A classification system of Antarctic inland aquatic ecosystems

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**An information paper submitted by New Zealand**

***Summary***

Ecological classification is the classification of land or water into units that represent variation. They can be used to support environmental management by grouping units with similar characteristics and hence management needs. A recent study (Hawes et al., 2021) developed a classification of lentic[[1]](#footnote-1) aquatic ecosystems (ponds and lakes) in the McMurdo Dry Valleys Antarctic Specially Managed Area (ASMA). Aquatic ecosystems have the potential to be highly sensitive to human activities through physical disturbance, contamination and the introduction of non-native species, and to climate variability. The lentic water body classes were assessed against these factors to identify the sensitivity of the different water bodies to support prioritised environmental management needs.

Aquatic ecosystems are recognised as biodiversity hotspots yet are under-represented in the Antarctic Specially Protected Area (ASPA) network (Howard-Williams et al., 2021). It is suggested that the classification process used here could be applied to other lentic aquatic environments elsewhere in Antarctica to support enhanced management.

***Classification of aquatic ecosystems***

Using a mixture of remote sensing and existing cartography, over 6,000 ponds and lakes were identified in the McMurdo Dry Valleys ASMA and then classified using a top down hierarchical system to define 13 class separations based on physical attributes. Rivers and stream ecosystems were excluded from the classification as existing remote sensing imagery was not adequate to allow for identification of active stream channels.

The first hierarchical level was classified based on landscape (topographic vs. kettle holes). Kettle holes (water bodies on glacially derived, thermokast formation) were separated from topographic water bodies as a distinct subset due to their high density, small size and occupation of recent, dynamic glacial terrain. The second hierarchical level was classified on catchment morphology (exorheic or endorheic[[2]](#footnote-2)), the third hierarchical level on summer ice conditions (open water, ice capped, or frozen to the base) and the fourth hierarchical level on the source of water inflow (glacier fed or non-glacier fed) (Figure 1). The classification was tested against existing information on water chemistry and microbial biodiversity and, where data was sufficient for statistical evaluation, class separations were found to reflect ecological differences.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Level** | **Criterion** |  | | | | | | | | | | | | | |
|  |  |  | | | | | | | | | | | | | |
| 1 | Landscape | Topographic | | | | | | | | | | |  | Kettle | |
| 2 | Catchment Type | Endorheic | | | | | Exorheic | | | | | |  | |
| 3 | Summer Ice Cover | Open Water | Ice capped | | Frozen to base | | Open Water | | Ice Capped | | Frozen to base | |  | Open water | Ice capped |
| 4 | Water Source | Non-Glacial | Non-Glacial | Glacial | Non-Glacial | Glacial | Non-Glacial | Glacial | Non-Glacial | Glacial | Non-Glacial | Glacial |
| CODE |  | TOP-END-OW-NG | TOP-END-ICE-NG | TOP-END-ICE-GL | TOP-END-FRO-NG | TOP-END-FRO-GL | TOP-EXO-OW-NG | TOP-EXO-OW-GL | TOP-EXO-ICE-NG | TOP-EXO-ICE-GL | TOP-EXO-FRO-NG | TOP-EXO-FRO-GL |  | KET- OW | KET-ICE |

Figure 1: Top down classification of lentic water bodies based on four hierarchical levels (Hawes et al., 2021).

***Aquatic ecosystem sensitivity and ASMA management objectives***

Water is a limiting resource in the McMurdo Dry Valleys and, where present, provides for hot spots of microbial biodiversity and ecosystem productivity in an otherwise extreme desert environment (Vincent and James, 1996). Aquatic ecosystems have the potential to be highly sensitive to human activities through physical disturbance, contamination and the introduction of non-native species, and to climate variability. The classification of lentic water bodies in the McMurdo Dry Valleys was assessed against these factors to identify the relative sensitivity of the different water bodies and compared with management actions available in the ASMA management plan (Figure 2). Prioritisation (low, medium and high) included consideration of abundance, rarity and representativeness of the aquatic ecosystem.

These considerations can be used to inform future research and logistical operations while ensuring adequate protection of wilderness and biodiversity values. Noting these ecosystems and environments are dynamic, the sensitivity and management response will likely need to be reviewed and adapted over time, supported by monitoring and assessments and increased knowledge and understanding of these sites.

Calendario

Descripción generada automáticamente

Figure 2: Relative prioritisation of ecosystem sensitivities and ASMA management actions by lentic water body class.

***Applicability to wider area protection***

Although freshwater ecosystems are recognised biodiversity hotspots and are sensitive to human activities, only 2 of the 72 ASPA management plans explicitly identify freshwater values as the primary reason for designation (Howard-Williams et al., 2021). 34 of them are known to include freshwater ecosystems, but often by virtue of their inclusion within identified boundaries with little thought of their representativeness, importance or management requirements.

A classification system, using similar principles to the ones developed here, may provide a systematic approach to prioritisation of aquatic ecosystems for protection in ice free areas across the Antarctic continent. It is acknowledged that the geographic settings and geological mechanisms for formation of aquatic ecosystems and catchment characteristics in other areas will be different to the McMurdo Dry Valleys, so any classification will need to accommodate local features.

A freshwater classification system in each Antarctic Conservation Biogeographic Region (ACBR) (Resolution 6 (2012)) could be considered to assist in identifying areas for protection, particularly since freshwater ecosystems are currently under represented.

***References***

Hawes, I., Howard-Williams, C., Gilbert, N. and Joy, K. 2021. Towards an environmental classification of lentic aquatic ecosystems in the McMurdo Dry Valleys, Antarctica. *Environmental Management* 67: 600-622.

Howard-Williams, C., Hawes, I. and Gilbert, N. 2021. Why do so few Antarctic Specially Protected Areas protect inland waters? (Editorial). *Antarctic Science* 33: 231-232.

Vincent, W.F., and James, M.R. 1996. Biodiversity in extreme aquatic environments: lakes, ponds and streams of the Ross Sea Sector, Antarctica. *Biological Conservation* 5: 1451-1471.

1. Lentic aquatic ecosystems refers to those with standing or still water such as ponds or lakes. [↑](#footnote-ref-1)
2. Exorheic refers to water bodies with an outflow and endorehic refers to water bodies with no outflows. [↑](#footnote-ref-2)