Whatcom Watch Online

Lake Whatcom Monitoring Through the Years

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Cover Story

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by Tom Pratum

Tom Pratum is a Lake Whatcom resident who is very concerned about the future of the lake.

Lake Whatcom is the most significant drinking water resource in Whatcom County—serving on the order of 87,000 people. The condition of the lake has been the focus of much concern and great debate over the years. Public policy debate has focused on the role of development on our current water quality.

Pro-development interests (such as Whatcom County Water District #10, and the Building Industry Association of Whatcom County) claim there is no evidence of development impacts, and environmental groups point to the negative water quality trends seen to date as evidence that development of the Lake Whatcom watershed must cease.

While the testing of Lake Whatcom water has been done by many governmental agencies over the years (e.g. Washington State Department of Ecology, Environmental Protection Agency, etc.), most of these tests were done to answer specific questions, and were not meant to provide long-term monitoring of the condition of the lake.

Fortunately, long-term monitoring data is available through the work of a large number of individuals at Western Washington University (WWU). Taken together, these are not perfect data for observing long-term trends, but they do tell us something about where the water quality of the lake has been in the past and possibly give an indication of where it is going in the future.

History

Two Professors Started Research Program

Beginning in 1962, then Professors Gerald Kraft and Charles Flora of the WWU (at the time it was Western Washington State College) biology department started a research program to investigate the characteristics of what is obviously now a very important body of water: Lake Whatcom. Starting in about 1892 the lake had provided the City of Bellingham with a large fraction of its water supply,[1] but 70 years later the city knew almost nothing about it — nor did anyone else.

For example, according to multifaceted environmental steward George Garlick, who worked with Flora and Kraft as a biology department technician, some people in the early days actually thought Lake Whatcom and Lake Samish might be hydrologically connected by an underground channel.[2]

In addition, in 1961 the city had completed the Middle Fork Nooksack River diversion, whose purpose was to provide another source of water to the lake to help control the previously wide fluctuations in lake level. While the initial studies were not specifically intended to show the effect of this major water input, they have indeed at least partly served that purpose.

This was originally a pure research project, done out of the raw interest of these two faculty members. With initial funding from the City of Bellingham, they presented the first report of the Lake Whatcom Study Project to then mayor John Westford on August 9, 1962. In this first report they stated that “The purpose of the Lake Whatcom Study Project is to carry on for the next several years as complete an ecological study of Lake Whatcom as funds and time will permit.” [4] The report covered the time period April 3 to July 17, 1962. The initial contract to carry out this study was for $3,700.

Initial Goals of Lake Whatcom Study Project

The initial goals of the work were to construct a model which showed the topography of the bottom of the lake (a bathymetric map), as well as to measure temperature, dissolved oxygen, light penetration, acidity (pH), nutrients (phosphate), plankton activity (chlorophyll), and fecal coliform bacteria levels. The bathymetric map was generated from chart-recorded depth soundings recorded as a boat traveled at a constant speed along 50 predetermined tract lines across the lake at various points.[3]

Again, technician George Garlick was intimately involved in this project. The bathymetric map so generated is still in use today (see Lake Whatcom Contour Map— Figure 1), although newer data have recently become available from the U.S. Bureau of Reclamation.[5]

In those initial years, the project was not without controversy. The city did not want its residents alarmed about their water quality, and when Kraft and Flora found high levels of fecal coliform bacteria in some areas, Mayor Westford became quite angry.[2,6] Even then, it appears that attempts were made to squelch scientific evidence of water quality concern.

Lake Sampled Weekly 1962 to 1969

Kraft and Flora sampled the lake weekly from 1962 through 1969, and the lake was more sporadically sampled during the tenure of Bruce Lighthart (1969-1973) of the then-named Institute of Freshwater Studies (IFS). Between 1973 and the summer of 1979 there was no sampling done at all, until Professor Flora again was able to obtain funding for two years of sampling (1979-1980 and 1980-1981).7

In those early years reports were not generated every year, but significant summary reports were generated in 1973 and 1981.7,8 The Institute of Freshwater Studies also published a number of other reports related to Lake Whatcom. These covered such topics as the morphology of the lake,3 inventory of plants around the lake, and the history of settlement around the lake.1

Regular Sampling Resumed Early 1980s

In 1982, David Brakke, who was then on the WWU faculty9 in the presently named Institute for Watershed Studies (IWS), obtained a contract for monitoring of Lake Whatcom as part of the Lake Whatcom Restoration Study. This study, which was compiled by URS Corporation (Seattle, WA), became part of what is also known as the URS Study, and was published in 1985.

The report took into account the findings of Brakke's measurements, and recommended a continuing monitoring program "to maintain an ongoing measure of lake water quality so that trends toward future problems can be detected before they become serious." 10

This can probably be considered the start of the modern era of Lake Whatcom monitoring. This also marks the beginning of Robin Matthews' involvement in the program. Matthews came to WWU in 1985, along with her husband Geoffrey Matthews of the computer science department.

Matthews was trained as a freshwater ecologist, but was not initially given an actual faculty appointment at WWU. She worked with the Institute for Watershed Studies as a research associate until 1992. In 1990, she obtained a tenure-track faculty appointment as an assistant professor. Matthews has been director of the Institute for Watershed Studies since 1994, and a full professor since 1995.

Reports Steady Since 1987

In contrast to prior years of sporadic reports, there has been a stable stream of Lake Whatcom Monitoring reports since 1987 under the helm of Matthews. This has not been a glamorous task, and the payoffs have been few. Long-term monitoring produces little in the way of scientific publications, which are the measure by which many scientists are judged. However, these data form the bedrock of Lake Whatcom monitoring. They have also provided excellent training opportunities for a large number of both undergraduate and graduate students.

As the demands of the monitoring program have increased, so has its budget; (see Lake Whatcom Monitoring Project— Figure 2). Monitoring has expanded to encompass creeks, and stormwater treatment systems, along with analysis of currents and sedimentation in the lake. This contract in 2001 supported one technician and one budget analyst part time, along with five graduate students, and eleven undergraduate students. The Lake Whatcom Monitoring Reports thereby produced are available for all to see at http://www.ac.wwu.edu/~iws/lakewhatcom.htm.

Trends

Comparison of Most Parameters Difficult

To determine trends in the data, one would most like to have a stable set of data which were acquired under identical conditions over time. Unfortunately, that condition only applies to the Lake Whatcom monitoring data acquired since 1987.

Prior to that time, methodological and, in some cases, environmental factors varied from year to year making comparison of many parameters difficult.11 Additionally, while at least one sampling site has always existed in each of the major basins of the lake (1, 2, 3a and 3b – see Figure 1), the actual sites where the sampling occurred have changed several times over the years.

Of the parameters which have been measured since 1962, it is likely that only temperature, pH, transparency, and dissolved oxygen (DO) would be comparable to those values measured today. Since the lake is 303(d) listed by the Washington State Department of Ecology for low levels of dissolved oxygen, this is an obvious target for comparison.

Disturbing Trend for Dissolved Oxygen

However, while dissolved oxygen has been collected by comparable techniques, and calibrated via the same Winkler method12 throughout the years, it has not been measured at consistent depths. From 1962-1981, measurements were taken only at the surface and at the bottom. In the mid-1980s, they were taken at the surface, bottom, and three points between. Only since 1987 have they been taken at regular depth intervals. This makes comparison of the data from earlier years impossible.

An analysis of the data prior to 1973 appears to indicate an increase in surface DO over the period 1962-1973.8 The 303(d) listing for low oxygen levels is based upon data taken from the mid-1980s through the late 1990s which show the seasonal rate of depletion of hypolimnetic13 DO (the hypolimnetic oxygen deficit rate) in basin 1 to be increasing over time.14 This greater rate of oxygen depletion is reflected in hypolimnetic DO levels which are decreasing over time. Recently acquired DO data continue this disturbing trend.15

Slight Increase in Secchi Depth Readings

Another parameter to look at as an indicator of water quality would be transparency. As explained in a previous article ("Does Lake Whatcom Qualify as an Impaired Waterbody," Whatcom Watch, February and March 2002), higher levels of nutrients in the water would lead to greater biological growth, and this growth would make the water cloudy and difficult to see through. This has classically been measured via a Secchi disk reading.16 The greater depth at which the Secchi disk can be seen, the more transparent and presumably cleaner the water is.

While this may sound like a simple test, it is also has a degree of subjectivity that makes it somewhat qualitative in nature. An additional complication regarding measurement of Secchi depths in Lake Whatcom is the fact that the Middle Fork diversion (Nooksack River) carries fine silt into the lake, which then tends to decrease Secchi depths but has nothing to do with the biological productivity of the lake.17

A trend in Secchi depth readings is not really discernable in the data taken over the past 15 years (see Lake Whatcom Secchi Disk Readings— Figure 3), however slight trends toward increased transparency were noted in the 1973 and 1981 analyses. Since 1981 the transparency of the lake appears to have changed little. As noted in 1981,7 the trend in Secchi disk readings, along with other measured parameters, indicated that the biological productivity of the lake had decreased in the time period 1962-1973.

Middle Fork Diversion Improved Water Quality

Professor Flora indicated in his 1981 report that the most likely cause of what appeared to be improved water quality was the input from the Middle Fork diversion. He noted that "…Lake Whatcom water is increasingly similar to that of the Middle Fork of the Nooksack River." And he continued, "[It's] doubtless the installation of sewers had an effect on Lake Whatcom water, but most of the changes noted above began before the sewers were installed." 7

It should be noted that the sewer line which Water District 10 installed on the South Shore of Lake Whatcom was not completed until 1974, and the sewer line that traverses much of the North Shore was not completed until 1977.

The conclusion that the diversion is mostly responsible for the apparent increase in water quality from earlier times can be placed in stark contrast to that put forth by some of our less-informed Whatcom County planning commission members, who seem to feel that installation of sewers, along with other unknown practices, have cleaned up the lake.

An interesting fact regarding the influence of the diversion on Lake Whatcom can be gleaned from a conservative interpretation of the diversion flow plotted in Yearly Diversion Input into Lake Whatcom (Figure 4) on next page. The entire volume of the lake is approximately 243.3 billion gallons.3 If we conservatively assume the diversion has input 10 billion gallons per year into the lake over the time period 1962-1997, then about five percent of the water in the lake was replaced each year with water from the Middle Fork Nooksack during this time period

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The Future

If indeed we have the Nooksack diversion to thank for our present good water quality, what can we expect in our future? The City of Bellingham has decreased its use of diversion water since 1998 in order to maintain in-stream flows in the Nooksack River; see Yearly Diversion Input into Lake Whatcom (Figure 4) top of next page.

In order to continue use of the diversion, the city is currently proposing a Habitat Conservation Plan which would allow them an incidental "take" of several endangered fish species due to their operation of the diversion. Regardless of the outcome of this process, the diversion will never again operate at the levels present in the 1960s, 1970s, and 1980s.

Without this flushing action, what is to become of the lake? No one knows for sure, but the past several years of Lake Whatcom monitoring have provided some hints. Basin 2 has become increasingly similar to basin 1 in many water quality respects, and the past several years of hypolimnetic13 ammonia data show a particularly disturbing trend;15 see Hypolimnetic Ammonia Concentrations in Basin 2 (Figure 5) bottom of next page.

Even With Unrestricted Diversion, Lake Was Declining

It should be noted that even with the flushing action of the diversion, the hypolimnetic DO deficit in basin 1 became severe enough by 1998 to warrant placing the lake on the 303(d) list of impaired waterbodies in 2000.14 This listing has led to the subsequent total maximum daily load (TMDL) study which is starting this summer.

As a number of prominent local environmental activists have pointed out, we seem to have thus far been satisfied with "the solution to pollution is dilution." Once dilution is taken away, as it likely will be in the form of the diversion, we will need to be ever more vigilant in the human activities that are allowed in our watershed.

Our best current asset in lake protection is the continued acquisition of Lake Whatcom monitoring data. These data, along with the analysis currently provided by Robin Matthews, will possibly help shape policy decisions to preserve beneficial uses of the lake for some time to come. Charles Flora, Gerald Kraft, all of their students, technicians, successors, and the university itself have provided this community a great benefit, which should not be taken for granted.

Footnotes

1 An Historical Geography of the Settlement Around Lake Whatcom Prior to 1920, F. Stanley Moore, June 1973.

2 George Garlick, personal communication.

3 The Limnology of Lake Whatcom I. Morphometry, Bruce Lighthart, Gerald Kraft, and Charles Flora, June 1972.

4 Lake Whatcom Study Project First Report, Charles Flora and Gerald Kraft, August 1962.

5 Lake Whatcom 1999-2000 Area and Capacity Survey, U.S. Department of the Interior, Bureau of Reclamation, 2001.

6 Charles Flora, personal communication.

7 Lake Whatcom Report for 1980-81, Charles Flora, Jennie A. Sheaffer, and Mary Olson, October 1981.

8 A Retrospective Examination of Data From the Study of Lake Whatcom April 1962 through April 1973, Jennie A. Sheaffer, February 1978.

9 Prof. Brakke is currently Dean of the College of Science and Mathematics at James Madison University at Harrisonburg, VA.

10 Lake Whatcom Water Quality Protection Study: Whatcom County Washington–URS Corporation, URS Engineers, 1985.

11 The Use of Historic and Recent Data to Examine the Spatial and Temporal Patterns in a Large Monomictic Lake in Washington State, Susan Blake, M. Sc. Thesis, WWU, July 1985.

12 Dissolved oxygen was measured in the field instrumentally; however, values were checked on actual water samples using the Winkler method. The Winkler method for determining oxygen content is a wet chemical (as opposed to instrumental) method which has been around for over 100 years. For further information see "Limnological Analyses," R.G. Wetzel and G.E. Likens, 3rd Edition, pg. 74.

13 In the late spring the lake stratifies into a warmer upper layer known as the epilimnion and a cooler bottom layer known as the hypoliminion. Hypolimnetic pertains to this cooler bottom layer.

14 "Does Lake Whatcom Qualify as an Impaired Waterbody," Parts I and II, Whatcom Watch, February and March 2002, see also references cited therein.

15 Lake Whatcom Monitoring Project 2000/2001 Final Report, R. Matthews, et al, March 2002.

16 "Limnology," R.G.Wetzel, 3rd Edition, 2001, pg. 66.

17 Robin Matthews, personal communication.

18 "Temperature Characteristics, Annual Heat Storage and River Diversion Influence on a Monomictic Lake," T. Loranger and D.F.Brakke, Huxley College, WWU, October 1983.

19 Bill McCourt, personal communication.

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