Introduction

The Utah Citizen Monitoring program is a statewide program that has used volunteers to collect lake water quality data for the past nine years. Utah Lake Watch (ULW), which began in 2002, uses volunteers to collect secchi depth measurements in lakes across the state. Secchi depth can be used to assess the general condition of a waterbody and how it changes over time. For the past two years the Utah Citizen Monitoring program has expanded to also include *E. coli* and total coliform sampling at some lakes and reservoirs. *E. coli* data are used to assess the potential health risks for swimmers and water recreationists from bacterial contamination. Both the ULW program and *E. coli* monitoring will be discussed in the sections below.

Utah Lake Watch Program

The major objectives of the ULW program are:

- acquire baseline data for Utah's lakes and reservoirs;
- offer data to Utah Division of Water Quality to determine if further monitoring is needed on lakes and reservoirs, particularly those in basins not monitored in any given year;
- provide education to state citizens on the importance of healthy lakes, how lakes function, and how to monitor lakes; and
- demonstrate that citizen monitors can collect credible water quality data that can be used to better manage and protect our lakes and reservoirs

Participants of the ULW program are trained to take secchi measurements using a secchi disk. They are encouraged to take measurements every two weeks, or as often as they are out on the lake from May to September. Collecting and analyzing data for these months can give an idea of how the lake is functioning, when algal blooms are taking place, and how the lake is changing throughout the summer months. Secchi measurements, along with weather observations, are recorded on a data sheet that can be found in Appendix C.

Since 2002, 37 lakes and reservoirs have been monitored as part of Utah Lake Watch (See Appendix B). Annual reports for the Utah Lake Watch Program can be obtained through the USU Water Quality Extension website at www.extension.usu.edu/waterquality, or by contacting USU Water Quality Extension directly at 435-797-2580.

In 2010, 13 waterbodies were monitored. More than one site was monitored in three of these waterbodies. In Pineview Reservoir, new volunteers collected data at two new sites. Through the continued support of past volunteers, two new sites were added at Burreston Ponds as well. New volunteers allowed us to monitor two lakes this past year that had been missed for several years. Data were collected on Willard Bay after not having data for 2009. Data were also collected on Quail Creek Reservoir, which hasn't had an active citizen monitor since 2003.

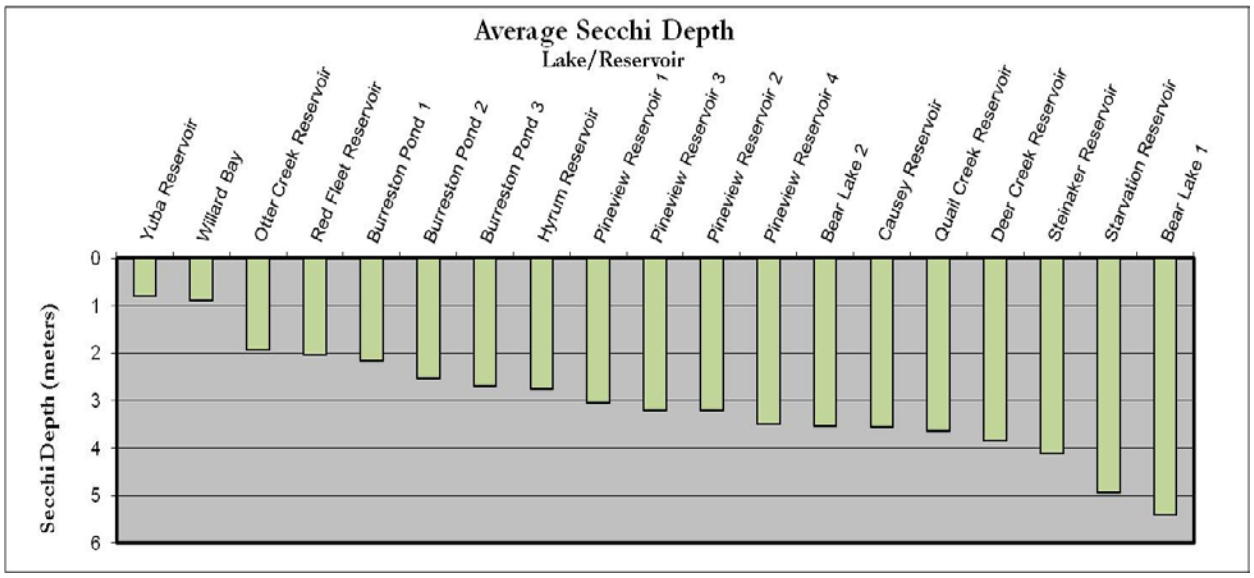


Figure 1. Average secchi measurements for each location monitored in 2010. Table 1 contains more detailed information about each of these sites.

As seen in Figure 1 and Table 1, average secchi readings in 2010 ranged from 0.80 meters at Yuba Reservoir, to 5.37 meters at Bear Lake Site 1. The highest one-time measurement (7.20 m) was recorded at Starvation Reservoir in August. The lowest one-time measurement (0.55 m) was recorded at Willard Bay in September. The number of samples and months they were taken varied between sites and are shown in Table 1. Secchi depths for all waterbodies can be found in Appendix A. Average secchi depths, converted to a Trophic State Index (TSI) value according to Carlson (1977), are also listed in Table 1. This index allows one to interpret the degree of eutrophication, using secchi depth measurements or chlorophyll a and total phosphorus concentrations. TSI values increase with the degree of eutrophication in a waterbody (see Table 2 for more explanation). Because we only used values of secchi depth to calculate TSI, caution should be taken in evaluating the overall health of a lake based on these data alone. For more information on TSI values, see http://www.epa.gov/bioindicators/aquatic/carlson.html.

Several lakes and reservoirs monitored in 2010 had TSI values below 50, indicating a mesotrophic or oligotrophic condition. These include Bear Lake, Burreston Pond, Causey, Deer Creek, Hyrum, Starvation, Pineview, Quail Creek, and Steinaker Reservoirs. Red Fleet and Otter Creek Reservoirs both had TSI values just over 50, while Willard Bay and Yuba Reservoir both had TSI values exceeding 60. These higher TSI index values suggest that these reservoirs are eutrophic.

Two reservoirs, Deer Creek and Pineview, that were classified as oligotrophic in 2009 had higher TSI values in 2010 and are classified as mesotrophic in this report. In contrast, 2 other waterbodies (Starvation Reservoir and Bear Lake) retained their oligotrophic status in 2010.

Willard Bay, Otter Creek, Red Fleet and Yuba Reservoirs were classified as eutrophic, consistent with past years. Yuba Reservoir, however, has had an increased TSI value for the past three years, suggesting a possible degradation in condition over time (see graph on Yuba Lake page).

Those waterbodies with monitoring sites at mid-lake and near inlets or shorelines offer some interesting contrasts. Mid-lake sites are generally considered reflective of the entire lake's trophic status, while near shore sites can help identify local sources or other impacts on localized conditions such as disturbance of shallow sediments. This can be seen for Bear Lake and Pineview, where nearshore sites (Bear Lake 1, Pineview 3, and Pineview 4) had lower secchi depths.

Lake / Reservoir	Max Depth (m)	Min Depth (m)	Average Depth (m)	Average TSI	Number of Measurements	Months of Collection
Bear Lake 1 (mid-lake)	6.40	3.60	5.40	36	7	May-September
Bear Lake 2 (near shore)	4.15	2.30	3.54	42	7	June-August
Burreston Pond 1 (mid-lake)	1.90	2.40	2.15	49	6	June-September
Burreston Pond 2 (mid-lake)	2.30	2.60	2.53	47	4	July-September
Burreston Pond 3 (mid-lake)	2.30	3.30	2.70	46	4	July-September
Causey Reservoir	5.60	2.50	3.55	43	3	June-August
Deer Creek Reservoir	4.60	2.80	3.80	41	7	June-August
Hyrum Reservoir	2.75	2.75	2.75	45	1	July
Otter Creek Reservoir	2.60	1.00	1.94	51	26	May-September
Pineview Reservoir 1 (mid-lake)	3.60	2.60	3.05	44	4	July-August
Pineview Reservoir 2 (mid-lake)	4.30	2.60	3.20	44	6	June-September
Pineview Reservoir 3 (near shore)	3.20	3.20	3.20	43	1	July
Pineview Reservoir 4 (near shore)	3.50	3.50	3.50	42	1	July
Quail Creek Reservoir	4.22	3.08	3.64	42	7	June-August
Red Fleet Reservoir	2.60	1.33	2.02	50	5	June-September
Starvation Reservoir	7.20	3.60	4.90	37	8	April-September
Steinaker Reservoir	5.90	2.40	4.10	41	5	June-September
Willard Bay	1.40	0.55	0.88	63	8	June-September
Yuba Reservoir	1.15	0.68	0.80	63	9	May-September

Table 1. Maximum and minimum secchi depths for each monitoring site, including number of measurements collected, average TSI, and months of collection.

Classification	Definition	Secchi Depth (m)	Chl (µg/L)	TP (µg/L)	TSI
Oligotrophic	A waterbody having low turbidity and abundant dissolved oxygen (i.e. good water quality).	> 4	< 2.6	< 12	< 40
Mesotrophic	A waterbody having moderate turbidity and moderate dissolved oxygen (i.e. moderate water quality).	2-4	2.6-7.3	12-24	40-50
Eutrophic	A waterbody having high turbidity and low dissolved oxygen (impaired water quality).	0.5-2	7.3-56	24-96	50-70
Hypereutrophic	A waterbody that is extremely turbid and exceptionally low in dissolved oxygen (i.e. very poor water quality).	< 0.5	> 56	96-384	> 70

Table 2. Trophic State Classifications (Carlson, 1996). Chl is Chlorophyll concentration, TP is Total Phosphorus concentration, and TSI is the calculated value of the Trophic State Index.

E. coli and total coliform monitoring program

In 2009 Water Quality Extension participated in a pilot program, working with Utah Division of Water Quality (DWQ) to collect *E. coli* and total coliform data for target waterbodies throughout the state. In 2010 that pilot program was modified to include more intensive monitoring. The program followed EPA's monitoring guidelines as incorporated in Utah's Bacterial Monitoring program. The DWQ prioritized sites based on impaired waters, high use lakes, and areas of known *E. coli* concentration. The goal was to use assistance from citizen monitors to test each of these lakes twice a month for the months of May to September.

In 2010, forty-four lakes and reservoirs were monitored by state employees and cooperators to the Bacterial Monitoring program. All samples were analyzed using the approved Idexx Quanti-Tray 2000 method (see http://idexx.com for a description of the method). The results were compared to Utah's numeric criteria for *E coli*, shown in Table 3.

Classification	Protected Beneficial Use	Not to Exceed Maximum	30-Day Geometric Mean
1C	Protected as a drinking water source.	668 mpn	206 mpn
2A	Protected for frequent primary contact recreation.	409 mpn	126 mpn
2B	Protected for infrequent primary contact recreation.	668 mpn	206 mpn
(mpn—most probable number of E. coli per 100mL sample)			

Table 3. Utah's numeric criteria for *E. coli* (http://www.waterquality.utah.gov/Monitoring/Bac/index.htm).

Water Quality Extension participated in this effort in several ways. We identified potential volunteers, trained some of these volunteers, and worked directly with some of the volunteers. Also, USU Water Quality Extension staff collected and processed some of the samples. In total, our employees or volunteers working directly with us monitored 15 of these waterbodies. These are listed in Table 3, which also identifies whether the monitoring was conducted by USU staff or by citizen monitors.

Lake / Reservoir	Number of Sampling Sites	Number of Sampling Events collected by:		Months of Collection
		Citizen volunteer working with USU	USU extension staff	
Bear Lake	10	9	1	May-September
Gunlock Reservoir	1	0	2	May-June
Hyrum Reservoir	1	8	0	May-September
Lyman Lake	1	0	2	June-August
Moon Lake	1	0	2	June-August
Otter Creek Reservoir *	1	0	8	May-August
Palisades Reservoir	3	0	8	May-August
Pineview Reservoir *	1	0	7	May-July
Piute Reservoir *	1	0	8	May-August
Pyramid Lake	1	0	1	June
Quail Creek Reservoir	2	0	2	May-June
Sand Hollow Reservoir	2	0	2	May-June
Scout Lake	1	0	2	June-August
Willard Bay	2	0	11	May-September
Yuba Reservoir *	4	0	8	June-August

Table 4. Lakes monitored by USU Extension staff or citizen monitors working directly with USU Extension. * These waterbodies had volunteers who were trained to help with sampling; however, sampling equipment was not readily available in these areas.

Of all the waterbodies monitored, ten had at least one sample that exceeded the state criteria. When this happened, a repeat sample was taken as quickly as possible following the reading of the initial results. Only two locations, Salem Pond and Maybey Pond, exceeded the criteria on several occasions. For more information on these sites, and for the results of all *E. coli* and total coliform sampling in the state for 2010, please see http://ecoli.utah.gov.

Citizen monitoring challenges

The Utah Lake Watch program has encountered some challenges over the past few years. Several of these challenges are being experienced by the pilot bacteriological program as well. These are discussed briefly below.

- **Volunteer recruiting and retention** – The Utah Lake Watch Program has had a total of 67 volunteers since 2002. Of these 20 are still actively involved. The *E coli* program utilized only 6 volunteers with varying levels of participation and had to rely on Extension employees to conduct sampling on 15 out of the 21 lakes which were originally assigned to the citizen monitoring program. The cost of this kind of participation from Extension was higher than anticipated for the program. For example, one trip to sample reservoirs in Central Utah (Yuba, Piute, Otter Creek, and Palisade Reservoirs) costs roughly $200 in travel, plus employee time. It is not feasible for Extension to continue this level of participation without further funding. As the program progresses, it is our hope that we can help facilitate volunteers while taking a minimal role in the actual collection of samples.

  There are many reasons why volunteers have stopped participating in the citizen monitoring program. Some of these reasons include moving, selling their boat, lack of time to commit to the program, and loss of interest. Water Quality Extension is putting together a survey to determine any other reasons and what can be improved in the program to help retain volunteers.

  Recruiting has been an ongoing challenge for citizen monitoring. Past recruiting has been accomplished through newspaper articles, flyers, posters, website advertising, emails, teaching events, and phone calls. While this has been successful to recruiting some volunteers, our numbers are consistently low. Recruiting methods may also need to be catered to each aspect of citizen monitoring. For example, volunteers in the Lake Watch program need a boat to get out onto the lake. Bacterial monitoring does not require a boat, however, may require more of a time commitment. Bacterial monitoring is also more complex than secchi depth and therefore the volunteers may need more training. Because of these differences, each of these programs may require different recruiting methods.

- **Details regarding data use** – As Citizen Monitors are being trained, many of them want to know how the data they are collecting is being used. This question is easy to answer with bacterial monitoring as it is a public health issue. The state has a website set up where the data is made available to the public. When exceedances are discovered, monitoring becomes more intense. In some cases, warning signs are set up to inform the public of the possible dangers to contact

with the water. However, with the Lake Watch program, this is more difficult. The Lake Watch data is sent to volunteers and DWQ employees, however, how that data is being used is unclear. To help with this challenge, questions regarding the Lake Watch final report are also being asked in the survey being prepared by Water Quality Extension.

- **Monitoring techniques -** Ironically, Lake Watch protocols may be too simple for some volunteers, while the methods required for the bacterial sampling may be too complex for others. This suggests the need to identify subgroups within the general pool of volunteers. For example, you may wish to note that volunteers have different abilities. Utah Lake Watch and programs that are relatively simple may work for one group of volunteers, while the *E. coli* program might work for volunteers who have more time, deeper knowledge of lakes and pollutant sources or monitoring techniques.

  The collection method for *E. coli* and total coliforms is more time consuming than simple secchi depth measurements. This makes the program more difficult for volunteers who have limited time. Some monitors also lacked the confidence to complete the sample collection themselves. This may be resolved in the future with more training provided for the volunteers.

- **Availability of equipment -** One of the biggest challenges for the bacterial monitoring program was the limited availability of the relatively expensive equipment required for this program. Because the equipment was housed in a limited number of locations in the state, it became difficult for volunteers to process samples. Water Quality Extension had two sets of equipment for use in the program. It proved difficult, however, to get this equipment to volunteers who needed it in many locations in the state.

Program modifications

To help resolve some of these concerns, USU Water Quality Extension plans to survey past and current volunteers and others involved in our monitoring program to identify what motivates volunteers in Utah, what barriers exist to their participation, why they leave the program, and how we might improve the program.

We are also continuing discussions with DWQ and the Utah Monitoring Council to identify other parameters that could be collected by volunteers, to determine whether we need multiple levels of training, and to determine whether we should have a volunteer certification program in the state.

Possible changes already identified for Utah Citizen Monitoring program include:

- Recruit through watershed days, community service projects, and training days set up in various locations throughout the state.
- Implement other parameters into the program such as dissolved oxygen, temperature, and chlorophyll a.
- Use a participation based incentive program, or certification program.
- Use a database on the state website where volunteers could enter their own data.

- Use an additional *E. coli* method, such as easy gels, as a screening tool.
- Link monitoring to TMDL listed lakes.
- Send out a quarterly citizen monitoring newsletter.
- Create a train-the-trainer program so citizen monitors have local contacts statewide.
- Showcase citizen monitors at Utah Monitoring Council annual meeting.
- House bacterial monitoring equipment at more locations in the state. This could help in the future expansion of the program.

We hope that the Utah Citizen Monitoring program can continue to help the Division of Water Quality and provide opportunities for citizen volunteers to help take care of their water resources. The program has the potential to expand to reach many more citizens and to collect more data that could be used by the DWQ in their monitoring efforts.

References

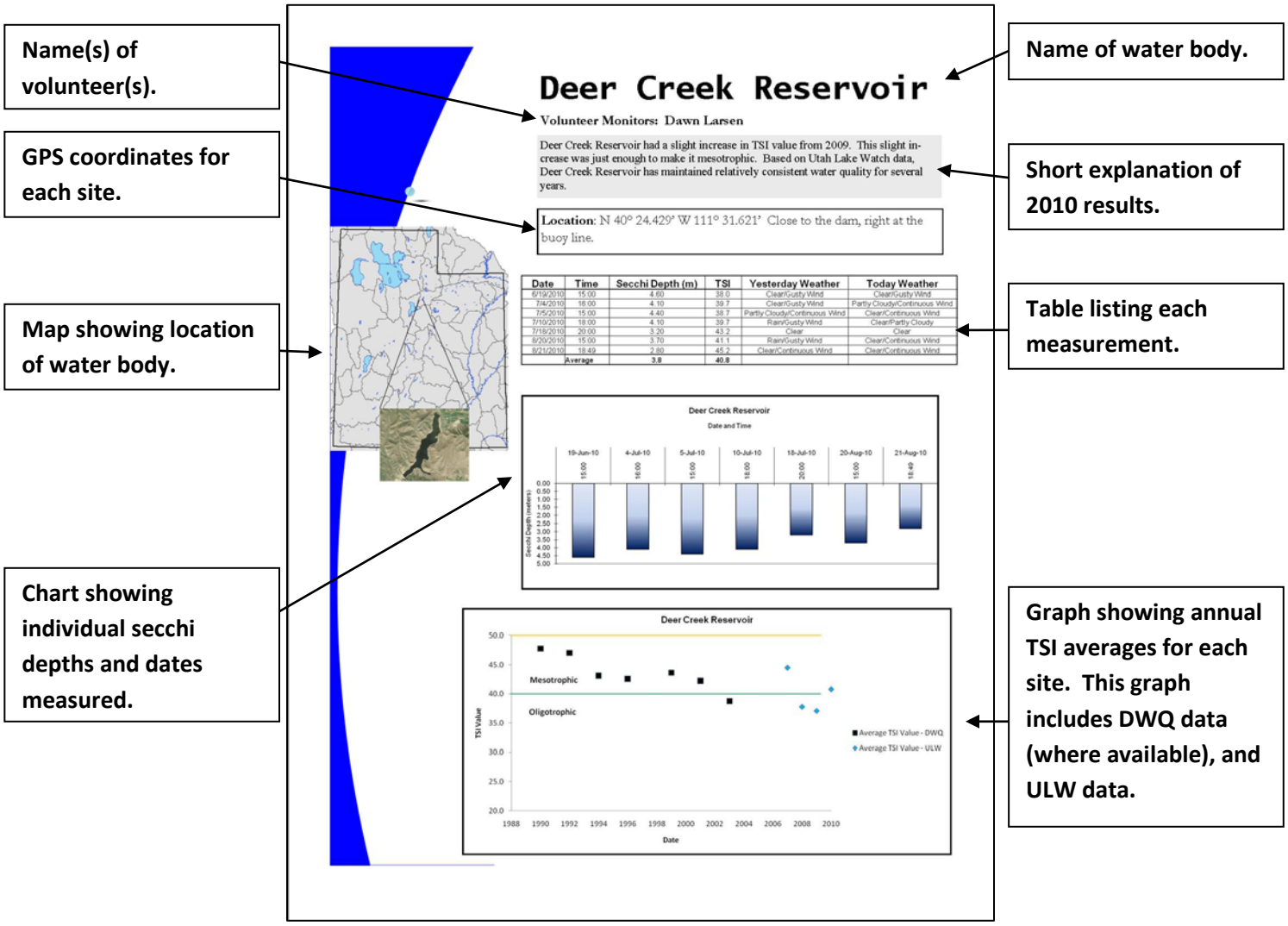
Utah Water Quality Division Lake Reports
< http://www.waterquality.utah.gov/watersheds/lakes.htm>

Carlson, Robert E. "A Trophic State Index for Lakes" Limnology and Oceanography 1977: 361-369.

Utah Bacteriological Monitoring Program
< http://www.waterquality.utah.gov/Monitoring/Bac/index.htm >

Explanation of Individual Lake and Reservoir Pages

Each waterbody that was monitored in 2010 has an individual results page. The following is an example of what you will find on these pages, along with an explanation of each section.



Date	Time	Secchi Depth (m)	TSI	Yesterday Weather	Today Weather
6/19/2010	15:00	4.60	38.0	Clear/Gusty Wind	Clear/Gusty Wind
7/4/2010	16:00	4.10	39.7	Clear/Gusty Wind	Partly Cloudy/Continuous Wind
7/5/2010	15:00	4.40	38.7	Partly Cloudy/Continuous Wind	Clear/Continuous Wind
7/10/2010	18:00	4.10	39.7	Rain/Gusty Wind	Clear/Partly Cloudy
7/18/2010	20:00	3.20	43.2	Clear	Clear
8/20/2010	15:00	3.70	41.1	Rain/Gusty Wind	Clear/Continuous Wind
8/21/2010	18:49	2.80	45.2	Clear/Continuous Wind	Clear/Continuous Wind
	Average	3.8	40.8		