

Subject:	Utah Lake Water Quality Study Charge Questions Reporting
Sub-Topic:	Criteria Development
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1.0 BACKGROUND AND APPROACH

Subgroups of the Utah Lake Water Quality Study (ULWQS) Science Panel (SP) have compiled interim responses to the ULWQS Charge Questions according to topic areas. Charge questions are listed below, followed by a traceable account of the evidence evaluation to answer each question. Other topic areas include an assessment of confidence and likelihood for each answer, but the criteria development charge question is phrased in a way that prevents a traditional assessment of uncertainty as laid out in the *Utah Lake Water Quality Study—Uncertainty Guidance* document. Instead, this SP subgroup provides an overarching assessment of the confidence in developing numeric nutrient criteria based on available data, followed by a summary of the evidence assessment sourced from other ULWQS efforts.

2.0 CHARGE QUESTIONS

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

3.0 QUESTION EVALUATION

Question 3 pertains to the evaluation of whether there is sufficient information to derive nutrient criteria for the aquatic life (sub-question 3.1), recreation (sub-question 3.2), and agricultural (sub-question 3.3) beneficial uses for Utah Lake, and if not what additional information is needed. For each of the beneficial uses, several lines of evidence have available information to derive nutrient criteria. In the event of missing information, the missing information is not likely to impact our level of confidence in developing numeric nutrient criteria, particularly because the available measures have direct connections to nutrients whereas the missing measures tend to be more indirectly tied to nutrients. Additionally, it is not uncommon to evaluate support of beneficial uses with some sources of information missing. The SP has high confidence that numeric nutrient criteria that protect the beneficial uses of Utah Lake can be developed with available data sources.

Detailed below are the specific lines of evidence and measures for which we do and do not have available information.

EVALUATION OF THE MANAGEMENT GOALS TABLE

The Steering Committee (SC) tasked the SP with answering several questions about the management goals, assessment endpoints, and measures for Utah Lake’s beneficial uses (ULWQS Science Panel 2020). The evaluation of the SP is summarized for the items relevant to charge question 3 below:

Are measures readily quantified with existing information?

- Many of the measures can be readily quantified using existing data. Exceptions include: cylindrospermopsin concentration, saxitoxin concentration, annual visitation to Utah Lake, measures from recreation survey to assess user experiences related to water quality, fish tissue algal toxin concentrations, mollusk diversity/abundance, percent change in non-algal turbidity associated with carp bioturbation, percent change in macrophyte density and distribution, percent cover of Phragmites on Utah Lake shoreline, percent cover of emergent and submergent macrophytes in littoral waterfowl and shorebird habitat areas, maximum # of days at each of littoral habitat exceeding a to be determined HAB threshold, and the maximum percent of littoral habitat area exceeding a to be determined HAB threshold.

What measures are infeasible to assess or very difficult to develop targets?

- Most measures can be assessed, and targets can be developed. Exceptions include: annual visitation to Utah Lake (difficult), measures from recreation survey to assess user experiences related to water quality (difficult), carp population density (not related to nutrients), and percent change in non-algal turbidity associated with carp bioturbation (not related to nutrients).
- The caveat to question 3 is that the ULWQS effort may not have the funding nor the time to quantify each and every measure provided by the SC in Attachment A. Careful consideration of the measures relevant to the development of in-lake numeric nutrient criteria is required to successfully move the ULWQS effort forward.

Management Goal	Assessment Endpoint	Relevant to developing in-lake N and P criteria?	Is the measure currently quantifiable?
Primary contact recreation (2a)			
Harmful algal blooms (HAB) will not create toxins that threaten public health.	Algal toxin concentrations	Yes	Yes
HAB occurrence is limited in spatial extent and infrequent to support robust recreational industry and community.	Magnitude, frequency, and duration of algal blooms.	Yes	Yes
Improve submersible recreation (swimming, paddle boarding, water skiing, etc.) experience.	Magnitude, frequency, and duration of algal blooms.	Yes	Yes
Swimming beaches and shoreline access locations are open all summer without nuisance algae or public health advisories.	Magnitude, frequency, and duration of algal blooms.	Yes	Yes
Recreation water quality standards are supported	Support of 2A Recreational Use Standards	Yes	Unknown since these are narratives.
Increase recreational opportunities and experiences.	Lake visitation and satisfaction statistics.	Likely	No, but upcoming survey pending
Improve public perception of Utah Lake water quality.	Lake visitation and satisfaction statistics.	Likely	No, but upcoming survey

			pending
Sport fish are safe for human consumption.	Fish tissue algal toxin concentrations.	Yes	No
Warm Water Fishery (3b)			
Warm water fishery is robust and healthy.	Water quality conditions	Yes	Yes
Warm water fishery is robust and healthy.	Food abundance and diversity	Yes	Yes, but limited
HAB toxins do not cause fish mortality.	Algal toxin concentrations	Yes	Yes
Warm water fishery can support reproductive populations of June Sucker.	Water quality conditions	Yes	Yes
Macrophyte habitat can support June sucker recovery and early life stages of other ecologically or recreationally important fish species.	Macrophyte abundance and distribution in Provo Bay, Utah Lake Littoral Zones, and Provo River delta.	Yes	Yes, but limited
Carp population does not inhibit June sucker recovery.	Carp density and water quality indicators related to carp activity.	Mixed	Mixed
Waterfowl, shorebirds, and other water-oriented wildlife (3D)			
Sufficient percentage cover of native and desirable nonnative littoral plant species.	Nonnative plant abundance, diversity, and distribution. Macrophyte abundance, diversity, and distribution.	Yes	No
Macroinvertebrates provide a diverse and sufficient food source to birds that use the open water and shorelines of Utah Lake.	Invertebrate abundance, diversity, and distribution.	Yes	Yes, but limited
HAB toxins do not threaten waterfowl and shorebirds and do not cause bird mortality.	Algal toxin concentrations.	Yes	Yes
HAB spatial and temporal extent supportive of healthy waterfowl and shorebird habitat.	Harmful algal bloom magnitude and duration.	Yes	Yes
Agricultural Water Use (4)			
Water used to irrigate crops will not present health risk.	Algal toxin concentrations.	Yes	Yes
Water used to water livestock will not pose health risk to animals.	Algal toxin concentrations.	Yes	Yes
Water used for secondary water does not clog or impede irrigation systems.	Algal and cyanobacteria density/biomass.	Yes	Yes

SUMMARY OF PLANNED STRESSOR-RESPONSE ANALYSES FROM NUMERIC NUTRIENT CRITERIA TECHNICAL FRAMEWORK

As part of the development for the Technical Framework (Tetra Tech 2021), planning was conducted for stressor-response relationships for both empirical and mechanistic models. The relationships of interest were evaluated for their specific beneficial use, assessment endpoint, and whether data and model output are available. Targets for chlorophyll a, cyanobacterial abundance, and clarity are derived to protect assessment endpoints (white cells) and then TN and TP criteria derived to meet the chlorophyll a, cyanobacterial abundance,

and clarity targets (gray cells). Cyanobacteria abundance encompasses cell count, biovolume, and proportional relative abundance.

Beneficial Use	Assessment Endpoint	Stressor	Response	Empirical S-R Data Available	Mechanistic Model Output
Recreation, Aquatic Life, Agriculture, Drinking Water	Algal toxins	Chlorophyll <i>a</i>	Microcystin concentration	Yes	No
Recreation, Aquatic Life, Agriculture, Drinking Water	Algal toxins	Cyanobacterial abundance	Microcystin concentration	Yes	No
Recreation	Algal blooms	Chlorophyll <i>a</i>	Cyanobacterial abundance	Yes	Yes
Recreation, Aquatic Life	pH	Chlorophyll <i>a</i>	pH	Yes	Yes
Recreation	Lake visitation	Chlorophyll <i>a</i>	Annual visitation	Yes	No
Recreation	Lake visitation	Cyanobacterial abundance	Annual visitation	Yes	No
Recreation	Lake visitation	K _d , Secchi depth	Annual visitation	Yes	No
Recreation	Public perception	Chlorophyll <i>a</i>	Public perception	Upcoming user perception survey	No
Recreation	Public perception	Cyanobacteria abundance	Public perception	Upcoming user perception survey	No
Recreation	Public perception	K _d , Secchi depth	Public perception	Upcoming user perception survey	No
Aquatic Life	DO	Chlorophyll <i>a</i>	DO	Yes	Yes
Aquatic Life	Food resources	Chlorophyll <i>a</i>	Zooplankton:Phytoplankton	National Model	No
Aquatic Life	Food resources	Chlorophyll <i>a</i>	Proportion cyanobacteria	Yes	Yes
Aquatic Life	Food resources	Chlorophyll <i>a</i>	Macroinvertebrate diversity/abundance	No	No
Aquatic Life	Food resources	Chlorophyll <i>a</i>	Mollusk diversity/abundance	No	No
Aquatic Life	Light	Chlorophyll <i>a</i>	K _d , Secchi depth	Yes	Yes
Criteria Setting		TN	Chlorophyll <i>a</i>	Yes	Yes

Criteria Setting		TP	Chlorophyll a	Yes	Yes
Criteria Setting		TN	Cyanobacterial abundance	Yes	Yes
Criteria Setting		TP	Cyanobacterial abundance	Yes	Yes
Criteria Setting		TN	K _d , Secchi depth	Yes	Yes
Criteria Setting		TP	K _d , Secchi depth	Yes	Yes

4.0 EVIDENCE

CITED STUDIES AND ANALYSES

Tetra Tech. 2021. Utah Lake Water Quality Study— Numeric Nutrient Criteria Technical Framework. Final report submitted to Utah Division of Water Quality.

ULWQS Science Panel. 2020. ULWQS Management Goals: Science Panel Responses to Steering Committee Questions. Report submitted to the ULWQS Steering Committee.

FORTHCOMING STUDIES AND ANALYSES

Empirical stressor-response analysis (as part of phase III of the ULWQS)

Mechanistic lake (EFDC-WASP) and watershed modeling (Tetra Tech)

FWS & USGS studies on toxin impacts on aquatic life (see Management Goals Table)

DWQ additions to monitoring program (e.g., saxitoxin)

Richards et al. food web model

Richards et al. MIBI

ULWQS Request for Proposals: Recreation perception surveys to establish water quality objectives for Utah Lake