Appendix A Water Quality Study Procedures

Water Quality Study Procedures
Pelton Round Butte

Portland General Electric

Updated March 2016

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Introduction

The purpose of this water quality study is to benchmark the condition of water entering and leaving the Pelton Round Butte project (Project) and assess the sensitivity of the lower Deschutes River to changing water quality in the reservoirs. The last time an extensive study of water quality in the lower river and reservoirs was completed was 1997. This is a two year sample collection beginning in February 2015.

Samples are collected in the three tributaries entering Lake Billy Chinook (Crooked River, Deschutes River, and Metolius River), the two primary Project reservoirs (Lake Billy Chinook and Lake Simtustus), one tributary of Lake Simtustus, and the lower Deschutes River downstream of Pelton Round Butte (RM 100.1 to RM 3.5), and five tributaries of the lower river.

Sampling Sites

Site	Site ID	RM	Latitude	Longitude
Lower Deschutes				
Mainstem				
Reregulating Dam	01	100.1	44.725650	-121.247542
Dry Creek	03	94.3	44.785444	-121.196467
South Junction	05	83.3	44.869411	-121.058139
Whitehorse	07	75	44.962581	-121.080769
Ferry	09	62.5	45.062264	-121.119781
Lower Wapinitia	11	54.4	45.149631	-121.115861
Sandy Beach	12	45.5	45.240450	-121.048969
Wreck	14	36.2	45.321460	-120.982923
Rattlesnake	16	29.6	45.345698	-120.938940
Bull Run	18	14.2	45.488080	-120.836221
Kloan Rapids	20	8.4	45.533842	-120.884097
River Mouth	21	3.5	45.595342	-120.897506
Tributaries				
Shitike Creek	SC	97.6	44.763861	-121.234050
Warm Springs	WS	84.3	44.859189	-121.068000
Trout Creek	TC	87.7	44.801350	-121.066289
Oak Springs	OS	50.6	45.224069	-121.082239
White River	WR	46.5	45.235839	-121.070500
Reservoir				
Reservoirs				
Pelton Dam Forebay	04	-	44.6933	-121.230853
Round Butte Dam Forebay	07	-	44.601310	-121.281193
Common Pool, Deschutes and Crooked	08	-	44.580890	-121.268180
Round Butte Tailrace	09	-	44.60586	-121.276945
Pelton Tailrace	10	-	44.69438	-121.231581
Lake Simtustus, near Indian Campground	25	-	44.63958	-121.265708

Site	Site ID	RM	Latitude	Longitude
Tributaries				
Willow Creek Inflow	05	-	44.671914	-121.227847
Deschutes River Inflow	14	-	44.49869	-121.320748
Metolius River Inflow	17	-	44.62113	-121.47536
Crooked River below Opal Springs	35	-	44.49214	-121.298266

Pre-Trip Activities

Equipment List

Equipment with an (R) is only needed when sampling the reservoirs and with (D) is only needed when sampling the lower river.

Meters

- ☐ Hydrolab/YSI
  - Cable (R)
- ☐ Algae Torch
  - Demarcated white rope (R)
- ☐ LiCor Light Meter
- ☐ Hach Flow Meter

Sample Equipment

- ☐ Sample Bottles
- ☐ Filtering equipment
  - Flask
  - Filtering base
  - Filters, nutrients and chlorophyll
  - Hand pump
  - Forceps
- ☐ Periphyton sampling kit
  - Pencil for outlining delimiter
  - Graduated cylinders (narrow 250mL and wide 500mL)
  - Pocket knife
  - DI water (squirt bottles and half-gallon jug)
  - Plastic container for collecting rocks
  - 2 in Delimiter
- ☐ Secchi disk with sufficient rope (R)
- ☐ Churn splitter (R)
- ☐ Van Dorn Sampler (R)
- ☐ Zooplankton net
- ☐ Bucket (R)
- ☐ Coolers, ice, and ice packs
- ☐ Plastic bags for sample bottles
- ☐ Measuring tape, for discharge cross sections
- ☐ GPS
- ☐ Camera
- ☐ Extra batteries
- ☐ Pressure transducer (White River)
  - Wrench
  - Downloader
- ☐ Miscellaneous tools
  - Pliers
  - Nippers
  - Screw driver
- ☐ Backpack
- ☐ Shuttle for weather station downloads

Paperwork and Logistics

- ☐ Clipboard
- ☐ Site files/maps
- ☐ Field sheets

- ☐ Truck keys and gas card
- ☐ Boat keys (R)
- ☐ Deschutes Rec Area keys (D)
- ☐ Chain of custody and lab forms
- ☐ Labels
- ☐ Extra pencils, pens and sharpies
- ☐ Labeling info
- ☐ SOPs
- ☐ Zip ties
- ☐ Electrical tape
- ☐ Duct tape

Personal Gear

- ☐ Waders
- ☐ Spot Satellite Messenger or Satellite Radio
- ☐ Food
- ☐ Water
- ☐ Sunscreen

Fire Equipment (D)

- ☐ Bucket
- ☐ Burlap bag
- ☐ Shovel
- ☐ Pick-axe
- ☐ Extra Water

Equipment Cleaning

Any equipment used in the lower river that is also used in the reservoirs and upstream tributaries and is wet with water from the lower river before it used in the reservoirs must be disinfected using 409®. An example of equipment that still might be wet from use in the lower river by the time it is to be used in the reservoirs is the zooplankton net.

Field Sheets

Field sheets document field conditions, how samples were collected, in situ measured field parameters, and other site observations. It is important that information is written legibly and documented in such a way for readers to understand the observations and measurements collected in the field.

Stream sites and reservoir sites each have a specific field sheet (Attachment A). Please completely fill out the spreadsheet for each site. If necessary, use the back for recording extra information.

Safety

At the beginning of each field day, a job briefing/tailboard must be completed with the crew. The briefing should cover

- Hazards associated with the job (e.g., high flows, uneven terrain, poisonous vegetation, wildlife concerns, fire risk, etc.)
- Work procedures to use
- PPE required
- Special precautions

The pre-job briefing/tailboard discussion must be documented on job briefing forms and all individuals on-site must sign this form.

The following guidelines apply to all field work:

- No sample or measurement is worth the risk of injury
- Field crew should consist of at least two members
- Be conscious of fire risk, ticks, rattlesnakes, and poison oak (see below)
- Do no trespass on private property, Tribal land, or posted restricted public lands without prior permission and written approval from property owner
- If something feels off or unusual at a sample site, leave and postpone the work to a later time
- Use a personal flotation device when working around swift or deep waters

Below are safety guidelines for the more common hazards encountered while collecting samples for this study.

Ticks

About 20 species of hard ticks are found in Oregon, but only four are known to prey on humans: western black-legged tick, Rocky Mountain wood tick, American dog tick, and Pacific Coast tick.

The western black-legged tick is the only known carrier of Lyme disease in Oregon (Figure 1 and Figure 2). If you find a western black-legged tick embedded or you cannot identify an embedded tick, remove the tick and keep it in a plastic bag so that it can be properly identified, and if necessary, tested for Lyme disease.

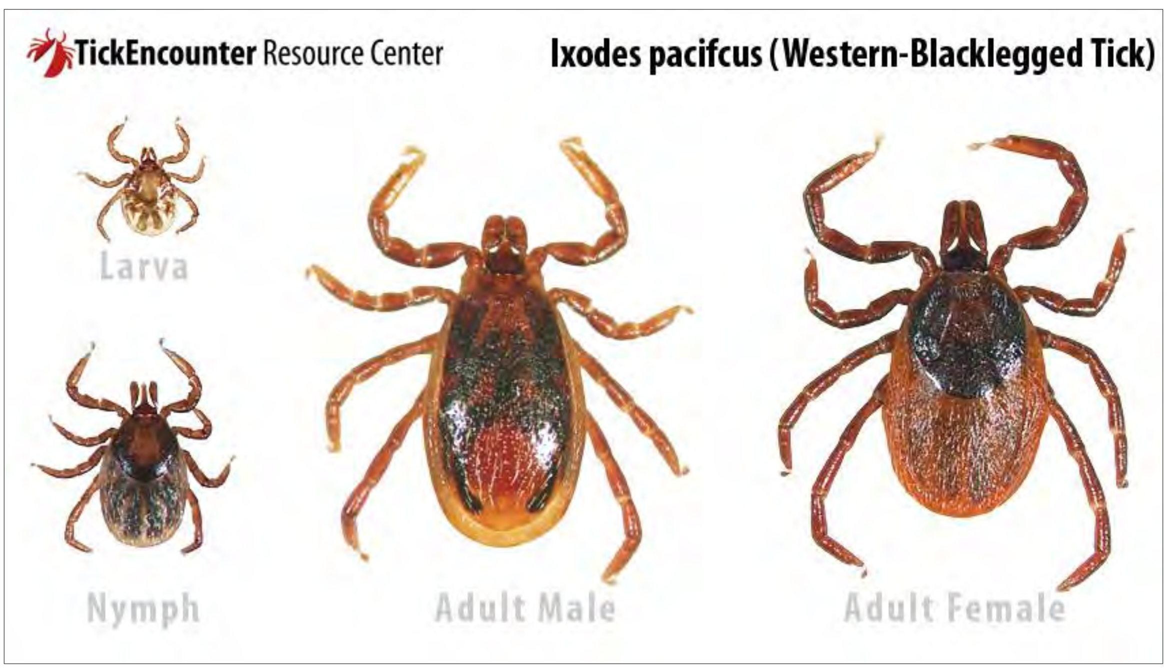

Figure 1. Western-Blacklegged tick is the only tick species that carries Lyme disease in Oregon.
(Source: TickEncounter Resource Center http://www.tickencounter.org/tick_identification/westernblacklegged_tick)

Figure 2. Nymph of the western blacklegged tick, Ixodes pacificus. (Source: University of California Agriculture and Natural Resources, Statewide Integrated Pest Management Program, Lyme disease in California, http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7485.html)

Tick Checks[1]

Inspect your clothing and exposed skin for ticks often when outdoors in likely tick habitats. Ticks may attach anywhere on the body, but on fully clothed persons they often attach to the scalp, behind an ear, or to an arm or leg. Pay particular attention to these areas when examining yourself or others. Furthermore, examine your bedding for up to several days after exposure to tick-infested habitats for presence of detached, fed ticks.

Nymphs of the western blacklegged tick, once attached to human skin, are easily overlooked because of their small size and sometimes hidden feeding sites (such as the scalp). However, fully satiated nymphs have been observed to detach from people during the night within as few as 3 days after exposure to ticks, and they are much easier to detect in a bloated state while digesting their blood-meal among bedclothes, including one's pillow.

Tick Removal[2]

If you find an attached tick, remove it immediately. Prompt removal of infected ticks can prevent Lyme disease and other tickborne diseases. Although research suggests that *Ixodespacificus* nymphs require about 2 or more days of attachment to begin transmitting *Borreliaburgdorferi*(Lyme disease) to a host, other tickborne agents (such as Colorado tick fever, Rocky Mountain spotted fever) may be transmitted within the first day.

Grasp the tick as close to the skin as possible with a pair of tweezers. If tweezers are unavailable, use your fingers, but protect them with tissue paper. Be careful not to squash a fed or partially fed tick because some tickborne agents may be transmitted through broken skin.

Slowly and steadily pull the tick straight out. Remove any mouthparts that break off in the wound (consult a physician if necessary). The mouthparts may be contaminated with other bacteria that

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[1]Source: University of California Agriculture and Natural Resources, Statewide Integrated Pest Management Program, Lyme disease in California, http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7485.html

[2]Source: University of California Agriculture and Natural Resources, Statewide Integrated Pest Management Program, Lyme Disease in California, http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7485.html

occasionally cause secondary infections, but the mouthparts alone will not transmit Lyme disease spirochetes.

Do not jerk or twist the tick as you extract it. Do not apply alcohol, fingernail polish, heat from a lit match, or petroleum jelly to the tick; these methods are completely ineffective. Clean the wound with soap and water. Apply a mild antiseptic such as povidone-iodine, if available. Report the exposure to your supervisor.

Poison Oak[3]

Poison oak is a woody shrub or vine with “leaves of three,” meaning groups of three leaflets (there can be up to seven leaflets in each leaf group), along its branches. In spring and summer, its leaves are shiny; in the fall, its leaves are often vibrant red before dropping (Figure 3). Its bare stems can be reddish color in winter. The irritating oils in the plant (urushiol) can be found in the leaves, stems and roots.

If exposed to poison oak

1. Wash the area with cold, soapy water or use the poison oak cleanser (available from PGE storerooms). DO NOT use hot water, as this can spread the irritating oils.
2. Change your clothes and shoes as soon as possible, being careful how you remove them. Consider protecting your hands with rubber gloves.
3. Place clothing directly in a laundry machine or a plastic bag until laundering can be done.
4. Clean leather boots with rags and isopropyl alcohol (wear gloves).
5. Report the exposure to your supervisor.

Treatment

Exposed skin usually develops an itchy, burning rash of red streaks or patches that may include swelling and blisters that “weep” or crust over. Symptoms may last one to two weeks. If you develop a reaction, try the following tips. Be sure to complete a Safety Incident Report and submit through mySafety.

- Use plain calamine lotion to help soothe the itch.
- Apply cold, wet compresses to reduce itching and inflammation.
- Keep the area clean after blisters have broken.
- Don’t scratch! Scratching can lead to an infection.

[3] Source: PGE Safety Manual, August 2015

Figure 3. Standard identification of poison oak (*top*) (photo Tom Kloster) and red leaves in the spring (*bottom*) (photo Steve Hart). (Source: http://www.oregonhikers.org/field_guide/Poison_Oak)

Rattlesnakes

The Western Rattlesnake is distinguished from other Oregon snakes by its broad, triangular head that is much wider than its neck, vertical pupils (a characteristic shared only with night snakes) and the rattles on the end of its tail (Figure 4). Overall color patterns differ with habitat, ranging from olive to brown to gray. Black and white crossbars may occur on the tail. Western rattlesnakes average 18 inches to 36 inches at maturity, with some individuals occasionally attaining lengths of four feet, and rarely five feet.

These snakes are most commonly seen near their den areas, which are generally in rock crevices exposed to sunshine. They are most likely to be seen during the spring and fall when moving to and from hibernation sites. Rattlesnakes do not view humans as prey and will not bite unless threatened.

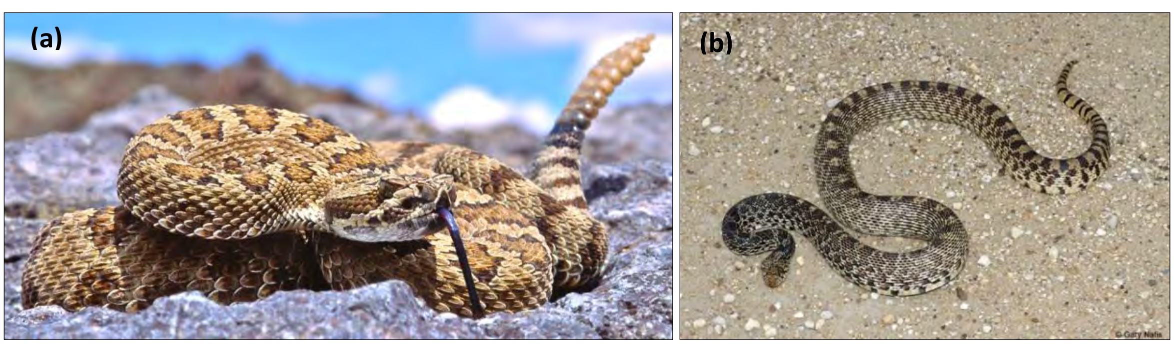


Figure 4. (a) Western Rattlesnake (*Croatusviridis*) (St. John photo), (b) Gopher Snake, also known as Bull Snake (*Pituophiscatenifer*) (Gary Nafis photo). (Source: Oregon Department of Fish and Wildlife and www.californiaherps.com)

Stream Field Procedures

The procedures in this section apply to the 12 lower Deschutes River sites and 5 tributary sites.

A field sheet much be filled out for each site during a sampling event, even for sites that cannot be sampled. For these sites, include a brief explanation of why the site was not sampled.

Always record the samples (parameter, # of bottles, volume, site ID, and replicate if applicable) that are collected at each site on the field sheet in the Samples Collected section.

Field Measurements

Water Chemistry - At each tributary and lower Deschutes River site, pH, DO (mg/L and %), conductivity, and temperature must be measured using the water quality meter. Place the probe in a riffle or other area where the water is moving swiftly. Record the readings on the field sheet.

Chlorophyll and Cyanobacteria - The AlgaeTorch is used to measure water column chlorophyll at each location where rocks are collected for periphyton sampling in the Deschutes River, for a total of three chlorophyll readings at each site. Record the cyanobacteria and total concentrations and sample time on the field sheet. Take a reading with the AlgaeTorch when collecting a water column chlorophyll sample that is sent to the lab.

Additional water column chlorophyll measurements can be taken at a site. On the field sheet, along with time and concentrations, please note where these additional measurements were taken.

Light Meter - Air and water light measurements must be taken at the three locations where rocks are collected for periphyton sampling. Measurements are recorded on field sheets along with time and depth of reading. If sun coverage should change (cloud passes over the sun) while taking a measurement, please note this on the field sheet. See Light Meter Section for how to use the meter.

Flow Measurements - Flow measurements are taken at the three locations where rocks for periphyton samples are collected. A measurement is also taken near the water surface when zooplankton and phytoplankton are collected in the lower river. Measurements are also collected in the White River and Willow Creek for calculating discharge. See Instrumentation Section on how to use the meter.

Nutrients

Nutrient samples are collected at all tributary and lower Deschutes River sites. The volume of sample water collected depends on the sampling scheduling (See Attachment B) and specific collection volumes are in Attachment C. Samples are collected in translucent plastic bottles provided by the lab. The parameters analyzed are

- **NUT:** total nitrogen, nitrate, ammonia, total phosphorus, phosphate, chloride
- **Extra NUT**: total nitrogen, nitrate, ammonia, total phosphorus, phosphate, chloride, total organic carbon, alkalinity

When filling out the chain-of-custody form, total organic carbon and alkalinity must be checked for the EXTRA NUT samples.

Collection Procedure

Method: U.S. EPA Standard Methods; Lab Guidelines

Bottle Size: 60 mL, 125 mL, 250 mL; see attachments B and C

Filtration: Yes

Preservative: None

**Fill out bottle label before submerging

1. Submerge an empty 1L bottle into water and let it fill half way, shake bottle, and then discard water. Do this 3 times.
2. Submerge bottle and fill to the neck.
3. If filtering back at the office or hotel, label the bottle and cover with ice in a cooler.
4. When ready to filter, rinse the flask and filter base with DI water.
5. Assemble the filter kit by attaching the filter base with rubber stopper to the filtering flask. Join the flask and a hand-operated vacuum pump using a section of tubing.
6. Place a 47-mm glass fiber filter paper (provided by the lab) on the filter base (funnel) and wet with deionized water. Wetting the filter paper will help keep it in place in windy weather. Attach the filter funnel.
7. Shake the sample component vigorously for about 30 seconds to ensure that it is well mixed.
8. Pour a small amount of sample into the filter funnel and filter. Discard the water in the flask.
9. Use the measurement lines on the filter funnel or the graduated cylinder to pour out a measured volume of sample from the 1L bottle. Attachment C identifies how much sample must be filtered for each site.
10. Filter the sample using 10 psi (69 kPa).
    a. IEH and CCAL are the two labs analyzing nutrient samples and both have provided bottles. It is important to use each lab's specific bottle for its sample.
    b. When filling the filtered sample that will be sent to IEH, pour a small amount of filtered water into the sample bottle. Shake the bottle and discard the water. Do this three times. It is not necessary to do this with CCAL's bottles.
11. After the appropriate volume of sample has been filtered, use the remaining water for the unfiltered sample. Attachment C identifies how much sample is needed for the unfiltered samples.
    a. When filling the unfiltered sample that will be sent to IEH, pour a small amount of unfiltered water into the sample bottle. Shake bottle and discard the water. Do this three times. It is not necessary to do this with CCAL's bottles.
12. Place bottles in cooler with ice

13. At the office or hotel, place the filtered samples in the freezer and the unfiltered samples in the refrigerator.

Periphyton

Periphyton samples are collected at the lower Deschutes River sites and the three Lake Billy Chinook tributary sites. Two sampling procedures are described: sample collection from rocks and collection from macrophytes (aquatic plants).

Note that a flow measurement, light reading, and an AlgaeTorch water column chlorophyll measurement are taken at every site where rocks are collected.

Rock Collection Procedure

Periphyton, ash free dry weight (AFDW), and chlorophyll are collected using this sample procedure.

Method: adapted from USGS Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities

Bottle Size: 125 mL, multiple bottles – chlorophyll collected in amber bottles, periphyton and AFDW collected in neutral bottle. Lab provides bottles for chlorophyll and AFDW.

Filtration: None

Preservative: Included in bottle for chlorophyll (lab added); must add Lugol to bottle for Rhithron periphyton sample (add enough Lugol's iodine to the sample bottle to turn the water a dark tea color); no preservative required for AFDW.

IMPORTANT: Flow measurements at each site must be taken before rocks are selected and removed for sampling.

**Fill out bottle label before filling with water sample

1. Collect 3 rocks from 3 different locations in areas with representative flow (a total of 9 rocks per site). The three locations need to be distributed throughout the reach. Place rocks in a plastic dishpan and transport them to an on-site processing station to scrape periphyton from each rock.
2. Identify the area on each rock where periphyton are attached. Use a colored pencil to delineate the area where the rock will be scrapped. Use the 2 in (20.3 cm^2) PVC delimiter ring to outline the circular scraping area.

   [Note: If for some reason a delimiter other than the 2 in diameter ring is used to delineate the sampling area, the diameter of that ring must be noted on the field sheet along with a brief description of why it was used.]

3. Using a pocket knife or small brush, scrape the periphyton from the sampling area on each rock. While scrapping, rinse periphyton from the pocket knife or small brush into the 100 ml graduated cylinder using DI water in the squirt bottle. ***Do not rinse scrapings from the rock directly into the graduated cylinder*** because periphyton from outside the delineated sample area will also enter the cylinder.

4. Repeat this process several times until all of the visible periphyton within the sample area is removed.
5. Repeat the sampling procedure for a single area on each of the rocks selected (the composited sample is composed of 9 discrete collections taken from 9 rocks).
6. Pour the contents of the graduated cylinder into a 500 mL measuring cup. Using the graduated cylinder, add DI water to the contents so that final sample volume is **375 mL** for periphyton, ash-free dry weight, and chlorophyll a.
    a. If taking a replicate sample, add enough DI water to double the volume (750 mL). Follow the steps below using 6 bottles instead of 3.
7. Line up the 125 mL sample bottle for periphyton, the 125 mL sample bottle for ash-free dry weight, and the 125 mL sample bottle for chlorophyll a.
8. Thoroughly mix the composite sample in the 500 mL measuring cup and partially fill each sample bottle. Continue to mix the sample and partially fill the bottles until they are all full.
9. Place the bottles on ice inside a cooler.

Macrophyte Collection Procedure

Macrophyte samples are taken only when indicated on the sampling schedule (See Attachment B). Only periphyton is analyzed from this sample; chlorophyll a and ash free dry weight are not collected. It is not necessary to determine the area of the macrophyte clipping. This sample is only analyzed for species composition.

Filtration: None

Preservative: Lugol's iodine; may be added before or after the sample is taken; add enough Lugol's iodine to the sample bottle to turn the water a dark tea color

**Fill out bottle label before filling with water sample

1. Take several clippings from multiple beds
2. Place clippings in a 125 mL amber algae bottle and fill with DI water
3. Place the bottles on ice inside a cooler and keep in the dark

Phytoplankton

Phytoplankton samples are taken only at the lower Deschutes River sites when indicated on the sampling schedule (See Attachment B).

Collection Procedure

Method: adapted from USGS Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities

Bottle Size: 250 mL neutral bottles when sample is sent to Rhithron

Filtration: None

Preservative: Lugol's iodine must be added to bottles sent to Rhithron; add the iodine after the grab sample is taken. Add enough Lugol's iodine to the sample bottle to turn the water a dark tea color.

**Fill out bottle label before filling with water sample

1. Submerge empty bottle into water and wait for it to fill completely
2. Shake bottle and discard water
3. Submerge empty bottle into water and wait for it to fill completely.
4. Return to the river bank and add enough Lugol's iodine to the sample bottle to turn the water a dark tea color
5. Gently shake the bottle and place it on ice inside a cooler and keep in the dark

Zooplankton

Zooplankton samples are only taken at the lower Deschutes River sites when indicated on the sampling schedule (Attachment B).

Collection Procedure

Bottle size: 250 mL, neutral

Filtration: None

Preservative: Ethanol, 25% of volume

**Fill out bottle label before filling with water sample

1. Place plankton net (80 to 125 micron mesh, 30 cm opening with a 20 cm reduction collar) into river with opening facing upstream approximately 5 to 10 seconds. If there is a lot of sediment in the water column, reduce the amount of time to 5 seconds or less. Record time on the field sheet
2. Retrieve the net and pour sample into bottle.
3. Take a surface flow measurement at the point where the plankton net was placed.
4. Place the bottles on ice inside a cooler. Add preservative as soon as possible.

Water Column Chlorophyll

Water column chlorophyll samples are collected only at the lower Deschutes River sites when indicated on the sampling schedule (See Attachment B).

Collection Procedure

Method: USGS Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities

Bottle size: 1 Liter

Filtration: Yes

Preservative: No

1. Submerge an empty 1L bottle into water and let it fill half way, shake bottle, and then discard water. Do this 3 times.
2. Submerge bottle and fill to the neck. While filling the bottle, take a reading with the AlageTorch at the same time and note the concentrations and time on the field sheet.
3. If filtering back at the office or hotel, label the bottle and cover with ice in a cooler.
4. When ready to filter, first assemble the filter kit by attaching the filter base with rubber stopper to the filtering flask. Join the flask and a hand-operated vacuum pump using a section of tubing.
5. Place a 47-mm glass fiber filter (for example, Whatman™ GF/F) on the filter base and wet with deionized water. Wetting the filter paper will help keep it in place in windy weather. Attach the filter funnel.
6. Shake the sample component vigorously for about 30 seconds to ensure that it is well mixed.
7. Use the graduated cylinder to pour out a measured volume of sample from the 1 liter bottle. **It is critical to keep track of the amount of sample filtered for reporting purposes.**
8. Filter the sample using 10 psi (69 kPa).
9. Examine the filter. An adequate amount of microalgal biomass for analysis is indicated by the green or brown color of material retained on the filter. Continue to filter until the desired level of biomass is obtained and before the filter paper becomes clogged. This may be obtained before the entire 1 liter of sample is filtered (Figure 5).

Figure 5. Example of algal biomass collected during filtration. (Source: USGS, Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities as Part of the National Water-Quality Assessment Program)

10. Rinse the funnel sides with deionized water. Always allow the water to be vacuumed completely before releasing the vacuum from the filtering apparatus.
11. Remove the filter from the funnel base with forceps.
12. Prepare the filter paper for shipping.
    a. Fold each filter into quarters with filtered biomass inside. Wrap each filter in a small piece of aluminum foil and place in separate Ziploc bags.
    b. Label the bag with the following required information: site, collection date, sample volume, and sample identification code.

c. Place the small plastic bags in resealable plastic bags and put into a freezer. If filtering in the field, pack in a cooler containing a lot of ice. Transfer to a freezer when available.

Reservoir Field Procedures

The reservoir sampling is carried out at 6 sites between Lake Billy Chinook and Lake Simtustus and 4 tributary sites. Refer to the Sampling Schedule (See Attachment B) for the list of parameters to be collected during each site visit.

Always record the samples (parameter, volume, and site ID) that are collected at each site on the field sheet in the Samples Collected section.

Field Measurements

Table 1 summarizes the sampling profiles described below.

Water Chemistry - At each tributary and reservoir site, pH, DO, conductivity, and temperature must be measured using the water quality meter.

At the tributary sites, place the probe in an area where the water is moving swiftly. At the two tailrace sites, lower and fill a bucket with water. Retrieve the bucket and take measurements with the probe.

At the reservoir sites, take profile measurements following the intervals listed in Table 1. Record the readings on the field sheet.

Chlorophyll and Cyanobacteria - The AlgaeTorch is used to measure water column chlorophyll at the reservoir sites and the three main tributary sites (Crooked River, Deschutes River, and Metolius River). At the tributary sites, a measurement is taken at each location where rocks are collected for periphyton sampling for a total of three chlorophyll reading at each site. Additional water column chlorophyll measurements can be taken at the tributary sites. On the field sheet, along with time and concentrations, please note where these measurements were taken.

At the four reservoir sites, a reading is taken at 0.5 m and then every 2 m from 2 to 10 m depth (Table 1). Record the cyanobacteria and total concentrations and sample time on the field sheet.

*****Do not lower the AlgaeTorch below 10 m!***

Light Meter – At the reservoir sites, take an air reading (sensor must be dry). Then lower the sensor into the water and take the first reading 1 meter below the surface. Continue lowering the sensor and taking a reading every 1 meter until the meter reads 1% of the first subsurface reading.

At the tributary sites, air and water measurements must be taken at the three locations where rocks are collected for periphyton samples. Measurements are recorded on field sheets along with time and depth of reading. If sun coverage should change (cloud passes over the sun) while taking a measurement, please note this on the field sheet. See Light Meter Section for how to use the meter.

Flow Measurements – For reservoir sampling, flow measurements are only taken at tributary sites when rocks are sampled for periphyton and for discharge curves in ungauged streams. See Light Meter Section for how to use the meter.

Table 1. Summary of sampling profiles for field measurements at reservoir sites.

Measurement	**Interval**
Water Chemistry	*0.5 m* *2-m interval from 2 to 20 m* *5-m interval from 20 to 40 m* *10-m interval from 40 to 60 m* *20-m interval from 60 to bottom*
AT Chlorophyll/Cyanobacteria	*2-m interval from 0 to 10 m*
Water Column Chlorophyll	*1 sample at 0.5 m*
Light Readings	1-m interval to 1% of first subsurface reading
Nutrients	*1, 10, 25, 45, 75 m (when available)*
Phytoplankton	*0.5 m and 10 m grab sample*
Zooplankton	*20 m to surface tow*

Nutrients

Nutrient samples are collected at all the tributary sites and the reservoir sites. The volume of sample water collected depends on the sampling scheduling (Attachment B) and specific collection volumes are in Attachment C. Samples are collected in translucent plastic bottles provided by the lab. The parameters analyzed are

- **NUT:** total nitrogen, nitrate, ammonia, total phosphorus, phosphate, chloride
- **Extra NUT:** total nitrogen, nitrate, ammonia, total phosphorus, phosphate, chloride, total organic carbon, alkalinity

When filling out the chain-of-custody form, total organic carbon and alkalinity must be checked for the Extra NUT samples.

Multiple nutrient samples must be collected at various depths at the reservoir sites. Refer to the Sampling Schedule (Attachment B) for specific information about each sampling site.

Collection Procedure

Method: U.S. EPA Standard Methods; Lab Guidelines

Bottle Size: 60mL, 125 mL, 250 mL or 500 mL; see attachments B and C

Filtration: Yes

Preservative: None

**Fill out bottle label before submerging

1. Use the Van Dorn to collect the sample at a discrete depth. See Attachment B for specific depth and replicate information.
2. Pour the contents of the Van Dorn into the churn splitter
3. Rinse a 1L bottle with DI water and some sample water and discard.
4. Fill the 1L bottle. If filtering back at the office, label the bottle and cover with ice in a cooler.
5. When ready to filter, rinse the flask and filter base with DI water.
6. Assemble the filter kit by attaching the filter base with rubber stopper to the filtering flask. Join the flask and a hand-operated vacuum pump using a section of tubing.
7. Place a 47-mm glass fiber filter paper (provided by the lab) on the filter base (funnel) and wet with deionized water. Wetting the filter paper will help keep it in place in windy weather. Attach the filter funnel.
8. Shake the sample component vigorously for about 30 seconds to ensure that it is well mixed.
9. Pour a small amount of sample into the filter funnel and filter. Discard the water in the flask.
10. Use the measurement lines on the filter funnel or the graduated cylinder to pour out a measured volume of sample from the 1L bottle. Attachment C identifies how much sample must be filtered for each site.
11. Filter the sample using 10 psi (69 kPa).
    a. When filling the filtered sample that will be sent to IEH, pour a small amount of filtered water into the sample bottle. Shake the bottle and discard the water. Do this three times. It is not necessary to do this with CCAL's bottles.
    b. IEH and CCAL are the two labs analyzing nutrient samples and both have provided bottles. It is important to use each lab's specific bottle for its sample.
12. After the appropriate volume of sample has been filtered, use the remaining water for the unfiltered sample. Attachment C identifies how much sample is needed for the unfiltered samples.
13. When filling the unfiltered sample that will be sent to IEH, pour a small amount of unfiltered water into the sample bottle. Shake bottle and discard the water. Do this three times. It is not necessary to do this with CCAL's bottles.
14. Place bottles in cooler with ice.
15. At the office or hotel, place the filtered samples in the freezer and the unfiltered samples in the refrigerator.

Phytoplankton

Phytoplankton grab samples are collected at the six reservoir sites. Use the Van Dorn Water Sampler to collect two discrete samples at 0.5 m and 10 m. Only one sample is collected at each of the tailrace sites.

Collection Procedure

Method: adapted from USGS Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities

Bottle Size: 250 mL, neutral

Filtration: None

Preservative: Lugol's – may be added to the bottle before the sample is collected or after; add enough Lugol's iodine to the sample bottle to turn the water a dark tea color

1. Lower the Van Dorn to 0.5 m. Drop the weight at the top of the cable down the line, which trips and closes the ends of the sampler.
2. Pour the contents of the Van Dorn into the churn splitter.
3. Add some sample water to the bottle, mix well, and discard water.
4. Fill the sample bottle and add preservative.
5. Repeat the same steps for the 10 m sample.

Zooplankton

At each reservoir site, one vertical tow from 0 to 20 m is taken for each sample.

Collection Procedure

Method: adapted from USGS Lake Monitoring Field Manual

Bottle Size: 250 mL, neutral

Filtration: None

Preservative: Ethanol; 25% of volume

1. While keeping a firm grasp on the line, slowly lower the plankton net to 20 m below surface; the weight of the bucket should pull the net down at a constant rate.
2. Retrieve the net using a gentle hand-over-hand motion (approximately 0.5 to 1 meter per second) while lifting vertically.
3. At the surface, gently lower and raise the net in the water to rinse down the sides without allowing water through the top.
4. Holding the net above the water, use the DI spray bottle to rinse down the OUTSIDE of the net.
5. Rinse the inside of the bucket and the screened areas into the container with DI water.
6. Add preservative (25% sample volume) to a labeled 250 mL bottle.
7. Pour sample into sample bottle; mix gently.

Water Column Chlorophyll

Water column chlorophyll samples from the reservoirs that are sent to the lab are collected only at the six reservoir sites as indicated in Attachment B. These samples are taken in order to compare lab measurements with AlgaeTorch measurements. They are collected at 0.5 m depth.

Collection Procedure

Method: USGS Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities

Bottle size: 1 Liter

Filtration: Yes

Preservative: No

**Fill out bottle label before filling with water sample

1. Lower the Van Dorn to 0.5 m and collect the water sample.
2. Retrieve the Van Dorn and pour the contents of the Van Dorn into the churn splitter and fill the sample bottle.
3. Take a reading with the AlageTorch at the same time and note the concentrations and time on the field sheet.
4. If filtering back at the office, label the bottle and cover with ice in a cooler.
5. When ready to filter, first assemble the filter kit by attaching the filter base with rubber stopper to the filtering flask. Join the flask and a hand-operated vacuum pump using a section of tubing.
6. Place a 47-mm glass fiber filter (for example, Whatman™ GF/F) on the filter base and wet with deionized water. Wetting the filter will help keep it in place in windy weather. Attach the filter funnel to the base.
7. Shake the sample component vigorously for about 30 seconds to ensure that it is well mixed.
8. Use the graduated cylinder to pour out a measured volume of sample from the 1L bottle. **It is critical to keep track of the amount of sample filtered for reporting purposes.**
9. Filter the sample using 10 psi (69 kPa).
10. Examine the filter. An adequate amount of microalgal biomass for analysis is indicated by the green or brown color of material retained on the filter. Continue to filter until the desired level of biomass is obtained and before the filter paper becomes clogged. This may be obtained before the entire 1L of sample is filtered (Figure 6).

Figure 6. Example of algal biomass collected during filtration. (Source: USGS, Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities as Part of the National Water-Quality Assessment Program)

11. Rinse the funnel sides with deionized water. Always allow the water to be vacuumed completely before releasing the vacuum from the filtering apparatus.
12. Remove the filter from the funnel base with forceps.
13. Prepare the filter paper for shipping.
    a. Fold each filter into quarters with filtered biomass inside. Wrap each filter in a small piece of aluminum foil and place in separate Ziploc bags.
    b. Label the bag with the following required information: site, collection date, sample volume, and sample identification code.
    c. Place the small plastic bags in resealable plastic bags and put into a freezer. If filtering in the field, pack in a cooler containing a lot of ice. Transfer to a freezer when available.

Replicate Samples

Replicate samples are two or more identical samples that are analyzed to provide an estimate of the overall precision of sampling or analytical procedures. Attachment B identifies which sites to take replicates.

- Nutrients: Replicate sample are taken in the river and reservoirs and are sent to CCAL.
- Periphyton: Replicates taken in the lower river are sent to Rhithron except during one week in July and September when samples are sent to Aquatic Analytics and just the replicate is sent to Rhithron.
- Phytoplankton: Replicates taken in the reservoir are sent to Rhithron except during one week in July and September when samples are sent to Aquatic Analytics and just the replicate is sent to Rhithron.
- Zooplankton: One replicate is taken per sampling event from the reservoir sites. The replicate sample is sent to Rhithron.

Instrumentation

Flow Meter

Flow measurements are taken

- Where rocks for periphyton samples are taken
- Where zooplankton and phytoplankton are collected in the lower Deschutes River
- For discharge curves in ungauged streams

Brand: FH950 Portable Velocity Meter

Discrete Measurement

1. Position the wading rod vertically with the sensor pointed upstream into the flow.
2. Determine the depth of water from the rod depth gauge to the nearest 10th of a foot. If the water level is at the half way mark between 0.4 feet and 0.5 feet on the depth gauge (hexagonal

rod); in this case the reading is 0.45 feet. If the water level is between 0.4 and 0.45 or between 0.45 and 0.5, round off to the nearest 1/10 foot increment.

3. Depress the unlocking lever and move the round rod up to depth you just recorded. This is 0.6 of the depth. Record the velocity for that station after the meter (0.4-depth position up from the streambed).

Discharge Measurements

Method: Velocity-Area, USGS Discharge Measurements at Gaging Stations, Techniques and Methods 3-A8

Width interval - USGS recommends that no more than 5% of the stream discharge be represented in each sub-sectional area of the cross-section; in practice, this usually equates to 20 to 25 measurements across the width of the stream. Divide the width of the stream channel by 20 and round to the nearest whole number.

Example: The channel is 46 feet wide, 46 / 20 = 2.3 ft. Take flow measurements every 2 feet.

Procedure

1. String measuring tape across the stream perpendicular to flow. Tie the tape off at both sides of the stream. Make it taut enough so that it doesn't sage near the middle. Measure the stream width. Leave the tape in place.
2. Start at the very edge of one bank and work your way across the stream, measuring velocity with the meter at each interval point and noting your distance from the bank edge where you started (Figure 7).

   NOTE: Stand at least 1 foot away on the downstream side of the tape and hold the meter and rod next to the tape. Be sure you are standing far enough from the meter to ensure that eddies around your boots are not interfering with the flow measurement.

3. For depths ≤ 2.5 feet. Position the wading rod vertically with the sensor pointed upstream into the flow). Determine the depth of water from the rod depth gauge to the nearest 10th of a foot. If the water level is at the half way mark between 0.4 feet and 0.5 feet on the depth gauge (hexagonal rod); in this case the reading is 0.45 feet. If the water level is between 0.4 and 0.45 or between 0.45 and 0.5, round off to the nearest 1/10 foot increment. Depress the unlocking lever and move the round rod up to depth you just recorded. This is 0.6 of the depth. Record the velocity for that station after the meter (0.4-depth position up from the streambed).

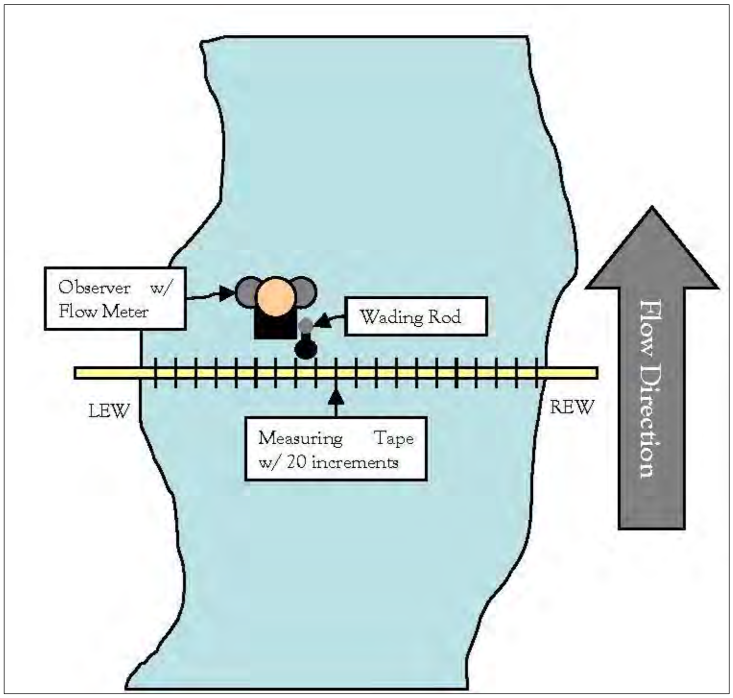


Figure 7. Plan view of observer and measuring tape with respect to the stream. Source: Arizona Department of Environmental Quality, Standard Operating Procedures for Surface Water Quality Sampling, March 2015.

Light Meter

The light meter measures Photosynthetically Active Radiation (PAR). PAR is the radiant energy used by most terrestrial and aquatic plants and algae in photosynthesis. The meter measures wavelengths between 400 and 700 nanometers.

Take light readings quickly because the amount of available light at the surface is sensitive to changes in the wind, cloud cover, and disturbance at the water's surface.

Brand: Li-Cor; LI-250A Light Meter and LI-192 Underwater Quantum Sensor

River Sites: Air and water measures must be taken at the three locations where rocks are collected for periphyton are sampled. Measurements are recorded on field sheets along with time and depth of reading. If sun coverage should change (cloud passes over the sun) while taking a measurement, please note this on the field sheet.

1. Take an atmospheric measurement above where the in-water measurement will be taken. The sensor must be dry and oriented vertically.
2. Submerge the sensor so that the mounting rack touches the stream bed and take measurements.

Reservoir Sites: Measurements are taken at multiple depths. Measurements are recorded on field sheets long with time and depth of reading. If sun coverage should change (cloud passes over the sun) while taking a measurement, please note this on the field sheet.

1. Take an atmospheric measurement above where the in-water measurement will be taken. The sensor must be dry and oriented vertically.
2. Submerge the sensor to 1 meter below the surface and record a measurement.
3. Continue lowering the sensor and taking a reading at every 1 meter interval until the meter reads **1 percent of the first subsurface light reading**.

   Example: Subsurface readings = 1800 µmol, last measurement is when reading is less than 18 µmol

Weather Stations

Data from the weather stations should be downloaded monthly and uploaded onto the Water Quality Study SharePoint site. It is important to regularly download the data so that it can be reviewed and suspect data identified.

Reservoir weather stations:

- Chinook Island
- Right below Cove Marina
- Round Butte FTF
- Pelton Dam

Lower river stations:

- Buckhollow
- Deschutes River State Recreation Area, past the gate

Equipment for downloading

- HOBO U-shuttle
- HOBO optic USB Base Station (Round Butte) with the Couplwer2-E
- USB to mini USB cord and Hobo shuttle interface cable for Round Butte station.
- Notebook for recording time and date of downloading

Procedure

1. Connect U-shuttle to the weather station using USB cord or interface cable.
2. Turn on U-shuttle and let it find device. It should immediately find the weather station and will ask to show sensors. You can press yes or no. If you press yes, the shuttle will show real-time measurements of the connected sensors.
3. Once through the measurements, memory use and battery percent will be displayed. Hit next and you will be asked to offload. Hit yes and offloading will begin.

4. You will then be asked about re-launching. Hit yes to have it re-launch the weather station. **This clears the memory, so the next time the station is downloaded, the information will be only from after the last download.** It will say are you sure, and hit yes. It will then say re-launch successful,
5. Remove device. Unplug from weather station and turn off U-shuttle.

The Round Butte weather station has a separate unit for temperature and relative humidity which use the HOBO optic USB base station.

1. Connect the base station to the HOBO pro v2 unit by slipping it on to the unit and press the lever on the base station to start data offloading.
2. A yellow transfer light will blink while offloading. Once offload is complete a green light will blink, hit the lever again to stop the green light blinking.
3. Disconnect the base station from the HOBO pro v2 unit.

Pressure Transducer

Two pressure transducers are located on the White River downstream of the White River State Park. One transducer is on the shore and the second is in the river (Figure 8). At least once a month, data from both transducers should be downloaded.

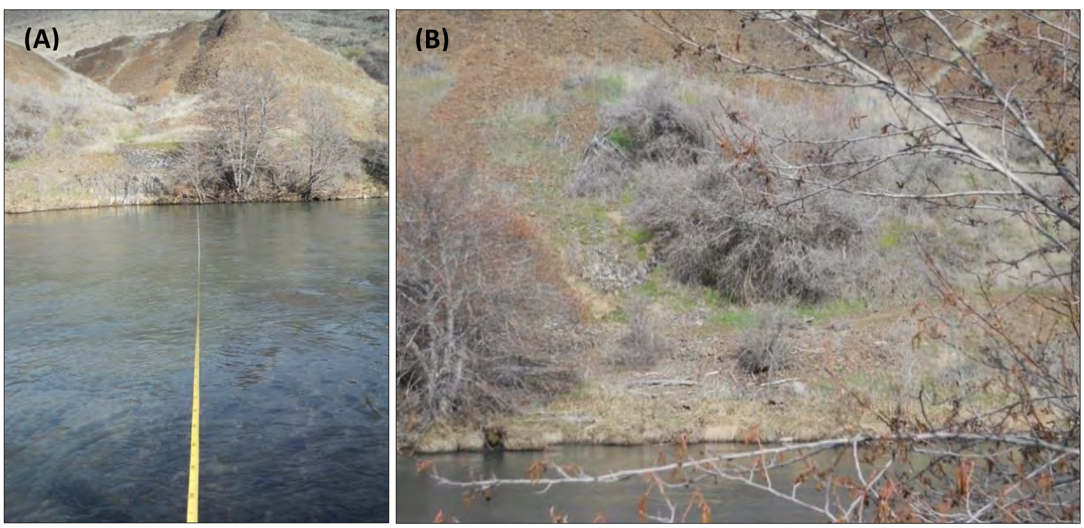


Figure 8. Location of the pressure transducer. Photo A shows the discharge transect location. The pressure transducer is in hidden in a black plastic tube in the bush shown in Photo B. This bush is to the left of the transect from the perspective of Photo A.

Post-Trip Procedures

Refrigerate and freeze samples

- Filtered samples must be placed in a freezer within 24 hours of collection

- Unfiltered samples must be placed in a refrigerator within 24 hours of collection
- Chlorophyll filter paper must be frozen within 24 hours of collection

Shipping Samples

- Nutrient samples and chlorophyll filters must be sent to IEH and CCAL the Monday following collection
- Algae and zooplankton samples should be sent within two weeks of collection to the appropriate labs
- A chain-of-custody form must be filled out and sent with each sample shipment and an electronic copy of it made and kept for our files

Scan field sheets

- As soon as possible, scan filled-out field sheets and either email or post them to SharePoint

Labels

Lower River and Tributaries

Sample Reach	
Lower River	LDR

Sample ID	
Site	Number
Rereg Dam	01
Dry Creek	03
South Junction	05
Whitehorse	07
Ferry	09
Lower Wapinitia	11
Sandy Beach	12
Wreck	14
Rattlesnake	16
Bull Run	18
Kloan Rapids	20
River Mouth	21
Shitike Creek	SC
Warm Springs	WS
Trout Creek	TC
Oak Springs	OS
White River	WR

Date
MODYYR

SampleType	
Periphyton	PER
Periphyton Macrophyte Habitat	PERM
Chlorophyll	CHL
Chlorophyll Water Column	CHLWC
Ash-free dry weight	AFDW
Nutrient	NUT
Phytoplankton	PYT
Zooplankton	ZOO
Chlorophyll	CHL

SampleReach_SampleID_Date_SampleType_AnalysisType

Example: Whitehorse Site, February 19, 2015, Periphyton Sample

LDR07021915PER

Example Oak Springs, February 19, 2015, Nutrients

LDROS021915NUT

Reservoir

Sample Reach	
Reservoir	RES

Sample ID	
Site	***Number***
Metolius River Inflow	17
Deschutes River Inflow	14
Crooked River Inflow	11
Crooked River below Opal Springs	35
Common Pool, Deschutes and Crooked	08
Round Butte Dam Forebay	07
Willow Creek Inflow	05
Lake Simtustus, near Indian Campground	25
Pelton Dam Forebay	04
Round Butte Tailrace	09
Pelton Tailrace	10

Date
MODYYR

Sample Type	
Periphyton	PER
Periphyton Macrophyte Habitat	PERM
Chlorophyll	CHL
Chlorophyll Water Column	CHLWC
Ash-free dry weight	AFDW
Nutrient	NUT
Phytoplankton	PYT
Zooplankton	ZOO
Chlorophyll	CHL

Depth	
Discreet Location	#

SampleReach_SampleID_Date_SampleType_AnalysisType

Example: Pelton Dam Forebay, February 19, 2015, Phytoplankton Sample, 0.5 m

RES04021915PYT0.5

Example: Round Butte Forebay, February 19, 2015, Nutrients Sample, 30 m

RES07021915NUT30

Attachment A Field Sheets

Stream Field Data Sheet

Station:	Date (MM/DD/YYYY): / / Start time: End time:
Station description:	
Collectors:	
Sample and photographic notes:	

RELATED SAMPLING ACTIVITES (circle all that apply)

Nutrients	Periphyton	Phytoplankton	Zooplankton	Discharge

PHYSICAL SITE CONDITIONS

Clouds: %	Wind (circle): Calm Light Moderate Gusty
Precipitation (circle): None Rain Sleet Snow	Precipitation intensity (circle): N/A Light Moderate Heavy
Other weather:	
Riparian shading (circle): Shaded Partial Full sun	
Water clarity (circle): Clear Slightly turbid Turbid Very turbid	
Water color (circle): Black Brown Clear Dark green Light green Yellow	
Physical site condition comments:	

Water Measurements (Meter Name:)

Time	Water Temperature (°C)	pH	DO (mg/L & %)	Conductance (µS/cm)	Turbidity (NTUs)

Light Measurements

	Depth 1 (Units)	Location 1	Depth 2 (Units)	Location 2	Depth 3 (Units)	Location 3
Air						
Water						

Flow Measurements

	Depth 1 (units)	Location 1	Depth 2 (units)	Location 2	Depth 3 (units)	Location 3
Ave						

Chlorophyll Measurements (Time, Cyano/Total)

Location 1 Turbidity:	Location 2 Turbidity:	Location 3 Turbidity:

SAMPLES COLLECTED

Replicate sample taken? Y or N

Parameter	No. Bottles	Volume	Label	Preservative Vol/Type

Stream Field Data Sheet

SAMPLES COLLECTED CONTINUED

Date: Station ID:

Parameter	No. Bottles	Volume	Label	Preservative Vol/Type

Reservoir Field Data Sheet

Station ID:	Date (MM/DD/YYYY) / /
Waterbody:	Start Time:
Collectors:	End time:
Sample and site notes:	

RELATED SAMPLING ACTIVITES (circle all that apply)

Nutrients	Phytoplankton	Zooplankton	WC Chl	Other:

PHYSICAL SITE CONDITIONS

Cloud Cover: %	Wind (circle): Calm Light Moderate Gusty
Precipitation (circle): None Rain Sleet Snow	Precipitation intensity (circle): N/A Light Moderate Heavy
Other weather:	
Water clarity (circle): Clear Slightly turbid Turbid Very turbid	**Secchi Disk Reading:**
Water color (circle): Black Brown Clear Dark green Light green Yellow	

Depth (units)	Light Reading
Air	

Depth (m)	Temper-ature	DO (mg/L & %)	pH	Conduc-tivity
0.5				
2				
4				
6				
8				
10				
12				
14				
16				
18				
20				
25				
30				
35				
40				
50				
60				
80				

Depth/Time	Algae Cyano/Total
0.5 m/	
2m/	
4m/	
6m/	
8m/	
10/m	

SAMPLES COLLECTED

Replicate sample taken? Y or N

Parameter	No. Bottles	Volume	Label	Preservative Type	Depth

Reservoir Field Data Sheet

SAMPLES COLLECTED CONTINUED

Date: Station ID:

Parameter	No. Bottles	Volume	Label	Preservative Type	Depth

Attachment B Sample Schedules

2015 Lower River Parameter Schedule

Site No.	Site Name	*15-Jun*	*6-Jul*	*20-Jul* [a]	3-Aug	17-Aug[b]	31-Aug	14-Sep	19-Oct[b]	9-Nov[b]
1	Rereg Dam (tailrace)	*Basic NUT* *PYT* *PER* *PER CHL* *AFDW* -	*500 mL NUT* *PYT* *PER* *PER CHL* *AFDW* *WC CHL*	*Basic NUT* *PYT/ZOO* *PER* ***(AA&RI)*** *PER CHL* *AFDW* *WC CHL*	500 mL NUT ZOO - - - -	Basic NUT PYT/ZOO PER PER CHL AFDW -	500 mL NUT ZOO - - - -	Basic NUT PYT/ZOO PER **(S-RI)** PER CHL AFDW -	500 mL NUT PYT/ZOO PER PER CHL AFDW -	500 mL NUT PYT/ZOO PER PER CHL AFDW -
3	Dry Creek	*Basic NUT* - *PER* *PER CHL* *AFDW* -	*Basic NUT* - *PER* *PER CHL* *AFDW* *Macro PER*	*Basic NUT* *Basic NUT* ***R*** *PER* ***(AA)*** *PER CHL* *AFDW* -	Basic NUT - - - - -	Basic NUT - PER PER CHL AFDW -	Basic NUT - - - - -	Basic NUT Basic NUT **(S)** PER PER CHL AFDW -	Basic NUT - PER PER CHL AFDW WC CHL	Basic NUT - PER PER CHL AFDW Macro PER
DC	Dry Creek Trib	*Basic NUT*	*Basic NUT*	*Basic NUT*	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
SC	Shitike Creek	*Basic NUT*	*Basic NUT*	*Basic NUT*	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
WS	Warm Springs	*Basic NUT*	*Basic NUT*	*Basic NUT*	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
5	South Junction (DS Warm Springs River)	*Basic NUT* *PER* *PER CHL* *AFDW* -	*Basic NUT* *PER* *PER CHL* *AFDW* -	*Basic NUT* *PER* ***(AA)*** *PER CHL* *AFDW* -	Basic NUT - - - -	Basic NUT PER PER CHL AFDW Macro PER	Basic NUT - - - -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -
TC	Trout Creek	*Basic NUT*	*Basic NUT*	*Basic NUT*	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
OS	Oak Springs	*Basic NUT*	*Basic NUT*	*Basic NUT*	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
7	Whitehorse	*Basic NUT* - - *PER* *PERM* *PER CHL* *AFDW*	*500 mL NUT* - *PYT* *PER* - *PER CHL* *AFDW*	*Basic NUT* - *PYT/ZOO* *PER* ***(AA)*** - *PER CHL* *AFDW*	500 mL NUT - ZOO - - - -	Basic NUT - PYT/ZOO PER **(S)** - PER CHL AFDW	500 mL NUT - ZOO - - - -	Basic NUT - PYT/ZOO PER **(S-RI)** - PER CHL AFDW	500 mL NUT 500 mL NUT **(S)** PYT/ZOO PER - PER CHL AFDW	500 mL NUT - PYT/ZOO PER - PER CHL AFDW

2015 Lower River Parameter Schedule

Site No.	Site Name	*15-Jun*	*6-Jul*	*20-Jul* [a]	3-Aug	17-Aug[b]	31-Aug	14-Sep	19-Oct[b]	9-Nov[b]
		-	-	-	-	-	-	Macro PER	-	-
9	Ferry	*Basic NUT* *PER* *PER CHL* *AFDW* -	*Basic NUT* *PER* *PER CHL* *AFDW* -	*Basic NUT* *PER* *PER CHL* *AFDW* -	Basic NUT - - - -	Basic NUT PER PER CHL AFDW -	Basic NUT - - - -	Basic NUT PER **(S-RI)** PER CHL AFDW -	Basic NUT PER PER CHL AFDW Macro PER	Basic NUT PER PER CHL AFDW -
11	Lower Wapinitia (DS Wapinitia Creek)	*Basic NUT* *Basic NUT* ***R*** *PER* *PER* ***Dup*** *PER CHL (DUP)* *AFDW (DUP)*	*Basic NUT* - *PER* - *PER CHL* *AFDW*	*Basic NUT* - *PER* ***(AA&RI)*** - *PER CHL* *AFDW*	Basic NUT - - - - -	Basic NUT - PER - PER CHL AFDW	Basic NUT - - - - -	Basic NUT - PER - PER CHL AFDW	Basic NUT - PER - PER CHL AFDW	Basic NUT - PER - PER CHL AFDW
WR	White River Trib	*Basic NUT*	*Basic NUT*	*Basic NUT*	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
12	Sandy Beach	*500 mL NUT* - *PYT* *PER* *PER CHL* *AFDW*	*500 mL NUT* - *PYT* *PER* *PER CHL* *AFDW*	*Basic NUT* - *PYT/ZOO* *PER* ***(AA)*** *PER CHL* *AFDW* -	500 mL NUT - ZOO - - - -	Basic NUT - PYT/ZOO PER PER CHL AFDW WC CHL	500 mL NUT - ZOO - - - -	Basic NUT - PYT/ZOO PER PER CHL AFDW	500 mL NUT - PYT/ZOO PER PER CHL AFDW	500 mL NUT 500 mL NUT **(S)** PYT/ZOO PER PER CHL AFDW
14	Wreck	*Basic NUT* - *PER* *PER CHL* *AFDW*	*Basic NUT* *Basic NUT* ***R*** *PER* *PER CHL* *AFDW*	*Basic NUT* - *PER* ***(AA)*** *PER CHL* *AFDW*	Basic NUT - - - -	Basic NUT - PER PER CHL AFDW	Basic NUT - - - -	Basic NUT - PER PER CHL AFDW	Basic NUT - PER **(S)** PER CHL AFDW	Basic NUT - PER PER CHL AFDW
16	Rattlesnake	*Basic NUT* - *PER* - *PER CHL* *AFDW*	*Basic NUT* - *PER* - *PER CHL* *AFDW*	*Basic NUT* - *PER* ***(AA)*** - *PER CHL* *AFDW*	Basic NUT - - - - -	Basic NUT - PER - PER CHL AFDW	Basic NUT Basic NUT **(S)** - - - -	Basic NUT - PER - PER CHL AFDW	Basic NUT - PER - PER CHL AFDW	Basic NUT - PER - PER CHL AFDW
		500 mL NUT	*500 mL NUT*	*Basic NUT*	500 mL NUT	Basic NUT	500 mL NUT	Basic NUT	500 mL NUT	500 mL NUT

2015 Lower River Parameter Schedule

Site No.	Site Name	*15-Jun*	*6-Jul*	*20-Jul* [a]	3-Aug	17-Aug[b]	31-Aug	14-Sep	19-Oct[b]	9-Nov[b]
18	Bull Run	*PYT* *PER* - *PER CHL* *AFDW* -	*PYT* *PER* - *PER CHL* *AFDW* -	*PYT/ZOO* *PER* ***(AA)*** - *PER CHL* *AFDW* *Macro PER*	ZOO - - - - -	PYT/ZOO PER - PER CHL AFDW -	ZOO - - - - -	PYT/ZOO PER - PER CHL AFDW -	PYT/ZOO PER - PER CHL AFDW -	PYT/ZOO PER PER **(S)** PER CHL AFDW -
20	Kloan Rapids	*Basic NUT* - *PER* *PER CHL* *AFDW*	*Basic NUT* - *PER* *PER CHL* *AFDW*	*Basic NUT* - *PER* ***(AA&RI)*** *PER CHL* *AFDW* -	Basic NUT - - - - -	Basic NUT Basic NUT **(S)** PER PER CHL AFDW -	Basic NUT - - - - -	Basic NUT - PER PER CHL AFDW -	Basic NUT - PER PER CHL AFDW -	Basic NUT - PER PER CHL AFDW WC CHL
21	River Mouth	*Basic NUT* - *PER* *PER CHL* -	*Basic NUT* - *PER* *PER CHL* -	*Basic NUT* - *PER* ***(AA)*** *PER CHL* *AFDW* -	Basic NUT Basic NUT **(S)** - - - -	Basic NUT - PER PER CHL AFDW -	Basic NUT - - - - -	Basic NUT - PER PER CHL AFDW WC CHL	Basic NUT - PER PER CHL AFDW -	Basic NUT - PER PER CHL AFDW -

[a]The periphyton samples sent to Aquatic Analytics and three split samples sent to Rhithron.

[b]All periphyton and phytoplankton samples, including splits, shipped to Rhithron - please use alternative labeling for splits

S= split, use the churn splitter for nutrient samples

AA - Aquatic Analytics, duplicate sample sent to Jim Sweet

RI - Rhithron; duplicate sample sent to Rhithron (33 Fort Missoula Rd, Missoula, MT 59804)

2015 Reservoir Parameter Schedule

Site ID	Site Description	22-Jun	13-Jul	27-July [a]	10-Aug	24-Aug[b]	7-Sep	28-Sep[a]	26-Oct[b]	16-Nov[b]
17	Metolius River inflow	Basic NUT	500 mL NUT	Basic NUT	500 mL NUT	Basic NUT	500 mL NUT	Basic NUT	500 mL NUT	500 mL NUT
		PER (AA)	PER (AA)	PER (AA)	-	PER (RI)	-	**PER (S-RI)**	PER (RI)	PER (RI)
		PER CHL	PER CHL	PER CHL		PER CHL		PER CHL	PER CHL	PER CHL
		AFDW	AFDW	AFDW		AFDW		AFDW	AFDW	AFDW
14	Deschutes River inflow	Basic NUT	500 mL NUT	Basic NUT	500 mL NUT	Basic NUT	500 mL NUT	Basic NUT	500 mL NUT	500 mL NUT
		PER (AA)	PER (AA)	**PER** (AA) **(R-RI)**	-	PER (RI)	-	PER (AA)	PER (RI)	PER (RI)
		PER CHL	PER CHL	PER CHL		PER CHL		PER CHL	PER CHL	PER CHL
		AFDW	AFDW	AFDW		AFDW		AFDW	AFDW	AFDW
35	Crooked River below Opal Springs		500 mL NUT	Basic NUT	500 mL NUT	Basic NUT	500 mL NUT	Basic NUT	500 mL NUT	500 mL NUT
			PER (AA)	PER (AA)	-	PER (RI)	-	PER (AA)	PER (RI)	PER (RI)
			PER CHL	PER CHL		PER CHL		PER CHL	PER CHL	PER CHL
			AFDW	AFDW		AFDW		AFDW	AFDW	AFDW
8	Common pool of Deschutes and Crooked arms	Temperature Profile: 40m (2m interval to 10m, then every 10m)	Temperature Profile: 40m (2m interval to 10m, then every 10m)	Temperature Profile: 2m interval to 20m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m
		Nutrients: 1 sample per mid-ep, mid-met, mid-hyp	**500mL Nutrients:** 1 sample per 1m, mid-ep, mid-met, **mid-hyp(R)**	Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp or 40 m	Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp or 40 m	500mL Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp or 40 m	Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp or 40 m	500mL Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp or 40 m	**500mL Nutrients:** 1 sample at 1m, mid-ep, mid-met, **mid-hyp(S)** or 40 m
		Phytoplankton - 1 sample per mid-ep	Phytoplankton - 1 sample per 1m, mid-ep	**Phytoplankton** - 1 sample per **1m(R-RI)**, mid-ep (2 samples to AA)	-	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to RI)	-	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to AA)	**Phytoplankton** - 1 sample at **1m (S),** mid-ep (send all 3 samples to RI)	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to RI)
		Chlorophyll: 1 sample per 1m, mid-ep (Use AT); 1 lab WC sample - epilimnion	Chlorophyll: 1 sample per 1m, mid-ep (Use AT, no deeper than 10 m)	Chlorophyll: 10 m profile, 1 m intervals	**Chlorophyll**: 10 m profile, 1 m intervals; **one WC lab sample @1 m**	Chlorophyll: 10 m profile, 1 m intervals	**Chlorophyll**: 10 m profile, 1 m intervals; **one WC lab sample @1 m**	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals
		Zooplankton: 1 sample per 1m, mid-ep	Zooplankton: 1 sample - 40 ft to surface tow	Zooplankton: 1 sample - 40 ft to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow
7	Round Butte Dam forebay	Temperature Profile - 40m (2m interval to 10m, then every 10m)	Temperature Profile: 40m (2m interval to 10m, then every 10m)	Temperature Profile: 2m interval to 20m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m
		Nutrients: 1 sample per mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp	Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp or 40 m	Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp or 40 m	500mL Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp or 40 m	**Nutrients:** 1 sample at **1m(S)**, mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp or 40 m	500mL Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp
		Phytoplankton - 1 sample per mid-ep	Phytoplankton - 1 sample per 1m, mid-ep	Phytoplankton - 1 sample per 1m, mid-ep (2 samples to AA)	-	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to RI)	-	**Phytoplankton** - 1 sample at 1m, **mid-ep(S-RI)** (split sent to RI, other 2 sent to AA)	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to RI)	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to RI)
		Chlorophyll: 1 sample per 1m, mid-ep (Use AT); 1 lab WC sample - epilimnion	Chlorophyll: 1 sample per 1m, mid-ep; use AT	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals	**Chlorophyll**: 10 m profile, 1 m intervals; **one WC lab sample @1m**	Chlorophyll: 10 m profile, 1 m intervals

2015 Reservoir Parameter Schedule

Site ID	Site Description	22-Jun	13-Jul	27-July [a]	10-Aug	24-Aug [b]	7-Sep	28-Sep [a]	26-Oct [b]	16-Nov [b]
		Zooplankton: 1 sample per 1m, mid-ep	Zooplankton: 1 sample - 40 ft to surface tow	Zooplankton: 1 sample - 40 ft to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow
32	**Seekseekqua Creek**	Basic NUT	Basic NUT	Basic NUT	**X**	**X**	**X**	**X**	**X**	**X**
5	**Willow Creek inflow**	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
25	**Lake Simtustus near Indian campground**	Temperature Profile: 40m (2m interval to 10m, then every 10m)	Temperature Profile: 40m (2m interval to 10m, then every 10m)	Temperature Profile: 2m interval to 20m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m
		Nutrients: 1 sample per mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp	Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp	**Nutrients:** 1 sample per 1m, mid-ep, **mid-met(S)**, mid-hyp	500mL Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp	Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp
		Phytoplankton - 1 sample per 1m, mid-ep	Phytoplankton - 1 sample per 1m, mid-ep	Phytoplankton - 1 sample per 1m, mid-ep (2 samples to AA)	-	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to RI)	-	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to AA)	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to RI)	**Phytoplankton** - 1 sample per 1m, **mid-ep(S)** (all samples sent to RI)
		Chlorophyll: 1 sample per 1m, mid-ep (Use AT); (2 samples taken)	Chlorophyll: 1 sample per 1m, mid-ep (Use AT)	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals; **one WC lab sample @ 1m**	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals; **one WC lab sample @ 1m**
		Zooplankton: 1 sample per 1m, mid-ep (?)	Zooplankton: 1 sample - 40 ft to surface tow	Zooplankton: 1 sample - 40 ft to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow
4	**Pelton Dam forebay**	Temperature Profile: 40m (2m interval to 10m, then every 10m)	Temperature Profile: 40m (2m interval to 10m, then every 10m)	Temperature Profile: 2m interval to 20m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m	Temperature Profile: 1m interval to 25m, then every 10m
		Nutrients: 1 sample per mid-ep, mid-met, mid-hyp (6 samples taken)	500mL Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp	Nutrients: 1 sample per 1m, mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample at 1m, **mid-ep(S)**, mid-met, mid-hyp	Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp	Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp	500mL Nutrients: 1 sample at 1m, mid-ep, mid-met, mid-hyp
		Phytoplankton - 1 sample per 1m, mid-ep	Phytoplankton - 1 sample per 1m, mid-ep	Phytoplankton - 1 sample per 1m, mid-ep (2 samples to AA)	-	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to RI)	-	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to AA)	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to RI)	Phytoplankton - 1 sample at 1m, mid-ep (both samples sent to RI)
		Chlorophyll: 1 sample per 1m, mid-ep (Use AT); (2 samples taken?)	Chlorophyll: 1 sample per 1m, mid-ep (Use AT)	Chlorophyll: 10 m profile, 1 m intervals; **one WC lab sample**	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals; **one WC lab sample @ 1m**	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals	Chlorophyll: 10 m profile, 1 m intervals
		Zooplankton: 1 sample per 1m, mid-ep	Zooplankton: 1 sample - 40 ft to surface tow	Zooplankton: 1 sample - 40 ft to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow	Zooplankton: 1 sample - 10 m to surface tow
9	**Round Butte Tailrace**	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth
		Nutrients: 1 sample at discrete depth	500mL Nutrients: 1 sample at discrete depth	**Nutrients (R)** : 1 sample at discrete depth	500mL Nutrients: 1 sample at discrete depth	Nutrients: 1 sample at discrete depth	**500mL Nutrients (S)**: 1 sample at discrete depth	Nutrients: 1 sample at discrete depth	500mL Nutrients: 1 sample at discrete depth	500 mL Nutrients: 1 sample at discrete depth
		Phytoplankton - 1 sample at discrete depth	Phytoplankton - 1 sample at discrete depth	Phytoplankton - 1 sample at discrete depth (AA)	-	**Phytoplankton(S)** - 1 sample at discrete depth (both samples sent to RI)	-	Phytoplankton - 1 sample at discrete depth (sent to AA)	Phytoplankton - 1 sample at discrete depth (send to RI)	Phytoplankton - 1 sample at discrete depth (send to RI)

2015 Reservoir Parameter Schedule

Site ID	Site Description	*22-Jun*	*13-Jul*	*27-July* [a]	10-Aug	24-Aug[b]	7-Sep	28-Sep[a]	26-Oct[b]	16-Nov[b]
		Chlorophyll: 1 sample at discrete depth (Use AT)	*Chlorophyll: 1 sample at discrete depth (Use AT)*	*Chlorophyll: 1 sample at discrete depth (Use AT)*	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)
10	**Lake Simtustus Tailrace**	*Temperature: 1 discrete depth*	*Temperature: 1 discrete depth*	*Temperature: 1 discrete depth*	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth
		Nutrients(R): 1 sample at discrete depth	*500mL Nutrients: 1 sample at discrete depth*	*Nutrients: 1 sample at discrete depth*	500mL Nutrients: 1 sample at discrete depth	Nutrients: 1 sample at discrete depth	500mL Nutrients: 1 sample at discrete depth	Nutrients: 1 sample at discrete depth	**500mL Nutrients(S)**: 1 sample at discrete depth	500 mL Nutrients: 1 sample at discrete depth
		Phytoplankton - 1 sample at discrete depth	***Phytoplankton (R-AA)*** *- 1 sample at discrete depth*	*Phytoplankton - 1 sample at discrete depth (AA)*	-	Phytoplankton - 1 sample at discrete depth (send to RI)	-	Phytoplankton - 1 sample at discrete depth (send to AA)	Phytoplankton - 1 sample at discrete depth (send to RI)	Phytoplankton - 1 sample at discrete depth (send to RI)
		Chlorophyll: 1 sample at discrete depth (Use AT)	***Chlorophyll:*** *1 sample at discrete depth (Use AT* ***and take one WC lab sample*** *)*	*Chlorophyll: 1 sample at discrete depth (Use AT)*	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)

[a]Samples will be sent to Aquatic Analytics and splits sent to Rhithron

[b]All periphyton and phytoplankton samples shipped to Rhithron

S = split, use the churn splitter for nutrient and phytoplankton samples

AA - Aquatic Analytics, duplicate sample sent to Jim Sweet

RI - Rhithron; (33 Fort Missoula Rd, Missoula, MT 59804)

2016 Lower River Sampling Parameters

Site No.	Site Name	22-Feb	18-Apr	2-May	16-May	6-Jun	20-Jun	4-Jul[a]	18-Jul	1-Aug	15-Aug	5-Sep[a]	19-Sep	17-Oct
1	Rereg Dam (tailrace)	Extra NUT PYT/ZOO **PER R** **PER CHL** **AFDW** WC CHL	Extra NUT PYT/ZOO PER PER CHL AFDW WC CHL	Basic NUT PYT/ZOO **PER R** **PER CHL** **AFDW** WC CHL	Extra NUT PYT/ZOO PER PER CHL AFDW WC CHL	Basic NUT PYT/ZOO PER PER CHL AFDW WC CHL	Extra NUT PYT/ZOO PER PER CHL AFDW WC CHL	Basic NUT PYT/ZOO PER PER CHL AFDW WC CHL	**Extra NUT R** PYT/ZOO PER PER CHL AFDW WC CHL	Basic NUT PYT/ZOO PER PER CHL AFDW WC CHL	**Extra NUT R** PYT/ZOO PER PER CHL AFDW WC CHL	Basic NUT PYT/ZOO PER PER CHL AFDW WC CHL	Extra NUT PYT/ZOO PER PER CHL AFDW WC CHL	Extra NUT PYT/ZOO PER PER CHL AFDW WC CHL
3	Dry Creek	Basic NUT PER PER CHL AFDW Macro PER	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -
SC	Shitike Creek	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
WS	Warm Springs	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
5	South Junction (DS Warm Springs River)	Basic NUT PER PER CHL AFDW WC CHL	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	**Basic NUT R** PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT **PER R** **PER CHL** **AFDW** WC CHL	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	**Basic NUT R** PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW Macro PER
TC	Trout Creek	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
OS	Oak Springs	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
7	Whitehorse	Extra NUT PYT/ZOO PER PER CHL AFDW -	Extra NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Extra NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Extra NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Extra NUT PYT/ZOO PER PER CHL AFDW WC CHL	Basic NUT PYT/ZOO PER PER CHL AFDW -	Extra NUT PYT/ZOO **PER R** **PER CHL** **AFDW** -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Extra NUT PYT/ZOO PER PER CHL AFDW -	Extra NUT PYT/ZOO PER PER CHL AFDW -
9	Ferry	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW Macro PER	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW WC CHL	Basic NUT PER PER CHL AFDW Macro PER	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	**Basic NUT R** PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	**Basic NUT R** PER PER CHL AFDW WC CHL
11	Lower Wapinitia (DS Wapinitia Creek)	**Basic NUT R** PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW Macro PER	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW WC CHL	Basic NUT PYT/ZOO PER PER CHL AFDW -	**Basic NUT R** PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW WC CHL	Basic NUT PYT/ZOO PER PER CHL AFDW -
WR	White River Trib	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
12	Sandy Beach	Extra NUT PYT/ZOO PER PER CHL AFDW	Extra NUT PYT/ZOO PER PER CHL AFDW	Basic NUT PYT/ZOO PER PER CHL AFDW	Extra NUT PYT/ZOO PER PER CHL AFDW	Basic NUT PYT/ZOO PER PER CHL AFDW	Extra NUT PYT/ZOO PER PER CHL AFDW	Basic NUT PYT/ZOO PER PER CHL AFDW	Extra NUT PYT/ZOO PER PER CHL AFDW	Basic NUT PYT/ZOO PER PER CHL AFDW	Extra NUT PYT/ZOO PER PER CHL AFDW	Basic NUT PYT/ZOO **PER R** **PER CHL** **AFDW**	Extra NUT PYT/ZOO PER PER CHL AFDW	Extra NUT PYT/ZOO PER PER CHL AFDW

Revised 5/6/16

2016 Lower River Sampling Parameters

Site No.	Site Name	22-Feb	18-Apr	2-May	16-May	6-Jun	20-Jun	4-Jul[a]	18-Jul	1-Aug	15-Aug	5-Sep[a]	19-Sep	17-Oct
14	Wreck	Basic NUT PER PER CHL AFDW -	Basic NUT **PER R** **PER CHL** **AFDW** -	**Basic NUT R** PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW Macro PER	Basic NUT PER PER CHL AFDW Macro PER	**Basic NUT R** **PER R** **PER CHL** **AFDW** -	**Basic NUT R** PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW Macro PER	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -
16	Rattlesnake	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW WC CHL	**Basic NUT R** PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT **PER R** **PER CHL** **AFDW** -	Basic NUT PER PER CHL AFDW -
18	Bull Run	Extra NUT PYT/ZOO PER PER CHL AFDW -	Extra NUT PYT/ZOO PER PER CHL AFDW WC CHL	Basic NUT PYT/ZOO PER PER CHL AFDW -	Extra NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW WC CHL	Extra NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO **PER R** **PER CHL** **AFDW** -	Extra NUT PYT/ZOO **PER R** **PER CHL** **AFDW** -	Basic NUT PYT/ZOO PER PER CHL AFDW Macro PER	Extra NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Extra NUT PYT/ZOO PER PER CHL AFDW -	Extra NUT PYT/ZOO **PER R** **PER CHL** **AFDW** -
20	Kloan Rapids	Basic NUT PER PER CHL AFDW -	**Basic NUT R** PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW WC CHL	Basic NUT **PER R** **PER CHL** **AFDW** -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW WC CHL	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -
21	River Mouth	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO **PER R** **PER CHL** **AFDW** -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO - - AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW WC CHL	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -	Basic NUT PYT/ZOO PER PER CHL AFDW -

[a]Samples will be sent to Aquatic Analytics and splits sent to Rhithron

AA - Aquatic Analytics, sample sent to Jim Sweet

RI - Rhithron; (33 Fort Missoula Rd, Missoula, MT 59804)

R = Replicate, use the churn splitter for nutrient and phytoplankton samples

AT - Algae Torch

2016 Reservoir Sampling Parameters

Site ID	Site Description	15-Feb	25-Apr	9-May	23-May	13-Jun	27-Jun	11-Jul[a]
17	**Metolius River Inflow**	Extra NUT	Extra NUT	Basic NUT	Extra NUT	Basic NUT	Extra NUT	Basic NUT
				PER				PER
				PER CHL				PER CHL
				AFDW				AFDW
14	**Deschutes River inflow**	Extra NUT	Extra NUT	Basic NUT	Extra NUT	Basic NUT	Extra NUT	Basic NUT
				PER				PER AA
				PER CHL				PER CHL
				AFDW				AFDW
35	**Crooked River below Opal Springs**	Extra NUT	Extra NUT	Basic NUT	Extra NUT	Basic NUT	Extra NUT	Basic NUT
				PER				PER
				PER CHL				PER CHL
				AFDW				AFDW
8	**Common pool of Deschutes and Crooked arms**	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom
		Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m
		Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	**Phytoplankton:** 1 sample at 0.5 m **(R)** and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples, send to AA)
		Chlorophyll: 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m
		Zooplankton: 1 sample - 20 m to surface tow	**Zooplankton:** 1 sample - 20 m to surface tow **(R)**	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow
7	**Round Butte Dam forebay**	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom
		Extra Nutrients: 1 sample at 1, 10, 25, 45, 75 m	Extra Nutrients: 1 sample at 1, 10, 25, 45, 75 m	Nutrients: 1 sample at 1, 10, 25, 45, 75 m	Extra Nutrients: 1 sample at 1, 10, 25, 45, 75 m	**Nutrients:** 1 sample at 1, 10, 25, **45 (R)**, 75 m	Extra Nutrients: 1 sample at 1, 10, 25, 45, 75 m	Nutrients: 1 sample at 1, 10, 25, 45, 75 m
		Phytoplankton: 1 sample at 0.5 m **(R)** and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	**Phytoplankton:** 1 sample at 0.5 m **(R)** and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	**Phytoplankton:** 1 sample at 0.5 m **(R)** and 10 m (grab samples, send to AA)
		Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**
		Zooplankton: 1 sample - 20 m to surface tow **(R)**	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	**Zooplankton:** 1 sample - 20 m to surface tow **(R)**	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	**Zooplankton:** 1 sample - 20 m to surface tow **(R)**
5	**Willow Creek inflow**	-	-	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT
25	**Lake Simtustus near Indian campground**	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom
		Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m	**Extra Nutrients:** 1 sample at 1, **10 (R)**, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m
		Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	**Phytoplankton:** 1 sample at 0.5 m and 10 m **(R)** (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples, send to AA)
		Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m
		Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	**Zooplankton:** 1 sample - 20 m to surface tow **(R)**	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow
4	**Pelton Dam forebay**	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom
		Extra Nutrients: 1 sample at 1, **10 (R)**, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	**Nutrients:** 1 sample at 1, 10, **25 (R)**, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m
		Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)-	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples, send to AA)
		Chlorophyll: 0.5 m, and 2-m profile to 10 m	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m
		Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	**Zooplankton:** 1 sample - 20 m to surface tow **(R)**	**Zooplankton:** 1 sample - 20 m to surface tow **(R)**	Zooplankton: 1 sample - 20 m to surface tow
9	**Round Butte Tailrace**	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth
		500 mL Nutrients: 1 sample at discrete depth	Extra Nutrients: 1 sample at discrete depth	Nutrients: 1 sample at discrete depth	Extra Nutrients: 1 sample at discrete depth	Nutrients: 1 sample at discrete depth	Extra Nutrients: 1 sample at discrete depth	Nutrients: 1 sample at discrete depth
		Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth (send to AA)
		Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	**Chlorophyll: one WC lab sample & AT reading**	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)
10	**Lake Simtustus Tailrace**	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth
		500 mL Nutrients: 1 sample at discrete depth	**Extra Nutrients**: 1 sample at discrete depth (R)	Nutrients: 1 sample at discrete depth	Extra Nutrients: 1 sample at discrete depth	Nutrients: 1 sample at discrete depth	**Extra Nutrients:** 1 sample at discrete depth (R)	**Nutrients:** 1 sample at discrete depth **(R)**
		Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth (send to AA)
		Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)

[a]Samples will be sent to Aquatic Analytics and splits sent to Rhithron

R = Replicate, use the churn splitter for nutrient and phytoplankton samples

AA - Aquatic Analytics, sample sent to Jim Sweet

RI - Rhithron; (33 Fort Missoula Rd, Missoula, MT 59804)

AT - Algae Torch

2016 Reservoir Sampling Parameters

Site ID	Site Description	25-Jul	8-Aug	22-Aug	12-Sep[a]	26-Sep	24-Oct
17	Metolius River Inflow	Extra NUT	Basic NUT	Extra NUT	Basic NUT	Extra NUT	Extra NUT
					PER		
					PER CHL		
					AFDW		
14	Deschutes River inflow	Extra NUT	Basic NUT	Extra NUT	Basic NUT	Extra NUT	Extra NUT
					PER AA		
					PER CHL		
					AFDW		
35	Crooked River below Opal Springs	Extra NUT	Basic NUT	Extra NUT	Basic NUT	Extra NUT	Extra NUT
					PER		
					PER CHL		
					AFDW		
8	Common pool of Deschutes and Crooked arms	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom
		Extra Nutrients: 1 sample at 1, **10 (R)**, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m
		Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	**Phytoplankton:** 1 sample at 0.5 m and 10 m **(R)** (grab samples, send to AA)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)
		Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m
		Zooplankton: 1 sample - 20 m to surface tow	**Zooplankton:** 1 sample - 20 m to surface tow **(R)**	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	**Zooplankton:** 1 sample - 20 m to surface tow **(R)**	Zooplankton: 1 sample - 20 m to surface tow
7	Round Butte Dam forebay	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom
		Extra Nutrients: 1 sample at 1, 10, 25, 45, 75 m	Nutrients: 1 sample at 1, 10, 25, 45, 75 m	Extra Nutrients: 1 sample at 1, 10, 25, 45, 75 m	Nutrients: 1 sample at 1, 10, 25, 45, 75 m	Extra Nutrients: 1 sample at 1, 10, 25, 45, 75 m	**Extra Nutrients:** 1 sample at **1 (R)**, 10, 25, 45, 75 m
		Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)
		Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m
		Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	**Zooplankton:** 1 sample - 20 m to surface tow **(R)**	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow
5	Willow Creek inflow	Basic NUT	Basic NUT	Basic NUT	Basic NUT	Basic NUT	-
25	Lake Simtustus near Indian campground	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom
		Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m
		Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples, send to AA)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	**Phytoplankton:** 1 sample at 0.5 m and 10 m **(R)** (grab samples)
		Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**
		Zooplankton: 1 sample - 20 m to surface tow **(R)**	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	**Zooplankton:** 1 sample - 20 m to surface tow **(R)**	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow
4	Pelton Dam forebay	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom
		Extra Nutrients: 1 sample at 1, 10, 25, 45 m	**Nutrients:** 1 sample at 1, 10, **25 (R)**, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m	**Nutrients:** 1 sample at 1, **10 (R)**, 25, 45 m	**Extra Nutrients**: 1 sample at 1, 10, **25 (R)**, 45 m	Extra Nutrients: 1 sample at 1, 10, 25, 45 m
		Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	**Phytoplankton:** 1 sample at 0.5 m and 10 m **(R)** (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)
		Chlorophyll: 0.5 m, and 2-m profile to 10 m	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m	Chlorophyll: 0.5 m, and 2-m profile to 10 m
		Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	**Zooplankton:** 1 sample - 20 m to surface tow **(R)**
9	Round Butte Tailrace	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth
		Extra Nutrients: 1 sample at discrete depth	Nutrients: 1 sample at discrete depth	**Extra Nutrients:** 1 sample at discrete depth (R)	Nutrients: 1 sample at discrete depth	Extra Nutrients: 1 sample at discrete depth	Extra Nutrients: 1 sample at discrete depth
		Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth
		Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)
10	Lake Simtustus Tailrace	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth	Temperature: 1 discrete depth
		Extra Nutrients: 1 sample at discrete depth	Nutrients: 1 sample at discrete depth	Extra Nutrients: 1 sample at discrete depth	Nutrients: 1 sample at discrete depth	Extra Nutrients: 1 sample at discrete depth	Extra Nutrients: 1 sample at discrete depth
		Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth	Phytoplankton: 1 sample at discrete depth
		Chlorophyll: one WC lab sample & AT reading	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)	Chlorophyll: 1 sample at discrete depth (Use AT)

[a]Samples will be sent to Aquatic Analytics and splits sent to Rhithron

R = Replicate, use the churn splitter for nutrient and phytoplankton samples

AA - Aquatic Analytics, sample sent to Jim Sweet

RI - Rhithron; (33 Fort Missoula Rd, Missoula, MT 59804)

AT - Algae Torch

Revised 5/23/16

2017 Lower River Sampling Parameters

Site No.	Site Name	June	July	August	September
1	Rereg Dam	Basic NUT **PER (R)** **PER CHL** **AFDW** WC CHL**	Basic NUT PER PER CHL AFDW WC CHL**	Basic NUT PER PER CHL AFDW WC CHL**	Basic NUT PER PER CHL AFDW WC CHL**
WS	Warm Springs	Basic NUT	Basic NUT	Basic NUT	Basic NUT
5	South Junction	Basic NUT PER PER CHL AFDW WC CHL**	Basic NUT **PER (R)** **PER CHL** **AFDW** -	Basic NUT PER PER CHL AFDW -	**Basic NUT (R)** PER PER CHL AFDW -
TC	Trout Creek	Basic NUT	Basic NUT	Basic NUT	Basic NUT
9	Ferry	Basic NUT PER PER CHL AFDW	**Basic NUT (R)** PER PER CHL AFDW	Basic NUT PER PER CHL AFDW	Basic NUT PER PER CHL AFDW
12	Sandy Beach	Basic NUT PER PER CHL AFDW	Basic NUT PER PER CHL AFDW	Basic NUT **PER (R)** **PER CHL** **AFDW**	Basic NUT PER PER CHL AFDW
14	Wreck	Basic NUT PER PER CHL AFDW -	Basic NUT PER R PER CHL AFDW WC CHL**	**Basic NUT (R)** PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -
16	Rattlesnake	**Basic NUT (R)** PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW WC CHL**
21	River Mouth	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW -	Basic NUT PER PER CHL AFDW WC CHL**	Basic NUT **PER (R)** **PER CHL** **AFDW** -

R = Replicate, use the churn splitter for nutrient and phytoplankton samples

**take a measurement with the Algae Torch at the same time

2017 Reservoir Sampling Parameters

Site ID	Site Description	June	July	August	September
7	**Round Butte Dam forebay**	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom
		Basic Nutrients: 1 sample at 1, 10, 25, 45, 75 m	**Basic Nutrients:** 1 sample at 1, 10, 25, **45 (R)**, 75 m	Basic Nutrients: 1 sample at 1, 10, 25, 45, 75 m	**Basic Nutrients:** 1 sample at **1 (R)**, 10, 25, 45, 75 m
		Phytoplankton: 1 sample at 0.5 m **(R)** and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	**Phytoplankton:** 1 sample at 0.5 m **(R)** and 10 m (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)
		Chlorophyll: 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5, 2, 10 m**	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5, 2, 10 m**	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5, 2, 10 m**	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5, 2, 10 m**
		Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow
4	**Pelton Dam forebay**	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom	Water Chemistry Profile: 0.5m; 2-m - 2 to 20 m; 5-m - 20 to 40 m; 10-m - 40 to 60 m; 20-m - 60 to bottom
		Basic Nutrients: 1 sample at 1, **10 (R)**, 25, 45 m	Basic Nutrients: 1 sample at 1, 10, 25, 45 m	**Basic Nutrients:** 1 sample at 1, 10, **25 (R)**, 45 m	Basic Nutrients: 1 sample at 1, 10, 25, 45 m
		Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	**Phytoplankton:** 1 sample at 0.5 m and 10 m **(R)** (grab samples)	Phytoplankton: 1 sample at 0.5 m and 10 m (grab samples)	**Phytoplankton:** 1 sample at 0.5 m **(R)** and 10 m (grab samples)
		Chlorophyll: 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5, 2, 10 m**	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5 m**	**Chlorophyll**: 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5, 2, 10 m**	**Chlorophyll:** 0.5 m, and 2-m profile to 10 m; **one WC lab sample & AT reading at 0.5, 2, 10 m**
		Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow	Zooplankton: 1 sample - 20 m to surface tow

R = Replicate, use the churn splitter for nutrient and phytoplankton samples

AT - Algae Torch

Attachment C Sample Volumes

2016 Lower River Sites - Nutrient Sample Volumes

PER = 125 mL, PER CHL = 125 mL, AFDW 125 mL, PHYT = 250 mL, ZOO = 250mL, WC CHL = 1L or Filtered

Bolded volumes = profile replicates

Site No.	1	3	SC	WS	5	TC	OS	7	9	11	WR	12	14	16	18	20	21
Site Name	**Rereg Dam**	**Dry Creek**	**Shitike Creek**	**Warm Springs**	**South Junction**	**Trout Creek**	**Oak Springs**	**Whitehorse**	**Ferry**	**Lower Wapinitia**	**White River Trib**	**Sandy Beach**	**Wreck**	**Rattlesnake**	**Bull Run**	**Kloan Rapids**	**River Mouth**
22-Feb																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	250 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	250 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	-	250 mL	-	-	-	-	-	-	-
18-Apr																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL
IEH Unfiltered	250 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	250 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	250 mL	-
2-May																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	-	-	-	-	250 mL	-	-	-	-
16-May																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	250 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	250 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	250 mL	-	-	-	-	-	-	-	-	-	-	-	-
6-Jun																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL	60 mL	60 mL
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	-	-	-	-	-	250 mL	-	-	-
20-Jun																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	250 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	250 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	-	-	-	-	250 mL	-	-	-	-
4-Jul																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	-	-	-	-	250 mL	-	-	-	-
18-Jul																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	125 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	250 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	250 mL	125 mL	125 mL
CCAL Unfiltered	500 mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Revised 5/10/16

2016 Lower River Sites - Nutrient Sample Volumes

PER = 125 mL, PER CHL = 125 mL, AFDW 125 mL, PHYT = 250 mL, ZOO = 250mL, WC CHL = 1L or Filtered

Bolded volumes = profile replicates

Site No.	1	3	SC	WS	5	TC	OS	7	9	11	WR	12	14	16	18	20	21
Site Name	**Rereg Dam**	**Dry Creek**	**Shitike Creek**	**Warm Springs**	**South Junction**	**Trout Creek**	**Oak Springs**	**Whitehorse**	**Ferry**	**Lower Wapinitia**	**White River Trib**	**Sandy Beach**	**Wreck**	**Rattlesnake**	**Bull Run**	**Kloan Rapids**	**River Mouth**
1-Aug																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	-	250 mL	-	-	-	-	-	-	-
15-Aug																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	125 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	250 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	250 mL	125 mL	125 mL
CCAL Unfiltered	500 mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5-Sep																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	250 mL	-	-	-	-	-	-	-	-
19-Sep																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	250 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	250 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	250 mL	-	-	-	-	-	-	-	-	-	-	-	-
17-Oct																	
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	250 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	125 mL	250 mL	125 mL	125 mL	250 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	250 mL	-	-	-	-	-	-	-	-

Nutrient Parameters

Parameters	Basic, No Replicate	Extra, No replicate	Basic, w/Replicate	Extra, w/Replicate
IEH Filtered	PO4, NO3, NH3 (60)	PO4, NO3, NH3 (60)	PO4, NO3, NH3 (60)	PO4, NO3, NH3 (60)
CCAL Filtered	Cl (60)	Cl (60)	Cl, NO3, NH3, PO4 (125)	Cl, NO3, NH3, PO4 (125)
IEH Unfiltered	TN, TP (125)	TN, TP, TOC, ALK (250)	TN, TP (125)	TN, TP, TOC, ALK (250)
CCAL Unfiltered	-	-	TN, TP (250)	TN, TP, TOC, ALK (500)

2016 Reservoir Sites - Nutrient Sample Volumes

PER = 125 mL, PER CHL = 125 mL, AFDW 125 mL, PHYT = 250 mL, ZOO = 250mL, WC CHL = 1L or Filtered

Bolded volumes = profile replicates

Site No.	**17**	**14**	**35**	**8**	**7**	**5**	**25**	**4**	**9**	**10**
Site Name	**Metolius River**	**Deschutes River**	**Crooked River below Opal Springs**	**Common Pool**	**Round Butte forebay**	**Willow Creek**	**Lake Simtustus near Indian campground**	**Pelton Dam forebay**	**Round Butte Tailrace**	**Lake Simtustus Tailrace**
15-Feb										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	-	60 mL	60 mL / **60 mL**	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	-	60 mL	60 mL / **125 mL**	60 mL	60 mL
IEH Unfiltered	250 mL	250 mL	250 mL	250 mL	250 mL	-	250 mL	250 mL / **250 mL**	250 mL	250 mL
CCAL Unfiltered	-	-	-	-	-	-	-	- / **500 mL**	-	-
25-Apr										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	-	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	-	60 mL	60 mL	60 mL	125 mL
IEH Unfiltered	250 mL	250 mL	250 mL	250 mL	250 mL	-	250 mL	250 mL	250 mL	250 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	-	500 mL
9-May										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL / **60 mL**	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL / **125 mL**	60 mL	60 mL
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL / **125 mL**	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	- / **250 mL**	-	-
23-May										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL / **60 mL**	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL / **125 mL**	60 mL	60 mL	60 mL
IEH Unfiltered	250 mL	250 mL	250 mL	250 mL	250 mL	125 mL	250 mL / **250 mL**	250 mL	250 mL	250 mL
CCAL Unfiltered	-	-	-	-	-	-	- / **500 mL**	-	-	-
13-Jun										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL / **60 mL**	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL / **125 mL**	60 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL / **125 mL**	125 mL	125 mL	125 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	- / **250 mL**	-	-	-	-	-
27-Jun										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL
IEH Unfiltered	250 mL	250 mL	250 mL	250 mL	250 mL	125 mL	250 mL	250 mL	250 mL	250 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	-	500 mL
11-Jul[a]										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	-	250 mL

Revised 5/23/16

2016 Reservoir Sites - Nutrient Sample Volumes

PER = 125 mL, PER CHL = 125 mL, AFDW 125 mL, PHYT = 250 mL, ZOO = 250mL, WC CHL = 1L or Filtered

Bolded volumes = profile replicates

Site No.	17	14	35	8	7	5	25	4	9	10
Site Name	**Metolius River**	**Deschutes River**	**Crooked River below Opal Springs**	**Common Pool**	**Round Butte forebay**	**Willow Creek**	**Lake Simtustus near Indian campground**	**Pelton Dam forebay**	**Round Butte Tailrace**	**Lake Simtustus Tailrace**
25-Jul										
IEH Filtered	60 mL	60 mL	60 mL	60 mL / **60 mL**	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL / **125 mL**	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	250 mL	250 mL	250 mL	250 mL / **250 mL**	250 mL	125 mL	250 mL	250 mL	250 mL	250 mL
CCAL Unfiltered	-	-	-	- / **500 mL**	-	-	-	-	-	-
8-Aug										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL / **60 mL**	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL / **125 mL**	60 mL	60 mL
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL / **125 mL**	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	- / **250 mL**	-	-
22-Aug										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	125 mL
IEH Unfiltered	250 mL	250 mL	250 mL	250 mL	250 mL	125 mL	250 mL	250 mL	250 mL	250 mL
CCAL Unfiltered	-	-	-	-	-	-	-	-	-	500 mL
12-Sep[a]										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL / **60 mL**	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL / **125 mL**	60 mL	60 mL
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL / **125 mL**	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	- / **250 mL**	-	-
26-Sep										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL / **60 mL**	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL / **125 mL**	60 mL	60 mL
IEH Unfiltered	250 mL	250 mL	250 mL	250 mL	250 mL	125 mL	250 mL	250 mL / **250 mL**	250 mL	250 mL
CCAL Unfiltered	-	-	-	-	-	-	-	- / **500 mL**	-	-
24-Oct										
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL / **60 mL**	-	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	60 mL	60 mL	60 mL	60 mL	60 mL / **125 mL**	-	60 mL	60 mL	60 mL	60 mL
IEH Unfiltered	250 mL	250 mL	250 mL	250 mL	250 mL / **250 mL**	-	250 mL	250 mL	250 mL	250 mL
CCAL Unfiltered	-	-	-	-	- / **500 mL**	-	-	-	-	-

Nutrient Parameters

Parameters	Basic, No Replicate	Extra, No replicate	Basic, w/Replicate	Extra, w/Replicate
IEH Filtered	PO4, NO3, NH3 (60)	PO4, NO3, NH3 (60)	PO4, NO3, NH3 (60)	PO4, NO3, NH3 (60)
CCAL Filtered	Cl (60)	Cl (60)	Cl, NO3, NH3, PO4 (125)	Cl, NO3, NH3, PO4 (125)
IEH Unfiltered	TN, TP (125)	TN, TP, TOC, ALK (250)	TN, TP (125)	TN, TP, TOC, ALK (250)
CCAL Unfiltered	-	-	TN, TP (250)	TN, TP, TOC, ALK (500)

Revised 5/23/16

2017 Lower River Sites - Nutrient Sample Volumes

PER = 125 mL, PER CHL = 125 mL, AFDW 125 mL, WC CHL = 1L or Filtered

Bolded volumes = profile replicates

Site No.	1	WS	5	TC	9	12	14	16	21
Site Name	**Rereg Dam**	**Warm Springs**	**South Junction**	**Trout Creek**	**Ferry**	**Sandy Beach**	**Wreck**	**Rattlesnake**	**River Mouth**
June									
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	**60 mL**	60 mL
CCAL Filtered	-	-	-	-	-	-	-	**125 mL**	-
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	**125 mL**	125 mL
CCAL Unfiltered	-	-	-	-	-	-	-	**250 mL**	-
July									
IEH Filtered	60 mL	60 mL	60 mL	60 mL	**60 mL**	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	-	-	-	-	**125 mL**	-	-	-	-
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	**125 mL**	125 mL	125 mL	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	**250 mL**	-	-	-	-
August									
IEH Filtered	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	**60 mL**	60 mL	60 mL
CCAL Filtered	-	-	-	-	-	-	**125 mL**	-	-
IEH Unfiltered	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL	**125 mL**	125 mL	125 mL
CCAL Unfiltered	-	-	-	-	-	-	**250 mL**	-	-
September									
IEH Filtered	60 mL	60 mL	**60 mL**	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL
CCAL Filtered	-	-	**125 mL**	-	-	-	-	-	-
IEH Unfiltered	125 mL	125 mL	**125 mL**	125 mL	125 mL	125 mL	125 mL	125 mL	125 mL
CCAL Unfiltered	-	-	**250 mL**	-	-	-	-	-	-

Parameters	Basic, No Replicate	Basic, w/Replicate
IEH Filtered	PO4, NO3, NH3 (60)	PO4, NO3, NH3 (60)
CCAL Filtered	-	Cl, NO3, NH3, PO4 (125)
IEH Unfiltered	TN, TP (125)	TN, TP (125)
CCAL Unfiltered	-	TN, TP (250)

Revised 5/10/16

2017 Reservoir Sites - Nutrient Sample Volumes

PHYT = 250 mL, ZOO = 250mL, WC CHL = 1L or Filtered *Bolded volumes = profile replicates*

Site No.	**7**	**4**
Site Name	**Round Butte forebay**	**Pelton Dam forebay**
June		
IEH Filtered	60 mL	60 mL / **60 mL**
CCAL Filtered	-	- / **125 mL**
IEH Unfiltered	125 mL	125 mL / **125 mL**
CCAL Unfiltered	-	- / **250 mL**
July		
IEH Filtered	60 mL / **60 mL**	60 mL
CCAL Filtered	- / **125 mL**	-
IEH Unfiltered	125 mL / **125 mL**	125 mL
CCAL Unfiltered	- / **250 mL**	-
August		
IEH Filtered	60 mL	60 mL / **60 mL**
CCAL Filtered	-	- / **125 mL**
IEH Unfiltered	125 mL	125 mL / **125 mL**
CCAL Unfiltered	-	- / **250 mL**
September		
IEH Filtered	60 mL / **60 mL**	60 mL
CCAL Filtered	- / **125 mL**	-
IEH Unfiltered	125 mL / **125 mL**	125 mL
CCAL Unfiltered	- / **250 mL**	-

Nutrient Parameters

Parameters	**Basic, No Replicate**	**Basic, w/Replicate**
IEH Filtered	PO4, NO3, NH3 (60)	PO4, NO3, NH3 (60)
CCAL Filtered	-	NO3, NH3, PO4 (125)
IEH Unfiltered	TN, TP (125)	TN, TP (125)
CCAL Unfiltered	-	TN, TP (250)

Revised 5/23/16

Appendix B Review of ZAPS Technologies LiquID Data

1 Overview

A LiquID instrument was installed at the ReReg site adjacent to the USGS flow gaging station (Madras) in August 2015. The site was operational to August 2017. The instrument was equipped with channels for measuring nitrate, chlorophyll *a*, phycocyanin, turbidity, fluorescent dissolved organic matter (FDOM), and total organic carbon (TOC). The instrument was configured to operate in the Deschutes River matrix by comparing analytical laboratory results to performance of the instrument. This was not a calibration in the typical sense but was conducted more to ensure the instrument was recording within the operational ranges typically experienced in the river. The instrument was serviced and ranges were reset approximately every three to four months.

1.1 Nitrate

The first parameter evaluated was nitrate (NO_3-N). The raw data exhibited peaks in February through March of 2016 and 2017, with a major spike in August-October 2016 (Figure 1). The peaks in the late winter of each corresponds with an influx of runoff associated with early snowmelt. However, the peak in late summer 2016 does not show a paired response in 2015 and is suspect. The instrument was serviced in October 2016 and the readings immediately declined to near 0.1 mg/L, further indicating the data preceding this were anomalous. An overlay plot of the 2016 and 2017 nitrate shows the 2016 nitrate values continuing to increase despite any plausible mechanism to explain the increase (Figure 2). A comparison with the ZAPS data and results from the analytical laboratory for samples collected at the ReReg Dam (Figure 3) shows that the ZAPS nitrate data are biased high, although the instrument appears to capture some of the major fluctuations in nitrate patterns (with the exception of the fall 2016 data).

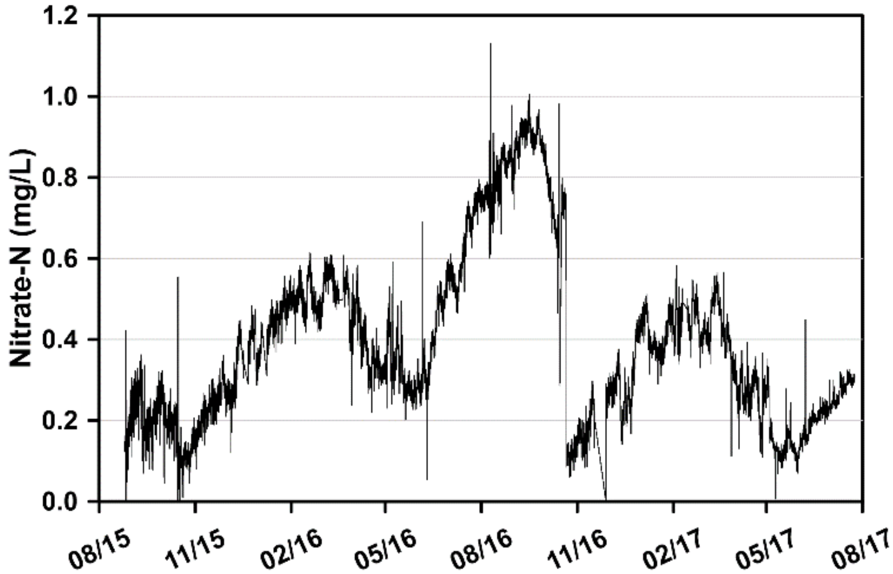


Figure 1. Nitrate-N measured with the ZAPS LiquID instrument

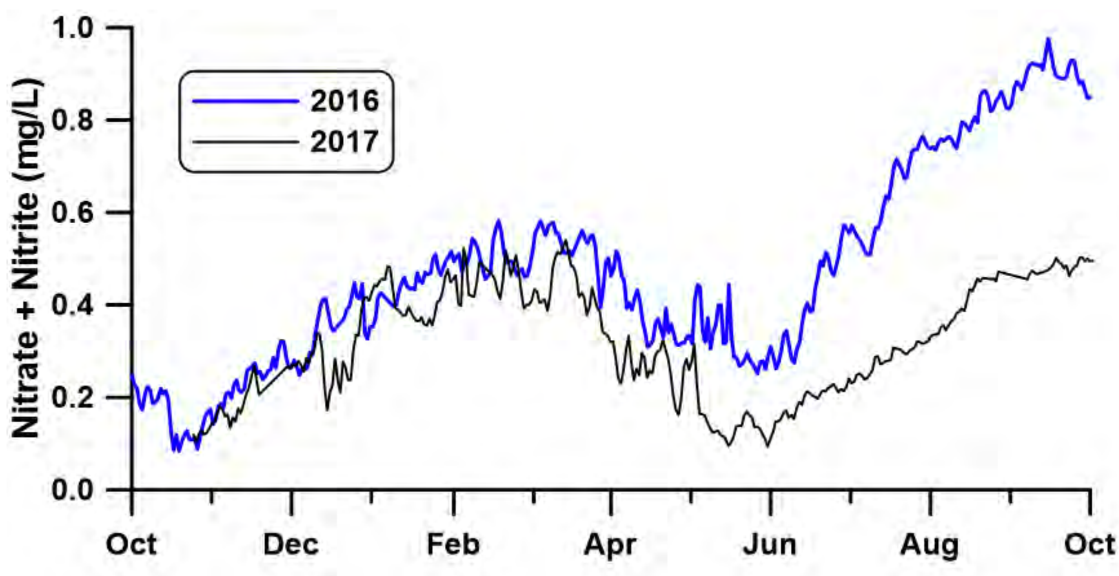


Figure 2. Nitrate-N measured with the ZAPS LiquID instrument for 2016 and 2017.

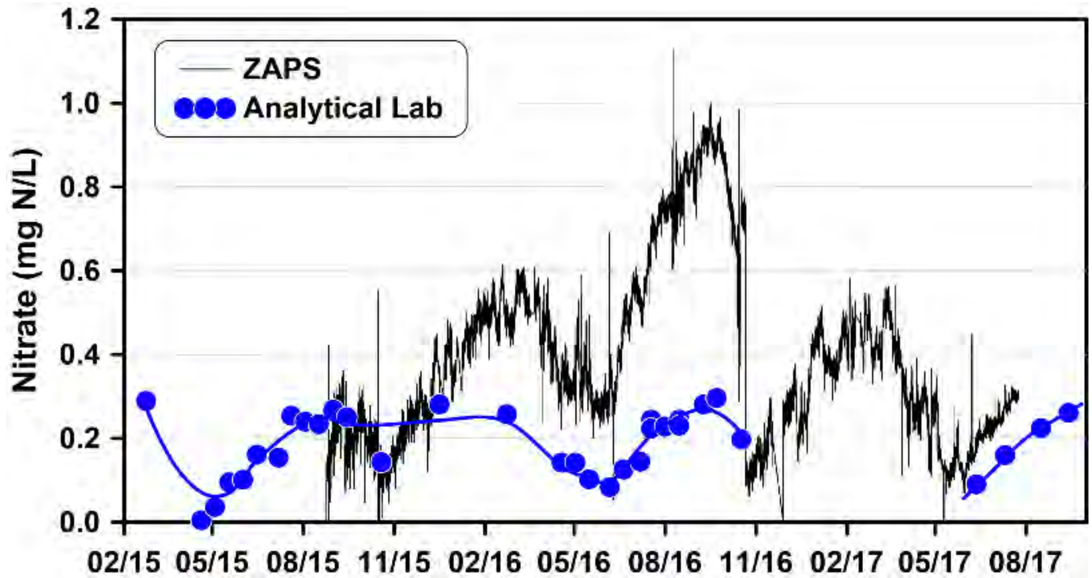


Figure 3. Nitrate-N measured with the ZAPS LiquID instrument compared to analytical laboratory measurements of nitrate.

1.2 Chlorophyll *a*

Concentrations of chlorophyll *a* measured with the LiquID instrument show several major peaks in spring and fall that generally correspond to blooms of *Stephanodiscus* spp (Figure 4). There was no significant peak of chlorophyll in spring of 2017. The relatively low concentrations of chlorophyll during the summer correspond to periods of dominance by cyanobacteria. Low values of chlorophyll during the winter reflect periods of low photosynthetic activity and high values of Secchi disk transparency in the reservoirs.

The comparison of analytical laboratory measurements of chlorophyll versus the ZAPS measurements show poor agreement on individual samples (Figure 5). This comparison is based on field collection of samples at various times versus ZAPS measurements at 1000 hr on the given day, so that has likely introduced some degree of variation. Overall there is reasonable agreement in that the two samples differ little with regard to summary statistics (Table 1).

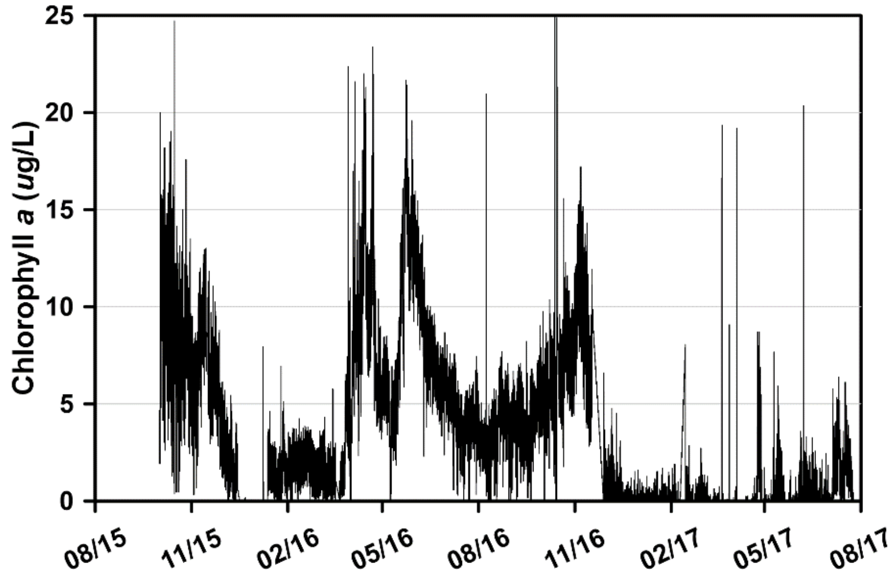


Figure 4. Chlorophyll *a* measured with the ZAPS LiquID instrument.

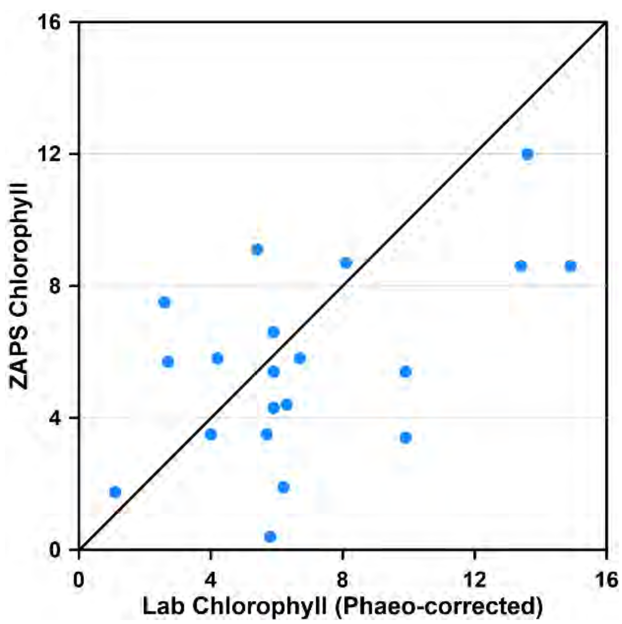


Figure 5. Chlorophyll a measured with the ZAPS instrument compared to analytical laboratory results.

Table 1. Comparison statistics for analytical laboratory and ZAPS measurements of chlorophyll a.

Statistic	Laboratory	ZAPS
Median	5.90	5.55
Mean	6.91	5.62
sd	3.73	2.88
Minimum	1.1	0.4
Maximum	14.9	12.0

1.3 Phycocyanin

Phycocyanin concentrations peaked in late August of each year (Figure 6). This pattern is distinctly different from the results for chlorophyll which exhibited a decline in the summer (Figure 7). The results show a clear separation of dominance between the diatom (*Stephanodiscus* spp.) and the cyanobacteria (*Dolichospermum/Anabaena*). We have no independent measures of phycocyanin, but we do have cyanobacteria abundance data which show that the cyanobacteria dominate the phytoplankton community during the period when phycocyanin is prominent (Figure 8).

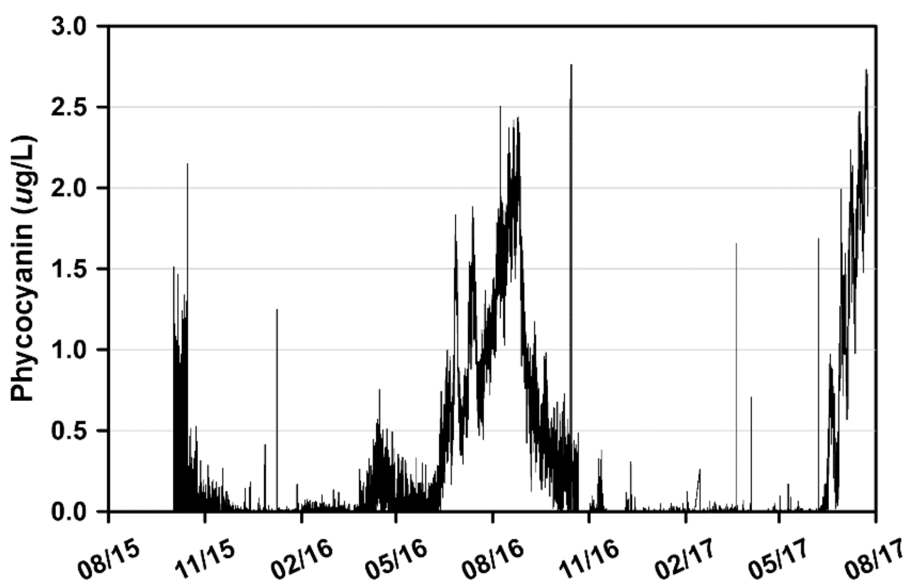


Figure 6. Phycocyanin measurements with the ZAPS instrument.

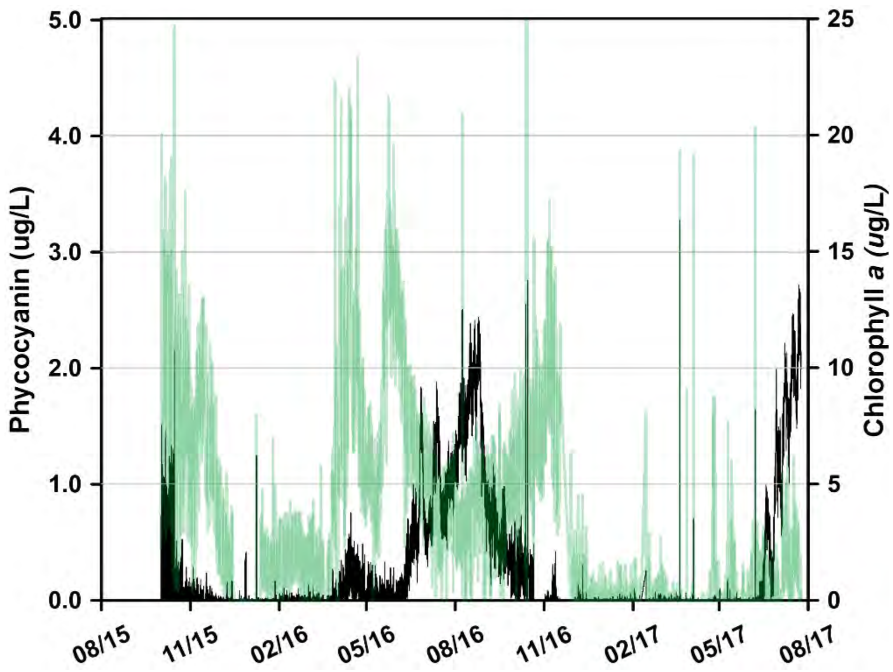


Figure 7. Phycocyanin (black) and chlorophyll *a* (green) measurements with the ZAPS instrument.

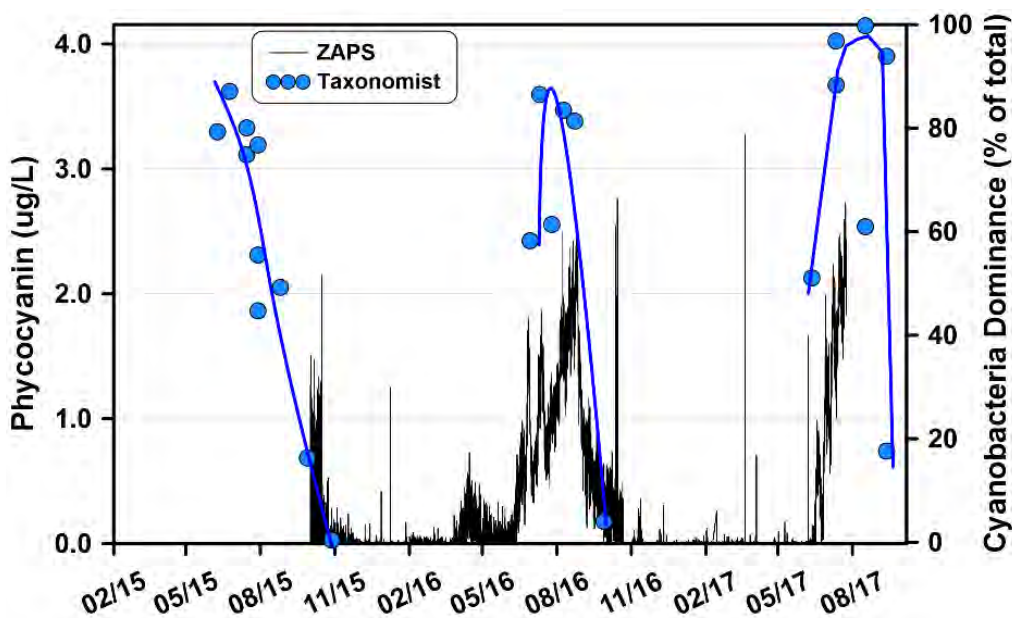


Figure 8. Phycocyanin measured with ZAPS instrument compared to phytoplankton results of percent dominant cyanobacteria.

1.4 Turbidity

Turbidity measurements with the ZAPS instrument did not begin on a continuous basis until January 2016 (Figure 9). The results show peak turbidity occurring in spring and late summer/early fall. The peaks in spring appear to coincide with the increase in *Stephanodiscus*, whereas the peak starting in late summer coincides with the peak in cyanobacteria abundance and the fall peak coincides with the resurgence of the *Stephanodiscus*. These results are in general agreement with measurements of turbidity using the Algae Torch and sonde measurements, although the values reported from the ZAPS instrument are slightly greater. This difference may be attributed to the instrument design in which the ZAPS measures turbidity at zero degrees, whereas most other instruments measure turbidity at a 90 degree angle. ZAPS turbidity results for 2016 and 2017 illustrate close agreement in patterns of turbidity being released at the ReReg dam (Figure 10).

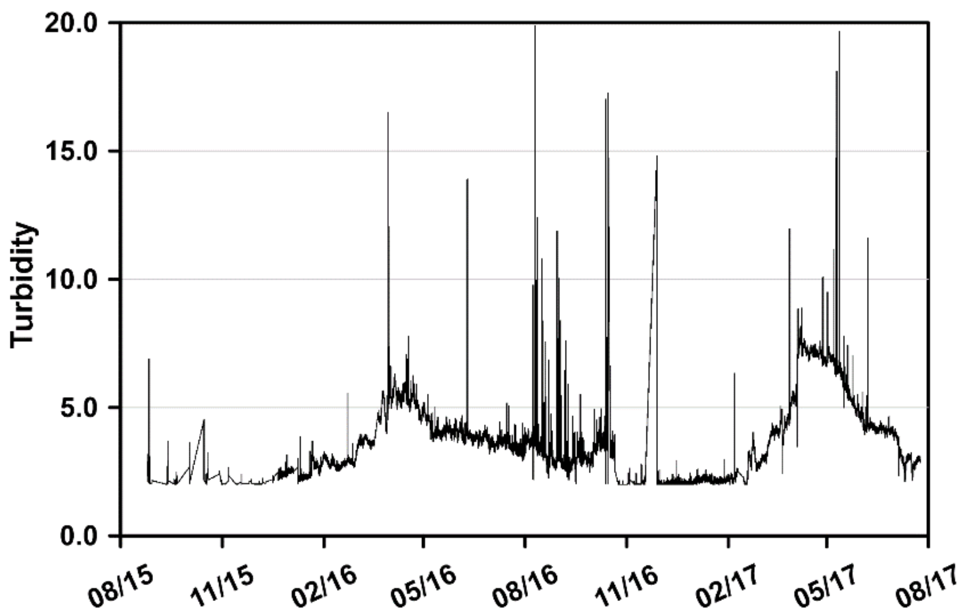


Figure 9. Instantaneous measurements of turbidity using the ZAPS instrument.

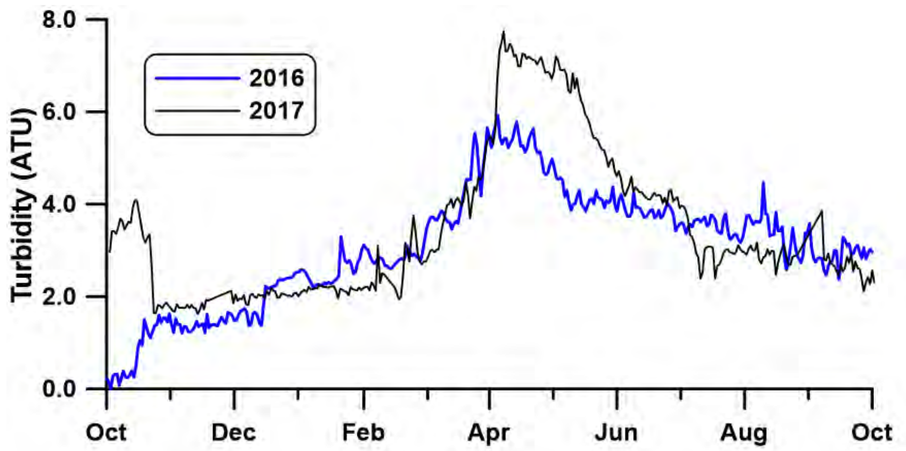


Figure 10. Daily average turbidity results for 2016 and 2017.

1.5 Fluorescent Dissolved Organic Matter

Fluorescent Dissolved Organic Matter (FDOM) measures organic compounds that fluoresce upon excitation. These are typically compounds that are not natural in origin but are rather manufactured such as herbicides, insecticides and other pesticides. The results for the period of record show peak FDOM values in the spring, coinciding with maximum runoff (Figure 11). The distribution of values exhibits some significant discontinuities associated with periods when the instrument was serviced, particularly from February 2016 to October 2016 where the values appear depressed relative to the values measured before and after those dates. The FDOM measurements show a general agreement in patterns between 2016 and 2017, however, the instrument results may have drifted upwards in April 2016 causing a displacement of the curve (Figure 12).

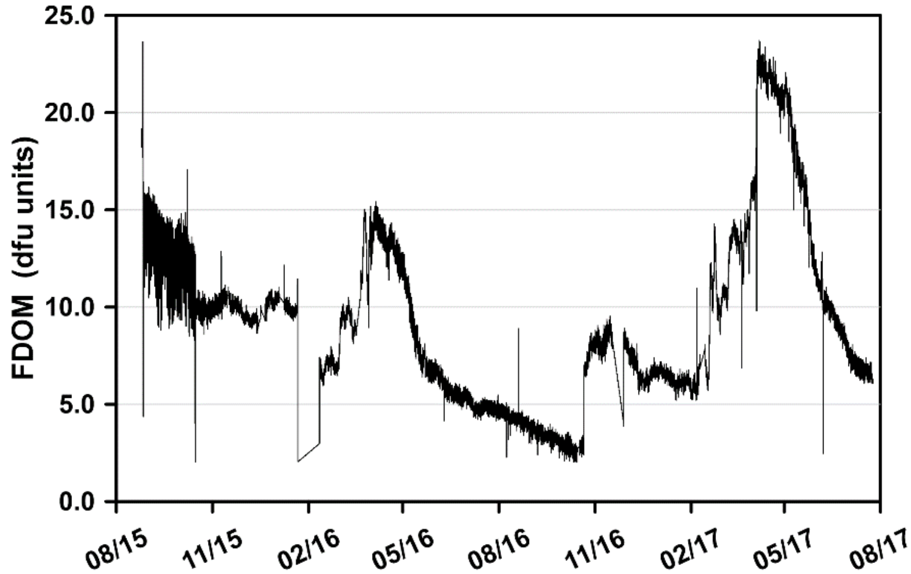


Figure 11. FDOM measurements with the ZAPS instrument.

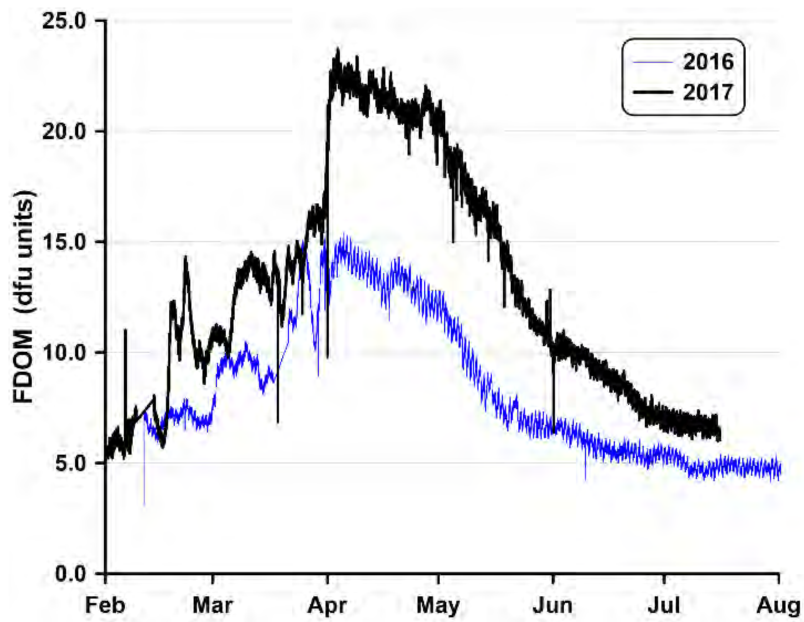


Figure 12. FDOM measurements for 2016 and 2017.

1.6 Total Organic Carbon

Total Organic Carbon (TOC) values are within the analytical range of near 1 mg/L to slightly over 2 mg/l (Figure 2-13). The patterns in TOC were similar between 2016 and 2017, although the values increased slightly in 2017 (Figure 2-14). Peak concentrations were observed in April and May, again during peak runoff.

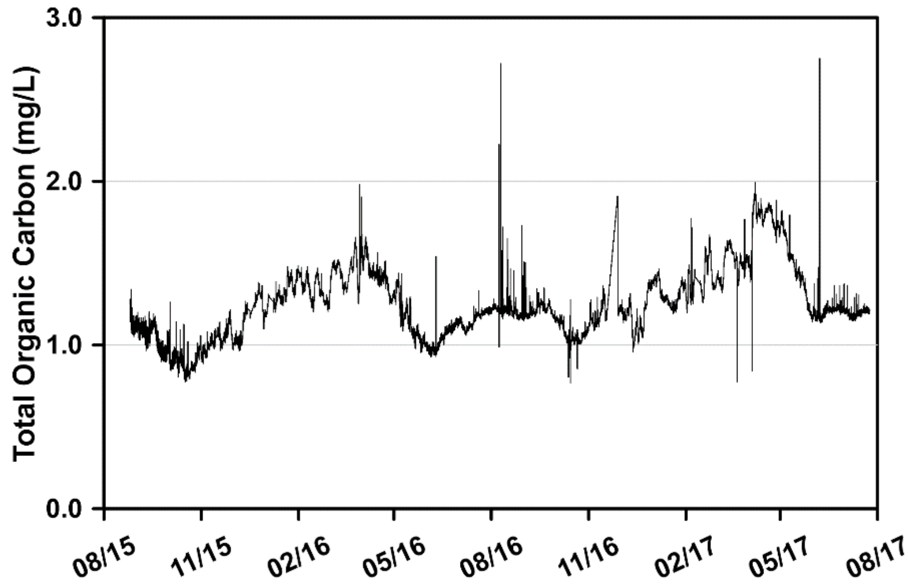


Figure 13. ZAPS measurements of total organic carbon.

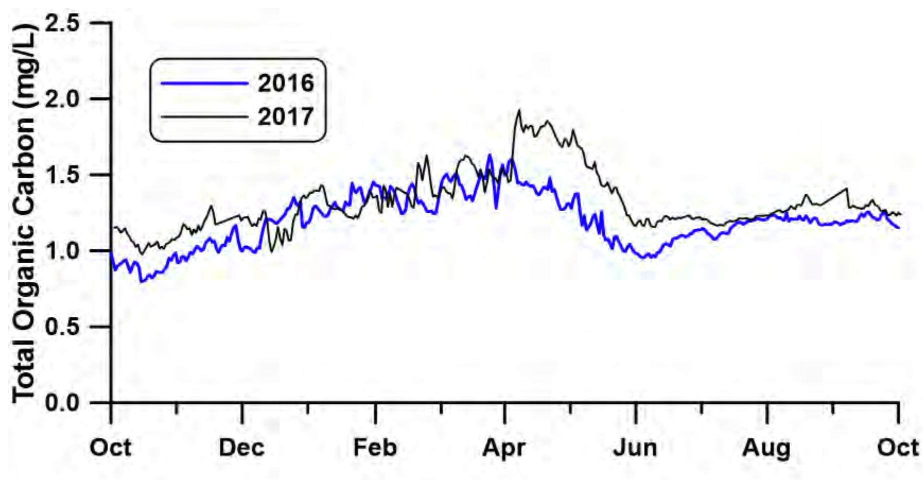


Figure 14. Comparison of ZAPS measurements of total organic carbon for 2016 and 2017.

2 Summary

Concentrations of nitrate reported by the ZAPS instrument were considerably greater than measured by the analytical laboratory and there was relatively poor correspondence between individual observations. The ZAPS nitrate measurements showed a repeatable seasonality, but the ZAPS nitrate data were judged to be useful only on a qualitative basis. The ZAPS chlorophyll measurements were within the same range as reported by the analytical laboratory, but the individual measurements exhibited poor correlation. It is unclear how much of the difference between measurements could be attributed to differences in time between ZAPS measurement and sample collection for the analytical sample. The pattern in ZAPS chlorophyll measurements appeared to coincide with spring and fall blooms of diatoms, with a corresponding decrease in summer associated with the onset of cyanobacteria. The ZAPS phycocyanin measurements had no analytical laboratory analogue. However, comparison of the ZAPS phycocyanin measurements with the phytoplankton cyanobacteria dominance showed a high degree of agreement. There was also a strong annual repeatability of phycocyanin measurements that lends credibility to the ZAPS measurements. The ZAPS turbidity measurements were within the same range as the values reported by the analytical laboratory and again showed an annual repeatability that appeared to correspond to expected peaks in turbidity from Lake Billy Chinook. FDOM had no analytical results for comparison and the instrument showed significant shifts in FDOM values following servicing. Nevertheless, values of FDOM peaked in spring of 2016 and 2017, when export of these types of compounds would be expected to show a peak. Concentrations of TOC reported by ZAPS were within the range of values also reported for analytical laboratory measurements. Concentrations of ZAPS TOC showed similar patterns between 2016 and 2017 and also exhibited peak values during spring when transport of TOC would be expected to be greatest.

Appendix C Evaluation of Phytoplankton and Periphyton Data

1 Overview

There was a need to evaluate the taxonomic results from the historical data collected during the PGE licensing studies and the data collected in this project. Both the reservoir (phytoplankton) and river (periphyton) algae samples spanning 1994-1997 were analyzed by Aquatic Analysts (Friday Harbor, WA). Aquatic Analysts (AA) analyzed many of the algae samples collected in Oregon from 1985 to present, including the 2006 ODEQ study of the Project reservoirs in 2006. AA counts only 100 natural units and employs a non-standard method of preparing samples for counting and identification. This lab does not update many taxa names, which facilitates comparison of their data from previous years, but makes it more difficult to compare results with other taxonomists. The following summarizes comparisons between the primary laboratory used for taxonomic analysis in this study, Rhithron Associates, Inc. (Missoula, MT), and samples analyzed by AA in this study and comparison with their data collected in1994-1997. To assist in reconciling some of the differences encountered, the services of two additional laboratories, PhycoTech, Inc. (St. Joseph, MI) and Georgia College (Milledgeville, GA) were used for comparison. Three components of the algae results were examined: abundance (biovolume), diversity, and dominant taxa. Many taxonomists divide algae into diatoms (hard-bodies) and soft-bodied taxa, in part, because the expertise to identify the two groups can be quite different and also because they can require different mounting/microscopic techniques.

1.1 Phytoplankton

There were eight phytoplankton samples split between AA and Rithron Associates, Inc. (Rh) during the study, prior to a subsequent round robin of QA samples that are described later. The results of the split samples showed that algal biovolume reported by Rh was consistently much greater than reported by AA (Figure 1). Furthermore, there was no systematic relationship between biovolume reported by the two laboratories that would have allowed for a consistent correction between labs. The differences in biovolume were particularly acute for the soft-bodied taxa, such as the cyanobacteria (Figure 2). Biovolume was calculated by Rh based on individual measurements of cell dimensions, whereas AA used a fixed biovolume for each taxon. Consequently, the biovolume measurements reported by Rh are likely to be more accurate.

A comparison of the dominant taxa and sub-dominant taxa for these same split samples showed that there was substantial lack of agreement in identifying the most common taxa present in the samples (Table 1). Three of the eight pairs of samples reported the same dominant taxon in the samples, but the majority of these showed serious differences. In particular, the samples from AA appeared to be much more likely to under-report the abundance of cyanobacteria. Rh reported the dominant Nostocales as *Dolichospermum*, whereas AA reported the taxon as *Anabaena*. Among the dominant diatoms, AA was more likely to report *Fragilaria crotonensis*, whereas Rh would be more likely to report *Stephanodiscus niagarae*.

Diversity of the phytoplankton community was not addressed in this project, but if there is a need to consider this component of the phytoplankton community in the future it is worth noting that Rh typically report two to three times the number of taxa per sample compared to AA. In some respects, this is expected since AA counted only 100 natural units per sample, whereas Rh counted 300-600 natural units per sample. However, this difference in the number of taxa was not random but rather Rh was far more inclined to report a much greater diversity of cyanobacteria compared to AA.

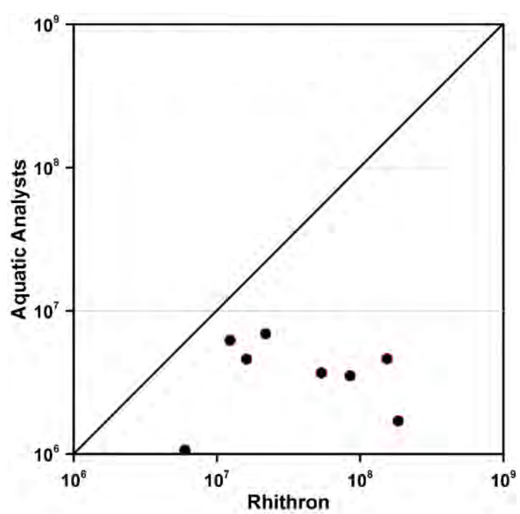


Figure 1. Comparison of total biovolume (µm^3/mL) from split samples between Aquatic Analysts and Rhithron from phytoplankton samples from the Project impoundments.

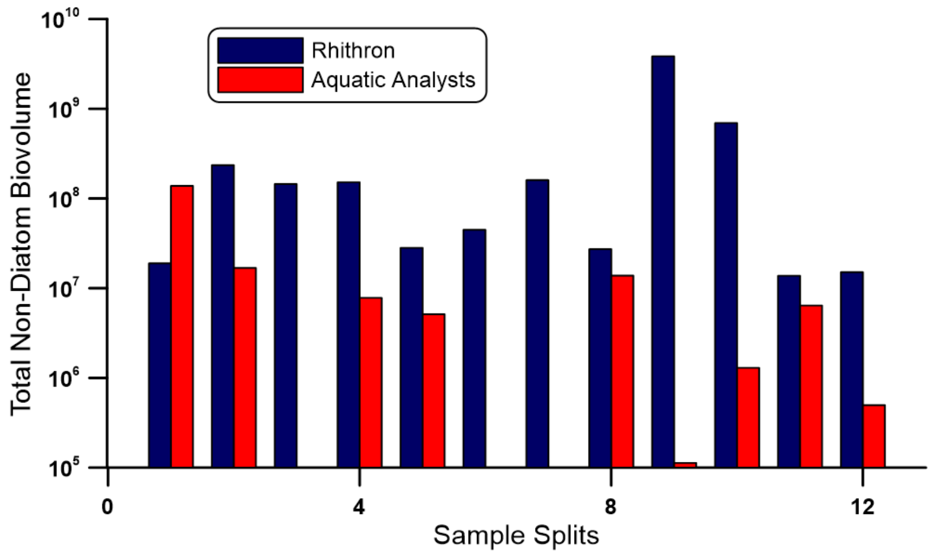


Figure 2. Total non-diatom biovolume (µm^3/mL) in split phytoplankton samples from the impoundments in the Pelton Round Butte Project comparing results from Rhithron and Aquatic Analysts.

Table 1. Comparison percent abundance (based on biovolume) of dominant taxa in phytoplankton samples from the impoundments.

Date	Site	Dominant				Sub-Dominant			
		Rhithron		Aquatic Analysts		Rhithron		Aquatic Analysts	
		Taxa 1	%	Taxa 1	%	Taxa 2	%	Taxa 2	%
6/24/15	Pelton Dam forebay (RES04)	Dolichospermum	49.7	Fragilaria crotonensis	82.6	Stephanodiscus niagarae	29.1	Stephanodiscus niagarae	8.6
6/24/15	Common Pool (RES08)	Dolichospermum	91	Anabaena	81.8	Stephanodiscus niagarae	8.3	Fragilaria crotonensis	7
6/25/15	Mid-Lake (RES25)	Stephanodiscus niagarae	94.6	Fragilaria crotonensis	39.8	Dolichospermum	3.9	Stephanodiscus niagarae	37.5
7/16/15	Pelton tailrace (RES10)	Stephanodiscus medius	43.5	Fragilaria crotonensis	39.3	Dolichospermum	17.5	Dolichospermum	25.4
7/29/15	Common Pool (RES08)	Dolichospermum	86.5	Stephanodiscus niagarae	89.7	Stephanodiscus niagarae	11.4	Pseudanabaena	2.8
9/28/15	Round Butte forebay (RES07)	Stephanodiscus niagarae	56.6	Stephanodiscus niagarae	85.5	Coelomoron	17.3	Fragilaria crotonensis	4.9
7/11/16	Round Butte forebay (RES07)	Dolichospermum	86.5	Anabaena	45.2	Stephanodiscus niagarae	12.0	Stephanodiscus niagarae	27.5
9/14/16	Common Pool (RES08)	Dolichospermum	90.0	Stephanodiscus niagarae	43.0	Stephanodiscus niagarae	8.4	Anabaena	42.0

1.2 Periphyton

Although knowledge of the phytoplankton community in the impoundments was certainly of interest in characterizing the systems, a much greater concern was the periphyton community in the Lower Deschutes River. This study was focused on possible changes in periphyton community between the study in 1997 (Raymond et al. 1998) and the current attached algae community. The 1997 periphyton samples were analyzed by AA and entering the current study we were hopeful that by having AA analyze periphyton samples from 2015-2017 using the same methods employed in 1997 it would be possible to determine if any substantial changes had occurred. However, some of the early comparisons of periphyton reported by Rhithron with those from AA indicated that there might be a serious challenge in meeting this goal.

In 2015, AA analyzed 44 samples and reported a total of 3062 total entries. Of these entries, only 4 percent were cyanobacteria and only 0.3 percent were chlorophyta. AA did not report any *Cladophora* present and of the cyanobacteria that they reported, most (77) were *Oscillatoria* and and second most abundant were *Calothrix*. Only one observation of *Rivularia* was reported. Thus AA reported that 96 percent of the entries were diatoms and diatoms dominated the biovolume for nearly all of these samples. This is in contrast to Rh which reported that diatoms were the least abundant group and cyanobacteria were dominant. Rh dominant cyanobacteria taxa were *Rivularia* and *Calothrix* with virtually no *Oscillatoria* present. The other group that was significant in the results reported by Rh was the chlorophyta with strong representation by *Cladophora*. During the river float of August 2016, we observed large mats of *Cladophora* which agreed with the reporting of Rh. Of the 44 periphyton samples analyzed by Rh in 2015, 12 of the sites were dominated by *Cladophora* with another 14 sites with Cladophora as a sub-dominant. Cyanobacteria dominated 27 of the 44 sites and diatoms were dominant in only 6 of the sites, one of which was dominated by *Stephanodiscus niagarae* derived from seston. The initial interpretation (and later revised following reporting errors by Rh) of the river periphyton based on samples analyzed by Rh is that the river was dominated by filamentous cyanobacteria and chlorophyta, with a minor representation by diatoms. In contrast, the river periphyton based on the AA samples was that the sites were dominated almost entirely by diatoms. Furthermore, the cyanobacteria reported by AA were commonly non-heterocystous taxa, whereas Rh reported mostly heterocystous cyanobacteria. The sample preparation/analysis by AA appeared to eliminate the vast majority of filamentous taxa from the results. A comparison of 12 split periphyton samples between AA and Rh in 2015 were examined in greater detail. The results showed that the labs exhibited good agreement with regard to total biovolume of the periphyton samples throughout a substantial range in abundance (Figure 3).

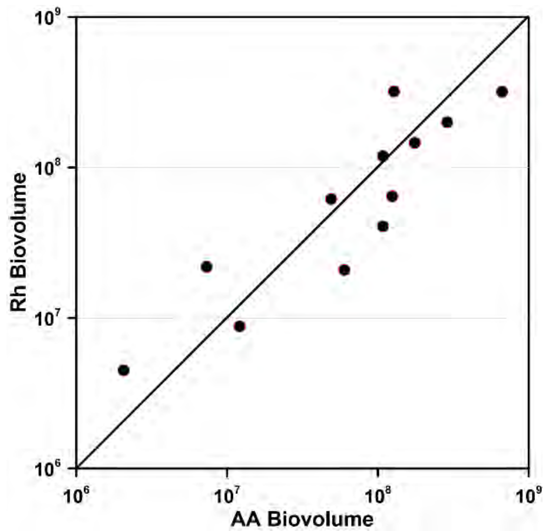


Figure 3. Total biovolume ($\mu m^3/cm^2$) of periphyton split samples between Aquatic Analysts (AA) and Rhithron (Rh) from 2015.

However, there was poor correspondence between the labs regarding the species identified in these samples. To allow for a less precise comparison, the results for the two labs were consolidated into genera and were compared again. The results showed that Rh identified an average of 21 genera per sample compared to 12 for AA. Of these, an average of 10 genera were reported to be the same between the labs. The much greater diversity of taxa reported by Rh is likely associated with their more comprehensive counts (600 natural units) compared to AA (100 natural units). Of these 12 split samples, in only one case did both labs report the same dominant genera (LDR0161515). For one-half of the samples Rh reported *Cladophora* as the dominant genera, whereas AA reported a diatom taxon as dominant. In three of the cases, AA never reported any non-diatom being present in the sample, whereas Rh reported robust abundance of *Cladophora*. Field visits by the senior author confirmed the presence of *Cladophora* at multiple sampling sites in the Lower Deschutes River. We conclude that the results from AA consistently under-represented filamentous algae (esp. *Cladophora*) and cyanobacteria in the periphyton samples and these results are not reliable indicators of the periphyton community in the Lower Deschutes River.

A second concern regarding the periphyton results related to the degree that filamentous cyanobacteria, especially *Rivularia* and *Calothrix*, were as dominant in the Lower Deschutes River as indicated by the results from Rh. A series of samples believed to contain a high proportion of these taxa were split among three taxonomists with Rhithron, PhycoTech and Georgia College and compared. The results showed that the three taxonomists identified numerous taxa that were not identified by the others (Table 2). However, the three taxonomists agreed on the presence and general abundance of cyanobacteria, including *Homeothrix, Leptolyngbya, Phormidium* and *Rivularia*. The overall agreement among the taxonomists was a modest 41 percent, but the importance of cyanobacteria in the samples was a general outcome of the comparison (Table 3). As the taxonomists pointed out, these microscopic sub-samples represent such a small proportion of the millions of cells present on a single slide that this level of agreement should be considered reasonable. Note that the comparisons were made based on counts of natural units so that a small number of counts of *Rivularia* when expressed as biovolume results in a much greater representation of taxa such as these.

Table 2. Comparison of counts of natural units of algae and cyanobacteria taxa from five periphyton samples from the Lower Deschutes River. Diatoms were represented by just a grouping.

Taxon	PhycoTech	Rhithron	Georgia College
Anabaena		1	
Aphanocapsa		3	
Monoraphidium.contortum		2	
Stigonemataceae		3	
Cyanobacteria.filament.3			1
Cyanobacteria.filament.sp.1			4
Cyanobacteria.filament.sp.2			3
Scenedesmus.acuminatus.(Lagerheim).Chodat			1
Unknown.Cyanophyte.coccoid.symbiont			21
Unknown.Cyanophyte.Pseudanabaenaceae			59

Taxon	PhycoTech	Rhithron	Georgia College
Ankistrodesmus.braunii	1		
Aphanothece	1		
Apodochloris	7		
Chlorococcum	2		
Chlorococcum.humicola	123		
Chlorophyta-Live	12		
Chroococcus.minimus	2		
Chroococcus.minutus	1		
Chrysophyta-Live	1		
Cladophora.fracta	6		
Cyanophyta-Live	1		
Euglena	1		
Geminella	5		
Jaaginema	101		
Miscellaneous-Live	5		
Monoraphidium.griffithii	1		
Oocystis.parva	8		
Oscillatoria	1		
Protoderma.viride	7		
Rhoicosphenia.curvata	3		
Synechococcus	698		
Synechocystis	3093		
Xenococcus	6		
Calothrix	93	227	145
Chamaesiphon	6	73	
Cladophora.glomerata		4	13
Diatoms	10555	2375	2253
Empty.diatom.cells	2912	524	523
Heteroleibleinia	741	78	
Homoeothrix	39	90	
Homoeothrix.janthina		33	77
Leptolyngbya	166	42	206

Taxon	PhycoTech	Rhithron	Georgia College
Phormidium	384	100	118
Pleurocapsa	1	3	1
Pseudanabaena	4	5	
Rivularia	10	25	57
Stigeoclonium	3	4	3
Ulothrix		2	2
Ulothrix.zonata		2	34
Total No. Taxa	**35**	**20**	**18**

Table 3. Percent similarity among the three taxonomists for species composition.

	PhycoTech	Rhithron
Rhithron	39.2%	
Georgia College	24.5%	58.8%
Grand Mean	40.8%	

There were twelve periphyton samples split between Aquatic Analysts and Rhithron in 2015. There was poor correspondence between the laboratories for results reported at the species level (Table 4). Rhithron reported approximately two to three times as many species as Aquatic Analysts. The comparison between the two laboratories was simplified to examine a comparison of genera instead of species. The results indicate a greater percentage of agreement between laboratories when the results are grouped by genera (Table 5). Most of the agreement in reported taxa occurred with the diatoms. The two laboratories exhibited poor agreement for the non-diatoms (Table 2). Aquatic Analysts reported few and sometime no non-diatoms, whereas the greatest biovolume reported by Rhithron was for the non-diatoms. Of these twelve split samples, the laboratories reported agreement on the dominant non-diatom genera for only one sample. Rhithron reported the dominant taxon in these splits was *Cladophora* for seven of the samples and the remaining dominants as cyanobacteria. Aquatic Analysts identified the dominant taxon as a diatom for all 12 split samples, whereas Rhithron reported a diatom taxon as dominant for only one of the 12.

Table 4. Comparison of the number and biovolume ($\mu m^3/cm^2$) of all taxa reported to species by Rhithron and Aquatic Analysts.

Site	Date	Split No.	Rhithron		Aquatic Analysts		No. of same taxon
			No. of Taxa	Biovolume	No. of Taxa	Biovolume	
ReReg Dam *(LDR01)*	6/15/15	1	46	108,146,682	22	119,018,363	14
Kloan Rapids *(LDR20)*	6/17/15	2	46	48,961,853	12	61,746,555	13
Lower Wapinitia *(LDR11)*	6/8/15	3	54	665,694,331	28	318,204,843	17
River Mouth *(LDR21)*	7/9/15	4	45	107,987,042	18	40,574,888	8
Dry Creek *(LDR03)*	7/20/15	5	48	287,734,245	22	200,052,447	14
Lower Wapinitia *(LDR11)*	7/21/15	6	47	128,016,738	17	320,833,518	11
Kloan Rapids *(LDR20)*	7/21/15	7	51	175,637,174	26	145,586,267	15
Deschutes River inflow *(RES14)*	7/28/15	8	37	124,026,185	18	64,583,336	8
Ferry *(LDR09)*	9/16/15	9	34	7,314,577	19	21,881,789	8
ReReg Dam *(LDR01)*	9/14/15	10	45	2,066,501	12	4,484,285	5
Whitehorse *(LDR07)*	9/15/15	11	49	60,040,365	21	20,852,522	9
Metolius River inflow *(RES17)*	10/1/15	12	48	12,089,295	12	8,801,298	7

Table 5. Split periphyton sample results between Aquatic Analysts and Rhithron from 2015. The table lists the total biovolume ($\mu m^3/cm^2$) reported and number of genera reported by each laboratory.

Site	Date	Rhithron Biovolume	Aquatic Analysts Biovolume	Rhithron Taxa	Aquatic Analysts Taxa	Common Taxa
ReReg Dam *(LDR01)*	6/15/2015	108,146,682	119,018,363	23	14	12
Kloan Rapids *(LDR20)*	6/1/2015	48,961,853	61,746,555	23	14	11
Lower Wapinitia *(LDR11)*	6/18/2015	665,694,331	318,204,843	23	16	14
River Mouth *(LDR21)*	7/9/2015	107,987,042	40,574,888	26	11	11
Dry Creek *(LDR03)*	7/20/2015	287,734,245	200,052,447	22	14	13
Lower Wapinitia *(LDR11)*	7/21/2015	128,016,738	320,833,518	18	14	11
Kloan Rapids *(LDR20)*	7/22/2015	175,637,174	145,586,267	25	17	16
Deschutes River inflow *(RES14)*	7/28/2015	124,026,185	64,583,336	17	10	9
Ferry *(LDR09)*	9/16/2015	7,314,577	21,881,789	17	11	8
ReReg Dam *(LDR01)*	9/14/2015	2,066,501	4,484,285	18	8	4
Whitehorse *(LDR07)*	9/15/2015	60,040,365	20,852,522	22	10	9
Metolius River inflow *(RES17)*	10/1/2015	12,089,295	8,801,298	16	9	6

Table 6. Split periphyton sample results between Rhithron and Aquatic Analysts from samples collected in 2015. The columns labelled "Taxa" indicated the number of non-diatom taxa identified in each sample. Biovolume units are $\mu m^3/cm^2$. The last two columns to the right indicate the dominant taxon recorded by each laboratory.

Sample	Date	Rhithron		Aquatic Analysts		Common Taxa	Rhithron Dominant	Aquatic Analysts Dominant
		Taxa	Biovolume	Taxa	Biovolume			
ReReg Dam *(LDR01)*	6/15/15	4	18,920,997	2	138,592,000	1	Calothrix	Calothrix
Kloan Rapids *(LDR20)*	6/17/15	8	235,679,836	1	16,858,588	1	Cladophora	Calothrix
Lower Wapinitia *(LDR11)*	6/8/15	9	144,837,209	0	-	0	Cladophora	Gomphoneis herculeana
River Mouth *(LDR21)*	7/9/15	9	151,645,011	2	7,805,813	2	Calothrix	Synedra
Dry Creek *(LDR03)*	7/20/15	7	28,215,582	1	5,132,838	1	Calothrix	Gomphoneis herculeana
Lower Wapinitia *(LDR11)*	7/21/15	12	44,778,558	0	-	0	Cladophora	Gomphoneis herculeana
Kloan Rapids *(LDR20)*	7/21/15	9	160,204,059	0	-	0	Cladophora	Gomphoneis herculeana
Deschutes River inflow *(RES14)*	7/28/15	5	27,254,846	2	13,842,574	1	Cymbella mexicana	Nitzschia
Ferry *(LDR09)*	9/16/15	8	3,851,719,385	6	112,779	0	Cladophora	Diatoma
ReReg Dam *(LDR01)*	9/14/15	7	694,160,935	1	1,297,467	1	Cladophora	Synedra

Sample	Date	Rhithron		Aquatic Analysts		Common Taxa	Rhithron Dominant	Aquatic Analysts Dominant
		Taxa	Biovolume	Taxa	Biovolume			
Whitehorse *(LDR07)*	9/15/15	7	13,781,086	3	6,413,836	1	Cladophora	Gomphonema
Metolius River inflow *(RES17)*	10/1/15	11	15,103,831	2	497,428	1	Homeothrix	Cymbella

Appendix D Selected Water Quality Profiles for Impoundment Sampling Sites

1 List of Figures

2 Lake Billy Chinook

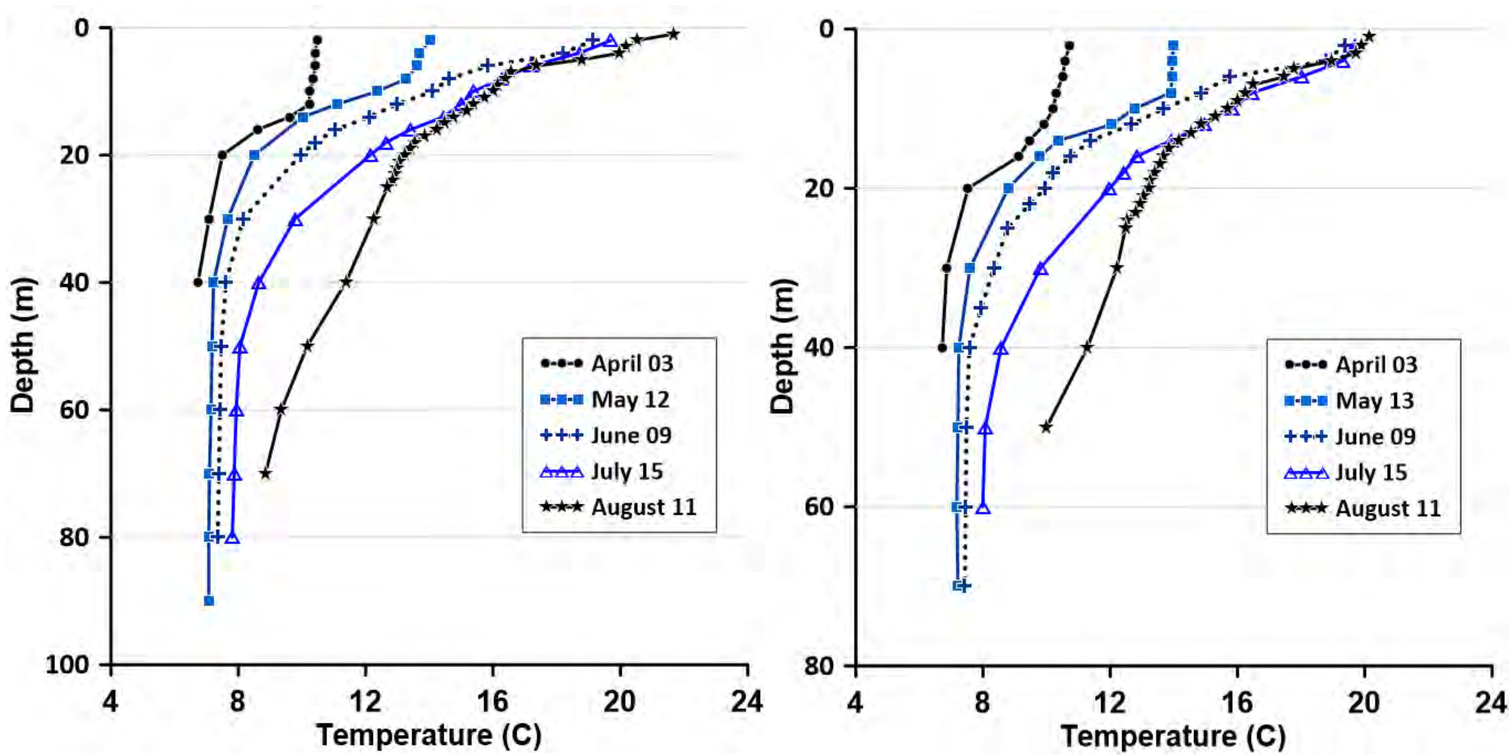


Figure 1. Selected temperature profiles in Round Butte forebay (left) and Common Pool (right) in 2015.

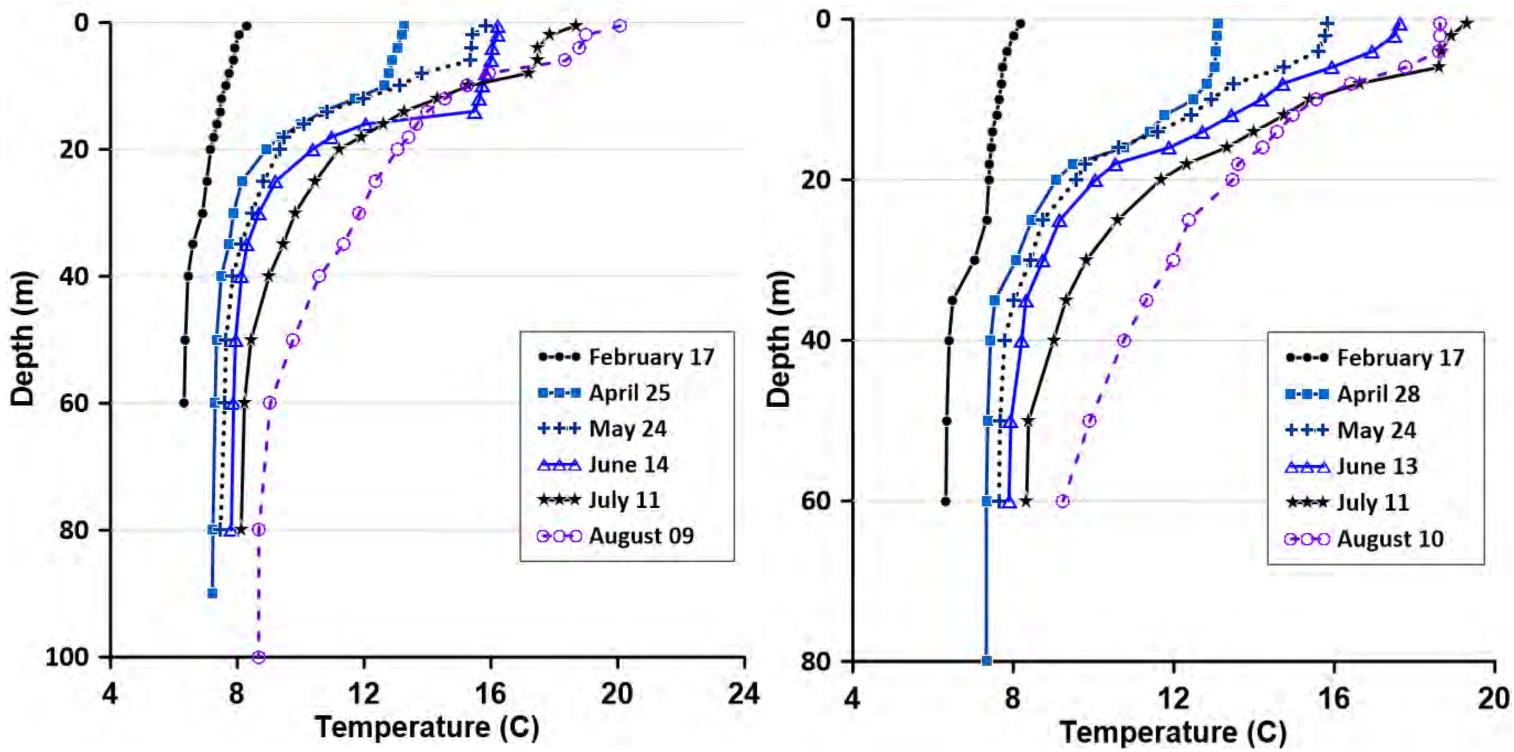


Figure 2. Selected temperature profiles in Round Butte forebay (left) and Common Pool (right) in 2016.

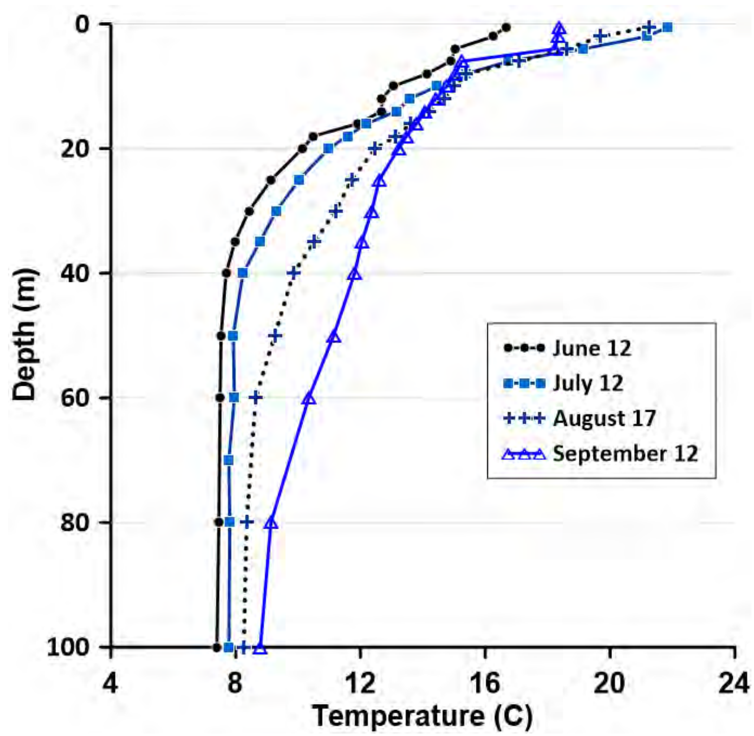


Figure 3. Selected temperature profiles in Round Butte forebay in 2017.

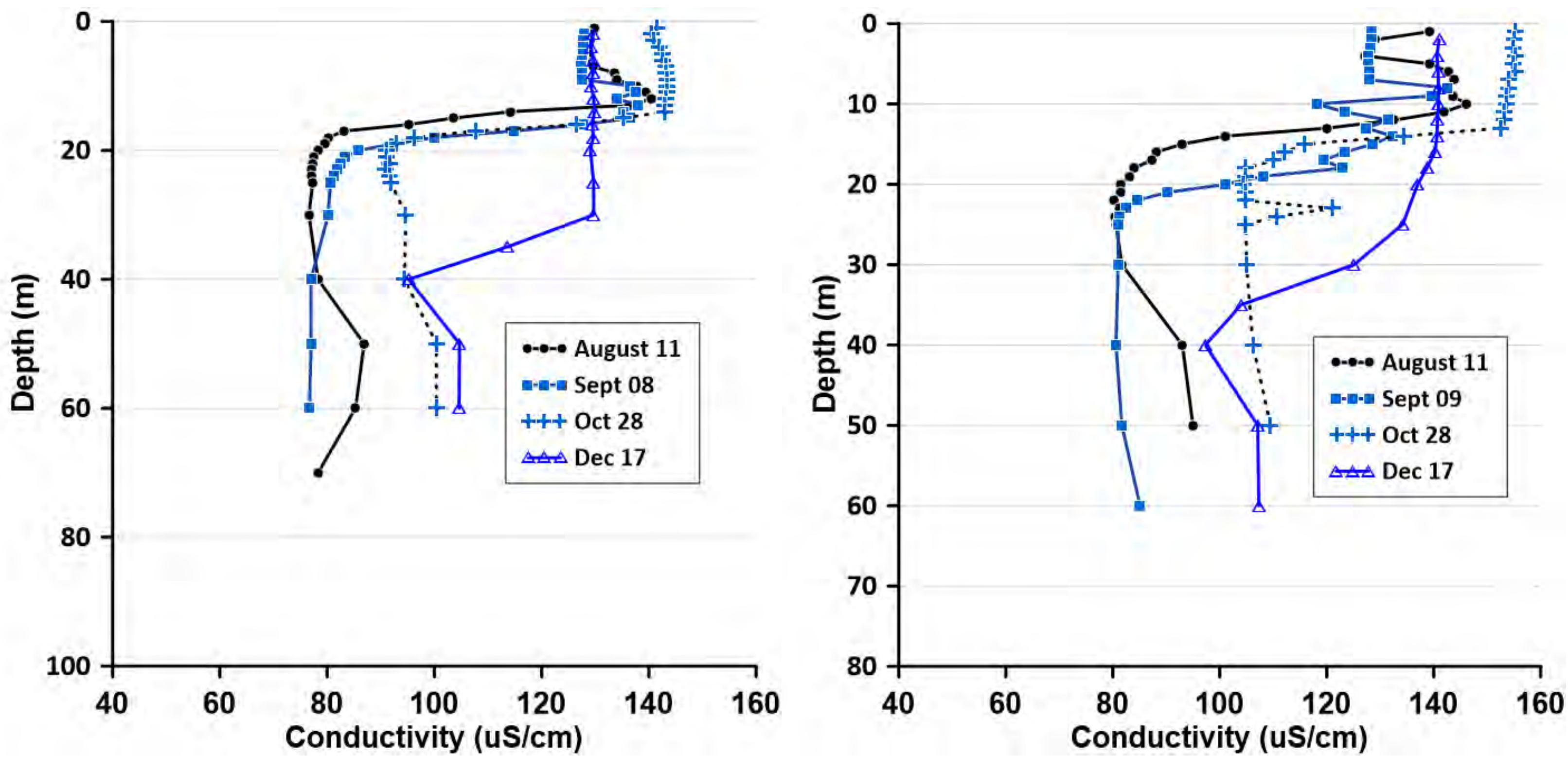


Figure 4. Selected conductivity profiles in Round Butte forebay (left) and Common Pool (right) in 2015.

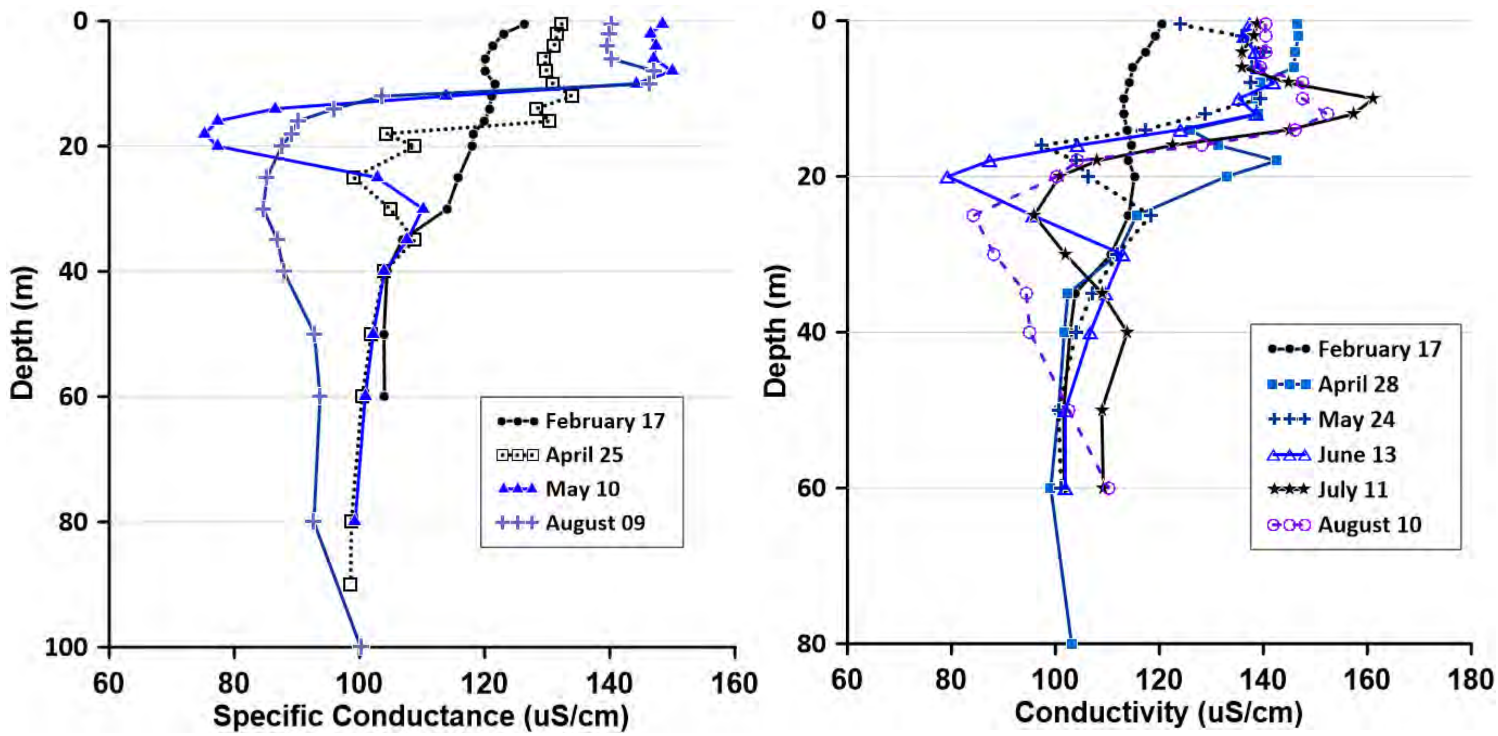


Figure 5. Selected conductivity profiles in Round Butte forebay (left) and Common Pool (right) in 2016.

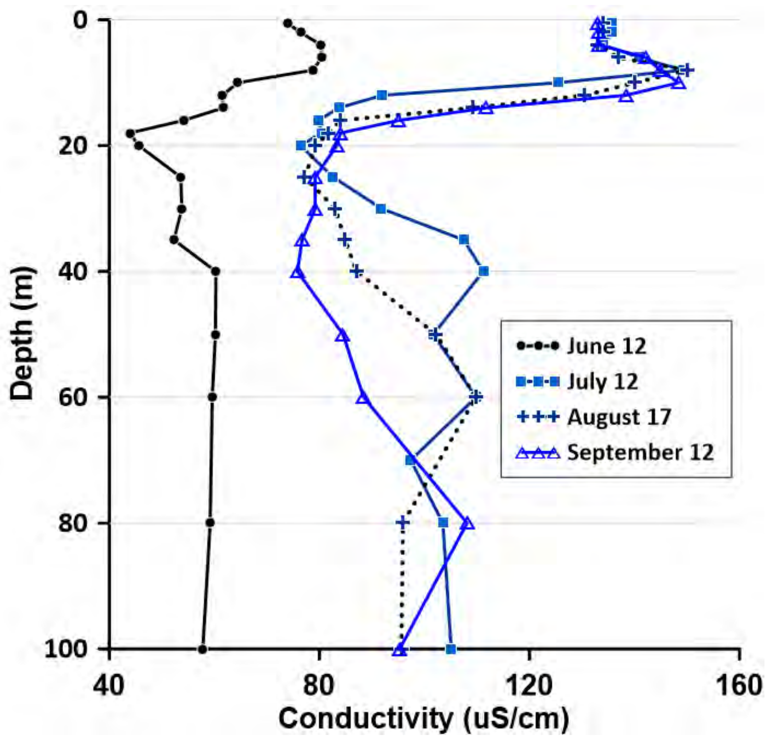


Figure 6. Selected conductivity profiles in Round Butte forebay in 2017.

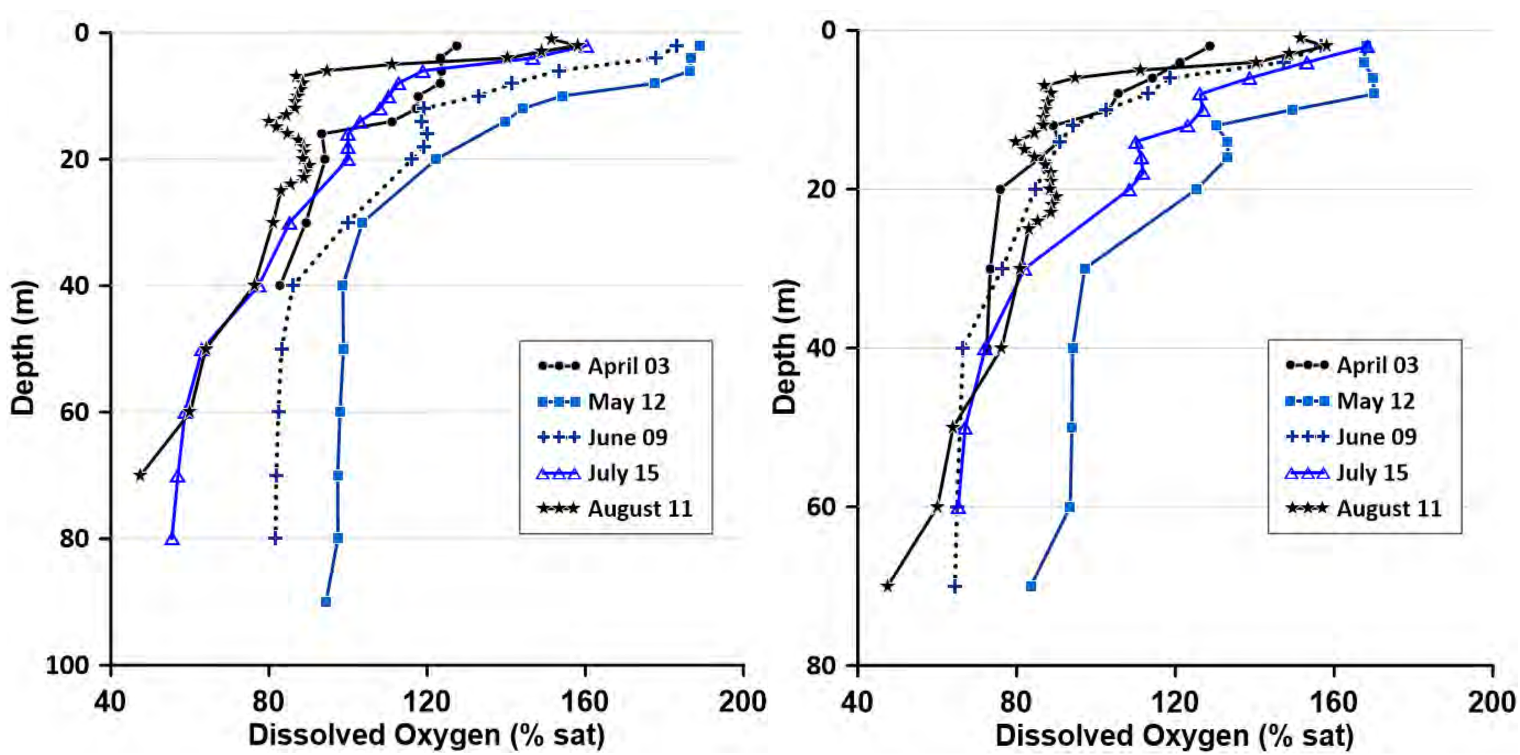


Figure 7. Selected dissolved oxygen saturation profiles in Round Butte forebay (left) and Common Pool (right) in 2015.

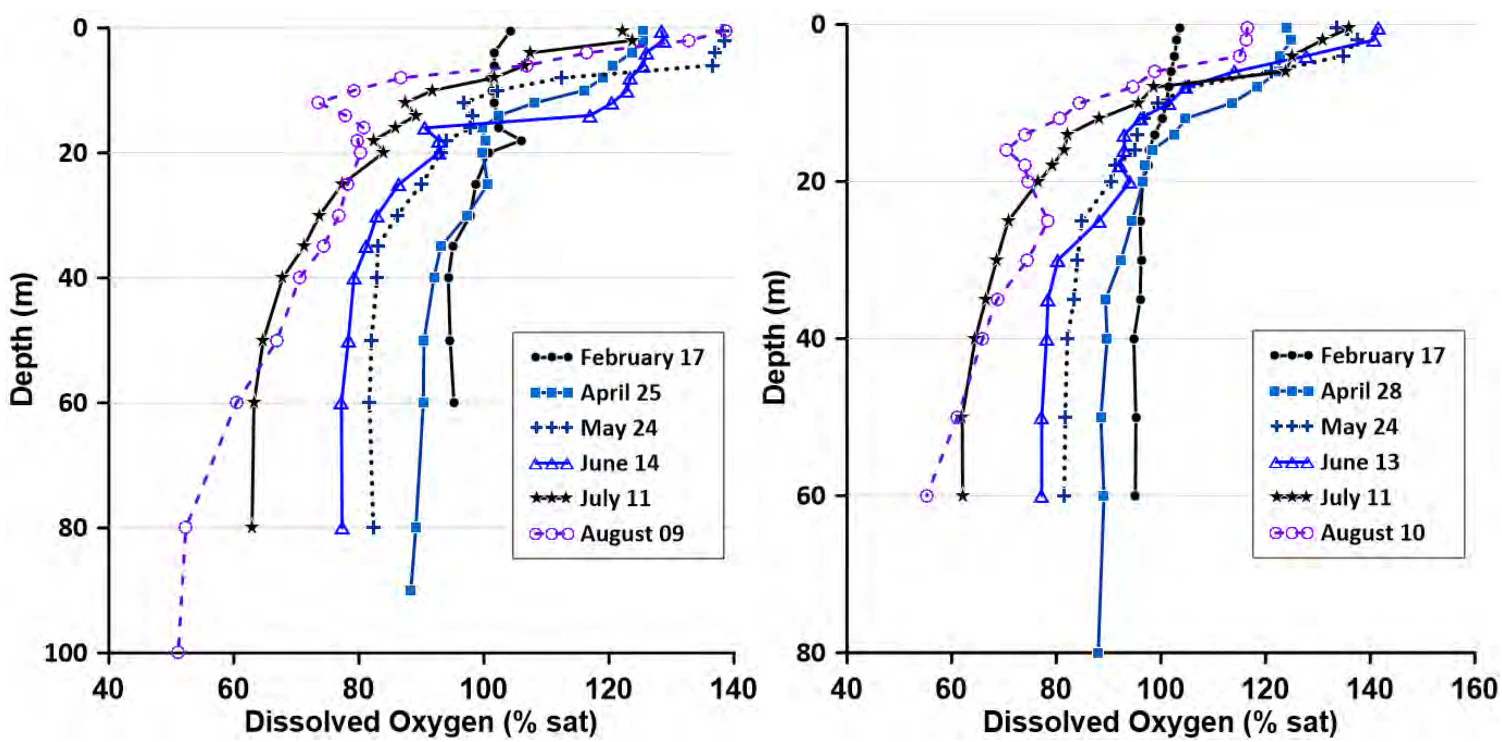


Figure 8. Selected dissolved oxygen saturation profiles in Round Butte forebay (left) and Common Pool (right) in 2016.

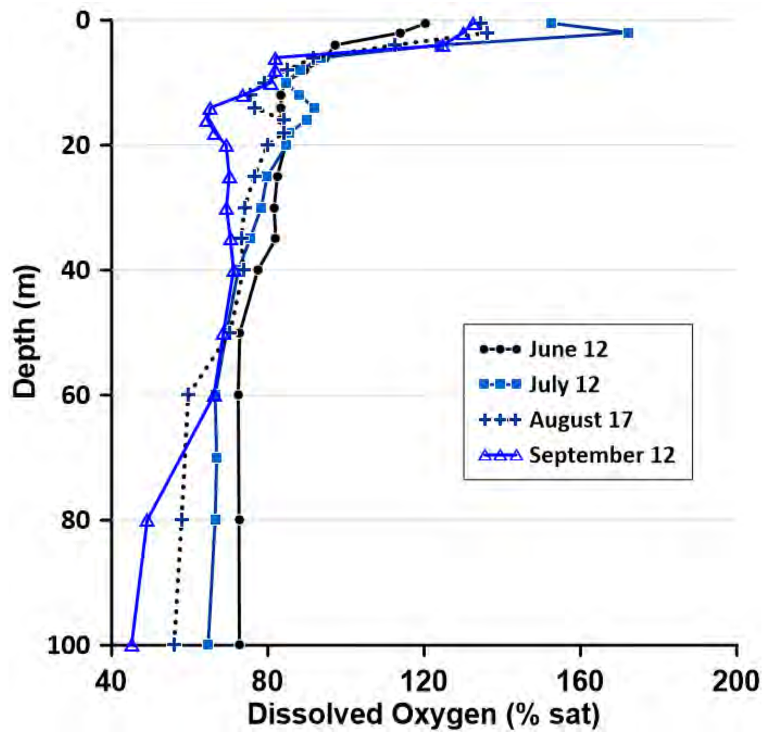


Figure 9. Selected dissolved oxygen saturation profiles in Round Butte forebay in 2017.

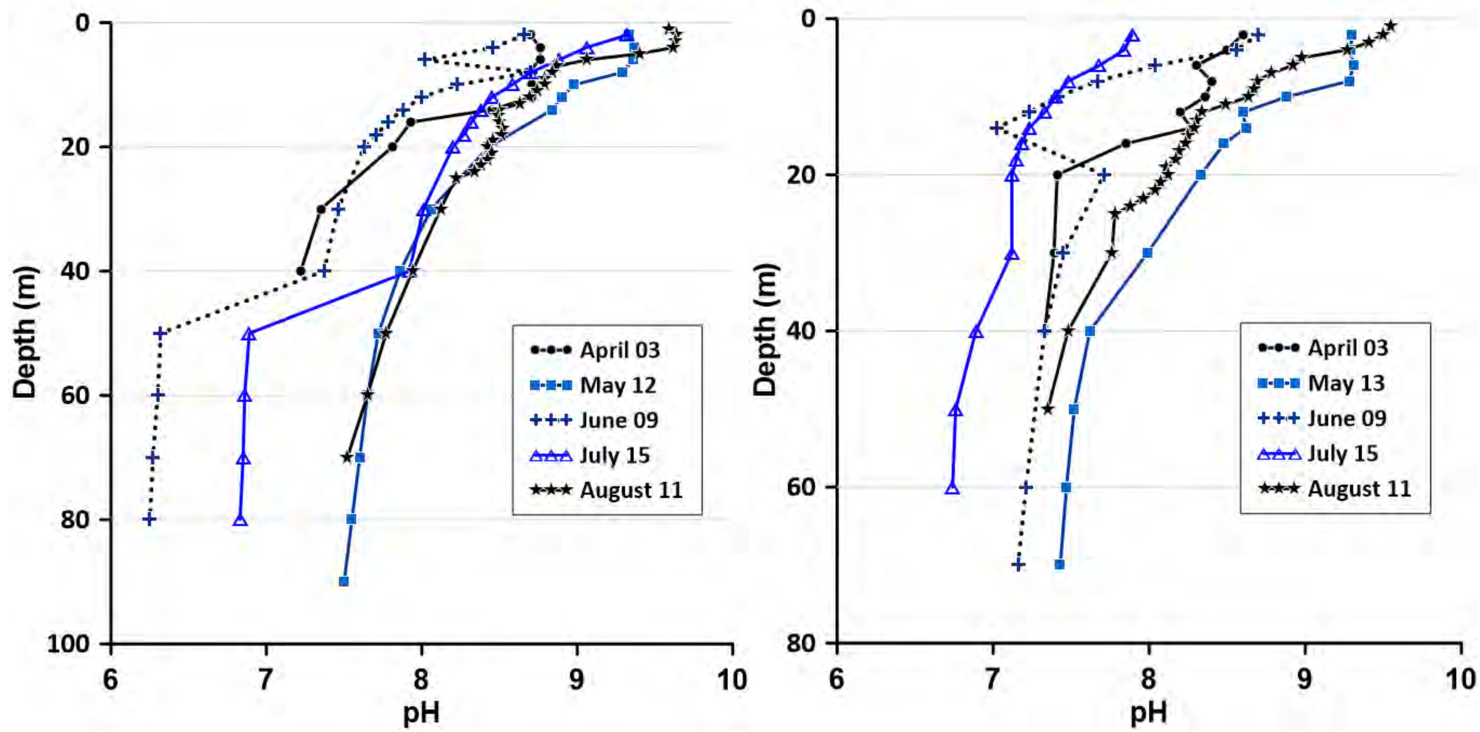


Figure 10. Selected pH profiles in Round Butte forebay (left) and Common Pool (right) in 2015.

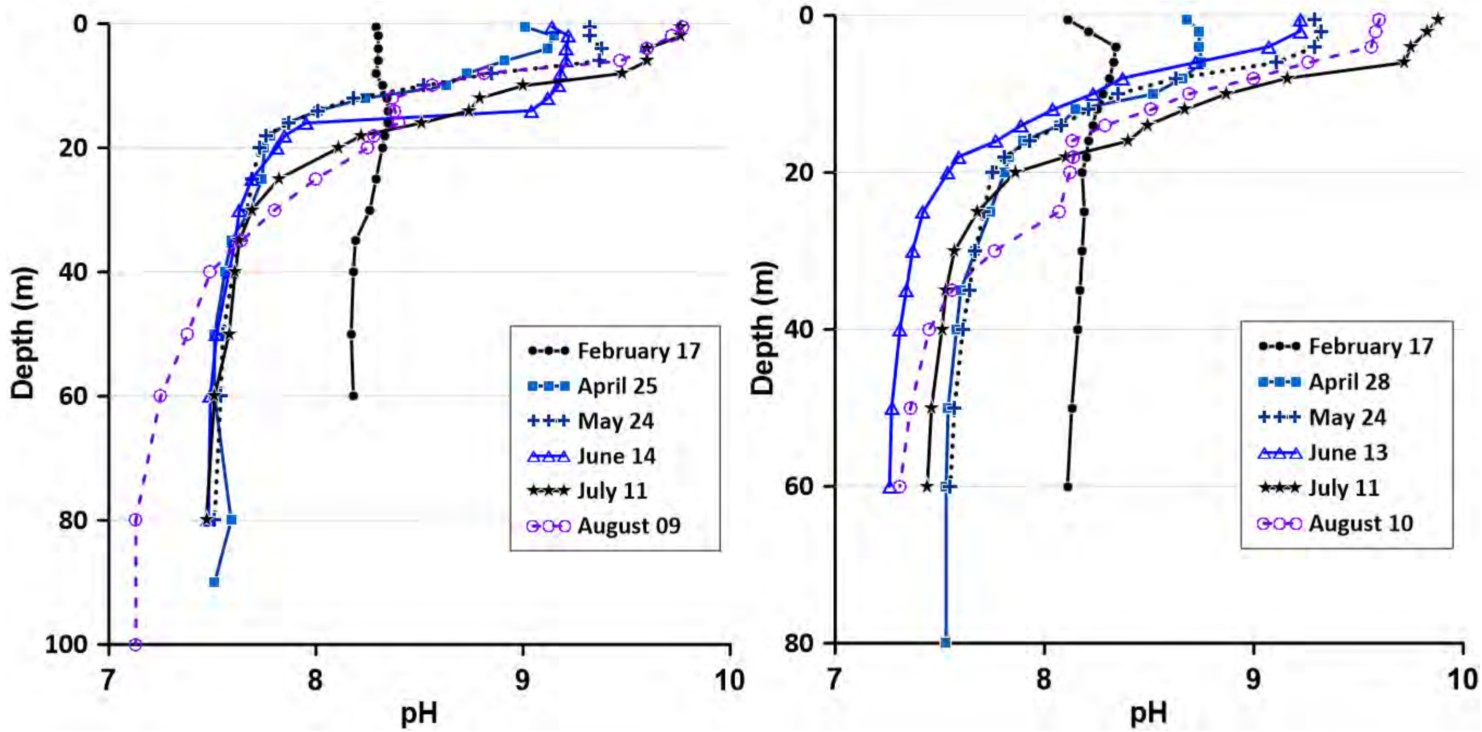


Figure 11. Selected pH profiles in Round Butte forebay (left) and Common Pool (right) in 2016.

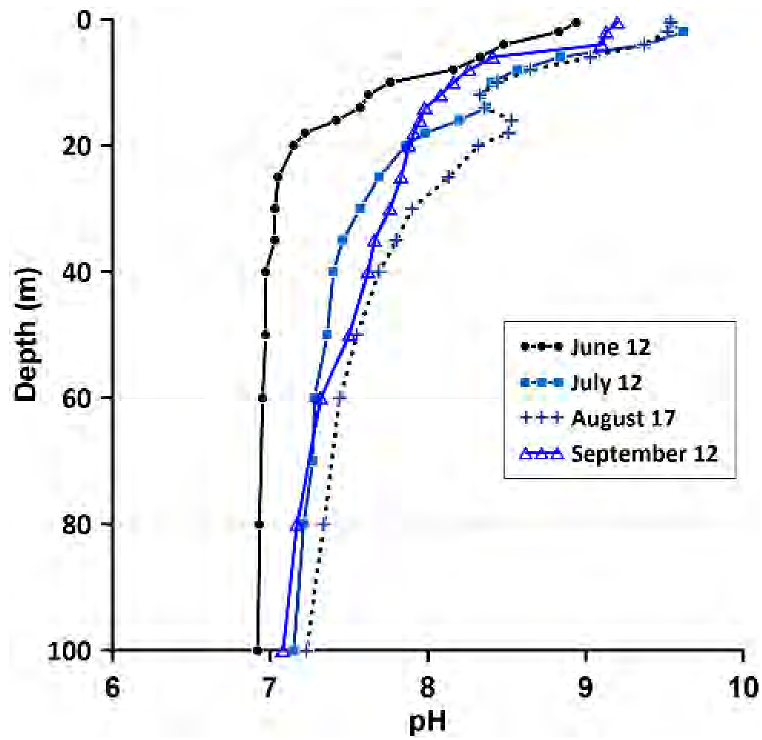


Figure 12. Selected pH profiles in Round Butte forebay in 2017.

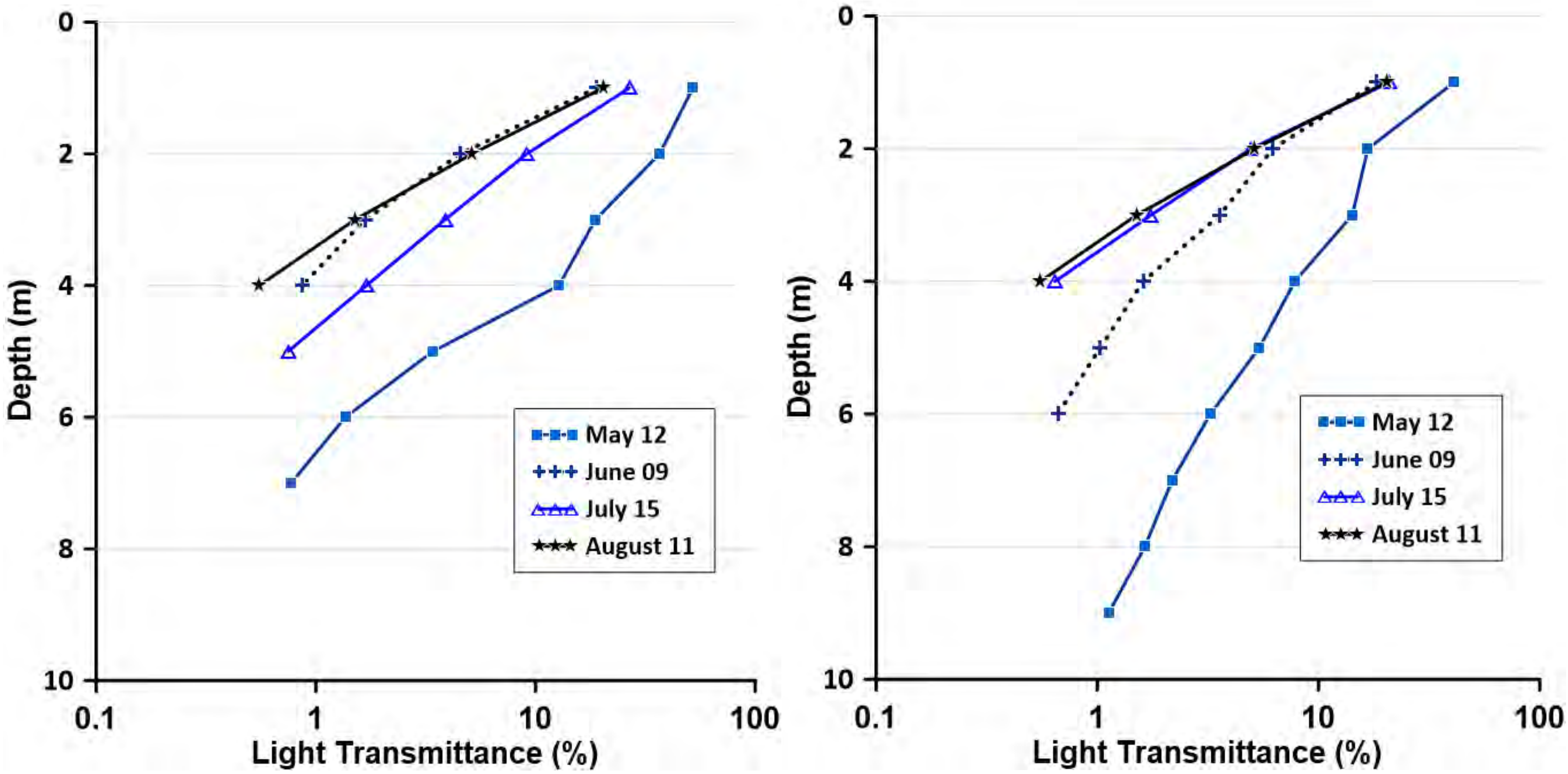


Figure 13. Selected light transmission profiles in Round Butte forebay (left) and Common Pool (right) in 2015.

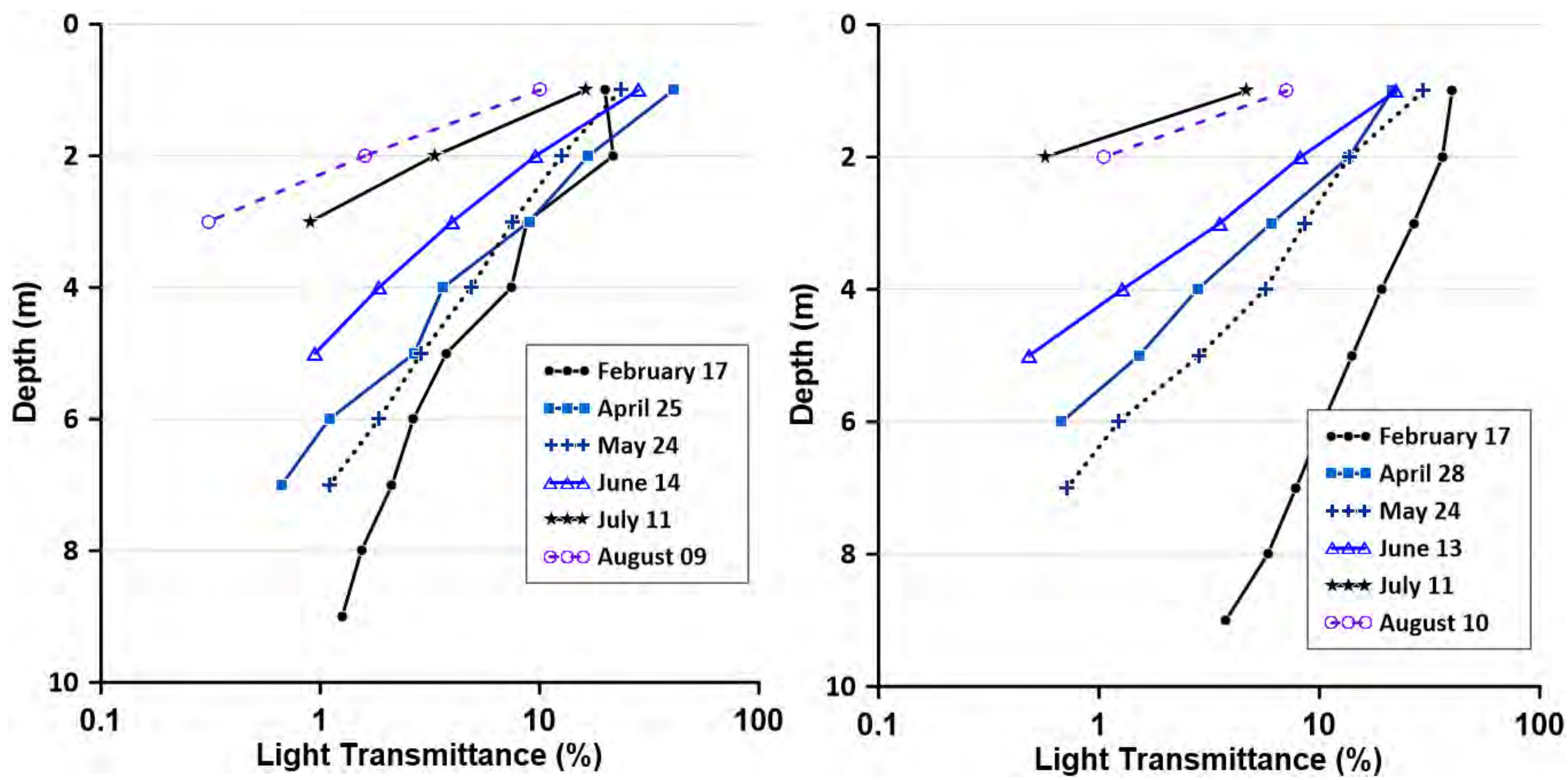


Figure 14. Selected light transmission profiles in Round Butte forebay (left) and Common Pool (right) in 2016.

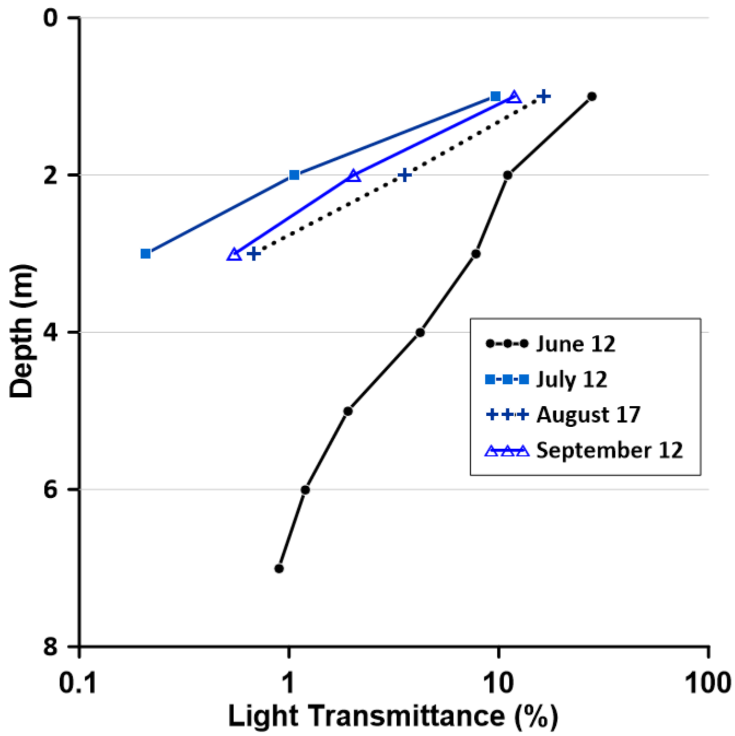


Figure 15. Selected light transmission profiles in Round Butte forebay in 2017.

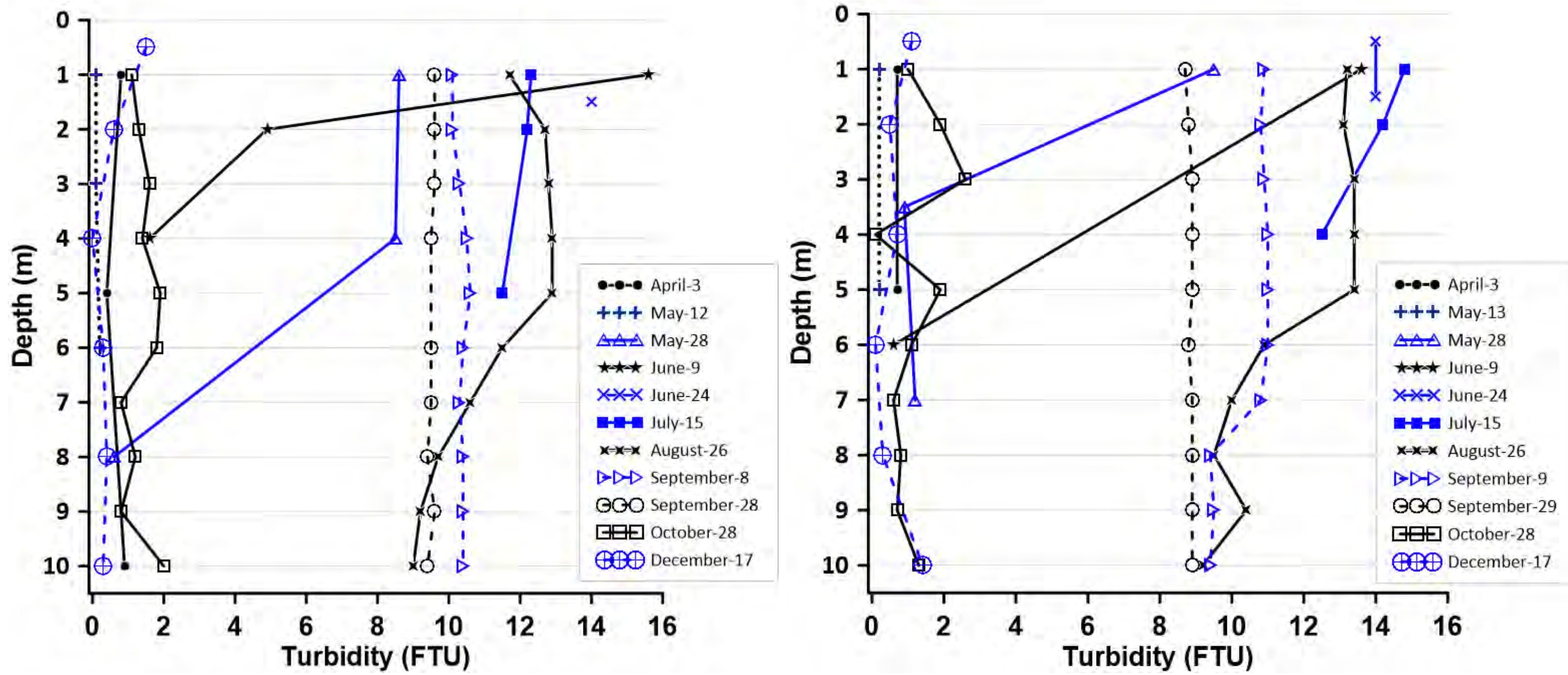


Figure 16. Turbidity profiles in Round Butte forebay (left) and Common Pool (right) in 2015.

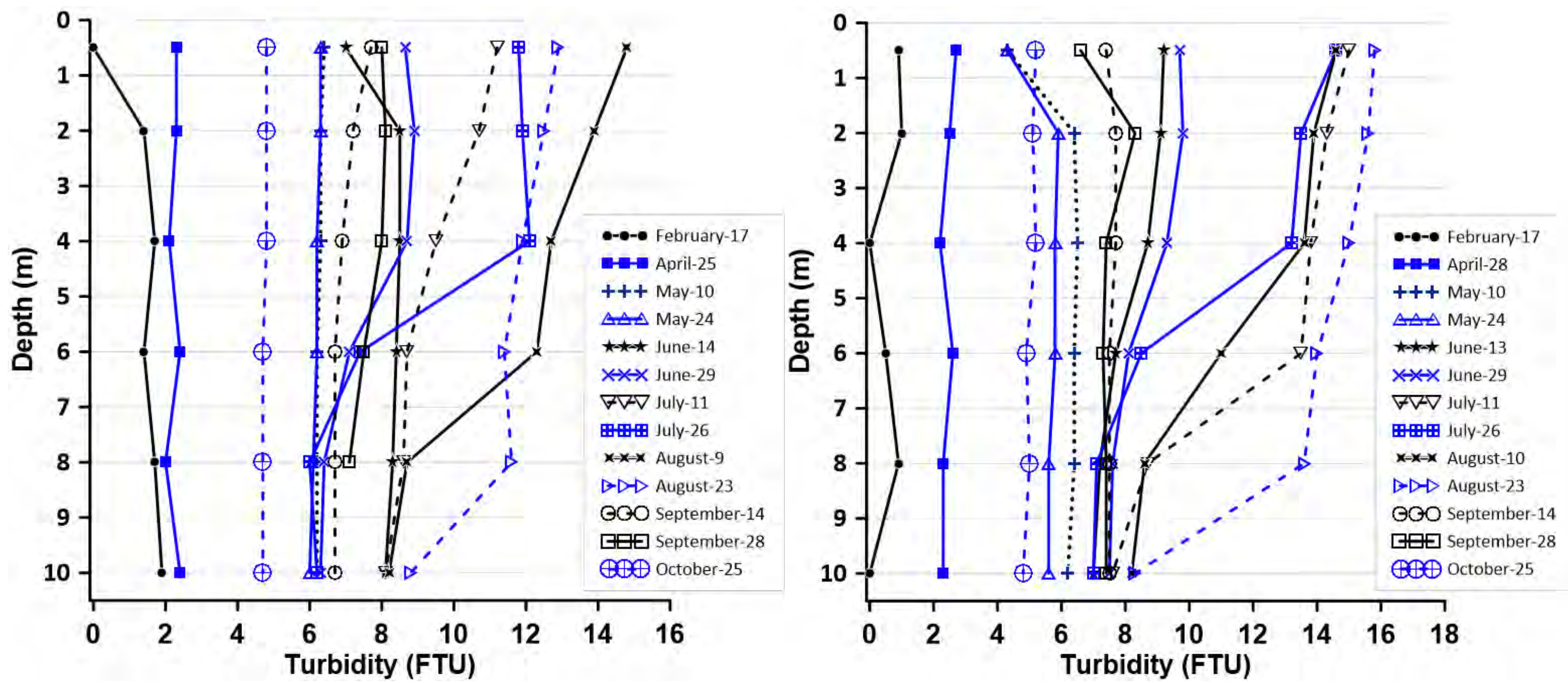


Figure 17. Turbidity profiles in Round Butte forebay (left) and Common Pool (right) in 2016.

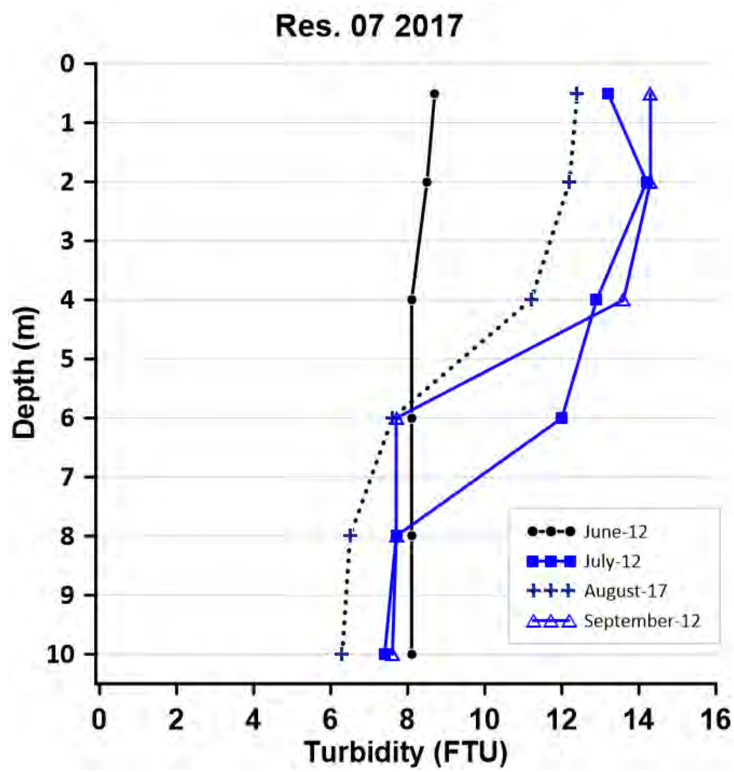


Figure 18. Turbidity profiles in Round Butte forebay in 2017.

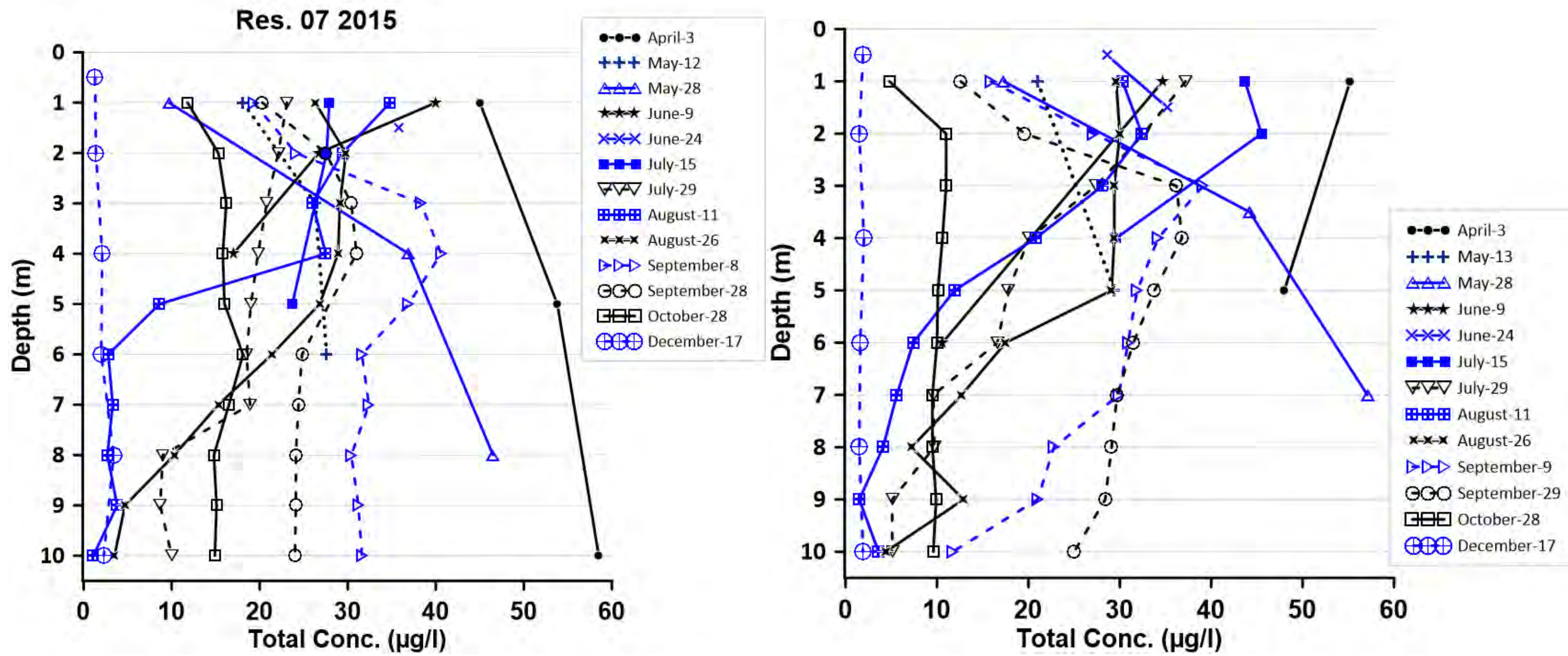


Figure 19. Total chlorophyll profiles in Round Butte forebay (left) and Common Pool (right) in 2015.

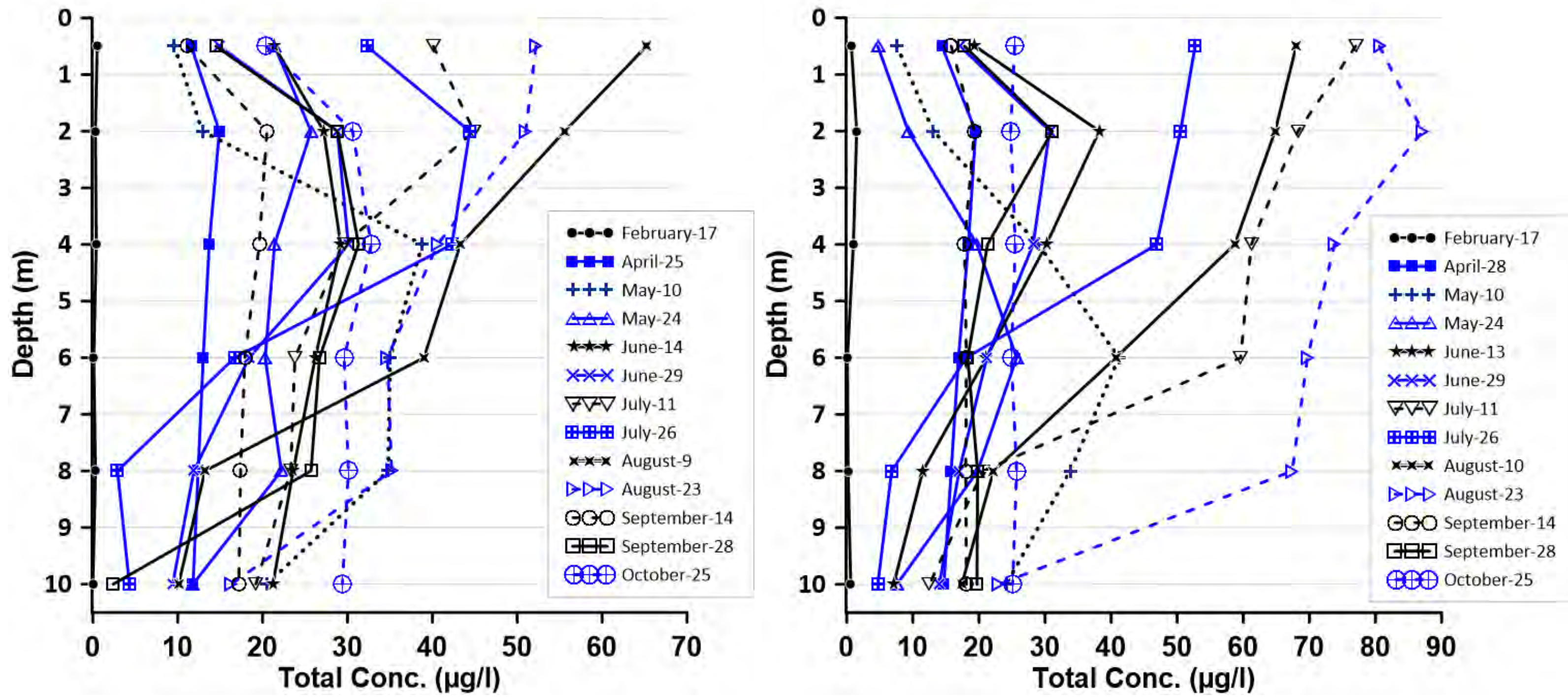


Figure 20. Total chlorophyll profiles in Round Butte forebay (left) and Common Pool (right) in 2016.

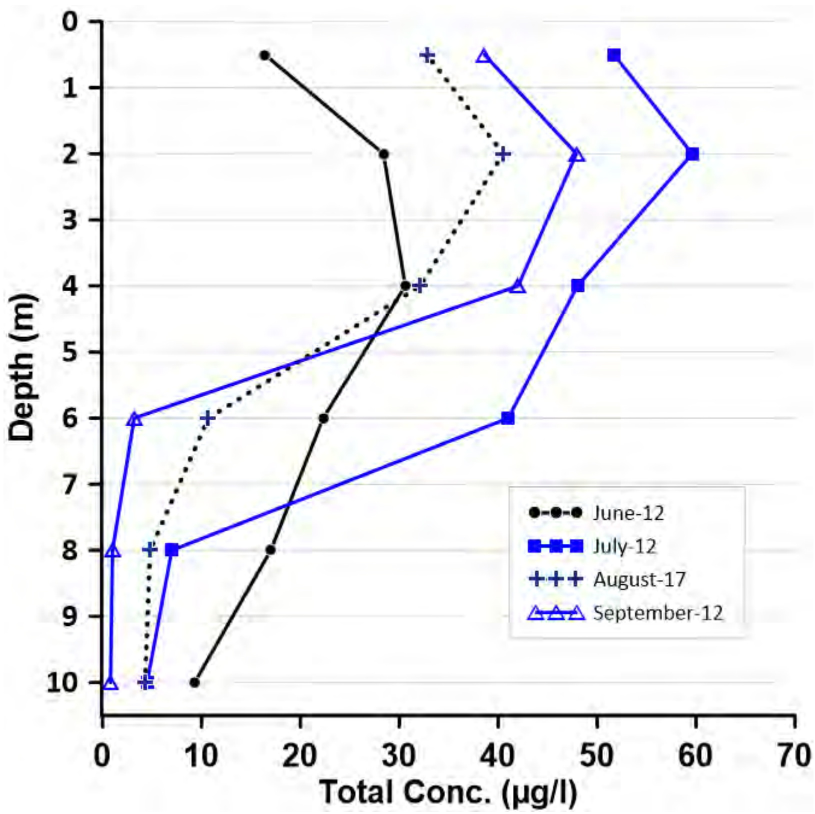


Figure 21. Total chlorophyll profiles in Round Butte forebay in 2017.

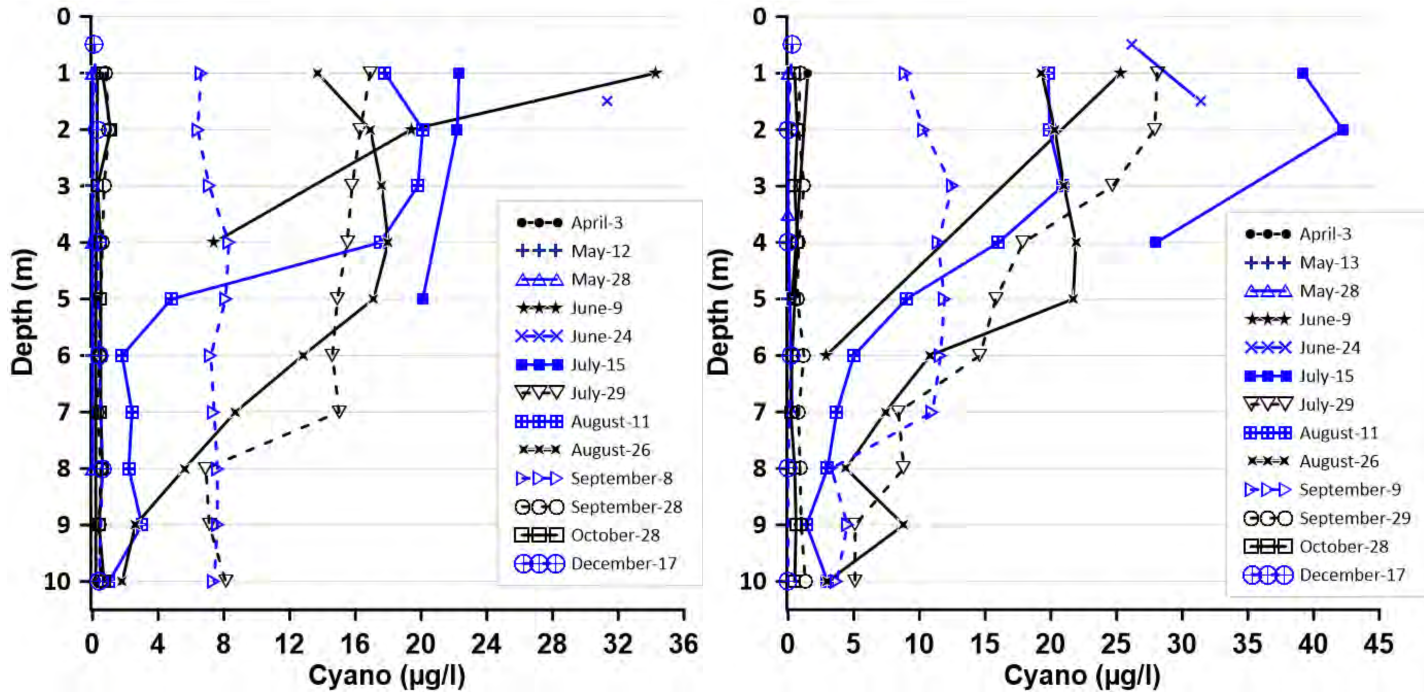


Figure 22. Cyanobacteria pigment profiles in Round Butte forebay (left) and Common Pool (right) in 2015.

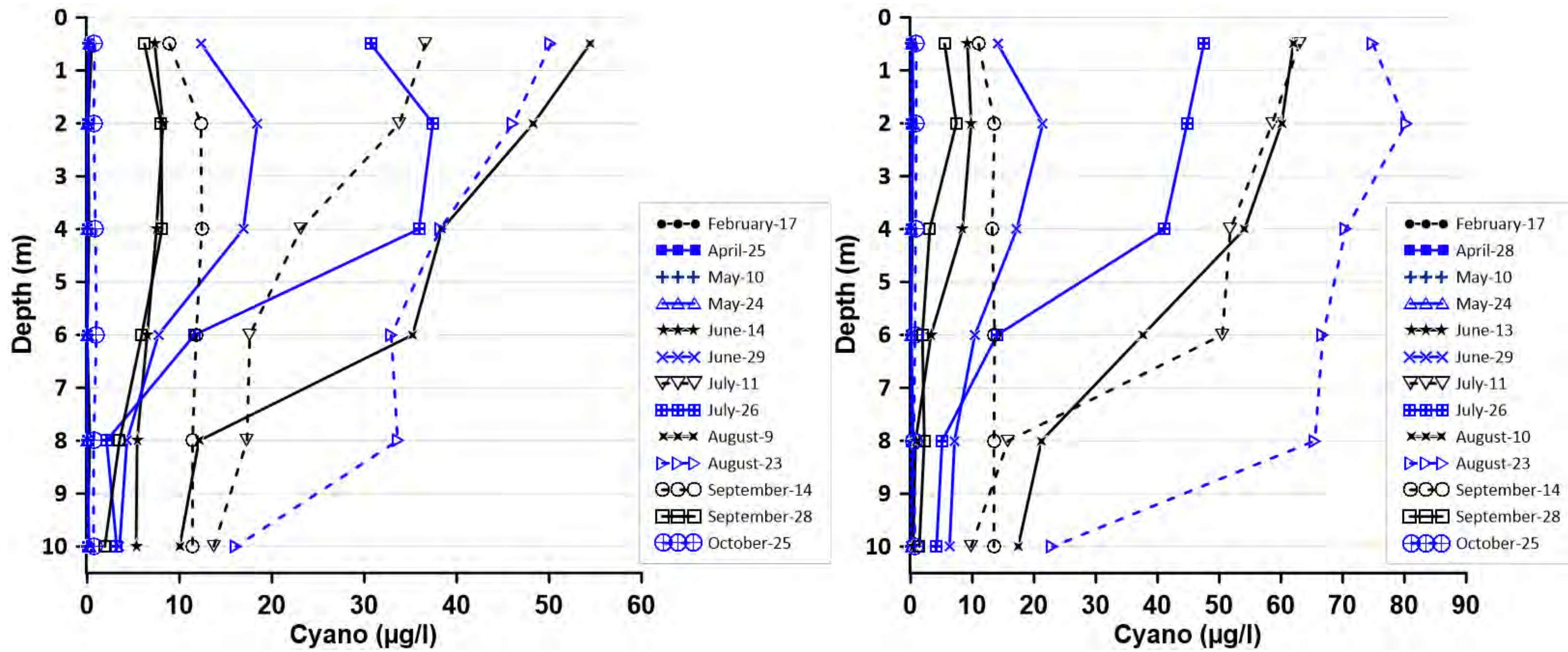


Figure 23. Cyanobacteria pigment profiles in Round Butte forebay (left) and Common Pool (right) in 2016.

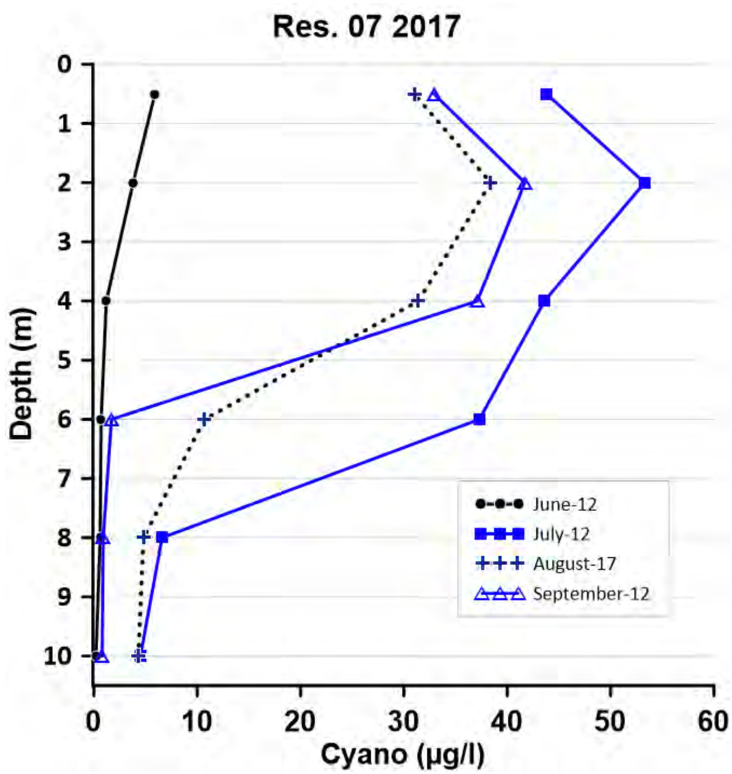


Figure 24. Cyanobacteria pigment profiles in Round Butte forebay in 2017.

3 Lake Simtustus

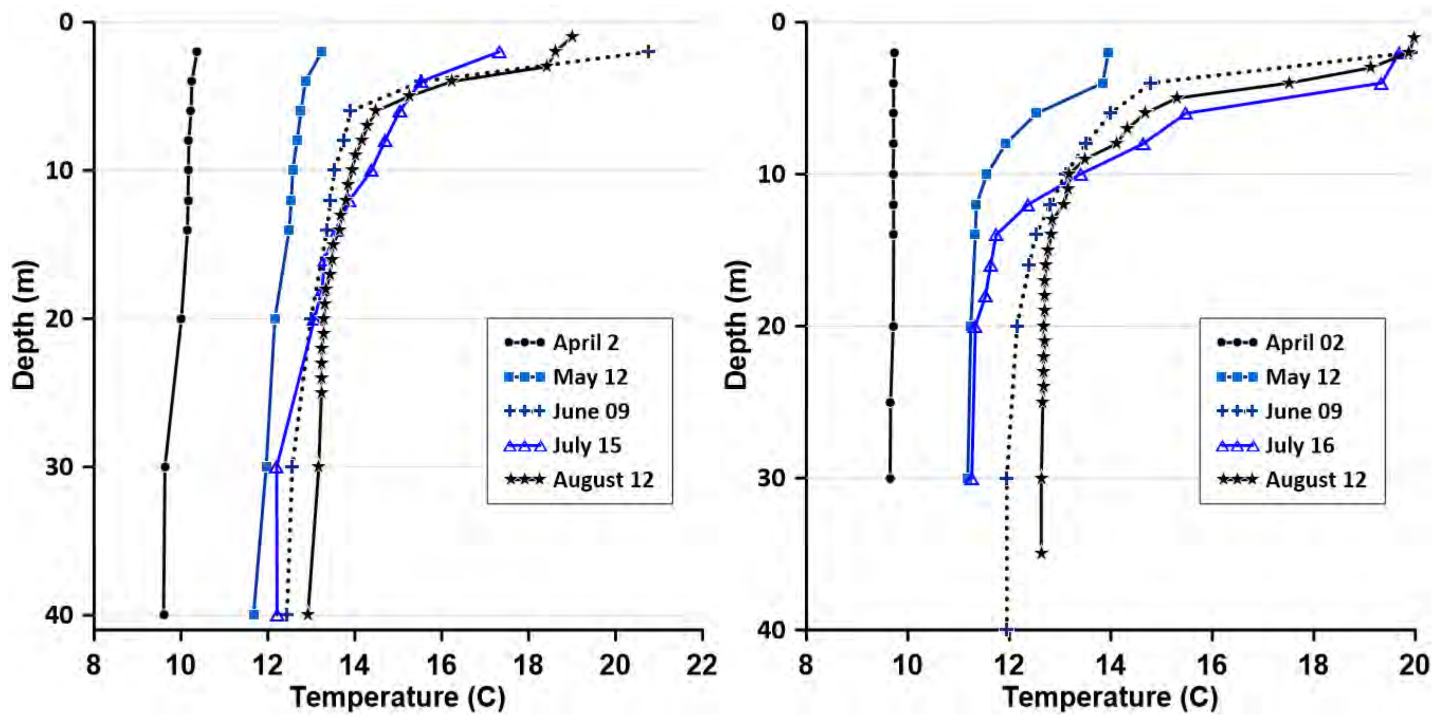
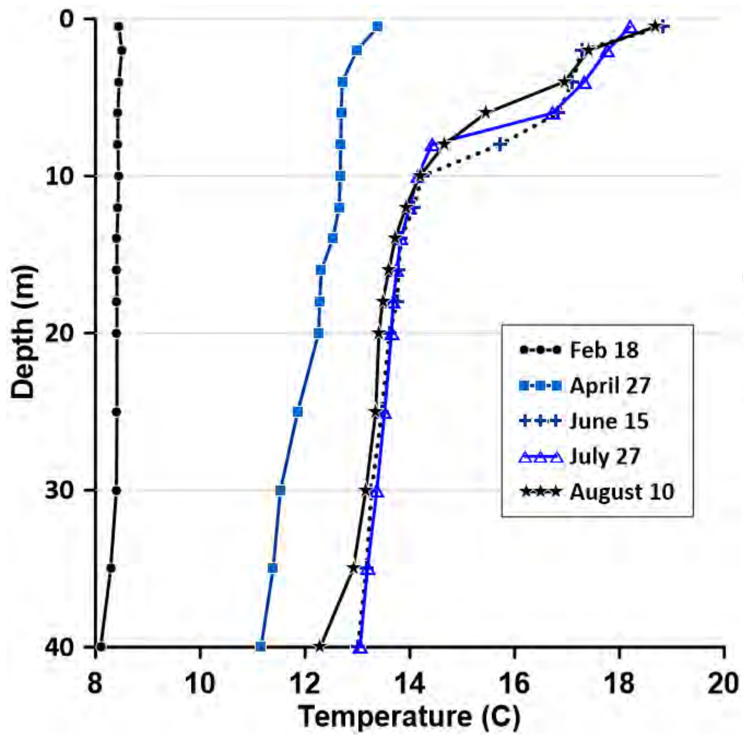


Figure 25. Selected temperature profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2015.



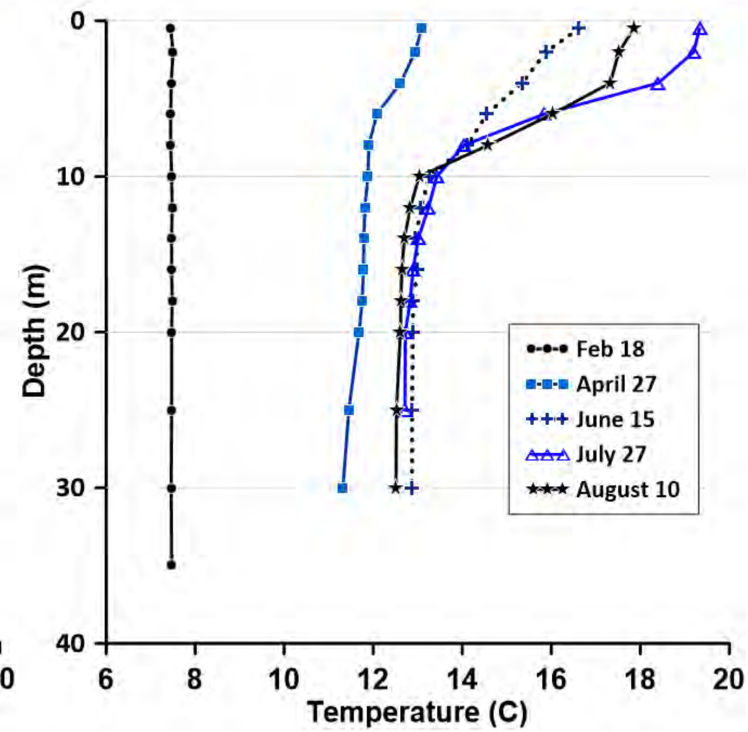


Figure 26. Selected temperature profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2016.

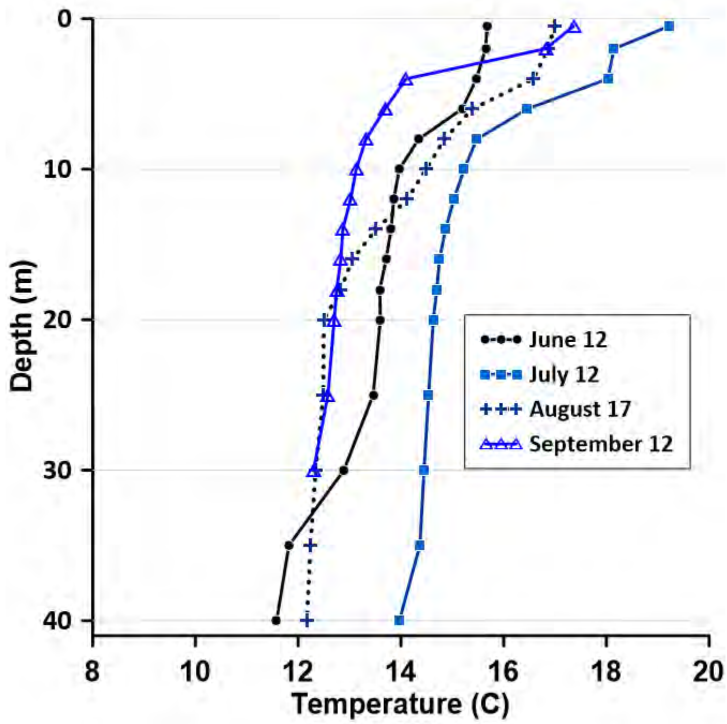


Figure 27. Selected temperature profiles in Pelton forebay in 2017.

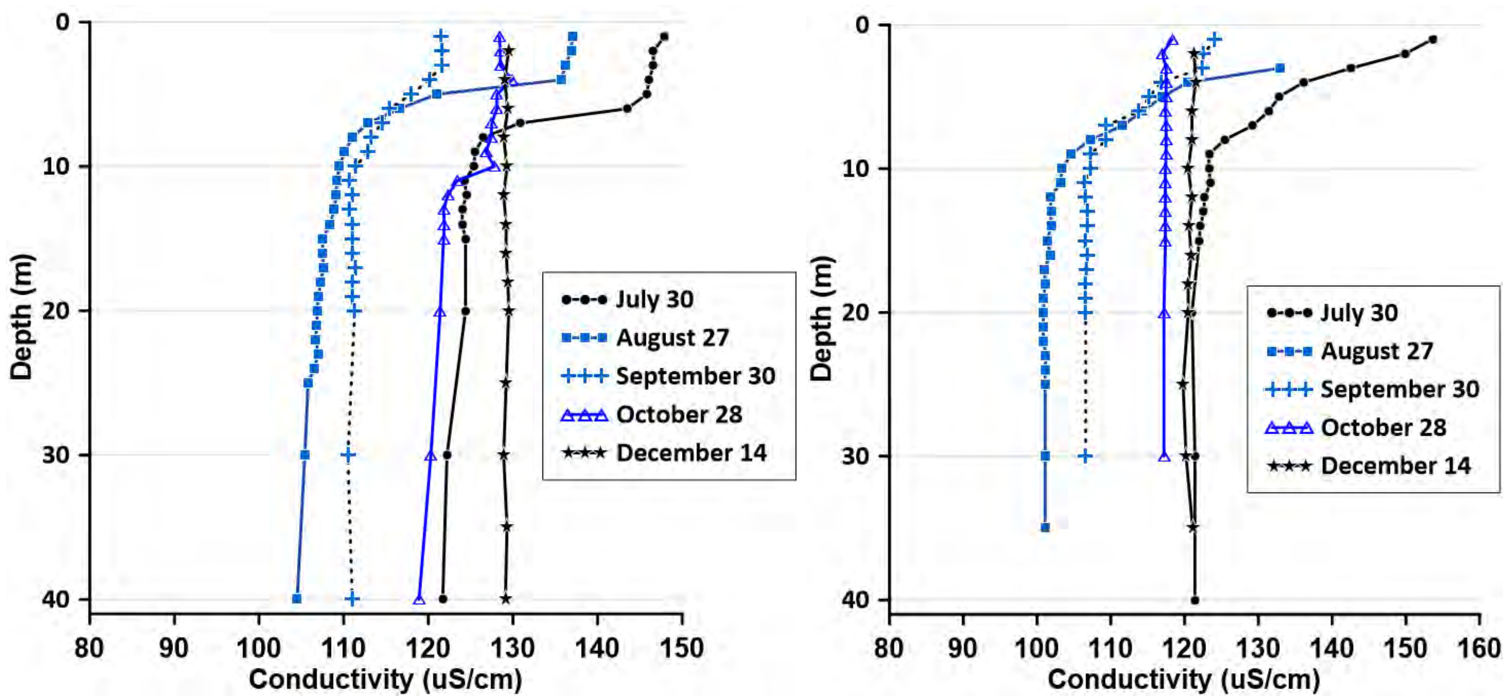


Figure 28. Selected conductivity profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2015.

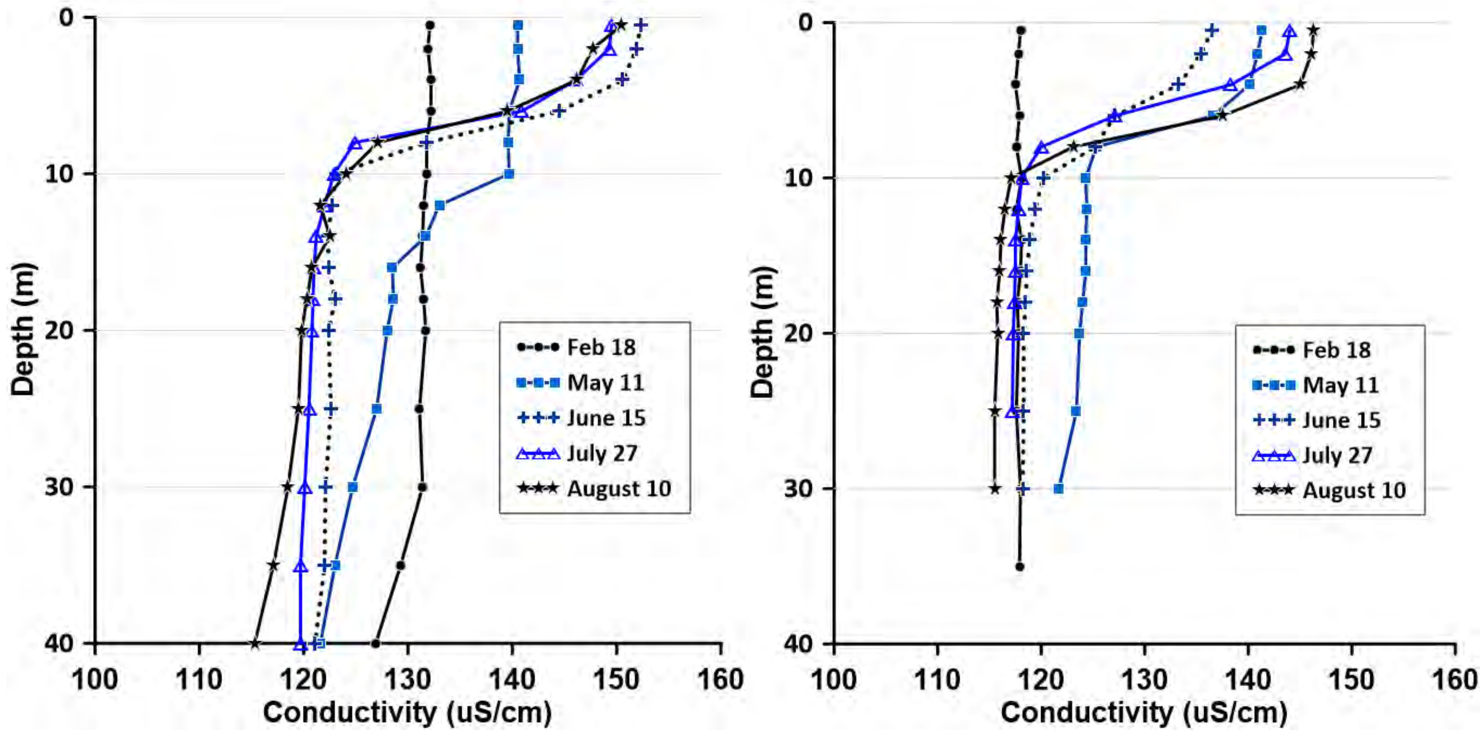


Figure 29. Selected conductivity profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2016.

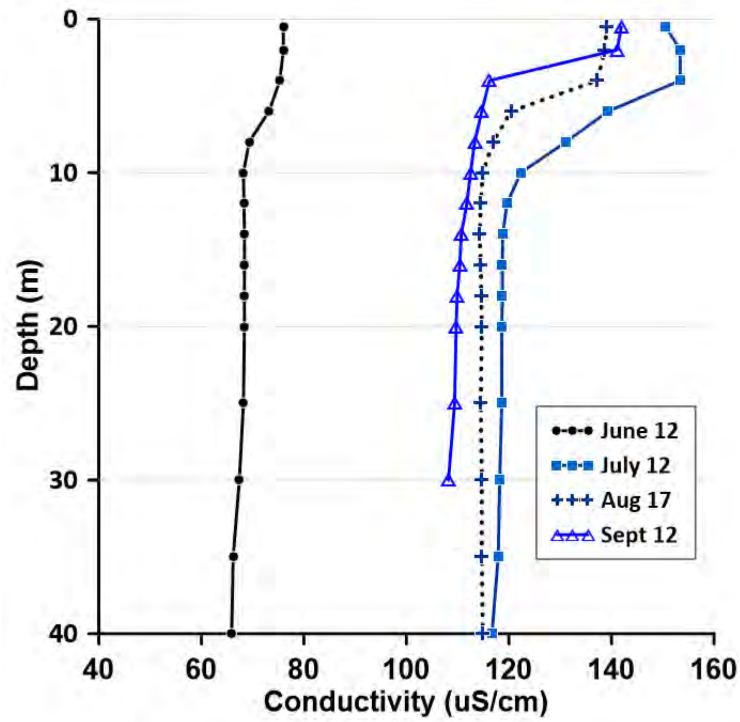
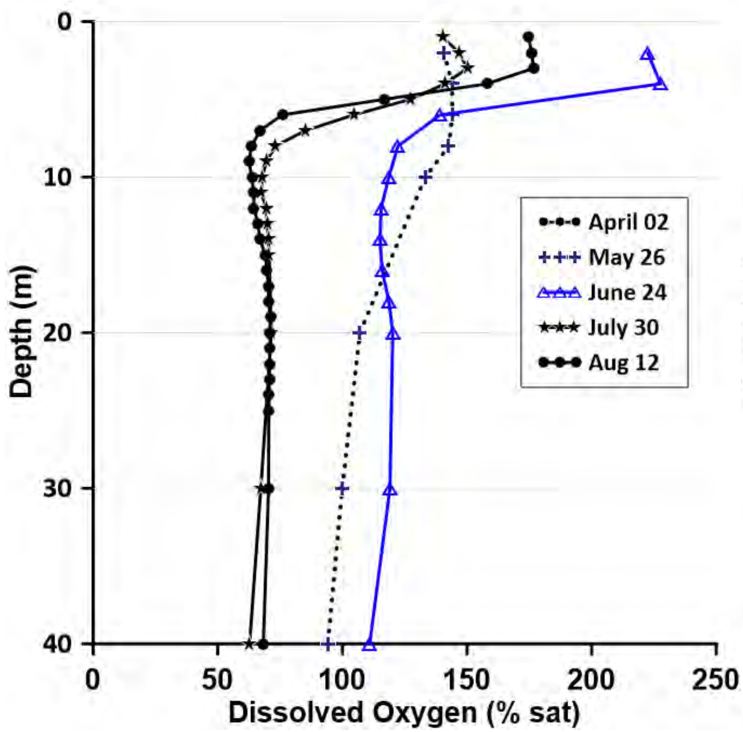


Figure 30. Selected conductivity profiles for the Pelton forebay in 2017.



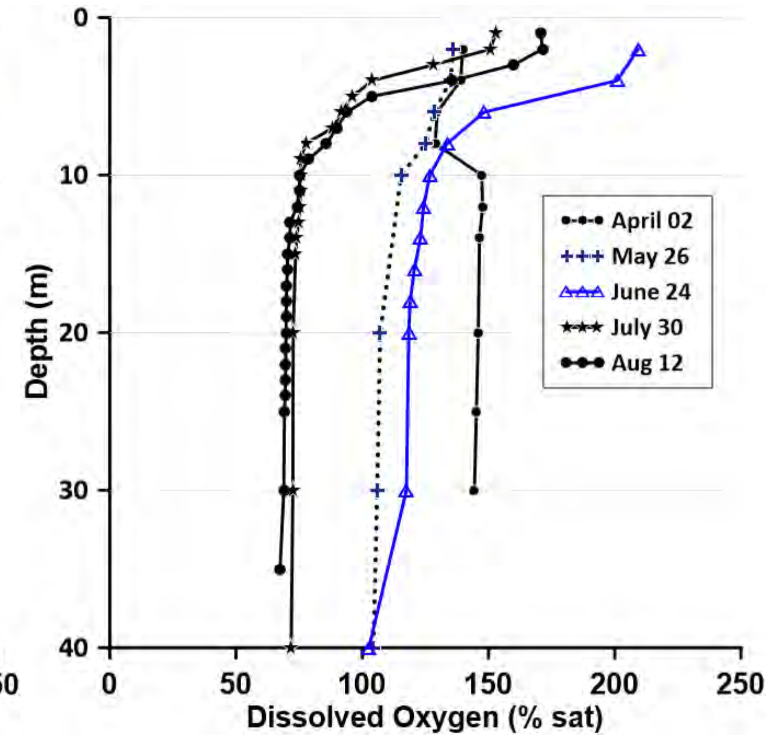
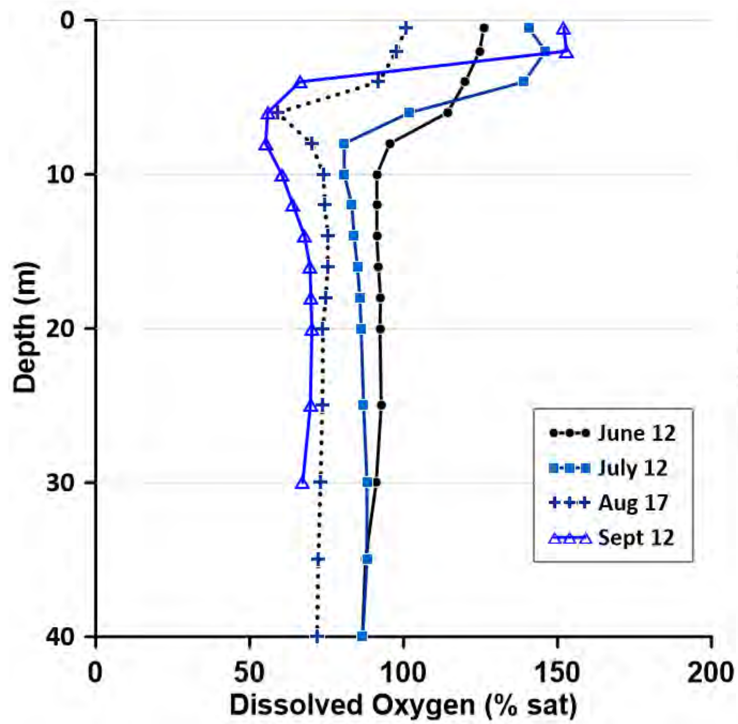


Figure 31. Selected dissolved oxygen saturation profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2015.



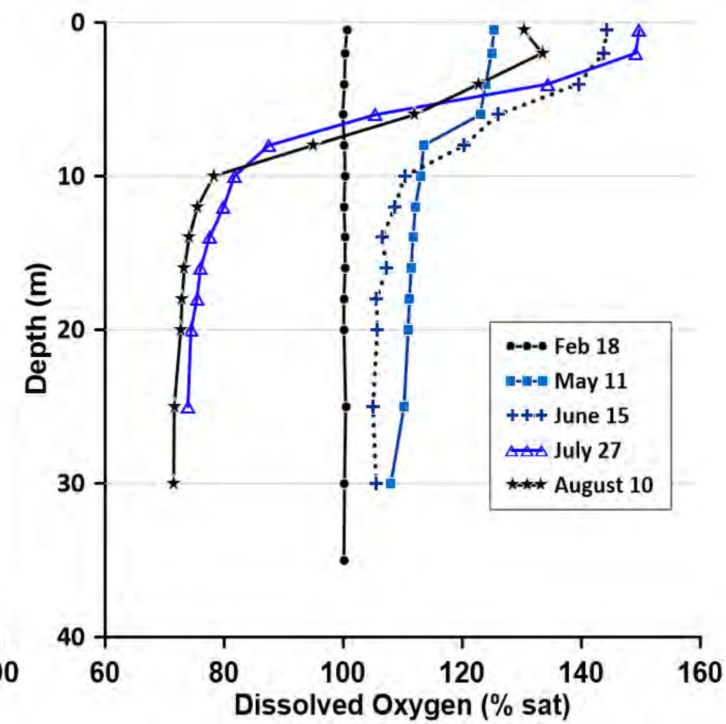


Figure 32. Selected dissolved oxygen saturation profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2016.

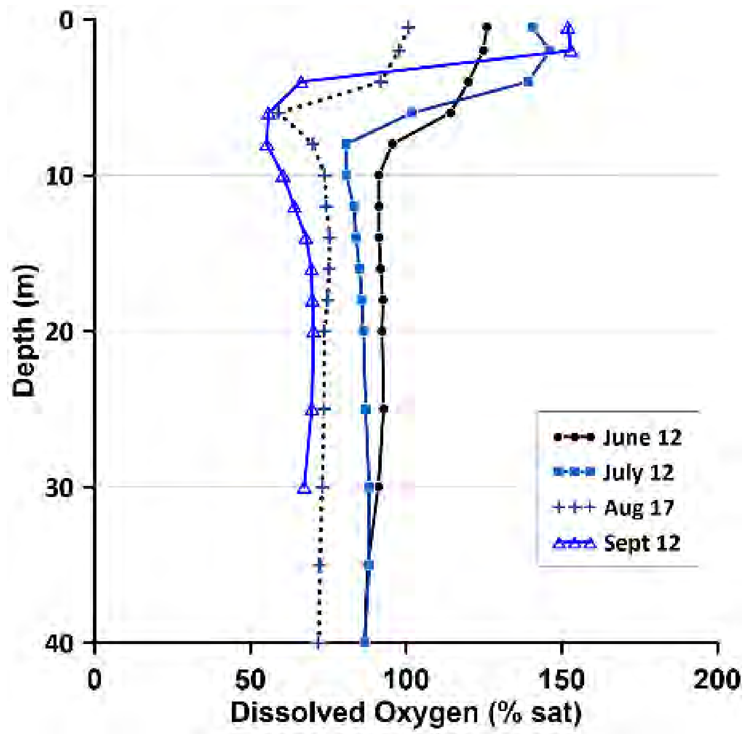


Figure 33. Selected dissolved oxygen saturation profiles in Pelton forebay in 2017.

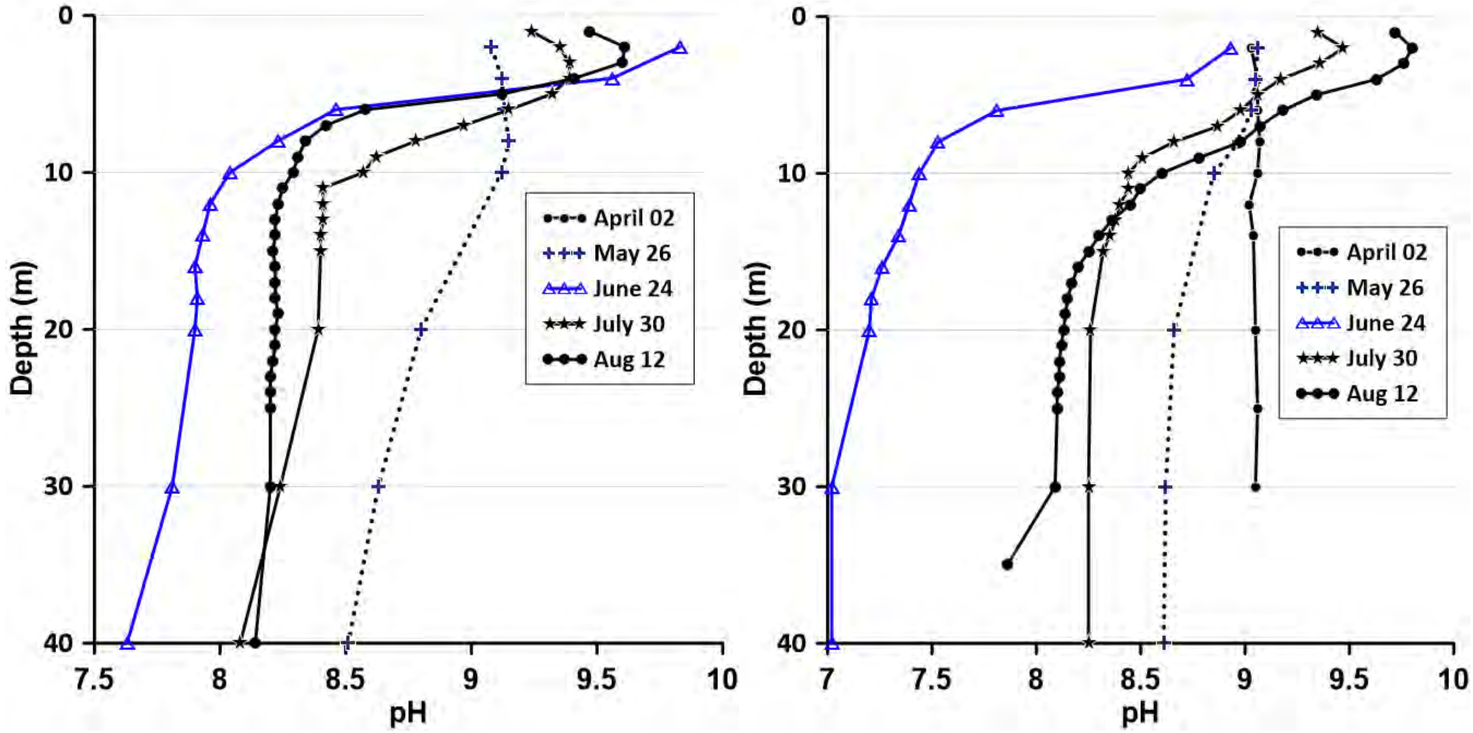


Figure 34. Selected pH profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2015.

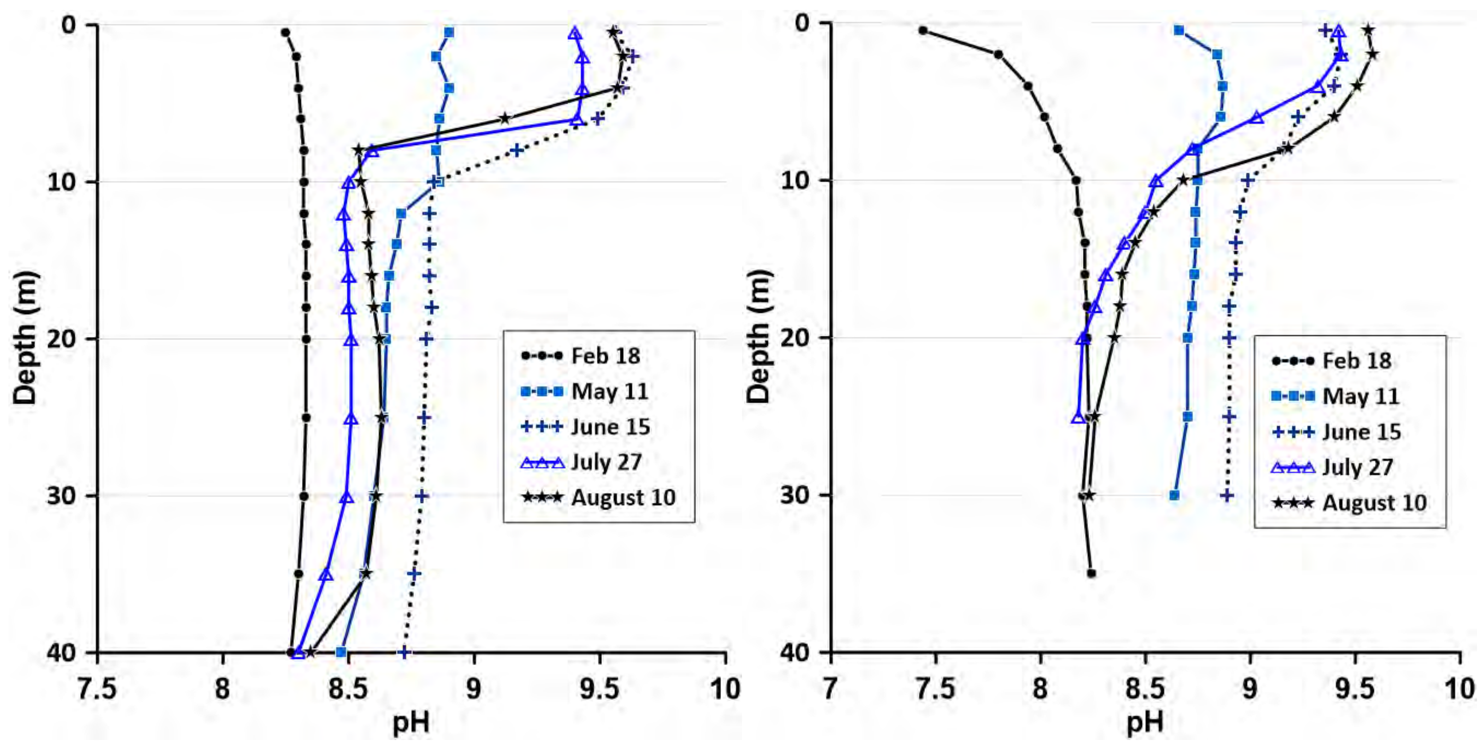


Figure 35. Selected pH profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2016

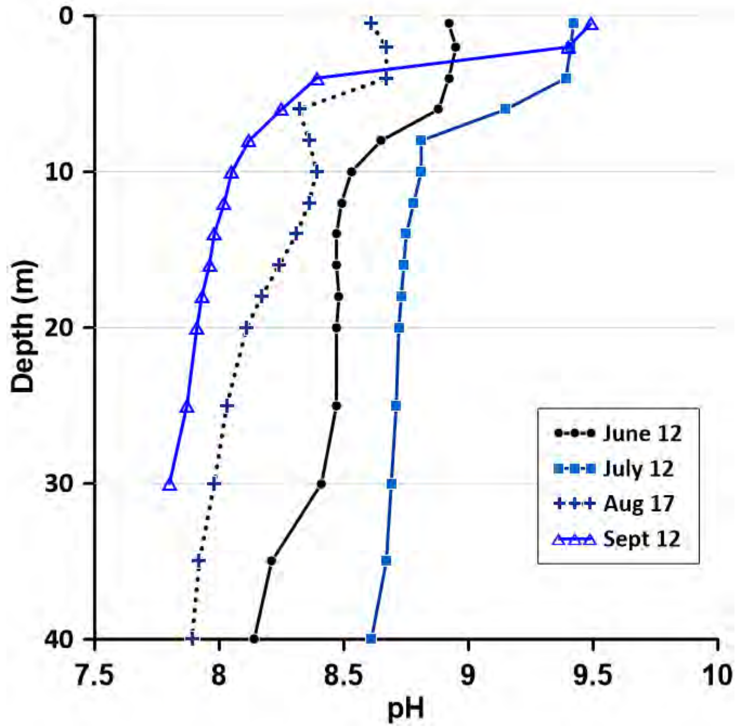


Figure 36. Selected pH profiles in Pelton forebay in 2017.

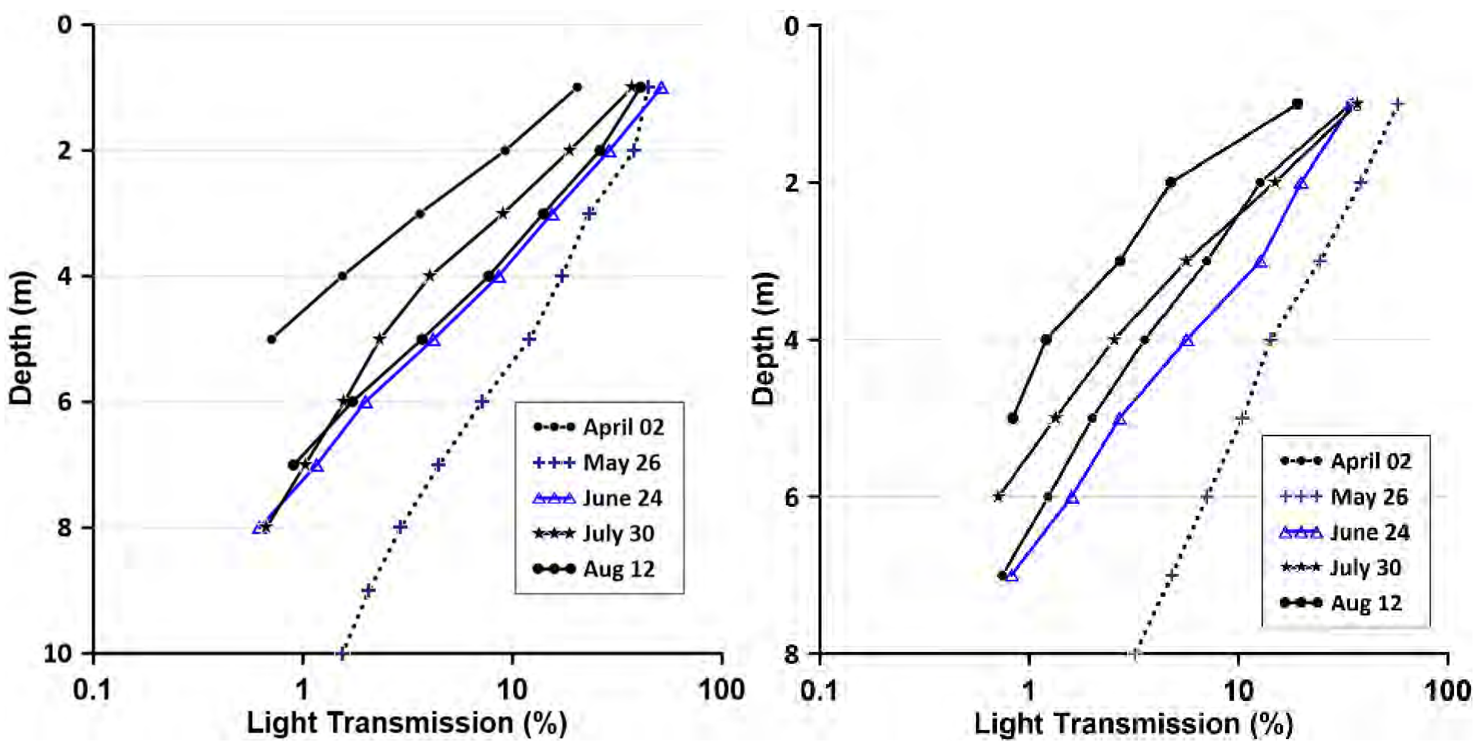


Figure 37. Selected light transmission profiles in the Pelton forebay (left) and the Mid-Lake site (right) in 2015

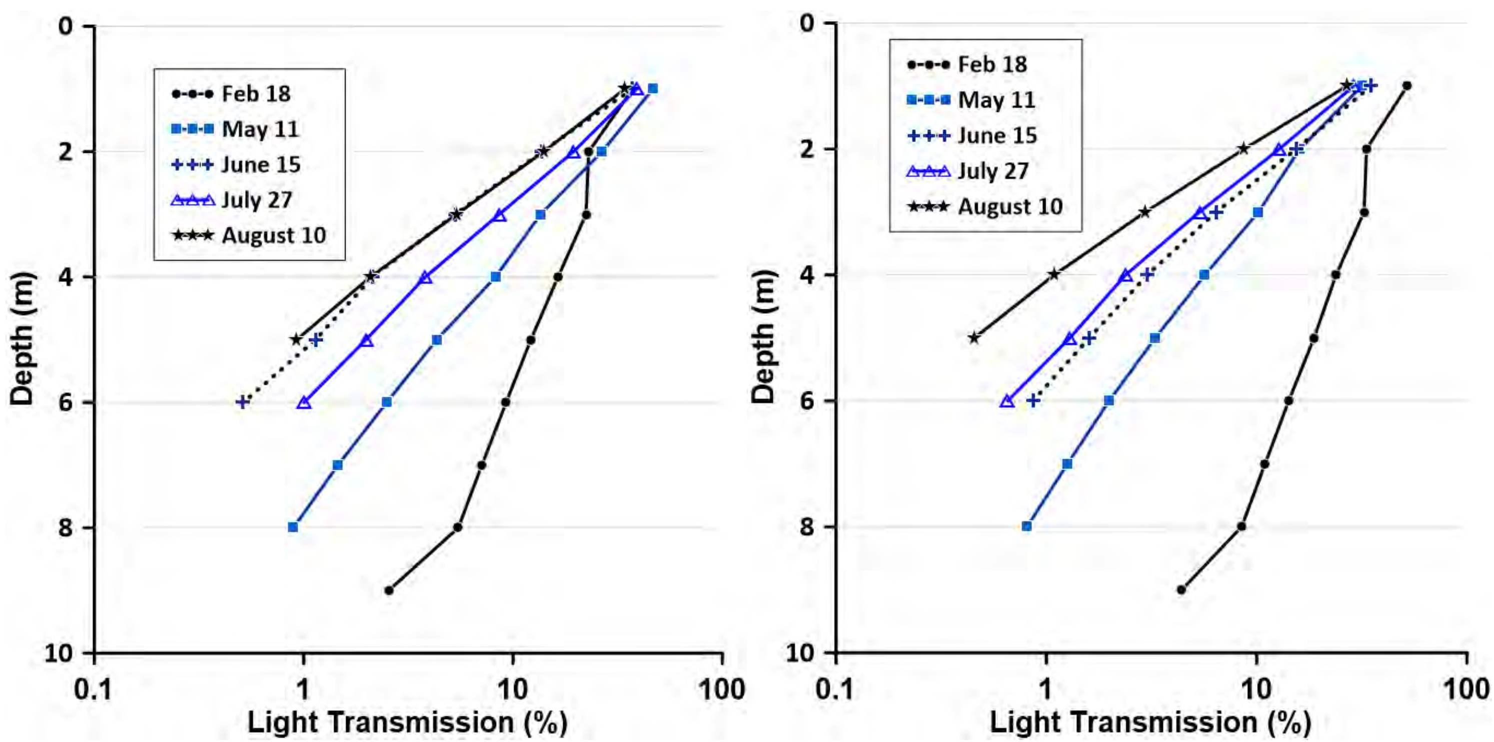


Figure 38. Selected light transmission profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2016.

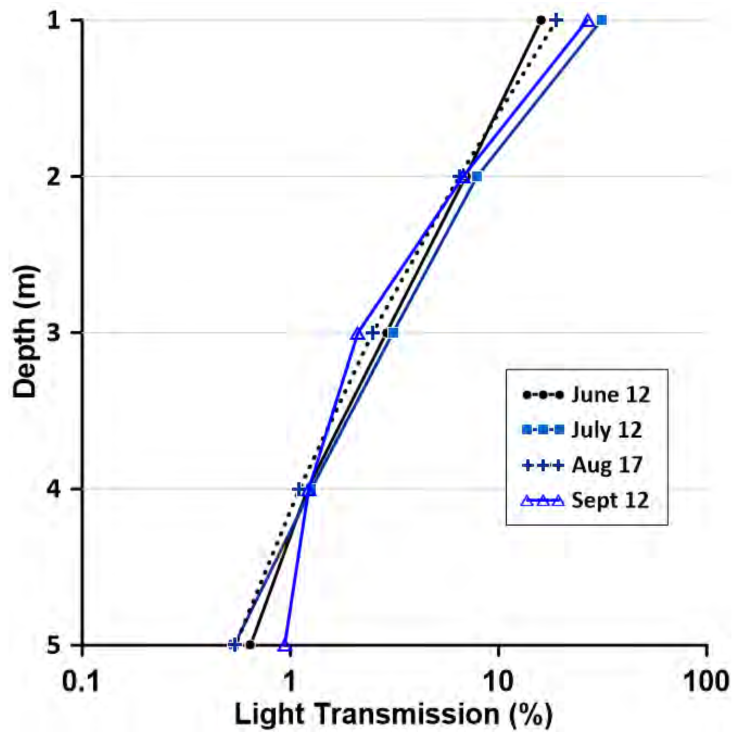


Figure 39. Selected light transmission profiles in Pelton forebay in 2017.

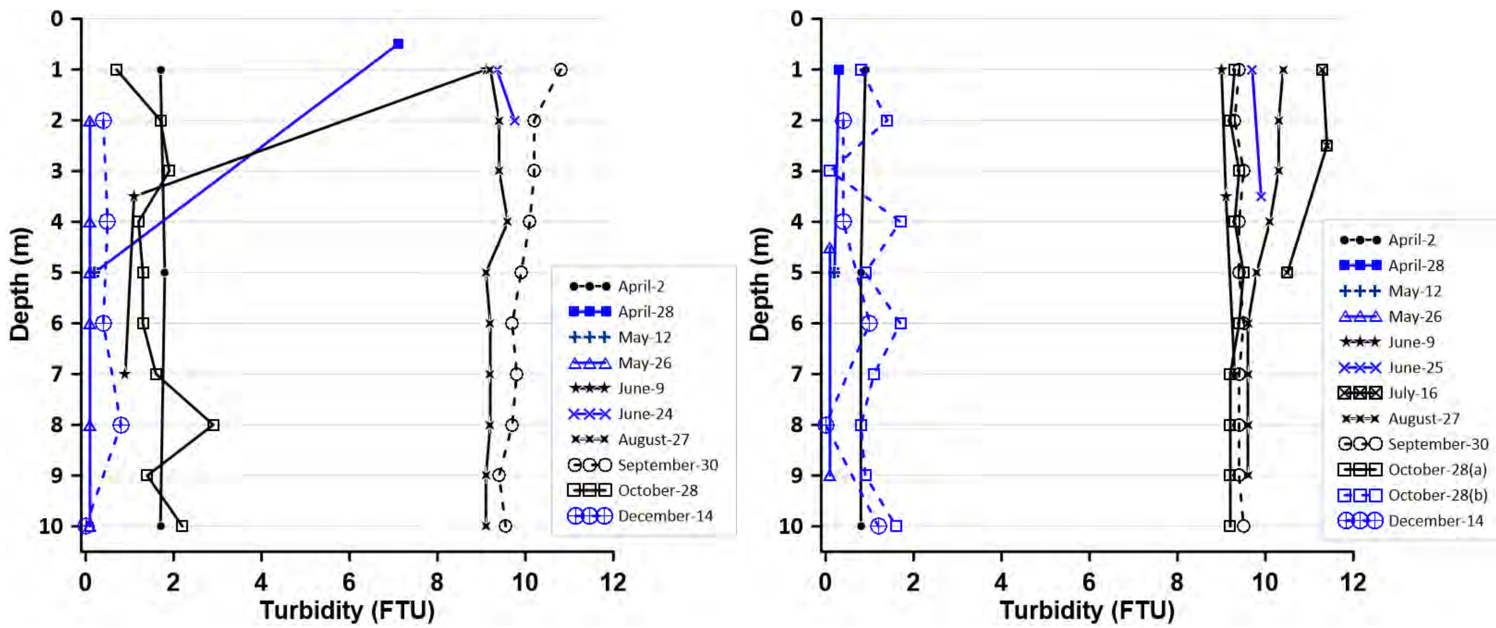


Figure 40. Turbidity profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2015.

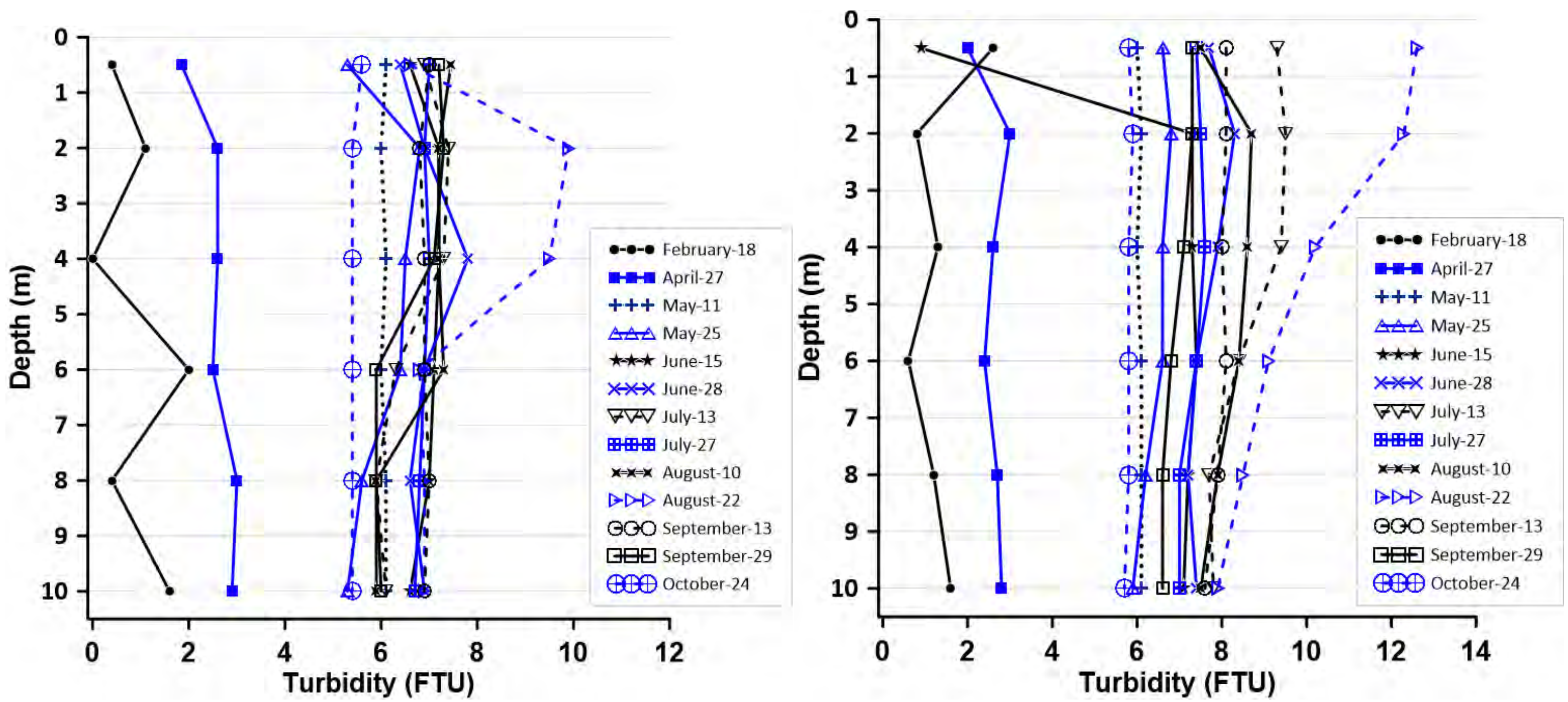


Figure 41. Turbidity profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2016.

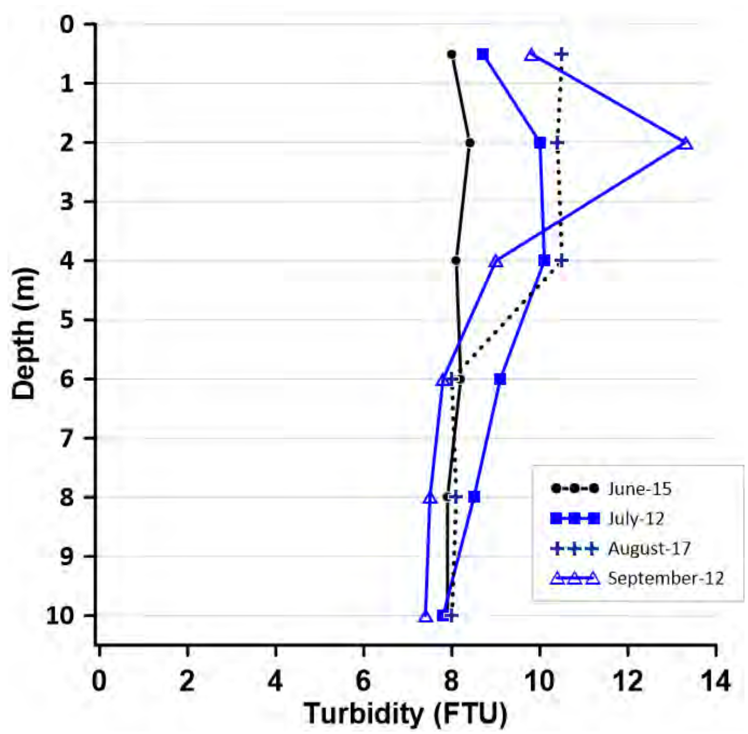


Figure 42. Turbidity profiles in Pelton forebay in 2017.

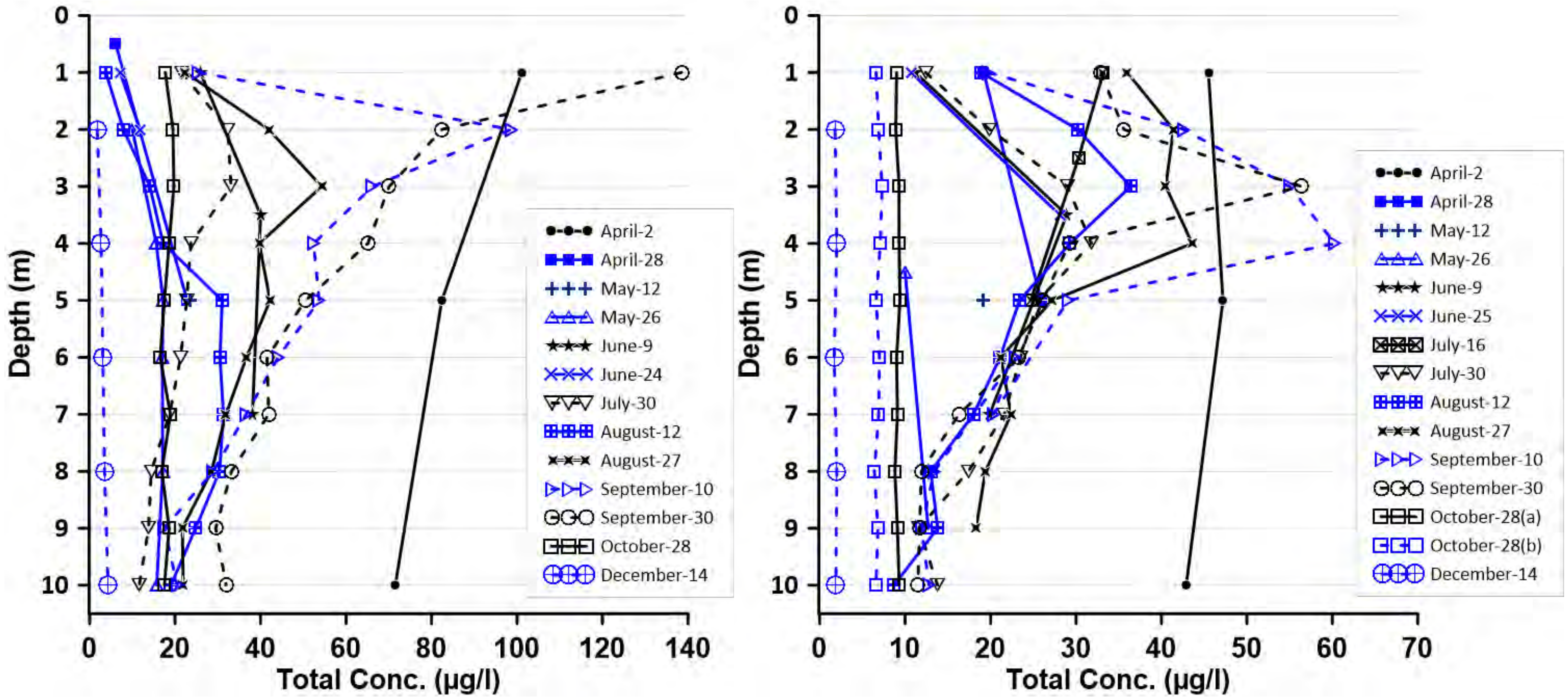


Figure 43. Total chlorophyll profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2015.

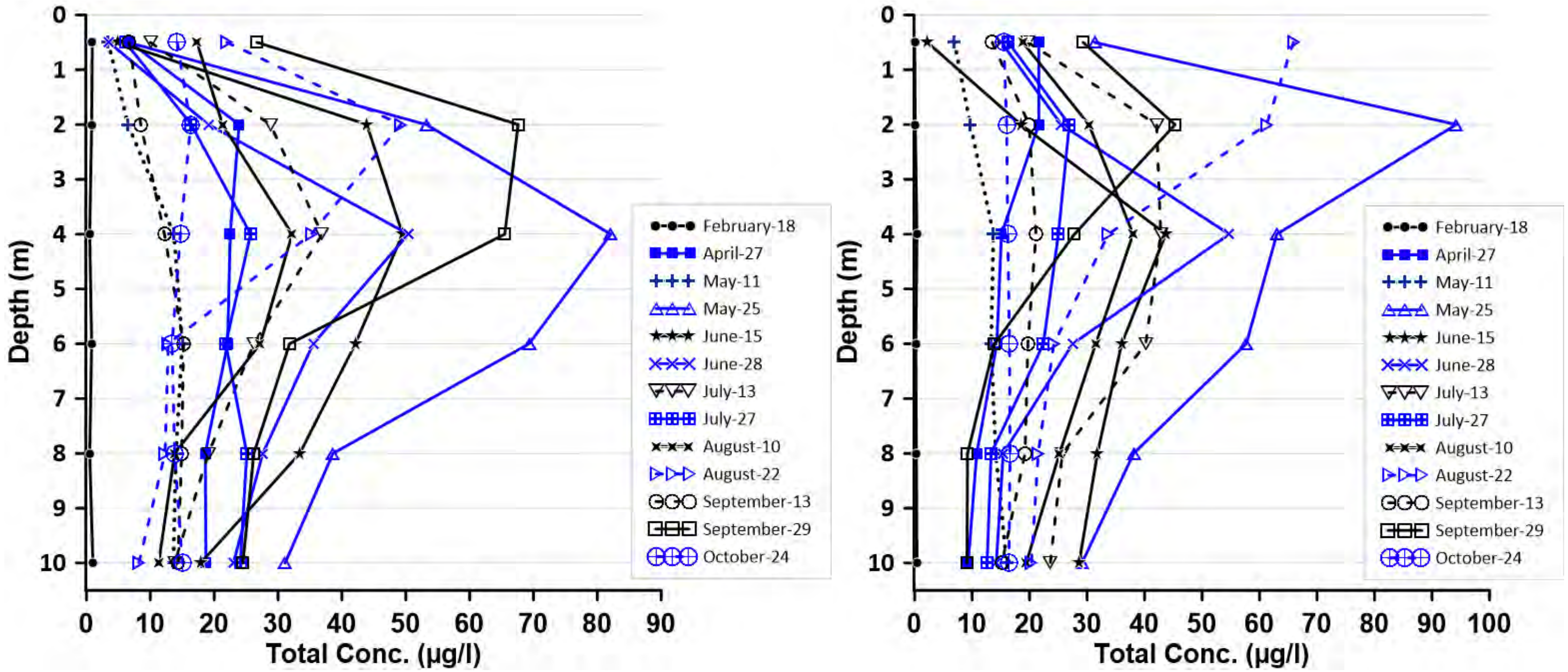


Figure 44. Total chlorophyll profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2016.

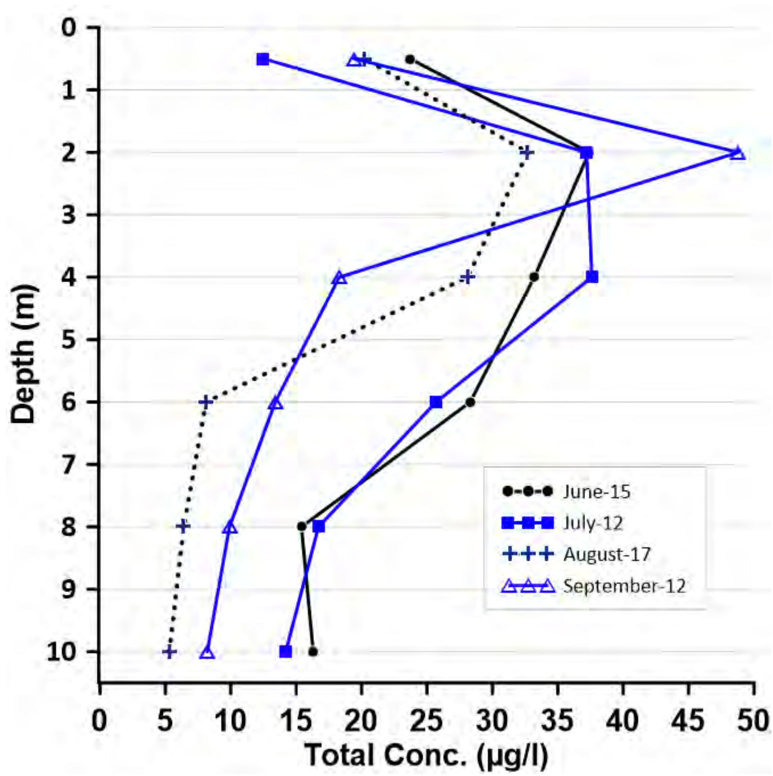


Figure 45. Total chlorophyll profiles in Pelton forebay in 2017.

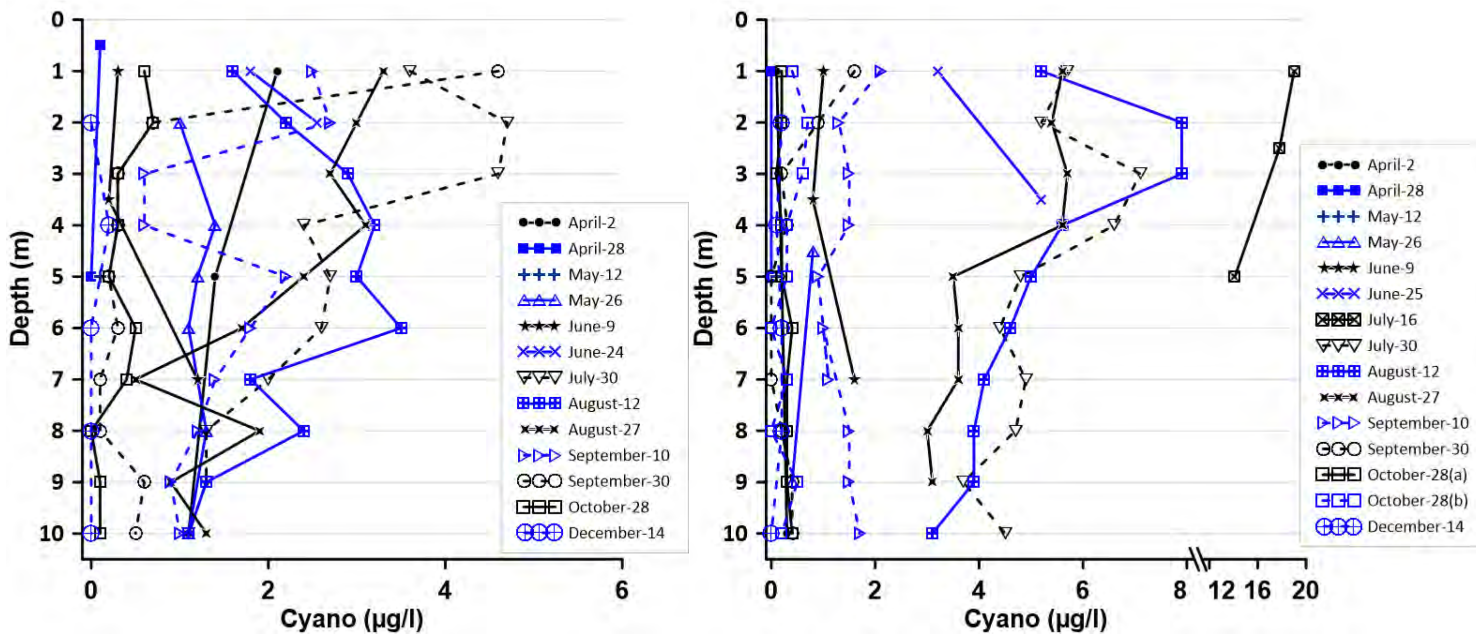


Figure 46. Cyanobacteria pigment profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2015.

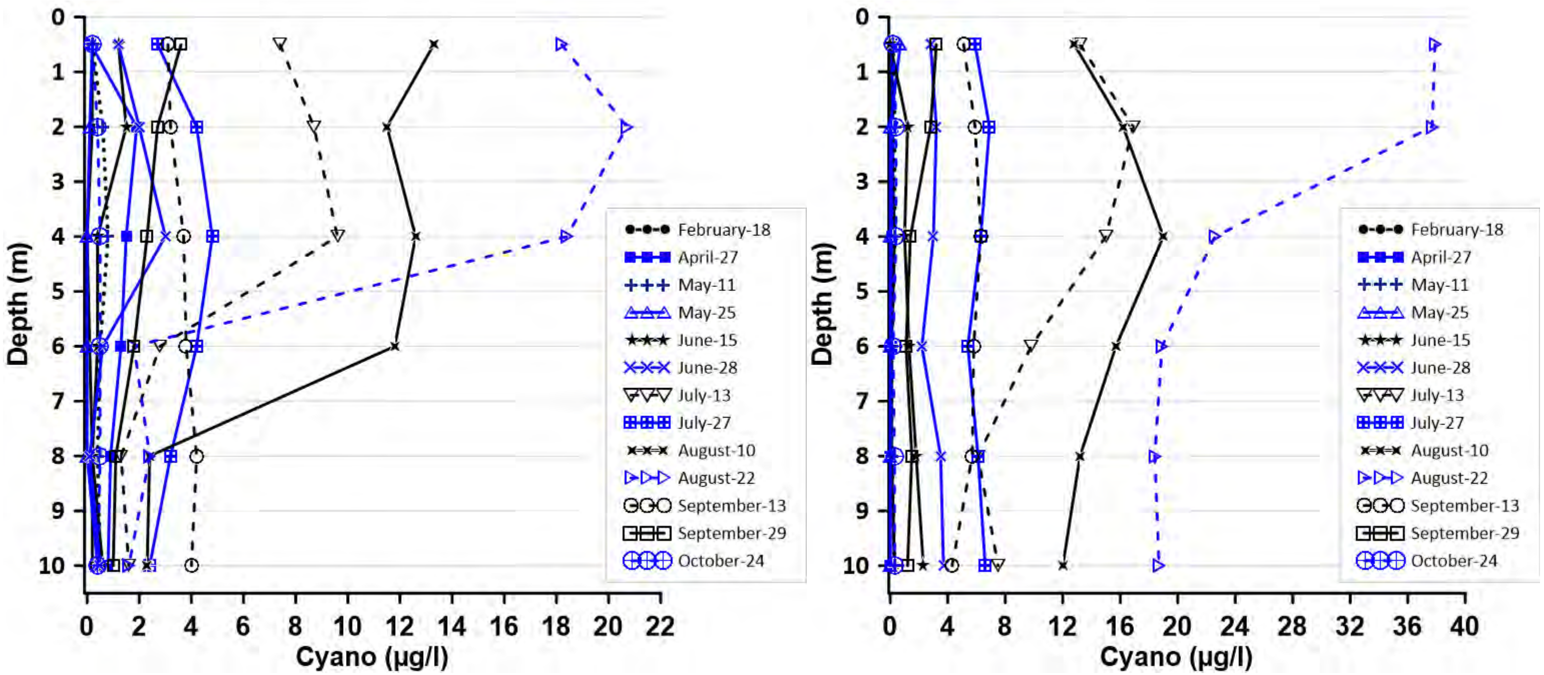


Figure 47. Cyanobacteria pigment profiles in Pelton forebay (left) and the Mid-Lake site (right) in 2016.

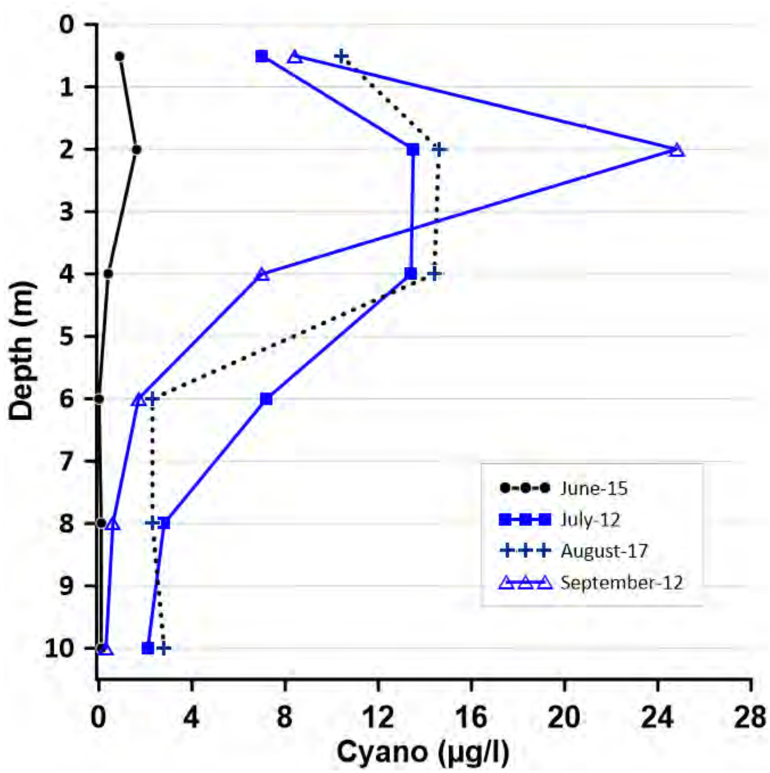


Figure 48. Cyanobacteria pigment profiles in Pelton forebay in 2017.

Appendix E Phytoplankton Community Composition at Reservoir Sampling Sites

Contents

Figures

1 Introduction

The information presented in this appendix provides a more detailed description of the phytoplankton community composition in LBC and Lake Simtustus. In sections 4.2.1.17 and 4.2.2.18 of the Water Quality Study, community composition analysis focused on the top three dominant taxa. The sections below discuss the dominant and minor phyla and genera present in the samples.

2 Lake Bill Chinook Phytoplankton Community Composition

Phytoplankton samples collected at Round Butte forebay (RES07) and the Common Pool (RES08) exhibited similar community composition and average biovolumes. Biovolume was almost always greater in the near-surface samples compared to the deeper samples, although the differences were not as great as might be expected (Figure 1). Although diatoms are more numerous and diverse, they are generally small and therefore do not represent as much biovolume as observed for the Cyanophyta. Pyrrophyta biovolume was intermediate between the two dominant phyla (Cyanophyta and diatoms) and the minor phyla (Chlorophyta and Cryptophyta).

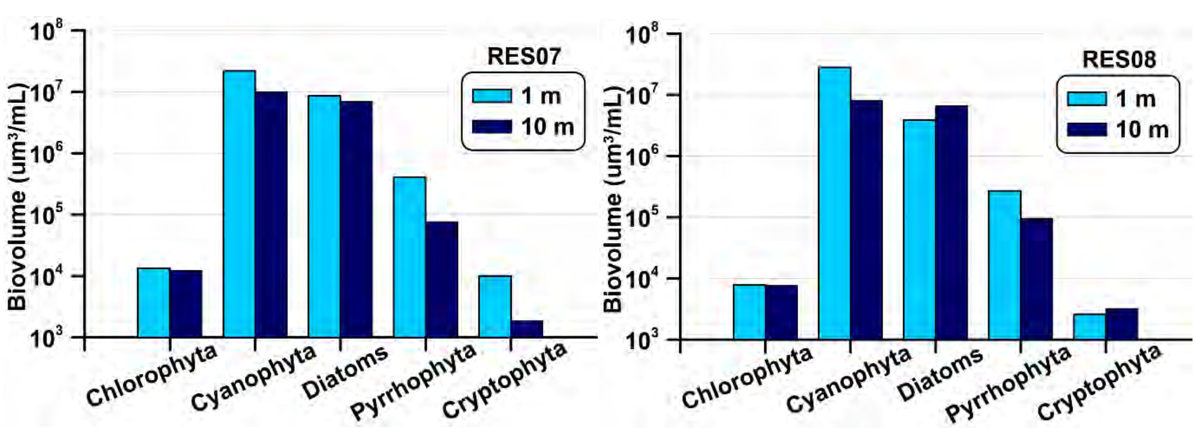


Figure 1. Average abundance of phytoplankton at Round Butte forebay (RES07) *(left)* and the Common Pool (RES08) *(right)* by phyla and depth for 2015-2017.

Temporal patterns in phytoplankton abundance in Round Butte forebay (RES07) show peak biovolumes in December 2015, October 2016, and August 2017 (Figure 2). The peaks in October and December are associated with *Stephanodiscus*, whereas the peak in August is associated with *Dolichospermum*. The February 2016 sample had the lowest biovolume, which increased by over two orders of magnitude in April.

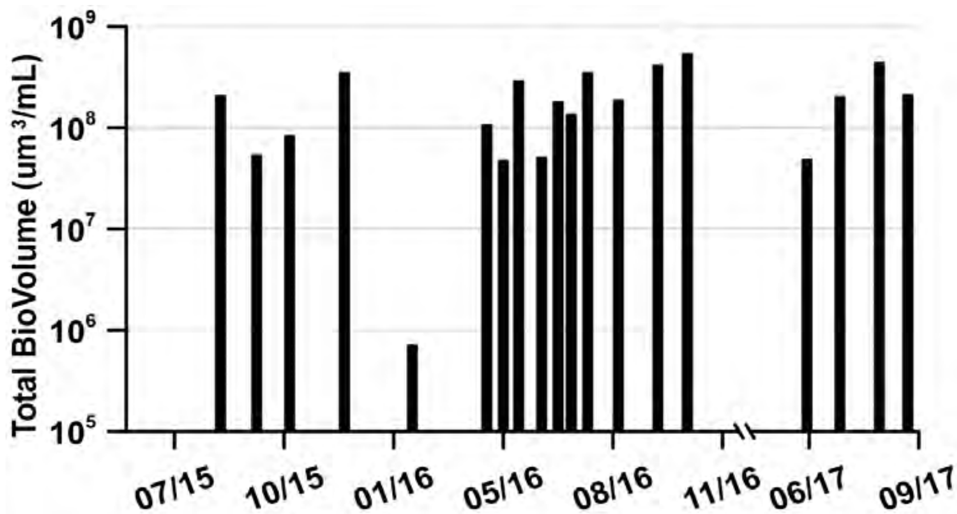


Figure 2. Total biovolume per phytoplankton sample at Round Butte forebay (RES07) at 1-m depth from 2015–2017.

Phytoplankton community composition in LBC shows diatoms dominated from fall to spring and cyanophytes dominated during the summer (Figure 3). However, diatoms remained an important component of the phytoplankton assemblage during summer and rebounded quickly in the fall when the cyanophytes declined. It is unclear if the resurgence of the diatoms in the fall was caused by the reduced competition from the cyanophytes as they declined or was associated with the increased availability of nutrients as the reservoir began to mix. Another phylum that is moderately abundant is the Pyrrophyta; however, they do not appear to exhibit a pronounced repeatable pattern for the monitoring period. The Pyrrophyta were nearly as abundant in the deeper samples as they were in the surface samples.

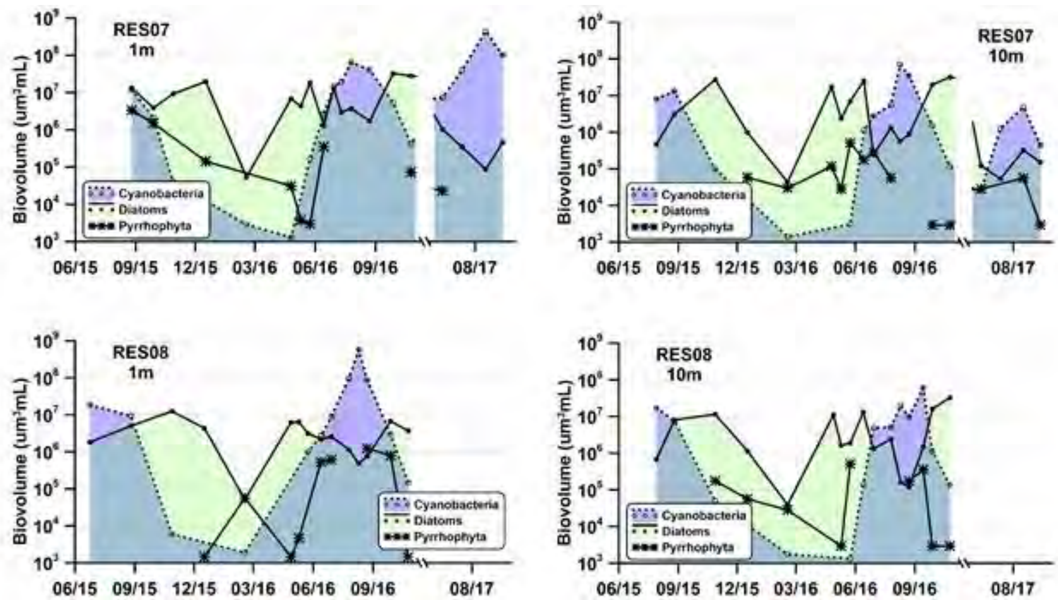


Figure 3. Biovolume of the three major phyla present in LBC at Round Butte forebay (RES07) (*top*) and the Common Pool (RES08) (*bottom*) at 1 m *(left)* and 10 m *(right)*. RES08 was not sampled in 2017.

Examination of the phytoplankton biovolume shows that the diatom *Stephanodiscus* and the cyanophyte *Dolichospermum* were the most abundant genera in LBC (Figure 4). Other diatoms, such as *Fragilaria, Encyonema, Cyclostephanos* and *Ulnaria*, comprised sub-dominant roles in the reservoir. Other taxa of cyanophytes present, but in low abundance, included *Coelomoron, Aphanizomenon, Aphanocapsa* and *Pseudanabaena,* among others. Several taxa of Pyrrophyta (dinoflagellates) were present, the most abundant being *Ceratium hirundinella*. Genera of chlorophytes and cryptophytes were also present, but in low abundance.

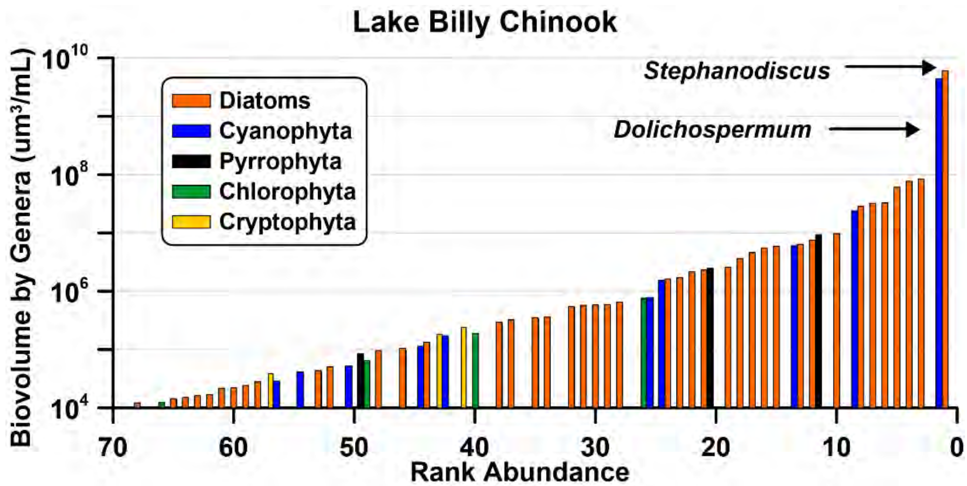


Figure 4. Distribution of phyla for LBC measured in 2015–2017. Genera with biovolume less than 10,000 μm^3/mL are not displayed.

Three of the taxa present in LBC – *Stephanodiscus*, *Dolichospermum*, and *Fragilaria* – are typically associated with eutrophic waters, especially when present in large numbers. These taxa are also associated with the seasonal changes in LBC (Figure 5). The most detailed data from 2016 show *S. niagarae* peaking in May and fall with *Dolichospermum* peaking in summer. *F. crotonensis* exhibited high biovolumes in May through June and relatively low biovolumes in other periods. These genera were moderately diverse; *Stephanodiscus* was represented by six species in LBC, of which *S. niagarae* was the largest species, while *Dolichospermum* was represented by four species that were only displayed as a genus because of taxonomic uncertainty in many of the cyanophytes. *Fragilaria* also had a total of four species in LBC. The pattern for *Dolichospermum* shows a close relationship with surface temperatures in (Figure 6). In 2016, *Dolichospermum* was not observed in the phytoplankton samples until the end of May when near-surface temperatures reached about 15.5°C; the population peaked in late July, coincident with a peak in reservoir surface temperatures. Once surface temperatures started to decline, *Dolichospermum* abundance declined concomitantly. No other major taxa showed a similar strong relationship with reservoir water temperature.

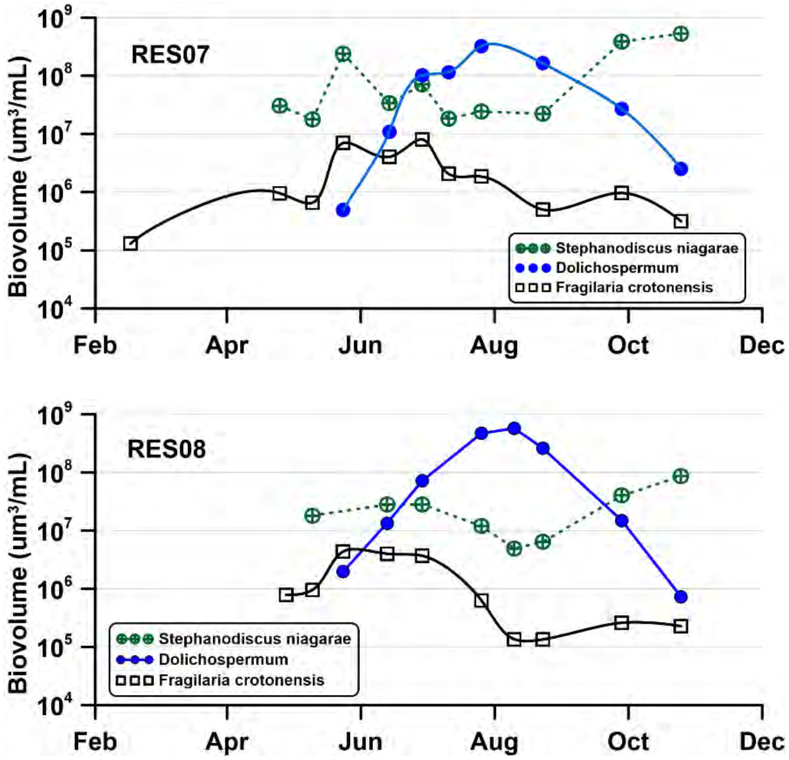


Figure 5. Biovolumes of the three dominant taxa at 1 m depth in Round Butte forebay (RES07) (*top*) and the Common Pool (RES08) (*bottom*) in LBC.

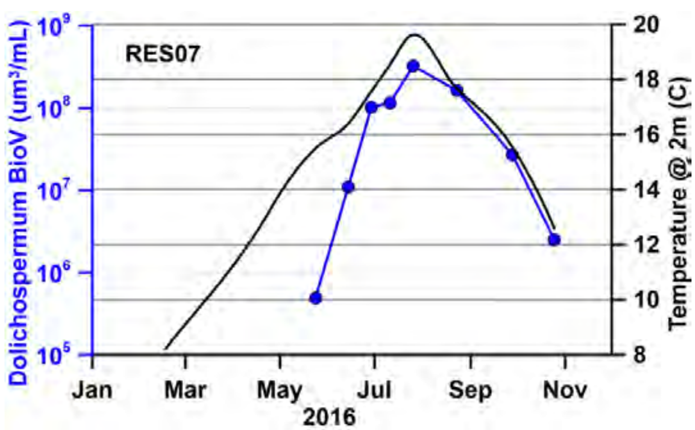


Figure 6. Biovolume of *Dolichospermum* compared to near-surface temperatures at Round Butte forebay (RES07) in LBC in 2016.

3 Lake Simtustus Phytoplankton Community Composition

Phytoplankton samples collected in the Pelton forebay (RES04) and Mid-Lake (RES25) in 2015 and 2016 displayed similar patterns in abundance of phyla. These were also similar to patterns observed for LBC. While phytoplankton community composition did not differ greatly between the two sampling sites in Lake Simtustus, biovolume was almost always greater in the near-surface samples with the exception of the diatoms, which had similar biovolumes in both surface samples and samples at depth (Figure 7). Although diatoms were more numerous and diverse than the other phyla, they were generally small, and therefore, did not represent as substantial a biovolume as observed for the Cyanophyta. The exception is *S. niagarae,* an extremely large diatom with a biovolume exceeding 3.1 x 10^4 μm^3/cell compared to an average biovolume of 1.3 x 10^3 μm^3/cell for all other diatoms in Lake Simtustus. The total biovolume of Pyrrophyta (dinoflagellates) was intermediate between the two dominant phyla and the minor phyla, Chlorophyta and Cryptophyta. The two dominant species of Pyrrophyta in the reservoir, *Ceratium hirundinella* and *Gymnodinium fuscum* were also extremely large-celled taxa (8.8 x 10^4 and 5.6 x 10^4 µm3/ cell, respectively).

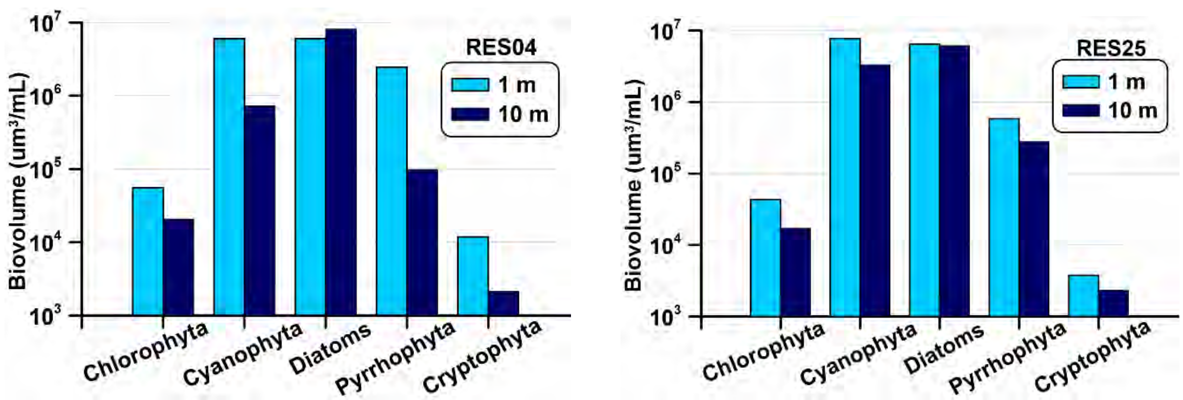


Figure 7. Average biovolume of phytoplankton in LBC by phyla and depth for Pelton forebay (RES04) *(left)* and Mid-Lake site (RES25) *(right)* for 2015-2017.

Temporal patterns in phytoplankton abundance show peaks in October 2015, October 2016, and August 2017 at Pelton forebay (RES04) (Figure 8). The biovolume peaks in October 2015 and 2016 are associated with *Stephanodiscus (diatom)*, while the peak in August 2017 is attributed to abundance of *Dolichospermum (cyanophyta)*. The sample with the lowest abundance at Pelton forebay (RES04) occurred in July 2017 when the dominant taxa were *S. niagarae, Dolichospermum* and *F. crotonensis*.

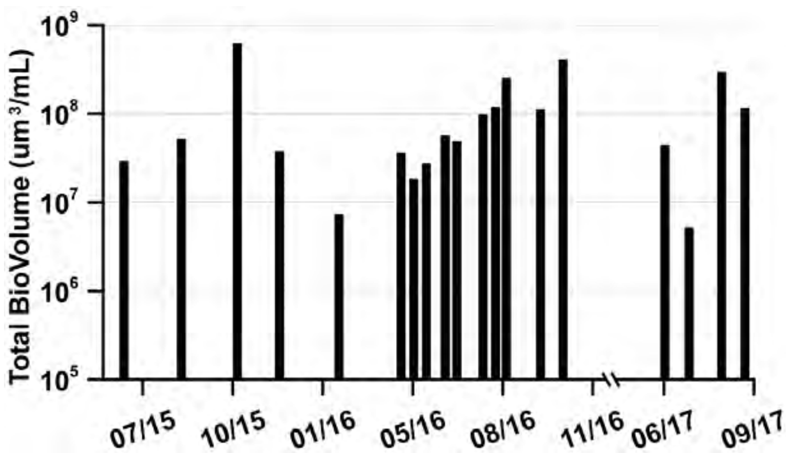


Figure 8. Total biovolume per phytoplankton sample for Pelton forebay (RES04) at 1-m depth from 2015–2017.

The community composition of phytoplankton in Lake Simtustus shows that diatoms dominated from fall to spring and cyanophytes briefly dominated in the summer (Figure 9). The duration of dominance of cyanophytes was considerably greater at the Mid-Lake site (RES25) compared to the Pelton forebay site (RES04). One possible explanation for this difference might be associated with the input of elevated concentrations of NO_3 (approximately 4 mg/L) entering Lake Simtustus from Willow Creek on the eastern shore about 1.7 miles upstream from Pelton Dam. The inflow from Willow Creek would be expected to move towards the forebay because of the Coriolis effect whereby a mass moving in a rotating system tends to deflect objects to the right in the northern hemisphere. The influx of elevated NO_3 can suppress heterocystous cyanophytes and favor growth of non-heterocystous taxa.

The diatoms are an important component of the phytoplankton assemblage during summer and rebound quickly in the fall when the cyanophytes decline. It is unclear if the resurgence of the diatoms in the fall is caused by the reduced competition from the cyanophytes as they decline or whether the increase in diatoms is associated with the increased availability of nutrients as the lake begins to mix. Another phylum that is moderately abundant is the Pyrrophyta (dinoflagellates), which do not appear to exhibit a pronounced repeatable pattern for the monitoring period. The Pyrrophyta are nearly as abundant in the deeper samples as they are in the surface samples.

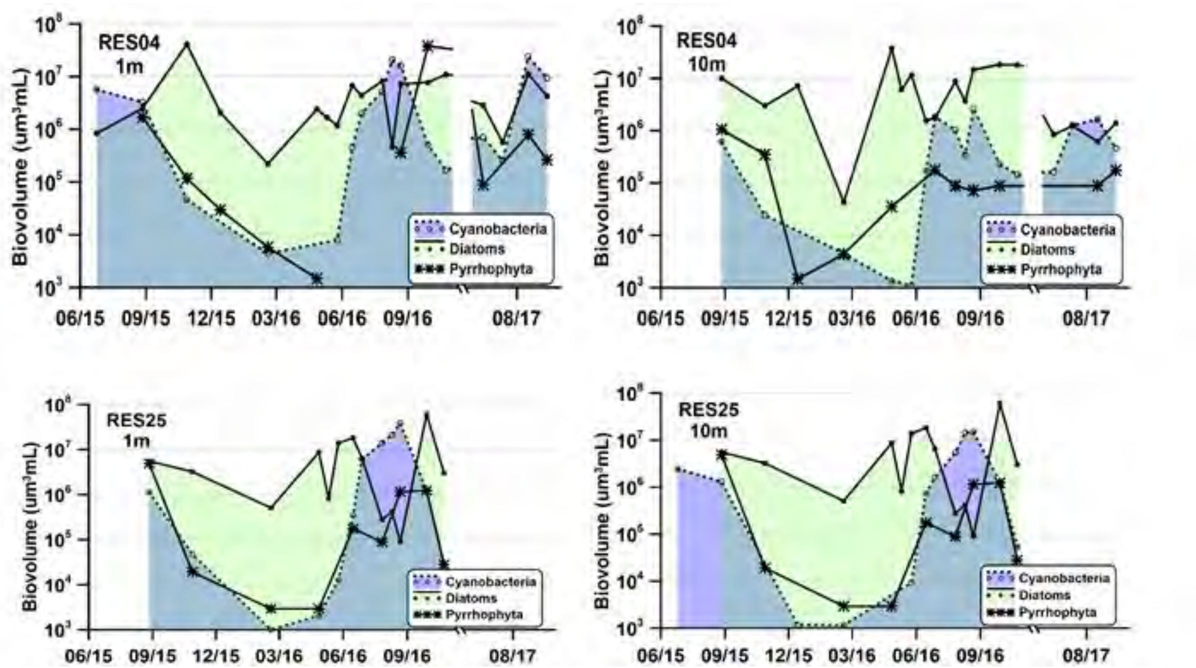


Figure 9. Biovolume of the three major phyla present in Lake Simtustus for samples from 1 m *(left)* and 10 m *(right)* at Pelton forebay (RES04) *(top)* and Mid-Lake site (RES25) *(bottom)*.

The same three phytoplankton genera dominant in LBC – *Stephanodiscus, Dolichospermum* and *Fragilaria* – stand out as the most abundant genera in Lake Simtustus (Figure 10 and Figure 11). All three taxa are typically associated with eutrophic waters, especially when present in large numbers. The most detailed data from 2016 show *S. niagarae* peaking in October with the *Dolichospermum* peaking in summer. *F. crotonensis* biovolume peaked in June, but abundance oscillated in other seasons. Also, these genera were moderately diverse. *Stephanodiscus* was represented by seven species in Lake Simtustus, of which *S. niagarae* was by far the largest species. Five species of *Dolichospermum* were present but only identified as a genus here because of taxonomic uncertainty with many of the cyanophytes. *Fragilaria* had a total of three species of which *F. crotonensis* was the most numerous. Other taxa, such as the dinoflagellate *Ceratium hirundinella*, and diatoms such as *Cyclostephanos, Ulnaria*, and *Encyonema,* had low biovolumes in Lake Simtustus. One exception was a measured biovolume of 3.78 um^3/mL for *Ceratium hirundinella* on September 29, 2016. Other cyanophytes present included *Coelomoron, Aphanizomenon, and Aphanocapsa* among others, but all in low abundance. Genera of chlorophytes and cryptophytes were present but also in low abundance.

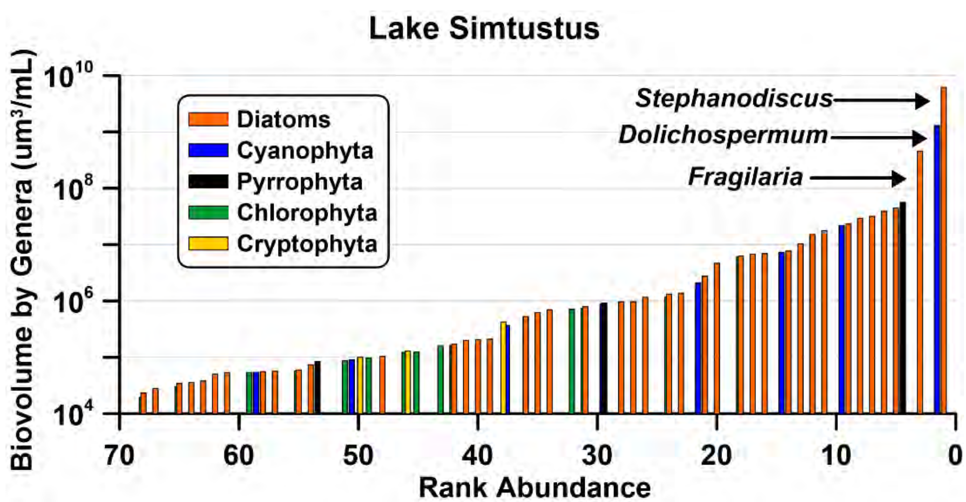
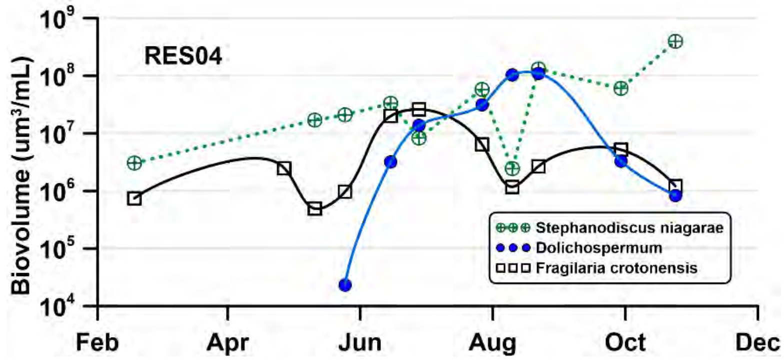


Figure 10. Distribution of genera classified by phyla for Lake Simtustus measured in 2015–2017. Genera with biovolume less than 10,000 µm^3/mL are not displayed.



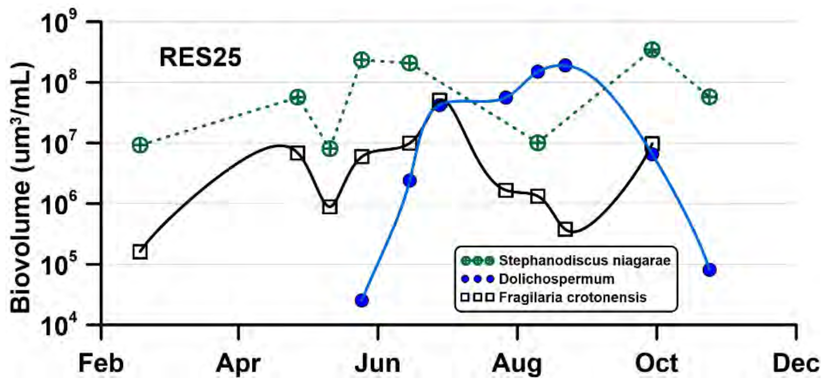


Figure 11. Biovolumes of the three dominant taxa in Lake Simtustus in 2016 at Pelton forebay (RES04) Mid-Lake site (RES25) at 1-m depth.

Similar to LBC, the pattern for *Dolichospermum* shows a close relationship with surface temperatures in Lake Simtustus (Figure 12). *Dolichospermum* was not observed in the phytoplankton samples at Pelton forebay (RES04) until May 25, 2016 when near-surface temperatures reached about 16°C. *Dolichospermum* appeared to peak in August, shortly after the peak in surface temperature. Again, *Dolichospermum* abundance declined as surface temperatures decreased.

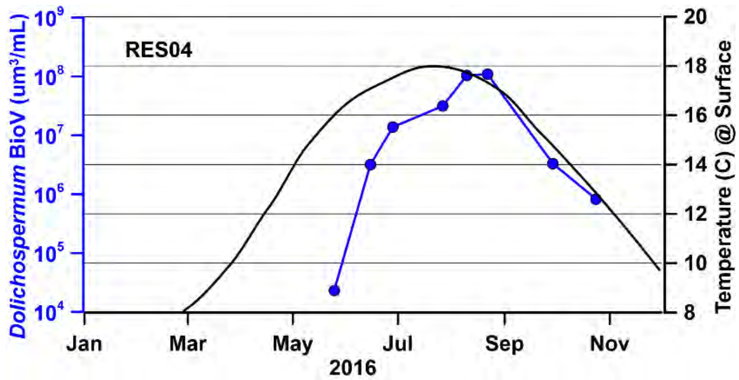


Figure 12. Biovolume of *Dolichospermum* versus near-surface temperatures at Pelton forebay (RES04) for 2016. The temperature curve is a LOESS fit of the thermistor data.

Appendix F   CE-QUAL-W2 Modeling Parameters

Table 1. Hydraulic coefficients used in the W2 modeling.

	Variable name	Default Values	WB #1
Hor. Eddy Viscosity [m2/s]	[AX]	1.0	1
Hor. Eddy Diffusivity [m2/s]	[DX]	1.0	1
Sediment Heat Ex. Coeff. [W/m2/s]	[CBHE]	0.3	0.3
Sediment Temperature [C]	[TSED]	10.0	13.1
Interfacial Friction [-]	[FI]	0.015	0
Fraction Solar at Sed. to Water [-]	[TSEDF]	1.0	1
Vertical Eddy Viscosity	[AZC]	W2	W2N
Max. Vertical Eddy Visc. [m2/s]	[AZMAX]	1.0	0.001
Vertical Transport Hor. Momentum	[AZSLC]	IMP	IMP
For TKE1: BC choice =1[Celik88],2[Rodi83],or 3[W2]	[FBC]	3	3
For TKE1: Rougness coefficient [-]	[E]	9.535	9.535
For TKE1: Coefficient used if FBC=1[0.431] or 2[0.07]	[ARODI]	0.431	0.43
For TKE1: Surface roughness and Manning's coefficient	[STRCKLR]	24.0	24
For TKE1: Boundary production coefficient	[BOUNDFR]	10.0	10
For TKE1: Calculation procedure for vertical transport	[TKECAL]	IMP	IMP
Friction Type	[FRICC]	MANN	MANN
Wind roughness height [m]	[Z0]	0.001	0.001

Table 2. Algal coefficients used in the W2 modeling.

# of Algae Groups	[NAL]	2	
		Algae #1	Algae #2
Algal growth rate, 1/day	[AG]	1	1
Algal dark respiration rate, 1/day	[AR]	0.02	0.01
Algal excretion rate, 1/day	[AE]	0.04	0.04
Algal mortality rate, 1/day	[AM]	0.1	0.05
Algal settling rate, 1/day	[AS]	0.1	0.15
Algal half-saturation P	[AHSP]	0.006	0.003
Algal half-saturation N	[AHSN]	0	0.014
Algal half-saturation SI	[AHSSI]	0	0
Algal Light Saturation, W/m^2	[ASAT]	100	100
Temperature Rates			
Lower temperature for algal growth	[AT1]	18	5
Lower temperature for max. algal growth	[AT2]	20	8
Upper temperature for max. algal growth	[AT3]	25	25
Upper temperature for algal growth	[AT4]	30	30
Fraction of algal growth rate at AT1	[AK1]	0.01	0.01
Fraction of max. algal growth rate at AT2	[AK2]	0.9	0.9
Fraction of max. algal growth rate at AT3	[AK3]	0.99	0.99
Fraction of algal growth rate at AT4	[AK4]	0.1	0.1
Stoichiometry			
Fraction P	[ALGP]	0.005	0.005
Fraction N	[ALGN]	0.08	0.08
Fraction C	[ALGC]	0.45	0.45
Fraction Si	[ALGSI]	0	0
Chlorophyll-algae ratio	[ACHLA]	100	100
Frac. algae lost by mortality to POM	[ALPOM]	0.8	0.8
Ammonia Preference Factor Equation 1 or 2	[ANEQN]	1	1
Ammonia Half Saturation Coefficient for Ammonia-Nitrate	[ANPR]	0.001	0.001
Oxygen equivalent for organic matter for algae growth	[O2AR]	1.1	1.1
Oxygen equivalent for organic matter for algae respiration	[O2AG]	1.4	1.4

Table 3. Zooplankton coefficients used in W2 the modeling.

# of Zooplankton Groups	[NZP]	1
		Zoop#1
Zooplankton growth rate, 1/day	[ZG]	0.5
Zooplankton respiration rate, 1/day	[ZR]	0.1
Zooplankton mortality rate, 1/day	[ZM]	0.01
Zooplankton assimilation efficiency [-]	[ZEFF]	0.5
Zooplankton preference factor for detritus(POM) [-]	[PREFP]	0.5
Zooplankton threshold food concentration at which feeding begins, g/	[ZOOMIN]	0.01
Zooplankton half-saturation constant for food concentration, g/m3	[ZS2P]	0.03
Temperature Rates		
Lower temperature for zooplankton growth	[ZT1]	0
Lower temperature for max. zooplankton growth	[ZT2]	15
Upper temperature for max. zooplankton growth	[ZT3]	20
Upper temperature for zooplankton growth	[ZT4]	36
Fraction of zooplankton growth rate at ZT1	[ZK1]	0.01
Fraction of max. zooplankton growth rate at ZT2	[ZK2]	0.99
Fraction of max. zooplankton growth rate at ZT3	[ZK3]	0.99
Fraction of zooplankton growth rate at ZT4	[ZK4]	0.1
Stoichiometry		
Fraction P	[ZP]	0.015
Fraction N	[ZN]	0.08
Fraction C	[ZC]	0.45
Oxygen equivalent of organic matter for zooplankton respiration	[O2ZR]	1.1
Preference factor for Algae		
Algae #1	[PREFA]	0
Algae #2	[PREFA]	0.5
Preference factor for Zooplankton		
Zooplankton #1	[PREFZ]	0.5

Table 4. Organic rates and coefficients used in the W2 modeling.

Dissolved Organic Matter		WB #1
Labile DOM decay rate, 1/day	[LDOMDK]	0.1
Labile to refractory decay rate, 1/day	[RDOMDK]	0.001
Maximum refractory decay rate, 1/day	[LRDDK]	0.01
Particulate Organic Matter		
Labile POM decay rate, 1/day	[LPOMDK]	0.08
Labile to refractory decay rate, 1/day	[RPOMDK]	0.001
Maximum refractory decay rate, 1/day	[LRPDK]	0.01
Settling rate, m/day	[POMS]	1
Organic Matter Stoichiometry		
Fraction P	[ORGP]	0.005
Fraction N	[ORGN]	0.08
Fraction C	[ORGC]	0.45
Fraction Si	[ORGSI]	0.18
Organic Rate Multiplier		
Lower Temperature for OM decay	[OMT1]	4
Upper Temperature for OM decay	[OMT2]	25
Fraction of OM decay rate at OMT1	[OMK1]	0.1
Fraction of OM decay rate at OMT2	[OMK2]	0.99

Table 5. Nutrient coefficients used in the W2 modeling.

Phosphorus		WB #1
Sediment Release rate	[PO4R]	0.001
Partitioning coef. for suspended solids	[PARTP]	0
Ammonium		
Sediment release rate	[NH4R]	0.001
Ammonium decay rate, 1/day	[NH4DK]	0.12
Ammonium rate multipliers		
Lower temperature for ammonium decay	[NH4T1]	5
Upper temperature for ammonium decay	[NH4T2]	25
Frac. of nitrification rate at NH4T1	[NH4K1]	0.1
Frac. of nitrification rate at NH4T2	[NH4K2]	0.99
Nitrate		
Nitrate decay rate	[NO3DK]	0.03
Nitrate sediment diffusion rate	[NO3S]	0.002
Frac NO3 diffused converted to SedORGN	[FNO3SED]	0
Nitrate rate multipliers		
Lower temperature for nitrate decay	[NO3T1]	5
Upper temperature for nitrate decay	[NO3T2]	25
Frac. of denitrification rate at NO3T1	[NO3K1]	0.1
Frac. of denitrification rate at NO3T2	[NO3K2]	0.99
Silica		
Dissolved silica release rate (frac. of SOD)	[DSIR]	0.1
Particulate silica settling velocity, m/day	[PSIS]	0
Particulate silica decay, 1/day	[PSIDK]	0.3
Silica partitioning coefficient	[PARTSI]	3

Table 6. Reaeration coefficients and iron coefficients used in the W2 modeling.

O2 Limits	[O2LIM]	3
IRON		WB #1
Iron sediment release rate	[FER]	0.5
Iron setting velocity, m/day	[FES]	3
Sediment CO2 Release		
Sediment CO2 release rate	[CO2R]	1.2
Stoichiometry		
O2 stoich. equiv. for ammonium decay	[O2NH4]	4.57
O2 stoich. equiv. for organic matter dec	[O2OM]	1.4
Reaeration		
Type	[Type]	LAKE
EQN#	[EQN#]	10
COEF1	[COEF1]	0
COEF2	[COEF2]	0.01
COEF3	[COEF3]	3
COEF4	[COEF4]	0

Table 7. BOD coefficients used in the W2 modeling.

# of CBOD Groups	[NBOD]	1
		BOD #1
CBOD5 decay rate at 20 deg C, 1/day	[KBOD]	0.0456
Temperature coefficient	[TBOD]	1.0147
Ratio of BOD5 to Ultimate BOD	[RBOD]	1
CBOD Settling rate, m/day	[CBODS]	0
Stoichiometry: Ratio of P to CBOD	[BODP]	0.02
Stoichiometry: Ratio of N to CBOD	[BODN]	0.08
Stoichiometry: Ratio of C to CBOD	[BODC]	0.45

Table 8. Light extinction coefficients used in the W2 modeling.

		WB #1
Water	[EXH2O]	0.25
Inorganic Suspended Solids	[EXSS]	0.05
Organic Suspended Solids	[EXOM]	0.05
Frac. of Solar Rad Absorbed at Water Surfa	[BETA]	0.45
Read Dynamic Light Extinction File?	[EXC]	OFF
Interpolate Dynamic Light Extinction File?	[EXIC]	OFF
Algae #1	[EXA1]	0.05
Algae #2	[EXA2]	0.05
Zooplankton #1	[EXZ1]	0.05

Appendix G CE-QUAL-W2 Grids

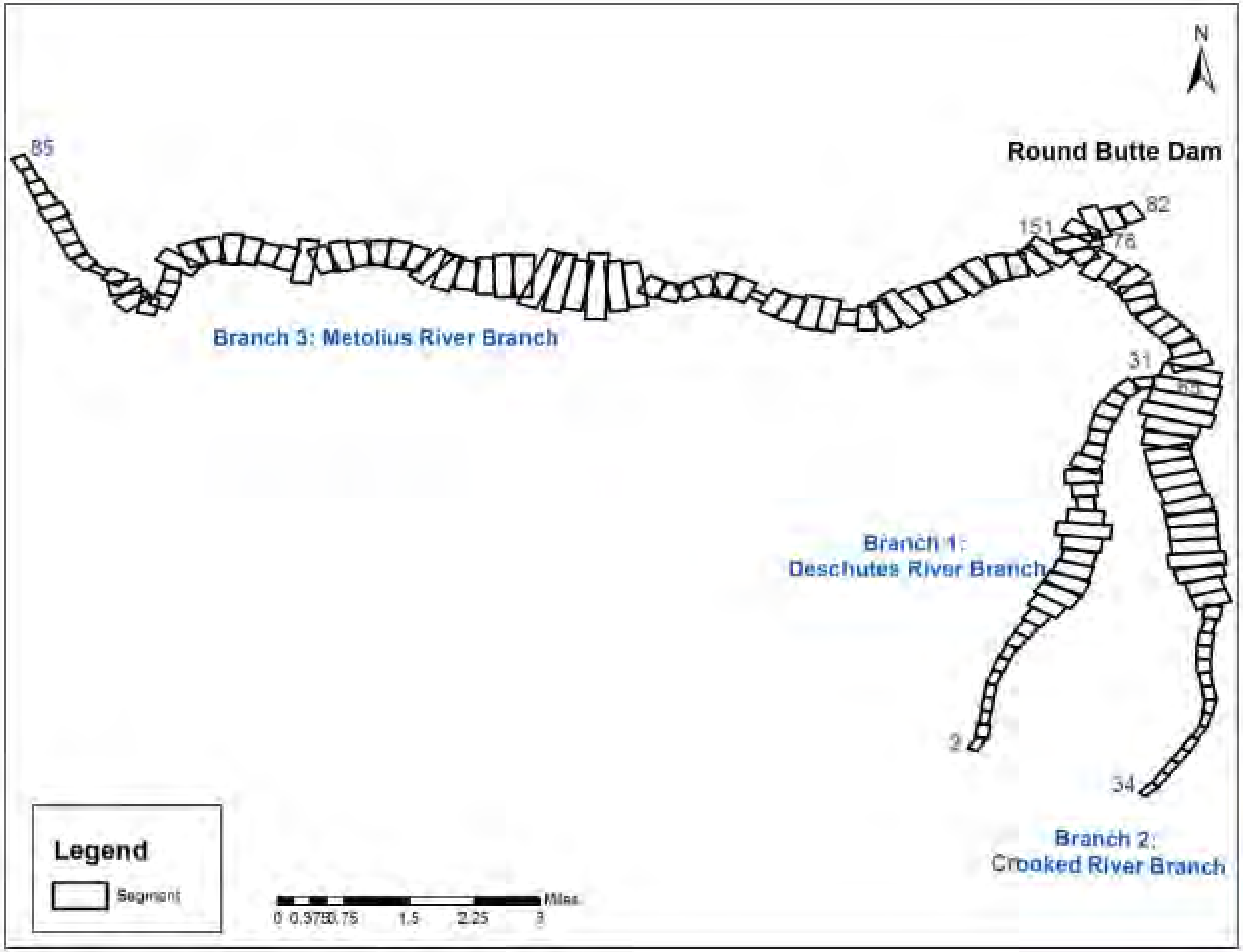


Figure 1. Plan view of Lake Billy Chinook CE-QUAL-W2 Grid. From the original Pelton Round Butte CE-QUAL-W2 report (Xu and Khangaonkar, 2015).

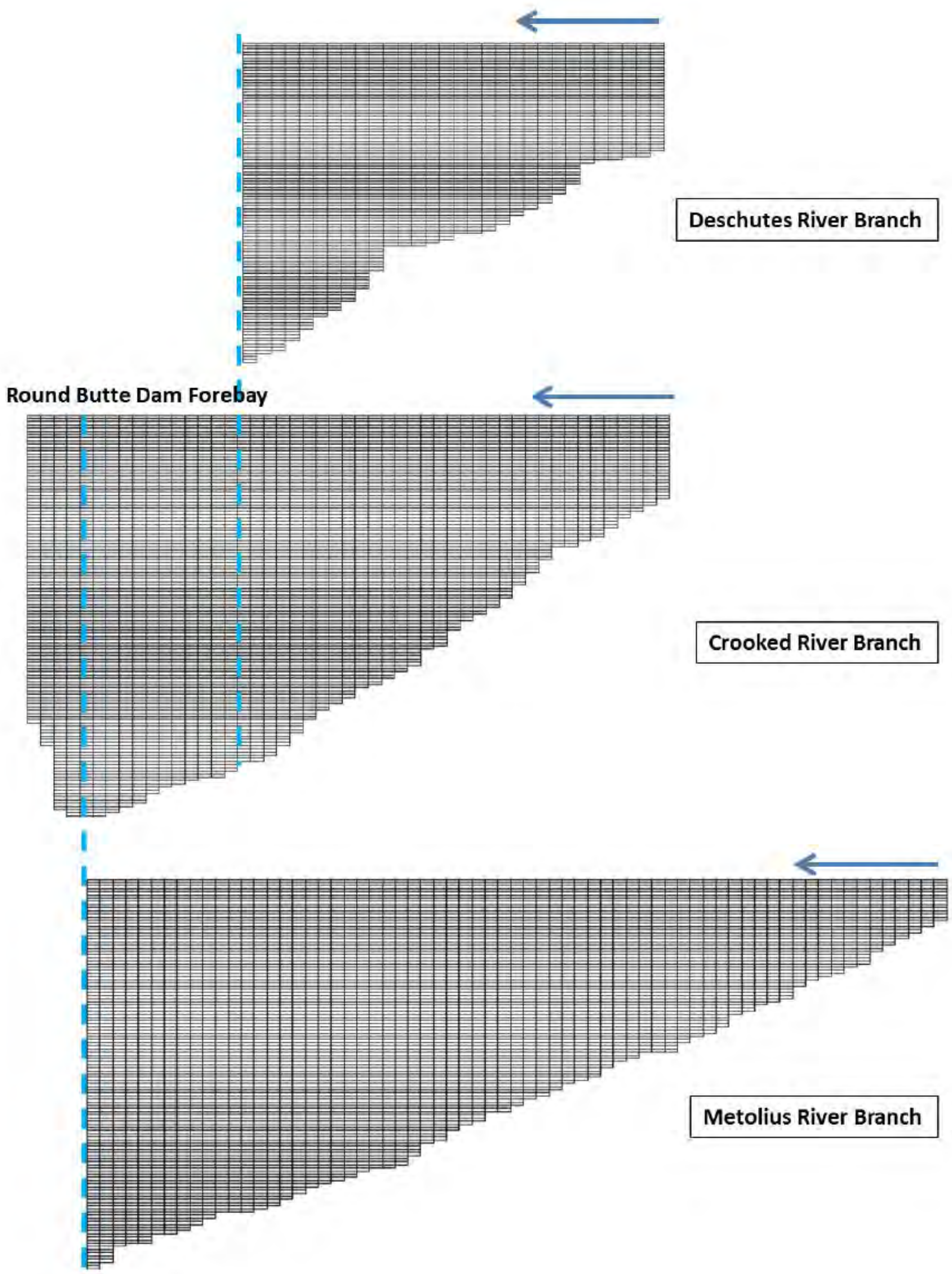


Figure 2. Side view of the Lake Billy Chinook grids. From the original Pelton Round Butte CE-QUAL-W2 report (Xu and Khangaonkar, 2015).

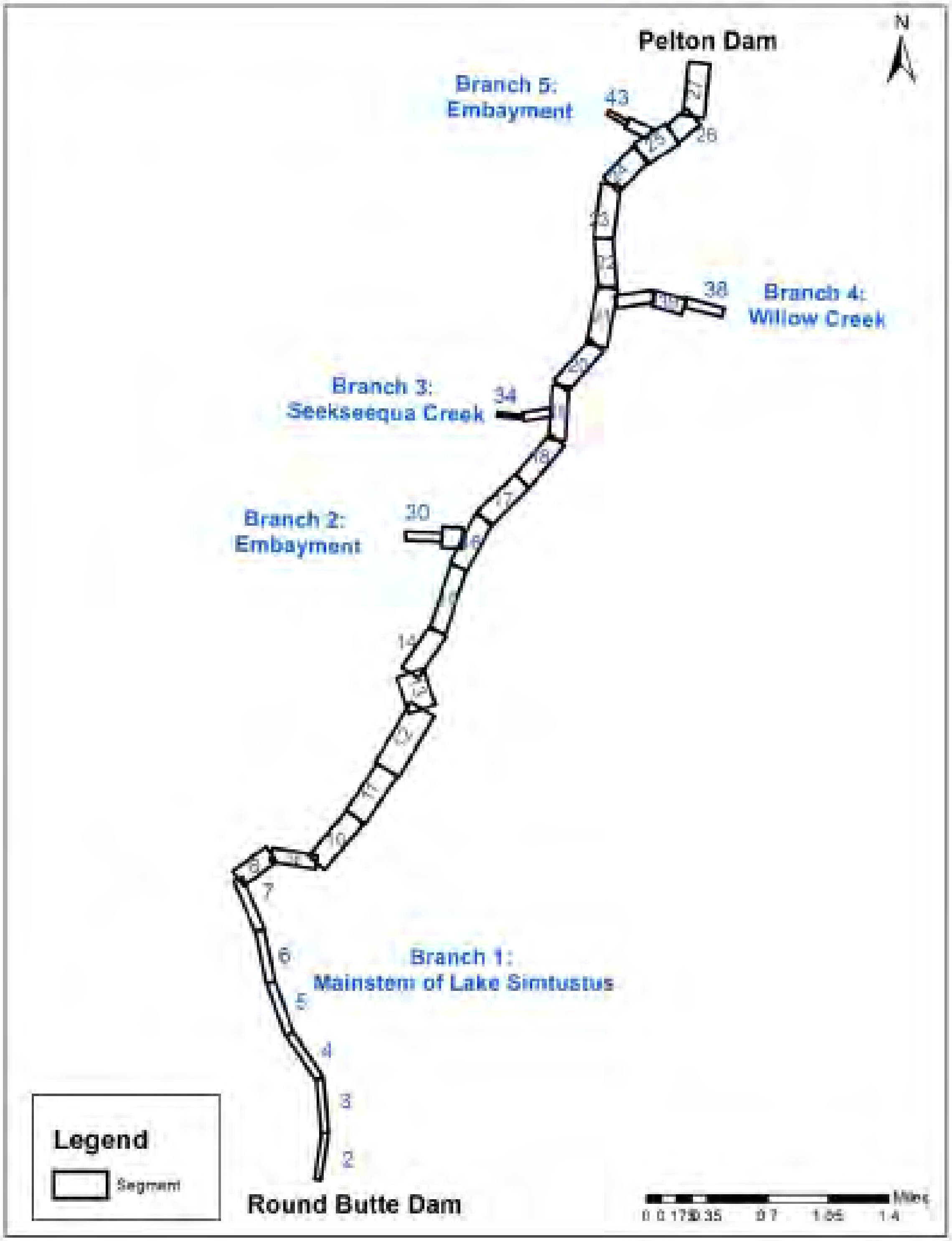


Figure 3 Plan view of the Lake Simtustus Grids. From the original Pelton Round Butte CE-QUAL-W2 report (Xu and Khangaonkar, 2015).

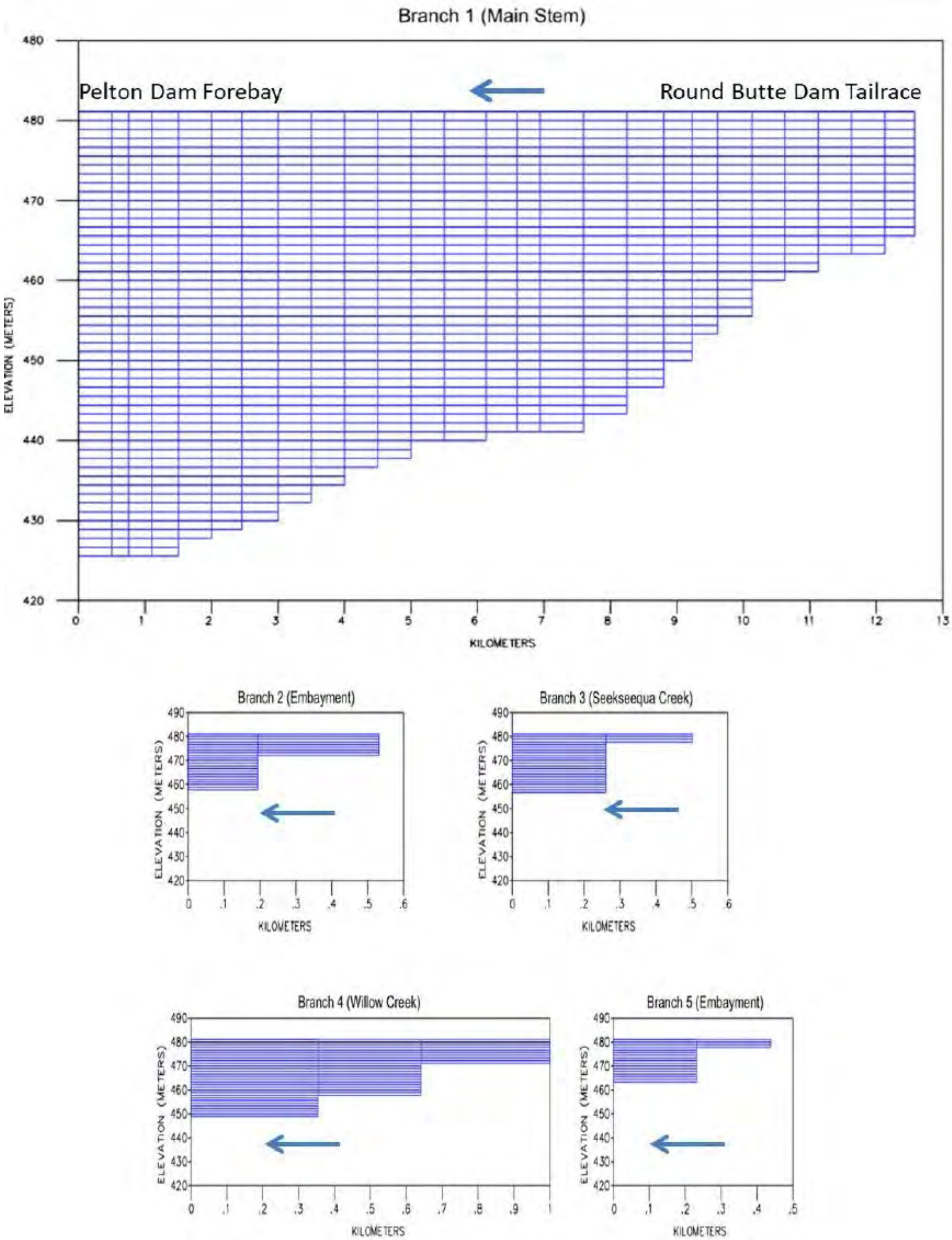


Figure 4. Side view of the Lake Simtustus grids. From the original Pelton Round Butte CE-QUAL-W2 report (Xu and Khangaonkar, 2015).

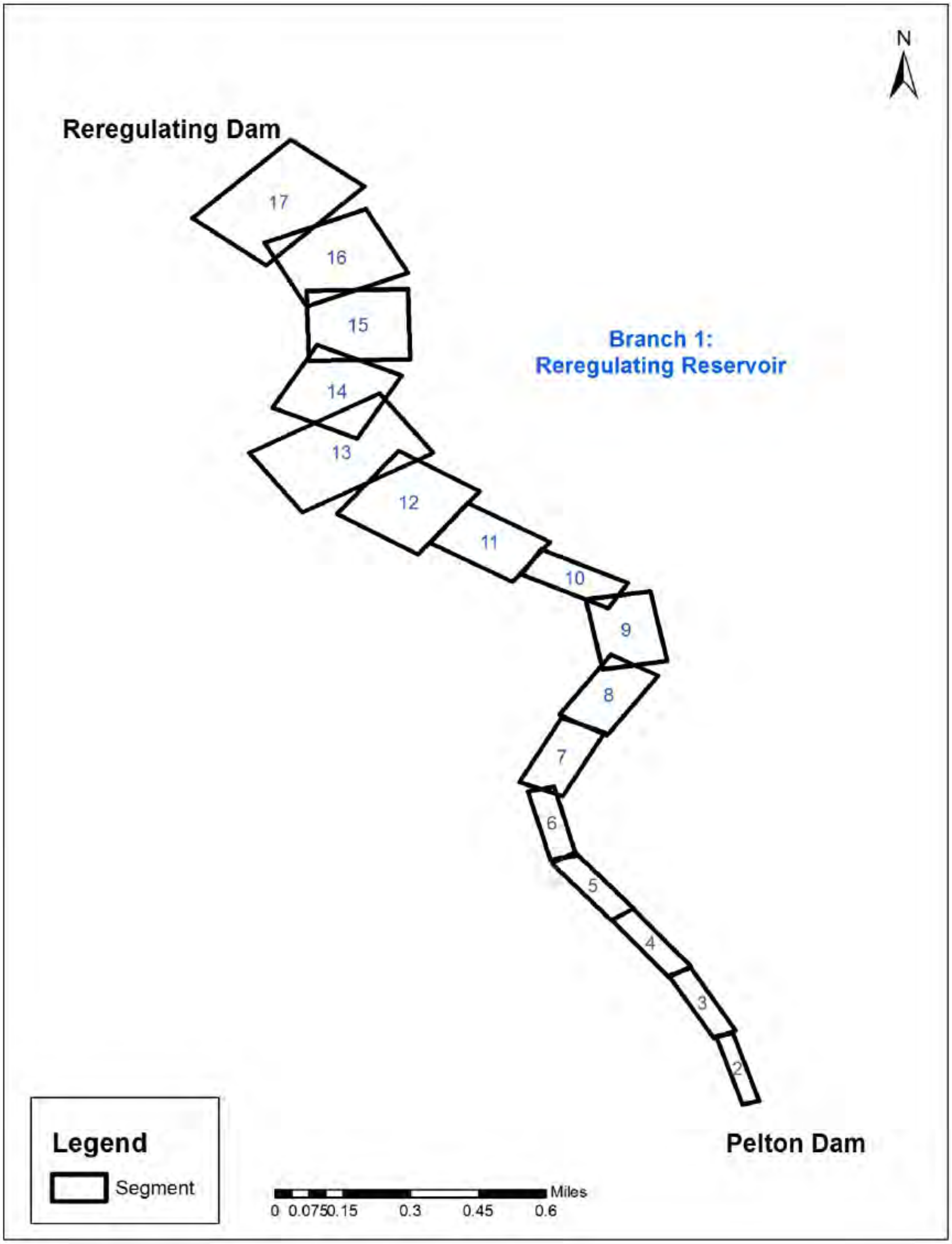


Figure 5. Plan view of the Lake Simtustus Grids. From the original Pelton Round Butte CE-QUAL-W2 report (Xu and Khangaonkar, 2015).

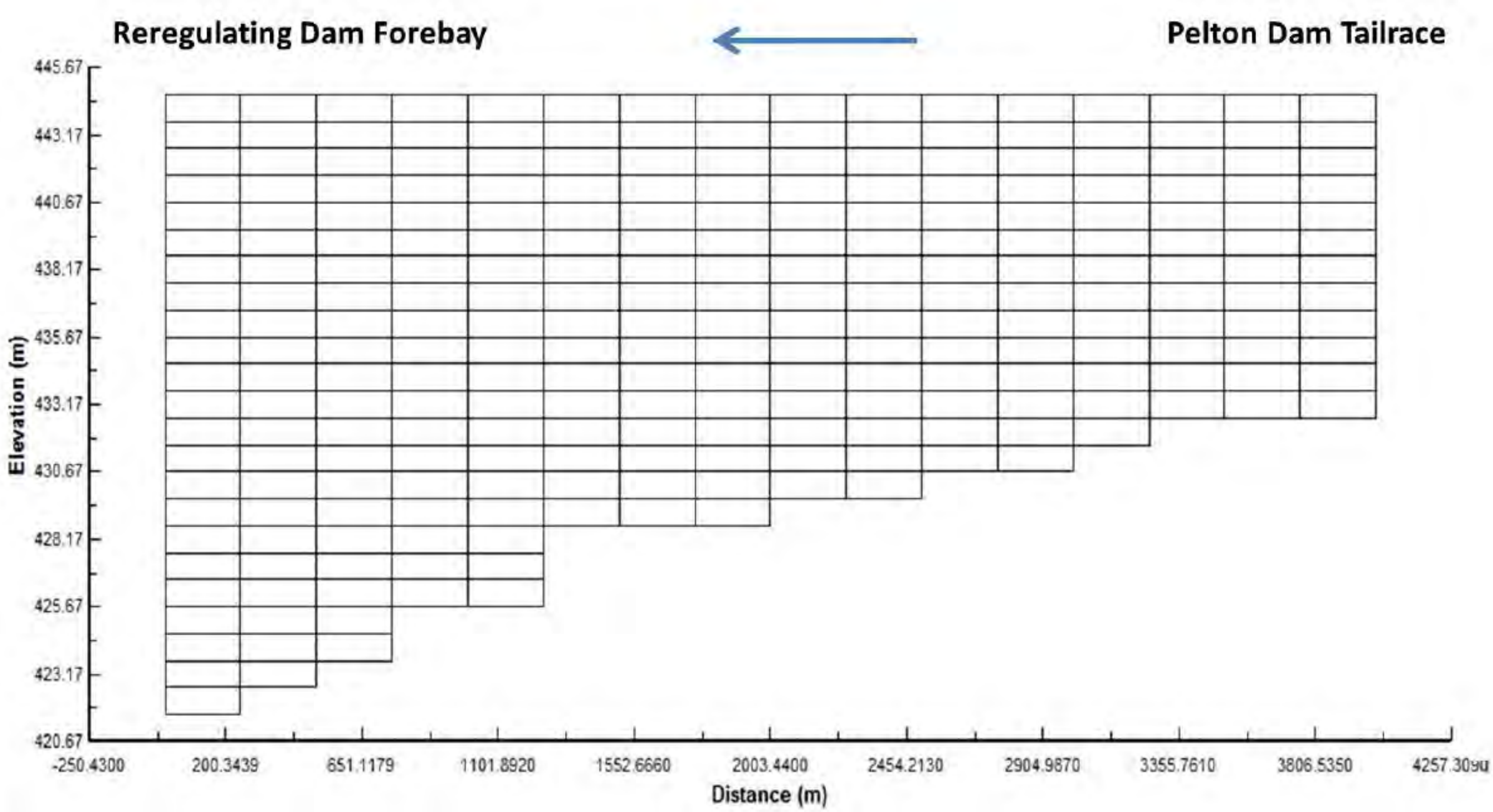


Figure 6. Figure 2. Side view of the Reregulating reservoir grid. From the original Pelton Round Butte CE-QUAL-W2 report (Xu and Khangaonkar, 2015).

Appendix H Model Output

1 List of Figures

2 Figures

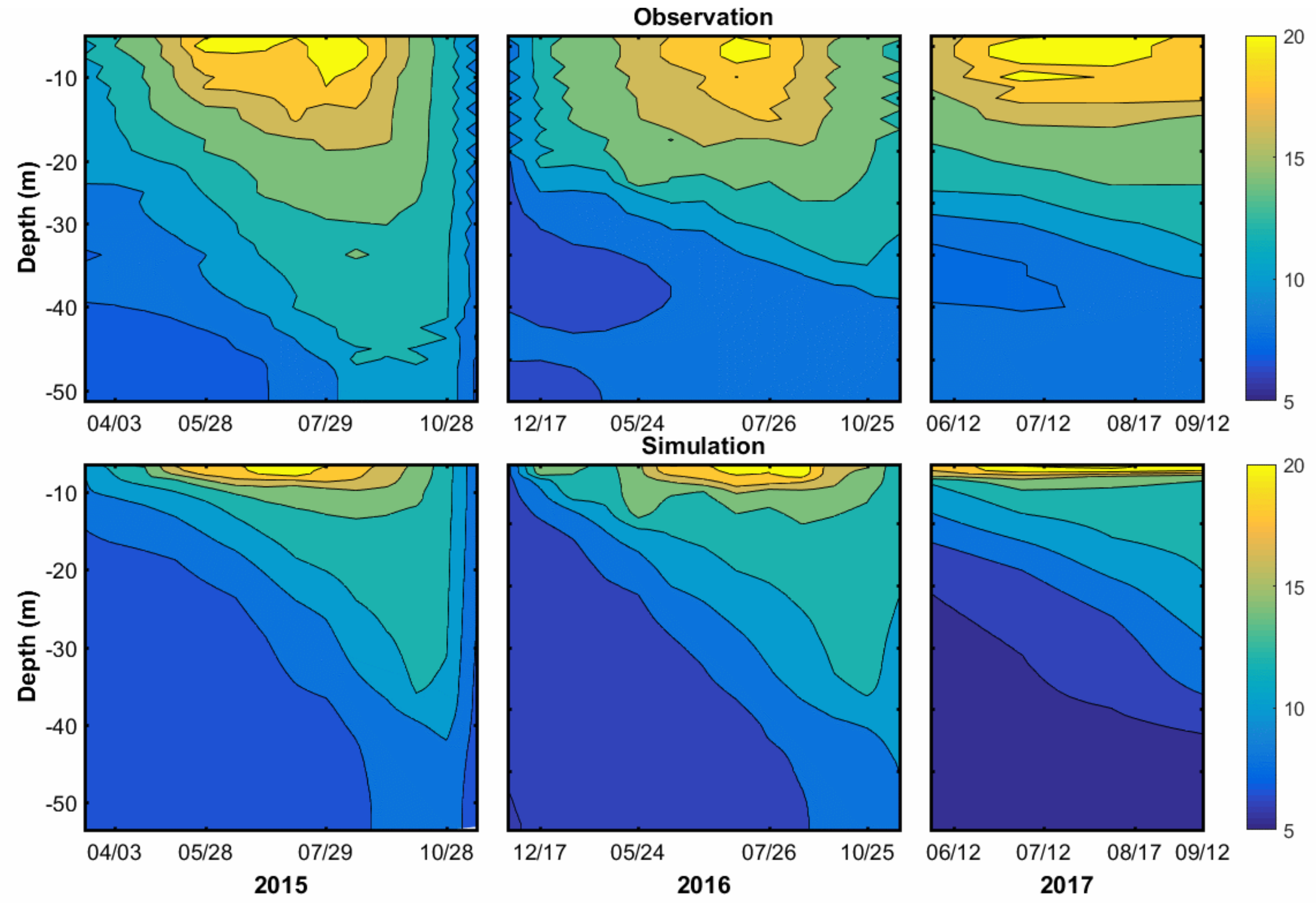


Figure 1. Observed and simulated water temperature at Round Butte forebay (RES07).

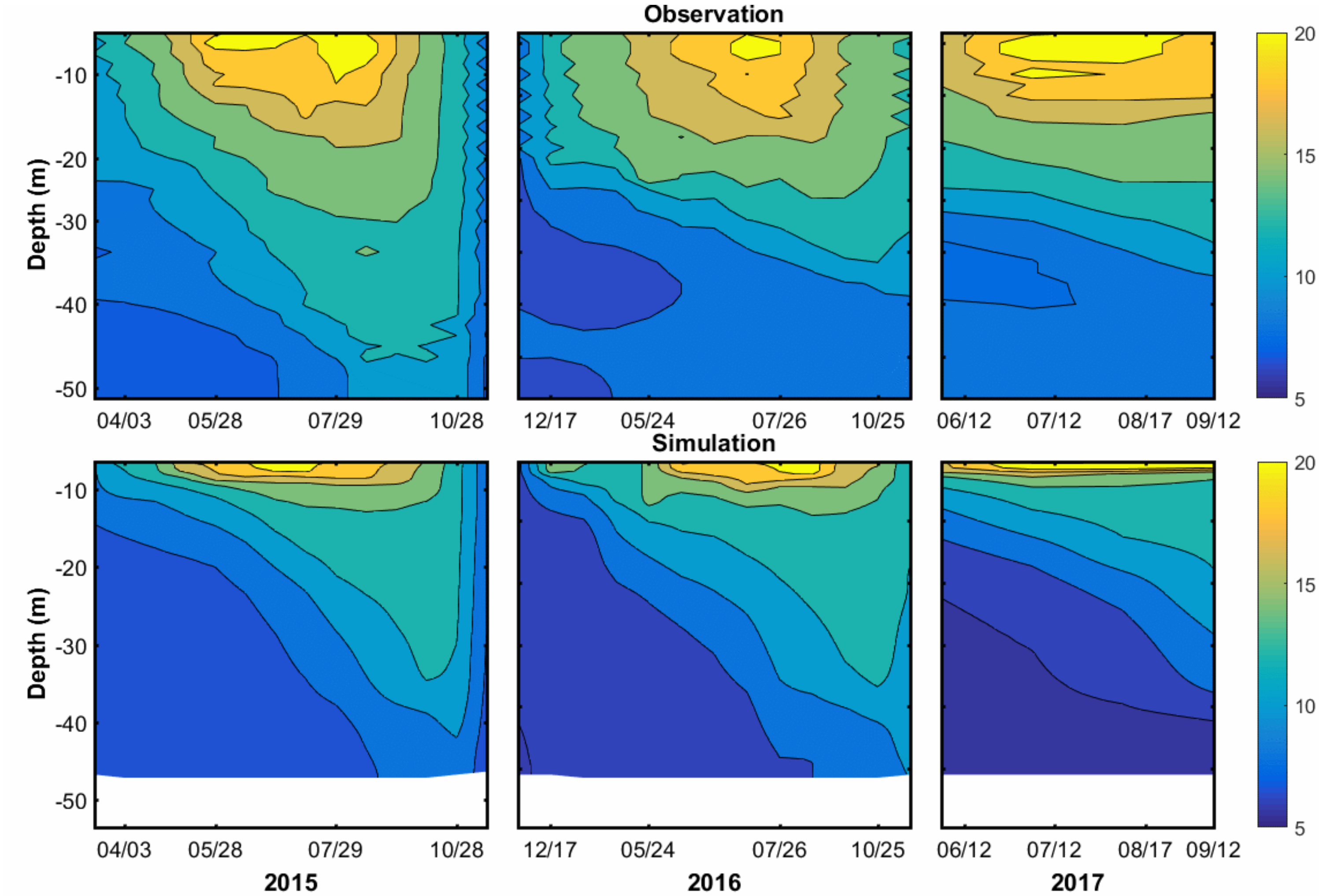


Figure 2. Observed and simulated temperature at the Common Pool (RES08).

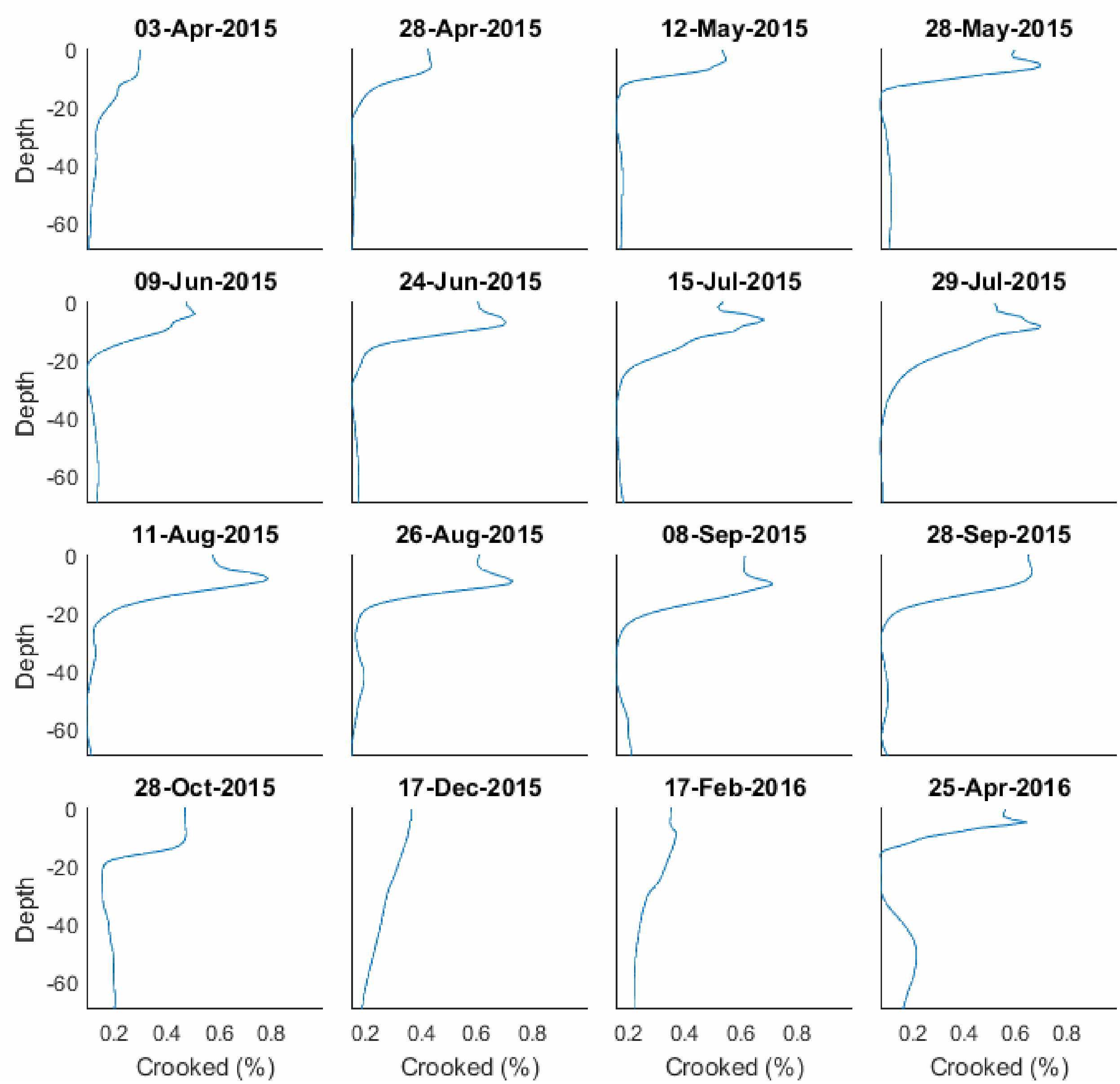


Figure 3. Simulated percent Crooked profiles at Round Butte forebay (RES07) for the first 16 profiles.

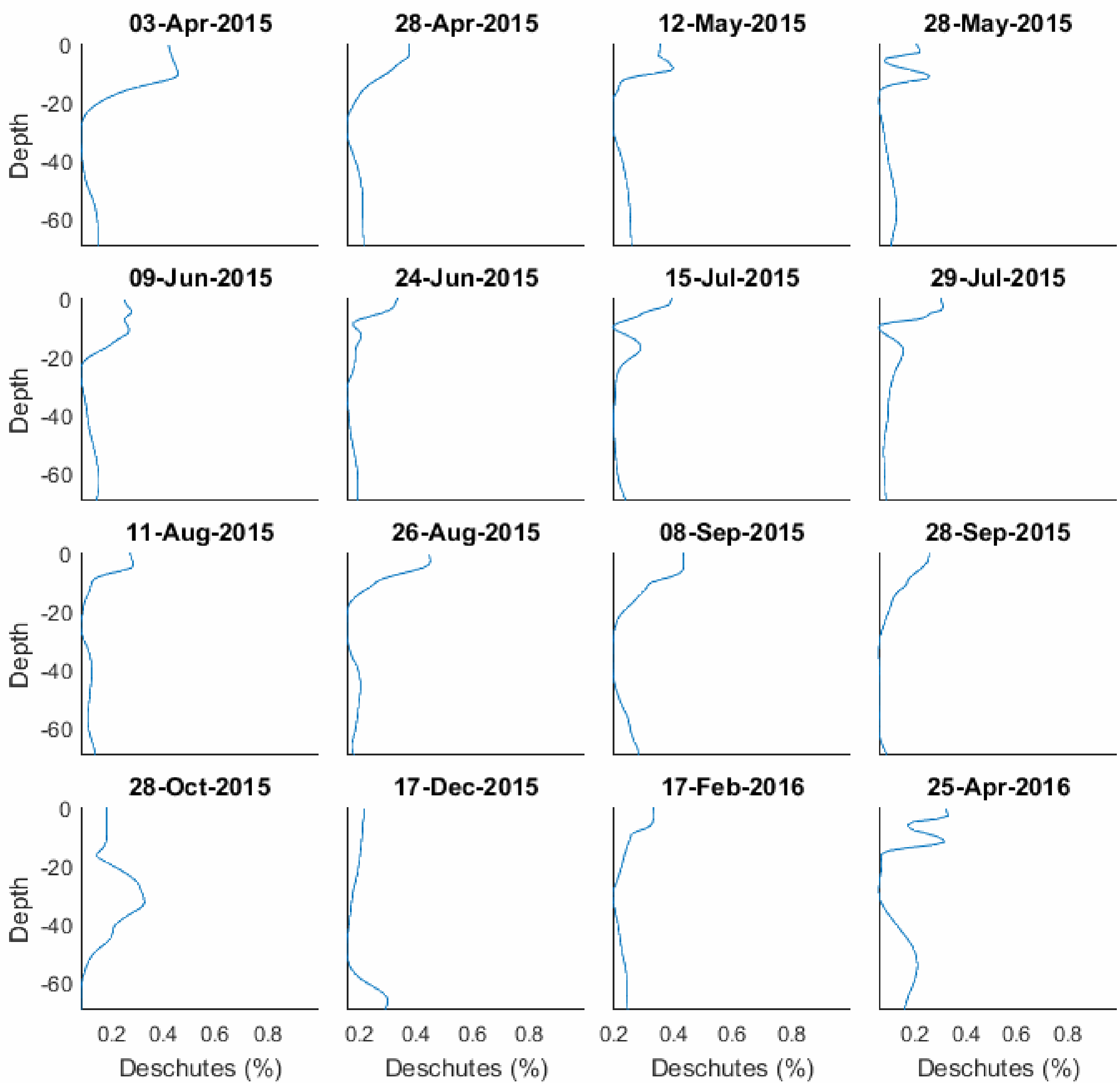


Figure 4. Simulated percent Deschutes profiles at Round Butte forebay (RES07) for the first 16 profiles.

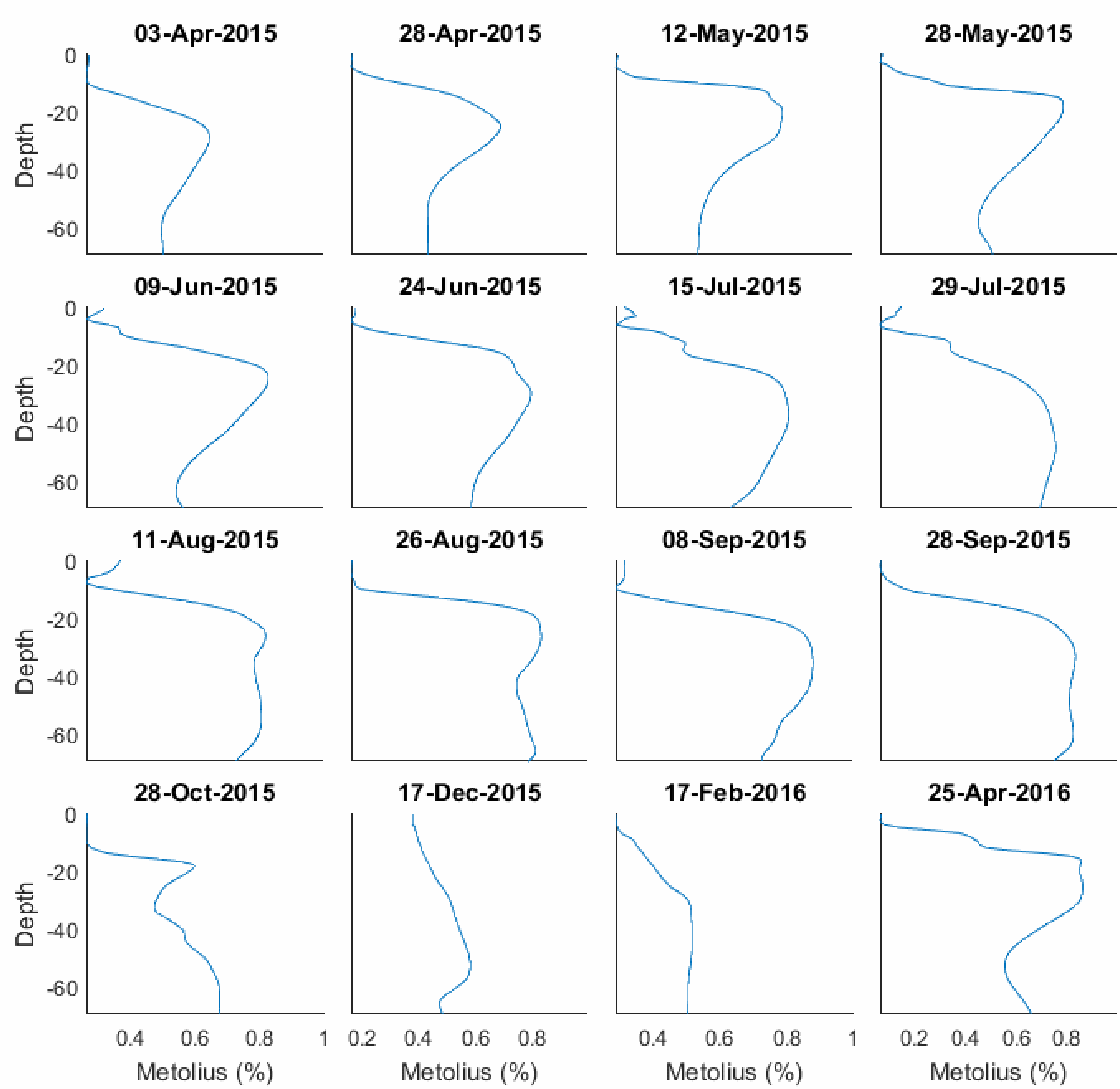


Figure 5. Simulated percent Metolius profiles at Round Butte forebay (RES07) for the first 16 profiles.

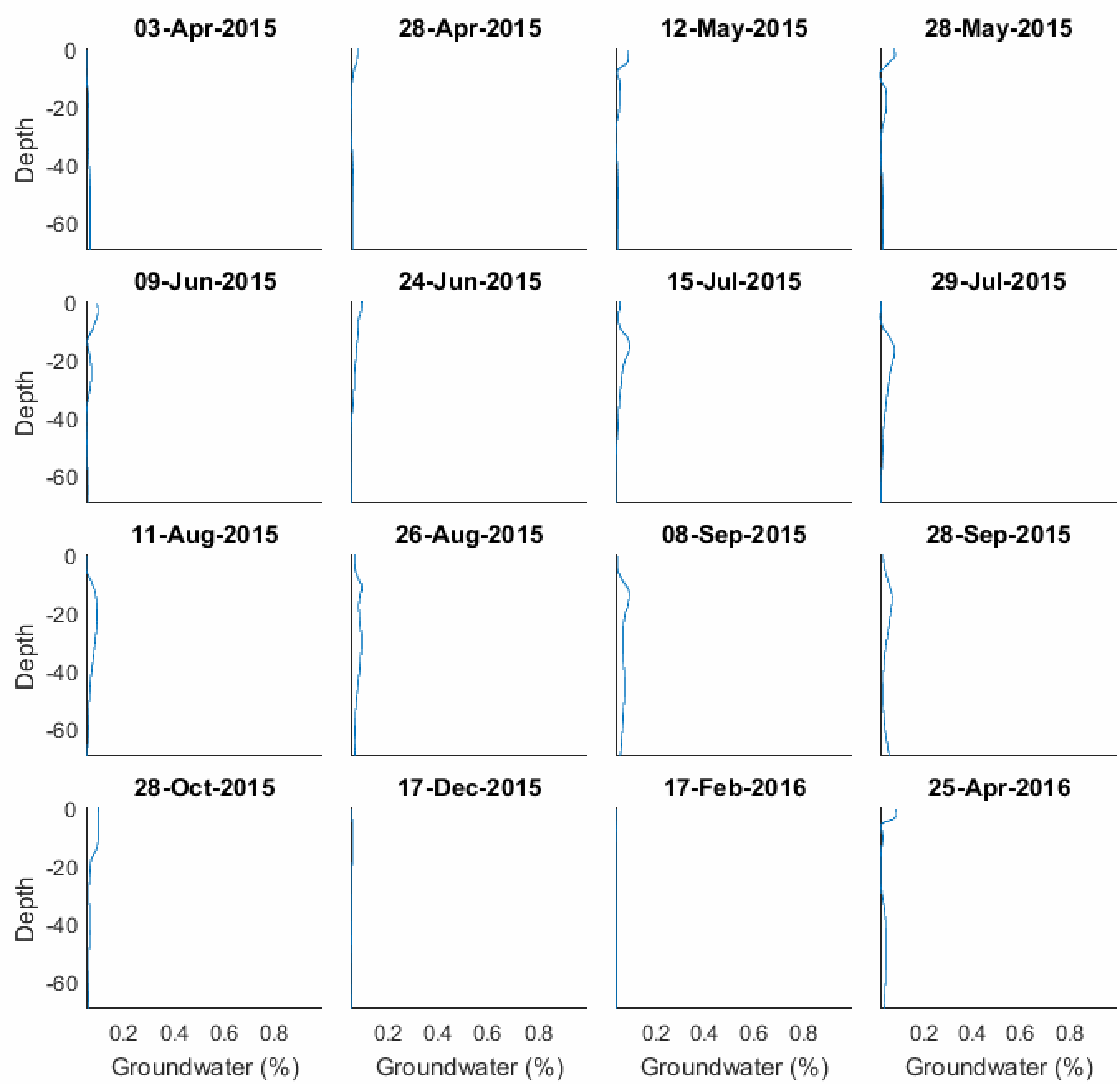


Figure 6. Simulated percent calibrated groundwater profiles at Round Butte forebay (RES07) for the first 16 profiles.

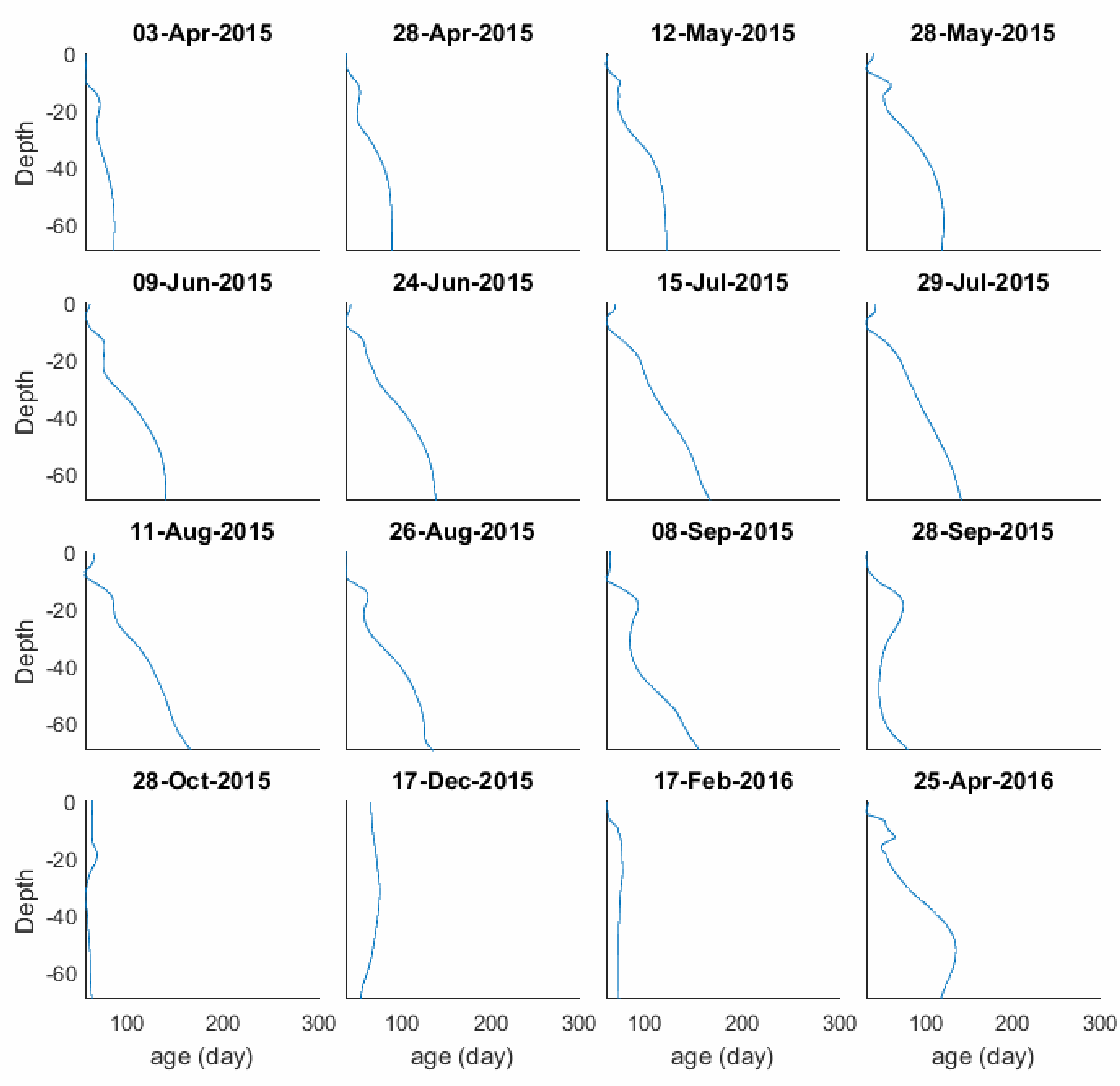


Figure 7. Simulated water age profiles at Round Butte forebay (RES07) for the first 16 profiles.

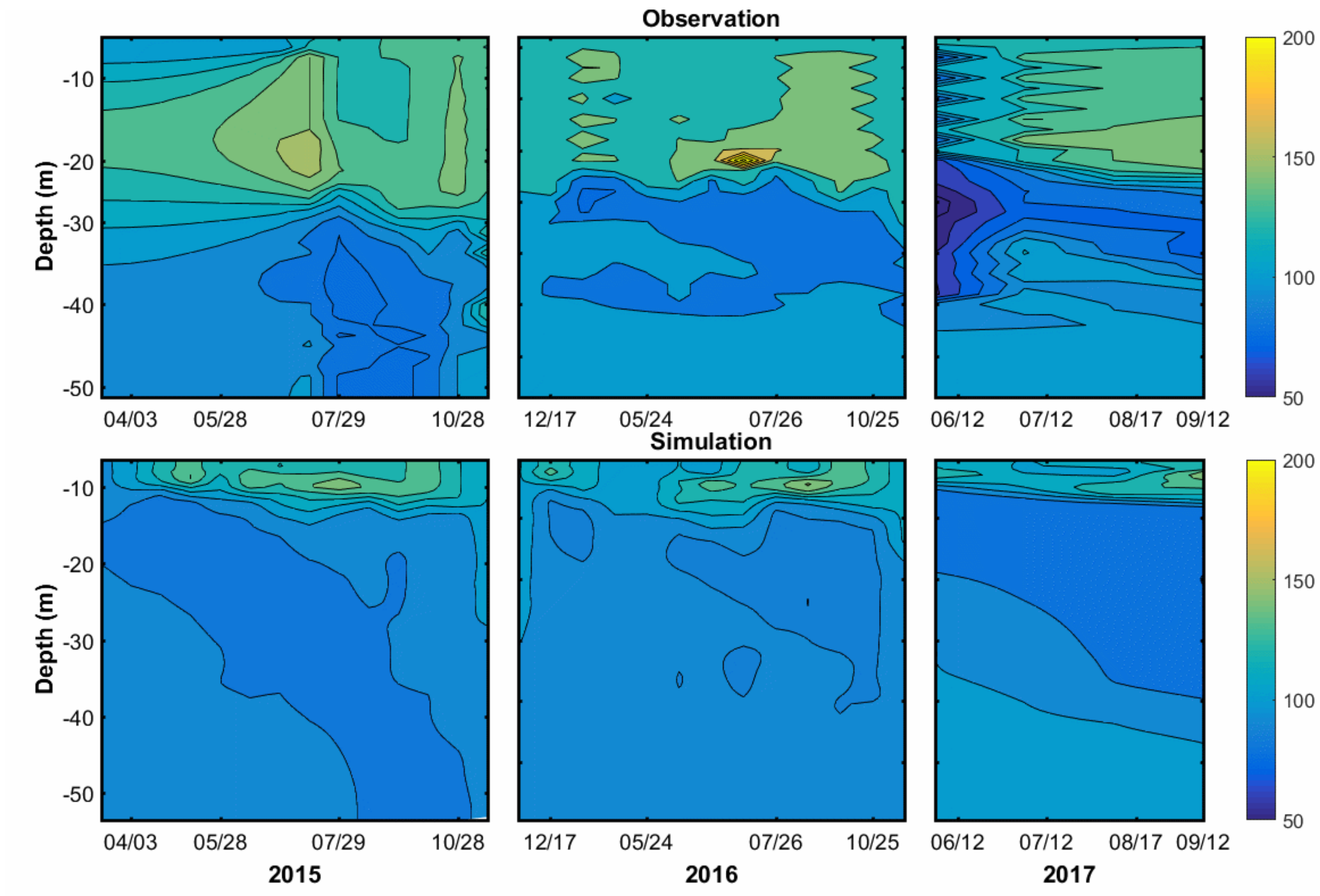


Figure 8. Observed and simulated specific conductivity at Round Butte forebay (RES07).

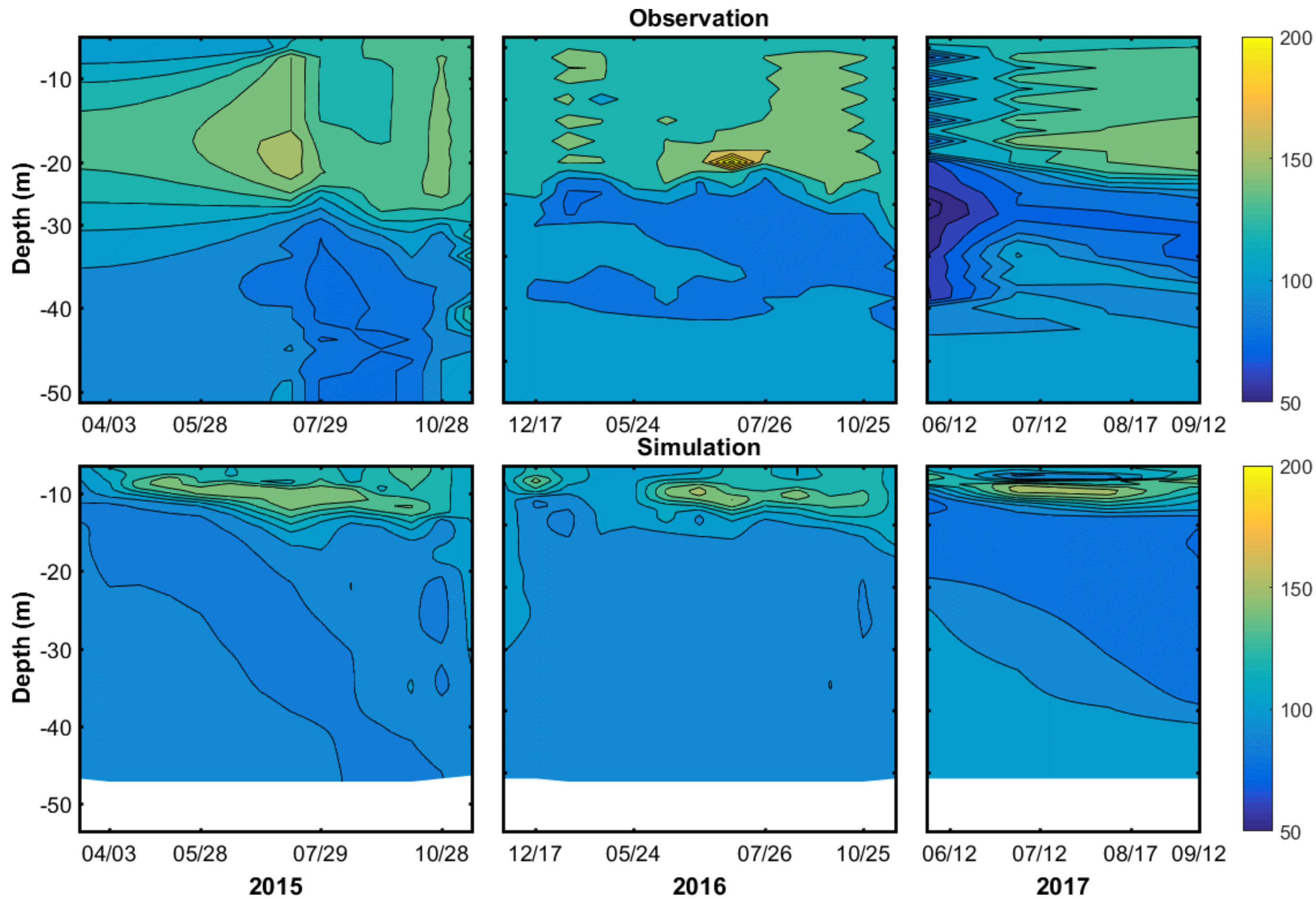


Figure 9. Observed and simulated specific conductivity at the Common Pool (RES08).

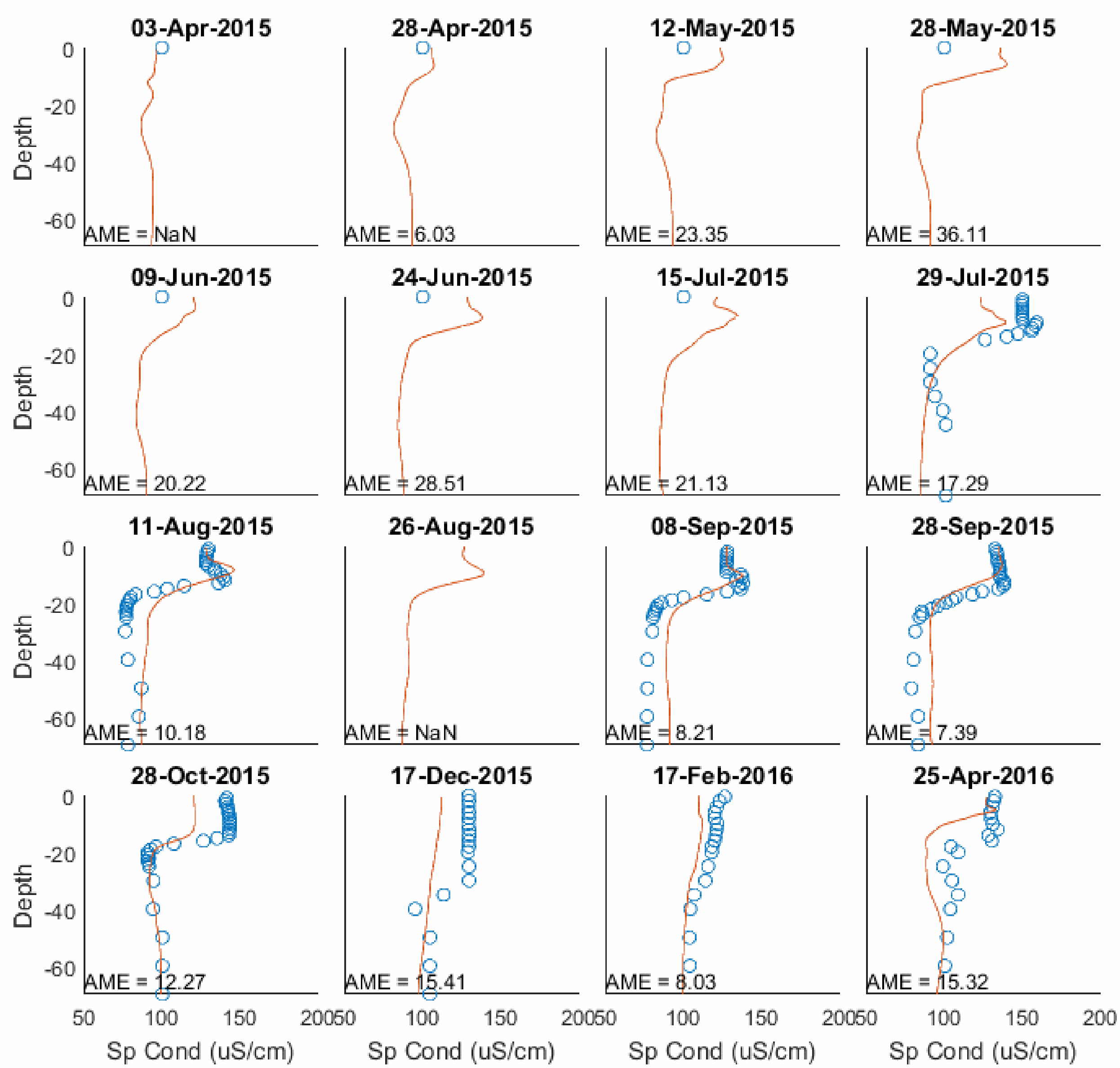


Figure 10. Simulated specific conductivity profiles at Round Butte forebay (RES07) for the first 16 profiles. The final 14 profiles are outlined in Figure 11.

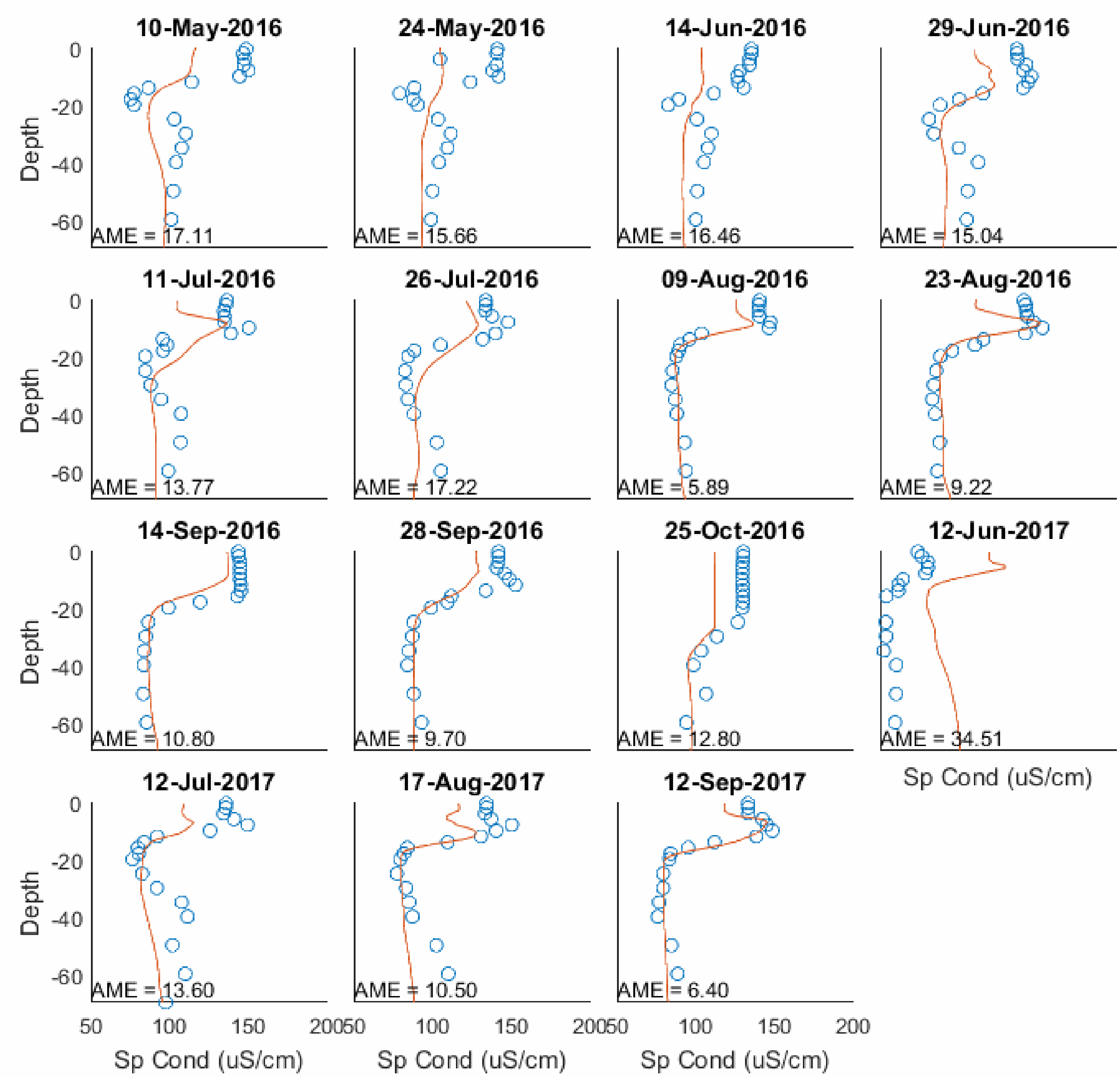


Figure 11. Simulated specific conductivity profiles at Round Butte forebay (RES07) for the final profiles.

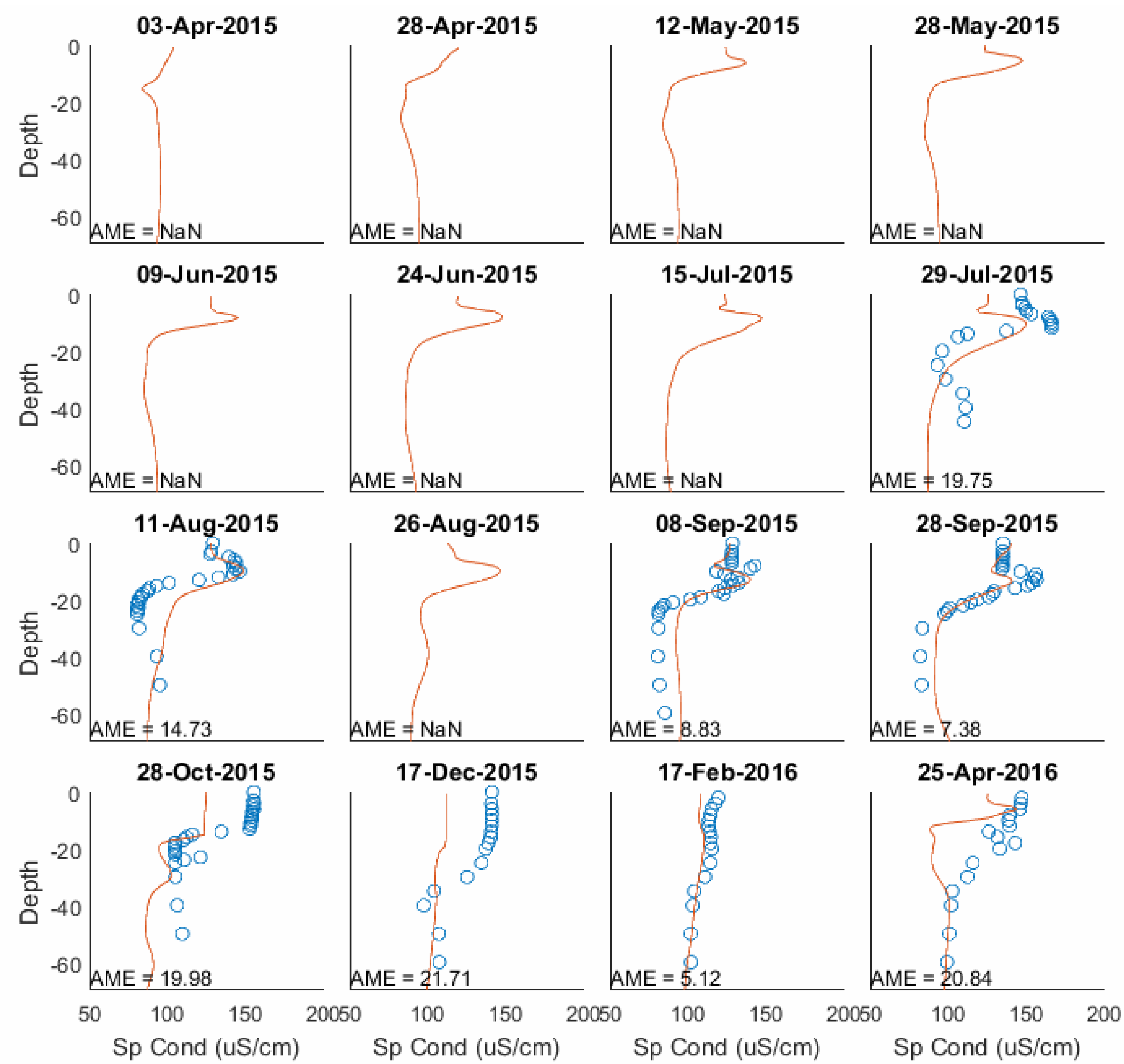


Figure 12. Simulated specific conductivity profiles at the Common Pool (RES08) for the first 16 profiles. The final 7 profiles are outlined in Figure 13.

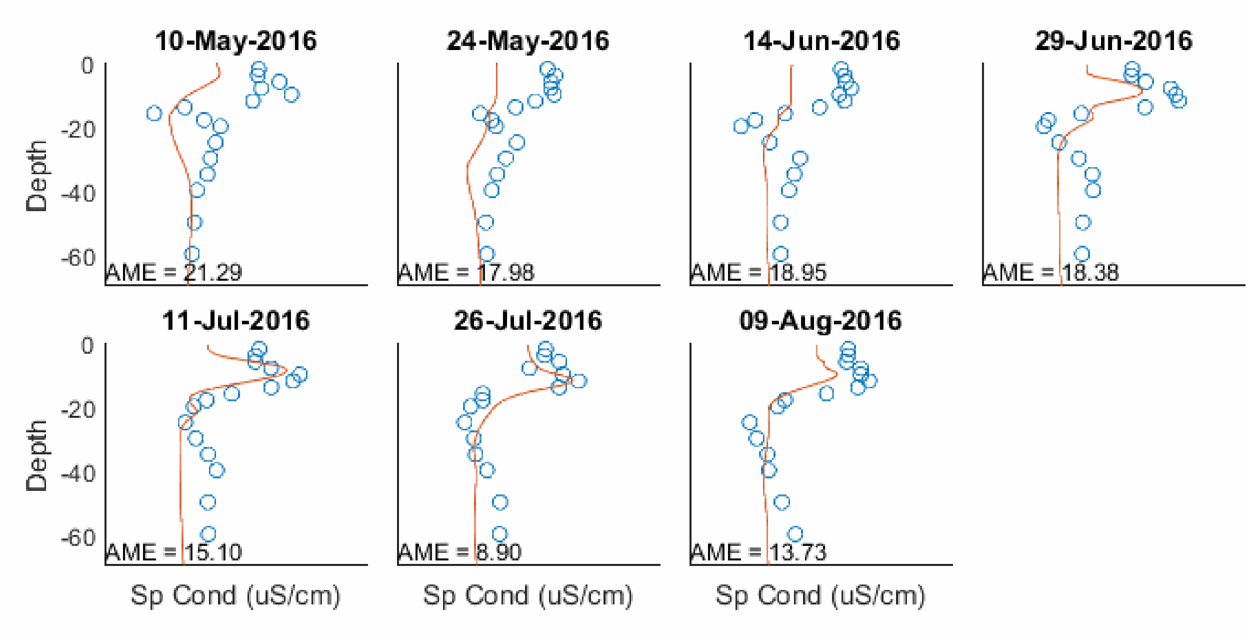


Figure 13. Simulated specific conductivity profiles at the Common Pool (RES08) for the final profiles

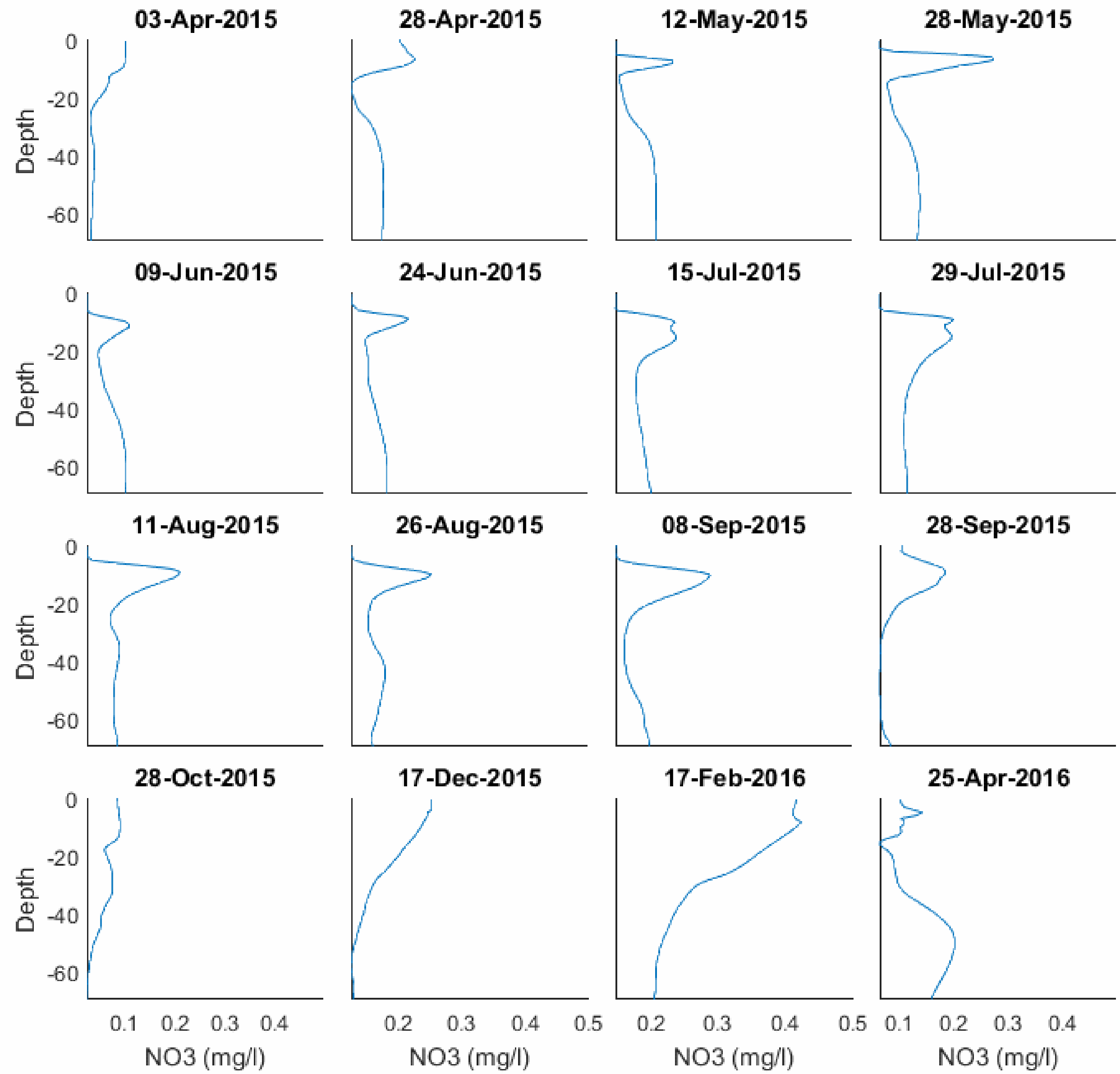


Figure 14. Simulated nitrate-nitrite profiles at Round Butte forebay (RES07) for the first 16 profiles.

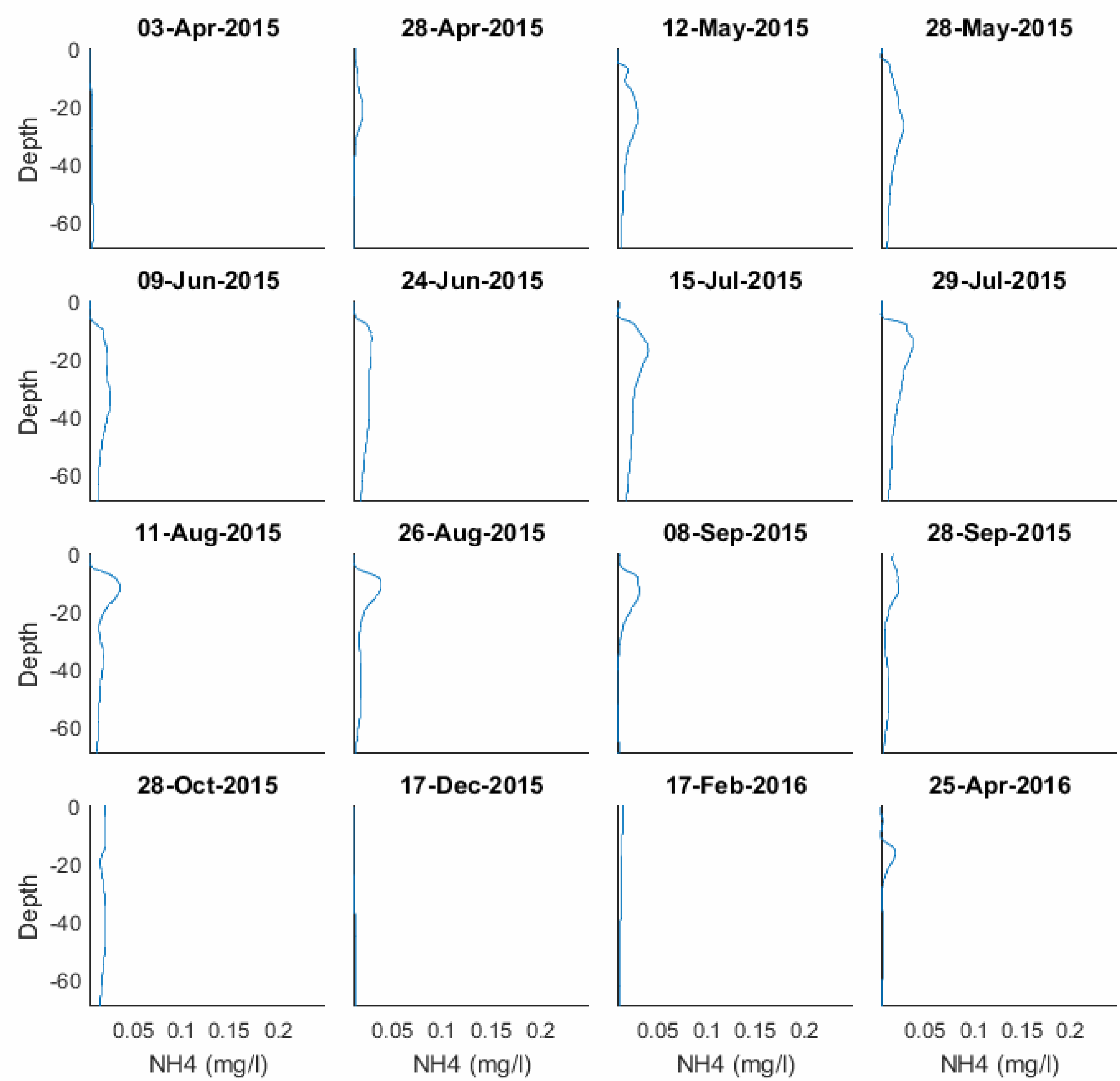


Figure 15. Simulated ammonia profiles at Round Butte forebay (RES07) for the first 16 profiles.

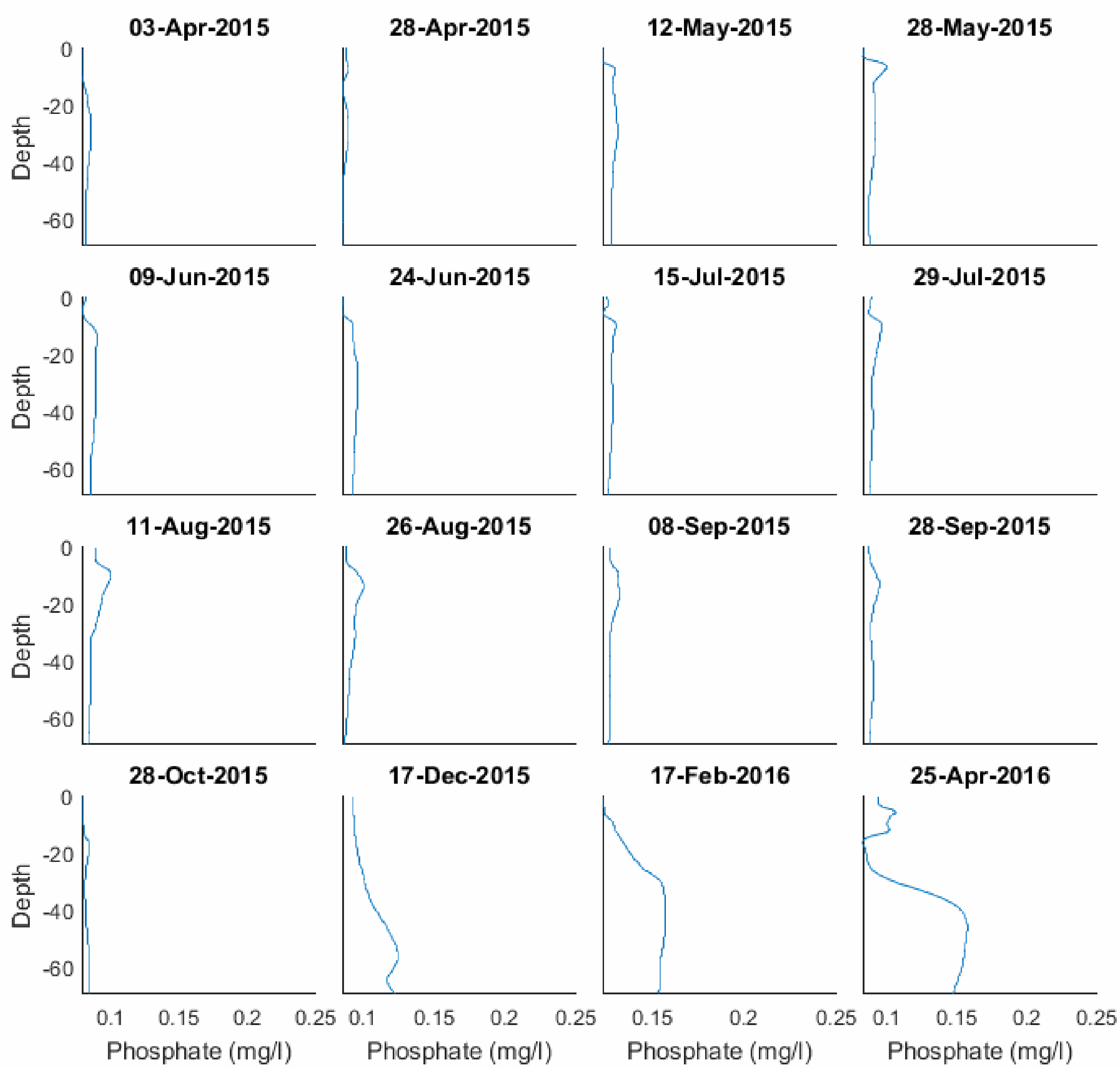


Figure 16. Simulated phosphate profiles at Round Butte forebay (RES07) for the first 16 profiles.

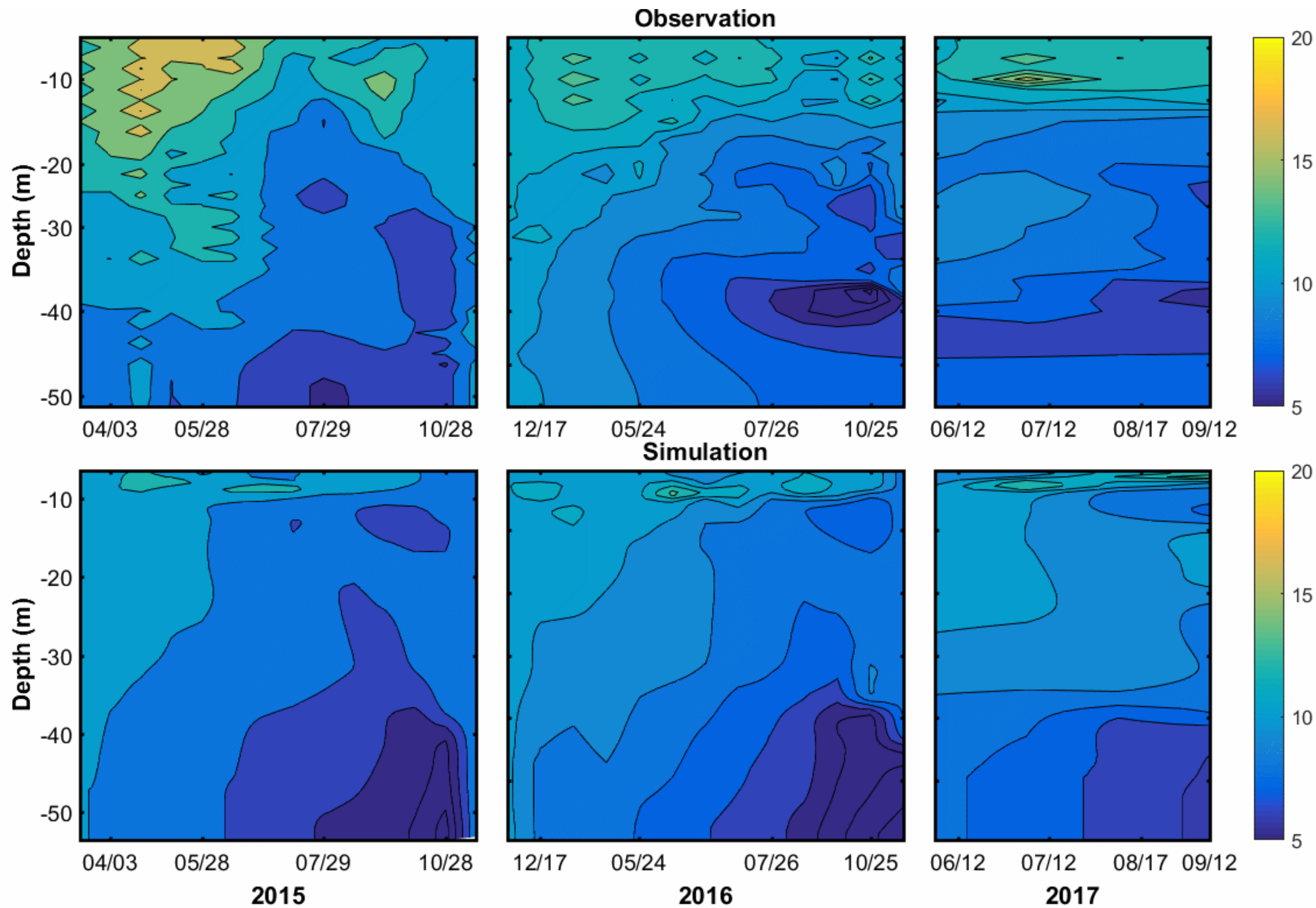


Figure 17. Observed and simulated dissolved oxygen at Round Butte forebay (RES07).

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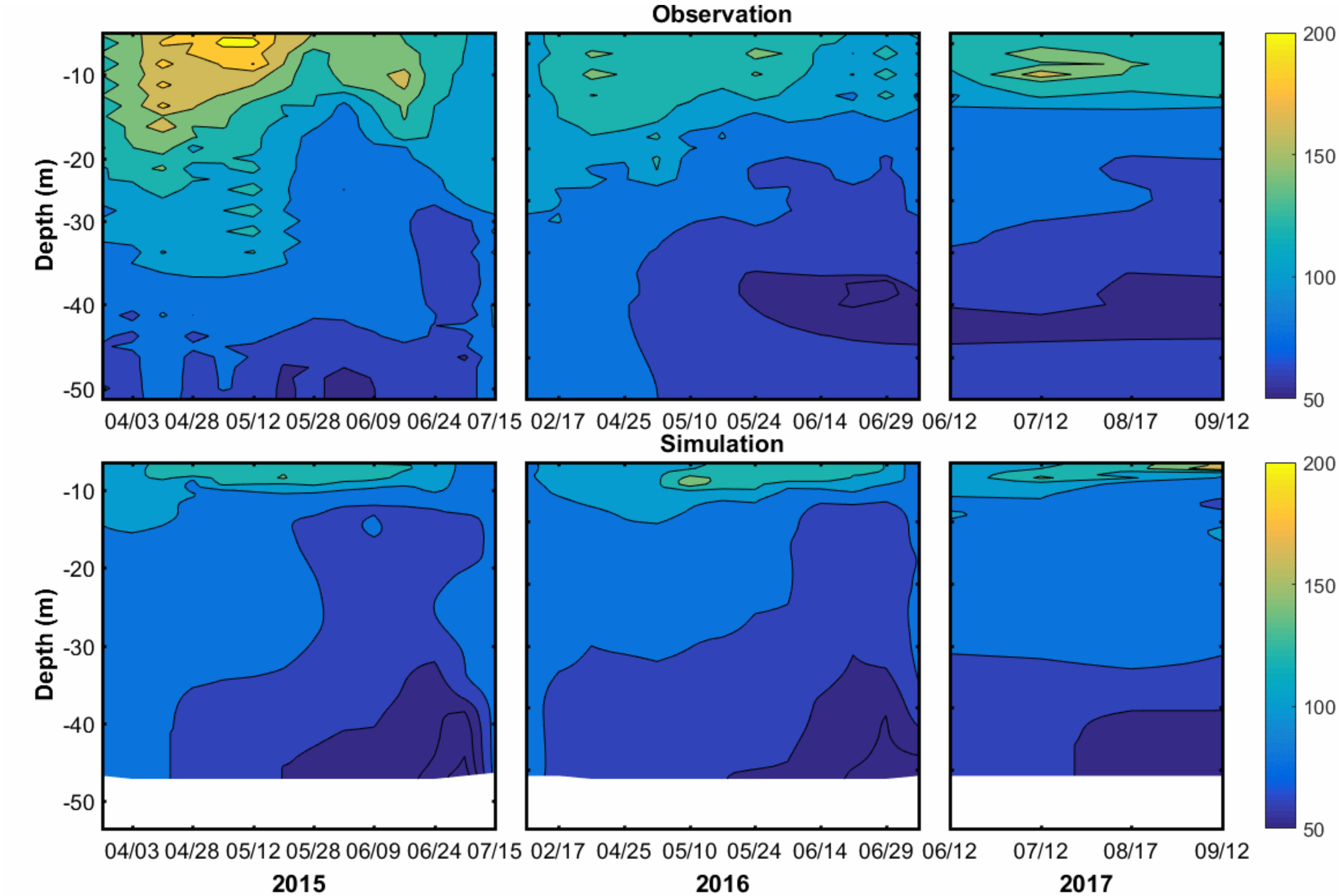

Figure 18. Observed and simulated dissolved oxygen at the Common Pool (RES08)

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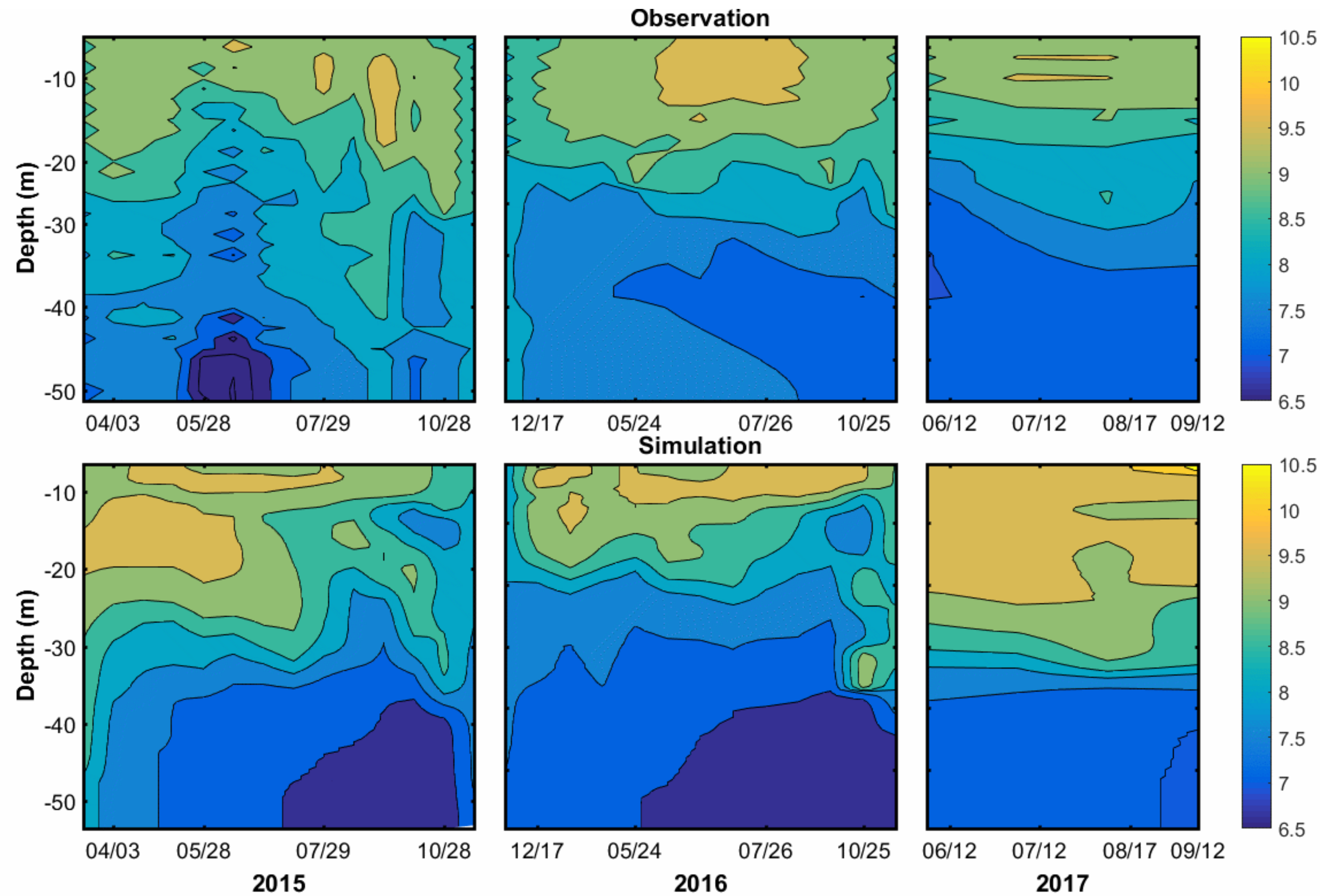

Figure 19. Observed and simulated pH at Round Butte forebay (RES07).

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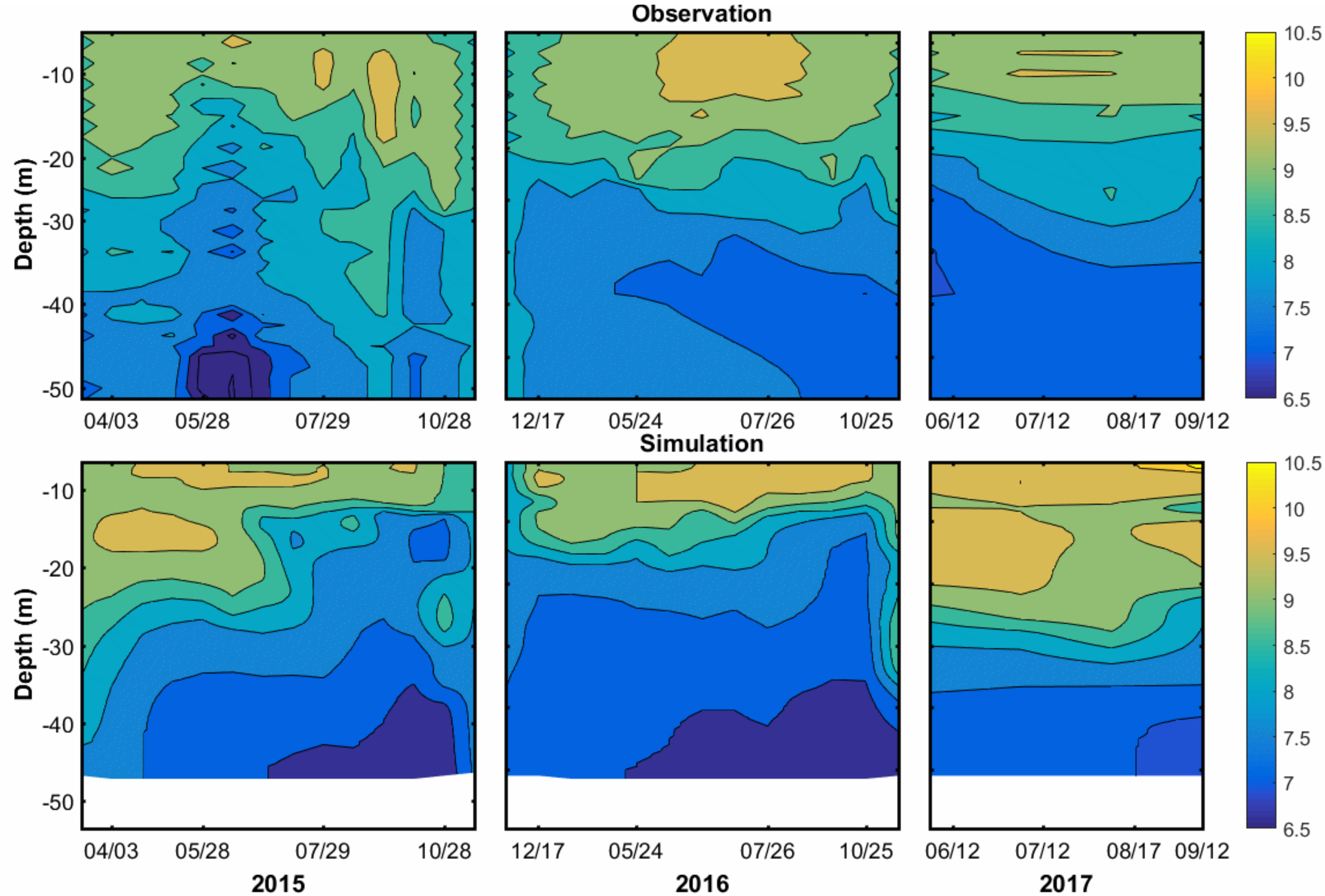


Figure 20. Observed and simulated pH at the Common Pool (RES08).

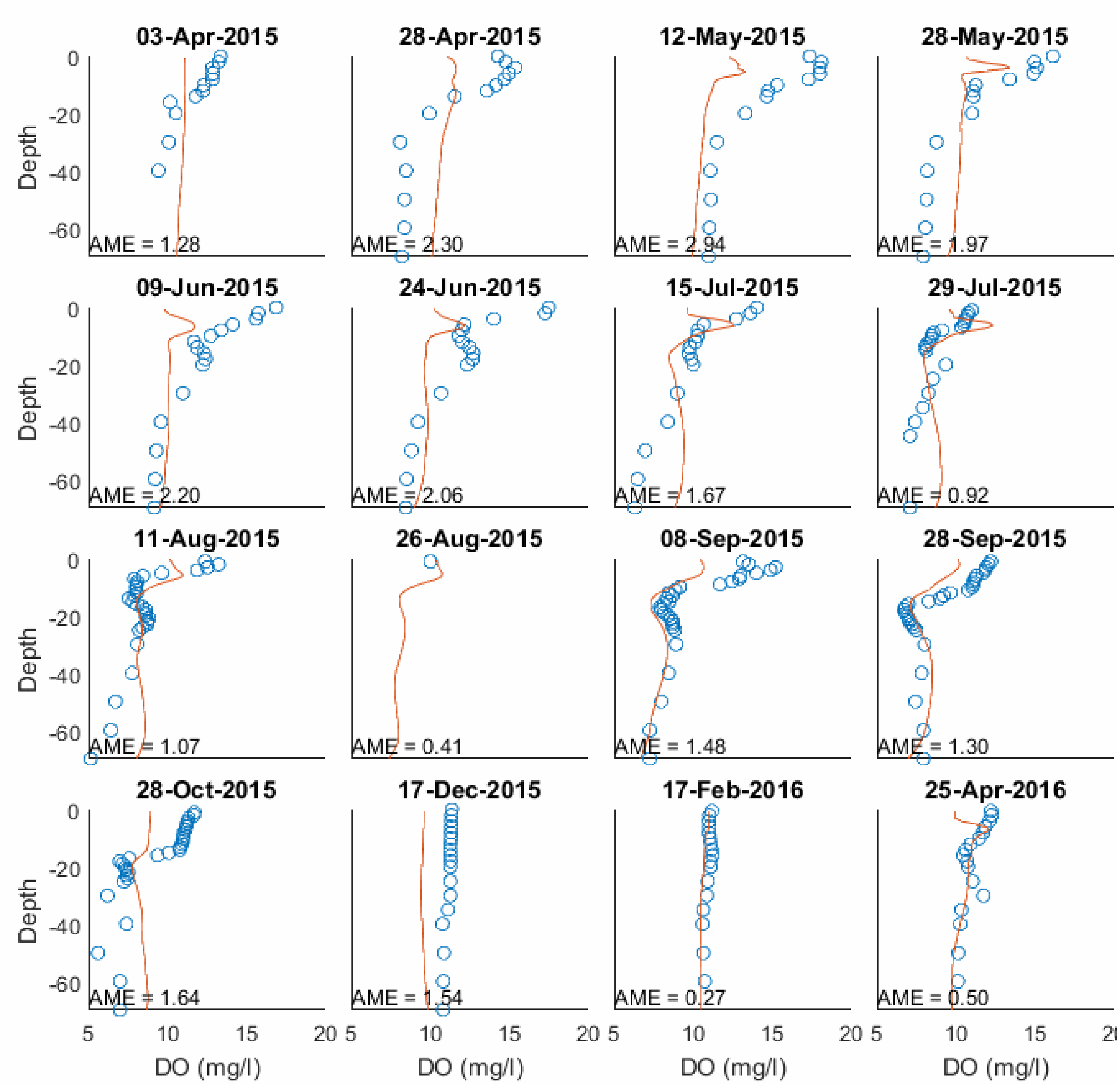


Figure 21. Simulated DO profiles at Round Butte forebay (RES07) for the first 16 profiles. The final 7 profiles are outlined in Figure 22.

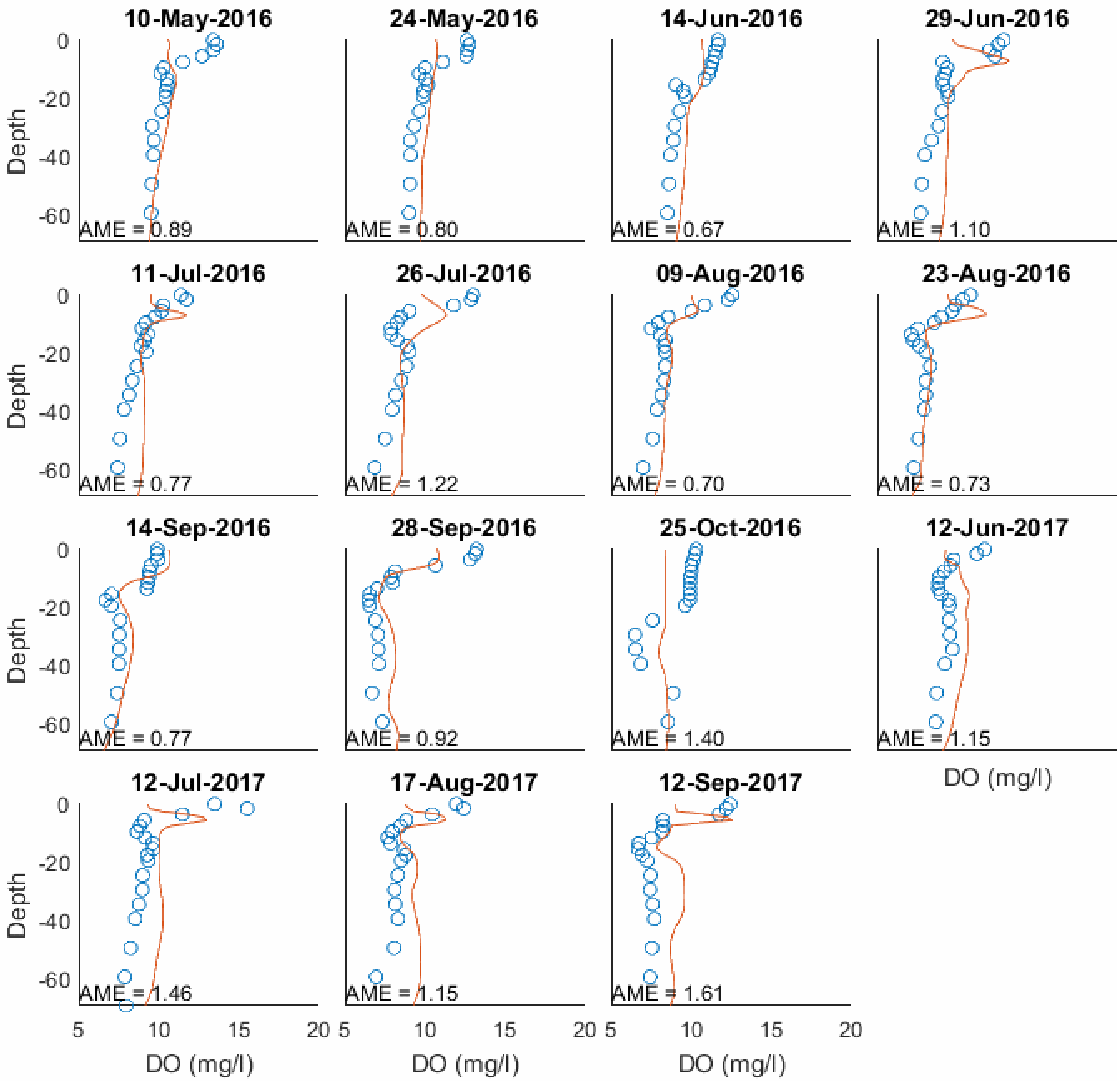


Figure 22. Simulated DO profiles at Round Butte forebay (RES07) for the final profiles.

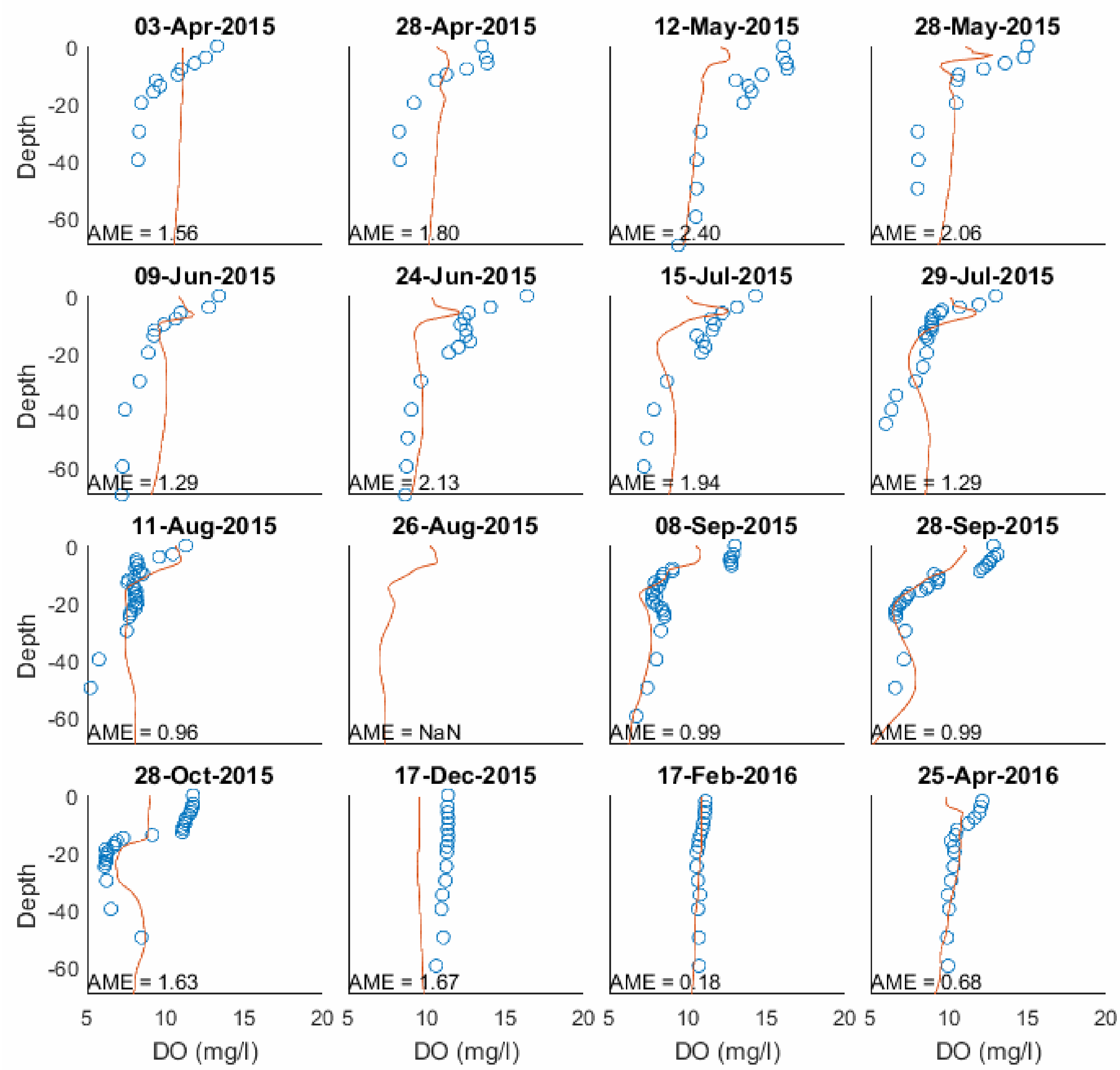


Figure 23. Simulated DO profiles at the Common Pool (RES08) for the first 16 profiles. The final 7 profiles are outlined in Figure 24.

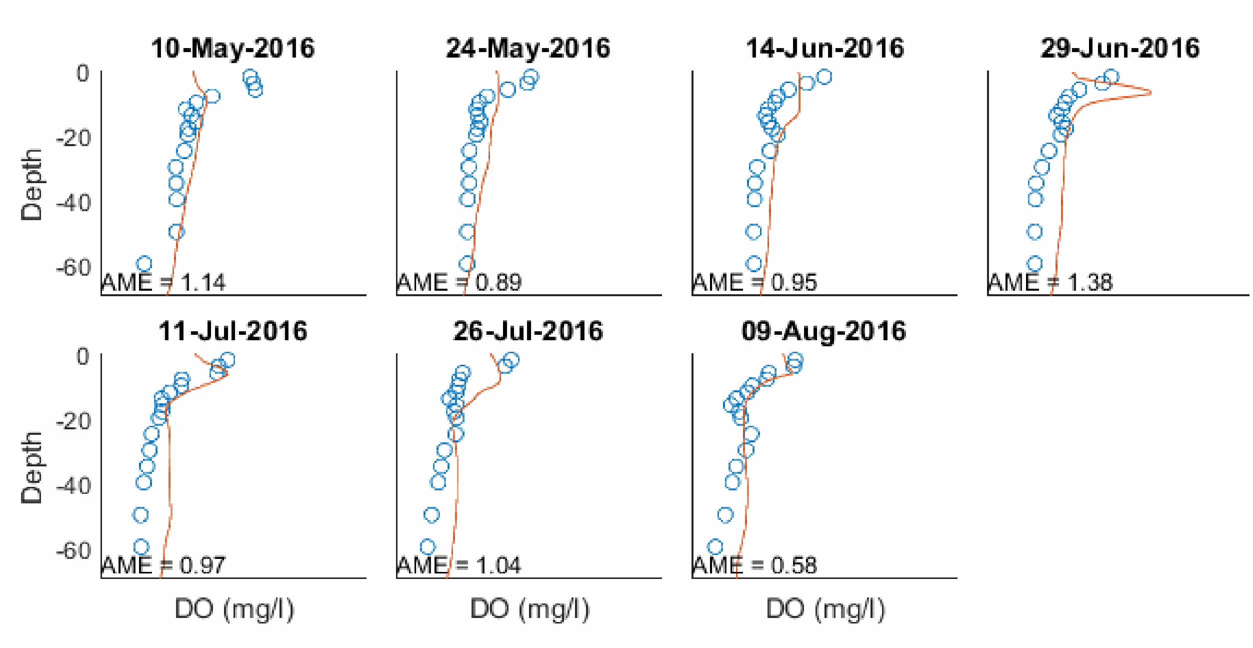


Figure 24. Simulated DO profiles at the Common Pool (RES08) for the final profiles.

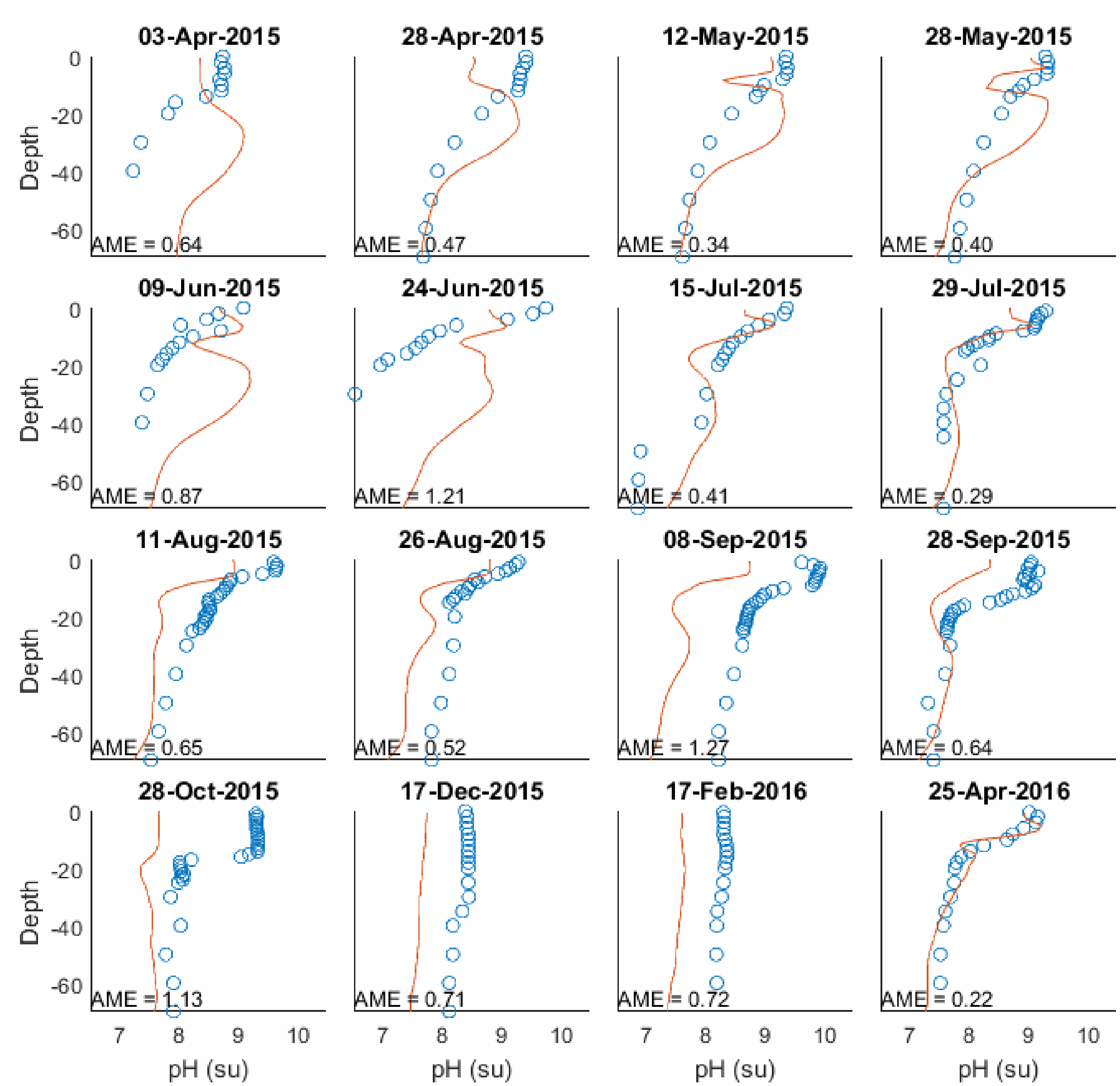


Figure 25. Simulated pH profiles at Round Butte forebay (RES07) for the first 16 profiles. The final 7 profiles are outlined in Figure 26.

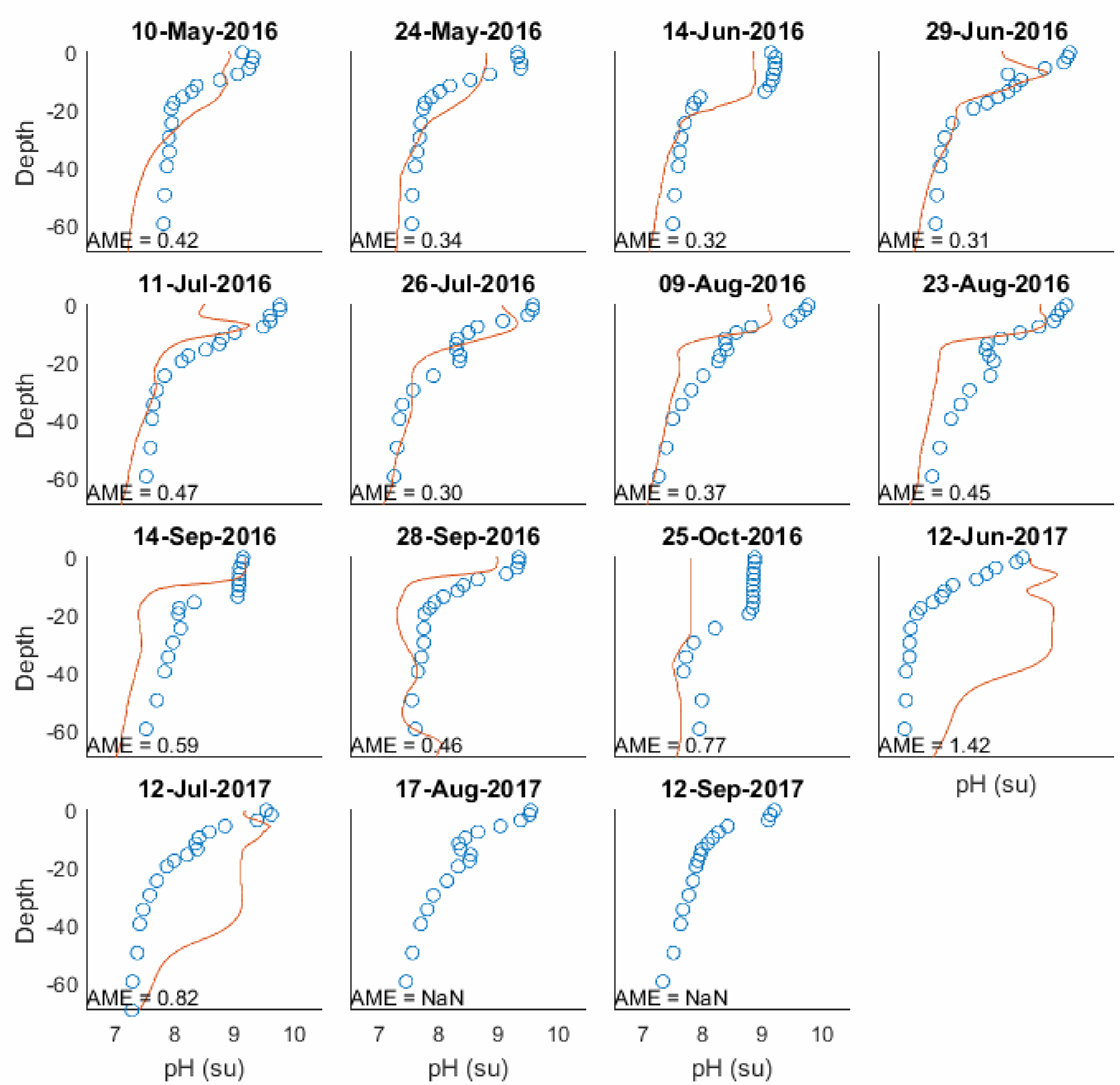


Figure 26. Simulated pH profiles at Round Butte forebay (RES07) for the final profiles.

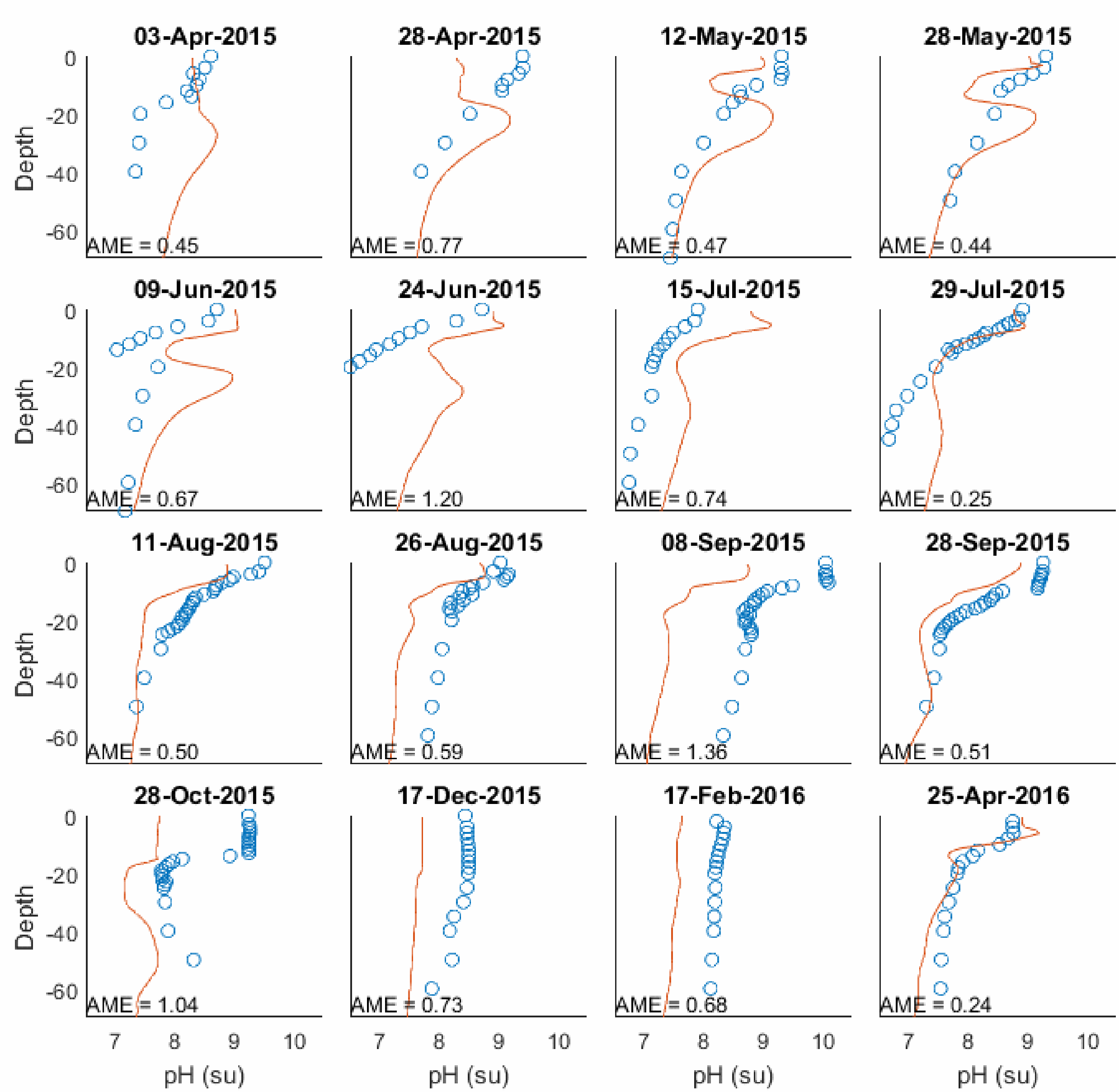


Figure 27. Simulated pH profiles at the Common Pool (RES08) for the first 16 profiles. The final 7 profiles are outlined in Figure 27.

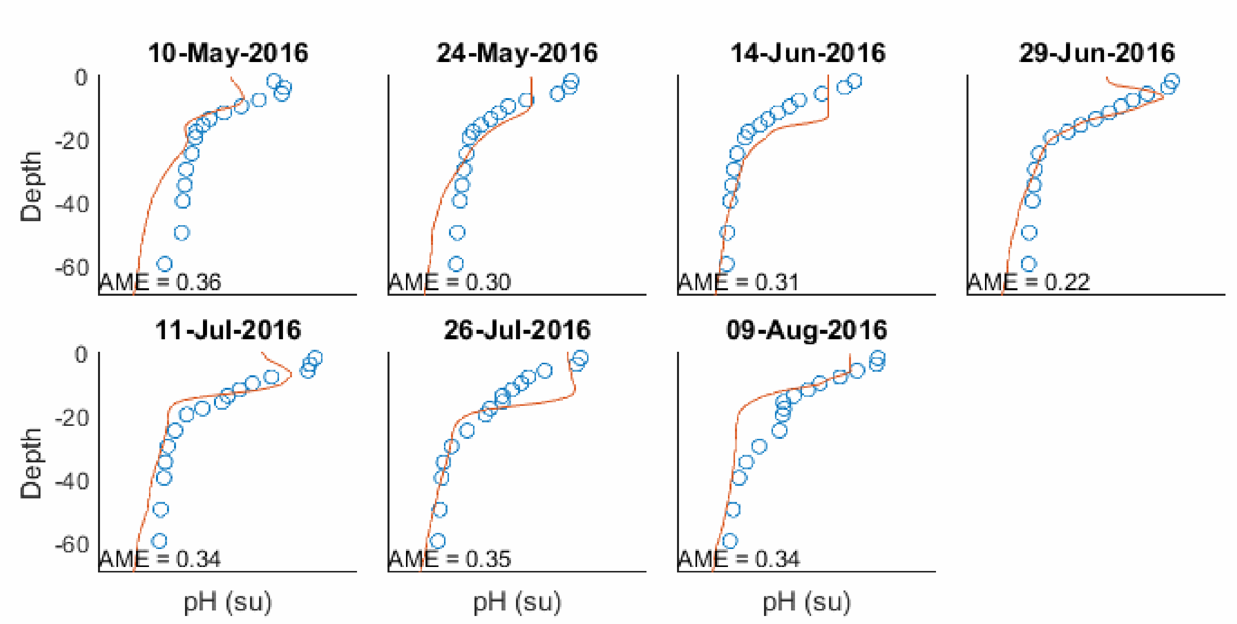


Figure 28. Simulated pH profiles at the Common Pool (RES08) for the final profiles.

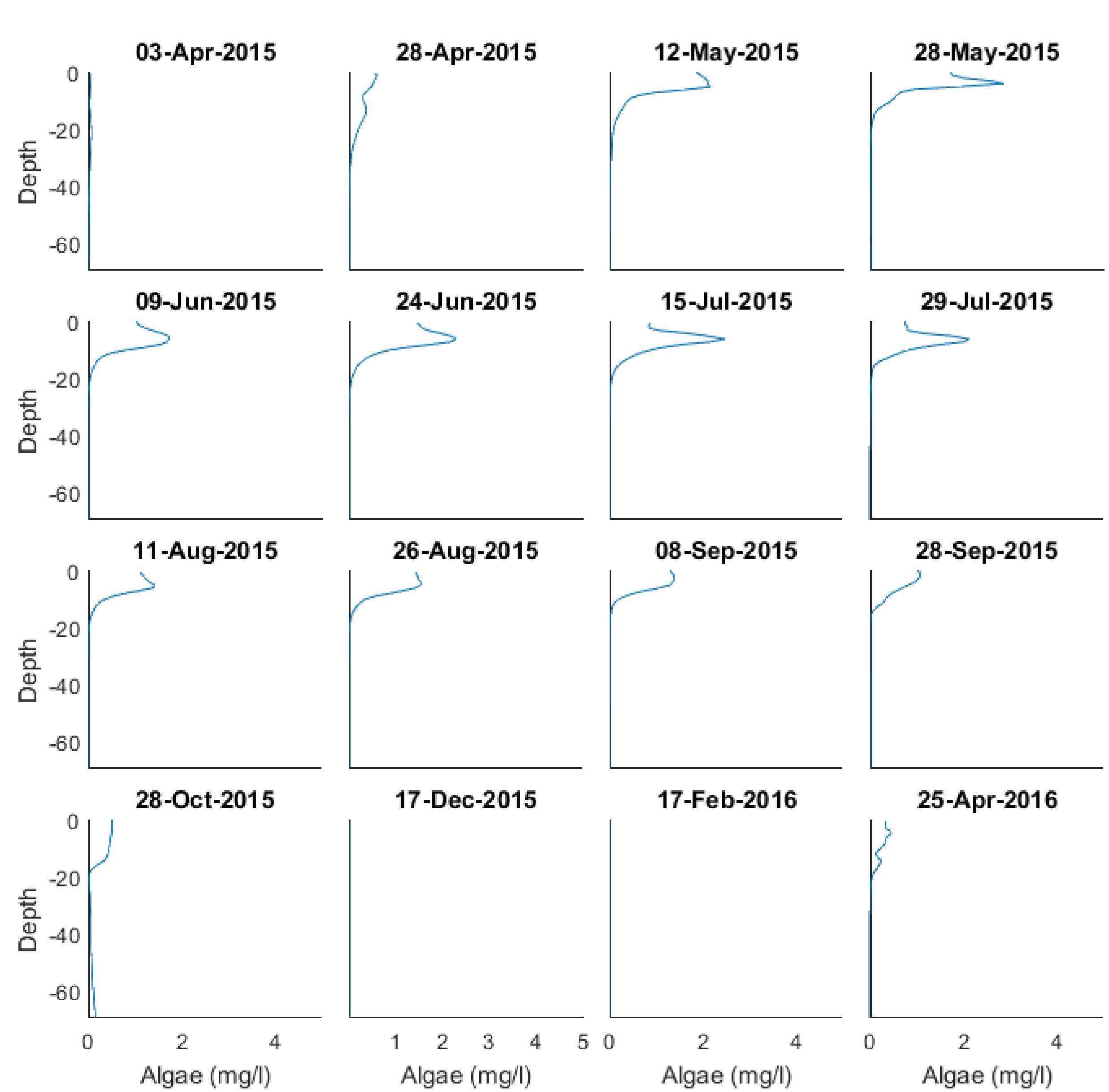


Figure 29. Profiles of simulated algae dynamics at Round Butte forebay (RES07) for the first 16 profiles

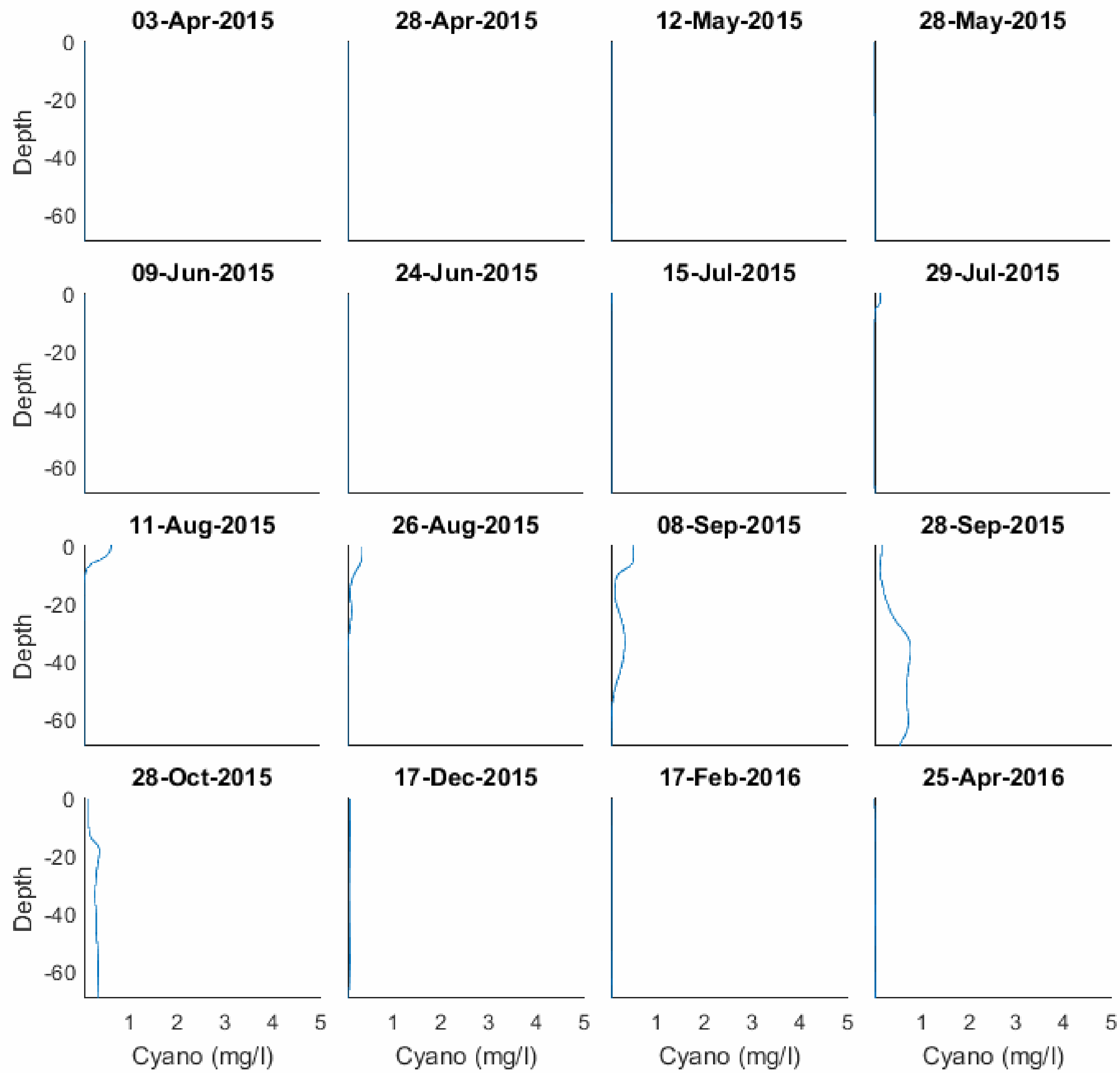
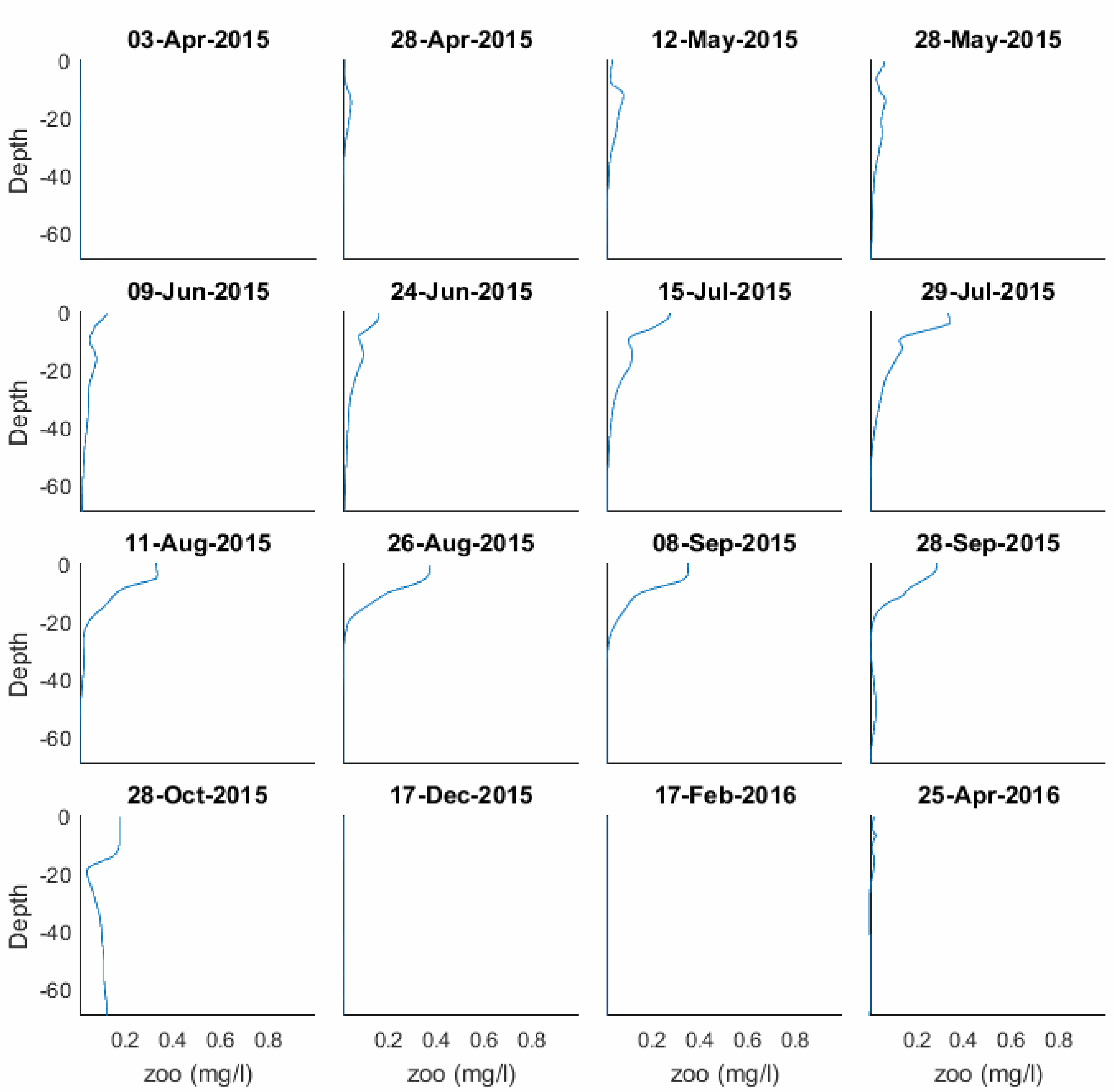


Figure 30. Profiles depicting the dynamics of cyanobacteria at Round Butte forebay (RES07) for the first 16 profiles.



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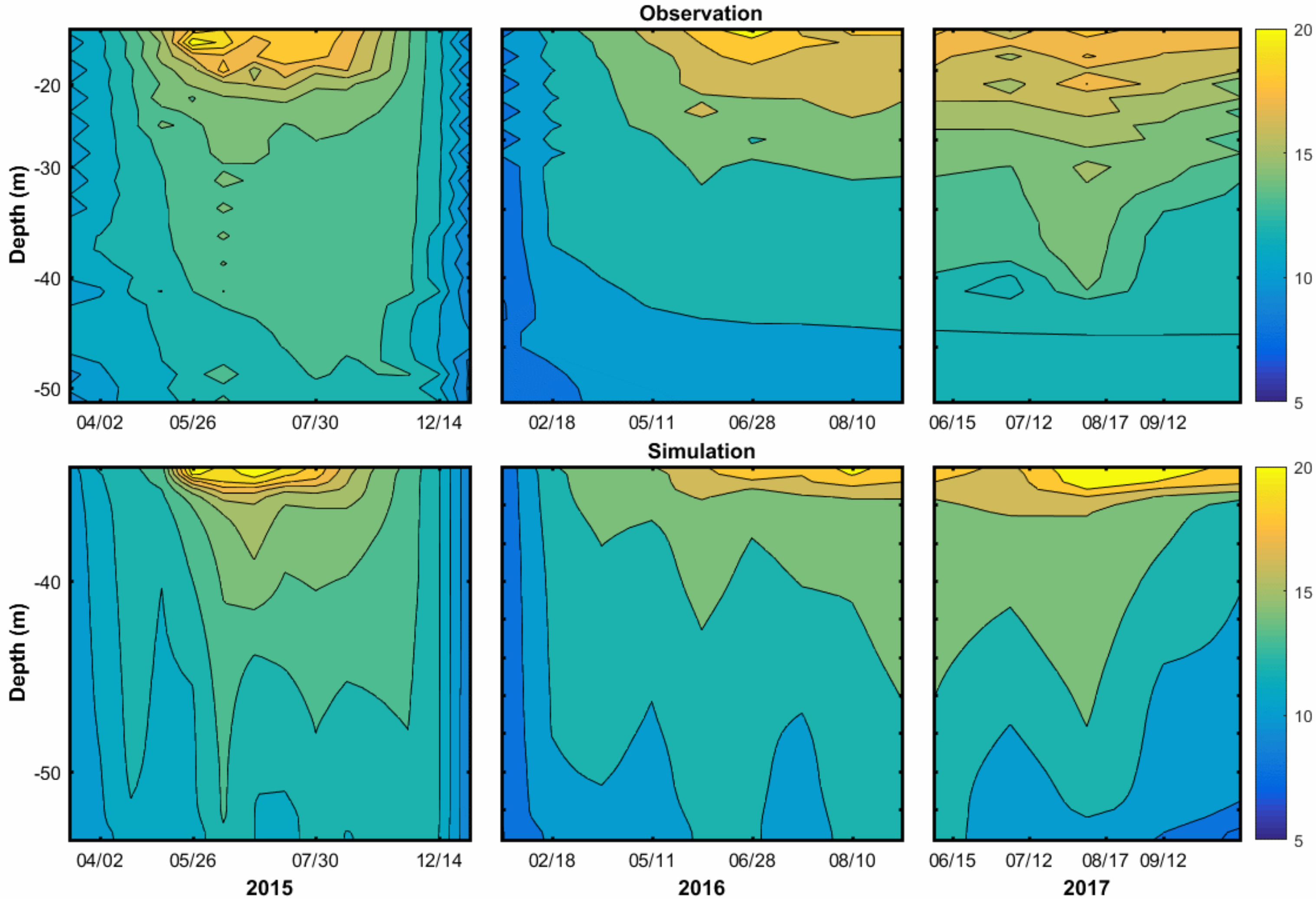

Figure 32. Observed and simulated water temperature at Pelton forebay (RES04).

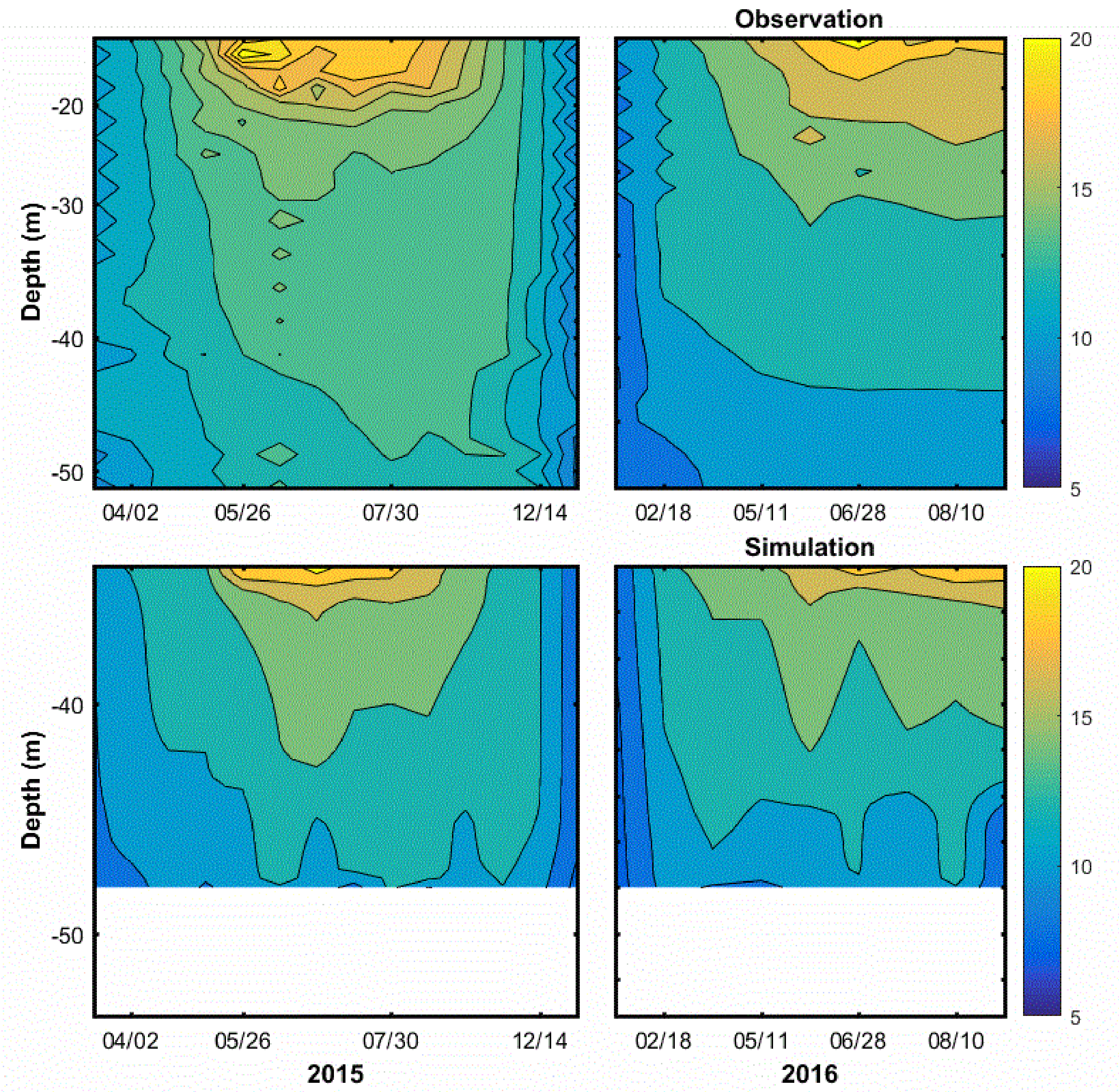

Figure 33. Observed and simulated temperature at Mid-Lake site (RES25). No observations were made in 2017.

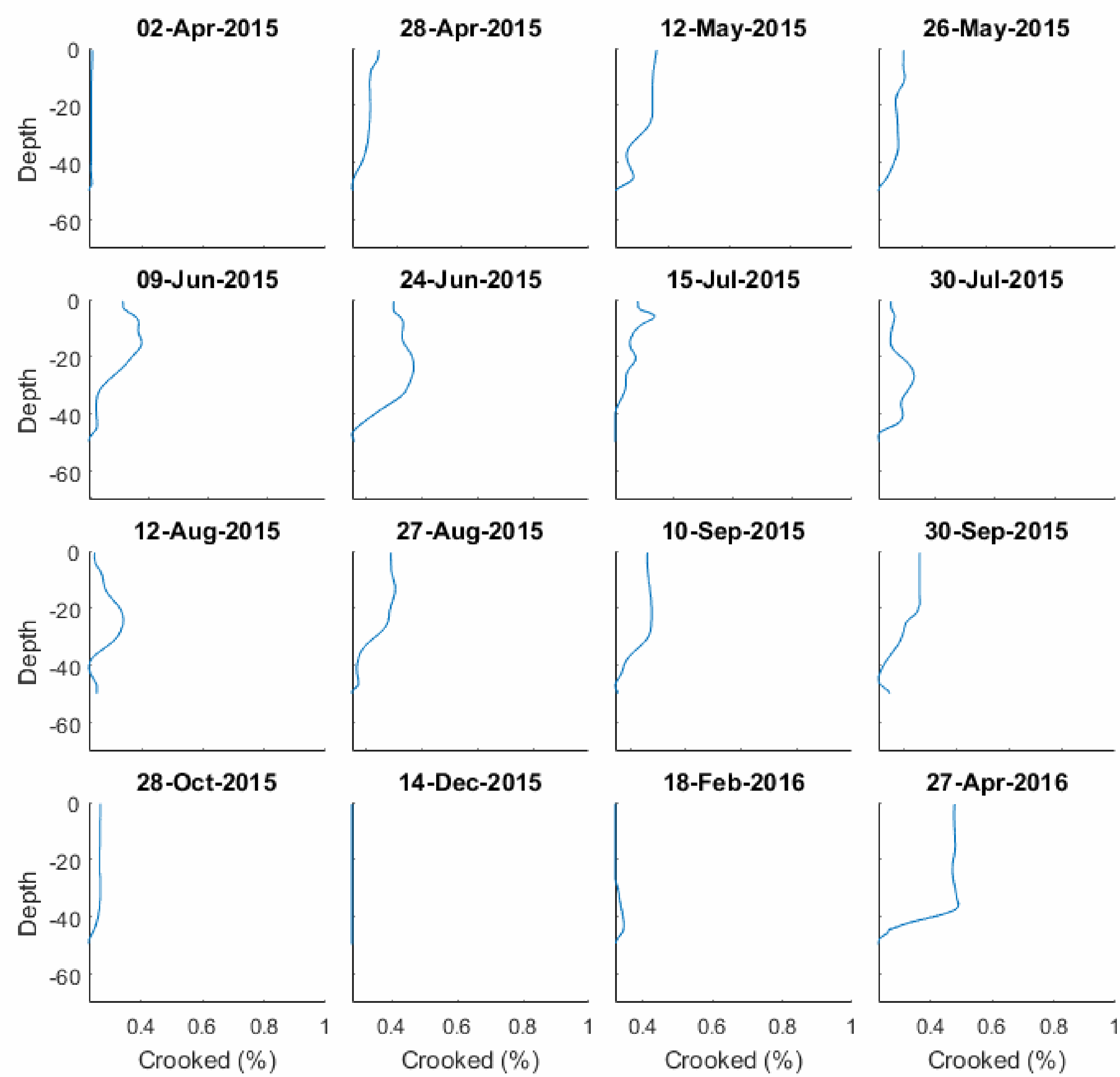

Figure 34. Simulated percent Crooked profiles at Pelton forebay (RES04) for the first 16 profiles.

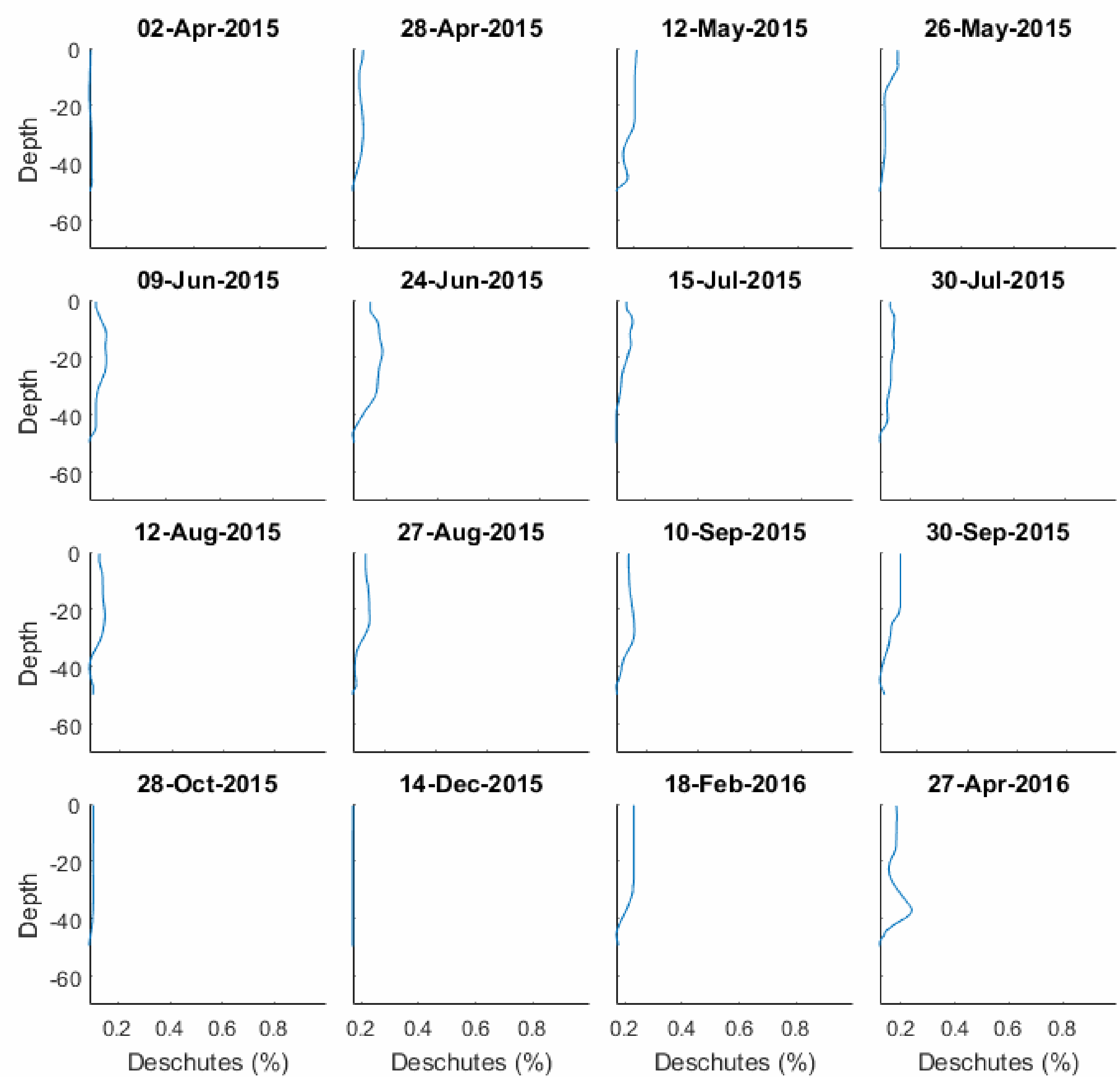

Figure 35. Simulated percent Deschutes profiles at Pelton forebay (RES04) for the first 16 profiles.

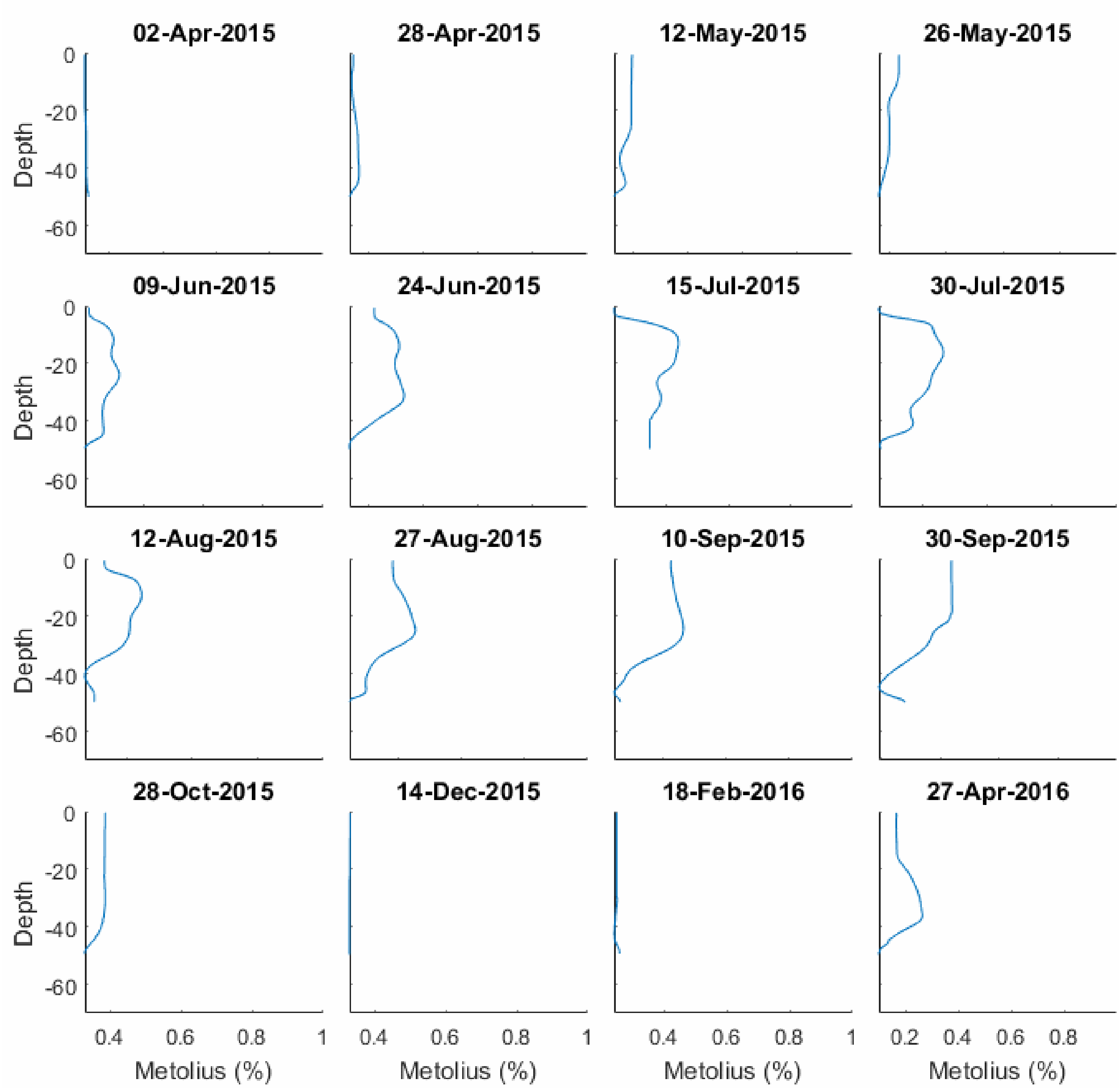

Figure 36. Simulated percent Metolius profiles at Pelton forebay (RES04) for the first 16 profiles.

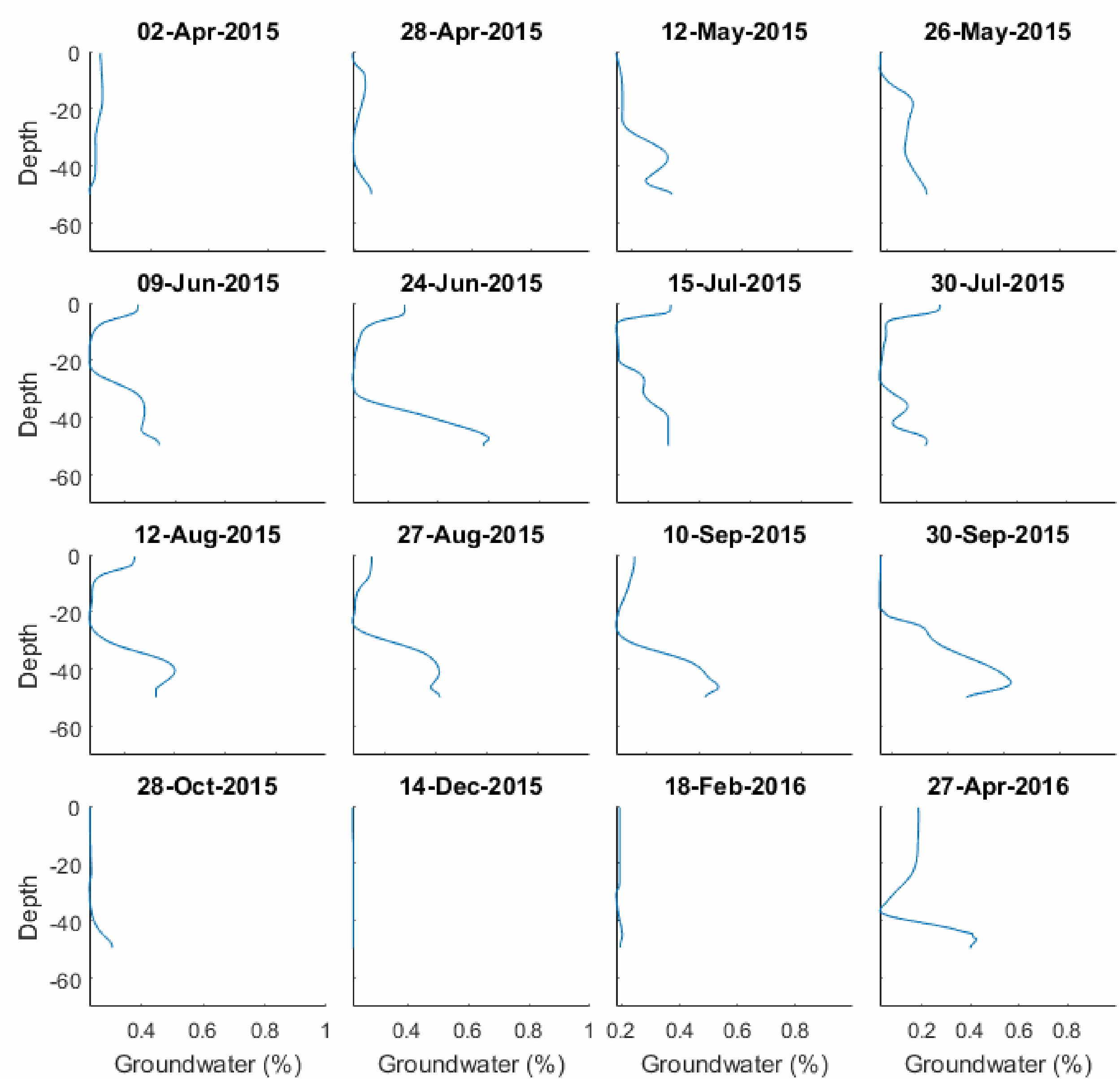

Figure 37. Simulated percent Groundwater profiles at Pelton forebay (RES04) for the first 16 profiles.

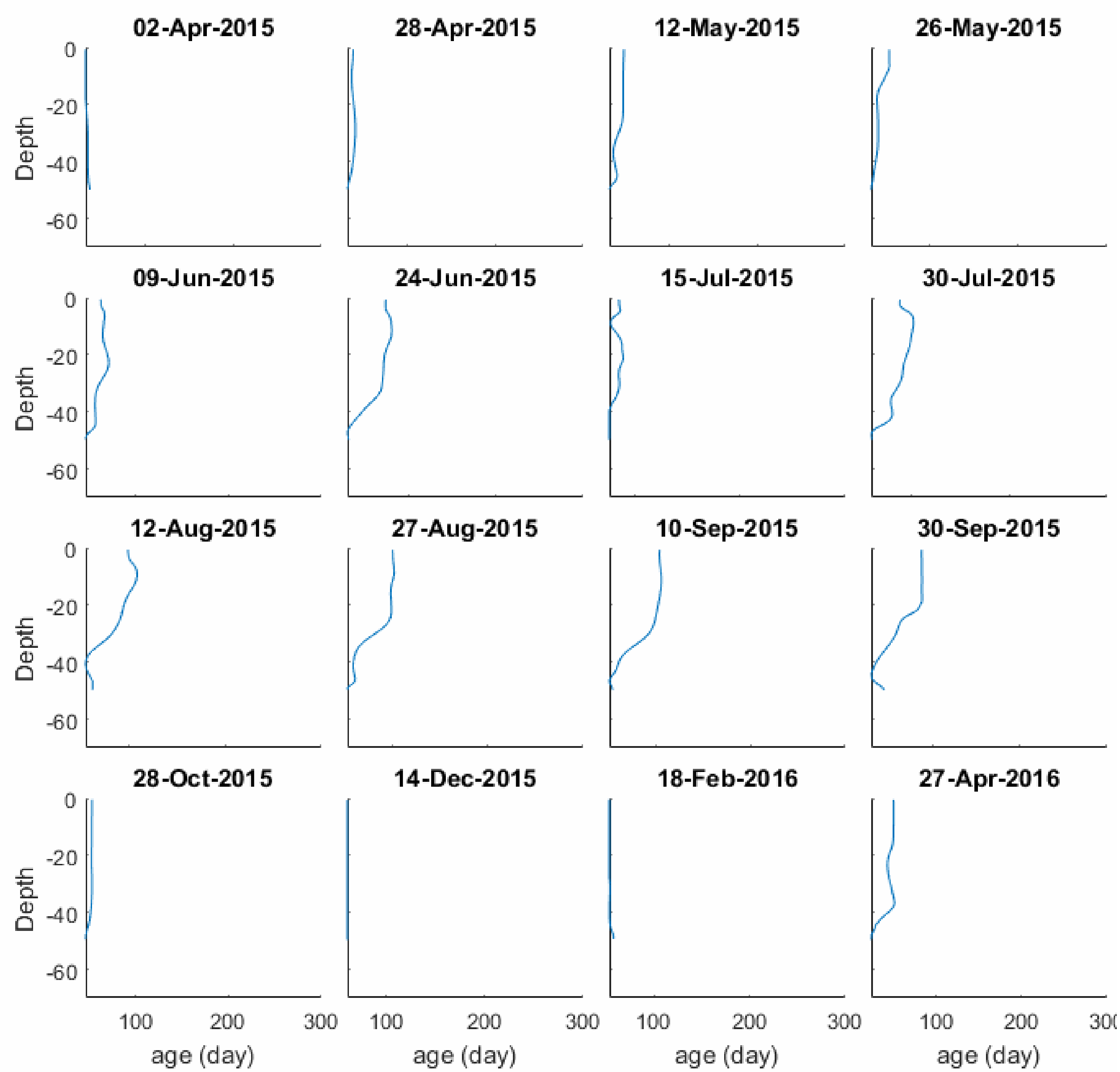

Figure 38. Simulated age profiles at Pelton forebay (RES04) for the first 16 profiles. Age represents the time since the water entered Lake Billy Chinook.

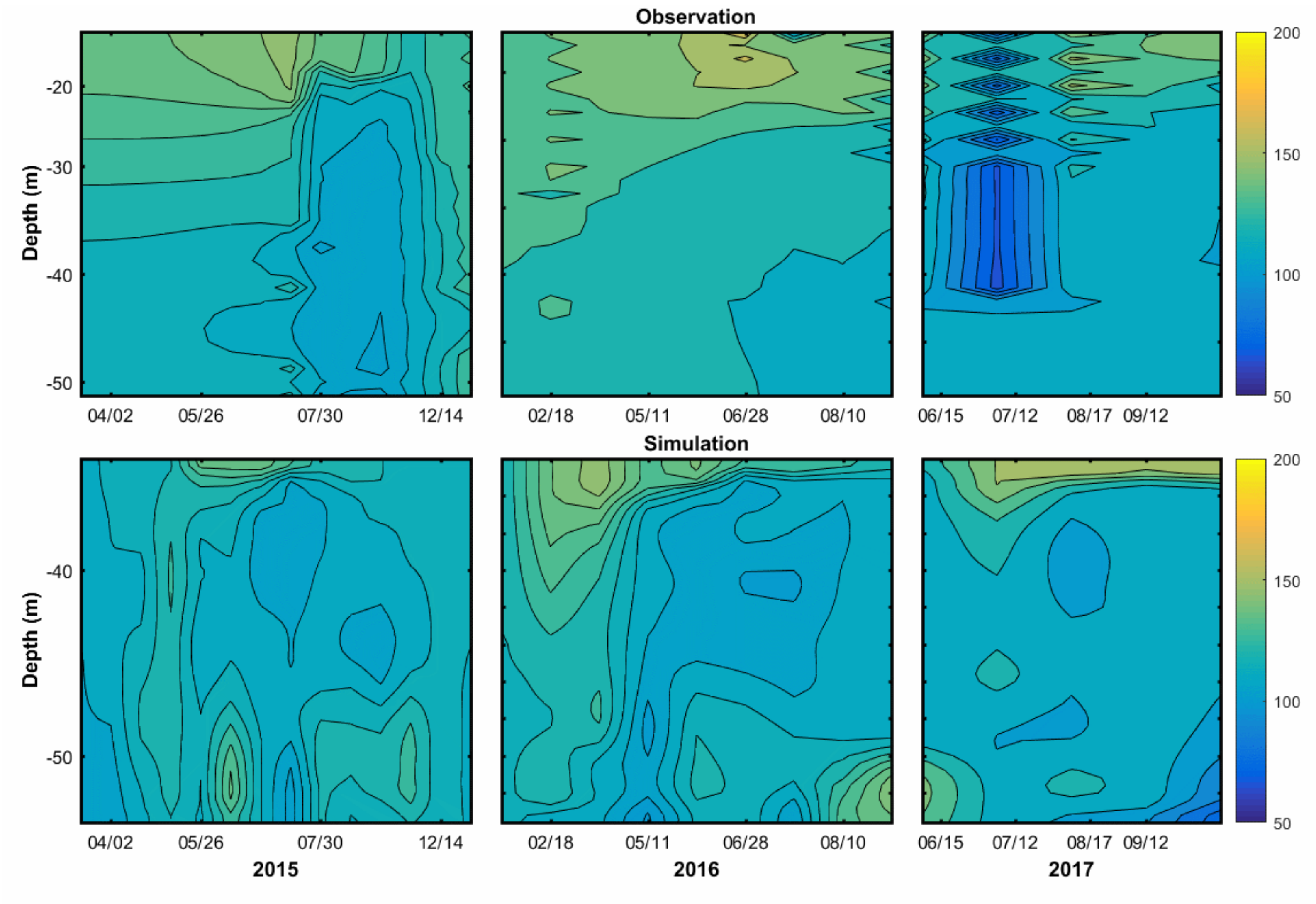

Figure 39. Observed and simulated specific conductivity at Pelton forebay (RES04).

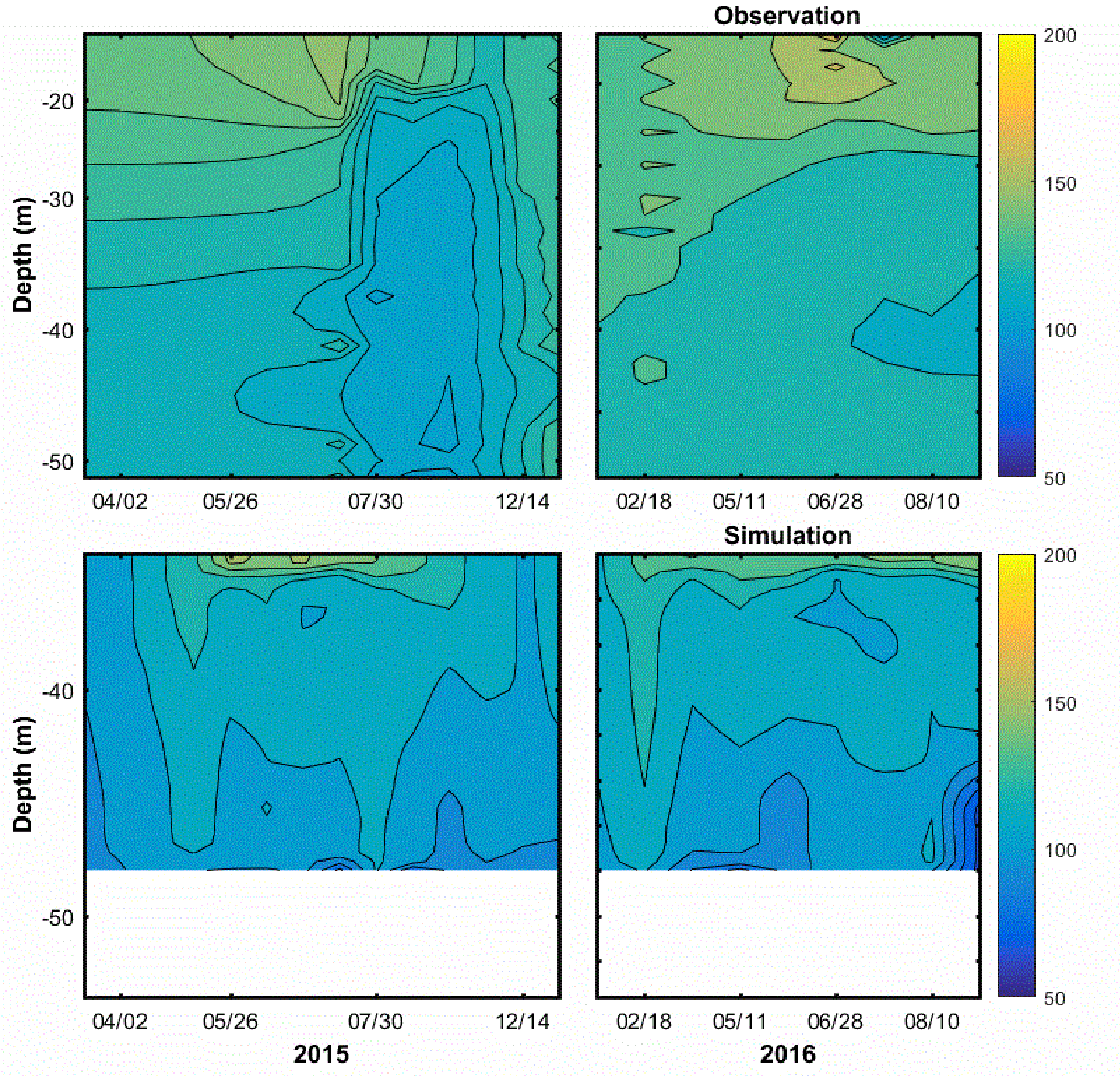

Figure 40. Observed and simulated specific conductivity at Mid-Lake site (RES25). No observations were made in 2017.

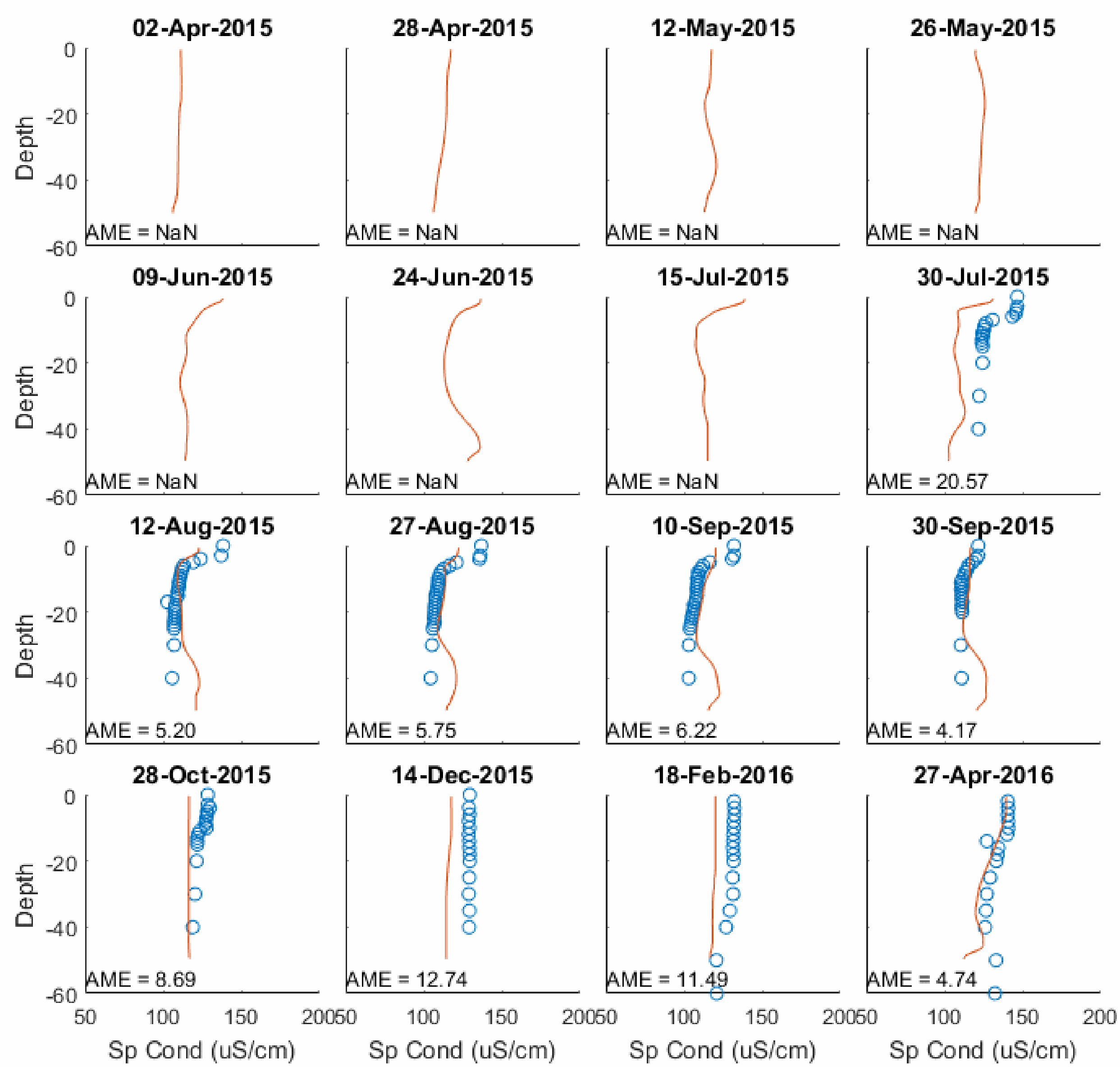

Figure 41. Simulated specific conductivity profiles at Pelton forebay (RES04) for the first 16 profiles. The final 14 profiles are outlined in Figure 42.

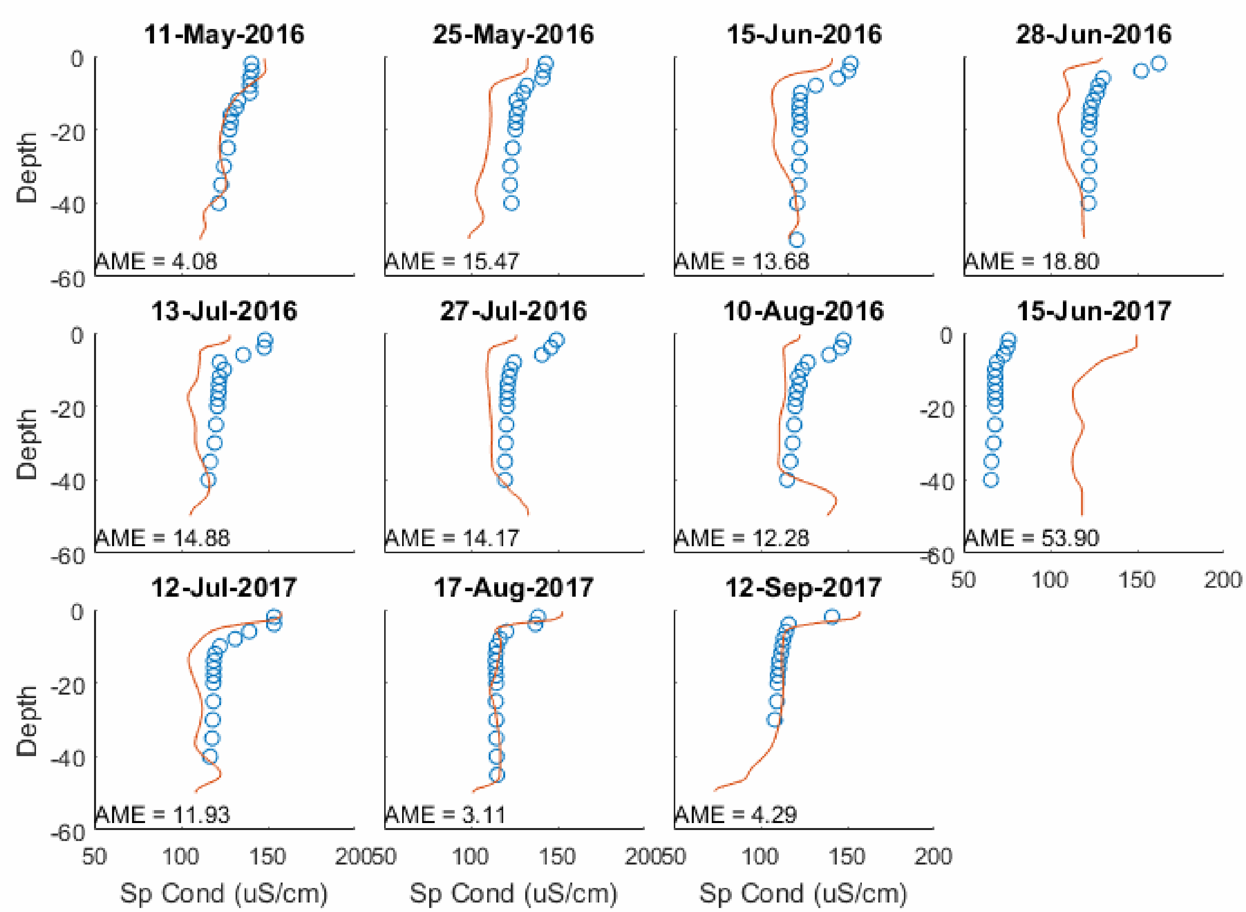

Figure 42. Simulated specific conductivity profiles at Pelton forebay (RES04) for the final profiles.

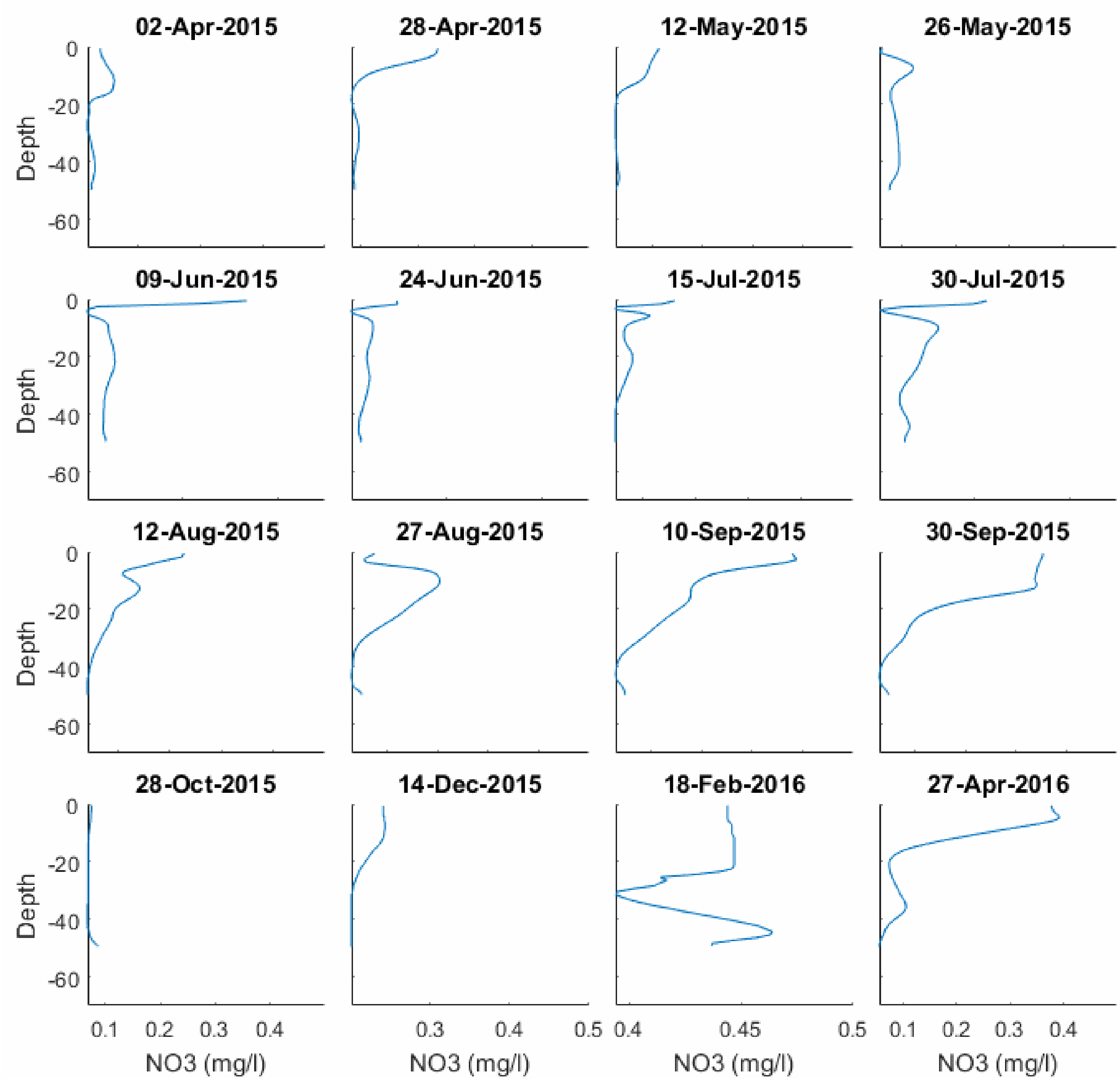

Figure 43. Simulated nitrate-nitrite profiles at Pelton forebay (RES04) for the first 16 profiles.

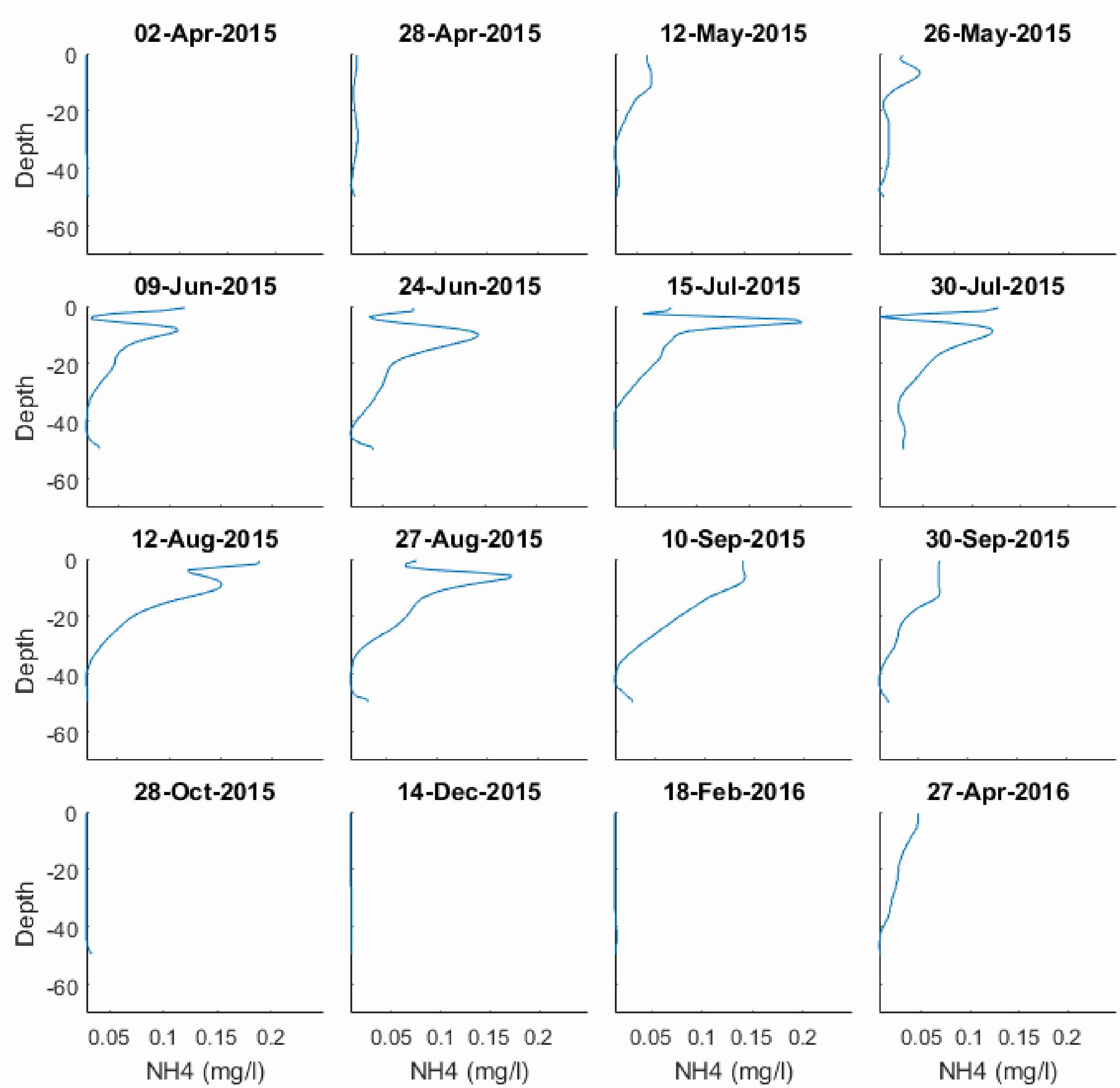

Figure 44. Simulated ammonia profiles at Pelton forebay (RES04) for the first 16 profiles.

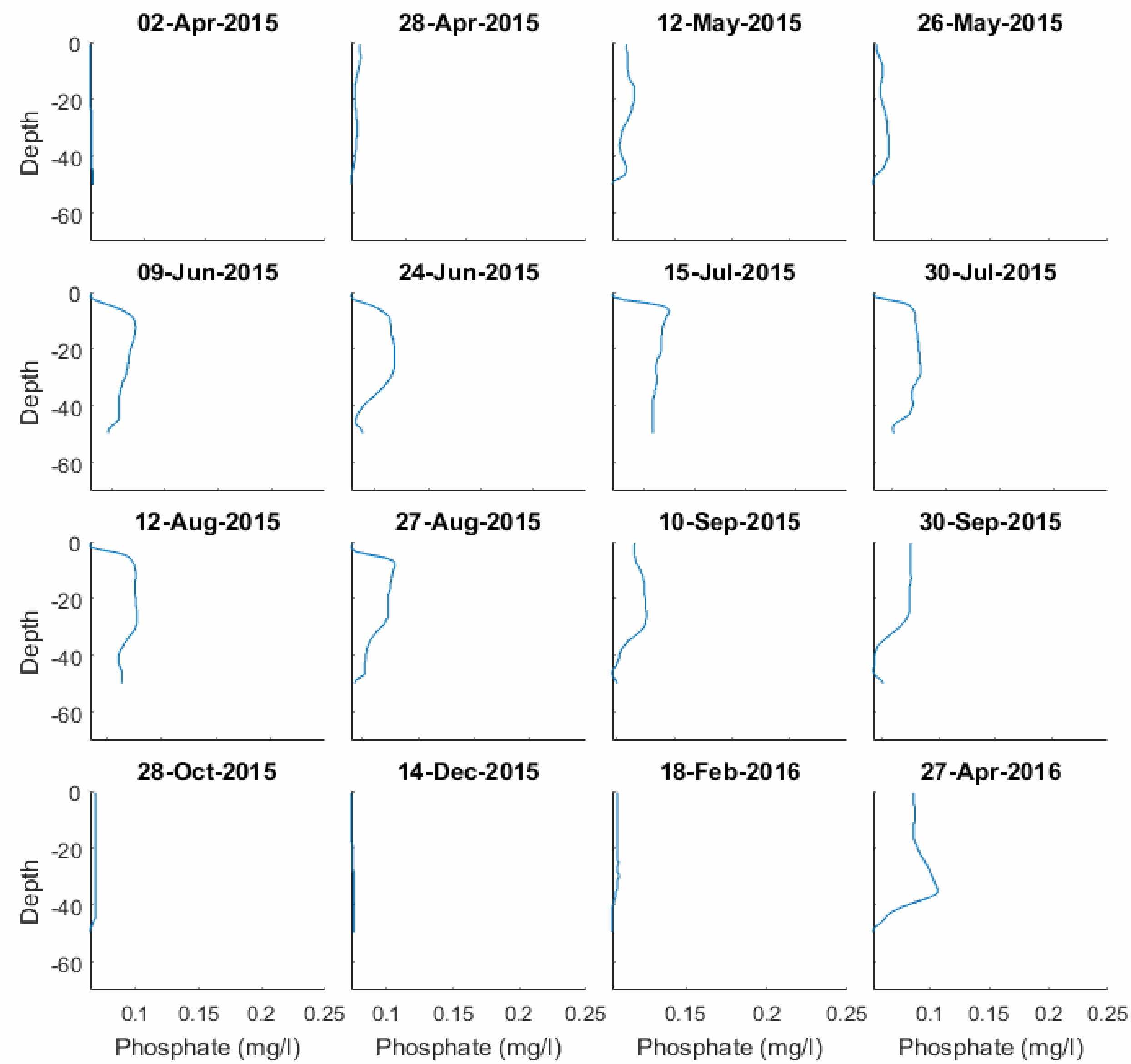

Figure 45. Simulated phosphate profiles at Pelton forebay (RES04) for the first 16 profiles.

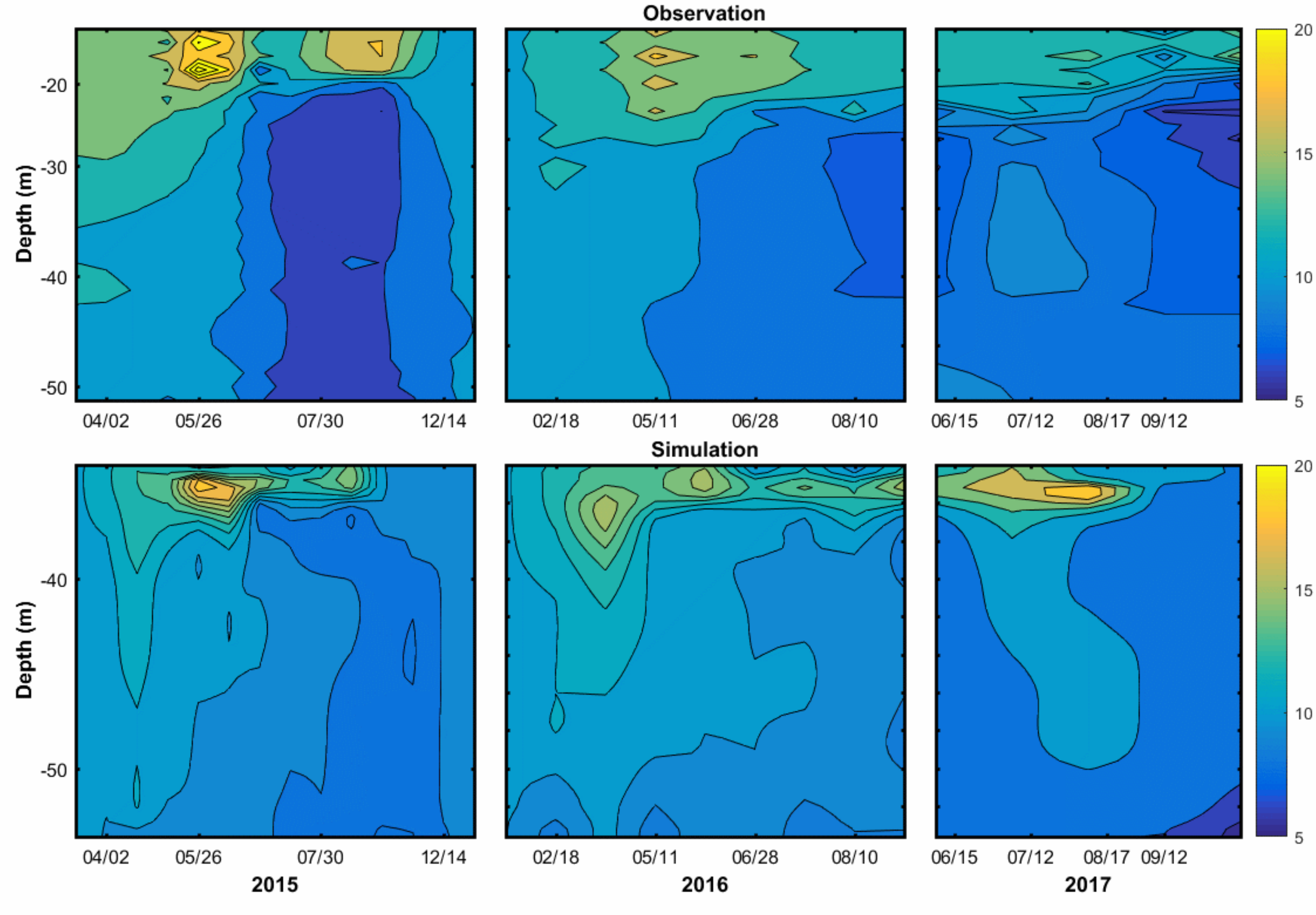

Figure 46. Simulated and observed DO at Round Butte forebay (RES07).

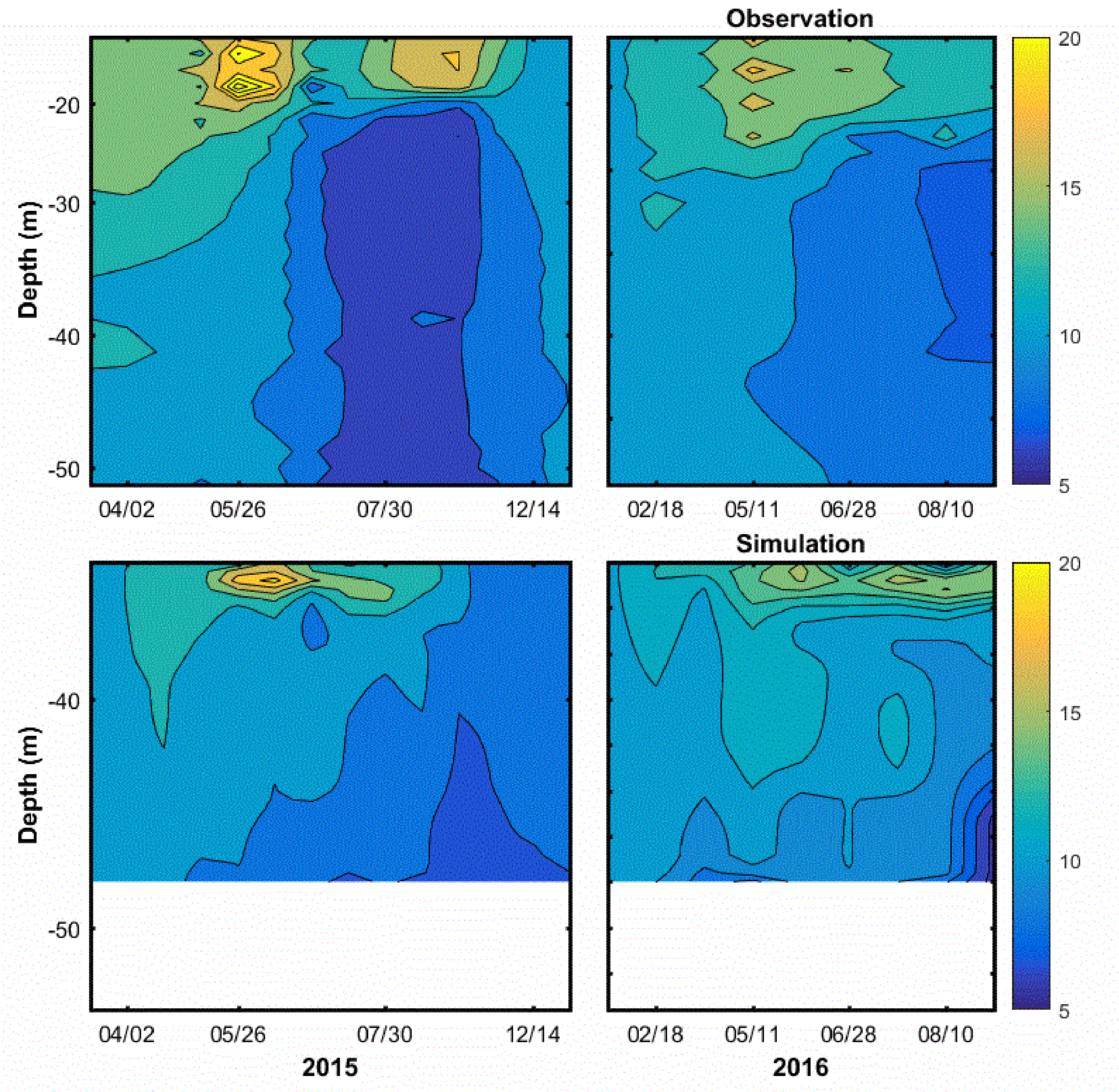

Figure 47. Simulated and observed DO at Mid-Lake site (RES25). No observations were made during 2017.

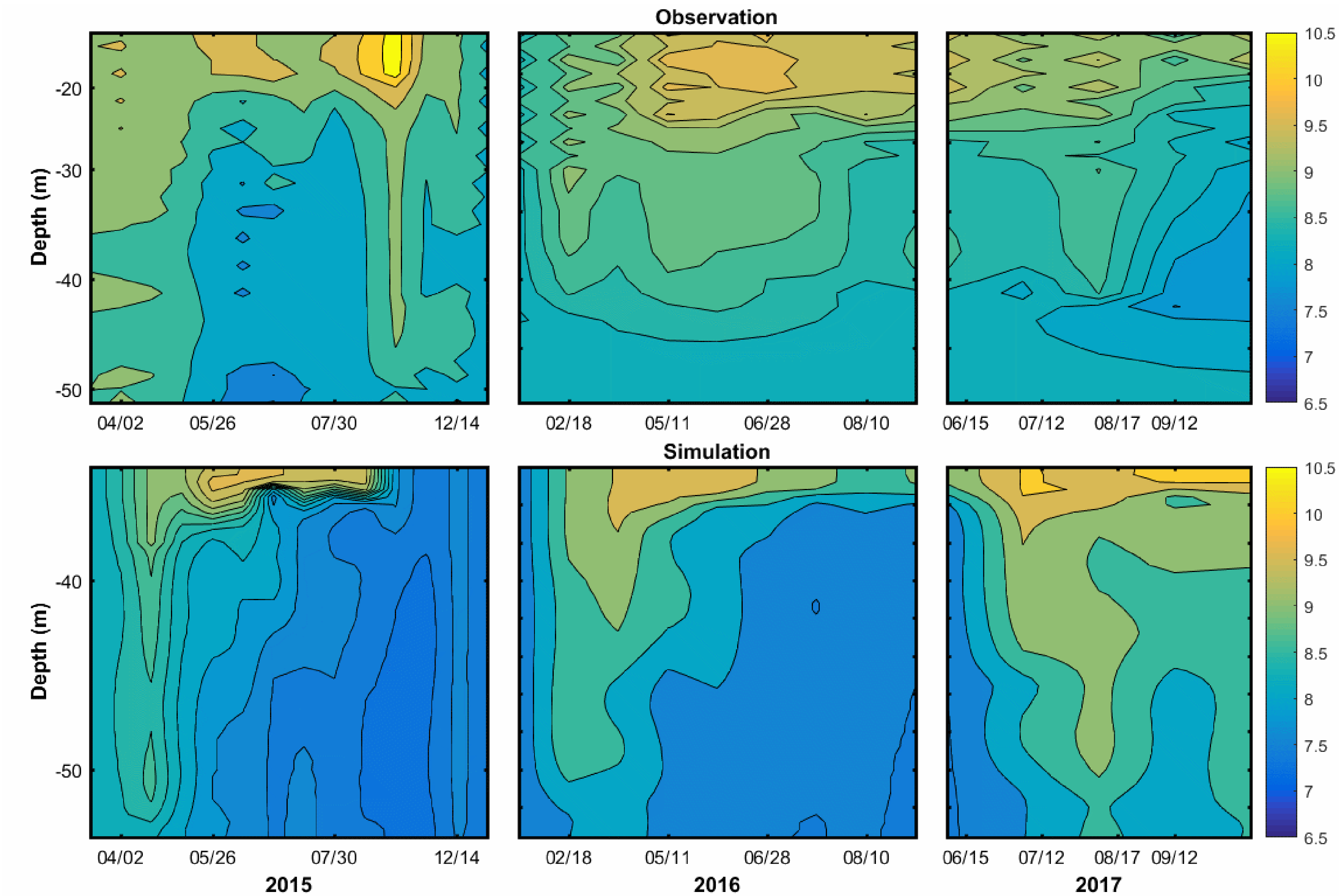

Figure 48. Observed and simulated pH at Pelton forebay (RES04).

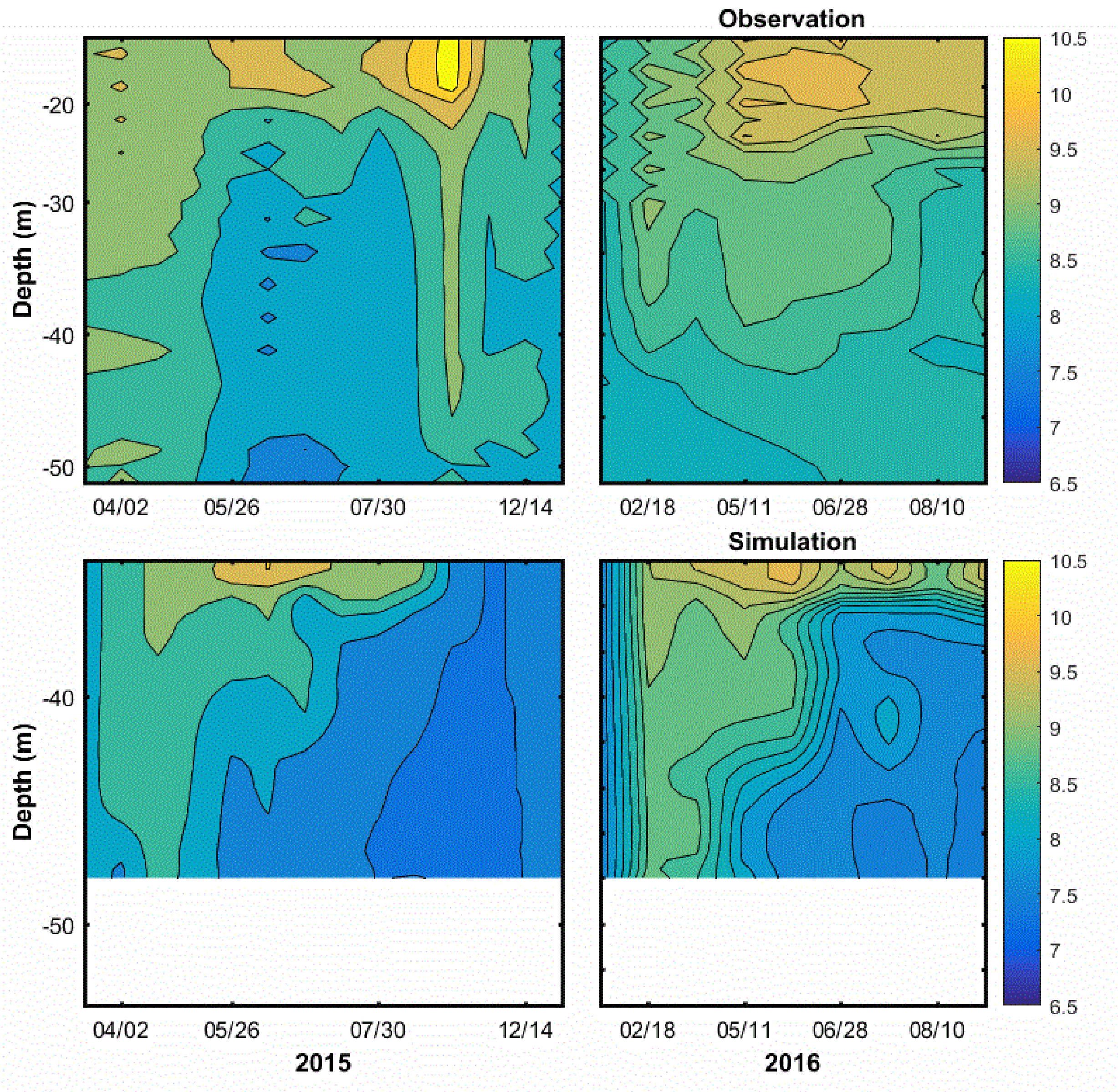

Figure 49. Observed and simulated pH at Mid-Lake site (RES25). No observations were made in 2017.

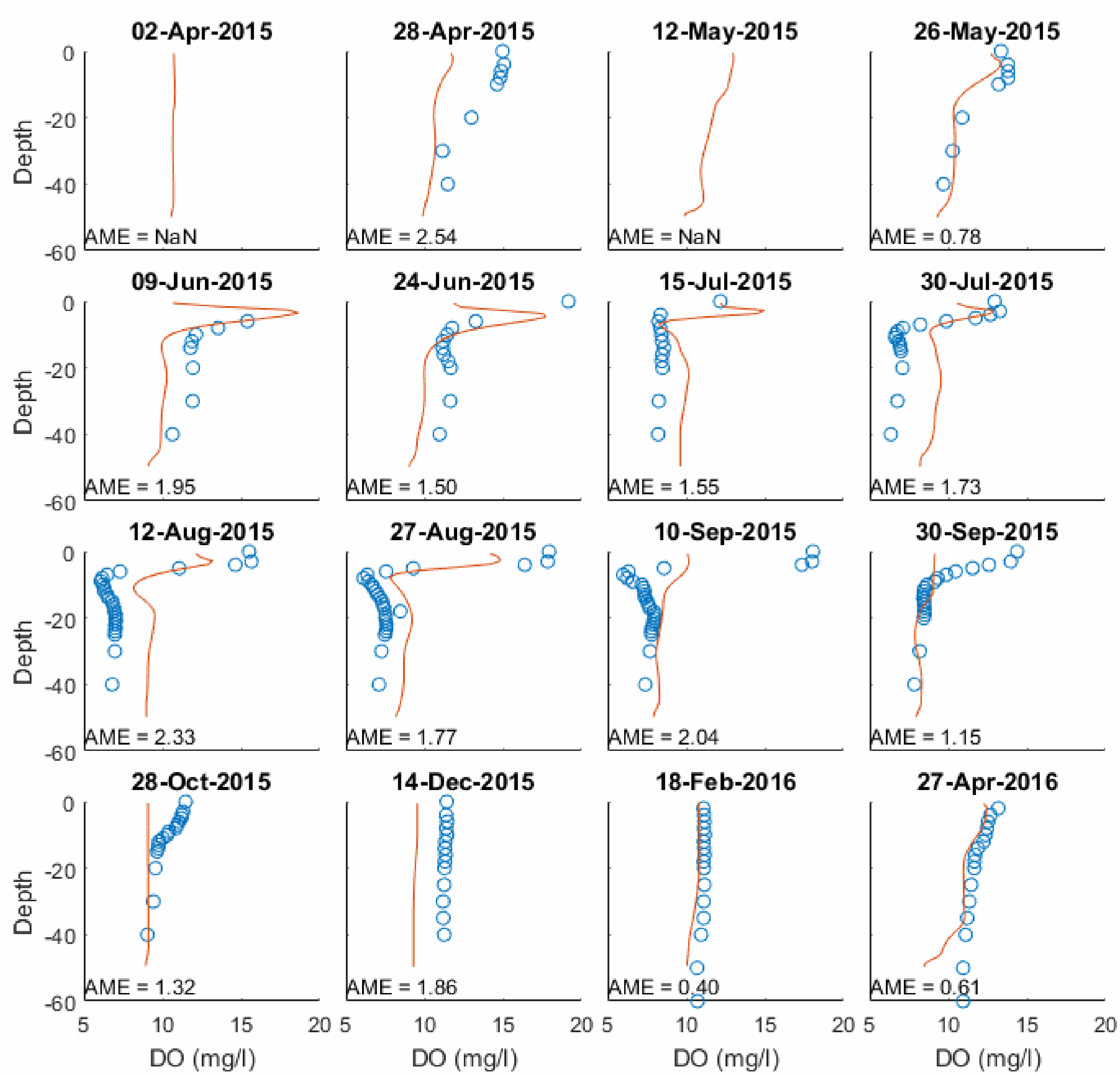

Figure 50. Simulated DO profiles at Pelton forebay (RES04) for the first 16 profiles. The final seven profiles are outlined in Figure 51.

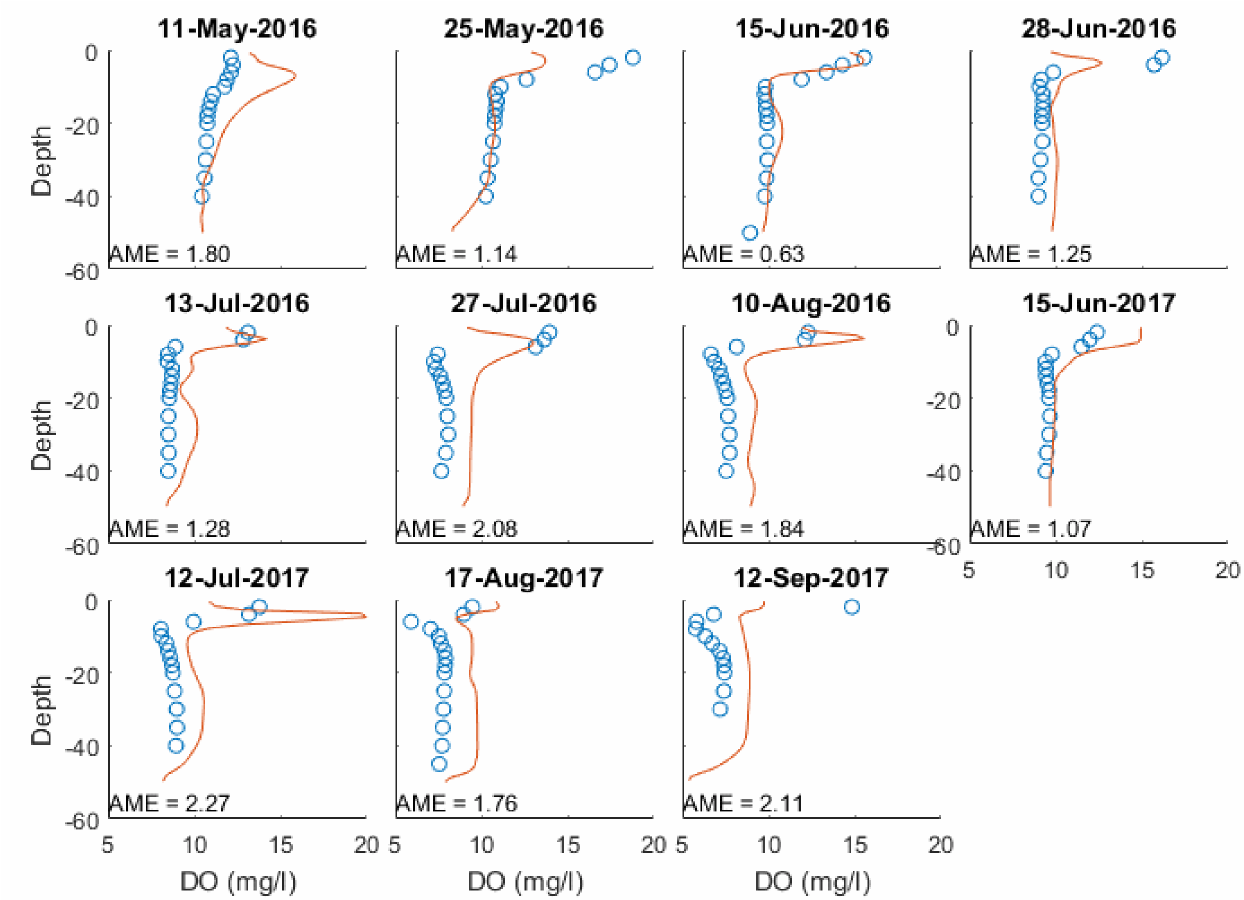

Figure 51. Simulated DO profiles at Pelton forebay (RES04) for the final profiles.

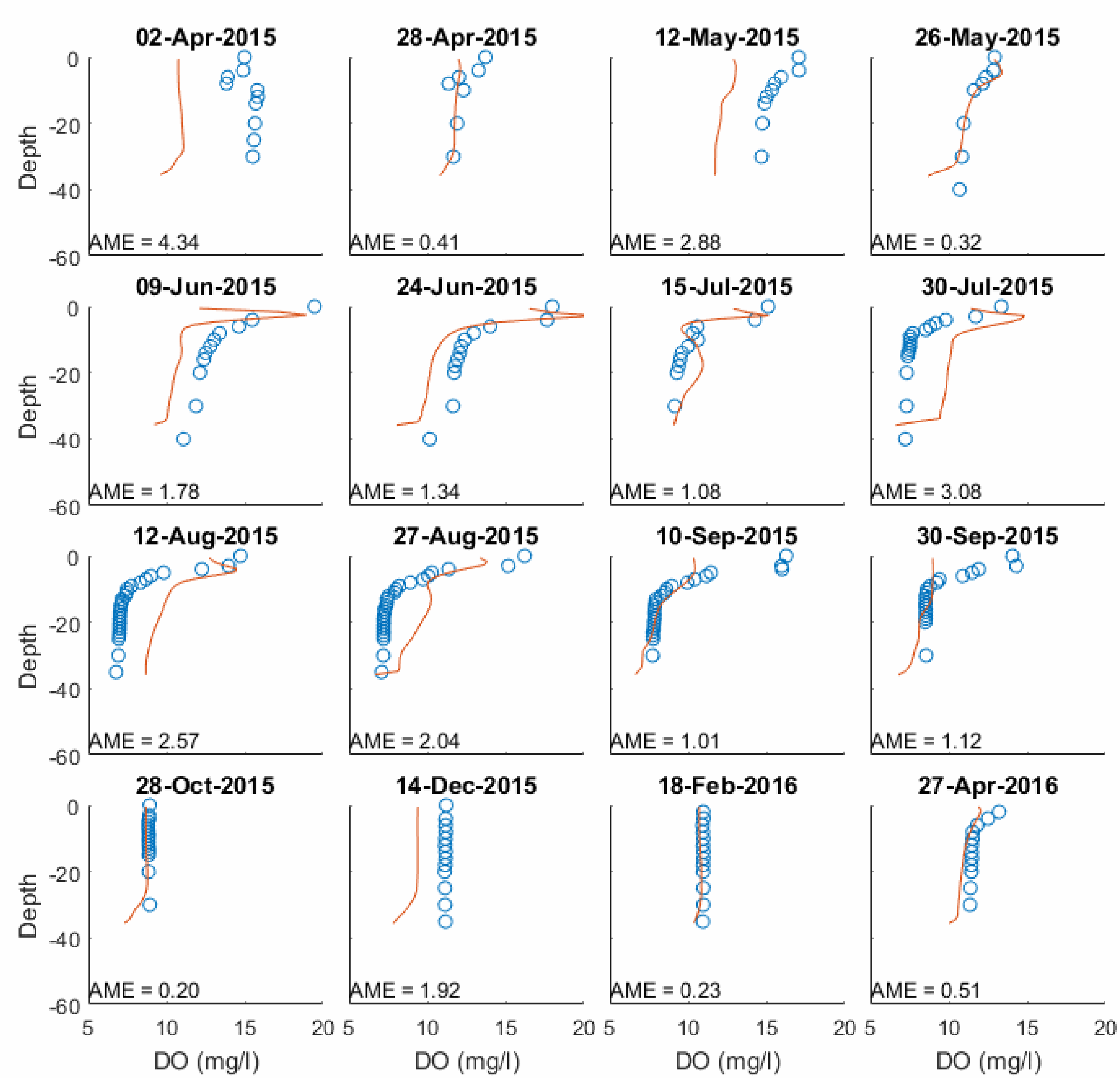

Figure 52. Simulated DO profiles at Mid-Lake site (RES25) for the first 16 profiles. The final seven profiles are outlined in Figure 53.

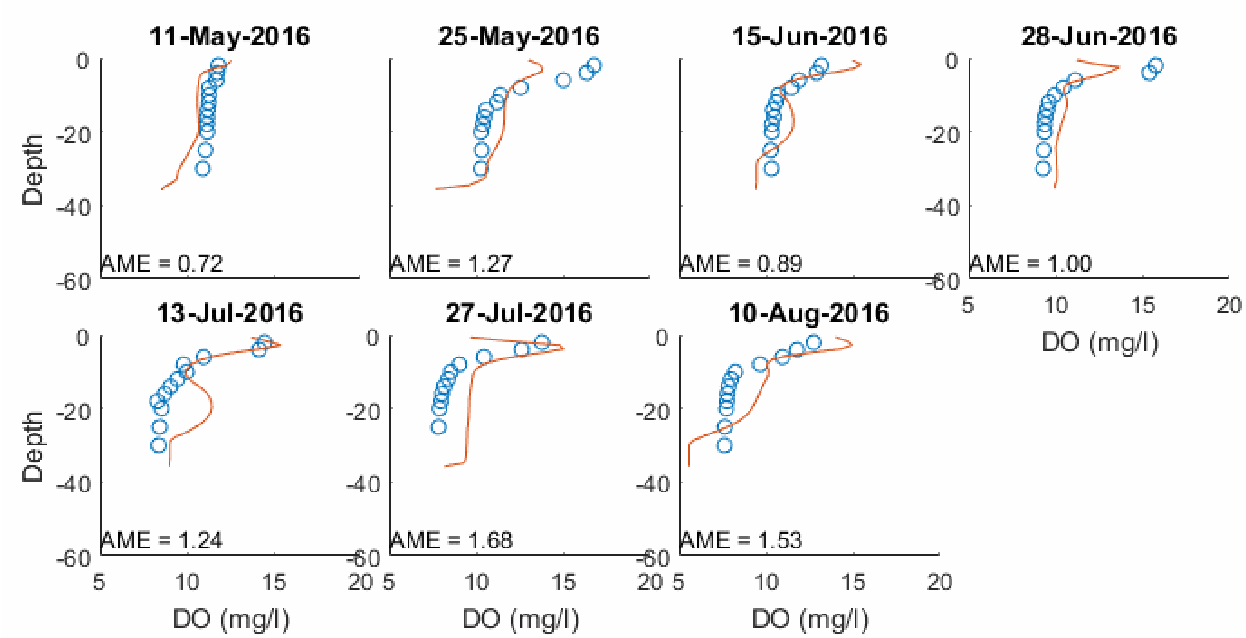

Figure 53. Simulated DO profiles at Mid-Lake site (RES25) for the final profiles.

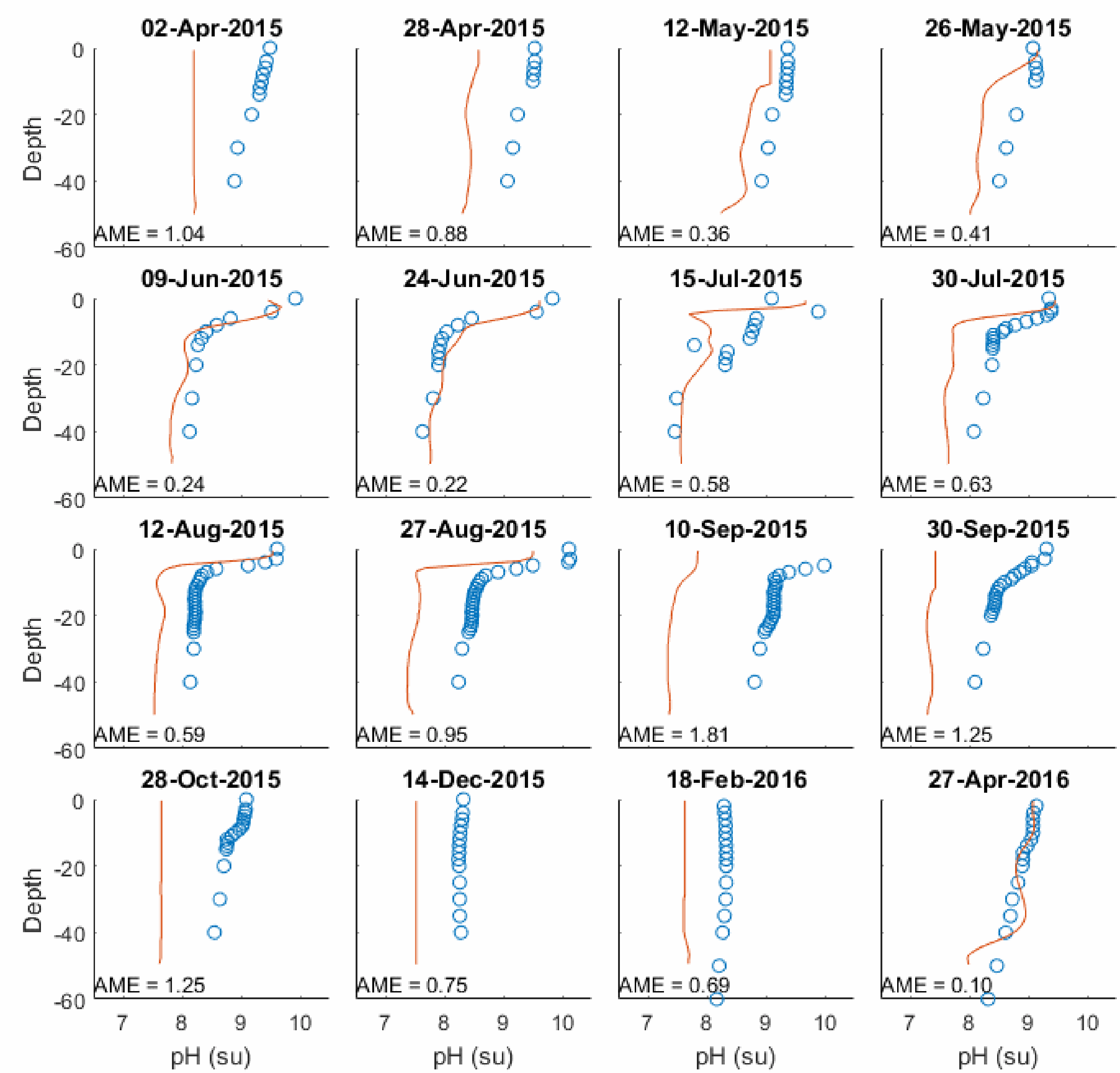

Figure 54. Simulated pH profiles at site RES08 for the first 16 profiles. The final seven profiles are outlined in Figure 55.

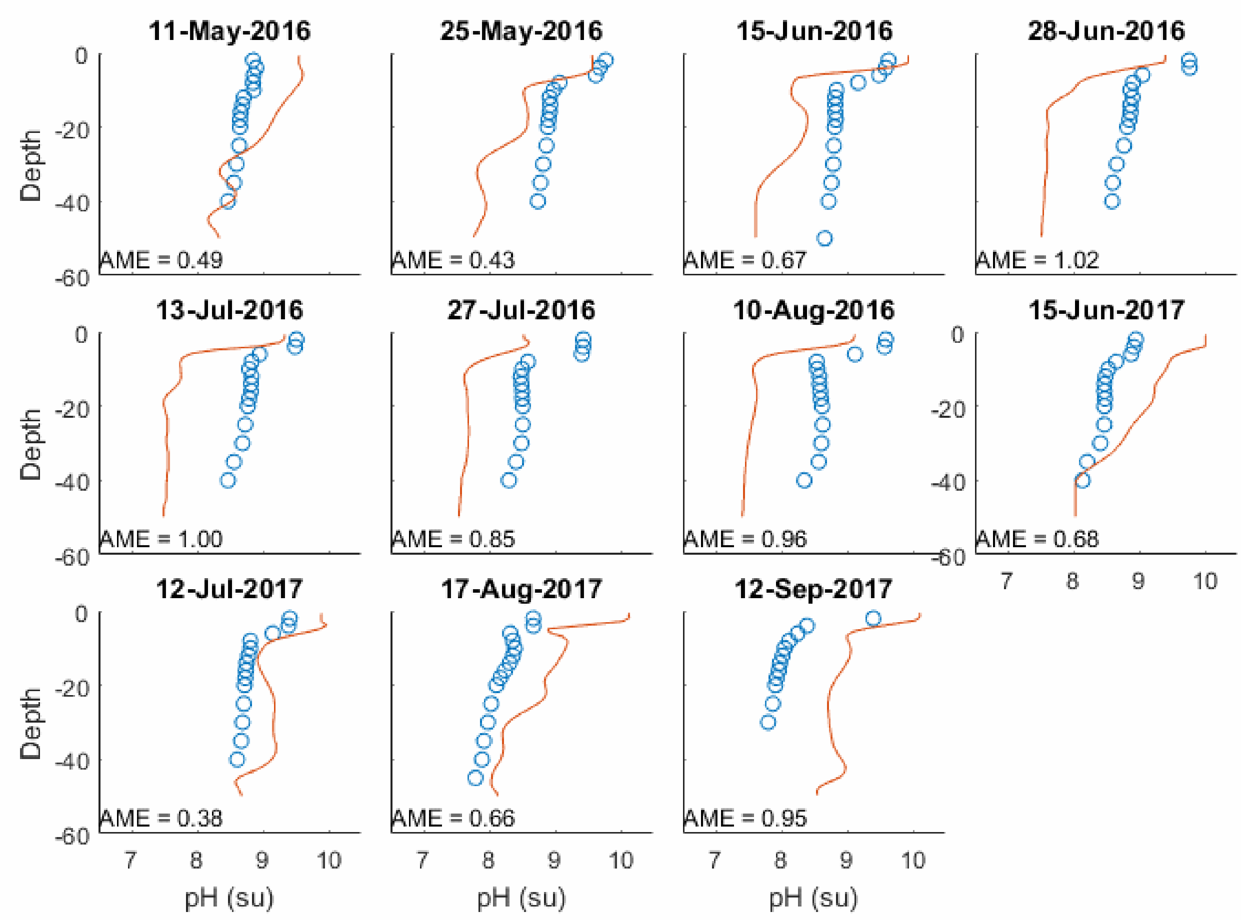

Figure 55. Simulated pH profiles at site RES04 for the final profiles.

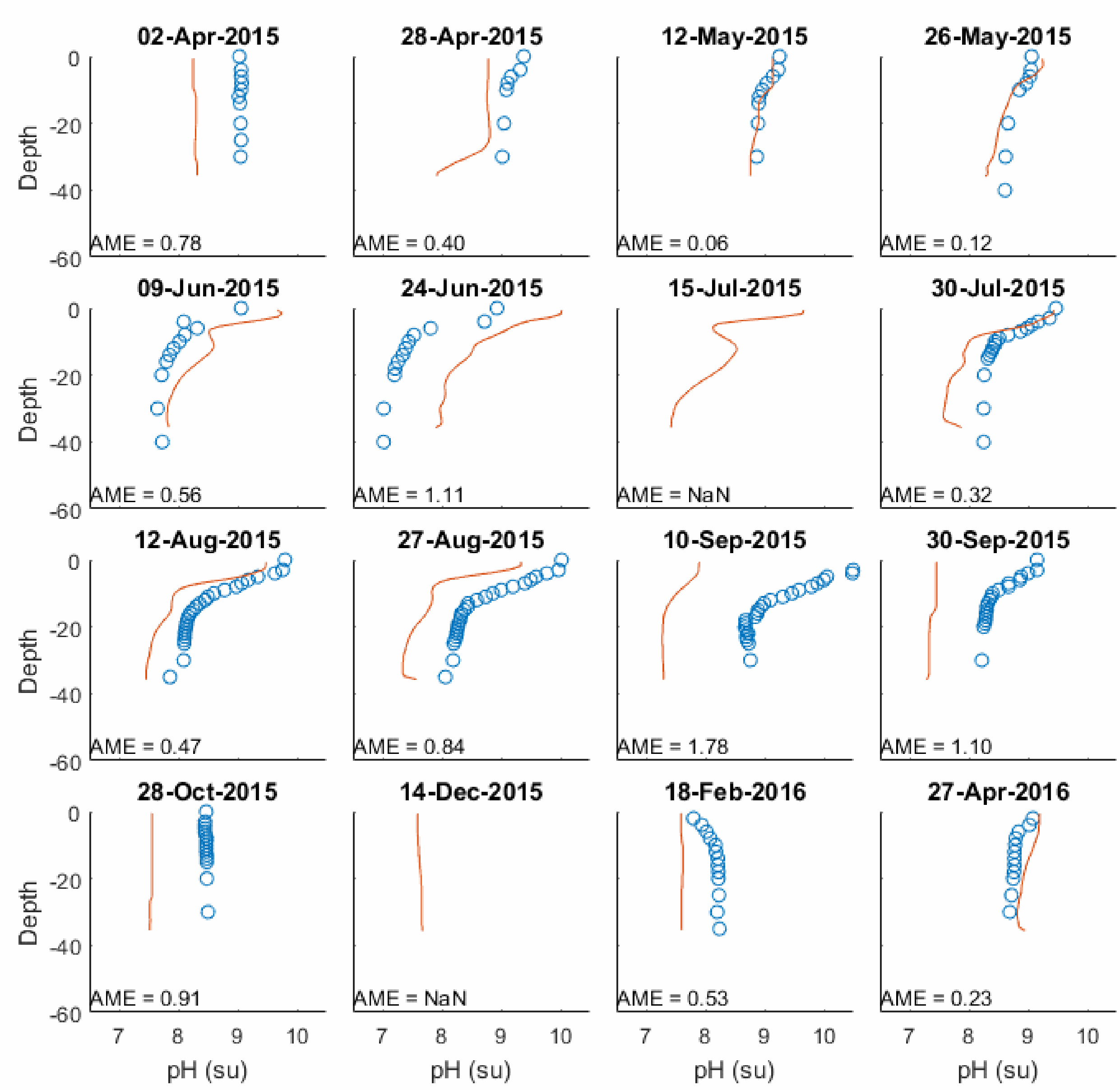

Figure 56. Simulated pH profiles at Mid-Lake site (RES25) for the first 16 profiles. The final seven profiles are outlined in Figure 57.

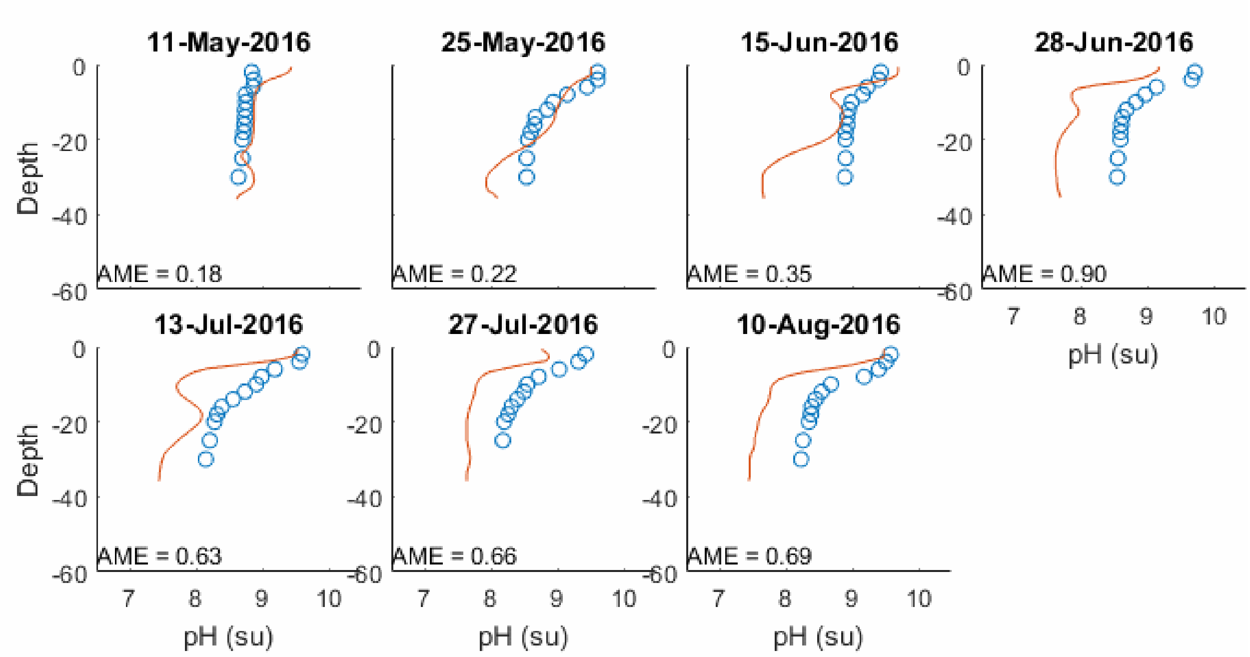

Figure 57. Simulated pH profiles at Mid-Lake site (RES25) for the final profiles.

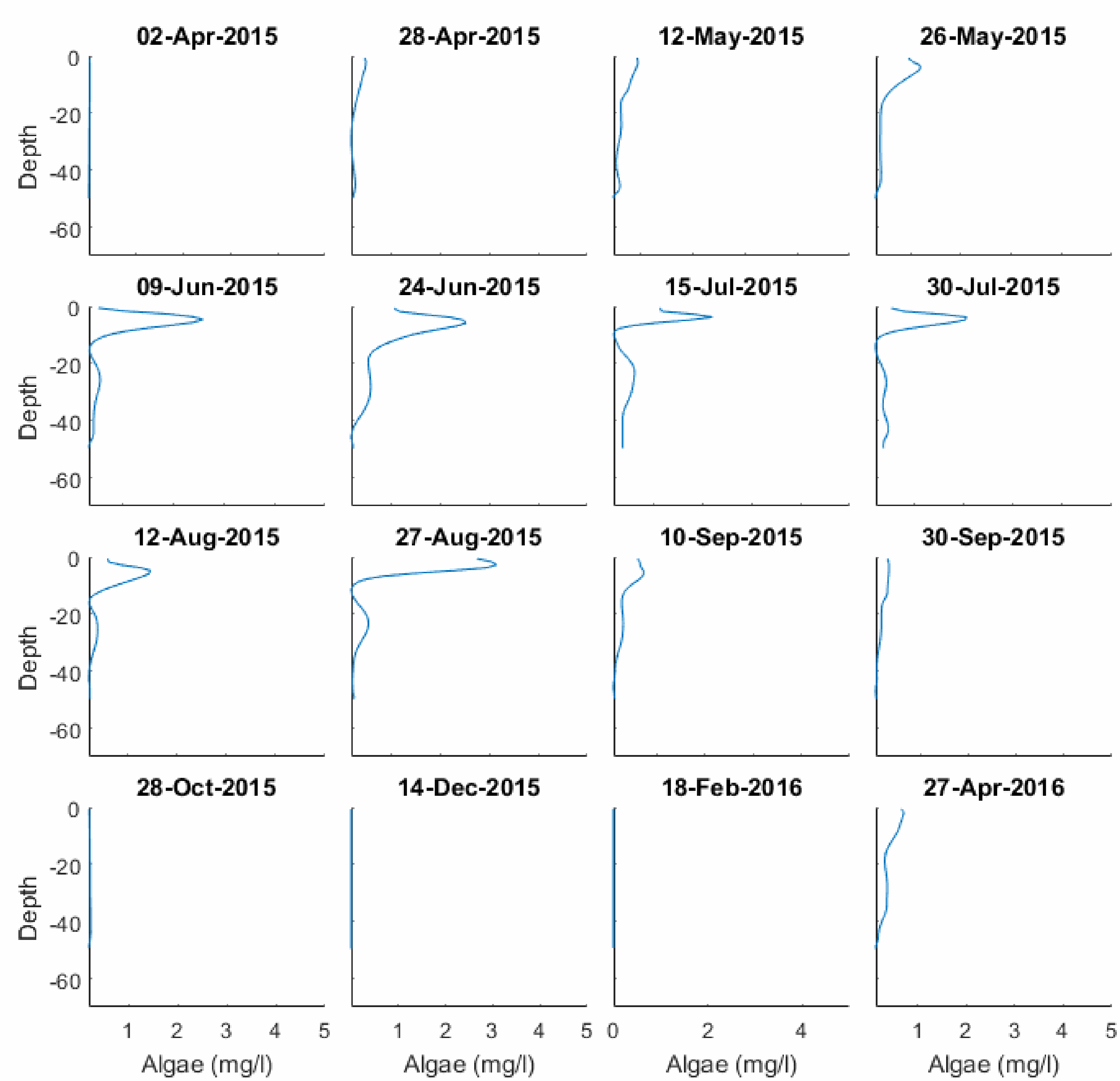

Figure 58. Profiles of simulated algae dynamics at Pelton forebay (RES04) for the first 16 profiles.

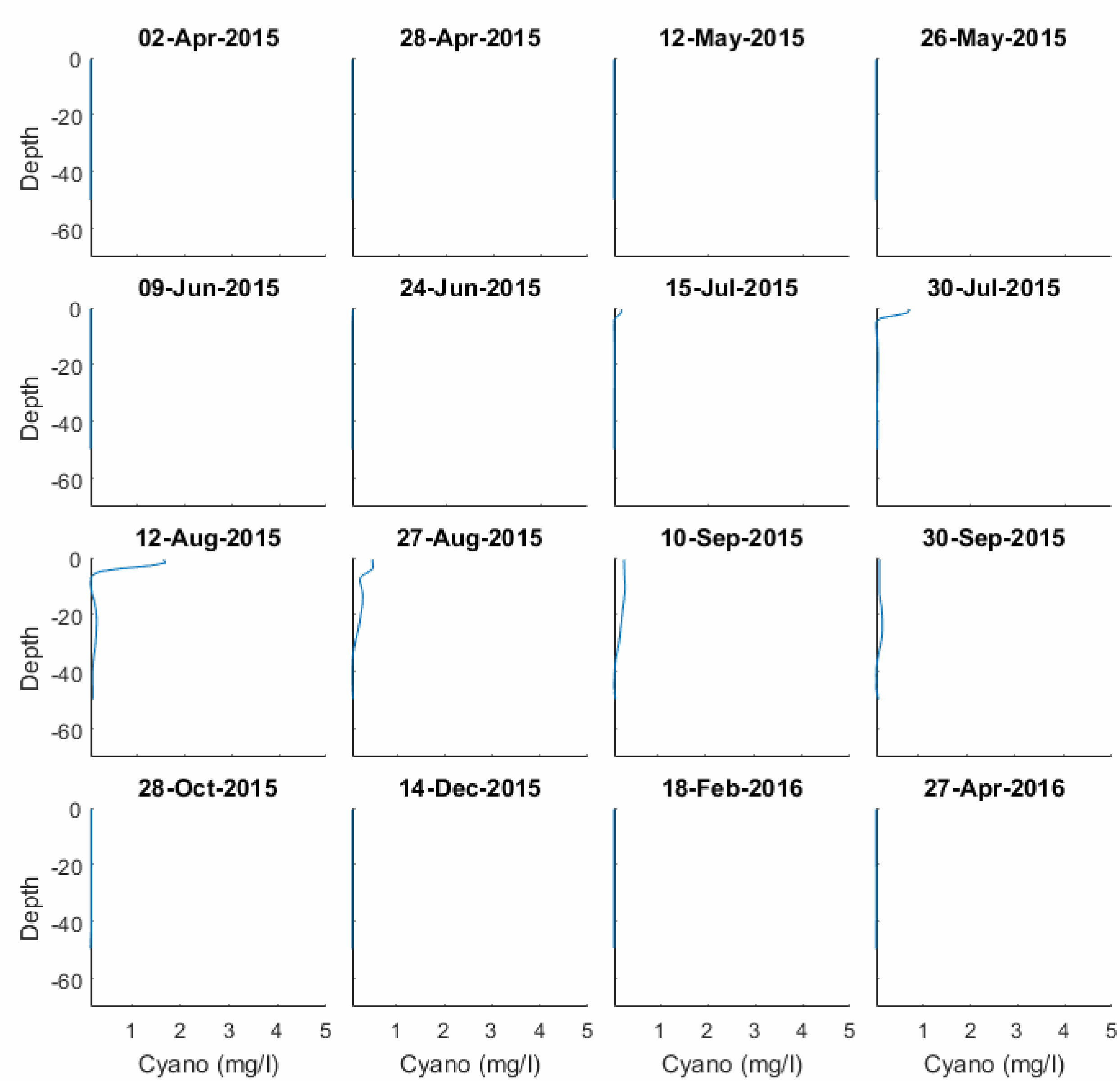

Figure 59. Profiles depicting the dynamics of cyanobacteria at Pelton forebay (RES04) for the first 16 profiles.

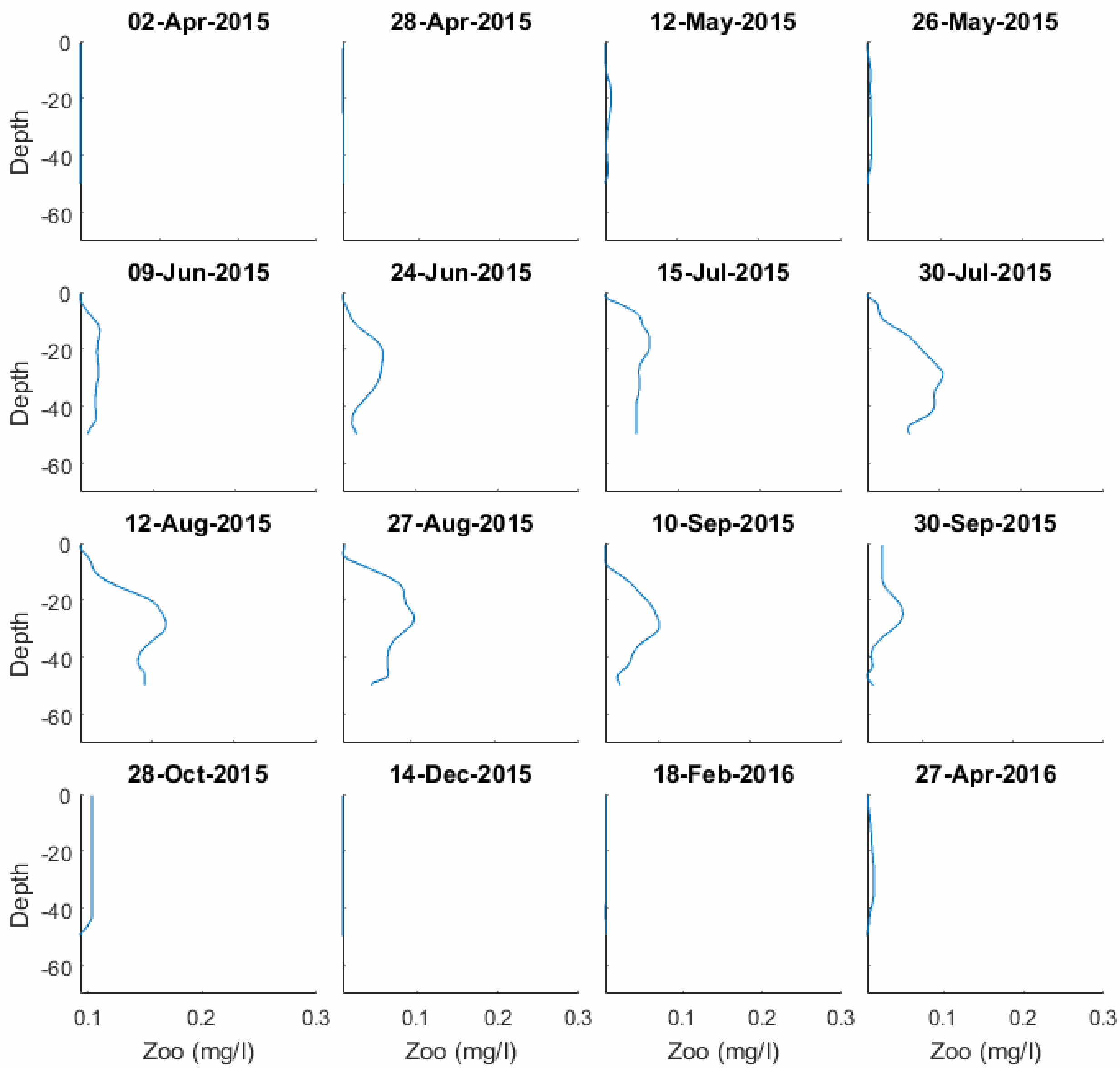

Figure 60. Profiles outlining zooplankton dynamics at Pelton forebay (RES04) for the first 16 profiles

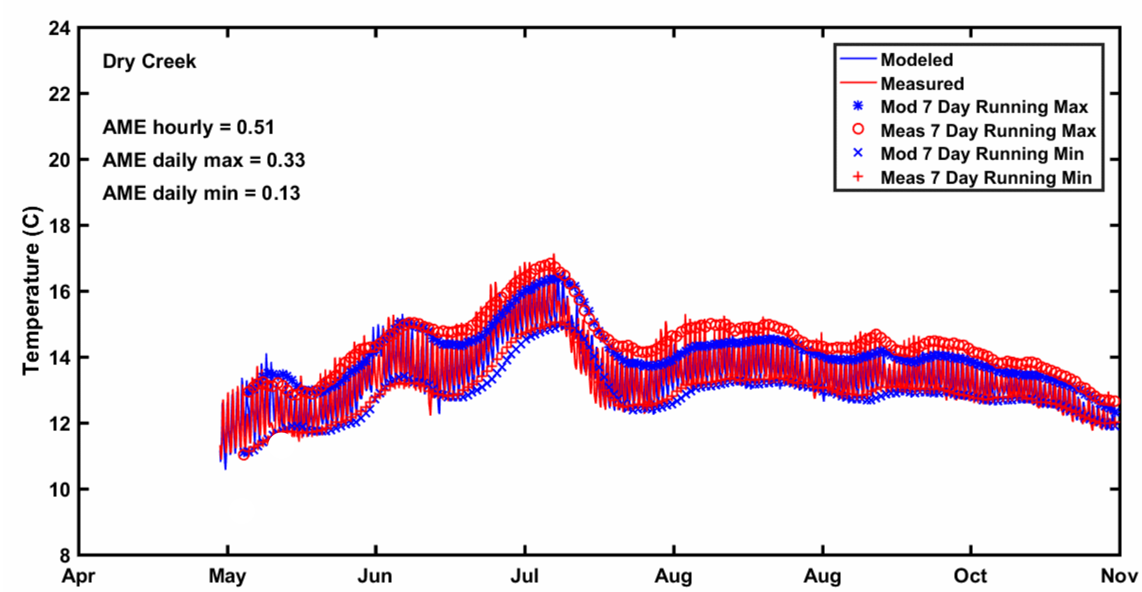

Figure 61. Diel time series at Dry Creek during 2015, including 7-day running averages.

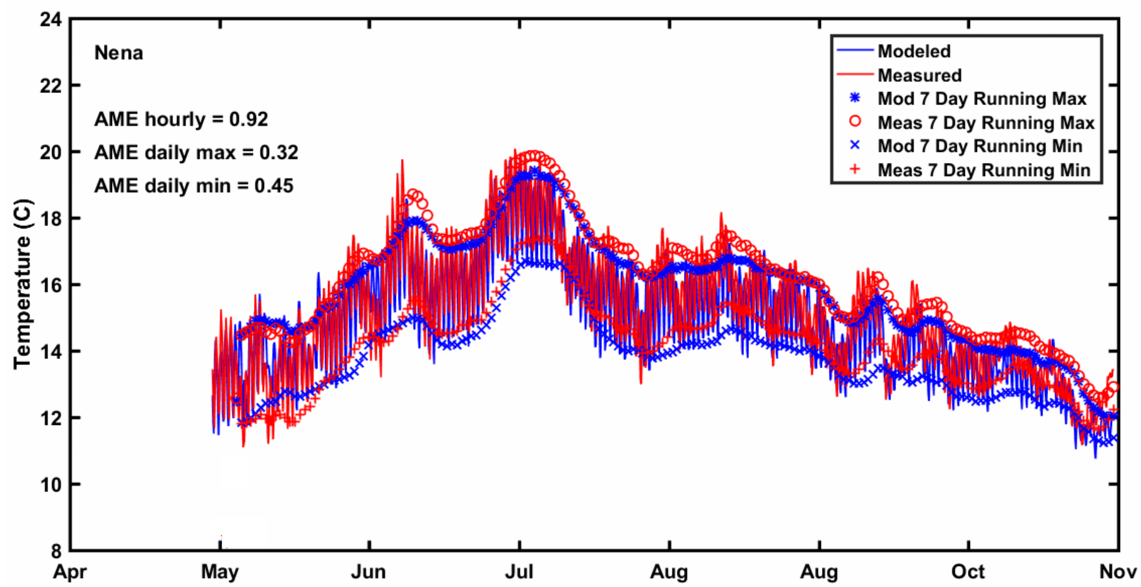

Figure 62. Diel time series at Nena during 2015, including 7-day running averages.

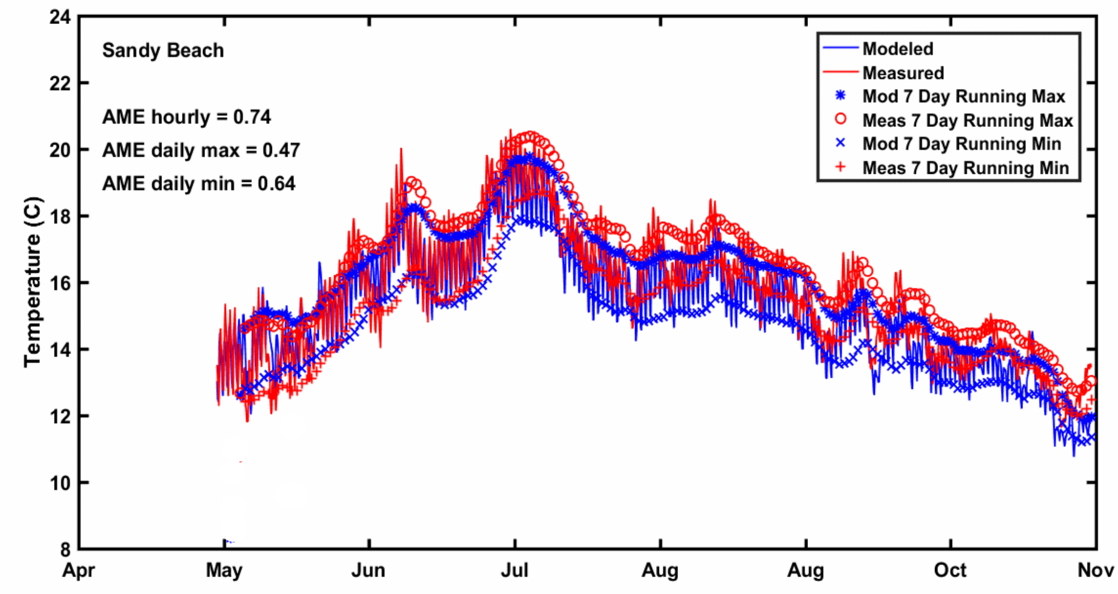

Figure 63. Diel time series at Sandy Beach during 2015, including 7-day running averages.

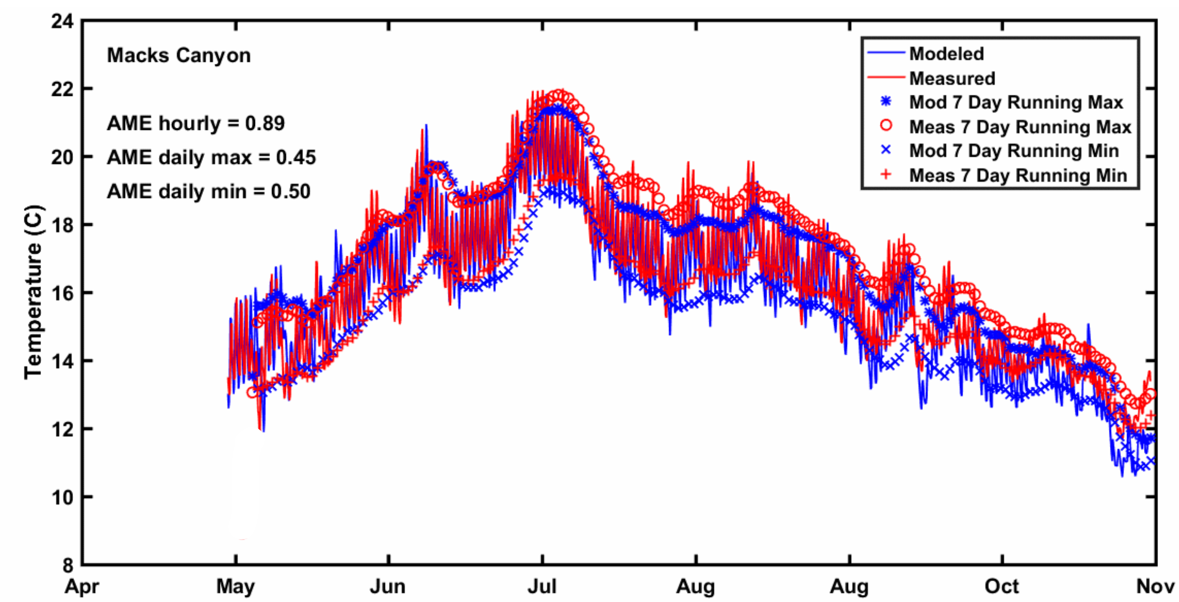

Figure 64. Diel time series at Macks Canyon during 2015, including 7-day running averages.

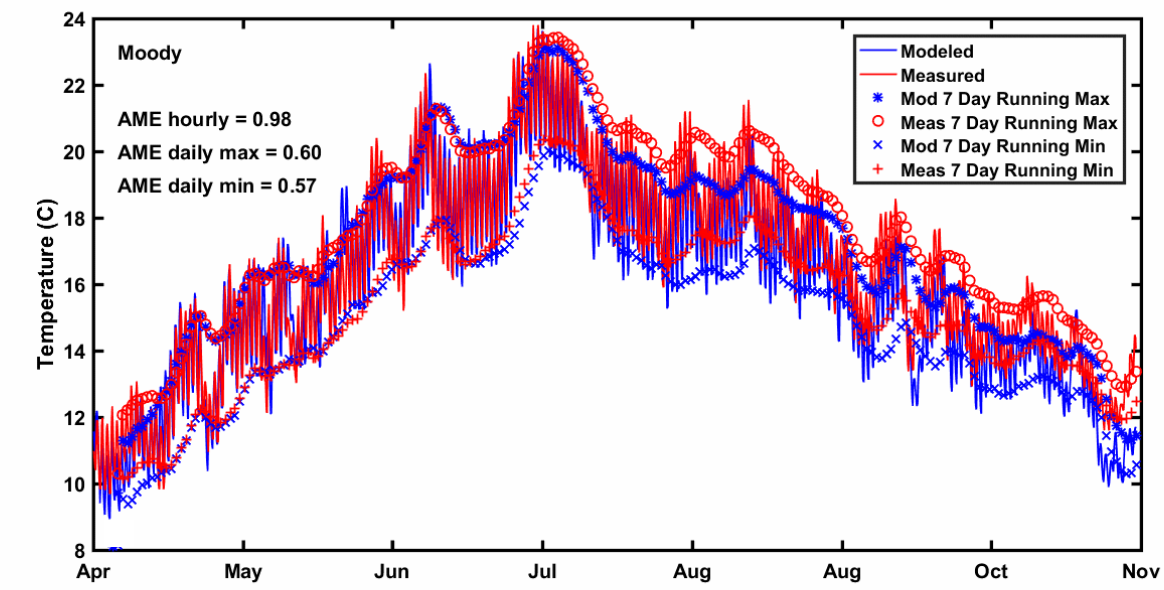

Figure 65. Diel time series at Moody during 2015, including 7-day running averages.

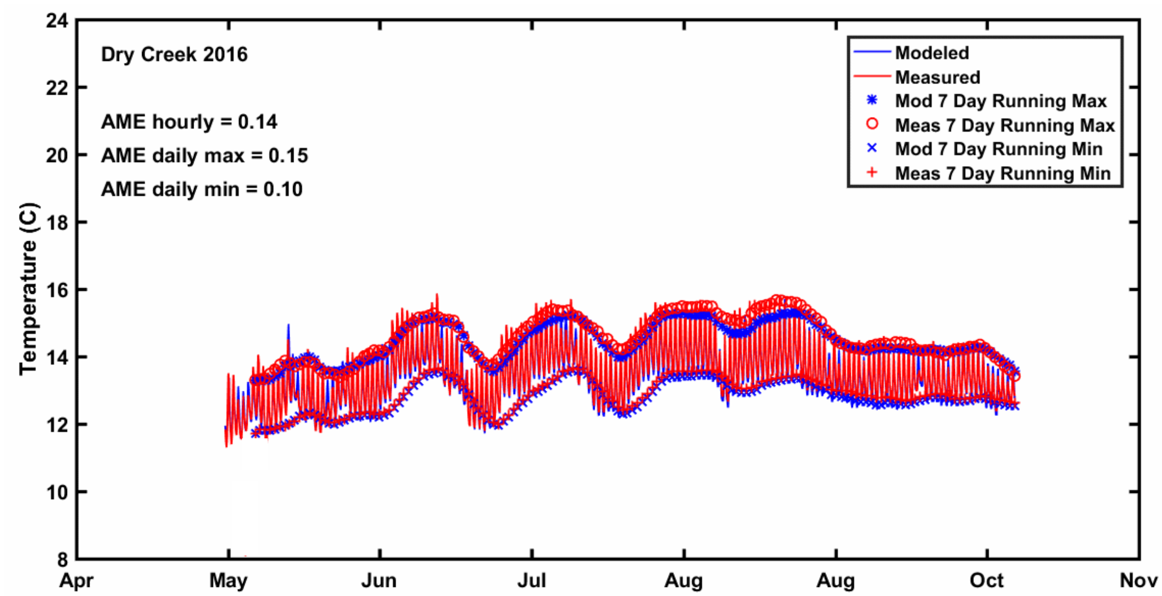

Figure 66. Diel time series at Dry Creek in 2016, including 7-day running averages.

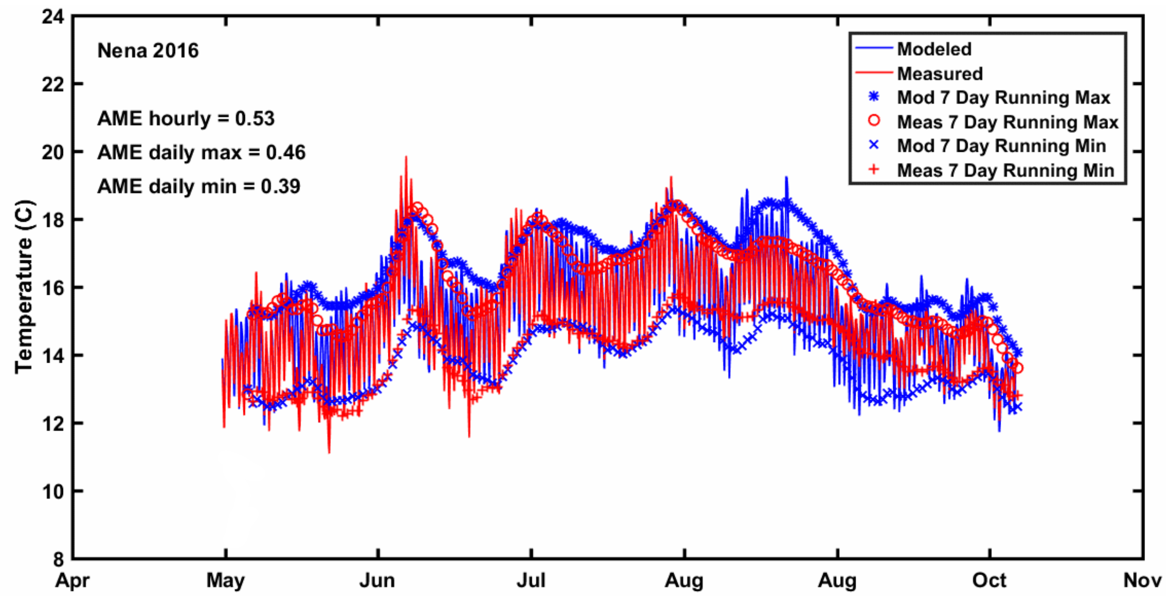

Figure 67. Diel time series at Nena in 2016, including 7-day running averages.

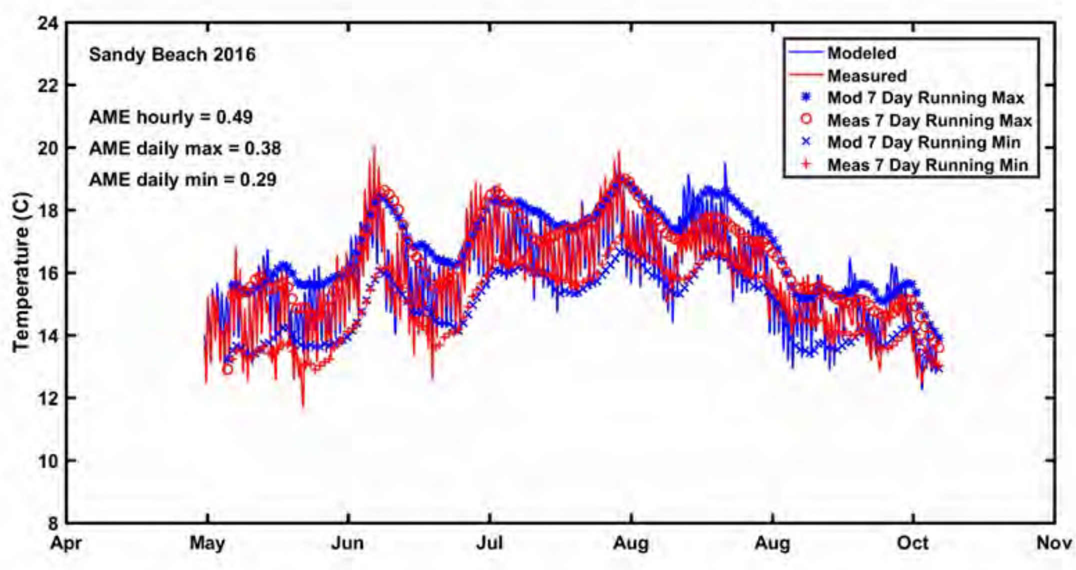

Figure 68. Diel time series at Sandy Beach in 2016, including 7-day running averages.

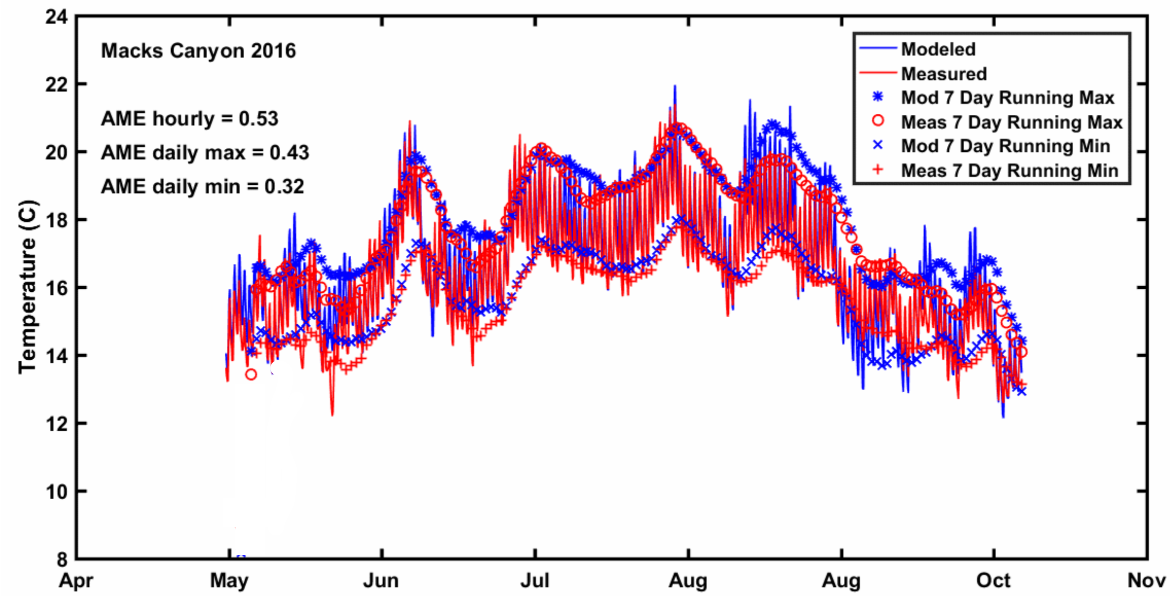

Figure 69. Diel time series at Macks Canyon in 2016, including 7-day running averages.

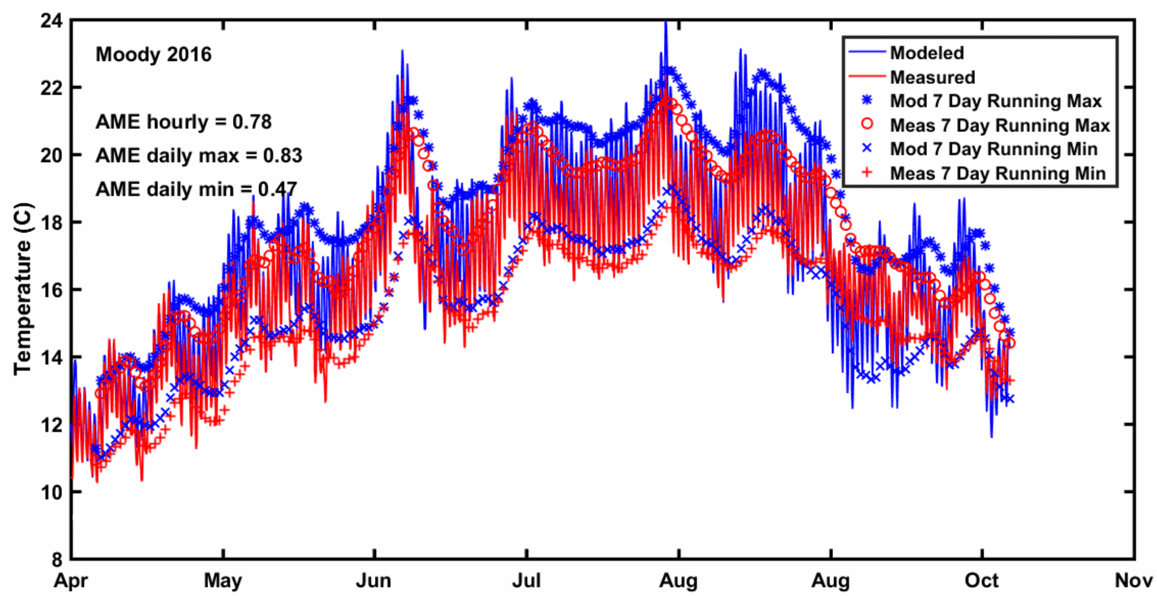

Figure 70. Diel time series at Moody in 2016, including 7-day running averages.

Appendix I QUAL2Kw Modeling Parameters

Parameter	Value	Units	Symbol	Min Suggested Value	Max Suggested Value
Stoichiometry					
Carbon	50	gC	gC	30	60
Nitrogen	5	gN	gN	5	9
Phosphorus	0.5	gP	gP	0.5	2
Dry weight	100	gD	gD	100	100
Chlorophyll	0.5	gA	gA	0.5	2
Inorganic suspended solids					
Settling velocity	0.25	m/d	v_i	0	2
Oxygen					
Reaeration model	Churchill				
User reaeration model parameter A	3			3	6
User reaeration model parameter B	0.5			0.5	1
User reaeration model parameter C	-1.85			-1.85	-1.5
Temp correction for reaeration	1.024		q_a		
Reaeration wind effect	Banks-Herrera				
O2 for carbon oxidation	3.00	gO_2/gC	r_{oc}		
O2 for NH4 nitrification	4.57	gO_2/gN	r_{on}		
Oxygen inhib model CBOD oxidation	Half saturation				
Oxygen inhib parameter CBOD oxidation	0.60	mg O_2/L	K_{socf}	0.60	0.60
Oxygen inhib model nitrification	Exponential				
Oxygen inhib parameter nitrification	0.60	L/mg O_2	K_{sona}	0.60	0.60

Parameter	Value	Units	Symbol	Min Suggested Value	Max Suggested Value
Oxygen enhance model denitrification	Exponential				
Oxygen enhance parameter denitrification	0.60	L/mg O_2	K_{sodn}	0.60	0.60
Oxygen inhib model phyto resp	Exponential				
Oxygen inhib parameter phyto resp	0.60	L/mg O_2	K_{sodn}	0.60	0.60
Oxygen enhance model bottom algae resp	Exponential				
Oxygen enhance parameter bottom algae resp	0.60	L/mgO_2	K_{sob}	0.60	0.60
Slow CBOD					
Hydrolysis rate	0.05	/d	k_{hc}	0.05	0.25
Temp correction	1.05		q_{hc}	1	1.07
Oxidation rate	0	/d	k_{dcs}	0	5
Temp correction	1		q_{dcs}	1	1.07
Fast CBOD					
Oxidation rate	1	/d	k_{dc}	0	5
Temp correction	1		q_{dc}	1	1.07
Organic N					
Hydrolysis	0.3	/d	k_{hn}	0.05	0.3
Temp correction	1.05		q_{hn}	1	1.07
Settling velocity	0.05	m/d	v_{on}	0.05	2
Ammonium					
Nitrification	3	/d	k_{na}	0.05	3
Temp correction	1.05		q_{na}	1	1.07
Nitrate					
Denitrification	0	/d	k_{dn}	0	2
Temp correction	1.05		q_{dn}	1	1.07

Parameter	Value	Units	Symbol	Min Suggested Value	Max Suggested Value
Sed denitrification transfer coeff	0	m/d	v_{di}	0	1
Temp correction	1.05		q_{di}	1	1.07
Organic P					
Hydrolysis	0.15	/d	k_{hp}	0.05	0.3
Temp correction	1.07		q_{hp}	1	1.07
Settling velocity	0.05	m/d	v_{op}	0.05	2
Inorganic P					
Settling velocity	0.05	m/d	v_{ip}	0	2
Sed P oxygen attenuation half sat constant	1	mgO_2/L	k_{spi}	0	2
Phytoplankton					
Max Growth rate	2.5	/d	k_{gp}	1.5	3
Temp correction	1.05		q_{gp}	1	1.07
Respiration rate	0.5	/d	k_{rp}	0.05	0.5
Temp correction	1.05		q_{rp}	1	1.07
Death rate	0.5	/d	k_{dp}	0	1
Temp correction	1.05		q_{dp}	1	1.07
Nutrient limitation model for N and P	Minimum				
Nitrogen half sat constant	25	µgN/L	k_{sNp}	10	25
Phosphorus half sat constant	2	µgP/L	k_{sPp}	1	5
Inorganic carbon half sat constant	1.30E-05	moles/L	k_{sCp}	1.30E-06	1.30E-04
Phytoplankton use HCO3- as substrate	Yes				
Light model	Half saturation				
Light constant	50	langleys/d	K_{Lp}	40	110
Ammonia preference	25	µgN/L	k_{hnxp}	15	30

Parameter	Value	Units	Symbol	Min Suggested Value	Max Suggested Value
Settling velocity	0.15	m/d	v_a	0.05	2
Include transport of phytoplankton	Yes				
Nitrogen uptake water column fraction	1		*phytoN-UpWCfrac*	0	1
Phosphorus uptake water column fraction	1		*phytoP-UpWCfrac*	0	1
Bottom Plants					
Growth model	Zero-order				
Max Growth rate	100	$gD/m^2/d$ or /d	C_{gb}	50	200
Temp correction	1.05		q_{gb}	1	1.07
First-order model carrying capacity	50	gD/m^2	$a_{b,max}$	50	200
Basal respiration rate	0.042	/d	k_{r1b}	0.02	0.2
Photo-respiration rate parameter	0.389	unitless	k_{r2b}	0	0.6
Temp correction	1.05		q_{rb}	1	1.07
Excretion rate	0.25	/d	k_{eb}	0	0.5
Temp correction	1		q_{db}	1	1.07
Death rate	0.5	/d	k_{db}	0	0.5
Temp correction	1.05		q_{db}	1	1.07
Scour function	Velocity				
Coefficient of scour function	0.05	/d/cms or /d/mps	*cdet*	0	0.1
Exponent of scour function	0		*ddet*	0	2
Minimal biomass after scour event	0	gD/m^2	*X0*	0	10
Catastrophic scour rate during flood event	0	/d	*Kcat*	0	100
Critical flow or vel for catastrophic scour	2	cms or m/s	*Qcrit*	0	50

Parameter	Value	Units	Symbol	Min Suggested Value	Max Suggested Value
External nitrogen half sat constant	500	ugN/L	k_{sNb}	100	500
External phosphorus half sat constant	100	ugP/L	k_{sPb}	25	100
Inorganic carbon half sat constant	1.00E-04	moles/L	k_{sCb}	1.30E-06	1.30E-04
Bottom algae use HCO3- as substrate	Yes				
Light model	Half saturation				
Light constant	80	langleys/d	K_{Lb}	40	110
Ammonia preference	15	µgN/L	k_{hnxb}	15	30
Nutrient limitation model for N and P	Minimum				
Subsistence quota for nitrogen	7.2	mgN/gD	q_{0N}	7.2	36
Subsistence quota for phosphorus	1	mgP/gD	q_{0P}	1	5
Maximum uptake rate for nitrogen	350	mgN/gD/d	r_{mN}	350	1500
Maximum uptake rate for phosphorus	50	mgP/gD/d	r_{mP}	50	200
Internal nitrogen half sat ratio	1.05		$K_{qN,ratio}$	1.05	5
Internal phosphorus half sat ratio	1.05		$K_{qP,ratio}$	1.05	5
Nitrogen uptake water column fraction	1		$N_{UpWCfrac}$	0	1
Phosphorus uptake water column fraction	1		$P_{UpWCfrac}$	0	1
Detritus (POM)					
Dissolution rate	0.25	/d	k_{dt}	0.05	0.5

Parameter	Value	Units	Symbol	Min Suggested Value	Max Suggested Value
Temp correction	1.05		q_{dt}	1.07	1.07
Settling velocity	0.1	m/d	v_{dt}	0.05	2
Pathogens					
Decay rate	0.05	/d	k_{dx}	0	20
Temp correction	1.05		q_{dx}	1	1.07
Settling velocity	0.05	m/d	v_x	0	2
alpha constant for light mortality	1	/d per ly/hr	*apath*	0	1
pH					
Partial pressure of carbon dioxide	396	ppm	p_{CO2}		
Hyporheic Metabolism					
Model for biofilm oxidation of fast CBOD	Zero-order		*level 1*		
Max biofilm growth rate	5	$gO_2/m^2/d$ or /d	*level 1*	0	20
Temp correction	1.047		*level 1*	1.047	1.047
Fast CBOD half-saturation	0.5	mgO_2/L	*level 1*	0	2
Oxygen inhib model	Exponential		*level 1*		
Oxygen inhib parameter	0.60	L/mgO_2	*level 1*	0.60	0.60
Respiration rate	0.2	/d	*level 2*	0.2	0.2
Temp correction	1.07		*level 2*	1.07	1.07
Death rate	0.05	/d	*level 2*	0.05	0.05
Temp correction	1.07		*level 2*	1.07	1.07
External nitrogen half sat constant	15	µgN/L	*level 2*	15	15
External phosphorus half sat constant	2	µgP/L	*level 2*	2	2
Ammonia preference	25	µgN/L	*level 2*	25	25
First-order model carrying capacity	100	gD/m^2	*level 2*	100	100

Parameter	Value	Units	Symbol	Min Suggested Value	Max Suggested Value
Generic Constituent					
Decay rate	0	/d		0	20
Temp correction	1.07			1	1.07
Settling velocity	0	m/d		0	2
Use generic constituent as COD?	No				
Photosynthetic quotient and respiratory quotient for phytoplankton and bottom algae					
Photosynthetic quotient for NO3 vs NH4 use	1.29	dimensionless	*PQ*	1.20	1.80
Respiratory quotient	1.00	dimensionless	*RQ*	0.85	1+A1:F142