



Back On Our Map

Maidenhair Fern Survey, Propagation and Reintroduction
Methods

Heather Marples

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1. Introduction to BOOM

Back on Our Map (BOOM) aimed to engage communities in South Cumbria with their natural environment, by restoring the landscape and reintroducing and reinforcing locally threatened or extinct native species. National Lottery players supported the £2m project, alongside several other public, private and charitable sector organisations. Led by the University of Cumbria, BOOM worked closely in partnership with Morecambe Bay Partnership, and lead partners Cumbria Wildlife Trust, Natural England and Forestry England.

The project a network of protected areas including Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNRs) and Arnside and Silverdale Area of Outstanding Natural Beauty (AONB). It covered an area of 600km², extending along the lowlands of Morecambe Bay from Barrow-in-Furness in the west to Arnside and Silverdale in the east and Ambleside in the north (Fig 1.1).

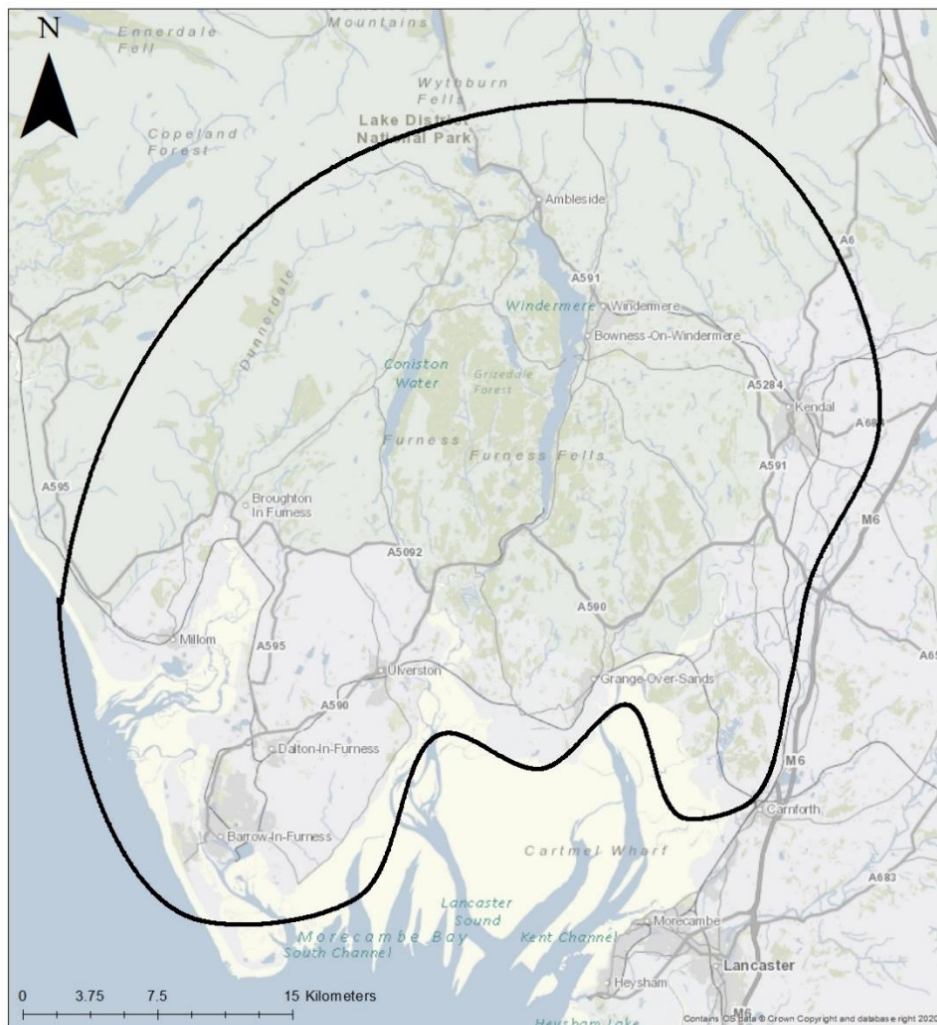


Figure 1.1: Map of the BOOM working area.

BOOM reintroduced and expanded the range of the hazel dormouse, small blue butterfly, goldilocks aster, great and oblong-leaved sundew, green-winged orchid, maidenhair fern, spiked speedwell, and aspen (table 1.1). A reinforcement of a Duke of Burgandy population was carried out on the Graythwaite Estate. The pine marten community-based feasibility study identified suitable locations for future reinforcement. For the Corncrake, public engagement sound walks raised awareness of the species.

Table 1.1: Species included in the BOOM project.

Common Names	Scientific Name	BOOM Objectives
Aspen	<i>Populus tremula</i>	Reintroduction
Corncrake	<i>Crex crex</i>	Public Engagement and Interpretation
Duke of Burgundy	<i>Hamearis lucina</i>	Reinforcement
Goldilocks Aster	<i>Galatella linosyris</i>	Reintroduction
Great Sundew	<i>Drosera anglica</i>	Reintroduction
Green-winged Orchid	<i>Anacamptis morio</i>	Reintroduction
Hazel Dormice	<i>Muscardinus avellanarius</i>	Reintroduction
Maidenhair Fern	<i>Adiantum capillus-veneris</i>	Reintroduction
Oblong-leaved Sundew	<i>Drosera intermedia</i>	Reintroduction
Pine Marten	<i>Martes martes</i>	Feasibility Study
Small Blue	<i>Cupido minimus</i>	Reintroduction
Spiked Speedwell	<i>Veronica spicata</i>	Reintroduction

Across south Cumbria, the project engaged a wide range of community groups, volunteers and members of the public. Social activities and training events helped communities get involved with the BOOM species reintroductions.

This document covers the work BOOM did on the maidenhair fern, including the propagation techniques, reintroduction methods and community engagement events.

2. Species Background

Maidenhair fern (*Adiantum capillus-veneris*) is an attractive, yet delicate fern belonging to the family Pteridaceae (Fig 2.1). It is native to various regions across the world, including North and South America, Europe, Asia, Australia and Africa (Farr *et al.*, 2017). In the UK it is typically found growing in damp and shaded crevices on limestone rocks, grykes, and cliff-faces near the sea (Stace, 2019). While maidenhair fern is common across the south of the UK, further north it is more restricted by its need for frost free periods through winter (Lansdown and Bilz, 2018).



Figure 2.1: Maidenhair Fern

As ferns do not produce flowers, the lifecycle of the maidenhair fern has additional stages which are shown in figure 2.2. This life cycle is known as alternation of generations, where the fern alternates between a diploid ($2n$) sporophyte stage and a haploid (n) gametophyte stage (Boavida and McCormick, 2010).

1: Sporophyte Stage:

The fern's life cycle begins with the mature adult plant (sporophyte), which produces spores in structures called sporangia located on the undersides of the fronds. The sporangia mature in August and unfurl to release the spores. These spores are tiny reproductive units that are adapted for dispersal by wind.

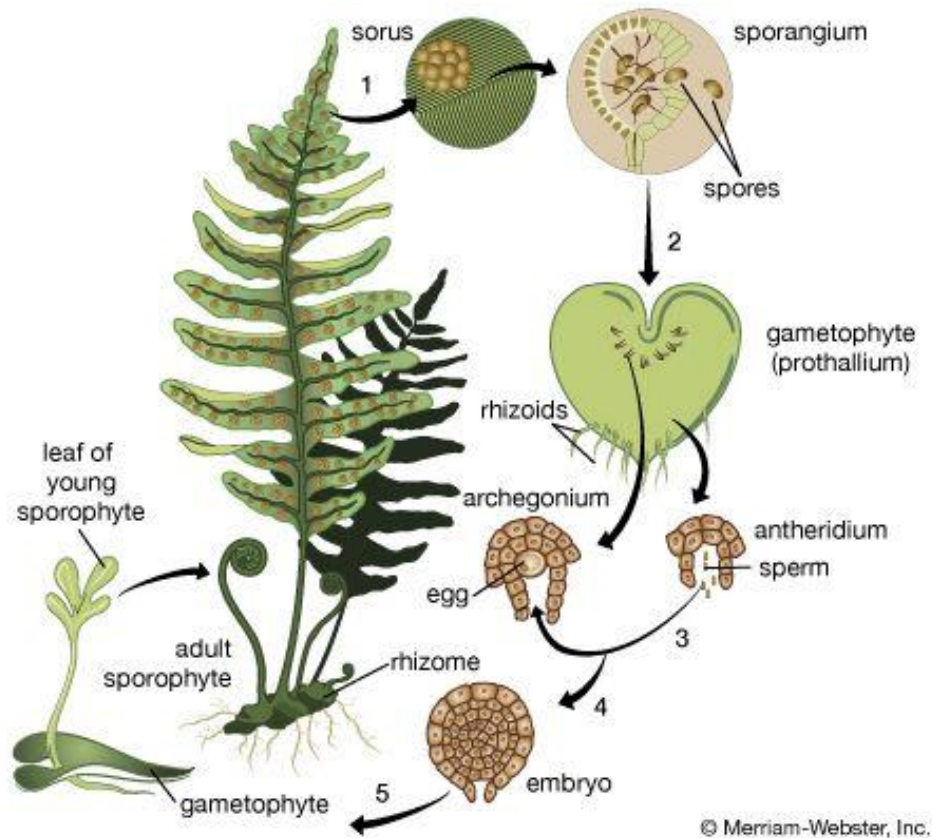


Figure 2.2: Lifecycle of a fern

2: Gametophyte Stage:

When a spore lands in a suitable environment with sufficient moisture and other favourable conditions, it germinates to form a haploid gametophyte. The gametophyte is a small, heart-shaped structure also known as a prothallus. On the underside of the prothallus, reproductive structures called antheridia (male) and archegonia (female) form. The antheridia produce sperm, while the archegonia produce eggs.

3: Fertilization:

Water is required for fertilization because the sperm produced in the antheridia need a water to reach the eggs in the archegonium. Once a water film is present on the prothallus, the sperm swim to the archegonia and fertilize the eggs. This results in the formation of a embryo.

4: Sporophyte Regeneration:

As the embryo grows into a young sporophyte it develops roots and leaves (fronds). The fronds gradually unfurl and expand, eventually becoming mature adult sporophytes capable of producing new sporangia on their undersides.

3. Reintroduction Objectives

The aim of the BOOM project was to raise awareness of and reinforce maidenhair fern populations in south Cumbria. The project staff and volunteers did this by:

- Learning propagation techniques from local volunteers.
- Collecting fern spores for propagation.
- Planting maidenhair ferns at two new reintroduction locations.
- Raising awareness of maidenhair ferns at community talks, conferences, and social media posts.
- Teaching the Arnside and Silverdale AONB how to propagate and reintroduce maidenhair ferns.

3.1. Project Locations



Figure 3.1: Donor and reintroduction sites for the maidenhair fern

Donor Sites

There were four potential donor sites for the Maidenhair Fern; Arnside Coastguard, Arnside Quarry, Meathop Sea Wall and Reake Hill. Reake Hill is located on the Holker Estate and permission to access to the estate was not granted during this project.

Arnside Coastguard and Quarry are very close to each other. The Coastguard population is growing on limestone rocks where the water leaches out of the cracks (Fig 3.2a). Many of the ferns here are in shady crevasses at chest height but the lower plants are at risk of being washed away by the sea at high tides. It is the most easily accessed population and well known to local botanists.

Around the corner, there is the Arnside Quarry population (Fig 3.2b). These are sheltered by the overhanging trees which creates shade and keeps the air around the plants more humid. This population develops its spores later than the Arnside Coastguard population despite only being 20 meters away. It is noticeable that there are more young plants starting to grow here, when compared to the Coastguard.



Figure 3.2: a) Arnside Coastguard; b) Arnside Quarry

The last site BOOM collected spores from is Meathop Sea Wall (Fig 3.3). Initially access to this site was difficult, however after liaising with the Environment Agency we gained permission to park at Ulpha Pumping station. From here it is a 20-minute walk along the saltmarsh and under the Arnside Viaduct. The cliff faces that this population grows on is noticeably different to the cliffs in Arnside. They appear drier and more exposed to higher levels of sunshine. The ferns do have their roots deep into the cliffs to be able to get moisture and are found in the shadier sections of the rocks.



Figure 3.3: a) Meathop sea wall cliffs; b) the ferns growing at Meathop sea wall.

Reintroduction Sites

Cliff faces along the coastline from Canal Foot in Ulverston to Baycliff were surveyed for tufa depositions. The cliffs appeared to be dry and therefore unsuitable for the reintroduction of maidenhair ferns.

The gunpowder works along the River Kent at Sizergh were also surveyed for suitability. The leet that used to direct water to the works has small limestone streams flowing into it which are depositing tufa. In summer these streams are small, however in winter one of the two is too fast flowing for the maidenhair fern. The other is a good reintroduction site, but permission needs to be granted from the National Trust.

The two sites that were used for the reintroduction of maidenhair fern by BOOM were Woodwell in Silverdale (Fig 3.4) and Sandside Cutting in Storth (Fig 3.5). Both sites were identified by Ann Kitchen. Ann had previously trialled a reintroduction of two plants at Woodwell, but both had been lost by unknown circumstances. The cliff face here is always wet as the water leaches through the rock into the well beneath. There are also tufa depositions which were ideal for the maidenhair ferns.



Figure 3.4: Woodwell

Sandside Cutting also has tufa depositions near the base of the cliff. Water drains from the woodland above and through the rocks here. The tunnel also provides a source of water, and it has been known that maidenhair ferns can survive on lime mortar on walls and tunnels (Lansdown and Bilz, 2018).



Figure 3.5: Sandside Cutting

3.2. Partners and Consents

The BOOM project worked closely with a variety of partners during the propagation and reintroduction of the maidenhair fern (Table 3.2).

BOOM worked closely with two local botanists who taught us how to grow the ferns and suggested some potential reintroduction locations. Ann Kitchen had been propagating Maidenhair Fern before the BOOM project started and had initially trialed a reintroduction at Woodwell, Silverdale, however the plants were removed. Working closely with Ann enabled BOOM to reintroduce the ferns to Woodwell and Sandside Cutting.

The Meathop Sea Wall was only accessible via Ulpha Pumping station and walking down along the saltmarsh, therefore EA had to grant us access permission to park at the pumping station and cross the land.

As Woodwell is a National Trust site, they were approached for consent to plant maidenhair ferns. Sandside is managed by the AONB and the local councillor at Beetham was asked for permission to plant at Sandside.

The AONB has been taught how to propagate the ferns and will be responsible for propagation of the ferns after BOOM.

Table 3.2: Summary of partners involved with the maidenhair fern reintroductions.

Partner	Person	Consent or Training Given	Role
National Trust	Craig McCoy	Consent	Own Woodwell and granted access permission to introduce maidenhair ferns.
Environment Agency		Consent	Gave permission for us to access Meathop Sea Wall by parking at the Ulpha Pumping Station
Local Volunteers	Ann Kitchen and Lynne Farrell	Training	Taught how to grow maidenhair ferns and best practice on how to plant them out
Silverdale and Arnside AONB	Lucy Barron	Propagation assistance and Consents	Consent to plant at Sandside Cutting via local councillor. Training given at the end of BOOM to continue propagation.

3.3. Donor Site Surveying

Arnside Coastguard and Arnside Quarry were assessed as donor sites in August 2021. The ferns were thriving in both locations and therefore spores were harvested from here in 2021 and again in 2022.

Meathop Sea Wall was not surveyed until September 2021, which was too late to collect spores. This was due to access issues as the best route in was unclear. After a discussion with the Environment Agency, access was granted to park at Ulpha Pumping Station and walk along the saltmarsh to the cliff face. When the site was visited the ferns were covering the shady cracks in the cliff and was deemed to be a healthy population to collect spores from. Spores were collected in August 2022.

Recommendations

- Assess the site for potential harvesting after a period of rain. This ensures the ferns are growing fully and you can assess their maximum range. If it has been dry, the ferns will die back due to lack of moisture and therefore you cannot see their full range.

3.4. Seed/Material Collection

The spores of Maidenhair ferns mature around early August; however, this can depend on weather conditions and location. The sori, located at the end of the leaf's lamina, turn from pale green to dark brown/black when they are ready to be collected. To collect the spores, it was best to collect one leaf from a variety of different fronds and plants. This ensured genetic variation and no plants were overharvested. The leaves were placed inside a paper envelope as a few of the sori were already opening to allow for the release of the spores.

The leaves were placed on white paper with the sori facing down and left overnight. This allowed the sori to open and drop the spores onto the paper (Fig 3.6).



Figure 3.6: Maidenhair fern spores

Recommendations

- Collecting from various fronds will ensure that viable spores are collected.
- Collecting fronds from varying locations across the donor site will ensure that one plant isn't overharvested and increases genetic variation when propagating.

3.5. Propagation

Stage 1: Spores

The spores were transferred into small seed trays filled with sterilised compost. The compost was sterilised by pouring boiling water over it and left to cool. The seed tray was then watered and placed into a gravel tray to retain the water, and a propagation lid put on top to create the humid conditions for optimal growing (Fig 3.7).



Figure 3.7: Maidenhair fern spores after planting

The ferns were placed on a northeast facing windowsill and left to grow. After six weeks the gametophytes began to grow and resembled a green mat. These then developed the structures to produce the egg and sperm which fertilised to produce new sporophytes. The new sporophytes have chevron shaped green leaves when they began to grow.

Stage 2: Transferred on to Tufa Rock

Once the ferns were approximately over 2cm tall (Fig 3.8a), they were transferred onto tufa rock. The tufa rock was sourced from online aquarium suppliers as getting tufa from the natural environment was considered too damaging.

The ferns had extremely good root systems and they were intertwined with each other. This mean that several plants were placed onto each small section of tufa (5x5cm). The tufa needed to be cut using a hacksaw into small sections to be able to fit into the plant pots with compost (Fig 3.8b).



Figure 3.8: a) ferns ready for transferring onto tufa rock; b) ferns potted onto tufa rock.

The plants were then placed back onto the north facing windowsill and covered with a propagation lid to retain humidity. They remained here until they were ready to be planted in April and September 2023.

Recommendations

- When sowing the spores, keep the tray inside to germinate on a windowsill. The spores didn't germinate when left outside in 2021 and were kept inside in 2022.
- If the gametophytes are growing in cramped conditions, they can be separated into sections and transferred into additional propagation trays.
- Transfer a few plants onto one section of tufa to reduce damage to the root system.

3.6. Reintroduction Methods

Surveying

The reintroduction locations were identified by Ann Kitchen. A follow up visit was done by BOOM to assess the site for suitability and to determine the number of plants that could be introduced. Both sites where maidenhair ferns were planted had water seeping from the rock face, which retained moisture in the area and cracks in the cliff face as planting sites for the ferns. The sites had liverworts growing on the damper surfaces, which suggested that they were damp enough year-round to allow these plants to become established.

Planting

The planting of maidenhair ferns was done in April and September 2023, when there was minimal chance of frost or extreme heat (Table 3.3). In total 48 ferns have been planted by BOOM. Each plant pot, with the one piece of tufa rock, was considered to be one plant, despite potentially being several plants on one section of tufa (see section 3.5).

Table 3.3: Planting locations, dates, and numbers of maidenhair ferns.

Location	Date Planted	Number Planted	Grid Reference
Woodwell	27/04/2023	26	SD 4649 7439
Sandside Cutting	05/09/2023	22	SD 4741 8037

To plant the fern, a large enough crack in the cliff face was identified. The plant, tufa rock and compost were then removed from the plant pot and slotted into the crack. Additional compost was used to nestle the plant into the crevice if required to ensure the crack was filled (Fig 3.9). If the crack was large enough, more ferns could be planted into the same place. In one location at Woodwell, four ferns were planted into one crack. Once planted, the ferns can be given a spray of water using a spray bottle.



Figure 3.9: Maidenhair ferns planted in the cracks of a cliff face at Sandside Cutting and Woodwell.

Recommendations

- Plant at high and low locations to cover as much cliff as possible.

3.7. Monitoring and Results

Monitoring

Monitoring on the donor and reintroduction sites was carried out throughout BOOM. The donor sites were monitored to see if harvesting the fronds for propagation damaged the population. The populations at all three sites are still thriving despite the harvesting.

At the reintroduction sites, monitoring was carried out following planting to assess survival rate. A local volunteer visited Woodwell every other day during the weeks after they were planted to give them a water and reported back if any had gone missing. A couple of plants did get removed, potentially by a vole.

Both sites had regular visits from the BOOM team to check on the ferns and to visually assess their growth.

Spores

In early August 2023, the reintroduced ferns at Woodwell were checked for sori production. It was found that they were in the early stages of producing the sori which contain the spores (Fig 3.10). This was a significant as it presents the opportunity that the maidenhair ferns will become a self-sustaining population. It is recommended that both reintroduction sites are surveyed in 2024 and 2025 to see if there is any new growth since the end of the BOOM project.



Figure 3.10: Sori on the reintroduced spores

Recommendations

- Have a local volunteer involved who can check on the ferns regularly and report back.
- Continue monitoring the ferns for spore production and gametophyte development. This will determine how successful the initial reintroduction has been.

4. Community Engagement Objectives

4.1. Public Engagement

BOOM has delivered various engagement activities throughout the project to engage the public with maidenhair ferns (Table 4.1).

In lockdown in 2021 Steven Lipscombe gave an online presentation for Morecambe Bay Partnership’s “Sunset Series”. Here he spoke about the plans for the Maidenhair Fern, oblong-leaved and great sundews and green-winged orchids to various members of the public. A benefit of digital online events is the ability to engage larger audiences with this species (over 100 people have viewed the online talk about maidenhair ferns) without putting pressure on their habitat along the coast.

We took Mind in Furness to visit the Woodwell ferns in May 2023 to educate them about the species and show them where we had reintroduced them.

As Maidenhair ferns are small, they were ideal to take to family nature discover days or have on show as part of an event. This meant that BOOM was able to showcase the ferns and educate members of the public about the species.

Table 4.1: Summary of community engagement for maidenhair ferns

Activity	Date	Number of Attendees
Online Talk – Orchids, Sundews and Ferns	25/02/2021	150
Maidenhair Fern Propagation	26/08/2021 – 27/09/2023	3
Maidenhair Fern Planting - Woodwell	27/04/2023	4
Maidenhair Fern Visit – Mind in Furness	15/05/2023	8
Maidenhair Fern Planting – Sandside Cutting	05/09/2023	2
Maidenhair Fern Propagation Training AONB	27/09/2023	3
Total		170

Recommendations

- Online talks can reach a wider audience to educate them about the importance of Maidenhair Ferns.
- The ferns are small and therefore easy to transport to events to educate a wider range of people in the community.

4.2. Propagation and Planting

Volunteers have played a crucial role in both the propagation and reintroduction of the ferns. In the first year of the spores being collected, the ones held by the BOOM project did not germinate. However, those collected by Ann Kitchen did germinate and she donated hers to the project. These were then grown on by the BOOM team and were planted out by volunteers

in April 2023. Ann continued to propagate ferns throughout the project and some these were planted at Woodwell and Sandside alongside the ones propagated by the BOOM team.

A BOOM placement student, Samantha Graves (University of Cumbria, BSc Animal Science), propagated ferns for two years, which helped increase the capacity of fern propagation.

During the planting session at Woodwell, four volunteers came to help plant the ferns and one local volunteer came and watered them every other day during the following weeks.

Recommendations

- Getting volunteers involved in the propagation results in additional capacity to grow the ferns.
- Having a local volunteer who is happy to water them after planting is ideal and will have increased the survival of those planted.

5. Conclusion

The BOOM project worked with a wide variety of organisations and volunteers to successfully propagate and reintroduce the maidenhair fern. A total of 48 plants have been reintroduced to two new locations in south Cumbria and north Lancashire. The ferns planted in April 2023 have already begun to produce spores and therefore should continue to reproduce in their new habitat in future years.

At least 170 people have been educated about maidenhair ferns, either through online talks, nature discovery events or by being involved with propagation.

Future work on maidenhair ferns should involve continued monitoring of the reintroduction and donor sites. Identification of new suitable reintroduction sites is recommended for future reintroductions of the remaining ferns that were not large enough to be planted out during BOOM. At the end of BOOM, it is anticipated that propagation will be continued by Ann Kitchen and Arnside and Silverdale AONB.

6. References

BOAVIDA, L.C. and MCCORMICK, S.,(2010). *Gametophyte and Sporophyte*.
10.1002/9780470015902.a0002038.pub2.

FARR, G., JONES, P.S., PEARCE, H. and WOODMAN, J., (2017). *Adiantum capillus-veneris* (Maidenhair Fern) along the Vale of Glamorgan Coastline, South Wales, UK: a comparison of surveys over 30 years. *BSBI News 135*, April 2017, pgs 29-33

LANSDOWN, R.V. & BILZ, M., 2018. *Adiantum capillus-veneris*. *The IUCN Red List of Threatened Species 2018*: e.T164082A67770327. <https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T164082A67770327.en>. Accessed on 15 August 2023. STACE, C., 2019. *New Flora of the British Isles*, Fourth Edition, p31.

Appendices

Appendix 1: BOOM Project Aims

Maidenhair Fern									
Planting out maidenhair fern in suitable sites	Arnsdale Silverdale Communities, Children young people and students	People will have learnt about maidenhair fern.	Heritage will be in better condition. People will have volunteered time.	CHO time to check receptor sites are suitable and obtain permission from landowner and organisations involved. Picking up ferns from growers – 3 days.	Total: £ 224 Trowels 20 @ £4 each = £80 Volunteer transport = 6 days per year, 12 total (@ £0.30 per mile, 40 miles per day) = £144	May/June 2021, 2022	10 plants introduced to new sites Volunteers: 3 days	Count number of plants introduced to new, suitable sites	
Survey to establish suitable habitat for maidenhair fern by volunteers after training and support from CHO.	Arnsdale Silverdale Communities, Children young people and students.	People will have learnt GIS skills to ID likely area – involving less mobile people. People will have learnt about the ecology of the species	People will have Volunteered time. Heritage will be identified/recorded	CHO 5 days CHO to produce maps and survey forms CHO to lead surveys or at least train volunteers. EO to source volunteers and organise survey days	Total: £183 Clipboards 3 x £30 = £90 Water proof notebooks 3 x £7 = £21 Volunteer transport = 6 days per year (@ £0.30 per mile, 40 miles per day) = £72	March 2020	Areas in project area with limestone adjacent to coast surveyed for suitable receptor sites Volunteers: 3 days	All suitable areas surveyed where access permissions allow	
Monitoring maidenhair fern introduction by volunteers	Arnsdale Silverdale Communities	Involved in a re-introduction project. Increase distribution of maidenhair fern.	Heritage will be identified/recorded. People have volunteered time.	Ro to provide site locations and arrange access = 1 day.	Clipboards (already in budget digital camera, field forms). Volunteer transport = £24	July/Aug 2022	All introduction sites checked for mortality of fern plants Volunteers: 2 days	Record of success	