

Lake Armstrong

Lake Armstrong shows signs of increasing eutrophication, with high nutrient levels, moderate to heavy algae, and low water clarity. The lake appears to be at risk of future declines in water quality, especially if widespread land clearing and land development occur near the lake.

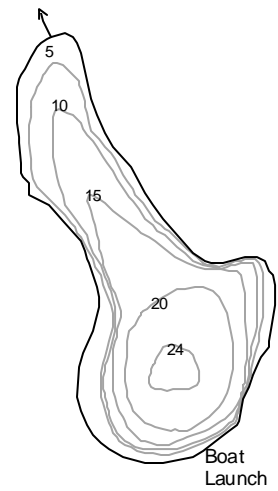


State of the Lakes Report
March 2003

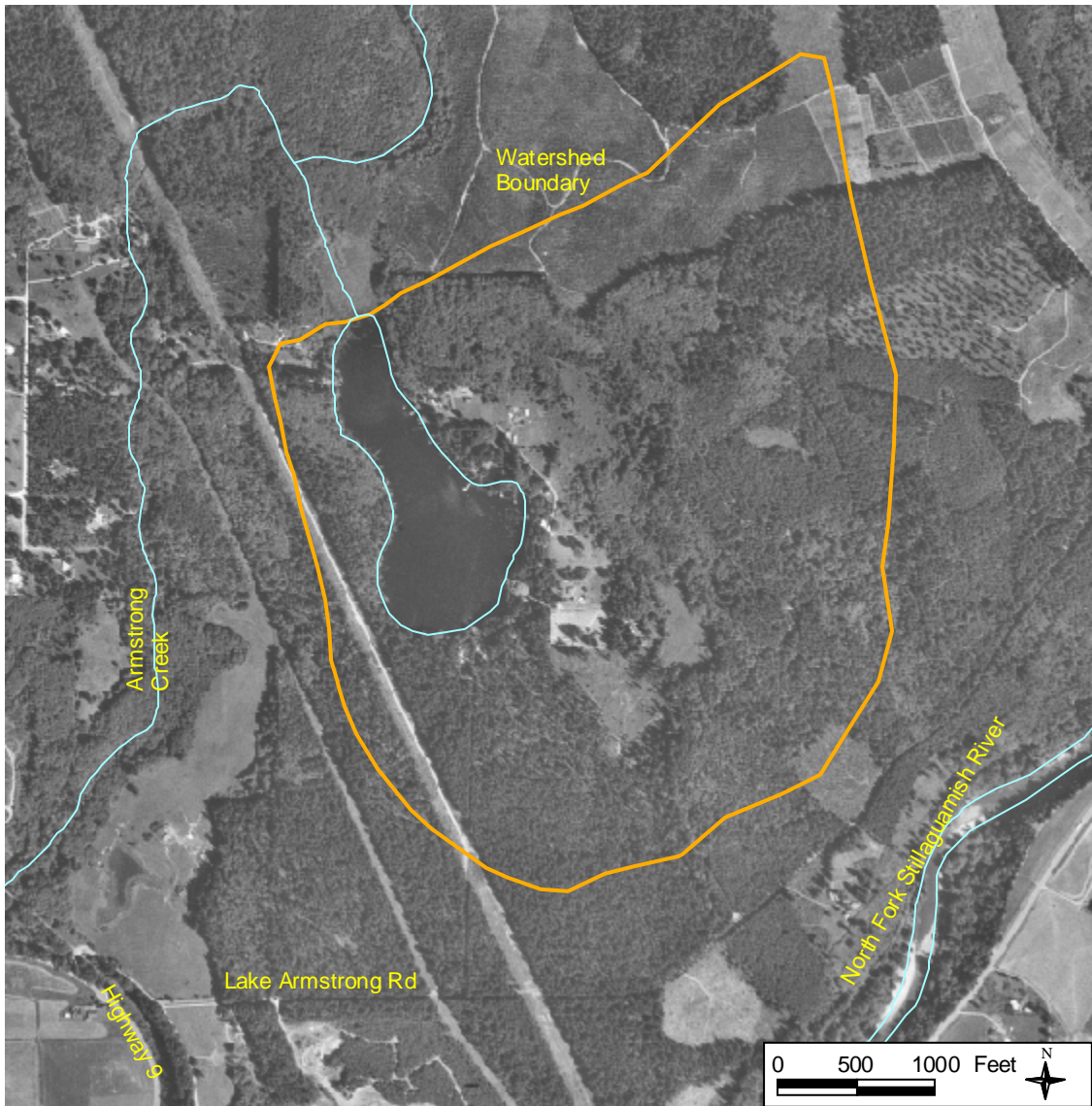
Snohomish County Public Works
Surface Water Management

LAKE AND WATERSHED DATA

Lake Area: 30 acres
 Watershed Area: 369 acres
 Watershed to Lake Area Ratio: 12.3
 Maximum Depth: 24 feet (7.3 meters)
 Average Depth: 15 feet (4.6 meters)
 Lake Volume: 450 acre-feet
 Length of Shore: 1.1 miles



	<u>1973</u>	<u>Mid-90's</u>
# of nearshore homes	8	11
# of homes/1000' of shoreline	1.3	1.9
% of homes with bulkhead or fill		36%
% of homes with some native vegetation near shore		64%
% of watershed developed (residential or commercial)	3%	5% (est.)



LAKE ASSESSMENT

DESCRIPTION

■ Location/Access – Lake Armstrong is located 2.5 miles north of Arlington. Fed mainly by groundwater, Lake Armstrong empties into Armstrong Creek, which eventually drains into the Stillaguamish River. There is a public boat launch at the south end of the lake. Gas-powered boats are not permitted on the lake.

■ Size/Shape – The lake is 30 acres in size with a maximum depth of 7.3 meters and an average depth of 4.6 meters. The lake volume contains 450 acre-feet of water. The lake stratifies strongly during the summer because it lies in a protected bowl surrounded by trees.

■ Watershed – The Lake Armstrong watershed, including the lake, covers 369 acres. The watershed is 12.3 times the size of the lake, which is near the median for Snohomish County lakes. Much of the watershed is undeveloped. In 1973, only 3% of the land was used for residential purposes, with another 11% in agriculture. By the mid-90s, residential development was still only 5% of the watershed, but agriculture was reduced and timber harvest was expanded.

■ Shoreline – The shoreline of Lake Armstrong is 1.1 miles in length. Along the shoreline, there were only 8 homes in 1973 and 11 by the mid-90s, making this one of the least developed lakes in the county. Approximately 64% of the homes have retained some native vegetation along the shore.

LAKE CONDITIONS

■ Water Clarity – Summer water clarity in Lake Armstrong averaged 2.3 meters from 1994-2002. However, year-to-year averages were somewhat variable. Summer water clarity averaged more than 3 meters in 1994 and 1995. However, clarity dropped to an average of 2 meters or less from 1996 through 2000. This decline may in part be the result of darker water color in those years. The average clarity increased somewhat to 2.7 and 2.5 meters in 2001 and 2002. In spite of the lower



averages since 1996, there is no statistical trend toward reduced water clarity in the lake.

■ Color – The lake is moderately colored by dissolved organic (humic) material from wetlands, making the water brown some years. In particular, the water was darker in 1996 and 1997.

■ Nutrients – Summer average total phosphorus concentrations in the epilimnion ranged from 19 $\mu\text{g/l}$ to 34 $\mu\text{g/l}$ between 1996 and 2002, with a long-term average of 23 $\mu\text{g/l}$. These values are moderately high for Snohomish County lakes. There was one extremely high reading in July 1998. Phosphorus values in the hypolimnion were typically much higher and more variable during this period, ranging from 29 $\mu\text{g/l}$ to over 500 $\mu\text{g/l}$. This suggests a build-up of phosphorus released from the bottom sediments during the summer. Total nitrogen was measured once in 1973. Nitrogen was abundant at that time, so phosphorus availability probably limited algal growth.

■ Oxygen/Temperature – Dissolved oxygen and temperature data for the summers of 1995 through 2002 show very strong stratification between warm, oxygenated upper waters and cool, oxygen-depleted bottom waters. This indicates the presence of significant decaying organic matter in the lake bottom. The June 1996 graph shows a spike in dissolved oxygen at 2 to 3 meters depth, suggesting vigorous algal growth at this level.

■ *Algae* – Chlorophyll *a* data are limited for Lake Armstrong. Three measurements taken in 1994 and 1995 ranged from 1.2 µg/l to 6.6 µg/l. Four samples in 2002 averaged 9.2 µg/l, which indicates high levels of algae. Analysis of algae samples in 1994-95 also revealed that blue-green algae were one of the dominant types in the lake (up to 39% biovolume and from 32% to 85% of total counts). Observations by citizen volunteers and SWM staff through the years indicate that blue-green algal blooms are a regular occurrence during summer months. At high concentrations, blue-green algae can create nuisance, or even potentially toxic, lake conditions.

■ *Aquatic Plants* – Except for dense native plants (bladderwort, yellow water-lily, and pondweed) at the shallow north end of the lake and several small patches of water-lilies elsewhere, there are few aquatic plants in Lake Armstrong. This lack of aquatic vegetation is the result of the steep shoreline and the colored water.

SUMMARY

■ *Trophic State* – Based on the low to moderate water clarity, high phosphorus concentrations, severe oxygen depletion, and regular blue-green algal blooms, Lake Armstrong may be classified as meso-eutrophic.

■ *Current Conditions/Trends* – The high levels of algae, especially blue-greens, and the build-up of phosphorus in the hypolimnion are signs of increasing eutrophication. Therefore, Lake Armstrong appears to be at risk of further declines in water quality.

■ *Future Concerns/Targets* – Up to the present, there has been little development around the lake and in the watershed. If future development increases, there may be more sources of nutrients that could increase problems with blue-green algal blooms and accelerate the process of eutrophication. Improving water clarity and reducing phosphorus levels are targets for the lake.

■ *Recommendations* – The lake should be monitored carefully to determine if algal blooms become more severe and if nutrient levels increase.

Monitoring should also seek to identify the sources of nutrients entering the lake.

CITIZEN VOLUNTEERS

Thanks to Brian Seguin, LeAnn Anderson, Eric Nordstrom, and Kenneth Black for volunteer monitoring of Lake Armstrong.

DATA SUMMARY TABLE

Source	Date	Secchi Depth (meters)	Total Phosphorus (ug/l)		Color (Pt-Co scale)	Chlorophyll a (ug/l)
			Surface	Bottom	Epilimnion	Epilimnion
Bortleson, et al, 1976	8/13/73	2.7	18	400	10	-
SWM Staff	Summer 1994	3.0 - 3.4 (3.2) <i>n</i> = 3	-	-	20 - 25 (22.5) <i>n</i> = 2	1.2 - 4.7 (3.0) <i>n</i> = 2
SWM Staff or Volunteer	Summer 1995	3.0 - 3.9 (3.5) <i>n</i> = 3	-	-	25	6.6
SWM Staff or Volunteer	Summer 1996	1.6 - 2.1 (1.8) <i>n</i> = 5	10 - 27 (19) <i>n</i> = 2	29 - 51 (40) <i>n</i> = 2	-	-
SWM Staff or Volunteer	Summer 1997	1.0 - 2.9 (1.7) <i>n</i> = 4	15 - 53 (34) <i>n</i> = 2	100 - 136 (118) <i>n</i> = 2	-	-
SWM Staff or Volunteer	Summer 1998	0.7 - 2.1 (1.5) <i>n</i> = 6	15 - 275 (22) ^a <i>n</i> = 4	46 - 575 (319) <i>n</i> = 4	-	-
SWM Staff or Volunteer	Summer 1999	1.8 - 2.2 (2.0) <i>n</i> = 4	20 - 29 (24) <i>n</i> = 4	142 - 524 (278) <i>n</i> = 4	-	-
SWM Staff or Volunteer	Summer 2000	1.4 - 2.6 (2.0) <i>n</i> = 4	18 - 30 (22) <i>n</i> = 4	102 - 294 (192) <i>n</i> = 4	-	-
SWM Staff or Volunteer	Summer 2001	2.3 - 3.1 (2.7) <i>n</i> = 4	15 - 26 (20) <i>n</i> = 4	105 - 283 (157) <i>n</i> = 4	-	-
SWM Staff or Volunteer	Summer 2002	2.3 - 2.7 (2.5) <i>n</i> = 4	17 - 25 (20) <i>n</i> = 4	74 - 439 (237) <i>n</i> = 4	-	2.1 - 19 (9.2) <i>n</i> = 4

NOTES

- Table includes summer (May-Oct) data only.
- Each box shows the range on top, followed by summer average in () and number of samples (*n*).
- Total phosphorus data are from samples taken at discrete depths only.

^a Median is shown for 1998 rather than average (mean) to avoid bias from one high TP value

SUMMARY OF OTHER DATA

■ ***Total Nitrogen*** – single samples in 1973 were 0.56 mg/l in the epilimnion and 2.42 mg/l in the hypolimnion, which suggests that nitrogen was abundant and not limiting algal growth at that time.

■ ***Alkalinity*** – data from 1994 and 1995 ranged from 18 – 36 mg/l CaCO₃ which suggests a low to moderate buffering capacity.

■ ***pH*** – 1994-2000 data averaged 7.2 near the surface and 6.1 near the bottom, with occasional bottom readings of 5.7; during algal blooms pH spiked to 8.7 at times; these values are normal for Snohomish County lakes. 2001-2002 data were similar.

■ ***Conductivity*** – 1994-2000 data averaged 55 µmhos in the epilimnion and 141 µmhos near the lake bottom, indicating moderate to high levels of dissolved materials in the water. 2001-2002 data were similar.

■ ***Iron*** – limited 1994-95 data showed moderate levels in the epilimnion (avg. 79 µg/l) and high levels in the hypolimnion (avg. 1147 µg/l, high of 2100 µg/l), which indicates release of iron and phosphorus from the bottom sediments under low oxygen conditions.

■ ***Algae*** – the following table shows the total biovolume and percent biovolume of the main types of algae from three samples collected in 1994-95. The data show that blue-greens, gold-browns/diatoms, and dinoflagellates were most prevalent. Cell counts of the same samples

revealed that blue-green algae were most abundant, ranging from 32% to 86%.

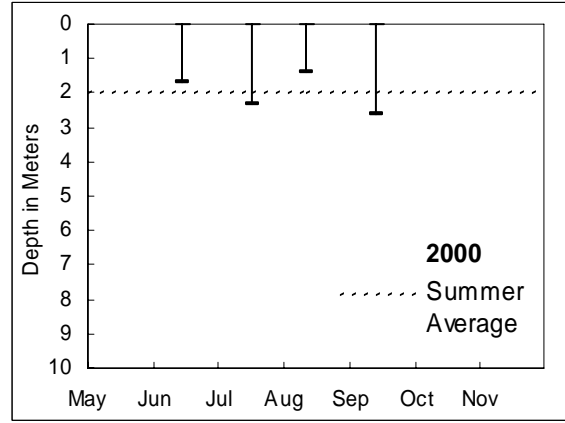
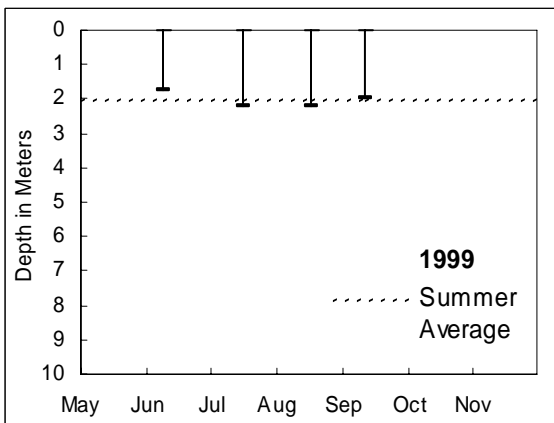
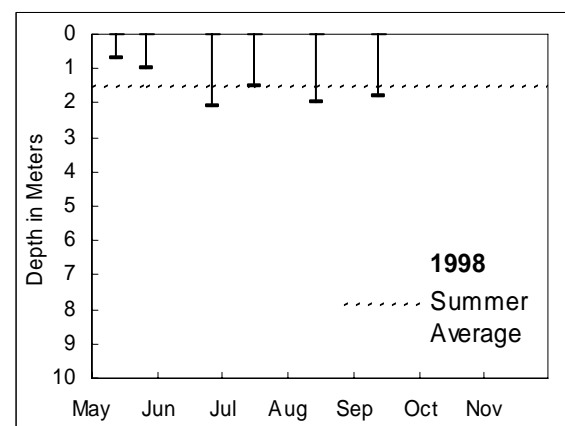
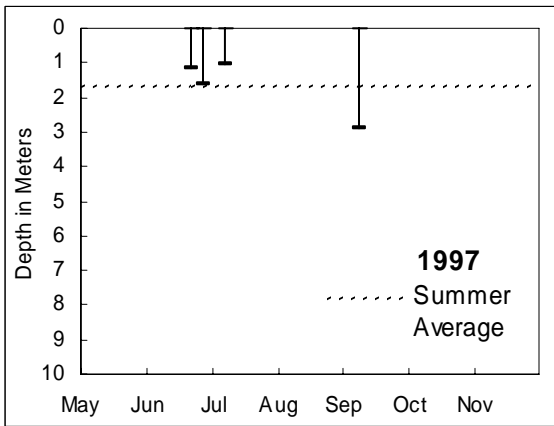
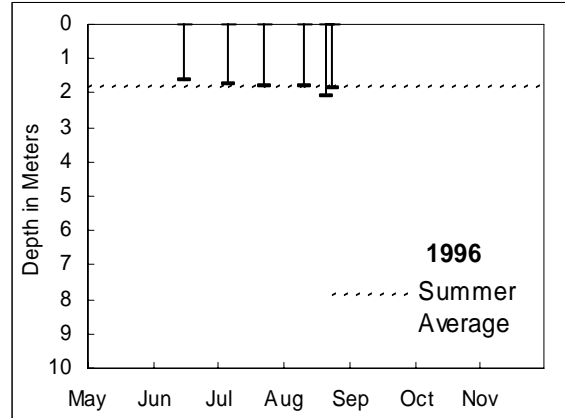
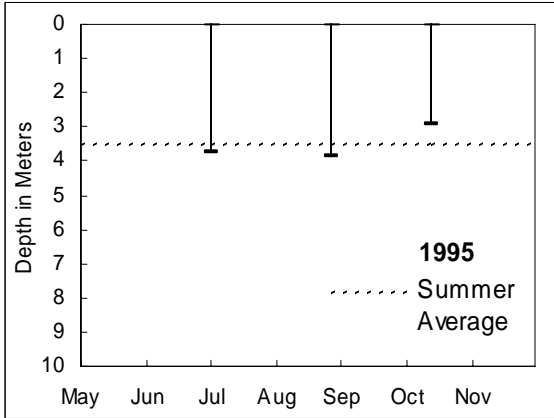
ALGAE TYPES	6/24/94	8/25/94	8/28/95
Cyanophyta (Blue-greens)	25%	39%	10%
Chlorophyta (Greens)	19%	12%	4%
Chrysophyta (Golden/diatoms)	15%	19%	28%
Cryptophyta (Cryptomonads)	15%	10%	24%
Euglenophyta (Euglenoids)	4%	1%	3%
Pyrrophyta (Dinoflagellates)	22%	19%	31%
TOTAL BIOVOLUME (mm³/l)	1.154	0.948	1.703

■ ***Fish*** – according to the Washington State Department of Fish and Wildlife (WDFW), the main fish found in Lake Armstrong are rainbow trout, which are usually stocked each year by WDFW.

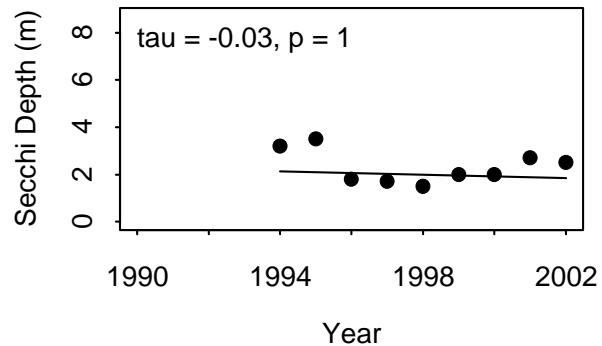
DATA SOURCES

In addition to data from Snohomish County SWM staff and citizen volunteers, data for Lake Armstrong are also available from: Bortleson, et. al., 1976. Please refer to the full list of references in the County-Wide Summary

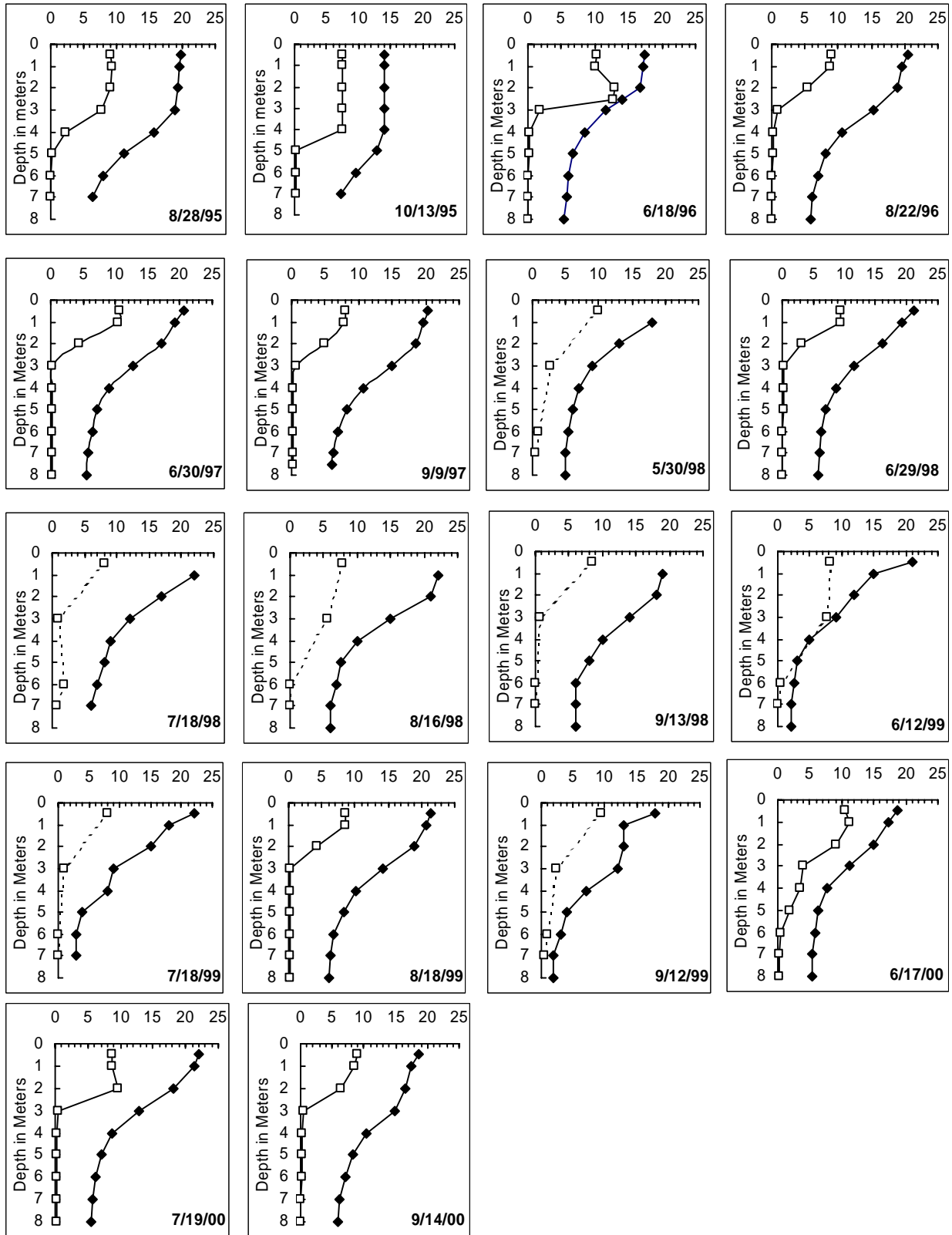
WATER CLARITY



TREND ANALYSIS

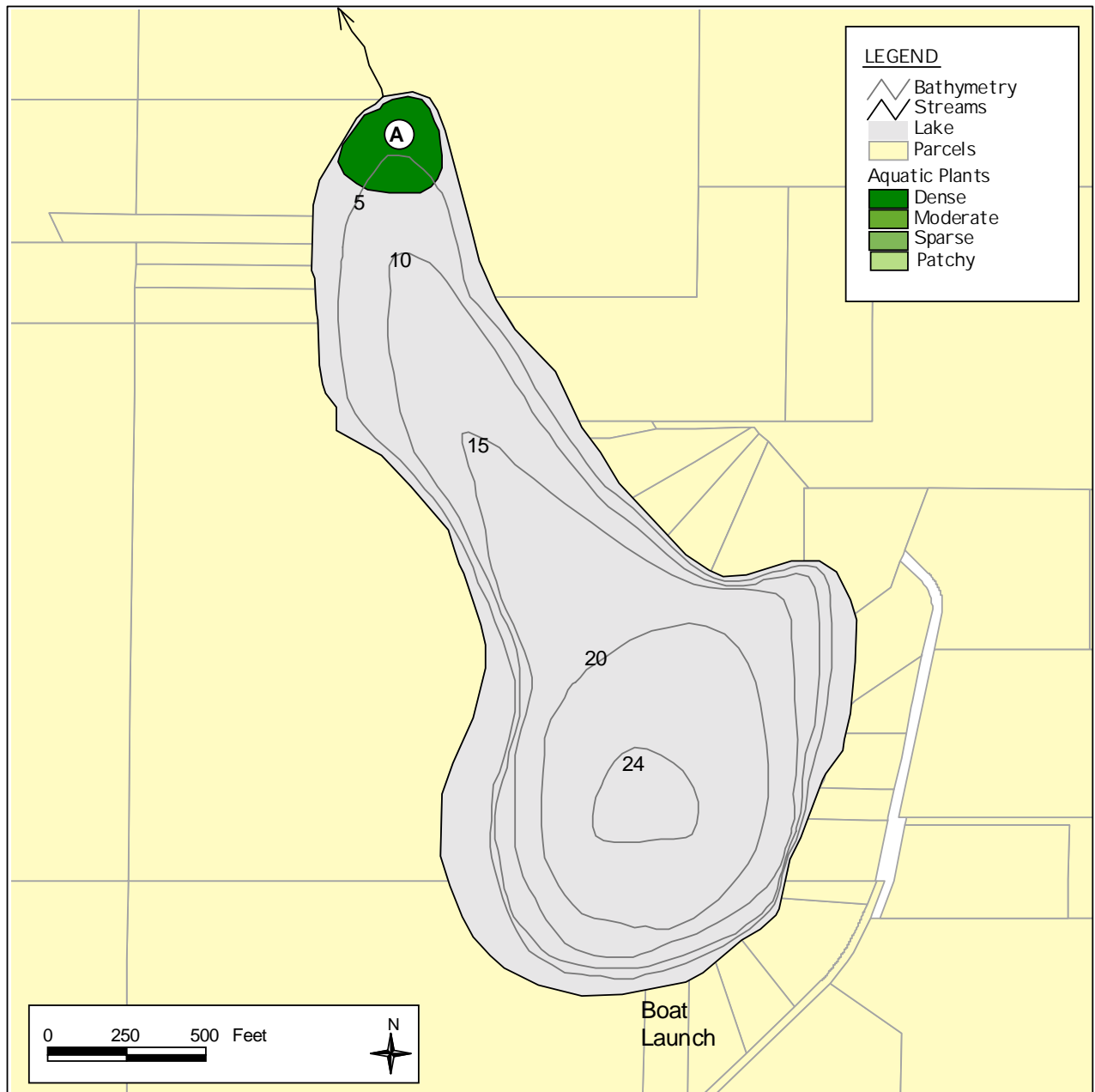


DISSOLVED OXYGEN AND TEMPERATURE PROFILES (SELECTED YEARS)



—□— DO (mg/l) —◆— Temp (°C)

AQUATIC PLANTS



Area	Density	Dominant Plants	Other Plants
A	Dense	<i>Utricularia vulgaris</i> (Common bladderwort)	<i>Nuphar polysepalum</i> (Yellow water-lily) <i>Potamogeton</i> sp. (Pondweed)

Note: Several very small patches of Nuphar are widely scattered along the lake edge.

BASIC MONITORING DATA

1995									
DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
7/4/95	3.8	21	17		75	moderate	light	lt brown	Aquatic plants slight. Garbage found around lake.
*08/28/95	3.9				0	none	calm	grnbrown	Large clumps of bright green algae near boat launch and in center of lake.
*10/13/95	3.0				100	moderate	light	lt brown	Oily sheen in middle of lake, towards N. end. Lots of insect casings towards N. end; many phantom midges and zooplankton visible near surface. Damselfly/Dragonfly (?) larvae very thick in vegetation at N. end.

1996									
DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
*06/18/96	1.6				75	light	calm	medbrown	Strong H2S smell at 7.5m.
7/8/96	1.8	22	21		25		light	dk brown	Garbage around boat launch.
7/25/96	1.8	26	24		0	none	breezy	dk brown	Garbage around boat launch and lakeshore trail as usual.
8/12/96	1.8	27	25		25	none	breezy		Garbage.
*08/22/96	2.1				0	none	calm	medbrown	A few small clumps of algae in water column.
8/25/96	1.9	24	22		10	none	light		Garbage at boat launch; lots of aquatic insect husks floating on water surface.

1997									
DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
6/24/97	1.2	19	21		10	heavy	light	lt brown	No algae, scum, plants, odor. 30 ducks/geese. Monitor notes that the lake appears 2"-4" higher than it has been in the last couple of months and the water seemed murky.
*06/30/97	1.7				90	moderate	calm	dk brown	Water may be darker than in past years. Moderate odor at 7.5 m and below.
7/10/97	1.0	17	20		50	modheavy	light	redbrown	10 ducks/geese
*09/09/97	2.9				0	none	light	medbrown	Moderate odor at 6.5m.

*Indicates data collected by Snohomish County staff.

1998									
DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
5/16/98	0.7	18	17	-1	0	moderate	strong	grnbrown	No algae or scum.
5/30/98	1.0	19	18.5	2	75	none	light	grnbrown	No algae, scum or ducks/geese.
*6/29/98	2.1				0	none	light	dk brown	No scum, slight plants, moderate algae, no ducks/geese. Lake level appears high.
7/18/98	1.5	26	24	-4	10	none	light	yellowgrn	
8/16/98	2.0	18	22	-8	90	moderate	calm	yellowgrn	No algae or scum; heavy plants; musty odor; 1 blue heron.
9/13/98	1.8	16.5	19	-12	100	none	calm	yellowgrn	No ducks/geese; light oil sheen on lake surface at boat launch.

1999									
DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
6/12/99	1.8	28		-5	25	none	calm	lt brown	Plant density heavy at N end of lake, moderate density emergent vegetation near shore.
7/18/99	2.2	26		-3	10	heavy	light	lt green	Trash at boat launch.
*8/18/99	2.2				100	none	calm	dk brown	no submersed vegetation, only emergent plants. One small bryozoan by boat launch.
9/12/99	2.0	21.5		-8	0	none	calm	lt green	H ² S odor @ 6m. Yellow iris around lake. Lake level measured from cedar tree near E fence at boat launch, top of lowest W root.

2000									
DATE	Secchi Depth (meters)	Air Temp (C)	Water Temp (C)	Lake Level (in)	Clouds (%)	Rain	Wind	Color	COMMENT
*6/17/00	1.7	20.5	18.8		0	trace	calm	dk brown	One duck, heavy algae, no algae scum or aquatic plants.
*7/19/00	2.3	18	22.07		100	none	calm	dk brown	No ducks, moderate algae, no algae scum or aquatic plants.
8/13/00	1.4	21	20	-3	75	none	light		No ducks, heavy algae.
*9/14/00	2.6	18	18.54		0	none	calm	dk brown	Leech. No ducks, heavy algae, no algae scum or aquatic plants.

[Click here to view more recent data.](#)

HOW YOU CAN HELP LAKE ARMSTRONG

- Educate yourself about lake ecology and the lake's health.
- Use lawn and garden fertilizers sparingly; test your soil first; choose low or no phosphorus fertilizers.
- Retain or plant native vegetation adjacent to the water to protect the shoreline and filter pollution.
- Infiltrate or filter the runoff from rooftops, patios, and driveways rather than piping it to the lake.



- Cover or mulch bare soil areas.
- Use pesticides, herbicides, and household chemicals sparingly and never near the water.
- Maintain your septic system—have it inspected every two years and pumped when needed.
- Conserve water both inside and outside.
- Clean up pet wastes and keep livestock away from the lake shore.

- Learn to identify non-native invasive aquatic plants and animals; check your boat and trailer for invaders; never empty an aquarium into the lake.
- Do not feed geese or ducks.
- Join with neighbors or the local property owners' association to work together to protect the lake.



Contact Snohomish County Surface Water Management at 425-388-3464 for information about these topics or if you have questions about Lake Armstrong.

(TTY users call 425-388-3700)