Characterising alpine peatland water quality on the Bogong High Plains, Victoria

In brief

Alpine Victoria is home to peatland communities that are categorised as an Endangered Community (Alpine Sphagnum Bogs and Associated Fens) under the *Environment Protection and Biodiversity Conservation Act (1999)*.

When in good health, these alpine peatlands support biodiversity and provide many essential ecosystem services. They are threatened by a host of disturbances which may impact the system hydrology and reduce their ability to provide ecosystem services. A key challenge in managing these peatlands is identifying peatlands with poor hydrological function, as indicators of hydrological health have not been developed.

In a search for useful indicators, we examined the chemistry of surface waters and compared these to expert assessments of alpine peatland condition. We found a lack of a relationship between our measurements and prior expert assessments of the peatlands as being in either good or poor condition, with all measures reflecting good water quality. This indicates that the surface water measures trialled here are too insensitive to make useful hydrological health indicators. This may be because the surface water attributes do not reflect hydrological condition of peatlands and/or that the expert assessments were based on other factors (e.g., vegetation composition, lack of cover) that did not substantially affect surface water chemistry.

However, our water quality assessments provide a baseline for a range of water chemistry characteristics that can be used by managers to assess future changes to peatlands.

An alpine bog peatland in the Bogong High Plains, Victoria with abundant Sphagnum moss (lime green areas) and Candle heath (Richea continentis). Image: Abbey Camaclang

MONASH University
LA TROBE UNIVERSITY
Parks VICTORIA — Healthy Parks Healthy People®

Background

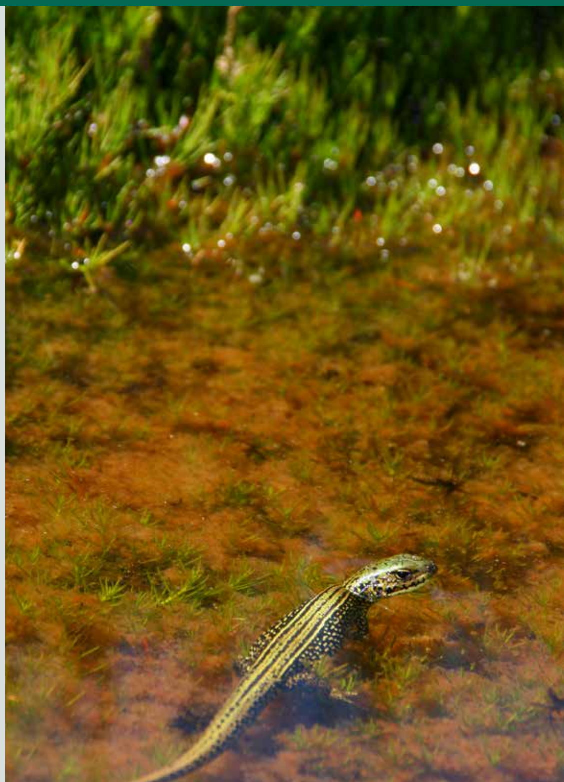
Alpine peatlands are nationally Endangered ecological communities which have high conservation importance and restricted distributions in alpine Australia. Characterised by the accumulation of peat, which is partially decomposed organic matter, these wetlands are found in high rainfall, water-saturated environments at high altitudes.

Peatlands are chiefly threatened by invasive species, infrastructure, trampling by livestock, draining and fire. Healthy alpine peatlands provide ecosystem services such as reducing erosion, forming soils, storing carbon and maintaining water quality. Peatlands filter water, removing nutrients and capturing and/or breaking down organic matter. They also provide habitat for many threatened plant and animal species.

The ability of peatlands to provide these important ecosystem services depends on the hydrology of the system. Undisturbed alpine peatlands have high water tables and slow water movement. In the Bogong High Plains of Victoria, disturbances from the key threats to peatlands are causing channels to form which drain water out of the peatlands. These disturbances result in the erosion of peat from the flow of water in channels as well as from wind erosion from exposed and dry peat. Furthermore, once dried, peat is hydrophobic reducing water infiltration.

Disturbances that impact hydrological function in peatlands may also impact the properties of surface waters. It is important to understand whether disturbances to the peatland environment are reflected in changes to surface water characteristics, but there are currently no baseline data to show whether this is occurring. Research could help with the early detection of hydrological disturbance, preventing negative environmental outcomes.

Alpine peatland experts had previously performed site evaluations and condition assessments of the Bogong High Plains alpine peatlands. These assessments were based on visual observations of local disturbance levels, the presence of invasive weeds and whether the peatland had contracted over time.
The expert assessments ranked peatlands as being in either good or poor condition. However, this method of assessment can only be performed by alpine peatland specialists, highlighting a need to find standardised methods that can be routinely undertaken to monitor the health of peatland systems.



The alpine water skink (Eulamprus kosciuskoi) *lives in alpine and subalpine peatlands and is listed as a Endangered species under Victoria's Flora and Fauna Guarantee Act. Image: James Kidman*

Main aims of research

The main aim of our research was to measure water quality across a range of peatlands on the Bogong High Plains in alpine Victoria and to use this data to:

- Create baseline data to inform future work on alpine peatlands in this region
- Identify surface water measures that might be suitable indicators of peatland disturbance
- Develop a methodology to assess peatland ecosystem health based on surface water measurements, as opposed to an expert assessment or extensive field assessments. This standardised method would allow managers to fast-track site assessments and enact appropriate management responses earlier.

RIGHT: Researchers taking water quality samples at a peatland in the Bogong High Plains. Image: Joslin Moore

What we did

We compared experts' condition assessments and water quality measurements for a subset of peatlands on the Bogong High Plains across the Victorian Alps.

In January–February 2018, to better understand how water quality might vary with assessed peatland condition, we measured the characteristics and chemistry of surface water and peat depth at 40 sites.

Measurements were made during normal conditions without rainfall. We evaluated whether these properties reflected the previous condition assessments made by experts. We measured peat depth and surface water parameters in the field (dissolved oxygen, pH, turbidity, temperature and electrical conductivity), and collected water samples for analysis in the laboratory. We measured these water samples for levels of phosphate, nitrate, nitrite and ammonia, which indicate nutrient loading; water residence time; and the rate of decomposition of organic matter. We also measured the concentration of organic carbon. We extracted site-specific geographic information such as slope, aspect and topography using geographic information software. Finally, we examined whether the condition of the peatland sites differed systematically across these geographic variables.

Table 1. *Summary of the measurements taken across 40 alpine peatland sites and the physical and biological processes they reflect*

What we measured	Why this is important
Peat depth	The maintenance of peat function depends on waterlogged conditions. Disturbances can lead to the peat drying out and increased erosion results in reduced depth.
Velocity	Velocity depends on stream shape, topographic position and on-ground vegetation. Reduced vegetation cover can increase erosion and channel formation, which leads to faster water flow speeds.
Turbidity	Higher turbidity indicates increased erosion and is associated with degradation of the peatland.
Acidity	Sphagnum bogs are often acidic (low pH). Degradation may cause lower acidity (higher pH).
Electrical conductivity	A measure of the dissolved ions (charged particles) in the water.
Temperature	Influences metabolic reactions and therefore the amount of dissolved oxygen that is consumed by microbes.
Dissolved oxygen	Decomposition of organic matter will consume oxygen and photosynthesis will produce oxygen. Values less than 100% oxygen saturation indicate that oxygen consumption is dominant.
Dissolved organic carbon	Dissolved organic carbon is produced by microbial decomposition. This is expected to be higher at degraded sites as a result of higher levels of decomposition and environmental discharge.
Nitrate or nitrite	A measure of available nitrogen concentration. Freshwater systems normally have low concentrations of nutrients. Elevated levels may occur in degraded peatlands.
Ammonia	Another measure of available nitrogen. Ammonia is produced by the decomposition of organic matter and removed by biological activity and plant uptake. Elevated levels may occur in degraded peatlands.
Filterable reactive phosphorus	Concentrations reflects plant uptake and release by mineralisation. Elevated levels may occur in degraded peatlands.

Key findings

Measured water quality characteristics did not vary between the peatlands that experts had previously characterised as being in either good or poor condition. Surface water quality was good overall. The characteristics we measured did vary, but peat depth and surface water quality were relatively constant. We found no evidence that disturbances impacted the quality of surface water.

No significant differences were seen in the water quality characteristics between peatlands that were classified by experts as being in either good or poor condition. The lack of differences observed between peatlands could be due to a true lack of variation in water characteristics (with the important caveat that we were unable to reliably measure turbidity).

However, this may also be because localised disturbance such as deer wallows or trampling may have led experts to classify a site as being in poor condition but these did not affect water quality. Although these disturbances impact peatland communities, they may not have led to changes in surface water quality if the disturbance was not close to the monitored waterway. As such, the water chemistry attributes that we measured might not reflect the assessments made by alpine peatland experts. Furthermore, our water quality measurements might not capture damage that has occurred in the past. For example, our turbidity measurement reflects the water quality at that point in time whereas the trampling by animals might have been severe but occurred weeks (or longer) previously with the eroded particles washed away.

The good water quality observed was consistent with what we expected of conditions in alpine headwaters. Nutrient concentrations were low, meaning excessive erosion and nutrification were not occurring. Often, the nutrient levels we measured were so low that they were almost below the detection limit of 1 part per billion. The one exception was weak evidence of higher turbidity (water 'cloudiness') in some poor condition peatlands, potentially caused by increased erosion. The method we used to measure turbidity was challenging to implement reliably in the field due to the shallowness of the water and the size of the probe, but if alternative methods of measuring turbidity were available, this might be a useful disturbance indicator.

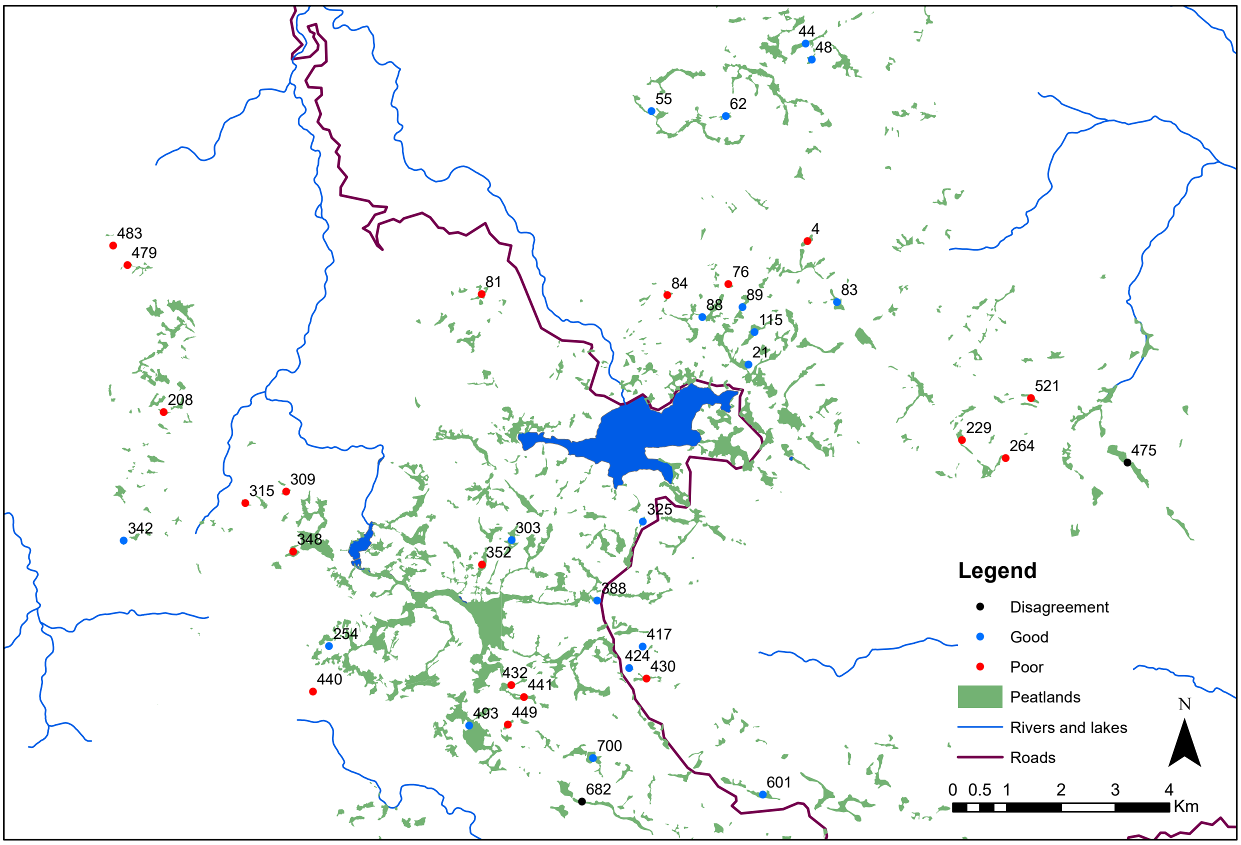


Figure 1: Location of peatlands within the Bogong High Plains. Green regions show locations of peatlands. The numbers show the ID number of peatlands that were surveyed. The blue dots show sites in good condition, the red dots show sites in poor condition and the black show sites where the experts disagreed on condition.

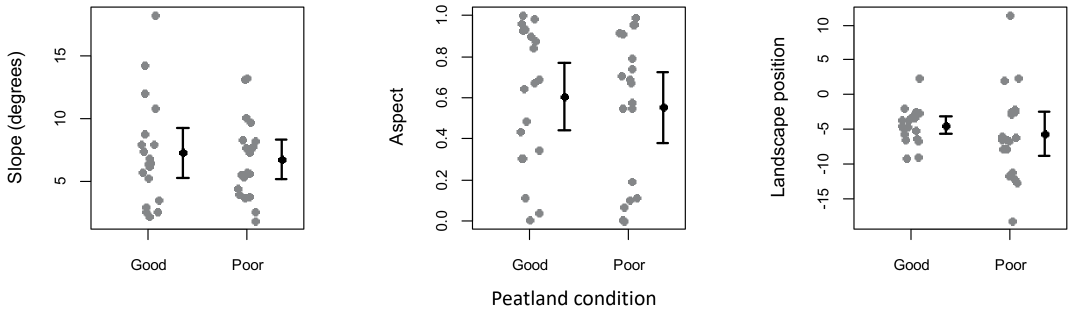


Figure 2: *Location characteristics of the peatlands classified as good (19 sites) and poor (19 sites). Aspect is described as a continuous variable ranging from 0-1. Values close to zero indicate a north-northeast direction and values close to one indicate a south-southwest direction. Landscape position shows the relative elevation of the site in the landscape with negative values indicating the site is lower on average than the surrounding landscape (within 200m) and positive values indicate that it is higher.*

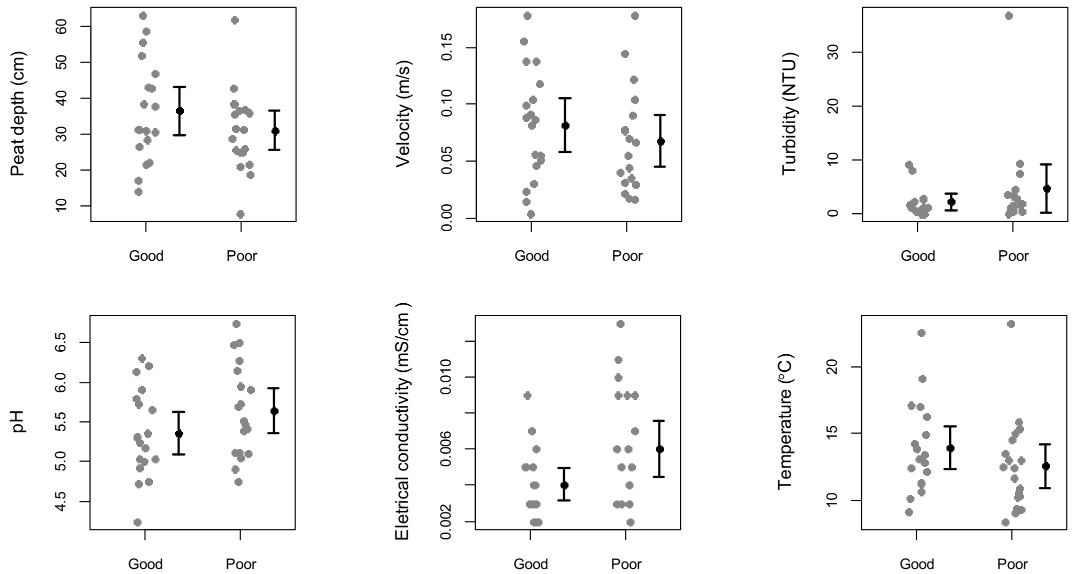


Figure 3: *Peat depth and surface water characteristics for 19 peatlands classified as good and 19 classified as poor.*

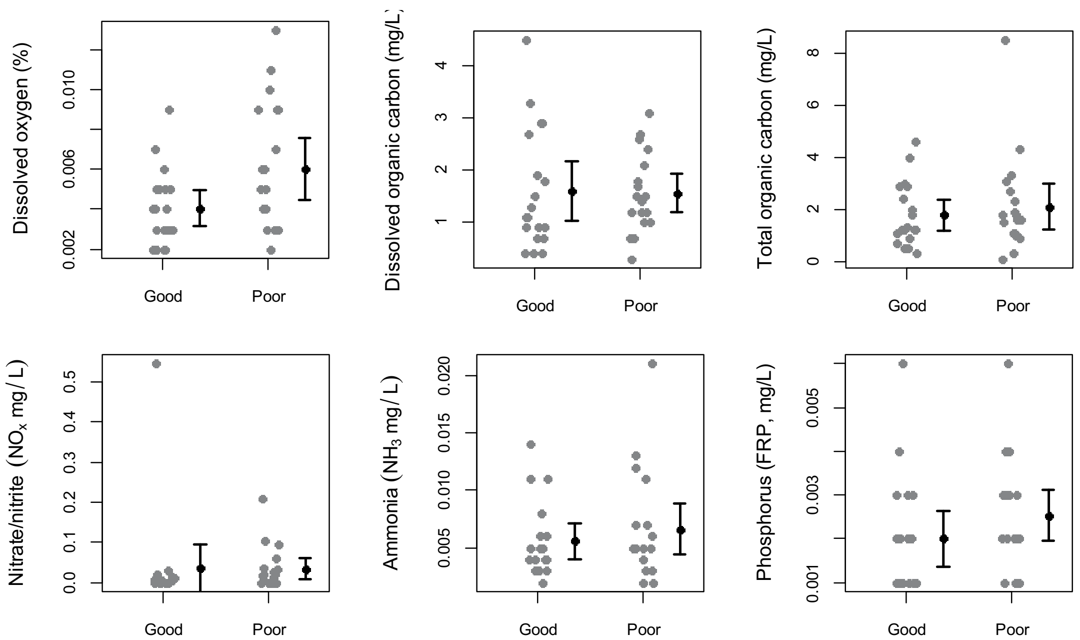


Figure 4: *Surface water chemical composition for 19 peatlands classified as good and 19 classified as poor.*

Implications and recommendations

This study is the first that has attempted to characterise surface water quality of alpine peatlands across an extensive area. We have provided a valuable baseline of surface water chemistry for alpine peatlands that will enable changes to be tracked in the future. Many of the measurements we took indicated that nutrient levels were very low – often close to the lower limits of detection. This indicates that despite extensive disturbances and increased deposition of atmospheric nitrogen over the past century, the water quality of alpine peatlands appears to remain largely unaffected.

These findings support a need for continued conservation management actions in the region. It appears that the Bogong High Plains alpine peatland ecosystems are functioning well enough that surface water quality has not been significantly compromised by disturbances. While these results suggest that the surface water component of alpine peatland ecosystems are in good condition, there is potential that they may periodically be negatively impacted by higher levels of erosion. This may occur during peak flow periods, particularly following heavy rainfall events. Such events may result in high overland flow events that can increase erosion, likely leading to more severe impacts on water quality. It is also possible that surface water attributes are relatively insensitive to disturbance and that ground water characteristics might better reflect hydrological processes occurring in the peatland.

Our water chemistry measurements suggest good water quality in surface waters under normal flow conditions. The higher levels of turbidity in some poor condition sites may indicate increased erosion but proactive management intervention would minimise this risk. Those alpine peatlands sites with outlier water quality values warrant further investigation, potentially needing more intensive management.

Feral deer damage vegetation and create tracks and wallows in peatlands, resulting in increased water drainage and peat drying. Image: Khorloo Batpurev

Further Information

Joslin Moore
joslin.moore@monash.edu

Cited material

Connolly, J. E. (2018). The relationship between surface water chemistry and expert condition assessment of peatlands at the Bogong High Plains. Honours Thesis. School of Biological Sciences, Monash University.

Threatened Species Recovery Hub
National Environmental Science Programme

Cite this publication as NESP Threatened Species Recovery Hub. 2021. Characterising alpine peatland water quality on the Bogong High Plains, Victoria, Project 1.2.3 Research findings factsheet.

This project is supported through funding from the Australian Government's National Environmental Science Program.