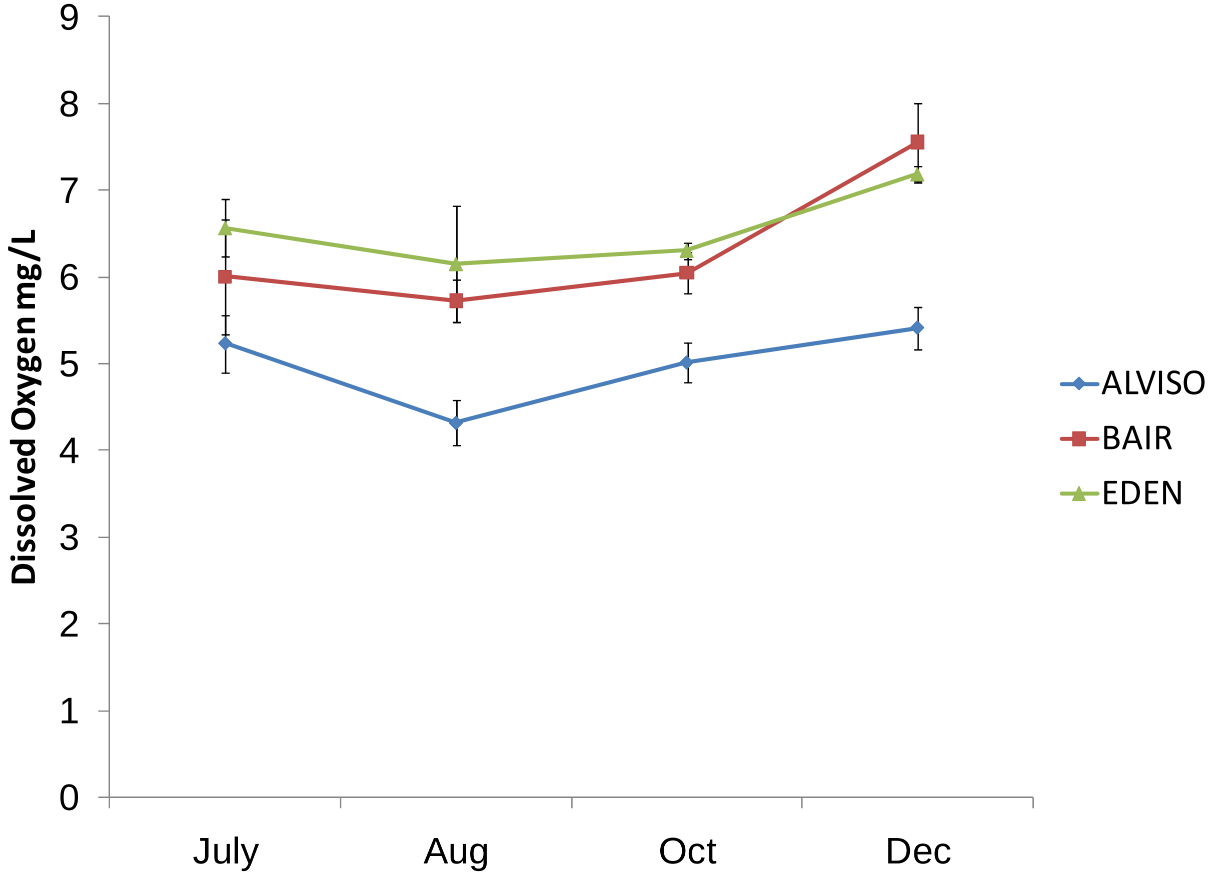

Figure 7: Mean monthly dissolved oxygen from slough sites.

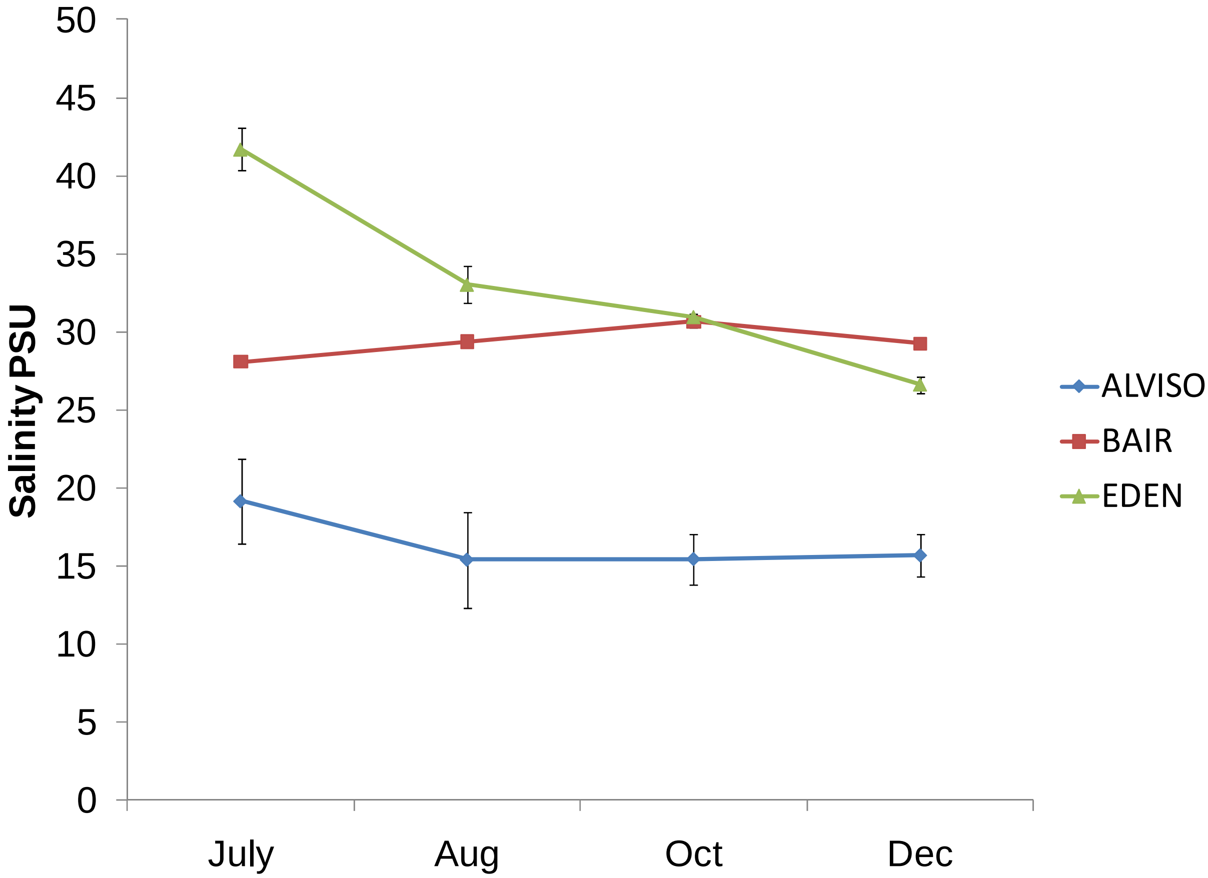

Figure 8: Mean monthly salinity from slough sites.

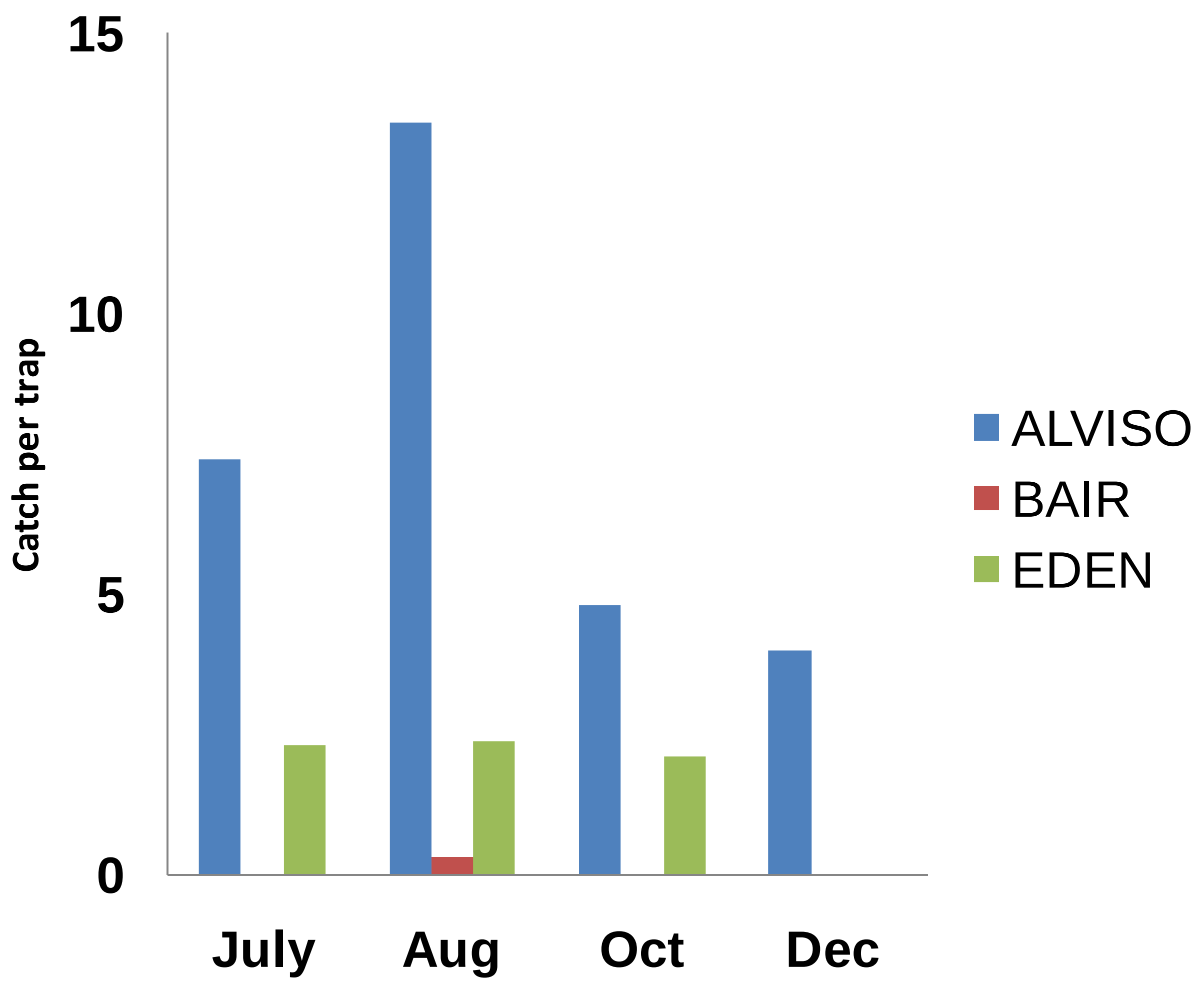

Figure 9: Mean monthly catch per minnow trap of the sentinel species longjaw mudsucker (*Gillichthys mirabilis*) in pickleweed marsh habitats adjacent to trawl sites.

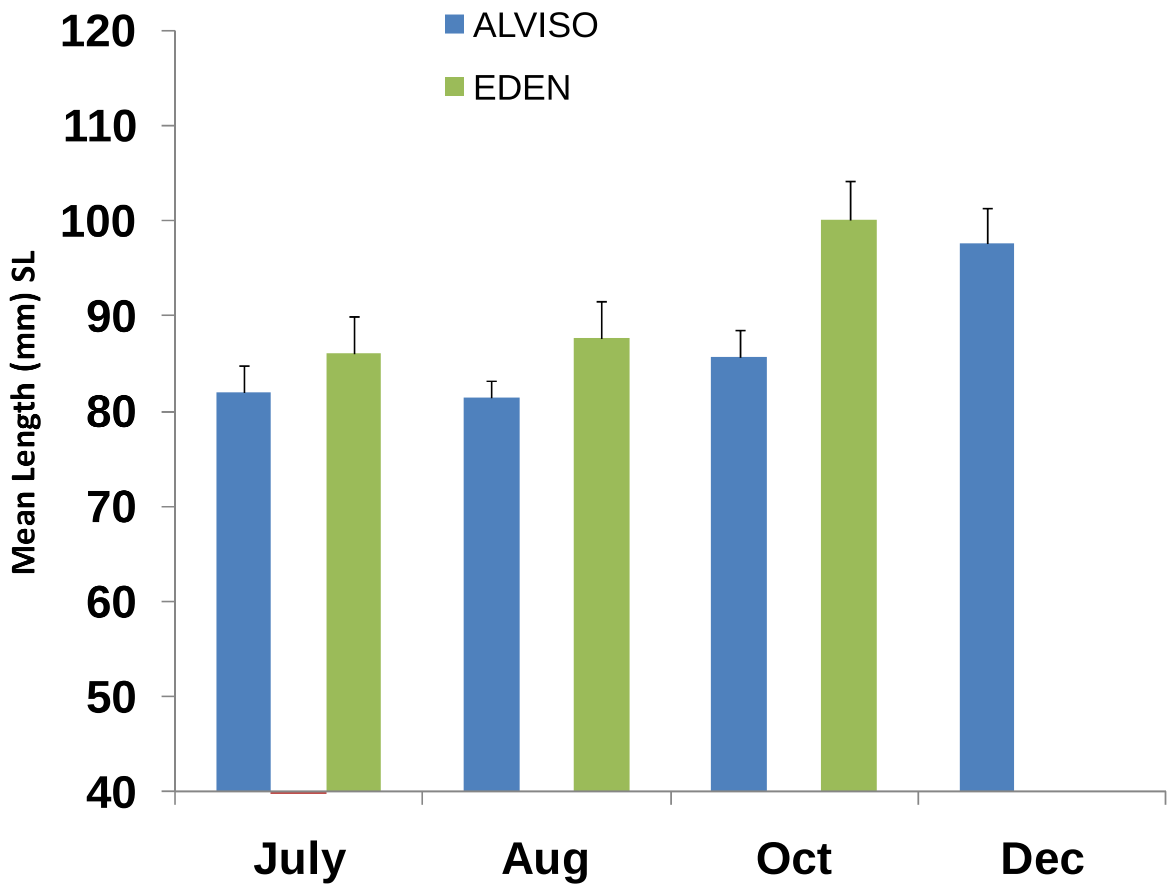

Figure 10: Mean length of sentinel species longjaw mudsucker (*Gillichthys mirabilis*).

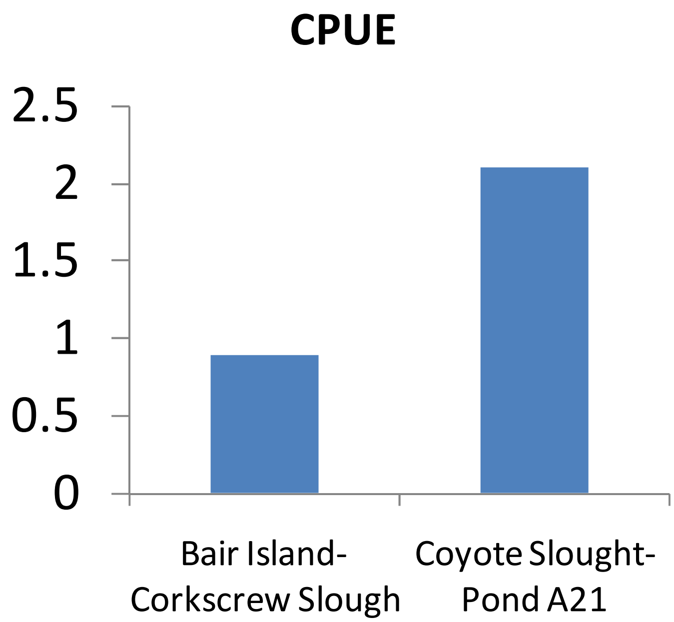

Figure 11: Catch per angler hour comparing outside island pond A21 to a similar site in Bair Island.

			2010							2011											
				Qt			Qt			Qtr 1			Qt			Qt			Qt		
I	**Main Workplan Sites & Actions**			J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
A	**Alviso Complex**																				
	Pond A6	To be Fully Tidal, Breaching complete late Fall 2010	O						x												
	Pond A8	Muted Tidal; Gates open 6/1-1/31 & closed 2/1-5/31.	m	o																	
	Alviso Slough	Sampling before & after breaching of Ponds A6 & A8	o	x	x		x		x												
	Alviso Slough fringing marsh		m	x	x		x		x												
	Pond A19	Fully Tidal,	om				x		x												
	Pond A20		om				x		x												
	Pond A21		om	x	x		x		x												
	Coyote Creek	Sampling associated with Ponds A19/A20/A21	o	x	x		x		x												
B	**Eden Landing Complex**																				
	E8A	Breaching &	m	x	x		x														
	E9		m	x	x		x														
	E8X		m	x	x		x														
	Mt. Eden Creek	Sampling before & after breaching of	o						x												
	Old Alameda Creek		o						x												
II	**Supplement #4 & Actions**																				
	Pond SF2	Managed Pond, Construction complete Fall 2010							x												
III	**Supplement #5 & Actions**																				
	Outer Bair Island*	Fully Tidal, Breached in January 2009	om	x	x		x		x												

Table 1. Sample schedule matrix. Green x's are sites and dates of successful sample collections. Red boxes depict sampling dates missed. Grey boxes are no sampling required. Yellow boxes are last sampling date prior to restoration actions.

Rank	Species	July	Aug	Oct	Dec	Total
1	3-spinned stickleback	236	223	827	392	1678
2	Northern anchovy	208	250	53	38	549
3	Topsmelt	5	21	50	316	392
4	Staghorn sculpin	81	61	68	43	253
5	Arrow Goby	55	74	8	5	142
6	Longfin smelt				61	61
7	Yellowfin goby	28	13	8	6	55
8	Shiner surf perch	19	9	8	2	38
9	Pacific Herring				23	23
10	Bat ray	7	7	1		15
11	Starry flounder	1	2	10	1	14
12	Threadfin shad				12	12
13	Prickly sculpin	9	1			10
14	American Shad				8	8
15	Leopard Shark	3	3	2		8
16	Bay pipefish		7			7
17	Rainwater killifish		1	5	1	7
18	Speckled sand dab			1	5	6
19	Brown smoothound		5			5
20	Diamond Turbot				5	5
21	Mississippi silverside			2	3	5
22	Barred surf perch	1	2			3
23	Bay pipefish	2				2
24	Shimofuri goby	1		1		2
25	Shokahaze goby				2	2
26	English sole				1	1
27	Longjaw mudsucker		1			1
28	Plainfin midshipmen		1			1
29	Striped bass		1			1
30	Sacramento sucker	1				1
				Total Fish		***3307***
				Native		***3215***
				Non-Native		***92***

Table 2. Rank order of abundance of the species and the total abundance among all sites and survey months.

Rank	Species	July	Aug	Oct	Dec	Total
1	Longjaw mudsucker	52	87	41	16	196
2	Yellowfin goby	44	63	10	10	127
3	Staghorn sculpin	4		2	4	10
4	3-spinned stickleback	8	1			9
5	Rainwater killifish	3				3
6	Topsmelt	1			1	2
7	Shiner surf perch	1				1

Table 3. Rank order of abundance of fish collected via minnow and clover trapping among all sites across the 4 survey months..

Summary of Expenditures through Quarter 1		
Salaries + Benefits		$18,693.92
Supplies		$8,039.66
Travel		$2,961.92
		$29,695.50
Labor	**% Effort**	**Expendatures**
Task 1 – Alviso Complex Sampling	0.40	$7,522.80
Task 2 – Eden Landing Complex Sampling	0.40	$7,522.80
Task 3 – Pond SF2 Sampling	0.03	$640.43
Task 4 – Bair Island Sampling	0.03	$640.43
Task 5 – Data Analysis	0.04	$800.69
Task 6a – Project Management	0.04	$783.38
Task 6b – Reporting	0.04	$783.38
		$18,693.92
Travel		
July		$805.72
August		$803.11
October		$787.04
December		$566.05
		$2,961.92
Supplies		
Boat Maintenance and Upgrade		$3,091.33
Field gear (nets, traps, sonar, wench etc.)		$4,948.33
		$8,039.66

Table 3. Budget breakdown for expenditures by task.