Reflecting on MSc placement at Ecos Nature Park

My main reason for choosing the work placement option as opposed to the project is because of the variety of experiences you get and the array of knowledge you can develop. While the detail and precision required to complete a project is admirable, I still felt unsure where my passions lay during this academic year, and therefore focussing on one specific topic was not the right option for me.

My work placement at Ecos Nature Park has allowed me to explore many different avenues. Some of these have interested me more than others, for example, while I enjoyed cooperating with others, community outreach is not where my strengths lie and while it is likely I will have to do this throughout my career, I will seek advice when carrying out such projects in the future. On the other hand, my placement has shown me the importance of carbon studies and flood mitigation and developed my interests in them, and these are aspects I will try considering throughout my career, wherever that may be.

Much of my work on placement has been independent, and while at times I sought advice on certain topics, I have tried to input as many of my own ideas into my management plan as possible. While other, more experienced stakeholders may not agree with all my suggestions, I have learnt this is not a problem, rather, it is an opportunity to open discussions and share knowledge regarding management techniques, which will hopefully lead to well informed decisions being made. For example, Ecos Nature Park is recognised for its diverse grasslands which support roughly a dozen different species of butterfly, some of which are struggling elsewhere. Regardless, I have suggested to convert a small section of this grassland to 'rewilded' woodland. The literature suggests that while grasslands are rich in flowering plants and several pollinator species, they are otherwise species poor, and therefore my suggestion aims to conserve other species such as small mammals, birds, and invertebrates. The confidence I have developed through my placement, and overall studies, has allowed me to still make this suggestion, despite knowing not everyone will agree with it.

As like many people during recent times, COVID-19 has disrupted some of my work and I have had to adapt to this. While much of my work is independent, on-site meetings have had to be carried out following regulations which can reduce their effectiveness. Other people I have only conversed with over email or zoom due to the pandemic, when the proper way to build connections is through face-to-face meetings. Regardless, I have still conducted myself in a professional manner and communicated effectively with these people.

I also had difficulties with transport and therefore conducting surveys on-site. This has made me prioritise my work and organise myself effectively. When transport was not available, I started my management plan or researching various topics to ensure that I was getting the most from my relatively short work placement.

Developing skills through surveying such as the small mammal and tree surveys, especially those using GIS and apps are important to me, but the aspect of placement I value the most is how it has improved my attitude. Mistakes were made and not everything materialised how I planned, but this is normal in project work, and has built my confidence, making me a more independent and valuable asset to any workforce.

RECOMMENDATIONS FOR ECOS NATURE PARK,

BALLYMENA, NORTHERN IRELAND

CONSERVATION MANAGEMENT PLAN

Report prepared for

Mid and East Antrim Council

Caolan McCaughan on MSc placement

with Fieldfare Ecology

August 2021

Section 1: Introduction

This document provides suggestions for the ecological enhancement, management, and protection of the Ecos Nature Park, Ballymena, Northern Ireland, for use by the Mid and East Antrim Council, and associated governing bodies. The extent of the Nature Park is shown in figure 1.

The structure of this document is as follows:

- **Section 1 – Introduction**: Outlining the objectives and structure of the conservation management plan.
- **Section 2 – Site description**: Provides an overview of the site, describing the key ecological management compartments.
- **Section 3 – Ecosystem services**: Offers estimates on the carbon storage and flood mitigation values of the site.
- **Section 4 – Biodiversity at Ecos Nature Park**: Details the important species associated with Ecos Nature Park
- **Section 5 – Management action areas**: Identifies aspects of the Nature Park that may need managed and offers suggestions of possible solutions to enhance the site.

This document aims to set in place practices that will not only conserve the positive aspects found throughout Ecos Nature Park (and remaining 37hectares of the Millennium Park, included as part of Ecos Nature Park from here on), but to develop them and enhance them.

Where necessary, this plan is supported by figures, popular media sources, and scientific literature.

Figure 1. Ecos Nature Park site boundary (red)

Yellow lines show un-grazed grassland (UGL) and grazed grassland (GL), and the yellow square shows the small woodland (WL) patch which were used for the small mammal surveys, described in section 4.2.

Section 2: Site description

2.1 Site overview

The Ecos site was developed between 1998 and 2000, and is a 99hectare site, 62hectares of which are a Nature Park. Ecos Nature Park is currently under the ownership of Mid and East Antrim Borough Council. The site is found on the eastern edge of Ballymena town, County Antrim and is adjacent to the M2 dual-carriageway. The nature park is mainly used by locals but can also act as a stop off point for those travelling further afield. The key components of the site are described below.

2.2 Ecological Management Compartments

2.2.1 Lake

The man-made 3.03ha lake is the centre piece to Ecos Nature Park. Many of the footpaths embroider the lake, and the picnic area at the main car park overlooking the lake is often found being enjoyed by families. The lake is host to several species of waterfowl including ducks, geese and swans, with the occasional rare visitor such as the Green-winged teal and the Russian White-fronted Goose which have been spotted in recent years.

2.2.2 Rivers and tributaries

The Braid is a spate river 9 metres in diameter on average and was assessed to have moderate ecological potential water quality upon its last assessment in 2018 conducted by DAERA. The Devenagh Burn is a tributary to the Braid River and was assessed as moderate on its last assessment in 2018 also by DAERA due to phosphorus content (See Figure 6 – Methods and examples). It feeds into the lake before re-entering the Braid River towards the south of the site.

2.2.3 Ponds/pools

Ephemeral ponds could be found to the east/northeast of the lake in the past, where there is roughly 7ha of marshy grassland with alluvial soils. It appears that the ponds/pools have dried out as a result of natural succession, the lowering of the water table, as well as the inter-connecting drainage having become clogged up and no longer fit for purpose. Whether permanent or temporary, these pools form a rich habitat for many species.

2.2.4 Grasslands

The main habitat found in ENP is wet/marshy grassland, mainly purple moorgrass rush pasture, which is a priority habitat. Sections of the park are also dry lowland meadow grasslands, another priority habitat. Together these grasslands equate to nearly 75ha of the total site. Much of this ground is grazed by Irish moiled cattle to prevent encroachment of other species and to maintain and enhance the species diversity of the site (see section 4.1).

2.2.5 Woodlands

There is approximately 19ha of woodland found throughout the Nature Park, comprising of several different species. Willow plantations equating to around 7ha were planted in 1990's for harvesting but this never materialised, so they are now dense and tall woodland blocks. Ash trees are found throughout the site, including a small woodland at the north-eastern edge of the park, where they have been planted alongside oaks. Several blocks of hazel can be found either side of the main carpark. Hawthorn, blackthorn, rowan, cherry, downy birch, and apple trees can also be found in certain areas throughout the park.

Section 3: Ecosystem services

Ecos Nature Park provides many ecosystem services that benefit a wide range of people and has the potential to offer more. For the purpose of this document, regulating services have been focussed on, as this is currently an area of great interest as governments try to achieve net-zero targets. Places such as Ecos Nature Park can go a long way to help meet the aim for the UK to be carbon neutral by 2050, outlined in the 'The Sixth Carbon Budget - The UK's path to Net Zero report'[1]. Flood associated costs are estimated to be around 40billion US dollars annually and this is only likely to increase if climate change trends continue[2].

3.1 Carbon sequestration

There are an estimated 7,025.99 tonnes of carbon stored at Ecos Nature Park (See methods and examples, page 19). This number was estimated using habitat types and their associated carbon contents for the site. If land use changes on the site, we would also expect the carbon content to change. For example, if improved or neutral grassland is converted to woodland, we can expect the carbon content for that area to almost double overtime, from 62/63.4 tonnes of carbon stored per hectare, to 123.3[16].

Currently, many practices that may deteriorate carbon storage, particularly molecules stored in soils, are banned from Ecos Nature Park. These include ploughing, re-seeding, and high stocking densities on grasslands, and it is important that this is maintained to ensure Ecos Nature Park remains as a carbon sink, rather than carbon source.

Estimates were created using University of Cumbria's guide - Hagon, S., Ottitsch, A., Convery, I., Herbert, A., Leafe, R., Robson, D. and Weatherall, A., 2013. Managing land for carbon: a guide for farmers, land managers and advisors.
http://insight.cumbria.ac.uk/id/eprint/2256/1/Weatherall_ManagingLandForCarbon.pdf

3.2 Flood mitigation

Firstly, it should be stated floodplains are an important aspect of landscapes, and that putting in place defences that prevent Ecos Nature Park from flooding may have detrimental effects elsewhere. Floodplains provide important ecosystem services such as water retention, carbon sequestration, water purification and habitats that support a suite of important species[3]. By flood mitigation in this document, we mean the value of the site in preventing flooding occurring elsewhere, for example in the nearby Ballymena Town, where flooding is likely to be much more dangerous and cause economic damage.

During periods of heavy rainfall, the Ecos Nature Park often stores significant quantities of water. Using contours in the Ecos area and river depth levels from the nearby Houstons Mill Monitoring Station, the volume of water stored in the area can be estimated. When the Braid River is in 1metre of flood, 181,446tonnes is estimated to be stored on site. When 2metres high, 600,018tonnes may be stored on site. For extreme cases of 3metre high floods, the site could store as much as 1,405,367tonnes of water. A breakdown of water stored at different floods can be found in Figure 2. Figure 3 shows the extent of such a flood on the site, as predicted by the Department for Infrastructure (DfI) in a 100year (Q100) flood. The impacts of the construction of the Northern Link Road, linking St Patrick's Barracks site and the A42 Broughshane Road Roundabout, remain to be seen, but it is likely that it will reduce water storage potential of the site by several thousand tonnes.

The bursting of the River Braid banks at Ecos Nature Park also reduces the flow rate of the water (increasing the area reduces the water pressure, and thus reduces flow rate). There are health and safety concerns regarding bursting of the banks, as the park is in close proximity to housing estates and remains open to the public during floods. The Department for Infrastructure collect data on water levels along different water bodies in Northern Ireland. Using estimates taken from Houstons Mill monitoring station, which is located upstream of Ecos, as the alert point, a water level ranging from 1-1.6metres for several hours was enough to cause significant flooding of the site, and therefore the public could be signalled to avoid the park at such times. Such floods happen on average every 3-4 months, although they more frequently between October and February in

comparison to the summer months (Dr Michael Meharg, Personal Communication). Caution should always be taken along or near waterways, even in times of low water levels.

The vegetation at Ecos Nature Park will also play a role in reducing flooding. It is estimated that hedges (such as hawthorn and blackthorn) reduce rainfall reaching the ground by as much as 57% directly below the canopy when in full leaf cover, and 24% for the surrounding ground area. Interception can be as high 49% directly below canopy and 19% in the surrounding area during leafless periods[4]. It is estimated that conifers over a year long period will mitigate floods better than broadleaves, particularly because they retain a constant canopy in winter when conditions are generally wettest. If considering both interception and transpiration and assuming a rainfall of 1,000mm in a year, conifers could be expected to use/intercept some 550-800mm of water, compared to 400-640mm for broadleaves[5]. Given that in 1cm difference between two gradients (45m & 45.01m), 2,525tonnes of water can be stored, the importance that trees may play, and the potential they have to mitigate floods, should not be underestimated. Of course, trade off between biodiversity gain from broadleaved plantations rather than coniferous should also be taken into account when making decisions.

Should aims to implement additional mitigative measures at Ecos Nature Park to reduce flooding be desired, it is recommended these are done at a catchment level further upstream rather than at Ecos. An aerial satellite survey of the region shows few additional areas where rainfall can be intercepted or stored, and therefore runs directly into the Braid River, before reaching Ecos Nature Park. The Rivers Trust use three key techniques to prevent the risk of hazardous floods (Personal communication, 2021);

1. Slowing water – through riparian buffer strips, riparian tree planting, and introduction or retention of large woody debris features.
2. Holding water – Floodplain bunds, flood bank removal, and sediment traps.
3. Intercepting water – Woodland creation, moorland restoration, and soil management.

Introducing even a few of these suggestions further upstream within the catchment has the potential to delay flooding by 0.5hours and reduce flooding volume by 25% during large floods[6].

Depth of River (m)	Floodwater stored on site (tonnes)
1	181,446
1.1	207,952
1.2	237,393
1.3	271,052
1.4	308,249
1.5	349,586
1.6	393,797

1.7	440,961
1.8	490,485
1.9	542,775
2	600,018
2.1	661,324
2.2	728,222
2.3	800,535
2.4	877,086
2.5	957,742
2.6	1,043,267
2.7	1,133,141
2.8	1,225,363
2.9	1,319,781
3	1,405,367

Figure 2. The amount of water stored in tonnes at Ecos Nature Park at different river depths (m). Calculated using QGIS 3.18.2 and data from OpenData NI.

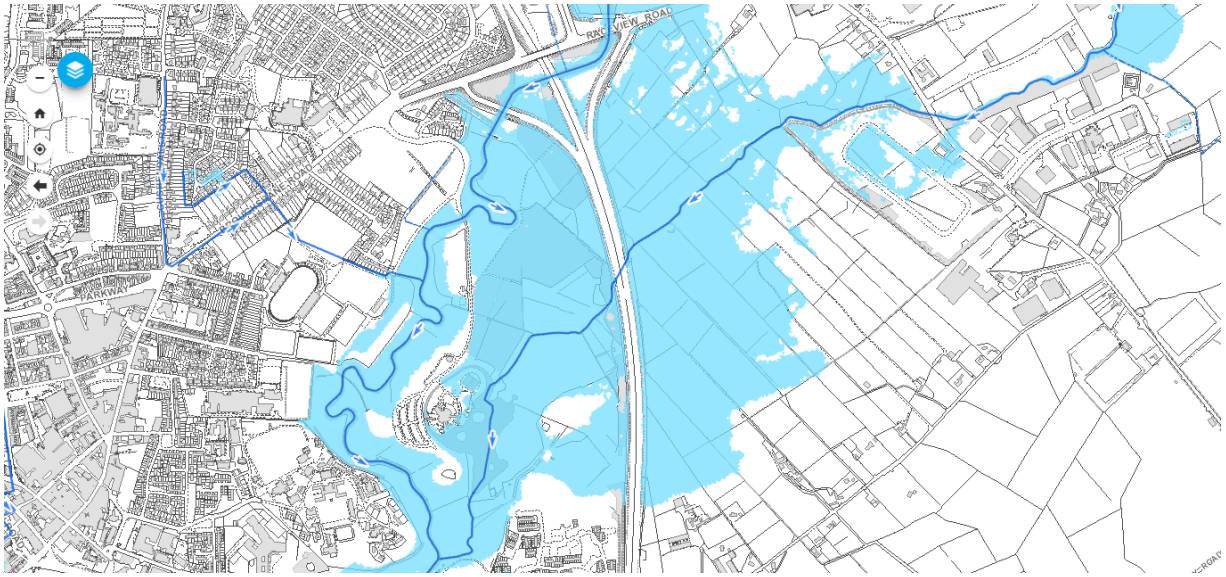


Figure 3. Department for Infrastructure map of the expected area to be flooded at Ecos Nature Park during a 100year level (Q100) flood.
https://dfi-ni.maps.arcgis.com/apps/webappviewer/index.html?id=fd6c0a01b07840269a50a2f596b3daf6

Section 4: Biodiversity at Ecos Nature Park

Nature Parks such as Ecos are invaluable in landscapes dominated by agriculture and urbanisation. Land use change is one of the leading contributors to a 52% decrease in biodiversity between the years 1970-2014[7]. Sites like Ecos can act as havens for biodiversity if managed correctly, from which wildlife can spread into the wider landscapes.

4.1 Floral diversity

Ecos Nature Park boasts an array of species rich swards, mainly due to the fact one of the main management practices is conservation grazing. Low stocking density of Irish Moiled Cattle currently

graze the site, mainly to prevent rush encroachment of species such as *Juncus effusus* which have been an issue in the past, and to maintain the diversity found within priority grassland habitats.

Throughout the site you can find bird's foot trefoil *Lotus corniculatus,* common centaury *Centaurium erythraea,* and various species of St. John's- worts *Hypericum spp.* There are also several species of orchid found on site, such as the common spotted orchid *Dactylorhiza fuchsia,* Broad leaved marsh orchid *Dactylorhiza majalis,* and the rare Irish lady's tresses orchid *Spiranthes romanzoffiana* has been recorded on the site but has not been present for several years.

There are occasional occurrences of invasive species such as Giant Hogweed *Heracleum mantegazzianum* and Himalayan Balsam *Impatiens glandulifera,* which could compromise the floral diversity, but these are often dealt with swiftly and effectively by the Friends of Ecos Group, Mid and East Antrim Council, and NIEA, who do important work to maintain the site (see section 5.1).

4.2 Faunal diversity

Bees and butterflies

Bees and butterflies have been declining worldwide[8,9] and therefore sites such as Ecos become much more important in their conservation. The Ecos Nature Park is mainly managed for the conservation of invertebrates such as lepidoptera which thrive in species rich grasslands. Since 2018, a total of 12 butterfly species have been recorded along transects within Ecos Nature Park, which are conducted on a regular basis should conditions allow, between the beginning of April and end of September (Figure 3). Cryptic wood white butterflies *Leptidea juvernica* are associated with the site, which suggests good quality habitat of both grassland and hedges/woodland edge which the species need to survive, but they have not been recorded in several years. Many different species of bees are also found throughout the site, of both the social and solitary kind. In recent years a bee bank was constructed on site for use by solitary bees, but it has not been regularly monitored and may need maintenance work carried out to reinstate effectiveness.

One of the main benefits of nature parks to insects in comparison to agricultural land is that there are no requirements to maximise output, and therefore chemicals such as pesticides can be avoided. Pesticides harm many different insect species, and in many cases greatly reduce their numbers[10]. Mid and East Antrim Council, along with local biodiversity officers have agreed to make public land pollinator friendly as part of the All-Ireland Pollinator Plan, and this site is a great example of working towards this objective.

Birds & rodents

Several bird of prey species have been seen throughout the site, for example buzzards *Buteo buteo,* sparrowhawks *Accipiter Nisus,* and the scarce long- eared owl *Asio otus* have all been spotted in recent years. Availability of prey such as small birds; Chaffinch *Fringilla coelebs,* Blue- tits *Cyanistes caeruleus,* great- tit *Parus major,* Dunnocks *Prunella modularis* and blackbirds *Turdus merula* are abundant, as well as small mammals such as grey squirrels *Sciurus carolinsis,* wood mice *Apodemus sylvaticus,* and pygmy shrews *Sorex minutus* being recorded on site. A small mammal survey to create population estimates for the site was unsuccessful as no individuals were caught across 9 trapping nights on three different sites (un-grazed grassland, grazed grassland and small patch of woodland, figure 1). Reasons for no captures are unclear as rodents have been captured on camera traps positioned near Longworth traps. It is possible flooding events may cause fluctuations in rodent populations, or that due to the rich grassland habitats in Ecos Nature Park, explorative foraging by rodents is minimal. Home range size and time spent foraging is seen to be negatively correlated with food availability in a wide variety of species[11]

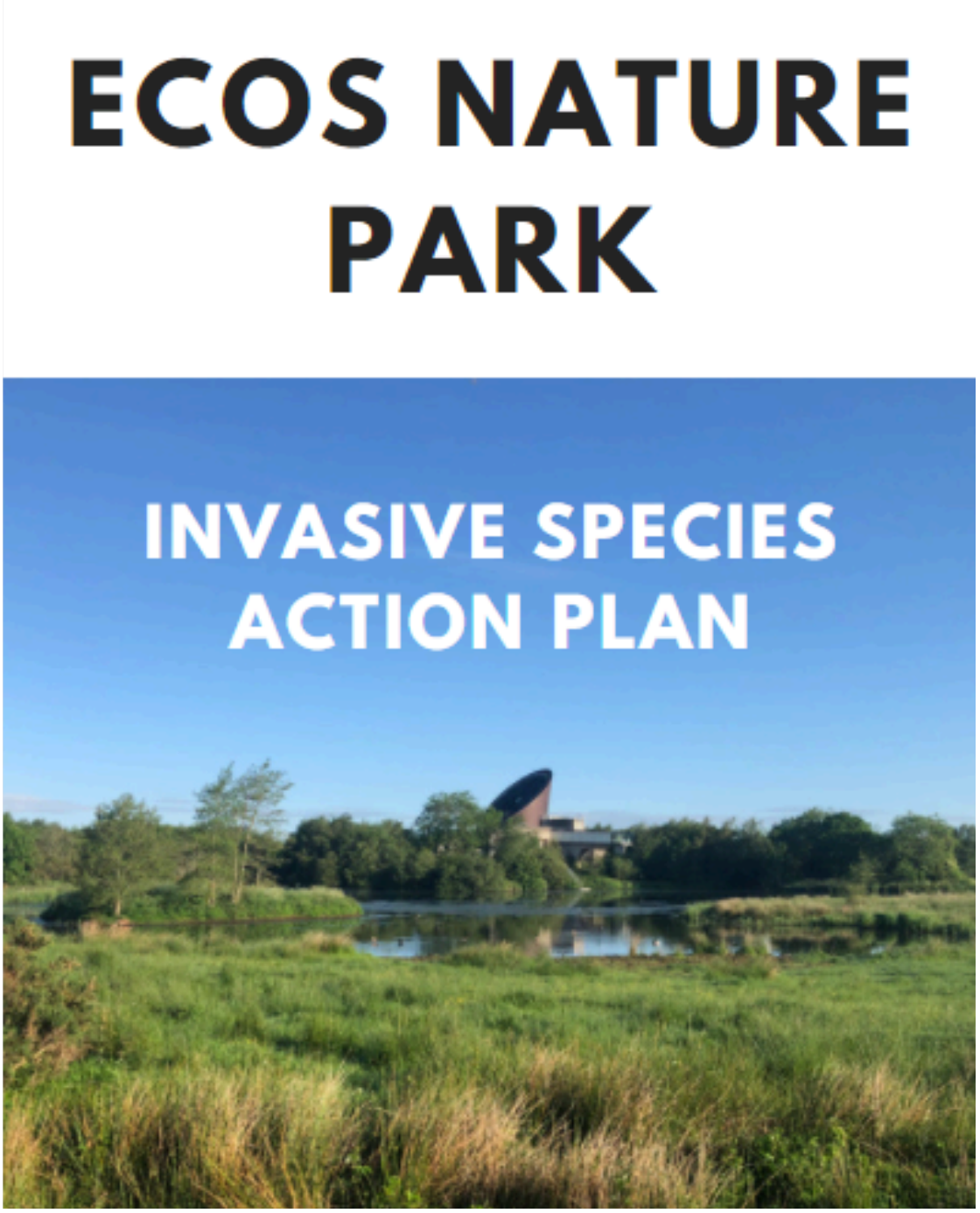
Mammals

There is a colony of rabbits *Oryctolagus cuniculus* residing at the southeast corner of the lake, and Red foxes *Vulpes vulpes* are regularly seen throughout the site, along with the occasional badger *Meles meles.* Otters *Lutra lutra* and as of very recently American Mink *Neovison vison* have been recorded along waterways within ENP. Hedgehogs *Erinaceaus europaeus* are also seen (often as roadkill) along the adjoining dual carriageway, and rescued individuals are sometimes reintroduced to the site, although it is questionable how much of the site is suitable for them due to its floodplain nature. There has been unconfirmed reports of the native red squirrels *Sciurus vulgaris* in the nature park, but it is unlikely a population will establish so long as the invasive grey squirrels *Sciurus chordata* remain on the site (see section 5.1).

Figure 3. Image of the transects used for butterfly surveys. The path walked can be seen in red, and where transects are taken is numbered 1-14. Conditions for surveying are from Butterfly Conservation guidelines: https://ukbms.org/sites/default/files/downloads/UKBMS%20G2%20Transect%20field%20guidance%20%20notes.pdf

Section 5: Management action areas

5.1 Invasive species action plan (**right click – open link to view**)



Objectives

1. Make information on identification, prevention, removal, and good practice available to the public. Encourage citizen science.
2. Create a partnership network between stakeholder groups - Friends of Ecos (FoE), Mid and East Antrim council (MEA), and Northern Ireland Environment Agency (NIEA).

3. Create projects to control invasive species and outline each stakeholder group's responsibility in the management of ENP.

Action	Meets objective number	Action by	Target
Public awareness			
Organise events to educate and train the public to identify, map and where appropriate remove invasive species.	1	MEA, FoE	2 events at ENP by end of 2022.
Encourage the uptake of existing campaigns in NI such as 'Be Plant Wise' and 'Check, Clean, Dry' which aim to prevent the spread of invasive species.	1	All	Promote campaigns at events, social media and websites by end of 2021.
Encourage a Citizen Science culture where members of the public record sightings of invasive species on free iRecord app, with an accompanying image for verification.	1,3	All	Promote iRecord app at all events, and through social media, drawing attention to the main species of concern.
Actions and Management			
Ensure stakeholders are aware of their responsibilities and maintain cooperation between groups to ensure successful management of invasive species.	2	All	Establish responsibilities by end of 2021.
Develop a realistic control programme to reduce likelihood of reinfestation from neighbouring areas, particularly upstream of ENP.	2, 3	All	Each stakeholder to inform others of their knowledge of current extent of invasive species in the area, and their resources to assist in control. By end of 2021.
Control Giant hogweed as it appears on site, and possibly at sites further upstream to prevent reintroduction.	3	All	FoE to inform MEA (land owners) of sightings. It is then MEA's responsibility to remove the plant(s). NIEA can provide advice on action.
Control Himalayan balsam on site, currently found mainly along Braid River.	3	FoE, MEA	FoE to identify and when possible, remove stands of Himalayan balsam. If necessary, MEA will provide training days on correct control methods.
Eradication of Grey squirrel population at ENP.	3	FoE, MEA	Volunteers from FoE to undertake grey squirrel control on site. MEA to liaise with local Red Squirrel organisations to create a cooperation network where knowledge can be shared and provide equipment where necessary.

Monitor and control other invasive species across the ENP.	3	FoE, potentially others	FoE to monitor for introduction of new invasive species on ENP, and if necessary, seek advice/assistance from MEA and/or NIEA.

5.2 River and water quality

Description

The Braid River supports a large head of native wild brown trout, and plenty of trout and salmon fry, as well as minnow, can be seen shortly after the spawning season. Electro fishing along the Braid River was carried out in the past, repeat survey would be the best way to get accurate estimates of population health of mature fish, but this was discontinued several years ago. The presence of Otters *Lutra lutra,* Kingfishers *Alcedo atthis* and grey herons *Ardea cinerea* in the river would support the suggestion of healthy fish populations.

A significant program of habitat enhancement work which involved deepening certain pools and placement of cobble and gravel was conducted upstream of the section at Ecos Nature Park in a collaboration between the Braid Angling Club and DAERA. Comparisons of the enhanced stretch of river, and other sections the club control, and the stretch of river found at Ecos Nature Park may offer suggestions on whether the Ecos section needs improved, and if so, how.

Concerns have been raised over a pollution source below the dual carriageway bridge at the north end of the site, where it appears raw sewerage is draining into the river. This may deteriorate water quality if not dealt with as it is often a source of phosphorus to water courses, which alongside nitrogen pollution, is a main source of eutrophication and algal blooms[12]. In severe cases, phosphorus pollution can even kill a river, as shown in the recent Rivercide documentary (https://youtu.be/5ID0VAUNANA).
A recent clean-up by the Friends of Ecos group also saw 4 shopping trollies removed from the Devenagh Burn, and 1 from the Braid River, along with other large items. However, tyres and other pieces of litter remain in the waterways.

Opportunities and constraints

Opportunities

- Survey fish populations.
- Habitat creation to improve spawning grounds for fish.
- Improve Devenagh Burn and Braid River Ballymena Overall water quality from moderate to good (see methods and examples, figure 6 for criteria).
- To promote Ecos Nature Park as a good location for catch and release fishing.

Constraints

- Costs.
- Regular occurrence of flooding can interfere with river structure.
- Possibility of invasive species along verges, in particular Giant Hogweed which is hazardous to human contact.
- Fly-tipping/littering.

Solutions

- Reintroduce electro fishing surveys to the river on a bi-annual or tri-annual cycle to ensure fish populations are and remain healthy.
- Establish a relationship with the local angling clubs or contract expert advice to compare sections of the river.

- Identify and report invasives as per guidance given in section 5.1.
- Install CCTV cameras, working or fake, to deter anti-social behaviour.

NOTE: The governing body of waterways in Northern Ireland, DAERA, should be contacted before undertaking any alterations to the river or tributaries on Ecos Nature Park.

5.3 Ephemeral ponds

Description

Several ephemeral ponds were present in the marshy grasslands to the east of the lake in recent years, but the ditches that supplied water to them appear to have become choked up with vegetation (figure 4), causing the water level to lower and the ponds to be dry much of the year. While temporary ponds increase biodiversity, creating ponds which are permanently wet would add to the habitats present on the site. A study by a professional hydrologist to assess requirements to rewet the area is needed. Bunds or small dams may help retain water in these scrapes.

Rewetting of the marshy grassland and ponds could provide essential habitat to many species such as frogs, newts, lapwing, snipe, dragonflies and perhaps even the provide for return of the Irish Ladies Tresses orchid which was found in this area in the past.

Opportunities and constraints

Opportunities

- Create a high-quality habitat that could host a rich suite of species.
- Reintroduction of an area of interest within Ecos Nature Park.

Constraints

- Costs.
- There is no guarantee that the water table can be permanently raised.
- Potential loss of grazing area.
- Possible encroachment of rushes.

Solutions

- Have a hydrological survey of the area conducted by an expert.
- Develop a grazing plan using only other grassland areas in the park to ensure livestock still have enough pasture.

Figure 4. Image of a drain clogged up with vegetation (taken 09/07/21), likely to be one of the leading causes as to why ephemeral ponds are dried out.

- Monitor and control any rushes in the area to prevent establishment/spread.

5.4 Willow plantation

Description

There are some 7ha of willow planted on previously marshy grassland in the Ecos Nature Park. The willow, which is not believed to be the native species, was planted to be harvested for biofuel but this never materialised and as a use is now redundant. The 6 blocks of woodland are now 25+ years old and due to the dense planting and wet ground, individual trees have grown tall and straight, many of which are unstable. Localised wind-blow events are a regular occurrence, sometimes damaging fences and blocking paths.

Willows, even non-native species, are a rich source of food for many insects including moths and also provide an early food source for pollinators. The thin foliage layer of this particular species means birds rarely, if ever, nest in the canopy, but the understory provides suitable habitat for species such as willow warblers.

While the plantations are valuable to some species, as a monoculture they are not as biodiverse as alternatives may be, such as native woodlands. There may be opportunity to remove sections of the plantation and replace them with alternative habitats.

Opportunities and constraints

Opportunities

- Removed biomass may be sold as biofuel.
- Introducing a new, more diverse woodland may promote biodiversity and resilience.
- Survey new habitats as they develop, and monitor the progression over time.
- A range of species is positive for biodiversity and will help with carbon sequestration targets.

Constraints

- Removal of willows can be difficult. All roots and stumps must be cleared to prevent reestablishment.
- Removal of willow may threaten present species if action occurs in one event.
- Substantial costs and initial labour required.
- Removing established ecosystems may create an environment in which invasive species can proliferate.

Solutions

- Assess the current state of the biodiversity within the willow plantations.
- Remove a section of the planted willow to be replaced with a species rich woodland/rewilded.

There is an opportunity to develop a project that could engage the public, while conserving/promoting biodiversity. By removing an area of roughly 3ha (43% of willow plantation, Figure 5), this will allow the area to be replaced with more natural woodland. We suggest planting half of the cleared area under normal management techniques i.e. selected tree species planted every 2metres. The remaining half will be allowed to ‘rewild’, meaning there will be no management of the site except maintaining fences to prevent grazing. After several years, juvenile woodlands separated by nothing more than a fence should be present, but may look completely unique to each other due to different management techniques. Biodiversity should be surveyed

regularly during the development stage and upon woodlands maturing to compare between the two management techniques (removal of invasive species may be necessary even on rewilded site to prevent establishment and spread).
It may also be possible to add another 2.1ha to the woodland site by converting the neighbouring grassland to the east (figure 5), which is currently not in optimal condition. While grasslands are rich in flowering plants and associated insect species, in some areas introducing a more diverse variety of plants including trees and hedges through rewilding may increase species richness further, and increase resilience of current species. It is also suggested rewilding protects the greatest number of threatened species in comparison to any other approach[13].

While conversion of grasslands to woodlands may seem counter-productive for lepidoptera, many woodland species are in decline, and may benefit from the introduction of new woodland. Of the primary factors identified as important to woodland lepidoptera species by Butterfly Conservation, low diversity of woodland age, lack of clearings and glades, and abrupt woodland edges effect the greatest number of species, and this project can introduce these, either naturally through rewilding, or by selective management in the managed woodland. Furthermore, of the secondary factors identified, woodland fragmentation is the most important, causing declines in all woodland lepidoptera species, and this would connect patches of woodland already found in Ecos Nature Park[14]. A list of woodland management techniques important to lepidoptera can be found in figure 6. Introduction of more woodland will also increase the regulating ecosystem services provided by Ecos Nature Park.

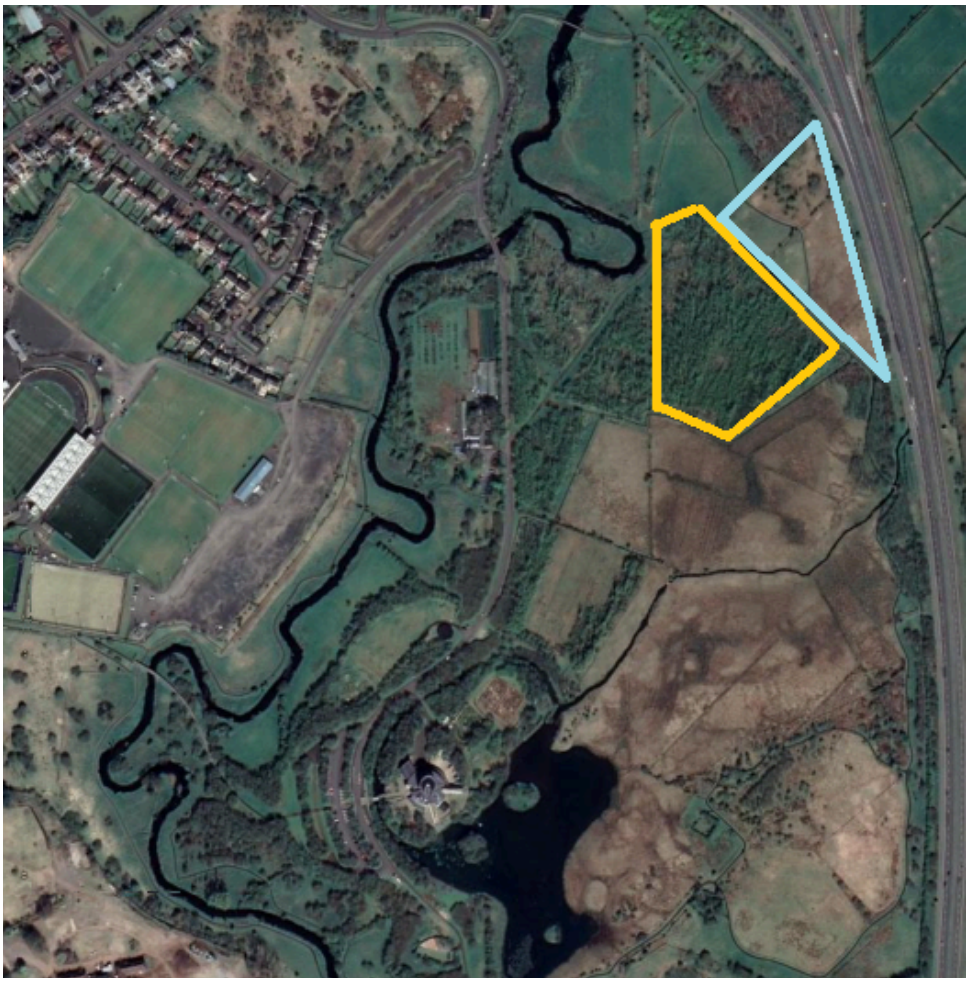


Figure 5. Satellite image of Ecos Nature Park showing the suggested area of removal of willow plantation (yellow), and grassland converted to woodland (light blue). Total 5.1hectares – path area.

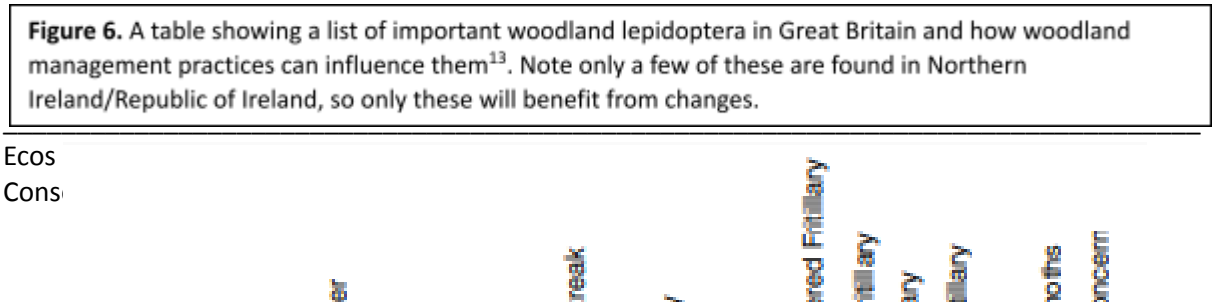


Figure 6. A table showing a list of important woodland lepidoptera in Great Britain and how woodland management practices can influence them[13]. Note only a few of these are found in Northern Ireland/Republic of Ireland, so only these will benefit from changes.

Ecos
Cons

5.5 Ash trees

Description

Ash trees *Fraxinus excelsior* are one the most common trees found throughout the UK and Ireland, and the Ecos Nature Park is no different. There are >125 individual ash trees on the site, of differing sizes and age. A significant portion of these can be found in the northeast section of the site, where there is a plantation of ash mixed with oak.

The presence of ash dieback *Hymenoscyphus fraxineus* throughout the park will most likely kill most ash trees, if not all. While the loss of healthy trees will have a negative impact, the benefits of deadwood, both standing and fallen are significant. Deadwood is high quality habitat for many invertebrates, as well as cavity nesting sites for birds and roosting sites for bats, and a rich foraging resource for many small mammals. In the past, as many as 20% of fauna in the UK relied on deadwood in some capacity[15]. Many of these species have likely since declined as the abundance of deadwood has been reduced through changes in land use/management practices.

The significant amount of deadwood likely to become available at Ecos Nature Park as a result of ash trees dying due to ash dieback may see populations of woodpeckers return to the site, which have already been spotted in low numbers on dead ash trees on the grounds.

Several of the ash trees on the site are near roads/paths and may need managed for health and safety reasons (figure 7). In areas where dense canopies are desired, removing and replacing ash trees may be necessary.

Opportunities and constraints

Opportunities

- To support an array of species with almost no inputs (labour or costs).
- Survey dead ash trees for unique/vulnerable species such as woodpeckers and bats (beneficial for promoting/protection of the nature park).

Constraints

- Loss of foliage- loss of nesting opportunities for some species, rain interception/water uptake, noise reduction from dual carriageway, and air quality filtration.
- Falling deadwood can be a health and safety hazard.
- May take a long time for deadwood dependent species to return to the site.

Solutions

- Regularly survey dead trees and surrounding areas to monitor presence of important species.
- Remove branches of ash trees which overhang paths/roads.
- If decided necessary, remove standing dead trees and replace with a different native species such as oak. All deadwoods should remain stacked on-site to provide habitat and foraging resources for wildlife.

Figure 7. Map of individual/clusters of ash *Fraxinus excelsior*. Yellow dots show trees which may need assessed for health and safety reasons. Created using a combination of QGIS, Merger and Input.

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Appendix

Methods and examples

Section 3 - Ecosystem services

Carbon sequestration

1. To get carbon estimates for the whole of Ecos Nature Park, a satellite image of the site was imported into Gimp (an image editing software).
2. A new overlapping layer was created. On this new layer, every piece of canopy was coloured over with a sharp brush.
3. This new layer was then exported into QGIS using the georeferencer and converted into a vector, which then gives the area output.

This method was recommended through personal communication with a member of Fieldfare Ecology who regularly carries out carbon asset surveys for clients and as part of their reports.

Using the estimates provided by Hagon et al. (2013), the area of trees was then multiplied by the tonnes of carbon stored in woodland and grassland, and these were added together to get the total carbon stored on site.

It was planned soil samples would be taken for analysis for more accurate carbon estimates, but due to covid-19 lab availability did not suit the timeframe and therefore this method was not carried out.

Flood mitigation

1. To create estimates of the flood water storage capacity of Ecos Nature Park, I downloaded a TIF file for the contours of the ballymena area from OpenData NI

(https://www.opendatani.gov.uk/dataset/osni-open-data-50m-dtm) and added it on top of a satellite layer on QGIS as a new layer. Satellite layers such as google maps can be found online for free. Once imported the new 'Ballymena' layer must be converted to a contour file type, which can be done by selecting the layer – Raster – Extraction – Contour and saving this as a new layer. This new layer then should be changed from singleband grey to contours in the render type tab under symbology in properties. This Should output an image similar to (Figure 1), labels can also be added in the properties menu.

2. The Ecos area was then isolated for analysis using Raster – Extraction - Clip Raster by extent – Selecting the Ballymena Layer as the input layer – Clipping extent as Use map canvas as extent. This then means only what it is on the map will be analysed (saves as a new layer). This still incorporated too much of the land to the east and west of the site, which are not part of the Ecos Nature Park, but would be included in analysis. Therefore, the same process was done 5 separate times at a closer zoom to cover the whole site (Figure 2).
3. These 5 sections were then analysed for their flood volume capacity using the Raster Surface volume tool, Processing – search volume – select Raster Surface volume tool – Input layer as 1 of the 5 sections – Base level set as your contour level you are interested in e.g. 47 – Method set as Count only below base level – Run. This will output a Results viewer, which will show the volume found below your selected contour in m^3. Repeat for all 5 layers. Then collect all 5 layers volume outputs in the results viewer separately and add them together to get the sites total volume below your set altitude. The relevant tabs described above are shown in (Figure 3).
4. Altitudes ranging from 45-47m were analysed, as the Braid River & Devenagh Burn have an average altitude of 44m (the lake, which is the main point of flooding, is also given as 44m) running through Ecos, these volumes should then be impacted by a 1metre, 2 metre and 3 metre depth floods. These can be compared with HydroMet data provided by the Department for Infrastructure (http://www.hydrometcloud.de/Rivers_Agency/sutronhome.jsp?menu=index). For example, between 20/05/2021 & 21/05/2021 (the most recent flood (Figure 4), the river depth ranged from 1-1.6m at Houstons Mill throughout the day, the nearest monitoring station to the site (Figure 5). This means water levels went from 44m (normal) to 45-45.6m (flood) in depth. Using the volumes between 44-45.6, Ecos has the capacity to store 418,572tonnes of water at a flood of this size ($1m^3$ can hold 1 tonne of water).

Figure 1. Contour lines on a satellite image

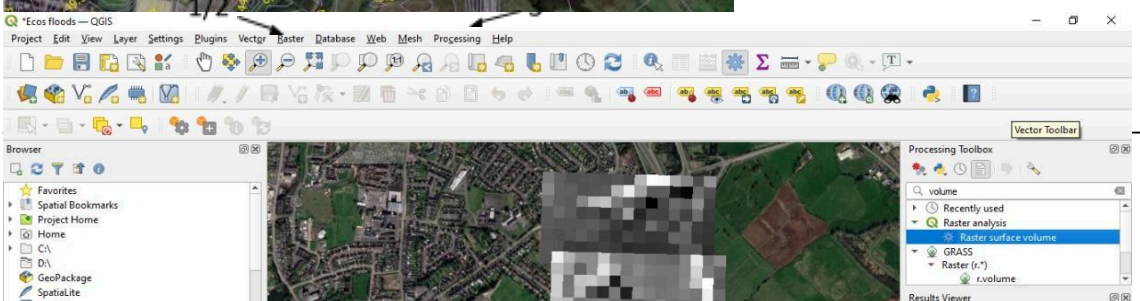

Figure 2. 5 different sections for volume analysis of Ecos.

3

Figure 3. Where to find the Raster, Processing and Results Viewer in QGIS, to be used as described in the text.

Figure 4. Flooding at Ecos Nature Park. Photo taken 21/05/2021. It is estimated the site stores 418,572tonnes of water in a flood of this size.

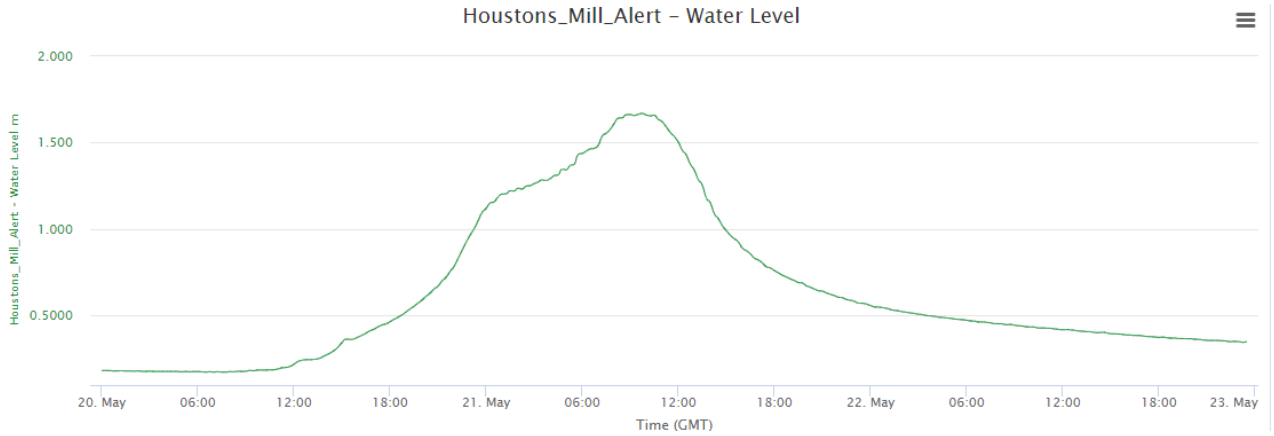

Figure 5. Graph showing the water level in metres recorded at Houstons Mill Monitoring Station from the 20th May 2021 – 23rd May 2021. The river was >1m in depth between the hours 23:15 20/05/2021 & 14:45 21/05/2021 (total 15.5hours), averaging 1.377m during this period.

Section 4 - Biodiversity at Ecos Nature Park

Floral diversity

Flora was recorded as it was found on site using iRecord. A mixture of phone applications such as PictureThis, PlantSnap, and BritishTrees were used for identification, along with the Wildflower Key by Francis Rose. Furthermore, records of other plants were noted for reporting purposes that may not be identifiable during spring and summer months, or may have previously disappeared from the site such as the Irish Lady's Tresses Orchid.

Faunal diversity

Animals were mainly recorded using camera traps which were placed throughout the park. Sightings were kept on a spreadsheet and sent to CEDaR (the NI Biological Records Centre) upon completion of the placement period. Other sightings caught during visits to the park were either added to the spreadsheet or recorded using iRecord.

Butterfly records were obtained from Butterfly Conservation NI, which contained the number of species recorded on site in the last three 3 years along with their abundances. These were collected by members of the public using Butterfly Conservation NI suggested method, available here - https://ukbms.org/sites/default/files/downloads/UKBMS%20G2%20Transect%20field%20guidance%20%20notes.pdf . This helped identify that more woodland verges and woodland connectivity may be required within the site as species associated with this are either declining or are no longer found on the site.

Small mammal surveys, mainly aimed at recording Pygmy Shrews, were conducted using similar methods to Montgomery and Dowie (1993). 10 consecutive Longworth traps were set every 10m in a line, except in the woodland site, where some were closer together due to the size of the study site. Traps were filled with seeds, at least 20 mealworms, and a small smear of peanut butter on wholemeal bread. Traps were set within an hour of sunset (9.30-10.30pm) and checked at sunrise (4.30-5am), and again at 7.30am. The relatively short time period between checking traps was to reduce likelihood of shrew mortality, as outlined by Van Boekel, (2013). This process was completed for three nights at each site.

Information regarding fish populations in the River Braid were obtained from the Braid Angling Club (Personal Communication, 2021).

Management Action areas

Invasive species action plans

Invasive species found throughout the site were obtained by surveying the area, mainly along waterways and paths, personal communication with members of the public and searching public records. Invasive species were recorded using iRecord. Future possible invaders were identified from researching invasive species found elsewhere in Northern Ireland, or which may be found in Northern Ireland in the future, such as the Greater White Toothed Shrew identified by McDevitt et al (2014).

Information on best practice for removal was collected from guidelines issued by the government (GOV.UK, 2019), and personal communications with an invasive species officer from Northern Ireland Environment Agency (NIEA).

River and water quality

River and overall water quality data for the site were obtained from Department of Agriculture, Environment and Rural Affairs/NIEA. They assess the quality of waterbodies every few years, the

most recent being 2018. The characteristics (statuses) surveyed to decide on the overall water quality of the waterbodies found in Ecos (Braid River and Devenagh Burn) can be seen in Figure 6.

River Waterbody Number	GBNI1NB030302010	GBNI1NB030302018	GBNI1NB030302021
River Waterbody Name	Braid River (Rabbit Hill)	Braid River (Ballymena)	Devenagh Burn
Macro-invertebrate Status	GOOD OR BETTER	GOOD OR BETTER	GOOD OR BETTER
Macrophyte Status	GOOD	GOOD	HIGH
Fish Status	NO DATA	NO DATA	NO DATA
Diatoms Status	GOOD	GOOD	GOOD
Final Biology Status	GOOD	GOOD	GOOD
DO% Sat Status	HIGH	HIGH	HIGH
SRP Status	GOOD	GOOD	MODERATE
pH Status	HIGH	HIGH	HIGH
Physico-chemical Status	GOOD	GOOD	MODERATE
Total Ammonia Status	HIGH	HIGH	HIGH
Other Specific Pollutants Status	HIGH	HIGH	HIGH
Final Specific Pollutant Status	HIGH	HIGH	HIGH
Morphology Status	MODERATE	MODERATE	NO DATA
Hydrology Status	HIGH	HIGH	HIGH
Hydromorphology Status	MODERATE	MODERATE	HIGH
Ecological Status	GOOD	GOOD	MODERATE
Chemical Status	HIGH	HIGH	HIGH
Overall Surface Water Status 2018	GOOD	MODERATE ECOLOGICAL POTENTIAL	MODERATE

Figure 6. The statuses and their associated ranking of three waterbodies in Ecos (Braid River Ballymena & Devenagh Burn) or near (Braid River Rabbit Hill) Ecos Nature Park (DAERA NIEA Water Info – Personal Communication, 2021).

Willow plantation

The area of willow present was measured using the same method as in Carbon Sequestration. The idea of a rewilding project and the methods behind doing so were inspired by the 2014 book Feral by George Monbiot.

Ash trees

Ash tree surveys were conducted using a phone application called Input, which allows data to be collected in the field and directly uploaded to QGIS. In order for it to work successfully, you must set up a few things first.

1. Create a Mergin account. This acts as a link between Input and QGIS.
2. Start a new project on QGIS and open the layers you want. I used a satellite image layer as it makes matching data points easier in the field.
3. Download Mergin in the QGIS Plugins and sign in.
4. Click Layer tab and add a new Geopackage layer.
5. For Database, Link to a suitable directory (save somewhere you will remember).
6. Depending on the type of data being collected, your geometry type will change. As I was recording a statutory object, I selected point.

7. In the new field section, add as many fields as necessary to record your data accordingly. I used species name as a value map with Ash *Fraxinus excelsior* as the only option to save time in the field. I also added a date option and an image. Once all fields are done, click ok.
8. To be able to use base layers such as satellite offline, open it on its own and click the eye symbol in the tab – add theme. This will now allow the theme to be viewed offline, for example in remote areas with no signal.
9. Click Mergin in the Browser tab – create new project – save in same folder fields data. This will link the QGIS survey with Mergin
10. Sign in to Mergin on the Input app on your phone and select/download the Project created for the appropriate survey.
11. You can now add data points in the field using input, which can be synced with QGIS by opening the project in QGIS and clicking Synchronise Mergin Project.

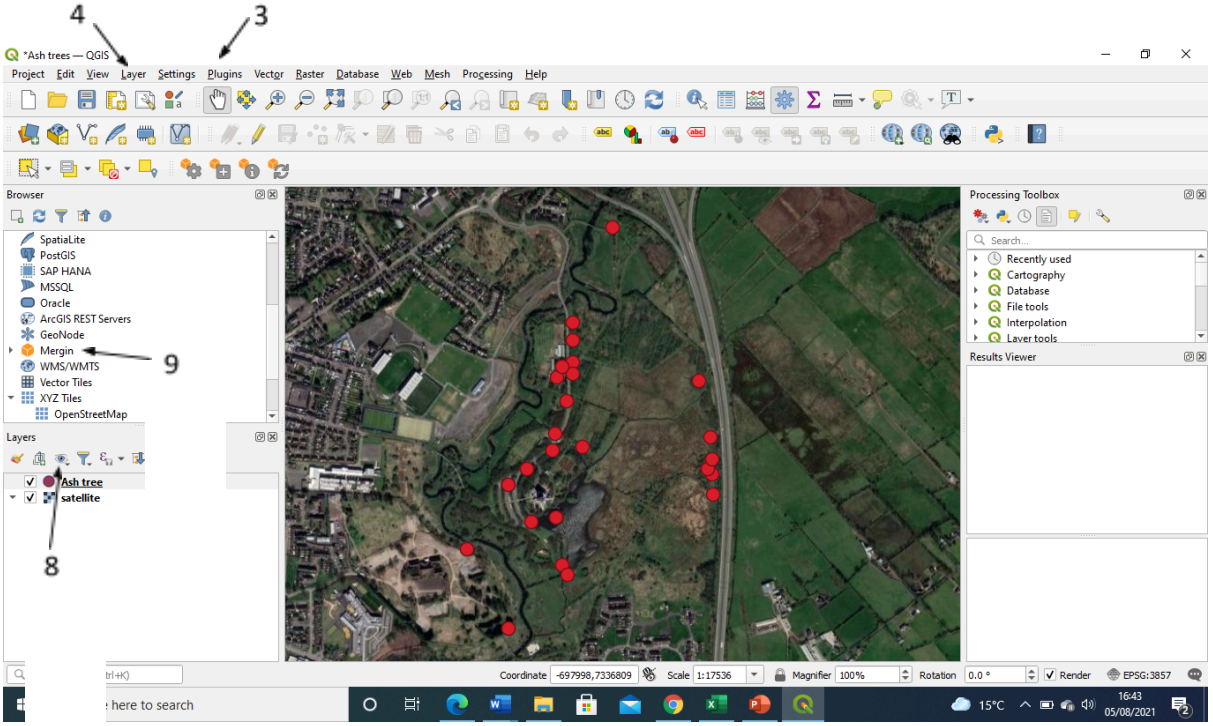

Figure 7. An example of data in QGIS collected using input and imported using Mergin.

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Discussion

Section 3 – Ecosystem services

Carbon sequestration

There are several caveats with the method used to estimate carbon stocks in Ecos Nature Park. For example, a satellite image using only canopy cover is a 2D representation of a landscape, and therefore the height of trees cannot be considered. The height of trees can greatly influence how much carbon it stores by increasing its size, as shown in Petrokofsky et al (2012). It is recommended that small footprint LiDAR is used to estimate tree height as it gives the best quality data when considering all factors, but even still it is unlikely to be completely accurate (Van Leeuwen & Nieuwenhuis, 2010).

While the method used (Hagon et al, 2013) gives a blanket figure of 123.3tonnes of Carbon per Hectare for all woodlands for example, which is clearly unlikely to be true for all woodlands depending on woodland age, species composition and abiotic factors, this number was created based off UK woodlands. There are lots of other equations and models that can be used available, however many of these are based on studies done in continents or countries with different climates, and therefore vegetation to the UK, making them unsuitable for comparison (Chave et al, 2005; Hofstad, 2005; Zianis; 2005). Data on some species such as *Fraxinus excelsior* found within Ecos Nature Park are available in Zianis (2005) paper, however it would be too time consuming given the limited time period of the study to survey all trees, as well as the likelihood of inaccuracies in measurements such as height from field surveys generating incorrect data.

Analysis of soil samples from the site would be beneficial, especially as soil contains the most carbon out of any terrestrial carbon cycle on average (Batjes & Sombroek, 1997). Due to the site's grasslands being conservatively grazed, and rarely exposed to heavy machinery, it is likely the grasslands contain more carbon than similar heavily worked agricultural fields.

All things considered, until more data is available, for example from a LiDAR survey of the area along with soil sample analysis, the method used is the most suitable to provide an estimate.

Going forward, as more accurate estimates are required by governments to show if they are meeting carbon neutral targets, more funding will have to be provided to create sufficient data for proper in-depth estimates for landscapes, similar to and much larger than Ecos Nature Park.

Flood Mitigation

There are several methods of determining water storage of a given site, often referred to as terrestrial water storage in the literature. The method used in this report can be considered a simplified land surface model (LSM), using land contours to estimate groundwater storage. Some studies use NASA's Gravity Recovery and Climate Experiment (GRACE) mission to generate terrestrial water storage of a given region, but as it uses a coarse resolution in both space and time (~400km and ~monthly), its applications to subbasin and submonthly scales

are limited (Tapley et al, 2004; Yin, Forman & Wang, 2021). Using ground-based Global Positioning System observations of surface displacement, mainly vertical displacement, and comparing these with GRACE and hydrological models has been trialled in recent years with some success (Ojha et al, 2019).

After personal communication with staff from Fieldfare Ecology who regularly do flood mitigation surveys, it was agreed given my own absence of expertise in the area, the lack of data and specialised equipment, as well as time constraints, the method used is the most suitable for a site of this size. Other methods require high levels of expertise and understanding, as well specialist equipment, often applied to research at country, sometimes even continental scales.

To improve the methodology used, more accurate LiDAR data could be processed to generate more accurate contour data, and thus floodwater storage capacity. 50km scale data was used, while 10km scale data is available for the area, although it requires significantly better computer processing power and memory storage than was available. Furthermore, a monitoring station such as Houstons Mill (~4.35km from Ecos) closer to the Ecos site would also be beneficial as there may be fluctuations in river depths between the two locations, which may result in inaccurate estimates of when the site floods. Cross referencing data between the monitoring station and actual flood dates in Ecos Nature Park was used to try compensating for this.

Section 4 – Biodiversity at the Nature Park

For this management plan, no set surveys of flora or faunal diversity were conducted other than ash tree and small mammal surveys, as it is the overall habitats that play an important role in alpha diversity (Busse et al, 2018). Therefore, identifying options for management to improve the quality of habitats found within Ecos Nature Park were more important than reporting what is currently there.

Floral diversity

DAERA has established a methodology for completing habitat and ecological surveys of all habitats across NI. This is called Rapid Condition Assessment (RCA) and gives repeatable quadrat information from surveys completed on a field-by-field bases on habitats > 0.1ha. These currently can only be obtained through request and the response was not quick enough for this method to be used during this placement period. Alternatively, Plant diversity could be surveyed throughout the site, or compared with other sites using Whittaker plots, as described in Chong & Stohlgren (2007). This could be useful in determining the service the site is providing to biodiversity by identifying the abundance and number of different species found growing there.

Faunal diversity

The use of camera traps to identify mammal and bird species on site is recommended as opposed to other methods such as footprint tunnels or capture mark recapture as they are non-invasive, can work independently and perform effectively in comparison to other methods (Balme, Hunter & Slotow, 2009). An issue with this however is that it makes generating population estimates difficult, as identifying unmarked individuals can be challenging. For example, grey squirrels were detected in our camera trap surveys, but the only population size that can be guaranteed from this is 2, as that was the most individuals caught on camera at any one time. One way to compensate for this is to space cameras further apart than the home ranges of individuals being surveyed (MacKenzie et al, 2017). This technique is difficult however when no single species is being surveyed, the site is not massively expansive, and habitats are fragmented and easily accessible by the public.

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Rewilding information guide

Rewilding at Ecos – what is it and how to do it

What is it?

Rewilding has many different definitions depending on who you ask/where you look, but to put it simply it is allowing nature to take over and choose its own course; little to no management and no particular end goal or species in mind. When allowed to do so, nature creates unique habitats best suited to the environment in which it is found. Species adapted to the region thrive, but in doing so alter the environment overtime, and succession takes place until a climax community is formed. Many large-scale rewilding projects (>1000 acres) reintroduce species that manage the land through their feeding actions i.e. boars, deer and recently in Scotland even moose.

There are different kinds of recognised rewilding on sites:

1. Passive restoration – Allows natural processes to shape the ecosystem completely unassisted by humans. Suitable to landscapes which have not been exposed to extensive degradation in previous land uses (Letcher & Chazdon, 2009).
2. Ecological restoration – In landscapes exposed to extensive deforestation, limited seed dispersal, invasive species, microclimatic extremes and/or soil degradation can result in slow or no recovery (Holl, 2017), and therefore people intervene to speed up the process through spreading seeds, removing invasive species and/or fertilising soil for example (Aronson et al, 2006).
3. Translocation/Trophic – The reintroduction of keystone species recently found in the area. These species fulfil ecological processes now missing or dysfunctional in the region (Torres et al, 2016). For example the reintroduction of beaver to parts of the UK.
4. Pleistocene – The reintroduction of megafauna, or closely related species, to a region in order to carry out ecological processes. Highly disputed as the introduction of foreign species can have unpredictable outcomes (Donlan et al, 2006).

Rewilding can help achieve goals set in the (2014) New York Declaration on Forests to reintroduce 350million hectares of woodland/forests worldwide, and in many cases requires very little work. The output or ecosystem services desired should influence the type of rewilding/restoration that occurs. Actively planting trees can speed up recovery of forests and therefore promote carbon sequestration, biodiversity, and the economic benefits to society through selection of more harvestable species (Laganiere, Da Angers & Pare, 2010; Knoke et al, 2014; Suganuma, De Assis & Durigan, 2014). Meanwhile passive restoration can result in more diverse forests, improve soil moisture and be the most cost effective (Birch et al, 2010; Holl et al, 2013; Lu et al, 2014). It is very unlikely for a site the size of Ecos Nature Park introduction of keystone or large species is feasible.

Important/protected species may be present at different stages of succession, this does not mean processes should be halted to protect them. How are other/new protected species meant to take advantage of habitats if we are always protecting old ones? As a nature park, Ecos should be natural, and introducing a rewilded area will be a step in the right direction to doing this.

How to do it at Ecos?

To create a natural landscape, unnatural aspects must be removed. For example;

- The willow plantations found in the suggested area for rewilding are a non-native species planted too closely together unlike those seen in wild settings. This needs to be removed. All the willow trees, roots and stumps included, need taken out of the ground and transported out of the site to prevent re-establishment.
- Once the site is cleared, it may need tilled to turn over soil which may have been compacted by heavy machinery. This will improve porosity, ventilation and improve establishment of vegetation.
- For the 2.1hectare grassland site to the east suggested for rewilding, it is recommended that it is passively restored. This will minimise costs and effort, and there are no consistently positive effects of active restoration over passive restoration on agricultural/grassland (Meli et al, 2017).

What to expect?

- At first grasses and flowers from neighbouring fields are likely to establish, and perhaps a few small shoots of trees will begin to show. The rewilded section may appear very similar to other parts of the park.
- As several years go by, the ecological community becomes less predictable as the environment changes. Floral and faunal abundance and diversity, and ecosystem services such as carbon storage are shown to recover in most former logged sites (similar process to removing willows) in as little as a decade (Meli et al, 2017).
- As deciduous trees grow, their decomposing foliage in the autumn changes soil pH over the years, allowing new species to establish.
- The increased shade and cover support species rarely found in grasslands such as fungi, Jays, and a few orchid species, with wild garlic appearing along forest edges. Displacement of grassland species by woodland species (Queiroz et al, 2014).
- Where standing trees begin to die the deadwood becomes a rich habitat for many invertebrates and cavity nesting birds and mammals such as woodpeckers, house martens and bats.
- Foraging small mammals and insects thrive on trees and branches that have fell and begun to decay.

While the outcomes of rewilding are unpredictable, there is an opportunity for Mid and East Antrim council to become the first organisation in Northern Ireland to champion large scale rewilding projects, and follow in the footsteps of Scotland, who plan to rewild 30% of publicly owned land by 2030 (Scottish Greens, 2021).

For more information on rewilding, examples can be found in this video - https://youtu.be/aY9QjlXaAAc

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