DARWIN PLUS 116

FALKLANDS WETLANDS AND AQUATIC HABITATS: BASELINES FOR MONITORING FUTURE CHANGE

ACTION PLAN RECOMMENDATIONS

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1. BACKGROUND AND SCOPE

The Wetlands Project is funded by the Darwin Initiative through UK Government and is supported by Falkland Islands Government's Environmental Studies Budget, the Ernest Kleinwort Charitable Trust, the John Cheek Trust, and through in-kind contributions by Swansea University.

The term 'wetlands' for this project was defined at the outset and differs from the internationally adopted Ramsar definition of wetland[1] (see also Stroud, D. A. (2022)) as it concentrates on selected inland wetland types. The following Ramsar wetland types[2] are included within the scope of the project but the primary focus is the first five categories, which can be summarised as 'inland aquatic wetlands':

- Rivers, streams and creeks (permanent and seasonal)
- Freshwater lakes, over 8 ha (permanent and seasonal)
- Saline and brackish lakes, over 8 ha (permanent and seasonal)
- Saline and brackish marshes, pools and ponds, under 8 ha (permanent and seasonal)
- Freshwater marshes, pools and ponds, under 8 ha (permanent and seasonal)
- Water storage areas (reservoirs)
- Excavations (quarry lakes)

The Falkland Islands (FI), a UK overseas territory in the South Atlantic, are a biodiversity hotspot. The Islands' wetland habitats are generally not well understood, but are known to be important as biodiverse sites that support rare species and regionally distinctive ecosystems. The FI historically lacked herbivorous mammals and the introduction of grazing animals with human settlement has led to vegetation changes and soil erosion. The impact of these changes on wetland ecosystems within the FI are not clear. In addition, human induced climate change will also both directly and indirectly impact wetland ecosystems. These landscape and climate changes have the potential to impact the hydro-ecological character of wetland ecosystems. Baseline data as well as long-term monitoring data are urgently required to understand threats, track changes into the future and mitigate threats through appropriate management.

This Wetlands Project took place between 2020 and 2022. Over this period literature and data reviews were undertaken, a number of sites were instrumented to provide continuous observations of water level and temperature and fieldwork was carried out over two summers to fill some of the knowledge gaps. Additionally, the project produced an indicator monitoring report (Carter et al., 2022) so that monitoring of inland aquatic wetlands can continue beyond this project. Whilst monitoring of selected indicator provides crucial information about baselines and trends in these ecosystems, actions on different levels must take place alongside monitoring to ensure adequate long-term care is in place.

[1] Article 1(1). "...wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres."

[2] Appendix B of Ramsar's Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance of the Convention on Wetlands

As a final project output, recommendations in the form of an action plan are presented here to provide:

a) an overview of the wetland types addressed throughout the project and to outline their characteristics;

b) a summary of direct and indirect drivers of change; and

c) actions that need to take place to eliminate, reduce or mitigate the identified pressures and threats as well as the provision of additional baselines where required.

2. INLAND AQUATIC WETLAND TYPES

The description of the different wetland types provided in this report are all based on data gathered from 81 waterbodies visited between February and December 2021 as part of the project's fieldwork activities across two austral summers (Figure 1). Whilst the fieldwork was carried out across both East and West Falkland, as well as two outer islands, and thereby covered a large geographic range, it is possible that the habitat descriptions and the range of values for pH, salinity and electrical conductivity (EC)[3] across the FI may not be entirely complete. To differentiate between freshwater and brackish water a cut-off value of 1 PSU[4] was applied. The first round of fieldwork took place at the end of the 2020/21 austral summer, whilst the second round occurred at the beginning of the 2021/22 austral summer. The categorisation of lakes and ponds into permanent or seasonal waterbodies was based on observations as to whether they retained water during these two summers.

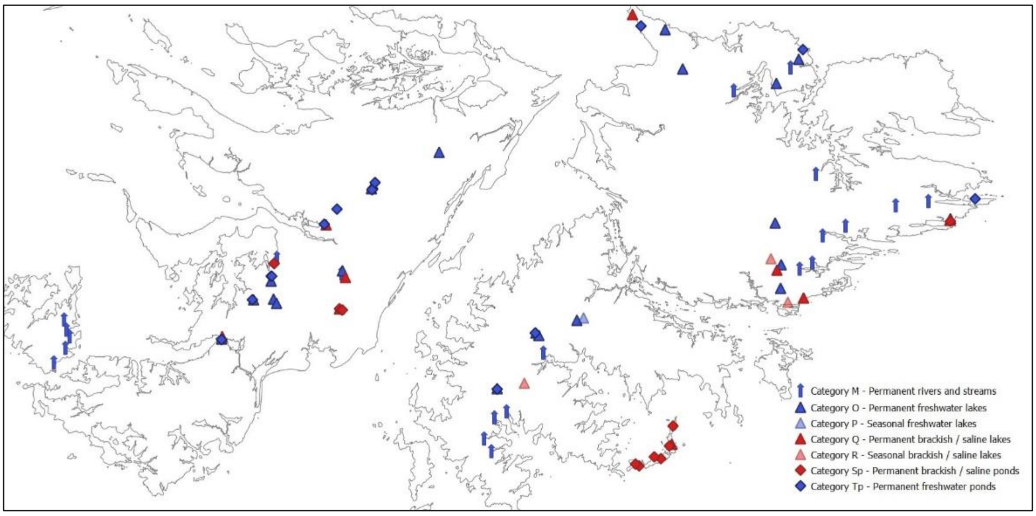

Figure 1: Site locations categorised by Ramsar wetland types: Arrow = stream or river, triangle = lake, square = pond, blue = freshwater, red = brackish or saline, dark colour = permanent waterbody, pale colour = seasonal waterbody.

[3] EC = electrical conductivity is a measure of the water's ability to pass electrical flow, which is directly related to the concentration of dissolved salts in the water. EC is very temperature dependent and should always be reported for a specific temperature; here all EC values are reported for a temperature of 25 °C. The EC unit is µS/cm; higher EC values can be reported in mS/cm. 1,000 µS/cm = 1 mS/cm.

[4] PSU = practical salinity unit, equivalent to parts per thousand.

Ramsar Wetlands Category M – Permanent River / Stream

Permanent rivers and streams occur throughout East and West Falkland as well as on many of the larger outer islands; 21 were surveyed during the fieldwork. The pH ranged between 5.2 and 7.7; 14 streams had a pH < 7 (i.e. below neutral, therefore acidic), one had a neutral pH of 7, and the other six were alkaline with a pH > 7. The salinity was either 0 or 0.1 PSU with an EC range between 101 and 374 µS/cm; therefore all contained freshwater. The water transparency tended to be good and the Secchi depth[5] always exceeded the actual depth of the water (maximum depth across all sites was 67 cm). Vegetation tended to be bryophytes growing on rocks, but other vegetation such as water milfoil *Myriophyllum quitense* and native pondweed *Potamogeton linguatus* was found in slower flowing sections.

Figure 2: Example of a 'Permanent Freshwater River / Stream' (Ramsar Code M), above water left, underwater right, with bryophytes, a pH of 5.22, a salinity of 0 PS and an EC of 129.6 µS/cm. Unnamed stream, Bluff Cove.

Figure 3: Example a 'Permanent Freshwater River / Stream' (Ramsar Code M), above water left, underwater right, with a pH of 7.06, a salinity of 0.1 and an EC of 304 µS/cm. Doyle River, Shallow Harbour.

Ramsar Wetlands Category O – Permanent Freshwater Lake

Permanent freshwater lakes are mostly found across East and West Falklands whilst some also exist on a few larger outer islands; 20 were surveyed during the fieldwork. The pH had a large range from 4.93 to 7.93; two lakes had a neutral pH of 7; whilst nine lakes each were acidic with a pH below 7 as well as alkaline with a pH above 7. The salinity

[5] Secchi depth refers to the depth at a disk with a prominent black and white pattern lowered into the water can no longer be seen from the surface. It is related to water transparency

ranged between 0 and 0.9 PSU with an EC range of 129–1,772 µS/cm. The water transparency was very variable with Secchi depths ranging between 5 and 80 cm. These lakes were often without visible emerging vegetation but some did support vegetation such as *M. quitense* and California clubrush *Schoenoplectus californicus*. The bed material varied and included, sand, silt, peat, gravel, cobbles and bedrock.

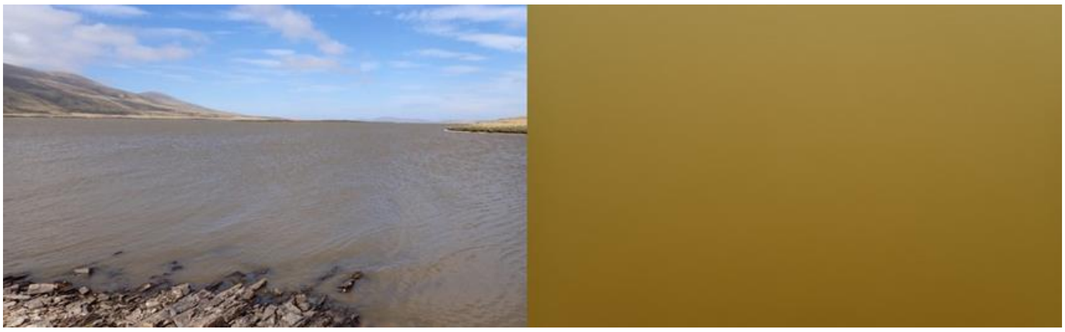

Figure 4: Example of 'Permanent Freshwater Lake' (Ramsar Code O), above water left, underwater right, with a pH of 7.3, a salinity of 0.36 and an EC of 838 µS/cm. Lake Sulivan North, Doyle Farm.

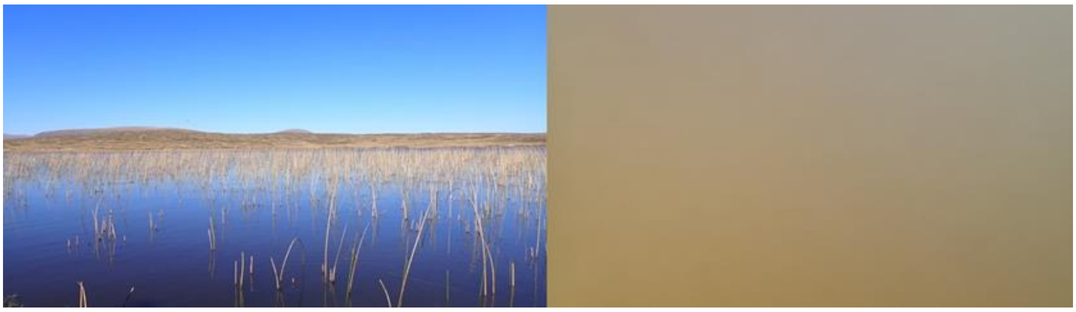

Figure 5: Example of 'Permanent Freshwater Lake' (Ramsar Code O), above water left, underwater right, with a pH of 7.89, a salinity of 0.2 PSU and an EC of 409.8 µS/cm. Bucket Peck Pond, Leicester Creek.

Ramsar Wetlands Category P – Seasonal Freshwater Lakes

Throughout the fieldwork of the Wetlands project, only one example of a seasonal freshwater lake was encountered (at Lafonia). This site had probably transitioned from Category O to Category P very recently. At the time of fieldwork, this lake had a pH of 6.97 (i.e. just below being neutral), a salinity of 0.3 PSU and an EC of 682 µS/cm. Its bed material was silt; it supported *M. quitense* and had poor water transparency with a Secchi depth of only 5 cm.

Figure 6: The only example of a 'Seasonal Freshwater Lake' (Ramsar Code P), with water (left) and after drying out (right).

Ramsar Wetlands Category Q – Permanent Brackish Lake

Permanent Brackish Lakes are found mainly on East and West Falkland whilst a few may occur on some of the larger outer islands although no potential permanent brackish lakes on outer islands were visited during the fieldwork. Nine lakes on East and West Falkland were surveyed during the fieldwork. The pH range from 6.97 to 9.61 meaning that none of the lakes were acidic, all either had a neutral or almost neutral pH or an alkaline pH. The salinity ranged from 1 to 3.5 PSU and an EC range of 1.92–6.67 mS/cm. The water transparency tended to be poor with Secchi depths commonly < 5 cm, but examples of clear water also existed. The bed material of these lakes was variable and included cobbles, gravel, sand, silt and peat. As with freshwater lakes, many brackish lakes did not appear to have emergent vegetation; the ones that did often had *M. quitense*, whilst *S. californicus* was also present.

Figure 7: Example of 'Permanent Brackish Lake' (Ramsar Code Q), above water left, underwater right, with a pH of 7.45, a salinity of 1.23 and an EC of 2.44 mS/cm. Round Pond, Stanley Common.

Figure 8: Example of 'Permanent Brackish Lake' (Ramsar Code Q), above water left, underwater right, with a pH of 7.63, a salinity of 1.3 and an EC of 2.32 mS/cm. Unnamed Lake, Leicester Creek.

Ramsar Wetlands Category R – Seasonal Brackish Lake

Three examples of seasonal brackish lakes were encountered during the fieldwork, all on East Falkland. Their pH ranged from 2.97 to 5.92, i.e. all were acidic. The salinity ranged from approximately 4 to 8 PSU and the EC ranged from 6.79 — 13.2 mS/cm. Their bed material was mainly silt and sand without any emergent vegetation present. At one lake the water transparency was poor with a Secchi depth of 1.5 cm; whereas the Secchi water transparency was deeper than the shallow water level at the other two lakes (i.e. the lake bottom could be seen from the surface).

Figure 9: Example of 'Seasonal Brackish Lake' (Ramsar Code R), above water left, underwater right, with a pH of 5.92 and an EC of 6.79 mS/cm. Old House Pond, Fitzroy River.

Figure 10: Example of 'Seasonal Brackish Lake' (Ramsar Code R), above water left, lake bed right, with a pH of 4.31, a salinity of 7.3 PSU and an EC of 13.2 mS/cm. Unnamed Lake, Fitzroy.

Ramsar Wetlands Category Sp – Permanent Brackish / Saline Pond

Twelve examples of permanent brackish and saline ponds were encountered during the project fieldwork across East and West Falkland as well as on Bleaker Island. Their pH ranged from 3.27 to 8.64; five were acidic and 7 were alkaline. The salinity ranged from 1.2 to 67.7 PSU and an EC range of between 3.1 and 146.5 mS/cm. Their bed material was either sand, silt, peat or a mix of these substrates. Their visibility was mainly poor with a Secchi depth of < 5 cm but a few had a Secchi depth which exceeded the measured water level. Many did not have emergent vegetation but *M. quitense* and *P. linguatus* occurred in some of them.

Figure 11: Example of 'Permanent Brackish Pond' (Ramsar Code Sp), above water left, underwater right, with a pH of 8.24, a salinity of 23 PSU and an EC of 39.0 mS/cm. Centre Camp Pond, Bleaker Island.

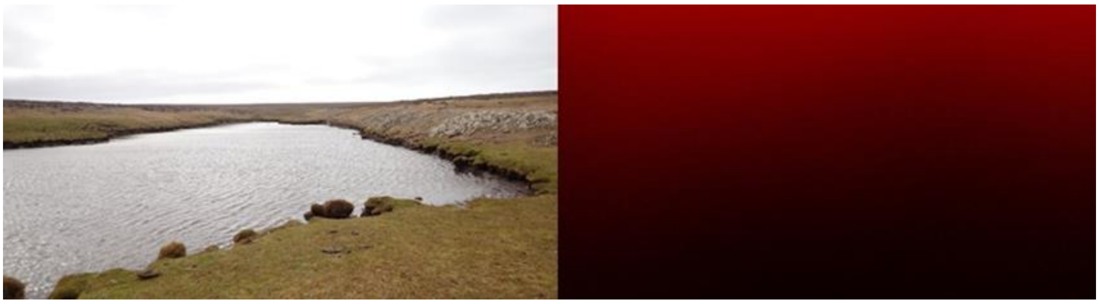

Figure 12: Example f 'Permanent Brackish Pond' (Ramsar Code Sp), above water left, underwater right, with a pH of 7.31, a salinity of 1.6 and an EC of 3.1 mS/cm. Long Grass Valley Pond, Bleaker Island.

Ramsar Wetlands Category Tp – Permanent Freshwater Pond

Permanent freshwater ponds occur across East and West Falkland and are likely to also occur on some outer islands; 15 were surveyed during the project fieldwork. Their pH ranged from 4.81 to 8.71, eight ponds were acidic, three were close to a neutral pH and the remaing four were alkaline. The salinity ranged from 0 to 0.95 PSU with an EC range of 183.6 to 889.9 µS/cm. Their bed material was mainly sand, whilst some also had silt, peat or cobbles. The majority did not show evidence of emergent vegetation but in some *M. quitense, S. californicus* and spike rush *Eleocharis melanostachys* did occur.

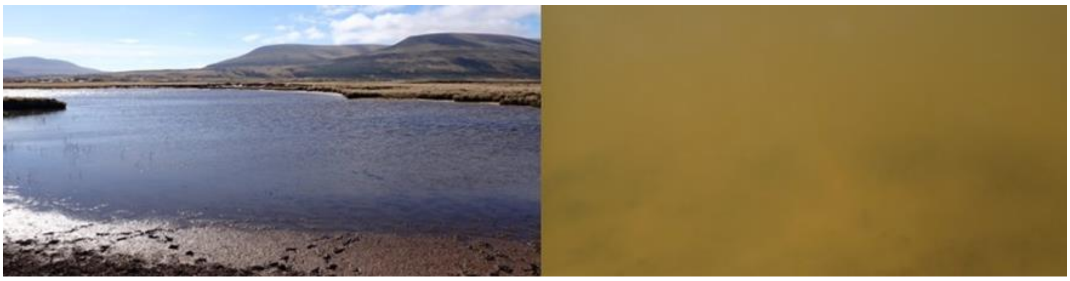

Figure 13: Example of 'Permanent Freshwater Pond' (Ramsar Code Tp), above water left, underwater right, with a pH of 6.9, a salinity of 0.95 PSU and an EC of 1.9 mS/cm. Unnamed Pond, Doyle Farm.

Figure 14: Example of 'Permanent Freshwater Pond' (Ramsar Code Tp), above water left, underwater right, with a pH of 7.99, a salinity of 0.3 PSU and an EC of 668.0 µS/cm. Unnamed Pond, Stoney Ridge.

3. STATUS AND TRENDS

The global and national policies related to wetlands in the Falkland Islands are summarised in the literature review produced by the Wetlands Project (Carter & Stroud 2021). Since then, the *Environment Strategy 2021 to 2040* (Falklands Islands Government, 2021) has been published. In this strategy, it is recognised that land and freshwater systems provide crucial ecosystem services, which underpin society and the economy. At the same time, The Falklands Islands' Government also recognises that the very same society and their economic activities put pressure on these ecosystems. The strategy stresses the need to:

- "manage and protect our native terrestrial and aquatic ecosystems (including wetlands) and the quality of land and water;
- improve terrestrial and aquatic ecosystem integrity, for the benefit of current and future generations, through considering the ecological impact of and improving land-management approaches, practices and incentivisation; and
- take an integrated land-water management approach that adopts a long-term view and incorporates ecological considerations alongside social and economic ones."

The Islands Plan of the current assembly is not finalised at the time of writing; however, the previous *Islands Plan 2018 to 2022* (Falkland Islands Government, 2018) included the vision to "ensure that the environment is preserved for future generations". Both the *Environment Strategy* and the *Island Plan* suggest that the political will to protect and sustainably manage all ecosystems is present.

As highlighted in the *Environment Strategy* baseline knowledge gaps exist across ecosystems, but more so for aquatic than terrestrial systems. Many studies are one-off investigations without any follow-up surveys, so that evidence of trends in environmental conditions for inland aquatic systems do not really exist.

4. DRIVERS OF CHANGE

The assessment of threats for the inland aquatic wetlands addressed in this report are based on the '*Global Wetland Outlook*' (Ramsar Convention on Wetlands, 2018), which differentiates between direct and indirect drivers of change. Compared to the threats faced by global wetlands, the Falkland Islands inland aquatic wetlands are affected by a relatively limited number of the drivers of change listed in the '*Global Wetland Outlook*'. Nonetheless, the threats identified here are still severe and some have already triggered changes in conditions.

5.1 Direct drivers of change

Culverts

Three native freshwater fish species occur in the Falkland Islands: minnow *Galaxias maculatus*, and two zebra trout species *Aplochiton zebra* and *Aplochiton taeniatus*. All species have landlocked and diadromous populations (McDowall *et al.*, 2001) so that the populations' survival therefore depends on their ability to migrate to and from the sea. Culverts occur throughout East and West Falkland where water courses pass beneath the main road network and have been highlighted as local threats for these migratory populations (Ross, 2009; Fowler & Garcia de Leaniz, 2012), although their impact has not been quantified.

Introduction of alien invasive species

Brown trout *Salmo trutta* were introduced between 1944 and 1962 and of all the fish species that were introduced in the Falkland Islands, they are the only one that became established (McDowall *et al.*, 2005; Fowler, 2013). The two *Aplochiton* species are declining due to the presence of *S. trutta* and now mainly only occur in areas that *S. trutta* have not reached. It is believed that the further spread of *S. trutta* into *Aplochiton* stronghold areas will lead to a further contraction of the latter's range (McDowall *et al.*, 2001). Whilst *G. maculatus* populations seem to co-exist with *S. trutta*, it can be assumed that this species would have been more abundant before the introductions occurred (McDowall *et al.*, 2005). Modelling suggests that *S. trutta* will be able to expand their range into all suitable habitats within the next 70 years threatening native fish species with extinction (Minett *et al.*, 2021).

The European non-native water-starwort *Callitriche stagnalis* has been recorded in Stanley; it is unclear how widespread the species is and whether it is affecting the native water-starwort *Callitriche antarctica* (Heller *et al.*, 2019).

Structural change

As identified during the Wetlands Project, the modification of existing streams, which is locally called 'ditching', is still widespread across farms where it is primarily undertaken to make land safer for livestock (The Wool Press, 2021). During ditching work the stream is opened up to become more visible and the slope of at least one side is reprofiled to a shallower angle to improve access for livestock and to increase livestock's chance of climbing out of a stream. Occasionally, stone dams are also built to slow down the flow of water. Whilst the impact of 'ditching' has not been assessed, it can be assumed, on the basis of experimental and other studies in similar habitats elsewhere, that the alteration of natural wetland habitat will have an impact on biota. Dams may limit the ability of fish to migrate and may separate fish and invertebrate populations. Larger exposed surface areas might promote evaporation losses and consequently drawdown in water levels with the potential for flashier responses to rainfall and lower levels in between rain and during dry periods.

5.2 Indirect drivers of change

Climate change

The frequency of gales and severe gales in the Falkland Islands has been increasing since the second half of the 20th century (Jones *et al.*, 2016), an increase in temperature of 2.2 °C (upper limit by 2080) is predicted alongside an increase in the annual soil moisture deficit leading to increased soil erosion (Upson *et al.* 2016). A climate change risk assessment for wetlands in the Falkland Islands has not been produced but it is likely that the impact of a changing climate on wetlands will be similar to those anticipated for soil moisture including increases in evaporation rates and modifications to catchment-wide hydrological processes with implications for the supplies of water to wetlands, their water levels and water quality. Climatic changes may also involve increased evaporation and increased salt deposition not only effecting hydrology but chemistry as well.

Anecdotally, some of these changes have already been recorded. Both fieldwork summers were exceptionally dry and some lakes and ponds that within living memory had retained water year-round actually dried out. Additionally, landowners' perception is that waterbodies are not fully replenished over the winter with reduced snow cover providing less snow melt in spring.

Even if ponds and lakes do not fully dry out, evaporation concentrates ions, increases salinity and EC and may change the pH. One example is Mappa Pond at North Arm, which in 1999 supported *G. maculatus*. In February 2001 the water had a pH of 5.90 and an EC of 3.4 mS/cm (Flower et al., 2012), meaning it was slightly acidic and brackish but a few years later the pond started to dry out over the summer (land manager, pers. comm.). During the Wetlands Project fieldwork a highly acidic pH of 2.97 and an EC of 11.9 mS/cm was recorded with no visible life present, highlighting the drastic change that has taken place in just over 20 years.

Agriculture

The ecosystems on the Falkland Islands have evolved without herbivorous mammals. The introduction of livestock in the 18th century and subsequent increases in the number of sheep (over 800,000 in 1898 - McAdam, 2014 – declining to 476,767 in 2019 - Falkland Islands Farming Statistics: Department of Agriculture 2019) has had profound impacts on the Islands' environment. This includes the well-documented loss of native habitat such as tussac *Poa flabellata* with the resulting bare peat areas being very susceptible to wind erosion (Strange *et al.*, 1988; Otley *et al.*, 2008). Erosion also occurs in areas of other vegetation and whilst some may be natural, erosion of recent origin can be mainly attributed to land management practices (Wilson *et al.*, 1993).

The impact of erosion on inland aquatic habitats has not been quantified but is likely to include alterations to water chemistry, nutrient availability and light levels as a result of the influx, deposition and periodic resuspension of soil and peat particles. Agriculturally induced erosion therefore is likely to have a direct impact on primary productivity and subsequently throughout the aquatic food chain. Climatic changes can also be exacerbated by land management and one landowner has observed a link between lake water levels and soil moisture, which he believes increased, when livestock numbers were reduced as a results of taller vegetation locking in more soil moisture, which then creates a moisture buffer around lakes.

5. OBJECTIVES AND ACTIONS

The Darwin Plus Wetland Project considers that the following objectives and actions would promote the 'wise use' (sensu Ramsar Convention) of Falkland Island wetlands; assist the Falklands Islands Government in the fulfilment of obligations it has assumed under the Ramsar Convention and other relevant multilateral environment agreements; as well as contributing to the delivery of objectives of the Falkland's *Environment Strategy 2021 to 2040* (Falklands Islands Government 2021).

5.1 Proposed objectives

To maintain the ecological character of Falkland Island wetlands this action plan proposes the fulfilment of the following objectives. These are mainly aimed at the Falkland Islands Government to develop policies and work plans with the support of landowners, research and conservation organisations. The proposed objectives are:

a) eradication or control of non-native invasive species;

b) rectification of existing and future avoidance of structural changes to waterbodies (i.e. 'ditching');

c) mitigation of climate change impacts by monitoring of long-term indicators and eliminating unsustainable land management practices; and

d) designation of protected sites under the Ramsar Convention.

5.2 Proposed Actions

A matrix of all the proposed actions for each identified pressure or threat is included in Table 1; whilst suggested actions are detailed below. Proposed actions fall into the following categories but not all actions may be required for all of the identified issues:

- Policy and legislation;
- Habitat & species management;
- Engagement with public and landowners;
- Monitoring; and
- Research.

Culverts

Habitat Management: Ross (2009) identified nine culverts that may cause problems for fish migration. Since that report was published extensive culvert replacements have been carried out across East and West Falkland. A full survey should take place to determine which culverts are likely to hinder fish migration. Ideally, problematic culverts should be replaced or dug deeper to allow fish to pass through.

Policy & Legislation: Planning law should be amended so that culvert positioning is required to consider fish migration and – in the event of likely impediment – require the construction of fish 'ladders', as widely used internationally.

Non-native *Salmo trutta*

Policy & Legislation: The non-native Brown Trout *Salmo trutta* should be removed from the protected species list in Schedule 2 of the Conservation of Wildlife & Nature Ordinance 1999. The lifting of the restricted fishing season and daily bag limit should also be considered. Legal restriction of the further introduction of *S. trutta* into freshwater systems should be established under relevant legislation.

Habitat & Species Management: Recognizing that trout fishing is a popular pastime, and that trout fishing is also important to tourism, habitat and species management should be done with the involvement of recreational fishing community and landowners. For example, this can involve working with recreational fishers and landowners to identify waterways that are important habitat for native fish, and where the spread of trout can be reversed or impeded.

Engagement with Public and Landowners: Work with the public and landowners to galvanize the support required to prevent the further spread of the species and where possible to control extant populations.

Research: McDowall *et al.* (2005) visited 148 sites (streams, rivers, ponds and lakes) across the FI in 1999. Whilst follow-up projects re-visited some of these sites, the full extent of the original survey has never been captured. An update on the distribution of all freshwater fish species is therefore urgently required to better understand the spread and impact of *S. trutta*.

Monitoring: Once current status is established, regular monitoring of key sites or key regions, should be carried out to monitor further spread of *S. trutta* and to assess the effectiveness of the proposed policy changes and species management actions.

Non-native water-starwort *Callitriche stagnalis*

Research: A vegetation survey of aquatic habitats is required to determine the extent and impact of water-starwort *Callitriche stagnalis* on the native *Callitriche antarctica*.

Ditching

Research: At present ditching is assumed to have negative impacts on freshwater habitats and water retention within the landscape (although this is based on evidence from elsewhere). A research project should identify what the actual impacts are and whether these are localised or widespread.

Engagement with Public and Landowners: Discussions with landowners should determine alternative land management options to reduce risks for livestock whilst reducing or eliminating the need for habitat modification. Greater public awareness of the issue should be promoted.

Climate change impacts

Monitoring: Monitoring of selected indicators of change in aquatic habitats can provide early warnings of changes in hydrochemical conditions which may have subsequent impacts on biota. The project's indicator monitoring report (Carter et al., 2022) outlines these indicators and what resourcing is required to implement a monitoring programme going forward into the future. The indicators include water level, water temperature, light levels, pH, EC, absorbance of organic matter, chlorophyll concentrations, diatom assemblage and invertebrate assemblage. In order to produce reliable environmental trends all, monitoring of wetland indicators requires long-term time series data.

Monitoring should also include the use of satellite imagery to determine the annual extent and variability in waterbodies including, in particular, which are drying out and so help identify priority areas for monitoring and intervention.

Research: Whilst fish, invertebrates, diatoms and water chemistry have been studied recently, the trend of inland aquatic bird populations is completely unknown. The only Falkland Islands wide survey took place between 1983/84 and 1992/93, which gave very wide-range breeding pair estimates (Woods & Woods, 1997). Another survey is required to determine population trends so that future climate change impacts can be assessed accurately. Assessment of the potential for annual, sample-based monitoring for selected terrestrial species should be undertaken.

Research should also focus on soil erosion extent, rates and the un underlying mechanisms influencing soil erosion. Research should also investigate the fate of the eroded soil and the impact on aquatic ecosystems.

Policy & Legislation: Whilst the overall contribution from the Falkland Islands to global climate change might be small compared to other countries, there are several important objectives set out in the Falkland Islands *Environment Strategy 2021-2040* that could help to slow climate change impacts, including the use of 100% renewable energy by 2050.

Land management

Policy & Legislation: Landowners' main income is from livestock farming, whilst tourism can also offer an additional but limited income. New policies should offer landowners ways to diversify their income, and ideally provide the economic flexibility to reduce grazing pressure. Examples include financial incentives as part of an agri-environment scheme or the establishment of a peatland code and carbon credit scheme.

Engagement with Public and Landowners: Landowners know their land better than anyone else and as detailed in some examples above, they are often the first to realise the actual impact of changes in land management. A shared internet-based platform should be established on which landowners can share experiences to collectively identify what management measures work and do not work to in terms of better water / soil moisture retention.

Research: As outlined above the negative impact of soil erosion on inland aquatic habitats is assumed. Further research to identify and quantify actual impacts should be undertaken to compare whether some land management and livestock management have differing impacts on rates of sediment delivery to wetlands and the consequent impacts on water levels and surface water extent, water quality and, in turn, biota.

Conservation designations

The action recommendations outlined above would be further strengthened by the designation of additional Ramsar Sites, which can be tied in with further national designations, and so demonstrate commitment to the international community to sustain their ecological character. The designation of particular sites would give a focus in highlighting priority areas for some of the recommended actions (although other recommendations apply across the wider landscape). Ramsar Sites are encouraged to have a management plan to usefully outline what, if any, management and species monitoring actions are needed, as well as site restoration plans if required. Many of the recommended actions could be integrated into Ramsar Site management for those areas.

Table 1: Matrix of proposed actions for identified pressures and threats.

ISSUES	ACTIONS				
	Policy & Legislation	Habitat & Species Management	Engagement with Public & Landowners	Monitoring	Research
Culverts	X	X			
Non-native *Salmo trutta*	X	X			X
Non-native *Callitriche stagnalis*					X
Ditching			X		X
Climate change impacts	X			X	X
Land management	X		X		X

6. FUTURE VISION

Compared to many more populous and industrialised countries in the world, the Falkland Islands' inland aquatic habitats are relatively unspoiled. The relatively pristine nature of these environments is one of the many attractions of the Falkland Islands to visitors. However, the almost unspoiled nature of the Islands inland aquatic habitats is likely to be currently changing.

A unified approach between government, landowners and research organisations is required to identify practical ways forward to eliminate, reduce, or mitigate the identified pressures and threats such that in the future, all inland aquatic habitats continue to sustain their unique ecological characters.

7. REFERENCES

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