

Utah Lake Water Quality Study (ULWQS)
Science Panel
October 20, 12:00 PM to 3:00 PM
Virtual Meeting
Meeting Summary - DRAFT

ATTENDANCE:

Science Panel Members: Janice Brahney, Mike Brett, Mitch Hogsett, James Martin

Steering Committee Members and Alternates: Erica Gaddis, Heidi Hoven, Christopher Keleher

Members of the Public: Jacob Krall, Tina Laidlaw, Renn Lambert, and Soren Simonsen

Utah Division of Water Quality (DWQ) staff: Scott Daly, Jodi Gardberg, Nicholas von Stackelberg

Technical Consultants: Kevin Kratt, Michael Paul, and Kateri Salk

Facilitation Team: Heather Bergman and Samuel Wallace

ACTION ITEMS

Who	Action Item	Due Date	Date Completed
Heather Bergman and Samuel Wallace	Follow up with Soren Brothers to get his perspective on the relative impact of nutrient reduction on macrophyte reestablishment in Utah Lake.	Oct 31	
	Send out a poll via email to Science Panel members to ask if they approve the Tetra Tech recommendation to proceed with the HPSF model and the QAPP for Utah lake model development.	Nov 1	
	Edit the interim synthesis statements from the charge question interim reports to make them more accessible to the general public and the ULWQS Steering Committee.	Nov 8	
Kateri Salk and Mike Paul	Incorporate the suggested revisions from today's meeting into the charge question interim reports.	Oct 31	
Kevin Kratt	Add a section to the QAPP on the quality assurance plans and procedures for existing model enhancements.	Nov 1	

DECISIONS AND APPROVALS

No formal decision or approvals were made at this meeting.

PROPOSED CHANGES TO THE CHARGE QUESTION INTERIM REPORT

- Proposed changes to the charge question interim report from the meeting include:

- Following up with Soren Brothers to get his perspective on the relative impact of nutrient reduction on macrophyte reestablishment in Utah Lake (question 4.2).
- Reevaluating the wording of the response to question 1.3 using research on the history of the sewage system in the cities around Utah Lake.
- Adding a statement on how Utah Lake has a large capacity to remove phosphorus from the water column in the response to question 2.4.i.
- Clarifying that carp excretion impacts the nutrient cycle but is not a direct source of new, external nutrients in the response to question 2.1.i.
- Adding the estimated amount of nutrients taken out of Utah Lake as a result of carp removal to the response to question 2.1.i.
- Clarifying that harmful algal blooms (HABs) are associated with higher nutrient concentrations even though the Science Panel has not yet come up with a quantitative prediction for Utah Lake itself (question 4.3).

CHARGE QUESTION INTERIM REPORT OVERVIEW

Kateri Salk, Tetra Tech, provided an overview of the process for developing the interim charge reports. Her comments are summarized below.

- Over the past couple months, Science Panel members have been developing interim responses to the charge questions posed by the ULWQS Steering Committee and expanded upon by the ULWQS Science Panel.
- The purpose of the interim charge question report exercise was to take stock of the available information and forthcoming information that will inform responses to the charge questions. The Science Panel also used the uncertainty guidance framework to assess the confidence in the responses, which is based on the quality, amount, and agreement of the evidence sources.

HISTORICAL CONDITIONS CHARGE QUESTION INTERIM RESPONSES PRESENTATION

Janice Braheny, Utah State University, presented the interim responses for the historical conditions charge questions. Her presentation is summarized below.

- The Science Panel members in the Historical Conditions Subgroup were Janice Braheny, Soren Brothers, Greg Carling, Mitch Hogsett, Michael Mills, and Hans Paerl.
- The historical conditions charge questions were:
 - 1.1. What does the diatom community and macrophyte community in the paleo record tell us about the historical trophic state and nutrient regime of the lake?
 - i. Can diatom (benthic and planktonic) and/or macrophyte extent or presence be detected in sediment cores? And if so, what are they?
 - iii. How have environmental conditions changed over time?
 - 1.2. What were the historic phosphorus, nitrogen, and silicon concentrations as depicted by sediment cores? (add calcium, iron, and potentially nitrogen and phosphorus isotopes)
 - 1.4. What do photopigments and DNA in the paleo record tell us about the historical water quality, trophic state, and nutrient regime of the lake?
 - 4.1. What would be the current nutrient regime of Utah Lake assuming no nutrient inputs from human sources? This question may require the identification of primary sources of nutrients.
- The Science Panel relied primarily on six studies to develop responses for these charge questions. Some of the studies were from last century, and some were conducted over the past several years.

- The interim synthesis statement for question 1.1 states that “overall, there is a higher degree of eutrophication and nutrient concentrations in Utah Lake at present compared to pre-industrial times, with associated shifts in the biological community that is preserved in the paleolimnological record.” In the available evidence, there are a number of graphs displaying trends towards eutrophic conditions over time using a number of indicators.
- The interim synthesis statement for question 1.1.i states that the “Science Panel has high confidence that diatoms and macrophytes can be detected in sediment cores. The historical presence of hardstem bulrush has been confirmed at Goshen Bay and Provo Bay sites. Gastropods feed on plant material and their presence in the historical sediments of Goshen Bay and Provo Bay suggest that plant material was readily available near the cores. Benthic and epiphytic diatoms dominated under pre-industrial conditions in Goshen Bay and Bird Island, with an increasing relative prevalence of planktonic diatoms approaching present day.” The evidence supports the historical presence of diatoms and macrophytes in Utah Lake based on the physical presence of plant material, eDNA evidence, the historical presence of organisms that consume plant material, and the historical presence of diatoms that live on plant material in sediment cores.
- The interim synthesis statement for question 1.1.iii states that the “Science Panel has high confidence that environmental conditions have changed from oligo-mesotrophic conditions to eutrophic conditions with a prevalence of pollution-tolerant taxa from preindustrial times to present day. Anodonta mussel shells were collected from Bird Island and north cores and may be sensitive to turbidity as well as fish extirpation. The Science Panel has medium confidence that the historical macrophyte-dominated state was negatively impacted by reductions in water clarity, but relationships evaluating the mechanistic link with nutrients will require further study as part of the EFDC-WASP application to Utah Lake.” Substantial shifts in community composition in the sediment cores indicate a shift from the oligo-mesotrophic to eutrophic conditions. It is difficult to discern causation from historical records, which is why the Science Panel has medium confidence in the second half of the response. This question was difficult to answer because there are many ways to interpret it.
- The interim synthesis statement for question 1.2 states that the “Science Panel has high confidence that concentrations and forms of phosphorus, nitrogen, silicon, calcium, iron, and aluminum have changed from preindustrial times to present day, with indicators consistently pointing to a shift to more eutrophic conditions in Utah Lake.” All paleo studies on Utah Lake involved elemental analysis, and all of them found substantial shifts in the concentration of the elements, notably an increase in total phosphorus and nitrogen-15 isotope concentrations.
- The interim synthesis statement for question 1.4 states that the “Science Panel has high confidence that the independent lines of evidence from phytopigments and DNA show a shift from oligo-mesotrophic conditions to eutrophic conditions from pre-industrial time to present, indicative of an increase in nutrient abundance, in Utah Lake.” Results from eDNA tests indicate an increasing frequency in cyanobacterial DNA fragments over time. Phytopigment data also suggests increases in cyanobacteria, green algae, and production in general.
- The interim synthesis statement for question 4.1 states that the Science Panel “hypothesizes the current nutrient regime of Utah Lake would be lower under a reduced human nutrient input scenario. However, direct evidence to answer this question has been limited to date, and this statement thus has low confidence. Upcoming work with the ULWQS will increase confidence to assess this question.” This question is difficult to answer using paleo records.

- Several forthcoming studies will help the Science Panel respond to these charge questions, including the mechanistic EFDC-WASP lake model, the Utah Lake nutrient mass balance and internal loading analysis, the analysis of cladocera species composition and size structure and chironomid community composition, and a Paleo Study being conducted by Dr. Steve Nelson and a student. Additionally, Science Panel members are exploring the possibility of using paleolimnological data to back-calculate the phosphorus mass balance.

Science Panel Discussion

The idea of back-calculating phosphorus concentrations is to use the phosphate in calcium-carbonate crystals as record of the ambient phosphorus in Utah Lake. If the system has a lot more calcium than necessary to bind phosphorus, then the change in calcite-bound phosphorus over time is a proxy for phosphorus inputs over time. Generally, total phosphorus in sediments is not a good proxy for historical loading because other forms of phosphorus are very mobile in sediments, but the phosphate in calcium-carbonate fraction would be a good proxy since they are not mobile. Using multiple cores with this data, researchers could extrapolate to estimate how much phosphorus has been locked up in calcium-carbonate in recent years compared to how much phosphorus has been locked up in calcium-carbonate historically. This information could be used to back-calculate the historical mass balance.

MACROPHYTES AND DIATOMS CHARGE QUESTION INTERIM RESPONSES PRESENTATION

Mitch Hogsett, ULWQS Science Panel, presented the interim responses for the macrophytes and diatoms charge questions. His presentation is summarized below.

- The Macrophytes and Diatoms Subgroup members were Mitch Hogsett, Janice Brahney, Soren Brothers, and James Martin.
- The macrophytes and diatoms charge questions were:
 - 1.1.ii. What were the environmental requirements for diatoms and extant and locally extirpated macrophyte species?
 - 2.2. What are the environmental requirements for submerged macrophytes currently present at Utah Lake?
 - i. What is the role of lake elevation and drawdown in macrophyte recovery? Are certain species more resilient to drawdowns and nutrient related impacts? Can some species establish/adapt more quickly?
 - ii. What is the relationship between carp, wind, and macrophytes on non-algal turbidity and nutrient cycling in the lake? What impact could macrophyte reestablishment have?
 - 4.2. Assuming continued carp removal and current water management, would nutrient reductions support a shift to a macrophyte-dominated state within reasonable planning horizons (i.e., 30-50 years)?
- The Subgroup used eight studies that were Utah Lake specific as the lines of evidence. The authors of those studies included Bollard, Brahney, Brotherson, King, Landom and Miller. In addition to the eight Utah Lake-specific studies, there were seven studies on similar shallow lake systems used as lines of evidence for the interim report. The June Sucker Recovery Program research and the ULWQS Analysis Report developed by Tetra Tech also informed the responses to the charge questions.
- The interim synthesis statement for question 1.1.ii states that the “Science Panel has medium confidence that historical macrophyte communities in Utah Lake were made up of clear-water submerged species including stoneworts as well as emergent macrophytes, such as hardstem bulrush (Goshen Bay), since these species have been identified in the sediments.” An important caveat to this response is that the absence of macrophyte species in the sediment cores does not necessarily mean that other species did not live in Utah Lake.

In the sediment cores from Goshen and Provo Bay, which were historically more wetland-like, there were clear-water macrophyte species, indicating less turbidity would be conducive for historical macrophytes. There is existing biomass around Utah Lake, notably phragmites, which is an invasive species along the shoreline. Efforts to remove phragmites are ongoing.

- The interim synthesis statement for question 2.2 states that the “Science Panel has medium confidence that submerged macrophytes in Utah Lake require higher water clarity than currently exists in Utah Lake. Additional considerations that will impact macrophyte recovery in the lake include sediment substrate and sheltering from mechanical disturbance, which have not been evaluated in Utah Lake to date, as well as water level.” Essentially, in addition to nutrients and turbidity, there are mechanical and physical disturbances (e.g., wind events, lake fluctuations) that impact submerged macrophytes.
- The interim synthesis statement for question 2.2.i states that the “Science Panel has medium confidence that low water levels in Utah Lake negatively impact the growth and reestablishment of submerged macrophytes, while emergent macrophytes are less affected by variable water levels. If Utah Lake historically experienced seasonal changes in water level, macrophyte communities may be more resilient to water level-related changes if they mimic natural variability in magnitude and timing.” Utah Lake experiences large lake fluctuations. Different species have different requirements for how long they can be submerged and how drought tolerant they are. These requirements will impact what can be grown on the shores of Utah Lake.
- The interim synthesis statement for question 2.2.ii states that the “Science Panel has high confidence that wind and carp increase non-algal turbidity in Utah Lake, with wind being the primary hypothesized driver of increases in turbidity and carp being a contributing factor. Macrophyte recovery has the capacity to stabilize sediments and reduce sediment resuspension events, although there is a good deal of uncertainty around the magnitude of this relationship.” In Utah Lake, around 75% of turbidity is non-algal. Wind is a driving force for producing non-algal turbidity in the water column. Macrophytes will increase the shear stress of the sediments and will decrease turbidity, but it is uncertain how much they will reduce turbidity.
- The interim synthesis statement for question 4.2 states that the “Science Panel hypothesizes that nutrient management and carp removal efforts will improve environmental conditions relevant for macrophyte reestablishment. However, direct evidence about the potential magnitude of these improvements is not currently available, and this statement thus has low confidence.” The Science Panel knows that carp disturbs sediments, consumes vegetation, increases turbidity, and increases sediment nutrient release. However, the Science Panel has low confidence on what will happen if carp are removed from a complex, disturbed system like Utah Lake.
- The EFDC-WASP model will provide additional information to help answer the macrophyte and diatoms charge questions.

Clarifying Questions

Science Panel members asked clarifying questions. Questions are indicated in italics, with the corresponding answer in plain text.

Can the Science Panel tease out the impacts of multi-year lake level changes and inter-year lake level changes to macrophytes?

- The June Sucker Recovery Program focused some of their studies on macrophytes. Their research indicated that over the period of a few dry years, some macrophytes disappeared

depending on the species. They also found that lake level fluctuations and dry periods are more likely to affect an establishing bed of macrophytes than an established one.

- The response to this question is more oriented around macrophytes on the shorelines rather than macrophytes in the middle of Utah Lake.

Would a reduction in non-algal turbidity impact algal growth? Presumably, less turbidity would increase algal access to light and increase populations. This question would help inform proposals to address wind and carp-produced turbidity.

- In general, reducing sediment resuspension can increase clarity, which means algae could grow more. That conclusion assumes that the current composition of algae experiences light-limited growth, which is a big assumption. There is evidence that the growth of algae is nutrient-limited in Utah Lake, and the phytoplankton assemblage potentially has the adapted strategy to compete in a light-limited environment.
- There is not a specific answer to this question as of now. It is possible that blooms could worsen with the reduction of non-algal turbidity, but that statement relies on the assumption that algae are optimized for light-limited growth.
- Cyanobacteria have buoyancy control, which allows them to float and sink as needed to access light at the surface and nutrients at the bottom of the lake.

How does the subgroup know wind is the most important source of non-algal turbidity and carp are secondary?

- Higher wind speeds are positively correlated to higher turbidity in the water column. The ratio of total suspended solids (TSS) to volatile suspended solids (VSS) indicate that the solids in the water column are primarily inert material.
- There are event-based increases in turbidity in response to wind. The response indicates that the Science Panel *hypothesizes* wind is the primary driver with carp contributing. There has not been a quantification of the relative magnitude of their importance.

What if carp cause a high baseline turbidity and wind causes spikes above that baseline? Perhaps the baseline and even the spikes would be lower without carp?

That is a possibility. There is the potential to study Utah Lake in the winter to see what the lake is like without wind impacts, but even then, there are limitations to that research as carp behave differently in the winter as well.

The intention of question 4.2 was to determine whether nutrient reductions would support a shift to a macrophyte-dominated state if carp were removed and water management practices remained the same. Could nutrient reductions help facilitate macrophyte reestablishment, potentially by reducing algal turbidity?

To answer this question, the Science Panel would need to identify the components of Utah Lake's baseline turbidity. Additionally, given that macrophytes have certain light requirements, the Science Panel would need to assess whether the baseline turbidity is sufficient for precluding the growth of submerged macrophytes. Light requirements are addressed in other charge question responses.

One study was able to assess the impact of wind through the installation of carp exclosures. Do the exclosures reduce wind mixing?

One study indicated that the wind conditions depended on the location of the exclosures within Utah Lake due to prevailing winds. Even though it was not an original goal of the study, the research included some initial evaluation of the impact of wind on Utah Lake.

Science Panel Discussion

Soren Brothers will have insight on whether nutrients are a factor that can be managed to facilitate macrophyte reestablishment (question 4.2). From a light level perspective, there is likely enough light to support macrophyte reestablishment, which would suggest other physical factors, like lake level fluctuations, are impacting macrophyte reestablishment. Samuel Wallace and Heather Bergman will follow up with Soren Brothers to get his perspective on the relative impact of nutrient reduction on macrophyte reestablishment in Utah Lake.

SEDIMENTS CHARGE QUESTION INTERIM RESPONSES PRESENTATION

Scott Daly, DWQ, presented the interim responses for the sediments charge questions. His presentation is summarized below.

- The Sediments Subgroup members included Greg Carling, Janice Brahney, James Martin, Mitch Hogsett, and Theron Miller.
- The sediments charge questions were:
 - 2.4. How do sediments affect nutrient cycling in Utah Lake?
 - i. What are current sediment equilibrium phosphorus concentrations (EPC) throughout the lake? What effect will reducing inputs have on water column concentrations? If so, what is the expected lag time for lake recovery after nutrient inputs have been reduced?
 - ii. What is the sediment oxygen demand (SOD) of, and nutrient releases from, sediments in Utah Lake under current conditions?
 - iii. Does lake stratification [weather patterns] play a result in anoxia and phosphorus release into the water column? Can this be tied to HAB formation?
- There were several studies conducted on Utah Lake that can inform the charge question responses. One of the studies on Utah Lake sediment-water interactions was conducted by Goel, Carling, and Smithson, which the ULWQS Science Panel oversaw. Goel and Hogsett conducted another study on internal nutrient cycling in 2019, and Randall et al. conducted a study on sediment controls in Utah Lake in 2019. Tetra Tech's Carbon, Nitrogen, and Phosphorus (CNP) Mass Balance Study also informed the charge question responses.
- The interim synthesis statement for question 2.4.i states that the "Science Panel currently has low confidence in the ability to assess EPC in Utah Lake, the impacts of reduced phosphorus loading, and the expected lag time between reducing phosphorus inputs and lower water column phosphorus concentrations given the capacity for internal sediment loading. The Science Panel hypothesizes that EPC is such that reducing phosphorus inputs may cause an increase in internal sediment phosphorus loading, but it is unclear how long elevated internal loading may last. Upcoming work with the ULWQS will increase confidence to assess this question." The confidence for this statement is low because there is only one study that assessed EPC in Utah Lake. Several other studies, including Dr. Josh LeMonte's Phosphorus-Binding Study, the mechanistic model, and Mike Brett's mass balance calculation, will provide more information to answer this charge question.
- The interim synthesis statement for question 2.4.ii states that the "Science Panel has high confidence that sediments in Utah Lake consume oxygen, with higher rates in Provo Bay (4.5 g m⁻² d⁻¹) than in the main basin (1-3 g m⁻² d⁻¹). The sediments overall represent a net sink for total nutrients, but bioavailable forms of nitrogen and phosphorus (soluble reactive phosphorus/orthophosphate, ammonium, nitrate) are released from the sediments depending on water column chemistry and organic matter content of sediments." Three independent studies informed the response to this question. The CNP Mass Balance Study used a SedFlux Model to estimate SOD rates. The results from the CNP Mass Balance Study were not comparable to the other two studies because of limitations in the SedFlux model.

- The interim synthesis statement for question 2.4.iii states that the “Science Panel has medium confidence that lake thermal stratification does not occur on a widespread seasonal scale, and the potential impacts on bottom water redox conditions and phosphorus release from the sediments are limited. Alternate processes, including anoxic microzones, diel fluctuations in water column dissolved oxygen, and sediment resuspension are mechanisms that are more likely at play in Utah Lake.” The primary source of evidence for this response is direct observational data. There is evidence of transient stratification, but generally, it is not a stratified lake. There may be localized stratification in periods of hot/cold weather.
- Future studies to help answer these charge questions are the mechanistic lake and watershed models, the Paleolimnological Study, the Phosphorus-Binding Study, the Littoral Sediment Study, and the Timpanogos Special Service District (TSSD) Limnocorral Study.

Clarifying Questions

Science Panel members asked clarifying questions. Questions are indicated in italics, with the corresponding answer in plain text.

Does pH fluctuation and calcium dynamics play a result in phosphorus release into the water column?

Calcium-phosphate minerals precipitate under elevated pH levels. Utah Lake is always above eight pH, so calcium-phosphate minerals are stable. During algal blooms, the blooms increase the pH, which is conducive for more calcium-phosphate precipitation. Phosphorus release from the sediments could occur if decomposition of organic materials in the sediment drove pH down, but this dynamic is not characteristic of Utah Lake.

In the bays, is there enough pH fluctuation to create a zones of phosphorus release?

Provo Bay has highly organically enriched sediment, so it is possible that the sediments are highly anaerobic, resulting in phosphorus releases.

What is the pH of the Utah Lake sediments? The pH levels would have to be low for calcium-bound phosphorus to be released.

The Phosphorus-Binding Study will provide additional information on the pH levels and redox reactions in the sediment. There will be more answers on this question later.

Science Panel Discussion

- In the Goel study, researchers tried to manipulate the pH in their sediment cores, and it did not go well because of the high pH in the sediments. They tried to bring the sediment pH down to seven. Their study may have data on the pH of the sediments as measured in the lab. Even if the pH levels of the sediment decrease to seven, that likely is not a low enough pH level to trigger phosphorus release.
- A review of several Utah Lake metrics, including nutrient concentrations, surface water elevation, storage volume, and mass of phosphorus and nitrogen, over time suggests that Utah Lake is removing 90% of the phosphorus. There could be a statement on how Utah Lake has a large capacity to remove phosphorus from the water column.
- The WASP model has a sediment diagenesis model, but the sediment diagenesis model does not include the alkalinity-pH carbonate system.
- Underlying all the sediment questions is ultimately the question to what extent are sediments controlling water column nutrient concentrations and in turn algal blooms. This type of information would help inform project proposals that are proposing to dredge sediments to control algal blooms.

- The Science Panel has data on the bioavailable, mobile fractions in the sediment. The Science Panel could use this data to determine the potential release of organic-bound phosphorus or exchangeable phosphorus compared to aluminum or iron-bound phosphorus. It would be helpful to hone on the organic fraction cycling because that is likely driving the system.
- It would be helpful to understand the sediment dynamics as they occur now and what the dynamics would be under a different nutrient loading regime. There is an ongoing discussion on whether projects should manage watershed sources, sediment sources, or both.

FISH, AQUATIC LIFE, AND BIRDS CHARGE QUESTION INTERIM RESPONSES PRESENTATION

Mike Paul, Tetra Tech, presented the interim responses for the fish, aquatic life, and birds charge questions. His presentation is summarized below.

- The Fish, Aquatic Life, and Birds Subgroup members included Mike Brett, Soren Brothers, Mitch Hogsett, Theron Miller, and Michael Mills.
- The fish, aquatic life, and birds charge questions are:
 - 1.3. What information do paleo records (eDNA/scales) provide on the population trajectory/growth of carp over time? What information do the paleo records provide on the historical relationship between carp and the trophic state and nutrient regime of the lake?
 - 2.1. What are the impacts of carp on the biology/ecology and nutrient cycling of the lake and how are those impacts changing with ongoing carp removal efforts?
 - i. What contribution do carp make to the total nutrient budget of the lake via excretion rates and bioturbation? How much nutrient cycling can be attributed to carp?
 - ii. What is the effect of carp removal efforts on macrophytes, nutrients, secchi depth, turbidity, and primary productivity?
 - iii. How much non-algal turbidity and nutrient cycling is due to wind action versus carp foraging? How much does sediment resuspension contribute to light limitation, and does wind resuspension contribute substantially in the absence of carp?
 - 2.5. For warm water aquatic life, waterfowl, shorebirds, and water-oriented wildlife:
 - i. Where and when in Utah Lake are early life stages of fish present?
 - ii. Which species are most sensitive and need protection from nutrient-related impacts?
- The evidence list contained studies within the past two decades focused on paleo records, carp excretion estimates, carp populations, wind versus carp bioturbation, and early fish life stages. There was not any studies used to discuss species sensitivity.
- The interim synthesis statement for question 1.3 states that the “Science Panel has medium confidence that the introduction of carp to Utah Lake circa 1881 is associated with a transition to eutrophic conditions, around the same time that evidence of wastewater treatment nutrient effluent loads were also detected. Given the concurrent timing of carp introduction and increases in anthropogenic nutrient loading, it is challenging to parse the specific mechanisms and magnitude of the impacts of carp alone on the trophic state of Utah Lake.” The Science Panel has medium confidence in this response because there was only one study used to inform the response, but the study used a direct and extensive dataset, which moved confidence from low to medium.
- The interim synthesis statement for question 2.1.i states that the “Science Panel has medium confidence that carp excrete a substantial amount of nitrogen and phosphorus in

Utah Lake, on the order of 19-85% of external phosphorus loads, 23-60% of phosphorus net retention, and 27-62 % of external nitrogen loads. Carp excretion represents nutrient recycling rather than a discrete input or output from Utah Lake, so comparisons of excretion rates with external loading should be made with caution.” The Science Panel has medium confidence in the general statement and low confidence in the specific quantitative values.

- The interim synthesis statement for 2.1.ii states that the “Science Panel has high confidence that carp removal efforts relieve negative pressures on macrophyte community growth and reestablishment, reduce nutrient recycling through the carp population, reduce bioturbation that mobilizes sediments and creates more turbid conditions. Macrophyte reestablishment is unlikely to occur spontaneously with carp removal efforts alone and may require active planting efforts and/or external nutrient loading reductions. Carp removal efforts may have mixed impacts on phytoplankton growth, because carp bioturbation and recycling have the capacity to both reduce transparency and also mobilize sediment nutrient pools into the water column.” Direct experimental manipulations in Utah Lake, carp excretion estimates, and macrophyte/recovery stable state literature informed the response to this question.
- The interim synthesis statement for question 2.1.iii states that the “Science Panel has medium confidence that carp and wind both contribute to increased non-algal turbidity and light limitation of photosynthesis in Utah Lake, with wind being the primary hypothesized driver of increases in non-algal turbidity. However, there is low confidence in the ability to assess the relative impacts of carp and wind because available studies did not evaluate these impacts concurrently.” Direct experimental manipulations in Utah Lake that looked at turbidity in exclusions with and without carp informed this response. Utah Lake wind/shear calculations and light attenuation calculations also informed this response.
- The interim synthesis statement for question 2.5.i states that the “Science Panel has medium confidence that spawning and rearing habitat meets the needs for some species in certain in-lake and tributary sites in Utah Lake but does not for other species and sites. The tables above provide more detail on specific species and sites.” Direct observational data in Utah Lake from the total maximum daily load (TMDL) study along with literature derived habitat needs informed this response.
- The interim synthesis statement for question 2.5.ii states that the “Science Panel is not prepared to assess which species are in need of protection from nutrient-related impacts.” Existing research has not focused on the sensitivity of June Sucker to nutrients; however, there may be an opportunity to explore the sensitivity of species to other related impacts, like dissolved oxygen.

Science Panel Discussion

- The Science Panel should reevaluate the wording of the response to question 1.3 using research on the history of the sewage system in the cities around Utah Lake. In 1950, there was a transition from raw to treated sewage. This represents a sixty year gap between the introduction of carp and the transition from raw to treated sewage. However, there is evidence that there were sewer farms in the Salt Lake Valley in the early 19th century. Canals flushed waste to a centralized place for agriculture. Many communities also likely started closer to the mountains, so many of the nutrients from the sewer farms were likely not making it to the lake. The oldest collection system in the state is from 1873.
- The interim synthesis statement for question 2.1.i should more clearly define that the carp excretion is a part of the nutrient cycle and is not a direct source of new nutrients in the lake. The response should describe the relative importance of carp excretion within a certain timeframe (e.g., annually, seasonally, etc.).

- One way to think about the role of carp in Utah Lake is that every atom of phosphorus entering Utah Lake either ends up in the water column or sediments. Carp has an impact by partitioning where the phosphorus atoms end up. For example, 95% of phosphorus in Utah Lake may end up in the sediment, but carp bioturbation releases the phosphorus. Carp is not an additional source of nutrients, but it impacts how much phosphorus ends up in the sediment and how much ends up in the water column. The phosphorus in the water column is what impacts the algal blooms. If there is a way to say that carp increase the mobilization of phosphorus by x%, that would be an accessible way to communicate the impact of carp.
- There is an estimate of how much phosphorus is coming out of the sediments during algal blooms because there is direct observational data of this dynamic. Carp likely play some role in phosphorus release along with the blooms themselves.
- Counting the nutrients from carp excretion may inflate the nutrient input numbers significantly because carp excretion could be recycling the same phosphorus molecule. The report addresses the issue associated with double and potentially triple counting phosphorus from carp excretion.
- The response should not refer to carp excretion in the context of external nutrient loading because carp excretion or biomass do not contribute additional external nutrients to Utah Lake. Because carp are removed from the lake, there is a net reduction in nutrients overall. Chris Keleher has calculated the amount of nutrients being removed from the lake as a result of carp removal. The number is overall insignificant in the total nutrient budget, but the numbers should be added to the report to highlight the different ways carp impact the nutrient budget.
- The intention of question 2.5.i is to identify where and when early life stages of fish are present because there are ammonia and dissolved oxygen criteria specifically for when early life stages are present. The Environmental Protection Agency (EPA) will ask the ULWQS to demonstrate that that the numeric nutrient criteria meets all standards. Right now, DWQ is only assessing dissolved oxygen and ammonia standards for when all life stages are present. The dissolved oxygen standards are much more stringent when early life stages are present, and early life stages do not occur all the time everywhere in Utah Lake. Dissolved oxygen criteria for early life stages in warm-water fishery is 5.0 mg/liter, and the seven-day average is 6.0 mg/liter. Knowing where and when early life stages are present will help demonstrate that the numeric nutrient criteria will help meet the dissolved oxygen standards for early life stages.
- In Provo Bay, there are impairments with all life stage assumptions. The June Sucker Recovery Program identified Provo Bay as an area that is explicitly important for early life stages. Mike Mills, June Sucker Recovery Program, will have more explicit information on other parts of the lake that are important for early life stages. Heidi Hoven, Audubon Society, is working on identifying areas of importance for the early life stages of birds. This information is still pending. The Science Panel will be able to incorporate this information next time they revisit these charge questions.
- The intention of question 2.5.ii is to confirm whether there are any other issues not captured by ammonia or dissolved oxygen that affect June Suckers, such as toxins. The question may be too speculative to answer.

HARMFUL ALGAL BLOOMS (HABs) CHARGE QUESTION INTERIM RESPONSES PRESENTATION

Kateri Salk, Tetra Tech, presented the interim responses for the HABs charge questions. Her presentation is summarized below.

- The HABs Subgroup members included Janice Brahney, Mitch Hogsett, Theron Miller, and Hans Paerl.

- The HABs charge questions are:
 - 2.3. What are the linkages between changes in nutrient regime and Harmful Algal Blooms (HABs)?
 - i. Where do HABs most frequently start/occur? Are there hotspots and do they tend to occur near major nutrient sources?
 - ii. Which nutrients are controlling primary production and HABs and when?
 - iii. If there are linkages between changes in nutrient regime and HABs, what role if any does lake elevation changes play?
 - iv. How do other factors affect HAB formation in Utah Lake (e.g., climate change; temperature; lake stratification; changes in zooplankton and benthic grazers and transparency)
 - v. What is the role of calcite “scavenging” in the phosphorus cycle?
 - vi. What is the relationship between light extinction and other factors (e.g., algae, TSS, turbidity)?
 - 4.3. If the lake stays in a phytoplankton-dominated state, to what extent can the magnitude, frequency, and extent of harmful and nuisance algal blooms be reduced through nutrient reductions?
- The evidence list for the responses included DWQ monitoring data, the Bioassay Study conducted by Dr. Zach Aanderud, and the ULWQS Analysis Report compiled by Tetra Tech.
- The interim synthesis statement for question 2.3.i states that the “Science Panel has medium confidence that cyanobacteria grow across all parts of Utah Lake, but HAB hot spots occur in Provo Bay and in the northeast part of the main basin of Utah Lake. HABs in Provo Bay and the northeast occur near major nutrient sources from publicly owned treatment works (POTWs), but it is unclear if HABs in the northeast main basin occur due to a proximity to nutrient sources.” DWQ monitoring data has tracked where HABs are occurring on Utah Lake. There could be prevailing chemical or physical conditions resulting in HABs in the northeast part of the main basin other than major nutrient sources.
- The interim synthesis statement for question 2.3.ii states that the “Science Panel is highly confident that both nitrogen and phosphorus limit primary production in Utah Lake, and the degree of limitation of one or both nutrients varies across the growing season, location in the lake, and taxa of interest.” One line of evidence for this charge question responses was the monitoring data that shows when certain taxa were outcompeting, which corresponds to certain nutrient limitations (e.g., diatoms outcompete in the early part of the season, green algae outcompete in the early part of summer and late part of fall, and cyanobacteria outcompete in the middle to late summer). Nitrogen-fixing cyanobacteria outcompeting in the middle to late summer indicates a nitrogen limitation in Utah Lake at that time. The Bioassay Study also charted when and where certain nutrient limitations occur in Utah Lake.
- The interim synthesis statement for question 2.3.iii states that the “Science Panel has a medium degree of confidence that lower lake elevations are associated with larger HABs. However, lake elevation appears to have a smaller impact than nutrients, and lake elevation encompasses several possible drivers which may co-occur in Utah Lake and should be parsed as part of future efforts.” Some of those drivers include water residence time, water clarity, and delivery of nutrients associated with higher flows of water.
- The interim synthesis statement for question 2.3.iv states that the “Science Panel has medium confidence that climate-related factors (precipitation, evaporation, air temperature) may have significant impacts on HAB formation in Utah Lake, with negative relationships between HABs and precipitation and evaporation, and positive relationships between HABs and temperature. The SP has medium confidence that lake stratification is

unlikely to impact HABs in Utah Lake due to the transient nature of thermal stratification. The impact of zooplankton and benthic grazers on HABs in Utah Lake is unknown at this time.” The recent EPA criteria report for lakes and reservoirs includes a model that demonstrates the relationship between zooplankton biomass and chlorophyll and the decoupling of that relationship at high chlorophyll levels.

- The interim synthesis statement for question 2.3.v states that “previous work suggests that calcite precipitation may be a dominant pathway for phosphorus sedimentation in Utah Lake (LeMonte et al. 2021). Uncertainty remains as to whether calcite precipitation renders phosphorus non-bioavailable to phytoplankton, and how much sediment phosphorus returns to the water column for phytoplankton uptake. The forthcoming Phosphorus-Binding Study (LeMonte et al. 2021) will address these knowledge gaps and help to answer this question.”
- The interim synthesis statement for question 2.3.vi states that the “Science Panel has high confidence that light extinction occurs rapidly with depth in Utah Lake, and the majority of light attenuation is due to non-algal turbidity, with a minor but substantial part of light attenuation occurring due to phytoplankton.” There are well-established relationships between total suspended solids, turbidity, Secchi depths, and chlorophyll-a.
- The interim synthesis statement for question 4.3 states that the “the interim assessment of the Science Panel is that information is not currently available to evaluate this question. The Science Panel hypothesizes that reductions in nutrients will result in decreased phytoplankton abundance, but the extent and rate of phytoplankton reductions are dependent on the combined effect of external and internal nutrient loading.” The EFDC-WASP model will provide evidence to answer this question more extensively.
- The Phosphorus-Binding Study, empirical stressor-response analyses, EFDC-WASP model, Mike Brett’s mass balance analysis, and Janice Brahney’s sediment core analyses will all inform the response to these charge questions in the future.

Clarifying Questions

Science Panel members asked clarifying questions. Questions are indicated in italics, with the corresponding answer in plain text.

Why can the Subgroup draw the conclusion that HABs in Provo Bay occur near major nutrient sources from POTWs but not draw a similar conclusion for HABs in the northeast part of the lake?

The Subgroup talked about this question extensively. The response is not meant to identify a specific mechanistic link between HABs and POTWs as the question asks whether the hotspots are occurring near major nutrient sources. The tributaries to Provo Bay are associated with nutrient loads from POTWs. In the northeast portion of the lake, there was a question of whether the loads from TSSD are making their way to the area associated with HABs. The hypothesis was that the input from TSSD come south into the lake and then move to the southwest. The Subgroup discussed using the EFDC-WASP model to evaluate larger circulation patterns in the lake.

Why is their medium confidence on the concentration of HABs occurring in the lake (question 2.3.i)?

- Since there was only one dataset from DWQ, the amount of evidence precluded having a higher level of confidence in this response. The Subgroup discussed using imagery from National Aeronautics and Space Administration’s (NASA) Cyanobacteria Assessment Network (CyAN) to use as an additional line of evidence for this charge question.
- Since Utah Lake is a well-mixed system, the nutrients from a POTW are distributed. There are hotspots close to POTWs, but the response also acknowledges that HABs can be pushed around Utah Lake.

What paper models the relationship between zooplankton biomass and chlorophyll-a concentrations?
The paper can be found at [this link](#), and the model can be found at [this link](#).

Will the ULWQS Steering Committee need to wait until the completion of the EFDC-WASP model to assess the impact of reducing watershed loads on HABs?

The Science Panel does have specific information relating nutrient concentrations to phytoplankton abundance. Those analyses will help the Science Panel quantify the relationships between nutrient concentrations and phytoplankton abundance through the EFDC-WASP model and stressor-response analysis.

Is there any confidence in the direction of the relationship between nutrients and HABs?

- The hypothesized statement is that reductions in nutrients will result in decreased phytoplankton abundance. Literature on other systems with similar physical and trophic characteristics also indicate that reductions in nutrients will result in decreased phytoplankton abundance.
- Phytoplankton needs nutrients to grow, so fewer nutrients means less opportunity for growth. The uncertainty is around the impact of nutrient reductions on the magnitude, frequency, and extent of HABs.

Does the Bioassay Study results suggest any specific relationship between nutrient reductions and HABs?

The Bioassay Study included observing assays with reduced nutrient concentrations to determine the corresponding impacts to the phytoplankton community. They found that less nutrient concentrations in the water resulted in less abundance of chlorophyll concentrations. It does not determine the relative impact of nutrient reductions on the magnitude, frequency, and extent of HABs, but it does provide quantitative support that nutrient reductions would result in a decrease in phytoplankton communities.

Science Group Discussion

- The interim synthesis statement for question 4.3 should clarify that HABs are associated with higher nutrient concentrations even though the Science Panel has not yet come up with a quantitative prediction for Utah Lake itself. As the response is written now, there may be some confusion on how the Science Panel has not been able to draw any conclusions on the relationship between HABs and nutrients at this time. There is a substantial body of evidence that HABs are more common in nutrient-rich systems than systems with less nutrients. The Science Panel does not yet know how to apply the qualitative information in a quantitative way in Utah Lake, but they are working on quantifying those relationships to develop more predictive capacity.
- The statement for question 4.3 could also indicate that lakes with lower nutrient concentrations have lower magnitude, frequency, and extent of HABs, and lakes with higher nutrient concentration have higher magnitude, frequency, and extent of HABs. There is a good amount of available evidence on lake nutrient concentrations and magnitude, frequency, and extent of HABs to support that statement. The dynamics in Utah Lake align with the relationship between chlorophyll-a and total phosphorus as outlined by the National Lakes Assessment.
- The statement that nutrient reductions in Utah Lake would result in a reduction in the magnitude, frequency, and extent of HABs is not meant to imply that a reduction in external nutrient loading would result in a reduction in HABs. It is only to say that nutrient reduction in the water columns would impact HABs.

- The mass balance indicates that if the average nutrient input concentration went down, the average lake concentration would also go down. The relationships between nutrient concentrations and HABs and external nutrient loading and in-lake nutrient concentrations are established, but these established relationships do not determine the degree and timeframe that nutrient reductions would have on HABs in the lake.

CRITERIA DEVELOPMENT CHARGE QUESTION INTERIM RESPONSES PRESENTATION

Scott Daly, DWQ, presented the interim responses for the criteria development charge questions. His presentation is summarized below.

- The Criteria Development Subgroup members were Mitch Hogsett, Theron Miller, and James Martin.
- The criteria development charge questions are:
 - Question 3: What additional information is needed to define nutrient criteria that support existing beneficial uses?
 - 3.1: For warm water aquatic life, waterfowl, shorebirds, and water-oriented wildlife
 - 3.2: For primary contact recreation
 - 3.3: For agricultural uses including irrigation of crops and stock watering
- These charge questions were different than the other charge questions because they asked what additional information is needed instead of what the Science Panel knows.
- The evidence list relied on two pieces of evidence. The first piece of evidence was the ULWQS Numeric Nutrient Criteria Technical Framework, which the Science Panel approved in 2020 and the Steering Committee recently approved. The second piece of evidence was the ULWQS Management Goals: Science Panel Responses to Steering Committee Questions, which is a document that captured the Science Panel’s comments to different Steering Committee questions on data availability and relevance of certain metrics.
- In the ULWQS Management Goals: Science Panel Responses to Steering Committee Questions document, the Science Panel created a series of tables to identify whether certain assessment endpoints were relevant to different management goals and whether those endpoints were quantifiable with existing information. These tables contained much of the relevant information for answering the charge questions.
- The ULWQS Numeric Nutrient Criteria Technical Framework outlines each stressor-response relationship planned for each beneficial use. Each beneficial use may have several associated lines of evidence and stressor-response relationships. The Framework identifies whether the stressor-response relationship will be assessed through empirical stressor-response data and/or the mechanistic model output.
- The response to these charge questions indicate that “for each beneficial use, several lines of evidence have available and relevant information.” It also states that where there is missing information, that information “is not likely to impact confidence in developing the numeric nutrient criteria.” Much of the missing information are indirect measures and not direct ones, like chlorophyll-a. Lastly, the response indicates that the “Science Panel has high confidence that numeric nutrient criteria that protect the beneficial uses of Utah Lake can be developed with available data sources.”
- The forthcoming studies for these charge questions include the empirical stressor-response analysis, mechanistic lake and watershed models, the US Fish and Wildlife Service and US Geological Survey’s studies on toxin impacts on aquatic life, DWQ additional monitoring (e.g., saxitoxins), David Richards’ food web model and Multi Metric Index of Biological Integrity (MIBI) Study, and the recreation perception surveys to establish water quality

objectives for Utah Lake. The request for proposals (RFP) is currently out to develop the recreation perception surveys.

PUBLIC COMMENT ON CHARGE QUESTION INTERIM REPORTS

No members of the public made comments on the charge question interim reports.

CHARGE QUESTION INTERIM REPORT NEXT STEPS

- The Science Panel received all the draft reports before the meeting.
- Kateri Salk and Mike Paul will incorporate the suggested revisions from today's meeting into the charge question interim reports. Tetra Tech's contract to complete the work expires on October 31. Any unaddressed comments or work will be added into the documents so they are not lost and incorporated in the future.
- The charge question interim reports will be distributed to the Steering Committee for review.
- In previous discussions, Steering Committee members have expressed that the Science Panel information can be difficult to digest at times. Heather Bergman and Samuel Wallace will edit the interim synthesis statements from the charge question interim reports to make them more accessible to the general public and the ULWQS Steering Committee.

UTAH LAKE WATERSHED MODEL SELECTION PRESENTATION

Kevin Kratt, Tetra Tech, presented an update on the Utah Lake watershed model selection process. His presentation is summarized below.

- Before the meeting, Science Panel members received a memo from Tetra Tech, which outlined the methodology for selecting a watershed model and a recommendation for which model to use. The recommendation is to use the Hydrologic Simulation Program – FORTRAN (HSPF) model.
- At the last Science Panel meeting, Kevin Kratt presented an overview of the plan to select a watershed model. The process involved creating objectives and criteria to evaluate potential watershed models. The objectives and criteria were shared with the Science Panel members at the last meeting. Tetra Tech used those criteria to evaluate watershed models and prepare a watershed model selection technical memorandum for the Science Panel to review.
- For the in-lake model, the Science Panel already had the EFDC-WASP model in place and prepared recommendations on how to improve it. Tetra Tech reviewed the existing model and is starting to implement some of the recommended improvements. Tetra Tech is also starting to develop the SWAN model, which will simulate wave conditions on the lake. The Quality Assurance Plan and Procedure (QAPP) documents the new team and some of the key issues.
- The process for reviewing watershed models involved: 1) defining objectives for the watershed model, 2) identifying criteria based on the objectives, 3) evaluating and ranking multiple models by the criteria, and 4) recommending a model(s) for the study.
- The objectives of the model were to:
 - Provide appropriate temporal, spatial, and process resolution of surface water and shallow groundwater flows and pollutant loadings to Utah Lake
 - Simulate continuous (as opposed to event-based) existing, historic, and potential future conditions (with the goal of producing daily, if not sub-daily, outputs)
 - Simulate point and nonpoint sources and provide outputs necessary to develop source assessments and allocations

- Allow for simulation of key stressors originating from the watershed (e.g., phosphorus, nitrogen)
- Provide outputs with sufficient accuracy to support management/regulatory discussions
- Produce outputs in a format that allows for linkage with the EFDC-WASP Utah lake Model
- There were over 20 criteria used to evaluate potential models. The criteria are categorized in four broad categories:
 - Key watershed characteristics and simulation capabilities (e.g., simulates parameters of concern, simulates runoff and shallow groundwater pathways)
 - Source representation (e.g., represents loads from distinct land covers, able to simulate loads from septic systems)
 - Suitability criteria (e.g., feasible to link to EFDC/WASP, capable of simulating potential reductions from different sources, ease of use)
 - General platform (e.g., sufficient documentation, public domain, stable code)
- Tetra Tech used a number of resources to identify candidate models, including those supported by the EPA's Center for Exposure Assessment Modeling and the Water Environment Research Foundation's (WERF) modeling guidance. One goal was to focus on non-proprietary models. Tetra Tech generated a list of models and ranked them based on how they performed for each criterion. Their scoring system identified whether a model met the criterion, partially met the criterion, or did not meet the criterion.
- After Tetra Tech implemented the scoring system, they identified that the HSPF model scored the best among all the models. The HSPF model has existed for some time and has a good track record for use. The Soil and Water Assessment Tool (SWAT) also scored well but is more oriented towards modeling agricultural watersheds and is not as sophisticated in modeling tributaries.

Science Panel Discussion

- The HPSF model is well-supported. Some models are more applicable to specific uses in the watershed, but the HPSF is the best model for the watershed as a whole.
- Science Panel members in the meeting agreed to proceed with HPSF model. Because there are not enough Science Panel members in the meeting for a quorum, Heather Bergman and Samuel Wallace will send out a poll via email to Science Panel members to ask if they approve the Tetra Tech recommendation to proceed with the HPSF model and the QAPP. They will follow up with Science Panel members as needed.

UTAH LAKE WATERSHED QAPP PRESENTATION

Kevin Kratt, Tetra Tech, presented an update on the Utah Lake model QAPP. His presentation is summarized below.

- The purpose of the QAPP is to document the goals and objectives of the model; identify project organization, personnel, and schedule; document data quality objectives; and document how to evaluate the outputs of the model.
- Tetra Tech took the Utah Lake QAPP previously reviewed by the Science Panel in 2019 and updated it.
- The QAPP presents the new team that will be working on the model development. It also summarizes which charge questions the model can help address. This information can be helpful in identifying the future use of the model in the context of the charge question interim report.

- The QAPP includes new information about the SWAN model, which is the model that will simulate wave conditions.
- The QAPP includes an updated discussion to analyze performance uncertainty using First Order Variance Analysis.
- The QAPP outlines that the Science Panel will determine the useability of the model based on performance metrics. The Science Panel can determine whether they have high, medium, or low confidence in the model depending on what question they are trying to answer. This evaluation method allows for a more nuanced decision than a pass/fail metric.

Science Panel Discussion

- One of the tasks of the modeling team is to enhance the EFDC-WASP model. Some of the enhancements will involve testing things that are not working, like alkalinity and pH, and incorporating new information, like data on the dynamics of wetting and drying. It will also involve expected enhancement model revisions. There should be a section in the QAPP that outlines the quality assurance procedures for model enhancements, considering there may be a need to develop new code and verify new information incorporated into the model. Kevin Kratt and the model development team will add a section to the QAPP on the quality assurance plans and procedures for existing model enhancements.
- The QAPP does not identify any recommended acceptance criteria. The QAPP identifies that it will be up to the Science Panel to determine whether the model is acceptable. Because Utah Lake is unique, acceptance criteria for other lakes and reservoirs may not apply to Utah Lake. The plan is for Tetra Tech to work with the Science Panel to evaluate how the model performs and look to the Science Panel to make decisions on its applicability.

PUBLIC COMMENT ON UTAH LAKE MODEL DEVELOPMENT

Jacob Krall from GeoTech Consultants joined the call to learn more about the work of the Science Panel. He is working on a water quality model as well.

OTHER SCIENCE PANEL UPDATES

Scott Daly, DWQ, presented an update on other Science Panel studies. His comments are summarized below.

- Tetra Tech is currently completing their scope of work under their contract, which expires at the end of October.
- Tetra Tech distributed the CNP Mass Balance Study draft report and the bioavailability memo to the CNP Mass Balance Study Subgroup for their review and feedback. The report and bioavailability memo are now finalized.
- Tetra Tech is completing their technical support work, which involved producing analytical tools, enhancing the Utah Lake Data Explorer, and developing the Technical Framework and conceptual models. Tetra Tech is completing the analysis report. There have been several updates to the analysis report based on Science Panel conversations in fall 2020, including a new section on cyanobacteria and toxins, an updated section on phytoplankton relationships with nutrients and other factors, and another updated section on non-algal turbidity. The charge question subgroups have been reviewing the analysis report to help them develop interim responses to the charge questions over the last few months.
- The final task for Tetra Tech under their contract is to update the datasets in the Utah Lake Data Explorer tool and add more detailed sonde data to it.
- DWQ released a request for proposals to provide technical support from the beginning of November 2021 to the remainder of the project. Under this contract, the technical team will develop a technical support document for criteria by conducting the analyses outlined in

the Numeric Nutrient Criteria Framework. These analyses will involve assessing the endpoints for all the lines of evidence and combine those lines of evidence into a criteria recommendation. The technical support team will help build on the interim charge question responses and finalize charge question responses using information from updated studies. Another task for the technical support team is to develop the numeric nutrient criteria recommendations with the Science Panel to send to the Steering Committee for their review. The final task for the technical support team is to conduct analyses as needed to support the Science Panel and Steering Committee. The independent Science Panel members are reviewing proposals and will provide guidance to the evaluation committee to select the most qualified consultant.

- There are several updates to completed and ongoing SRP studies:
 - The Bioassay Study and CNP Mass Balance Study are completed and finalized.
 - Dr. Josh LeMonte's research team is currently collecting samples for the Phosphorus-Binding Study.
 - Dr. Janice Brahney's research team are analyzing the sediment cores for the Paleo Study.
 - The Littoral Sediment Study research team is collecting samples from the field.
 - The Atmospheric Deposition Study research team is continuing to work on their report.
 - A subgroup of Science Panel members met with the TSSD Limnocorrals Study research team and reviewed their methodologies. The research team collected data in 2021 and have lessons learned on how to manage the mesocosms in Utah Lake. The team is actively developing a sampling plan, which the Science Panel subgroup will review ahead of field sampling in 2022.
- The Steering Committee approved the NNC Technical Framework. They are currently working on implementation planning and thinking about how to implement recommendations coming from the ULWQS. Input from POTWs and Steering Committee members on what factors to consider in an implementation plan were incorporated into a single document. DWQ is using that information to develop an implementation planning roadmap. The implementation planning roadmap is similar to the Numeric Nutrient Criteria Technical Framework but for implementation.
- The Steering Committee will be meeting in mid-November to discuss the implementation framework and the Science Panel interim charge reports.
- The Science Panel has recently focused time on the CNP Mass Balance Study and charge question reporting. Moving forward, it would be valuable to check in on ongoing studies in more detail and give the Science Panel time to discuss the Bioassay Study. There may also be a need for the Phosphorus-Binding Study, Littoral Sediment Study, and Model Development Subgroups to meet to discuss those studies.
- Soren Brothers took a new job at the University of Toronto and decided to step away from the ULWQS. The charge question interim reports were his last engagement with the Science Panel. The project management team will revisit the operating principles for filling Science Panel seats. The Science Panel will discuss it as an agenda item at their next meeting.

Clarifying Questions

Science Panel members asked clarifying questions. Questions are indicated in italics, with the corresponding answer in plain text.

What is the status of the user perception survey?

DWQ released the request for proposals for the user perception survey. The request for proposals will close in two weeks. The purpose of the survey is to identify chlorophyll thresholds related to

different levels of user acceptance. Essentially, the survey will ask respondents to evaluate at what point do algal populations affect their recreational activities. The results can be used as explicit assessment endpoints.

Science Panel Discussion

Mitch Hogsett, Janice Brahney, Mike Brett, and James Martin indicated they would be interested in providing input on the Steering Committee's implementation planning. The Science Panel should think about if there are additional areas of expertise that should be brought into the process for implementation planning, such as economics, restoration, etc.

NEXT STEPS

The next meeting for the Science Panel is expected to be in December. Science Panel members will receive updates on ongoing studies and discuss the open position on the Science Panel left by Soren Brothers.