Lake water quality

Annual monitoring summary

2007-2008

Key Points

- Lake Wanaka and Lake Wakatipu are oligotrophic (low in nutrients)
- Lakes Johnson and Onslow are mesotrophic (moderate levels of nutrients)
- Lake Hayes is eutrophic (nutrient rich)

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 (RPW) for their outstanding natural and cultural values.
- Lakes Hayes, Johnson and Onslow are smaller lakes but they too have significant ecosystem and wetland values including high species diversity and habitat for threatened native fish and bird species.

The natural state of all these 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' (Burns et. al, 2000a).

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.

photos courtesy of Stephen Moore

Otago Regional Council

Stratification

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 2009, 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 Onslow	3.0-7.0 Johnson Hayes	10-20	200-300 Onslow
High	**Eutrophic**	4.0-5.0	5.0-15 Hayes	1.0-3.0 Onslow	20-50 Johnson Hayes Onslow	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 Lakes Hayes, Johnson and Onslow fall into categories ranging from mesotrophic to supertrophic. It is clear that the three smaller lakes are far more nutrient rich than Lakes Wakatipu and Wanaka.

Lake Hayes algal bloom, summer 2007

In summer 2008, Lake Hayes once again experienced an algal bloom (dinoflagellate Ceratium) which created very alkaline pH conditions. From November to April the pH of Lake Hayes generally exceeded pH 9.0 (to a depth of 5 m).

pH is particularly important in terms of ammoniacal nitrogen toxicity to fish, however the prevalence of ammonia (NH3) is dependent on both pH and temperature. In Lake Hayes the surface temperature in January and February exceeded 20 DegC. The combination of this high temperature and high pH meant it was likely that ammonia toxicity was present in the lake.

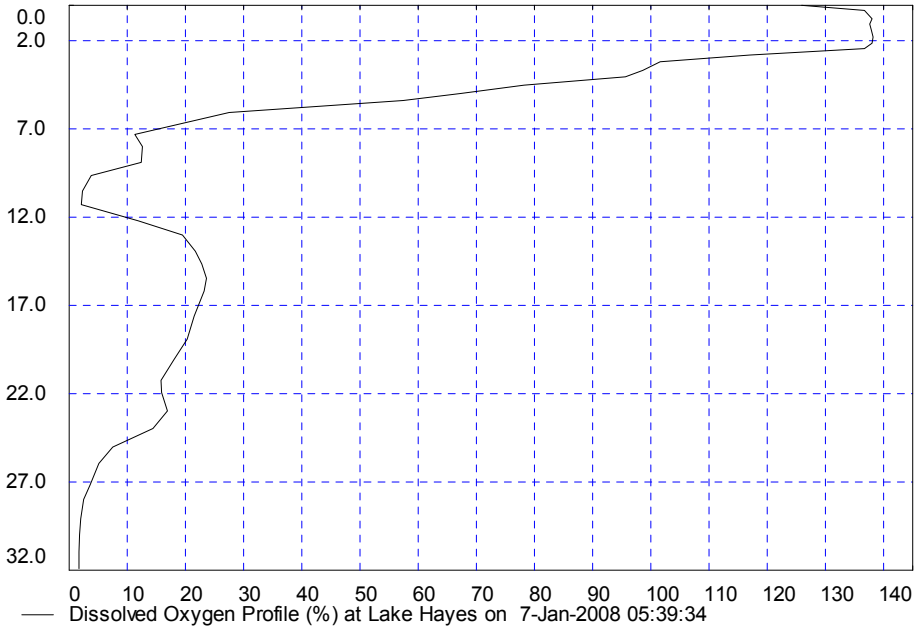
At the same time dissolved oxygen (% saturation) was abundant in the top few metres due to the algae bloom, but oxygen levels dropped to very low concentrations at depth due to the lake being stratified (warm water at the top and colder water at the bottom).

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 suitable habitat for trout.

Depth profiles were taken in Lake Hayes on 7th January 2008. The results clearly show that high pH, temperature and chlorophyll *a* conditions were occurring in the epilimnion and that dissolved oxygen levels in the hypolomnion were extremely low.

Right: Kawarau River, Lake Hayes Estate and Lake Hayes.

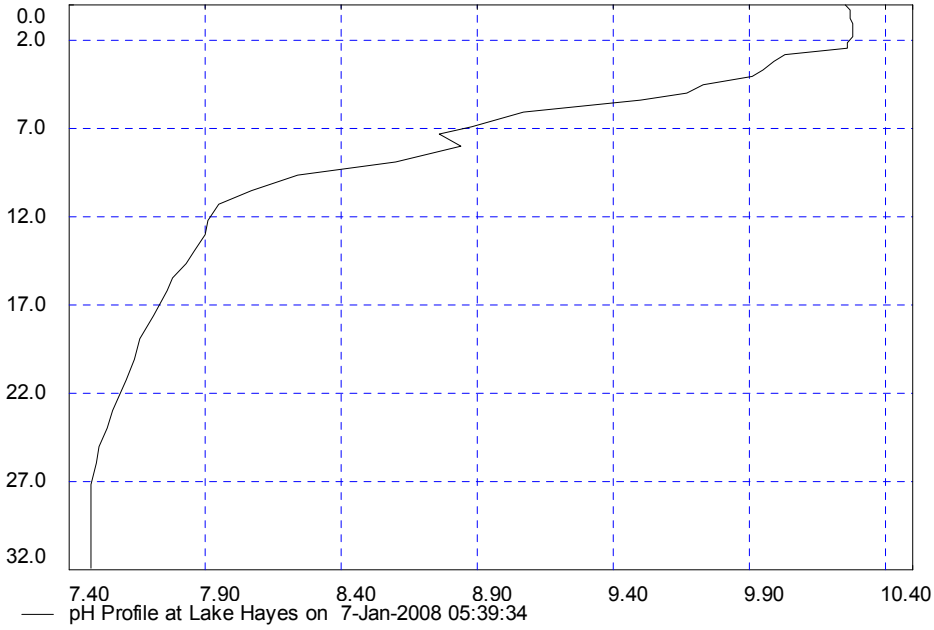
Dissolved Oxygen



Dissolved Oxygen

- Extremely high dissolved oxygen levels in surface waters.
- Below 8m depth anoxic conditions prevail.
- Maximum value 138% at 1.8 m. (Supersaturation of dissolved oxygen in the epilimnion occurs due to elevated primary production, due to prolific algal growth).

pH



pH

- Extremely high pH in surface waters.
- Maximum value pH 10.28 at 1.4m
- High pH combined with elevated temperature creates conditions suitable for ammonia (NH_3) which is toxic to fish.

Left: Hayes Creek looking towards Lake Hayes.

Chlorophyll *a*

- Maximum value 158 ug/l at 5m which is likely to be the depth at which most algae are concentrated.
- Below 8m chlorophyll concentrations drop off rapidly.

Temperature

- Summer surface water temperatures are high, but drop off rapidly.
- Maximum value is 20.83 DegC at the surface
- In the 6.5m between 8m and 14.5m depth, the temperature drops by over 8 DegC.

Contact

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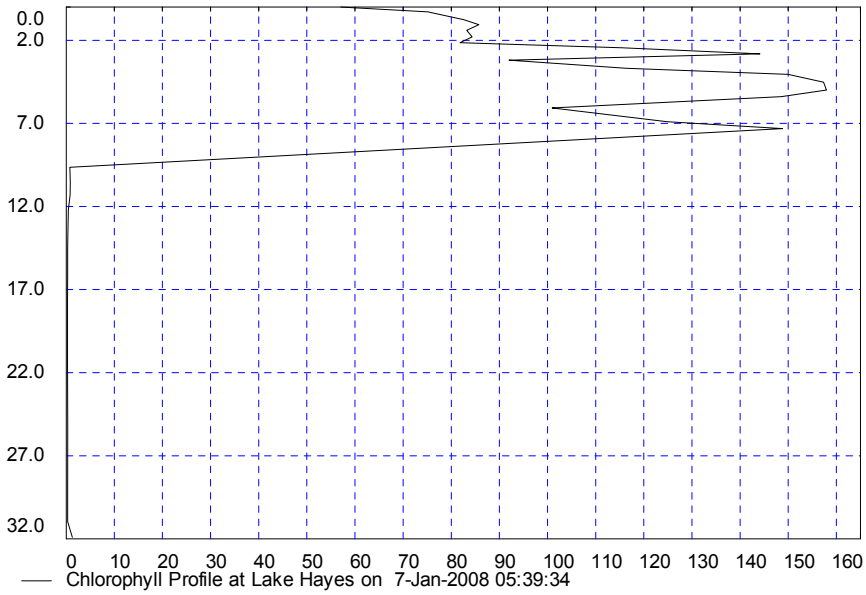
Chorophyll *a*



pH