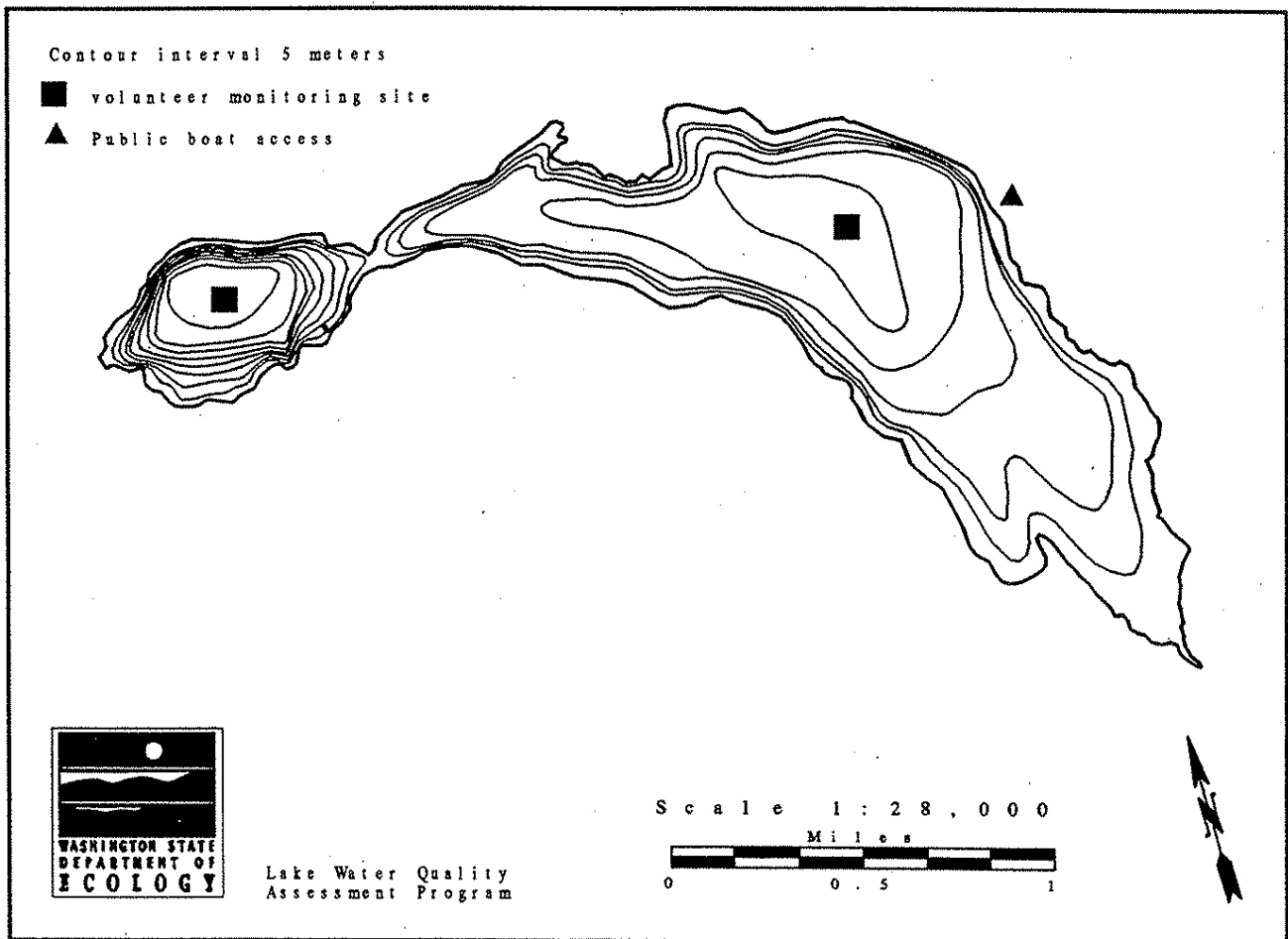


Lake Samish -- Whatcom County

Lake Samish is located 6.5 miles southeast of Bellingham. It is comprised of two basins which are connected by a narrow strait. The west arm is a small deep bay, and the east arm is a larger shallow bay. There are several small inlets that flow into the lake, including Lake Creek and Barnes Creek. Lake Samish drains via Friday Creek to the Samish River.

	<u>East Arm</u>	<u>West Arm</u>
Size (acres)	680	130
Maximum Depth (feet)	75	140
Mean Depth (feet)	31	71
Lake Volume (acre-feet)	24,000	9,100
Drainage Area (miles ²)	9.2	3.7
Altitude (feet)	273	273
Shoreline Length (miles)	6.3	1.8

Data From Bortleson *et al.* (1976)



Overall Assessment

In 1993, both basins of Lake Samish were assessed as oligo-mesotrophic, based primarily on fairly good water clarity. Water samples were collected from the larger east basin in May and August. In May the east basin had a moderately high concentration of total phosphorus, and a low density of algae. In August, it had a low concentration of total phosphorus, and a moderately high density of algae.

In comparison with data collected from 1989-1992, in 1993 water temperatures were lower throughout the water column, dissolved oxygen concentrations were higher in the lower layer of water, and pH values were less variable and closer to neutral. Most likely, cooler summer weather in 1993 resulted in the lower water temperature, which would also tend to reduce algal productivity. Reduced algal productivity was also indicated by surface pH measured by the volunteers from 1992-1993.

1993 Monitoring Results/Summary of Other Available Information

Secchi Depths

Water clarity was good in both basins. Secchi depths ranged from 11.0 feet to 17.0 feet in the east basin, and from 10.3 feet to 21.8 feet in the west basin. Secchi depths greater than 13.0 feet indicate good water clarity, and are typical for oligotrophic lakes.

Secchi depth data collected since 1989 were analyzed for trend in water clarity. There was no statistically significant trend in water clarity from 1989 to 1993.

Total Phosphorus

The concentration of total phosphorus in the upper layer of water (the epilimnion) was moderately high in May (22 $\mu\text{g/L}$), but was low in August (8 $\mu\text{g/L}$). The May result was the highest epilimnetic concentration measured in Lake Samish since 1989. However, algal density (as indicated by the chlorophyll *a* concentration) at the time was low, suggesting that phosphorus may not have been in a form that could be readily used by to algae (which can happen if phosphorus is bound to suspended sediments), or there were other factors at the time that limited algae growth (such as wind or low water temperature).

Total Nitrogen

Total nitrogen concentrations were moderately high to high, and the concentration was higher during May (0.57 mg/L) than in August (0.32 mg/L). Data from 1989-1992 also indicated higher total nitrogen concentrations in spring than in late summer.

Profile Data

Profile data collected in August 1993 were quite different from profile data collected in September 1989, August 1990, and August 1992. In comparison to previous years, 1993 water column had lower temperature, higher dissolved oxygen concentrations, and neutral, less variable pH values. Most likely cool air temperatures and cloudy summer weather in 1993 contributed to these changes in profile data.

In previous years, dissolved oxygen in the lower layer of water (the hypolimnion) has been depleted in the bottom four to five meters of the lake. Low concentrations of dissolved oxygen result when bacteria use oxygen as they decompose aquatic plants and algae in the water. However, oxygen concentrations will also be affected by water temperature, because cooler water can hold more dissolved oxygen than warmer water. Cooler water in the epilimnion during 1993 (see above) can also restrict algae growth, which would reduce the oxygen demand in the lower layers of water by reducing the amount of organic material that is decomposing near the lake bottom. Therefore, water temperature throughout the water column, and possibly reduced algae growth, allowed the water to hold more dissolved oxygen.

Seasonal changes in pH are often related to changes in algal growth. Although Secchi depths and chlorophyll data do not indicate that algae growth was unusually low in 1993 compared to earlier years, pH data from 1992 and 1993 suggest there may have been more algae productivity in 1992 than in 1993 (higher pH indicates more productivity). In addition to the less variable pH profiles measured during the 1993 sampling visits, surface pH (measured by the volunteers) was much lower in 1993 than in 1992. The volunteers measured pH in both basins using a temperature-compensated Cole-Parmer pH pen (provided by Ecology) during 1992 and 1993. In the east basin, surface pH ranged from 7.6-10.3 in 1992 and from 7.0-8.0 in 1993. In the west basin, pH ranged from 8.1-10.3 in 1992, and from 7.7-9.1 in 1993. Values from the pH pen used by the volunteers were very similar to values obtained from the profiling instrument during the sampling visits. Observations from the volunteers also indicated that algal productivity was higher in 1992 than in 1993.

Plants

Chlorophyll *a* is a pigment found in photosynthesizing plants, and is used to determine the amount of algae in a volume of water. In May, the chlorophyll concentration (1.2 µg/L) indicated a low density of algae. In August, the chlorophyll concentration (3.0 µg/L) was higher than we would expect given the low phosphorus concentration.

Aquatic plants identified by Ecology staff during the August 24, 1992, sampling visit were tapegrass (also known as wild celery; *Vallisneria americana*), coontail (*Ceratophyllum demersum*), watershield (*Brasenia schreberi*), duckweed (*Lemna minor*), waterweed (*Elodea nuttali*), and white-flowering lily (*Nymphaea odorata*). Additional aquatic plants observed in 1993 include pondweed (possibly *Potamogeton berchtoldii*) and water buttercup (*Ranunculus* sp.).

Other Available Information

From Johnson and Norton (1990): In 1989, Ecology staff collected sediment and largemouth bass samples from both basins, and analyzed the samples for selected heavy metals and organic pollutants. No unusual concentrations of metals, and no organochlorine pesticides or PCBs, were detected in the fish samples. Sediments contained arsenic (21.0 µg/Kg), 4-methylphenol (1500 µg/kg), and polyaromatic hydrocarbons (PAH; 81-110 µg/Kg). The concentrations found were not high enough to warrant further study. Possible sources of the 4-methylphenol are natural degradation of biological material, auto exhaust, asphalt, and domestic sewage. The most likely sources of PAH are urban runoff and combustion of fossil fuels.

From Larson (1990): Approximately 440 residences withdrew Lake Samish water for drinking and domestic use, and new construction of homes is expected to increase demand for water withdrawal. However, very low streamflow down the outlet (Friday Creek) during late summer affects fish habitat and has raised concern about additional water withdrawal from the lake. At present, the lake level is affected primarily by beaver dams along Friday Creek, which are periodically broken down to allow flow through the creek. To investigate the possible effects from additional water withdrawal from Lake Samish, computer models using lake stage and creek flow data were used. Results indicated that a control dam for storing additional water and supplementing creek flow, or pumping lake water to maintain streamflow (which would reduce the lake stage below the natural levels), may remedy the situation.

From A. Larson (Ecology, pers. comm.): In addition to the concern over limiting the amount of development around the lake by limiting the number of water withdrawal permits, Whatcom County Health Department generally does not encourage direct withdrawal from lakes for drinking water purposes. As a result, negotiations between the county (to permit direct withdrawal despite health concerns), Ecology (to allow additional water resource permits for direct withdrawal) and Department of Wildlife (to determine the amount of water needed in Friday Creek to provide adequate fish habitat) were initiated in 1990, following the findings reported in Larson (1990).

Summary of Questionnaire Results and Information from the Volunteers

The 1993 questionnaire on lake and watershed uses was not received by the volunteers. The following is a summary of the volunteer's remarks and responses to questionnaires completed from 1989 to 1992.

Lake Samish is used for fishing, boating, water skiing, swimming, rowing and jet skiing. Public recreational facilities on the lakeshore include a park, a picnic area, a beach, and one boat ramp. About five percent of the shoreline is publicly-owned. Currently the watershed is being logged, and the lakeshore is being developed

Lake Samish -- Whatcom County

further for residences. In the past, the watershed was logged and used for animal grazing, and the lake was dredged. In 1990, there were about 60 culverts or stormdrains that drained into the lake.

There are 529 residences in the Lake Samish basin; 295 of these are on the lakeshore, and 11 of the 15 residences under construction in the basin are also located on the lakeshore. Lake water is withdrawn for drinking and other domestic uses. The lakeshore is fully sewerred. Water District #12, which is responsible for sewage collection, is currently gathering information about a community water system that will be voted on by residents in 1993. There is a lake management district and a community association for the lake.

In 1992, the volunteers found that Lake Samish had excellent water quality. Problems in the lake in 1992 were ranked as (1) excessive aquatic plant growth, and (2) algae. Possible sources of problems are weeds, sediment from streams, and algae. In comparison to 1991, weeds were spreading rapidly in 1992, especially along the shore in water up to 10 feet deep.

From 1990 to 1992, the predominant plants in the lake were tapegrass, watershield, and northern watermilfoil (*Myriophyllum exalbescens*). All three plants were reported to be growing or spreading rapidly in the lake. There is a wetland at the south end of the east basin, at the lake's outlet. Beaver dams at the outlet are periodically torn down; in 1990 the dams were torn down three times.

Acknowledgments

I thank A.B. Davis and J. David Jenkins for volunteering their time to monitor the east and west basins of Lake Samish, respectively, during 1989-1993.

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1993 Trophic Status ¹	East Arm	West Arm
Estimated Trophic State:	Oligo-mesotrophic	Oligo-mesotrophic
Mean Trophic State Index (Secchi):	40	38
Mean Trophic State Index (Total Phosphorus):	41	--
Mean Trophic State Index (Chlorophyll <i>a</i>):	37	--

Volunteer-Collected Data

Date	Time	Temp	Secchi	pH	Lake	Water	% Cloud	Recent	Wind	Abbreviated Comments
1993	(°C)	(°F)	(ft)		Ht (ft) ²	Color	Cover	Rain		
<u>East Basin</u>										
03-Jun	1305	19.0	66.2	16.0	268.81	lt-green	75	light	calm	
19-Jun	1330	20.0	68.0	13.5	268.54	lt-green	0	none	breezy	
01-Jul	1330	20.0	68.0	11.0	268.46	lt-green	95	trace	light	
16-Jul	1330	20.0	68.0	14.5	7.0	lt-green	90	moderate	light	
27-Jul	1345	21.0	69.8	17.0	7.1	268.74	lt-green	100	none	calm
13-Aug	1330	22.0	71.6	14.0	7.2	268.89	lt-green	100	none	breezy
16-Aug	1015		14.5				100		light	Onsite visit.
26-Aug	1330	22.0	71.6	12.0	7.4	268.90	lt-green	90	trace	light
15-Sep	1400	21.0	69.8	11.0	8.0	268.36	lt-green	10	trace	calm
30-Sep	1345	20.0	68.0	12.0	268.14	lt-green	0	none	breezy	
<u>West Basin</u>										
03-Jun	1400	20.0	68.0	21.8	268.81	lt-green	75	light	calm	
19-Jun	1400	20.0	68.0	14.5	268.54	lt-green	0	none	breezy	
01-Jul	1330	21.0	69.8	17.0	7.7	268.46	lt-green	95	trace	light
16-Jul	1405	20.0	68.0	16.0	8.4	268.50	lt-green	90	moderate	light
27-Jul	1445	21.0	69.8	19.0	268.74	lt-green	100	none	light	Secchi with view tube 19.25'. No rain last two days, but raining while we were gathering info. on card.
13-Aug	1400	22.0	71.6	17.0	8.2	268.89	lt-green	100	none	breezy
26-Aug	1400	21.0	69.8	13.5	268.90	lt-green	90	trace	light	Drift at trolling speed during Secchi reading.
15-Sep	1400	21.0	69.8	12.5	8.6	268.36	lt-green	10	light	Lake height changed since last report--beaver dams removed from Friday Creek.
30-Sep	1435	20.0	68.0	10.3	9.1	268.14	lt-green	0	none	breezy

¹ Trophic State Indices calculated from Carlson's model (1977).

² "Lake height" refers to change in water level. Based on volunteer-collected data, the level of Lake Samish dropped 0.67" from June 3 to September 30.

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1993 Onsite Visit Data - East Basin Profile Data

Date 1993	Depth (meters)	Temp (°C)	pH	Dissolved Oxygen (mg/L)	Conductivity (µmhos/cm)
05/22	0.0	17.4	7.7	5.9	61
	1.0	17.1	7.7	5.6	61
	1.9	16.8	7.7	5.4	61
	2.0	16.8	7.7	5.5	61
	3.1	16.5	7.7	5.2	60
	4.0	16.1	7.7	5.2	60
	5.0	15.4	7.7	5.2	60
	6.0	13.5	7.7	5.3	60
	7.0	11.8	7.7	5.5	60
	8.1	11.2	7.6	5.4	59
	10.0	10.2	7.6	5.1	59
	12.0	9.7	7.5	4.9	60
	14.1	9.3	7.4	4.7	59
	16.0	8.9	7.4	4.5	60
	16.5	8.7	7.3	4.4	59
	08/16	0.0	19.6	7.7	9.4
1.0		19.6	7.8	9.4	64
2.0		19.7	7.9	9.5	64
3.0		19.7	8.0	9.5	65
4.1		19.7	8.0	9.5	65
5.1		19.7	8.0	9.6	64
6.0		19.7	8.1	9.6	64
7.0		18.2	7.8	9.5	63
8.1		16.0	7.8	9.6	63
9.0		14.4	7.8	9.3	63
10.1		12.2	7.8	8.4	62
12.1		10.3	7.8	7.2	63
14.0		9.5	7.6	5.4	63
16.0		8.9	7.5	4.3	64
18.1		8.6	7.4	3.7	66
19.2	8.6	7.4	3.3	67	

Lake Samish -- Whatcom County

1993 Onsite Visit Data - East Basin Water Chemistry

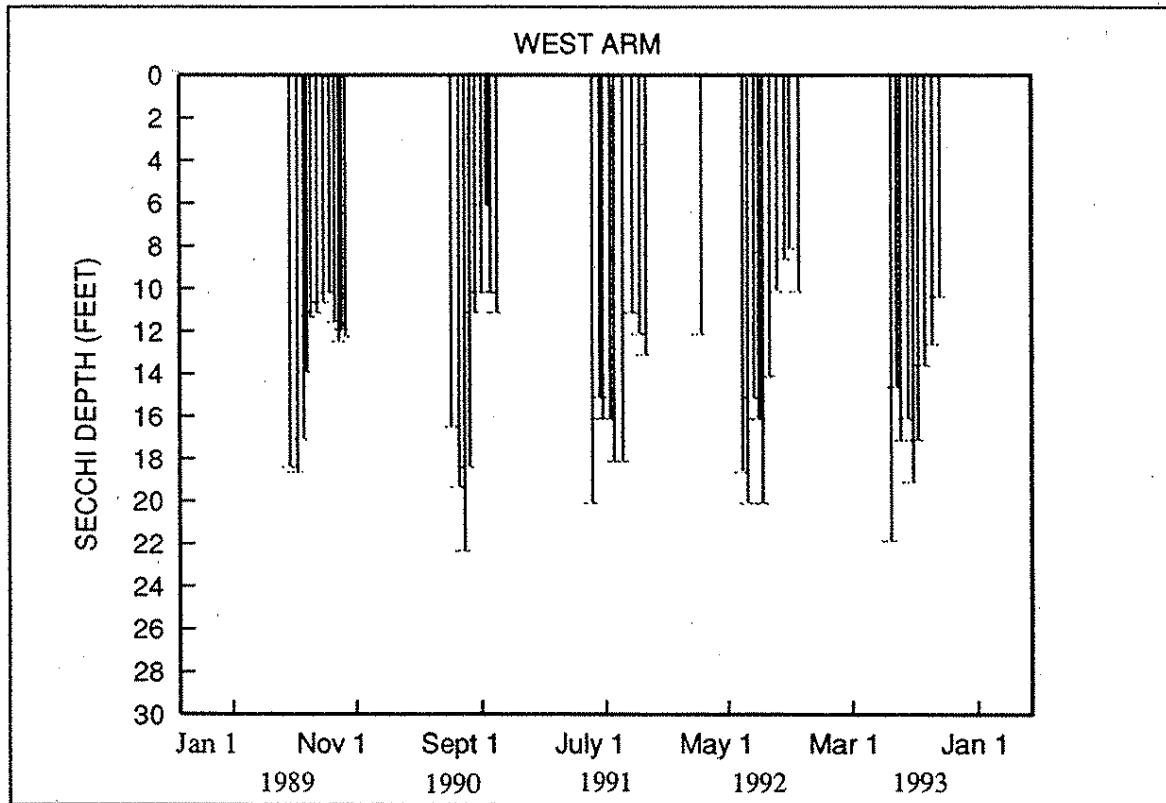
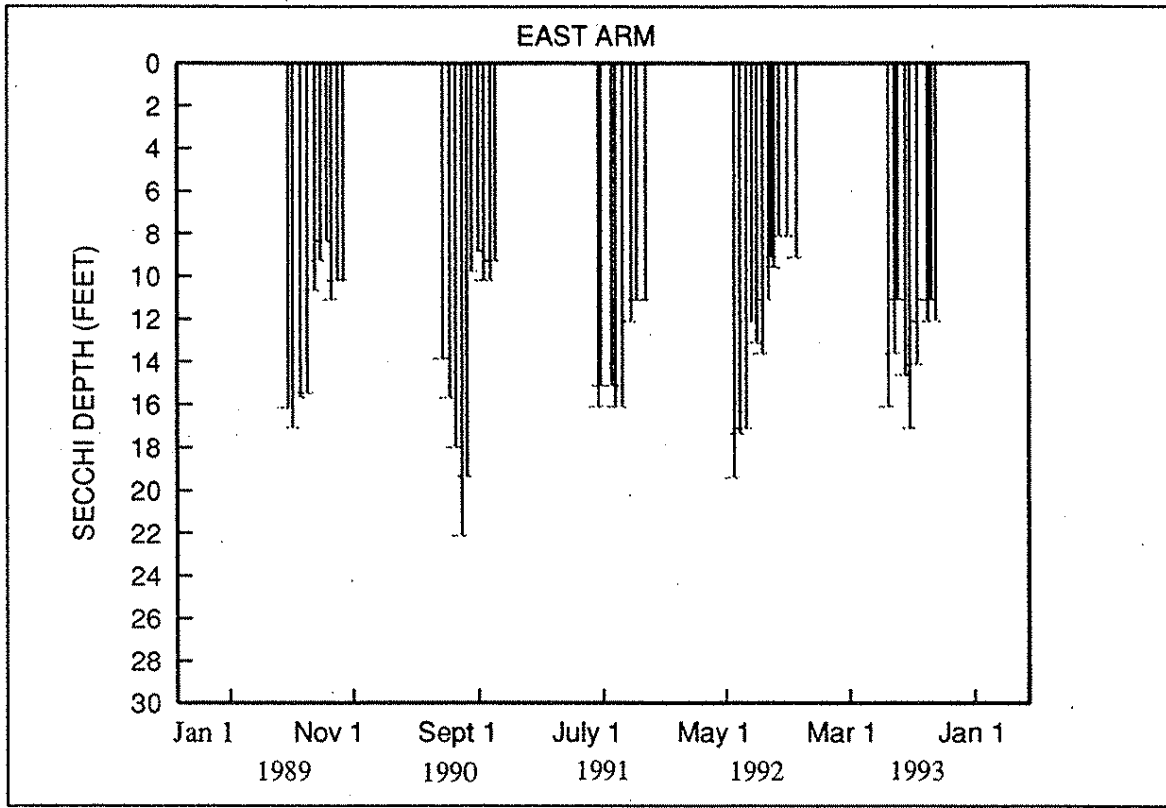
	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll <i>a</i> (µg/L)	Total Suspended Solids (mg/L)	Total Nonvolatile Suspended Solids (mg/L)	Fecal coliform bacteria (colonies/100 mL)	
						Site #1	Site #2
May 22							
Epilimnion	22	0.57	1.2	--	--	--	--
Hypolimnion	18	0.59	--	--	--	--	--
August 18							
Epilimnion	8	0.32	3.0	--	--	--	--
Hypolimnion	12	0.54	--	--	--	--	--

Historical Data From Ecology - Epilimnion Data Only, East Basin

	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Chlorophyll <i>a</i> (µg/L)
08/24/74 ^a	0	--	--
06/27/89 ^b	6	0.62	2.7
09/26/89 ^b	12	0.40	6.3
06/04/90 ^c	13	--	--
08/15/90 ^c	10	0.36	--
05/29/91 ^d	--	0.58	--
05/21/92 ^e	4	0.66	1.2
08/24/92 ^e	10	0.25	1.3

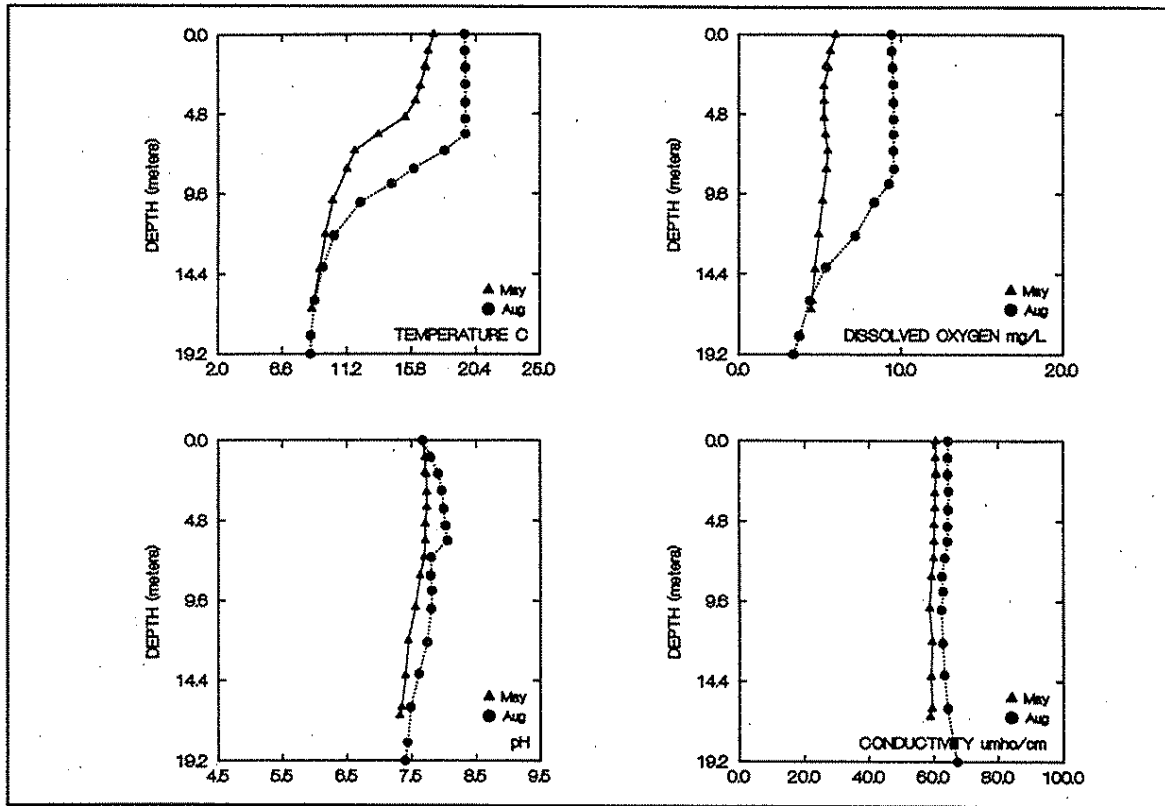
- a. Bortleson *et al.* (1976)
- b. Brower and Kendra (1990)
- c. Rector (1991)
- d. Rector (1992)
- e. Rector (1993)

LAKE SAMISH (WHATCOM COUNTY)



1993 Secchi Depth and Profile Data Graphs

PROFILE DATA FOR EAST BASIN STATION



1993 Secchi Depth and Profile Data Graphs