Lake water quality

Annual monitoring summary 2006-2007

Key Points

- Lake Wanaka and Lake Wakatipu are oligotrophic (low in nutrients).
- Lake Hayes and Lake Johnson are eutrophic (nutrient rich and generally promotes excessive plant growth).

Why we monitor water quality

Water quality is important in lakes for many reasons, primarily for sustaining freshwater plant and animals and for aesthetic, cultural and spiritual reasons. Otago Regional Council regularly monitors four lakes:

- Lake Wakatipu and Lake Wanaka are iconic lakes, of near pristine water quality, listed in the Regional Plan Water for their outstanding natural and cultural values.
- Lakes Hayes and Johnson are smaller lakes but they too have significant ecosystem and wetland values including high species diversity, habitat for threatened native fish and bird species.

The natural state of all these Central Otago lakes are under pressure, primarily due to the intensification of land use. It is important to determine the current state of water quality, so that changes in water quality can be quantified in the future.

How Lake Water is Classified

Lakes are often classified according to their trophic status. The trophic state of a lake refers to the life supporting capacity per unit volume of a lake.

Trophic State	Description
Microtrophic	lakes are very clean, and often have snow or glacial sources.
Oligotrophic	lakes are clear and blue, with low levels of nutrients and algae.
Mesotrophic	lakes have moderate levels of nutrients and algae.
Eutrophic	lakes are green and murky, with higher amounts of nutrients and algae.
Supertrophic	lakes are fertile and saturated in phosphorus and nitrogen, and have very high algae growth and blooms during calm sunny periods.
Hypertropic	lakes are highly fertile and supersaturated in phosphorus and nitrogen. They are rarely suitable for recreation and habitat for desirable aquatic species is limited.

Otago Regional Council uses the Trophic Level Index (TLI) to assess the water quality of lakes. Four key variables are measured as indicators of the trophic level of a lake:

1. Chlorophyll *a* (Algal content)
2. Sechhi depth (Clarity)
3. Total Phosphorus (Nutrient)
4. Total Nitrogen (Nutrient)

The combined result of these parameters give the TLI, the lower the TLI the better the water quality.

Otago Regional Council

photos courtesy of Stephen Moore

Stratification and Thermocline formation

- Thermocline formation can be surprisingly rapid. As surface waters heat and become less dense, the relative thermal resistance (RTR) to mixing increases. Only a few degrees difference are sufficient to prevent further circulation.

Recent ORC reports

- Lake Waihola and Lake Waipori: Trophic Level Status March 2005.
- State of Environment Report, Surface Water Quality in Otago May 2007.

The monitoring programme is due to run until the end of summer 2008, however preliminary results are as follows:

Nutrient Level	Trophic State	Trophic Level	Chla (ug/l)	Secchi Depth (m)	Total Phosphorus (ug/l)	Total Nitrogen (ug/l)
Low	Oligotrophic	2.0-3.0	<2.0 Wanaka/ Wakatipu	>7 Wanaka/ Wakatipu	<10 Wanaka/ Wakatipu	<200 Wanaka/ Wakatipu
Medium	Mesotrophic	3.0-4.0	2.0-5.0 Johnson	3.0-7.0 Johnson/ Hayes	10-20	200-300
High	Eutrophic	4.0-5.0	5.0-15 Hayes	1.0-3.0	20-50 Johnson/ Hayes	300-500 Hayes
Very High	Supertrophic	5.0-6.0	15-30	0.5-1.0	50-100	500-1500 Johnson

The table above shows that Wanaka and Wakatipu are classified as oligotrophic in all parameters, whereas the water quality parameters of Lake Hayes and Johnson fall into categories ranging from mesotrophic to supertrophic. It is clear that the two smaller lakes are far more nutrient rich than Lakes Wakatipu and Wanaka.

Lake Hayes algal bloom, summer 2007

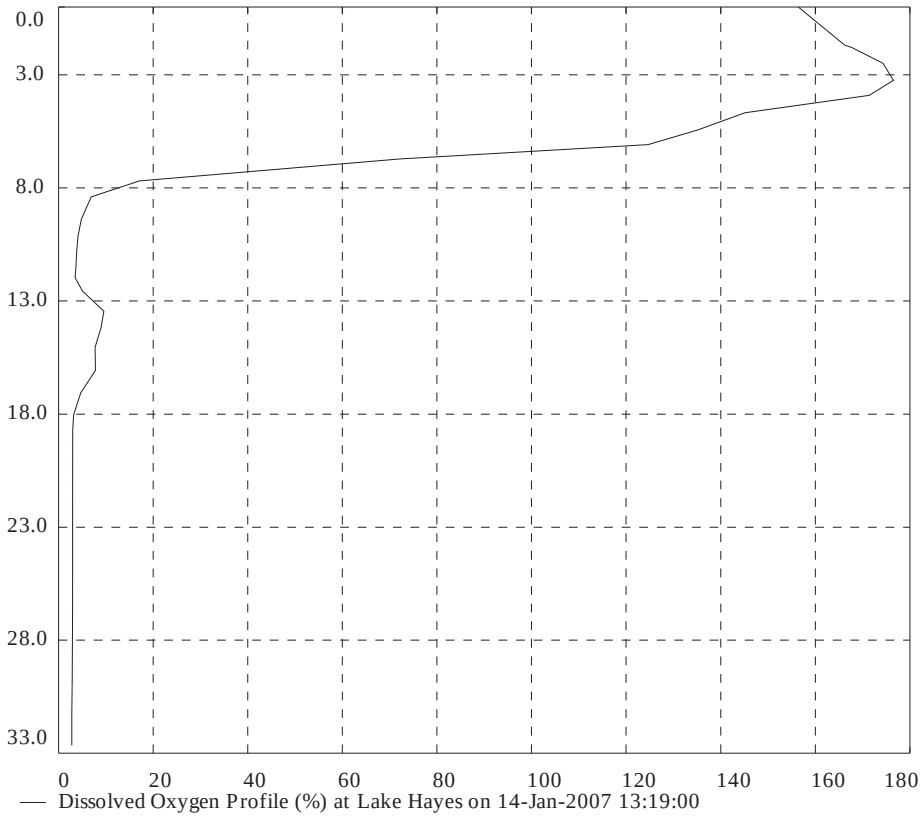
In summer 2007, Lake Hayes had an algal bloom (dinoflagellate Ceratium) which created very alkaline pH conditions. pH is particularly important in terms of ammoniacal nitrogen toxicity to fish. Ammonia (NH3) is the main toxic component for aquatic organisms, the prevalence of which (in freshwater) is dependent on the pH and temperature. In Lake Hayes the temperature reached 20 DegC, the high temperature and high pH meant it was likely that ammonia toxicity was present in the lake. In December this would have occurred to a depth of approximately 12m.

Dissolved oxygen (percentage saturation) was abundant in the top few metres due to the algae bloom, but oxygen levels dropped to very low concentrations at depth due to the lake being stratified (warm water at the top and colder water at the bottom).

The combination of ammonia toxicity in the epilimnion (upper layer) and low dissolved oxygen levels in the hypolimnium (lower layer) meant that there was little room for manouvere for trout, which is why the trout were seen in very poor condition (with some fatalities) and also seen to be congregating around the fresh water input from Mill Creek.

Depth profiles were taken in Lake Hayes on 14th January 2007 and the results clearly show that high pH, temperature and chlorophyll a conditions were occurring in the epilimnion and that there was low dissolved oxygen levels in the hypolomnion.

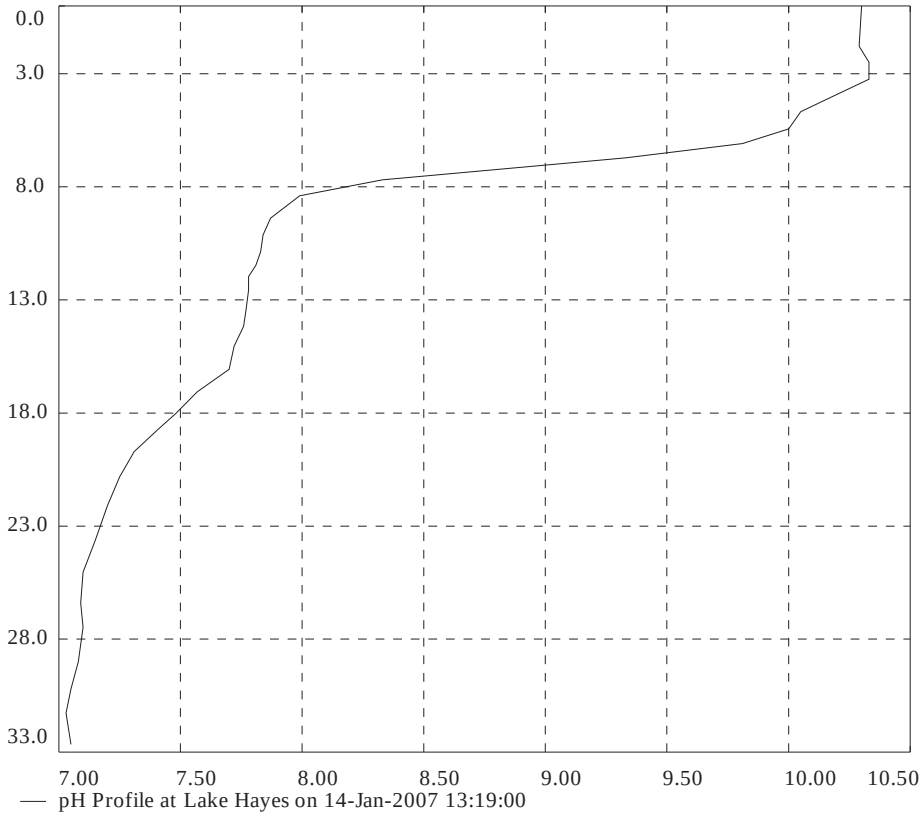
Dissolved Oxygen



Dissolved Oxygen

- Extremely high levels in surface waters
- Below 8m depth anoxic conditions prevail.
- Maximum value 176.5% at 3.24m. (Supersaturation in the epilimnion of dissolved oxygen occurs due to elevated primary production).

pH



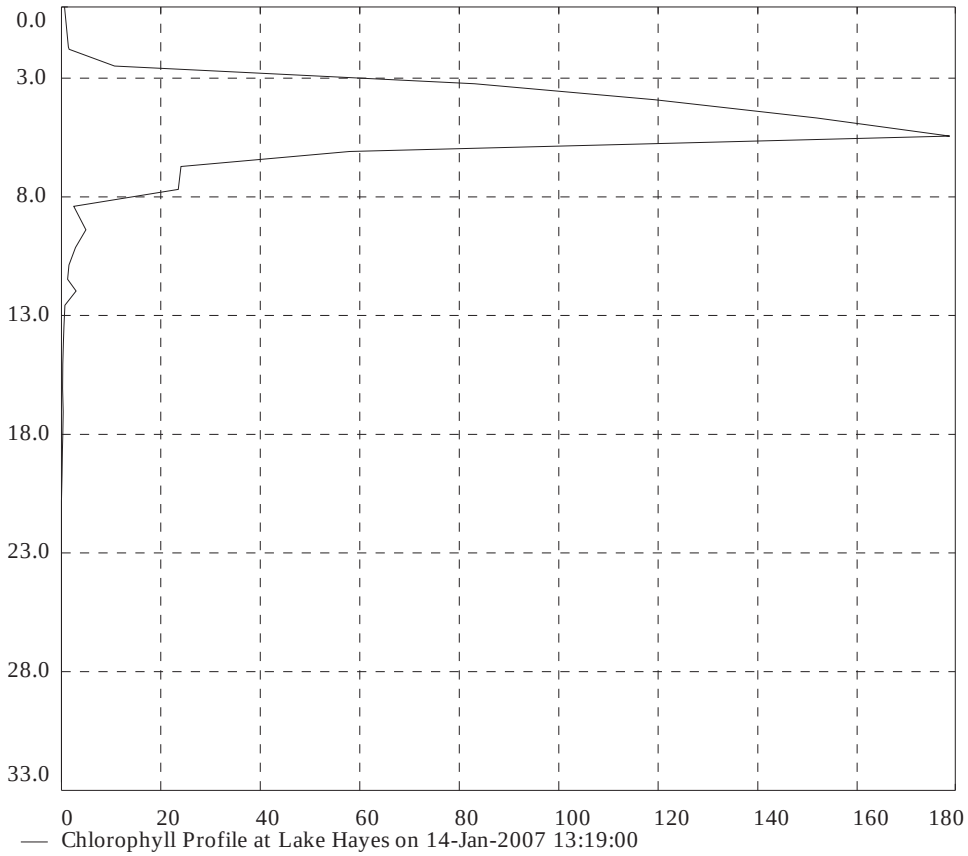
pH

- Extremely high pH levels in surface waters.
- Maximum value of pH 10.33 at 3.24m.
- High pH combined with high temperature creates conditions suitable for ammonia (NH_3) which is toxic to fish.

Chlorophyll *a*

- Maximum value 178 mg/l at 5.44m (likely to be the depth where most algae are concentrated).
- Levels drop off quickly below 8m depth.

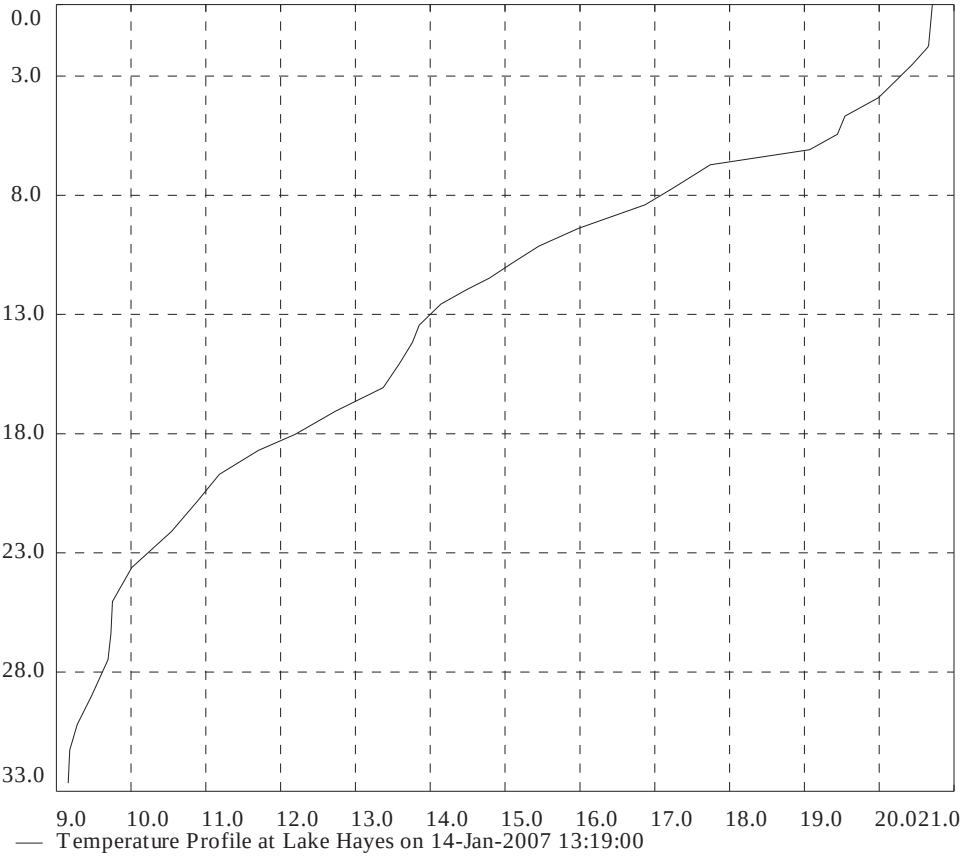
Chlorophyll *a*



Temperature

- High surface water temperatures which drop with depth.
- Maximum temperature at the surface is 20.71°C.
- At depth temperature is just 9.1°C.

Temperature



Contact

Otago Regional Council
Ph: 0800 474 082

www.orc.govt.nz

Otago Regional Council