Science for Saving Species

Research findings factsheet

Project 1.2.3

Threatened Species Recovery Hub

National **Environmental Science** Programme

Effectiveness of conservation management actions for cool climate peatlands

In brief

Peatlands are among our most spectacular wetlands and support many unique and threatened species. In Australia, despite many peatlands occurring within conservation reserves, they face a range of threats.

To restore peatlands to a healthy state, we need to know which management actions actually work. We used a rapid synthesis approach to summarise evidence on the effectiveness of different management actions at restoring degraded peatlands around the world.

Actions that were found to support peatland recovery include the use of rewetting, shading or mulching, reprofiling, mowing, controlling grazers and active revegetation. Planned burns and applying fertilisers had both positive and negative impacts on peatlands and grazing was largely harmful.

We found that considering the impact of management actions across the whole ecosystem is vital for peatland conservation to be successful, as peatland hydrology, chemical properties and biodiversity are intrinsically linked.

Our novel approach to evidence synthesis is a highly useful way of summarising evidence to support evidence-based conservation management.

Background

Peatlands are important wetland ecosystems that support specialised plants and animals (such as *Sphagnum* mosses). They also support many nearby ecosystems by providing water to downstream waterways and ground water.

Peatlands provide clean water, food, storm flow protection and carbon storage. Yet land-use change, extraction of *Sphagnum* and peat, and climate change are threatening peatlands globally. To restore degraded peatlands, key features that typify the ecosystem need to be repaired – the hydrology, chemical properties and key species.

Australian alpine *Sphagnum* bogs and associated fens are a nationally threatened ecological community. They provide habitat for several endemic and threatened species, including the Southern Corroboree frog. These ecosystems are threatened due to their small size and damage from fire, climate change, weeds, grazing, trampling by introduced hoofed animals and increased human activity.

Conservation actions should be based on the best-available evidence, yet filtering, synthesising and interpreting huge amounts of information can take a lot of time and resources.

Rapid evidence reviews have emerged as a useful way of quickly synthesising information while keeping much of the rigour of longer systematic reviews. Rapid reviews can do this by systematically searching the literature for reviews rather than primary studies.

Main aim of the research

Using a rapid evidence review approach, we aimed to show the effectiveness of different management actions at restoring degraded peatlands.

We also aimed to gauge the benefits of using rapid evidence synthesis to inform conservation management.

Seedling invasive willow in alpine peatland,Victoria. Image: Joslin Moore

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An intact Australian alpine Sphagnum *peatland. Image: Joslin Moore*

What we did

We made a diagram (**conceptual model**) of the features and ecological processes (i.e., response categories) that characterise intact peatland ecosystems (Figure 1). These included the hydrology, chemical properties, erosion, vegetation, animals, carbon storage and greenhouse gas emissions, and legal protection status.

We did a **rapid evidence review** to find out the effectiveness of each management action at improving peatland condition. To do this, we systematically searched two scientific databases for peer-reviewed literature reviews reporting the impacts of management actions on cool-climate (excluding tropical) peatlands around the world. We compared our results for the impacts on vegetation to the findings of the *Peatland Evidence Synthesis* (Taylor et al., 2019), a detailed summary of evidence for actions to improve peatland vegetation. For the literature reviews included in our study and the Peatland Evidence Synthesis, we recorded if the response within the ecosystem to the action was positive, negative, neutral or mixed/conditional. Responses were *conditional* if an action occurred with other actions, as the response may depend on the combination of actions.

Lastly, **we mapped this evidence onto our conceptual model** of peatlands to show the role of each action in ecosystem-wide peatland conservation. Our rapid evidence review captured evidence for the impact of **11 actions on peatlands across seven ecosystem response categories**. This information came from 453 unique papers in the 23 reviews included in our study. Seven reviews focused on peatlands globally and the other reviews focused on cool-climate peatlands in Europe (9), North America (5), Asia (1) and across northern latitudes (2). Our approach allowed us to map the effectiveness of actions on and among each feature of peatland ecosystems (Figure 1).

Key findings

Our key findings are:

- While no reviews specifically focussed on Australian peatlands, eight reviews and the Peatland Evidence Synthesis included evidence from Australian studies.
- Rewetting, shading or mulching, reprofiling, mowing, controlling grazers and active revegetation largely improved peatlands in all response categories, including hydrology, chemical priorities and vegetation (Tables 1, 2). For example, **both actions that directly alter hydrology** (rewetting and shading or mulching) **had positive effects on peatlands**. Rewetting (e.g., blocking drainage channels) especially improved peatland condition across all response categories if applied properly (Figure 1, Table 2).
- **All actions altered the vegetation** in peatlands, so regardless of the actions used or peatland feature targeted for conservation, the vegetation was also affected.
- Secondary (indirect) effects of actions were very common, stressing the importance of taking into account the desirability of flow-on effects when using an action. Most actions that were targeted to improve a specific part of peatlands, ultimately affected several parts of the system, especially rewetting, prescribed burning and cutting or mowing (Figure 1).
- Six of eleven actions were often reported to occur alongside other actions – rewetting, shading or mulching, reprofiling, fertiliser, revegetation and cutting or mowing. Commonly used combinations of actions include rewetting plus revegetation, reprofiling plus revegetation, and rewetting plus reprofiling. **The effectiveness of some actions depended on whether other actions were also implemented, particularly when aiming to improve vegetation regrowth.**
- There were notable gaps in available review-level evidence. For example, there were no systematic reviews examining the effectiveness of actions on hydrology and there were few reviews on the impacts of implementing new policy. There was also little evidence on the effects of actions on peat formation or peatland fauna.

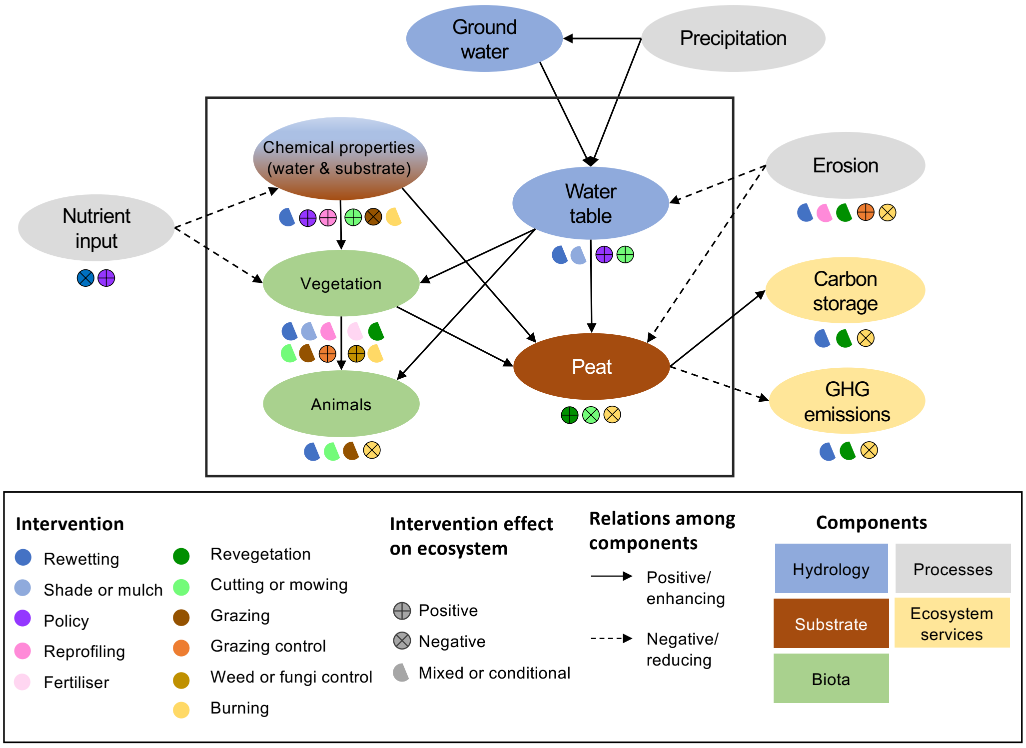

Figure 1. *Conceptual model of the peatland features, processes and one ecosystem service (carbon storage/greenhouse gas flux) provided by peatlands and the effect of each intervention. GHG = greenhouse gas. Intervention effect was evaluated as the overall effect on the action reported among the relevant reviews.*

Table 1. *Summary of actions that could be used address common issues in peatlands.*

Issue	Management action
Degraded hydrology or low water table	**Rewetting, shading and/or mulching** have positive impacts on hydrology, but shading or mulching may need to be conducted in combination with rewetting, reprofiling surfaces to remove degraded topsoils, and revegetation. Cutting and **removing planted trees** may increase the water table and implementing **policies**, to reverse or reduce water losses have been effective.
Poor water and substrate quality	In peatlands with excess nutrients or an undesirable pH, **rewetting, reprofiling, mowing** and implementing **policy** (such as wastewater treatment) may improve the water and substrate chemical properties. Planned **burns** had mixed results and **grazing** appears largely detrimental on eutrophic peatlands.
Erosion	Rewetting, reprofiling and revegetating degraded peatlands can work collectively to reduce erosion and sediment flow. **Rewetting** can slow water flow and ensure soils are waterlogged, while **reprofiling** can remove the degraded topsoils and **revegetating** can cover bare soils and filter sediment. **Reducing grazing** intensity can lower erosion, likely due to less trampling, pugging of the substrate and damage to vegetation. **Planned burns** can promote erosion by damaging vegetation and soils.
Low cover of characteristic vegetation	Active **revegetation** is important to restore key plant species but often only occurred after actions to ensure suitable hydrology and growing conditions, including **rewetting, shading or mulching, reprofiling** and/or fertilising (although **fertilising** had mixed effects).
Feral herbivores or weeds	**Controlling grazers** (such as livestock or feral herbivores) can enhance peatland vegetation by limiting plant grazing and damage from trampling. **Cutting or mowing** vegetation or **weed or fungi control** (e.g., fungicide, herbicides) can manage competitive or problematic plant species. Using **grazing** (e.g., by cattle or ponies) to manage peatland vegetation had inconsistent impacts on the vegetation, depending on the type of grazer and peatland wetness, as wetter peatlands are more prone to damage from trampling. **Prescribed burns** also had mixed or negative impacts on peatland vegetation and animals.
Loss of peat and carbon stores	**Rewetting** had a complex impact on greenhouse gas emissions and/or soil carbon stocks, but net emissions (particularly carbon dioxide) tend to decrease over longer timeframes and methane emissions may increase over time, as is typical for intact peatlands. **Revegetation** had a largely positive effect on greenhouse gas emissions and soil carbon stocks in the long term, but there may be mixed results for different gases. Prescribed **burns** substantially decreased carbon stores and regular **mowing** in eutrophic fens may reduce peat production.

A mound of Sphagnum moss in an intact alpine peatland in Victoria. Image: Joslin Moore

Table 2. Interventions for rewetting to restore peatland hydrology and revegetation to restore peatland vegetation.

Successful rewetting interventions

Actions

- Creating peat terraces/banks and shallow depressions
- Levelling soils and adding mineral substrate
  - Filling ditches with peat or with mineral soils
- Blocking ditches/drains (broadly) with caveats:
  - May not be sufficient to allow local hydrological control across a peatland to avoid a fluctuating water table
  - Large-scale hydrological actions may be required to restore the water table and ground water discharge patterns
- Pumps and sluices with caveats:
  - Success to raise the water table depended on the water volume and ability of water to move into the soil, which can be highly variable
- Installing an upland aquifer to supplement ground water and maintain a uniform water table
- Installing seepage reservoirs
- Removing blocks to groundwater flow (e.g., raising road surfaces, berms)
- Damming with wood or peat with caveats:
  - May not be sufficient to allow local hydrological control across a peatland to avoid a fluctuating water table
  - Large-scale hydrological actions may be required to restore the water table and ground water discharge patterns
- Damming with plastic sheeting (piling), local vegetation or straw bales with caveats:
  - Plastic sheeting is not suitable for shallow peatlands due to high risk of leaking if in mineral soils
  - Straw bales tended to fail quickly

Successful revegetation interventions

Actions

- Replanting vascular plants
- Directly planting mosses, herbs or trees/shrubs
- Moss layer transfer technique
- Passive restoration with caveats:
  - Effective after reprofiling and restoring hydrology
  - Effective after some active restoration
  - Due to short longevity of many characteristic species (< 5 years), short dispersal distances (<100 m) and often highly fragmented landscapes, spontaneous recolonization of vegetation can be unlikely
- Introducing seeds of peatland herbs
- Replacing blocks of vegetation after mining or peat extraction
- Adding mixed vegetation
- Adding mosses to the surface with caveats:
  - Most effective if sown fresh (rather than refrigerated), larger Sphagnum plantlets at higher cover (1-5 cm thick) at the start of the growing season
  - Large-scale mechanised moss revegetation methods are inefficient
  - Use of propagules (e.g., seeds, rhizomes, moss fragments, moss spores) give variable results based on the seed viability and germination conditions

Implications

Our review has identified a range of conservation actions that are likely to be beneficial for peatland recovery and some of their limitations. This provides a valuable starting point for managers wishing to identify recovery actions and should be followed by a more detailed review of local factors and the cost and suitability of individual actions at individual sites. For example, a technique that requires heavy machinery may be possible in a peatland beside a road but may be logistically and economically prohibitive and environmentally destructive for some sites.

The review also exposes the existing knowledge gaps in literature reviews, in particular the lack of evidence on actions to encourage peat formation or manage peatland wildlife.

Our findings highlight that taking a whole-systems approach is central for peatland conservation, as peatland hydrology, chemical properties and species are intrinsically linked. Actions can have effects beyond the targeted feature; this may be a win-win for conservation or demand trade-offs. Tackling one problem (e.g., vegetation) may also be ineffective or limited if other aspects (e.g., hydrology) stay degraded.

The rapid review approach allowed the evidence to be quickly gathered and synthesised across a challenging range of topics. Synthesising all primary studies relevant to this topic would have been an almost impossible task. However, the approach relies on the accuracy of the literature reviews in representing the evidence in primary studies. Overall, we showed that the novel rapid review approach can be a valuable tool for the conservation sector to efficiently synthesise information to support evidence-based conservation management.

Cited material

This fact sheet summarised key findings from:

Rowland, J. A., Bracey, C., Moore, J. L., Cook, C. N., Bragge, P., & Walsh, J. C. (2021). Effectiveness of conservation interventions globally for peatlands in cool-climate regions. *Biological Conservation*, 263, 109327.

Other cited materials:

Taylor, N. G., Grillas, P., & Sutherland, W. J. (2019). Peatland Conservation: Global evidence for the effects of interventions to conserve peatland vegetation. In *Synopses of Conservation* Evidence Series. University of Cambridge, Cambridge, UK. https://doi.org/10.11647/obp.0179.06

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

Further Information

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