7. Vegetation Monitoring

7.1 Background

The New Forest supports a wide range of wetland habitats which are key features of the New Forest SAC/SSSI. Several of these habitat types are found in the riparian zone, notably:

- Mires
- Wet & dry heath
- Wet grassland (lawns)
- Riverine Woodland
- Bog Woodland
- Ponds

Straightening and canalisation of the river courses in the past and reduction of seasonal flooding has had a number of negative impacts which have resulted in habitat degradation within New Forest wetland habitats as described below.

- Peat development in New Forest mires is very slow, typically accumulating at a rate of 20cm per 1000 years giving rise to shallow peat rarely in excess of 2 metres deep (Clarke 1988). This makes mires particularly vulnerable to damage from artificial drainage because the drainage and associated headward erosion causes lateral peat slumping as the water table drops and causes further drying of the upper soil profile. The drying effect can be seen in changes to the vegetation community with species indicative of drier conditions such as pine and birch, or species indicative of lower water levels and faster flows such as Purple Moor Grass and Bog myrtle becoming more abundant. Scrub invasion can lead to secondary management issues such as loss of grazing. Mires act like giant sponges and provide the main sources of water to headwaters. Thus, the drying of mires means that a stream's source of water is reduced which can be significant during extended dry periods, particularly in the summer months resulting in lower flows.

- Canalisation of rivers has resulted in reduced flooding of the floodplain thus isolating stands of riverine woodland, bog woodland and wet grassland and reducing the hydraulic connectivity which is vital to maintaining the condition of these habitats.

- Prior to enclosure, riverine and bog woodland would have bordered the streams in a rich mosaic of wooded and non-wooded habitats. However, the effects of drainage, enclosure and subsequent forestry activities have altered the true species diversity of the habitats by the planting of non-native forestry crops, often up to the banks of the streams. Furthermore, spoil banks from drainage works have frequently been re-colonised by scrub. Loss of grazing within the Inclosures has also had an impact on the species diversity.

- Troublesome species such as Rhododendron and American Strawberry *(Gaultheria shallon)*, can detract from the natural species diversity of woodland habitats and take up space that could be used for native species. In addition, other alien wetland loving species, notably Himalayan Balsam *(Impatiens glandulifera)*, Parrots Feather *(Myriophyllum aquaticum)* and Australian Swamp Stonecrop *(Crassula helmsii)* and North American Skunk Cabbage (*Lysichiton americanus)* are invading streamsides

and ponds. These species can be extremely invasive, highly damaging to native flora and fauna and are difficult to control or eradicate.

In order to reverse this trend, a key element of the HLS project has been wetland restoration work is to restore the original function of the floodplain and the restoration of the hydraulic processes as well as the removal of exotics from the flood plain.

7.2 Restoration Objective

To restore sites/habitats to achieve favourable condition status through the restoration of natural hydraulic processes to develop rich and diverse habitat communities, increasing the percentage cover of damp and wet loving species typically found in New Forest wetland plant communities.

7.3 HLS Monitoring Sites

A great deal of work has been done on the removal of exotics by Forestry England as part of the HLS terrestrial programme (conifers & rhododendron) and on the control/removal of non-native wetland invasive species by the New Forest Non-Native Project. The results of these activities are not addressed in this review but must be acknowledged as making a significant contribution to the restoration of New Forest habitats.

Six sites at Ferny Croft, Millersford, Holmhill, Parkhill Lawn, The Noads and Wootton have been monitored as part of the HLS monitoring programme to try and record:

- Riparian vegetation changes as a result of restoration
- Habitat recovery post restoration

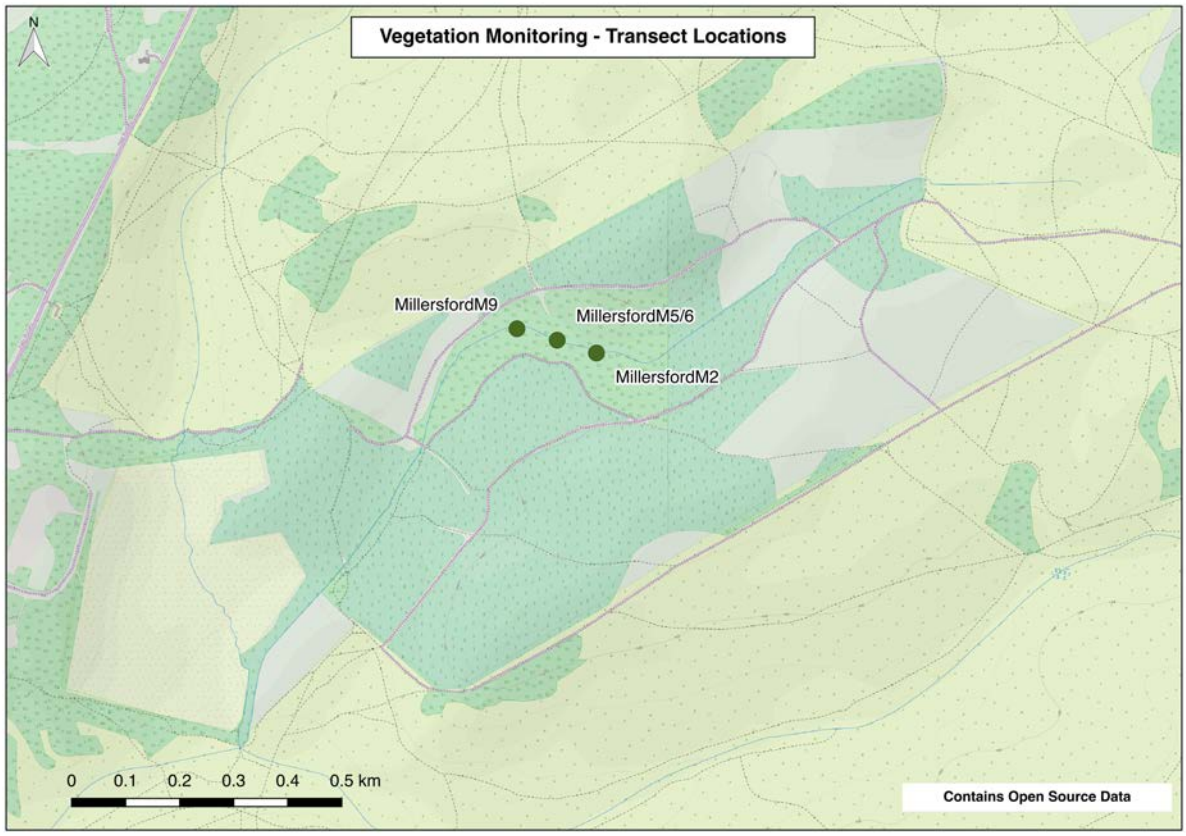
Table 7-1 & Figure 7.1 show the location of these sites.

Table 7-1: Vegetation Monitoring Sites

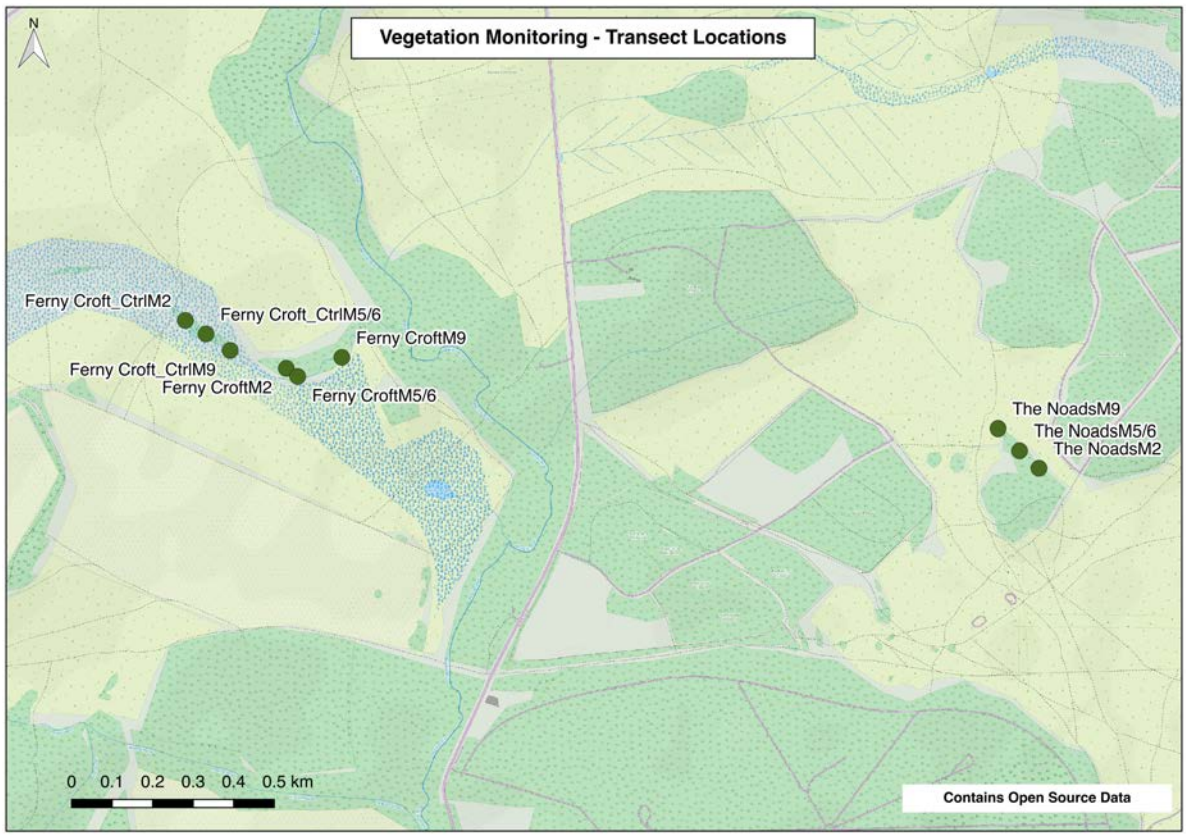
Site Name	Habitat Type	Pre-Restoration Survey	Post-Restoration Survey
Ferny Croft (upstream control)	Mire	No	Yes (2019)
Ferny Croft	Mire	Partial (2017)	Yes (2018,2019)
Millersford	Mire	Yes (2017)	No (not restored)
Holmhill	Riverine woodland	Yes (2017)	No (not restored)
The Noads	Mire	Yes (2017)	Yes (2018)
Wootton (Sections B-C, D-E,E-F)	Riverine woodland	No	Yes (2018,2019)
Wootton (Control)	Riverine woodland	No	Yes (2019)
Parkhill Lawn		Yes (2017)	Yes (2018)

Figure 7.1: Location of Vegetation monitoring sites

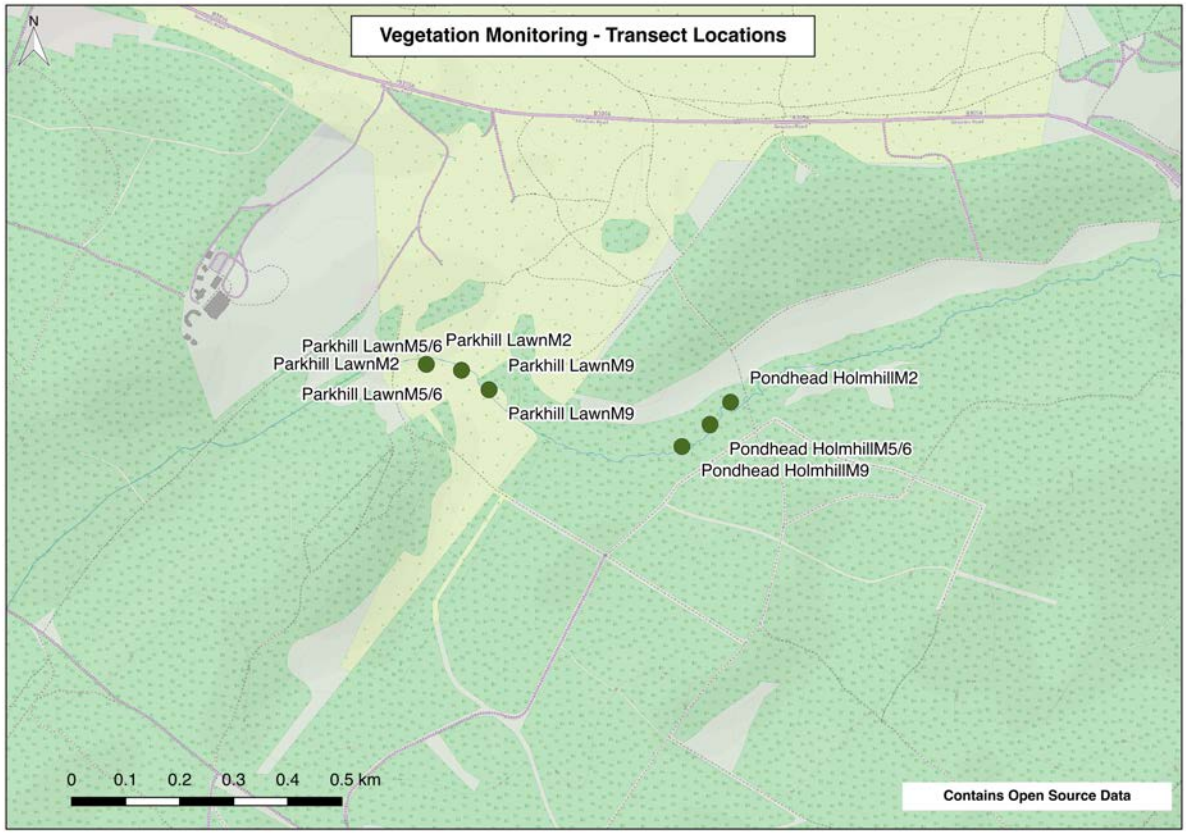
a) Millersford



b) Ferny Croft & The Noads



c) Parkhill Lawn & Pondhead



d) Wootton

7.4 Methodology

Vegetation transect surveys have been carried out by Forestry England (2017), Footprint Ecology (2018) and Amanda Marler (2019) using a Before-After-Control-Impact (BACI) approach devised by Forestry England. The BACI design and its modifications are frequently used to assess the success of restoration efforts or other management experiments. BACI design allows for comparisons in similar systems over time to determine the rate of change in relation to the management activity, for example, to assess the success of a wetland hydrologic restoration.

The methodology used for the vegetation monitoring involves surveying sites pre and post restoration using a series of transects placed at intervals along the stream section to capture a control upstream, impact locations corresponding to Morph sections within restored reaches (refer to section 2) where work was carried out and a downstream control. Transects comprised 8 quadrats – 4 on the left bank and 4 on the right bank placed at:

Quadrat 1,5 - Bank face/channel margin (2x2m or 0.5X8m)
Quadrat 2,6 - Bank top (5mx5m)
Quadrat 3,7 - Floodplain 1 (5m x 5m)
Quadrat 4,8 - Floodplain 2 (5m x 5m)

Spreadsheets to capture the percentages of specific species and species groups were produced to record the result of each transect. A series of photographs taken at each quadrat location has helped to replicate samples and compare visual difference (refer to Figures 7.2 to 7.8)

Key parameters and species recorded for each quadrat include the percentage cover of:

- water surface
- bare ground
- litter
- heath spp
- herbs
- rush
- gorse
- bracken
- bramble
- sphagnum
- bryopytes
- bog myrtle
- purple moor grass
- ivy
- ferns
- fungi
- lichens
- tree canopy
- seedling
- saplings
- scrub
- negative indicators (Ragwort, Spear and Creeping Thistle, Nettle, Broad-leaved Dock and Curled Dock)

7.5 Analysis & Discussion of Results

The results for those sites that have before and after data have been evaluated to determine the average percentage of each parameter/species group across the transects for sites which have pre-restoration and post-restoration data, notably Ferny Croft, Wootton, The Noads and Parkhill Lawn. From the results (refer to Figures 7.2 to 7.8) it is possible to see both subtle and marked changes in the vegetation community as well as rates of recovery and recolonization of bare ground. Results have also been collated/analysed for channel, bank top, floodplain 1 and 2 quadrats. These results are listed in Appendix but the transect averages do tend to pick the localised vegetation changes reflected in the individual quadrats.

The photo sequences recorded by Footprint Ecology (2017) and Amanda Marler (2018) are also included after the graphs of each transect location where available to give a visual representation of the survey site and they also allow visual changes to be observed.

Vegetation communities respond readily to even subtle changes in soils moisture and micro-topography and percentage cover can vary considerably within a small area. Unless quadrats are placed in exactly the same position at each survey, there are likely to be survey errors but nevertheless changes in percentage cover are likely to be indicative of overall changes/trends.

Comparison of the graphs and photographs do show some key trends and observations in response of the vegetation community and these are summarised in Table 7-2 below.

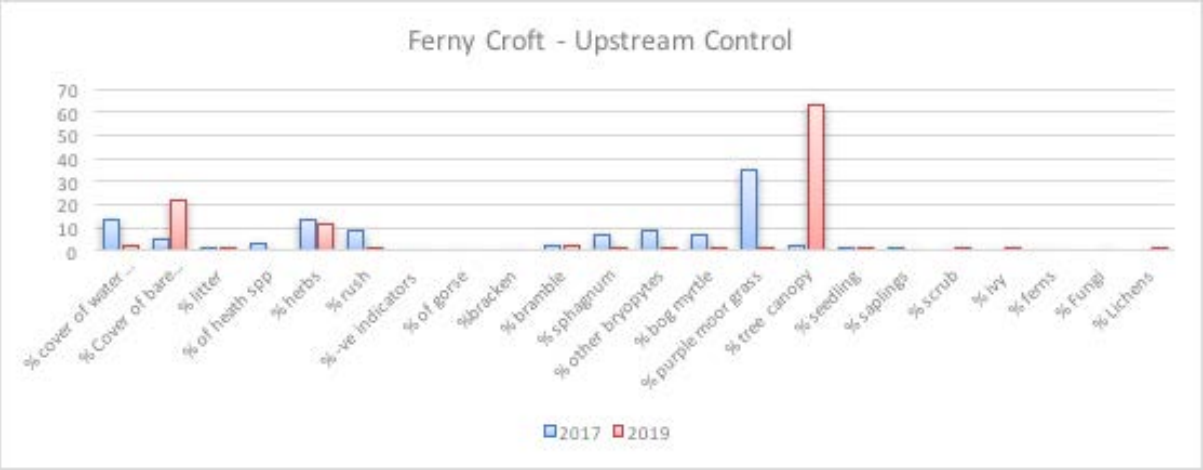
Table 7-2: Observed Trends in Transect Vegetation Parameters

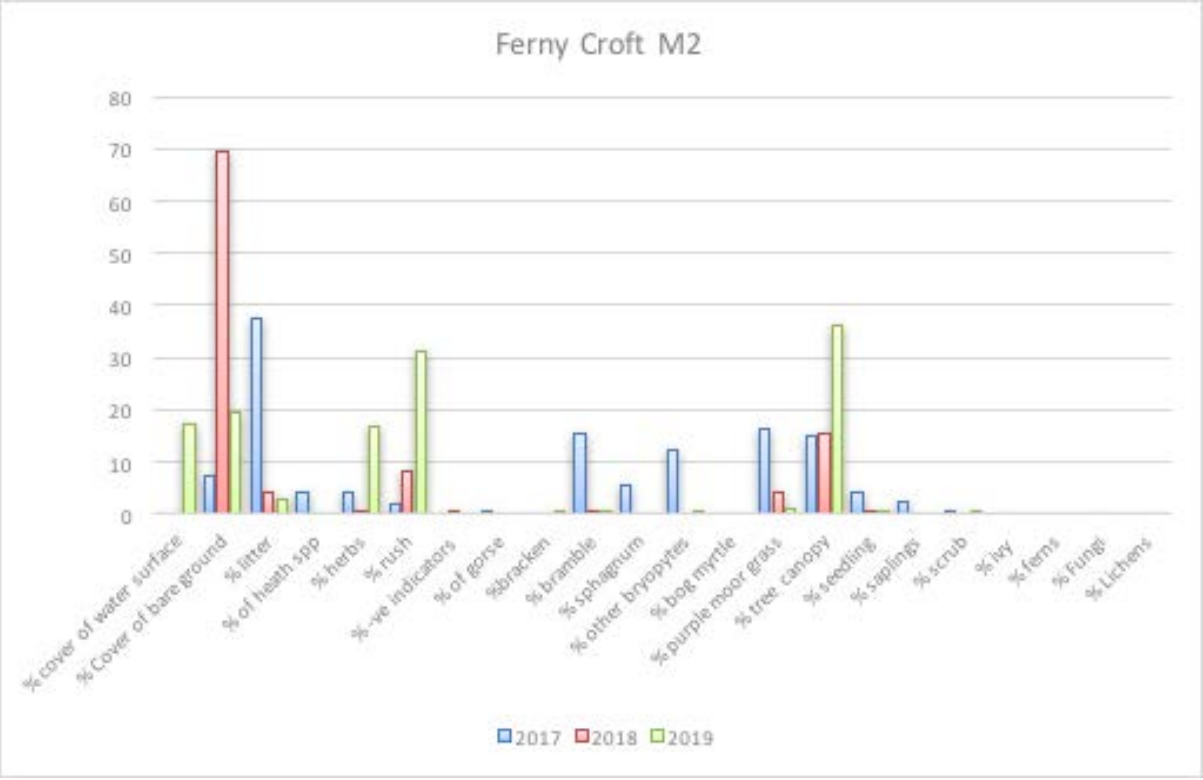
Vegetation Parameter	**Observation/trend**
Cover of water surface	At some sites the percentage of water surface recorded within the transects has increased post-restoration, for example at Ferny Croft (M2, M5/6, downstream control) and Wootton (M2, M5/6 – 2018). The percentage of surface water is mainly recorded at the bank face/channel margin and can be related to the water levels on the day of survey. Results vary from year to year between the same quadrat location and are not necessarily related to pre-post restoration status.
Cover of bare ground	Bare ground significant increases immediately post-restoration but recovers quickly and within 2-years vegetation cover appear to be close to pre-restoration levels at most sites.
Litter	The percentage cover of litter has significantly declined at several sites. This seems to primarily correspond to a reduction in tree cover but could also be a result of floodwater washing way leaves and debris. A reduction in litter is often beneficial for low growing plants, typical of grazed New Forest swards as litter can have a smothering affect.
Heath species	Variable, small responses at sites where heath species are present. At a few sites where they are recorded cover seems to be declining post restoration. Further monitoring and more

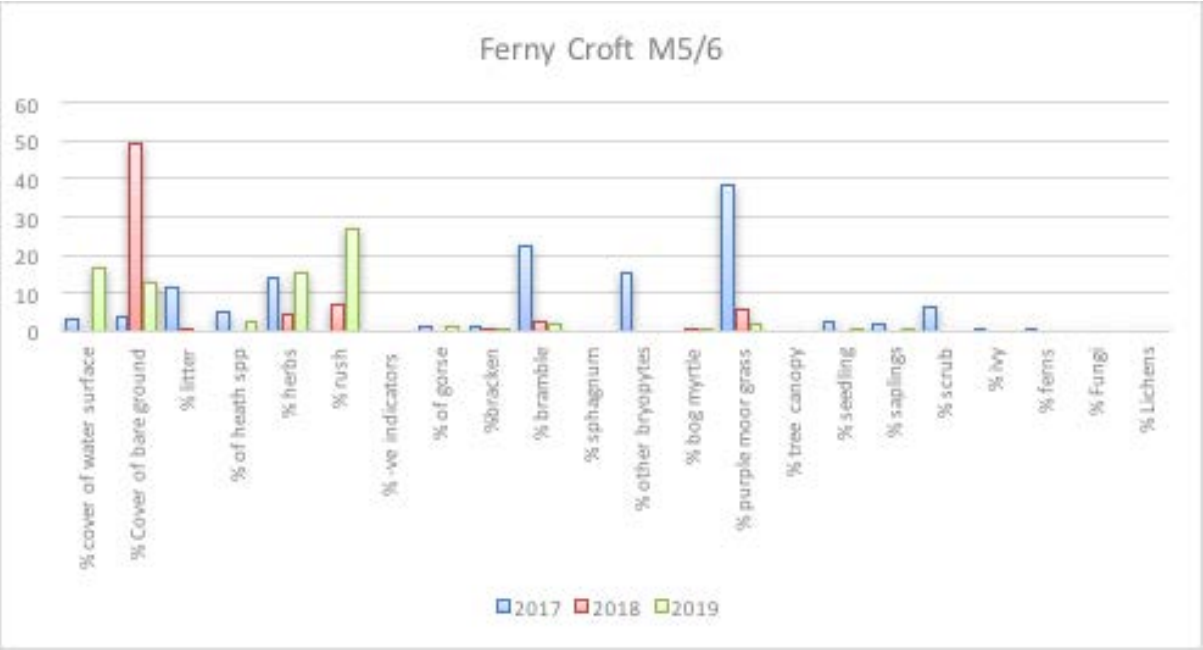
Vegetation Parameter	Observation/trend
	detailed evaluation of species specific indicator species will be required to see whether any significant trend emerges.
Herbs	Where sites have been restored for at least two years, e.g Wootton and Ferny Croft, the herb composition seems to be increasing and for some transects is surpassing pre-restoration percentage herb cover. For other sites where recovery time has been shorter, such as Parkhill Lawn and The Nodes, herb cover has not yet reached pre-restoration levels.
Rush	Rush is generally an indicator of damp soils. Rush communities are significantly increasing in cover at restored sites for example Ferny Croft M2, M5/6, M9, DS and Parkhill M5/6. Sites where rush cover has diminished still have high percentages of bare ground so may still be in the process of re-colonising (e.g Parkhill M2, The Noads M2).
Gorse	Low percentage cover or absent at most sites. Although small increases or decreases between sites where gorse is present no key trend is standing out. At sites where gorse is present it may well increase post restoration as the site recovers from pre-restoration vegetation clearance as gorse is a robust species that recovers well from cutting.
Bracken	Variable response. Generally absent or small percentage cover at most sites. However, where it is present it appears to be increasing very slightly e.g. at Wootton, Ferny Croft M9 & downstream control possibly as vegetation recovers whereas at other sites e.g. Parkhill Lawn M5/6 it has decreased significantly. Further monitoring of bracken would be interesting as the theory is bracken cover should decrease as a site gets wetter.
Bramble	Bramble appears to be decreasing within the site transects for restored sites.
Spaghnum	Decreases in sphagnum can be observed in in year after restoration works, probably as a result of ground disturbance at the Noads and Parkhill Lawn. At other sites there are noticeable increases within 2 years, for example at Wootton M5/6-S2-S3, M9-S3. Damper conditions should suit spaghnum.
Bryophytes	Bryophytes are showing a decrease across all sites post restoration. It is possible that they are sensitive to disturbance and are slower to re-colonise or it may be due to vegetation clearance and shade factors. This aspect requires further monitoring/investigation. As many bryophytes prefer damp, moist condition they would be expected to respond positively to moister conditions.
Bog Myrtle	Bog myrtle tends to have a low percentage cover across most transects. No significant trends stand out but there are very slight decreases at some sites eg Wootton M9-S3, The Noads M2-M5/6

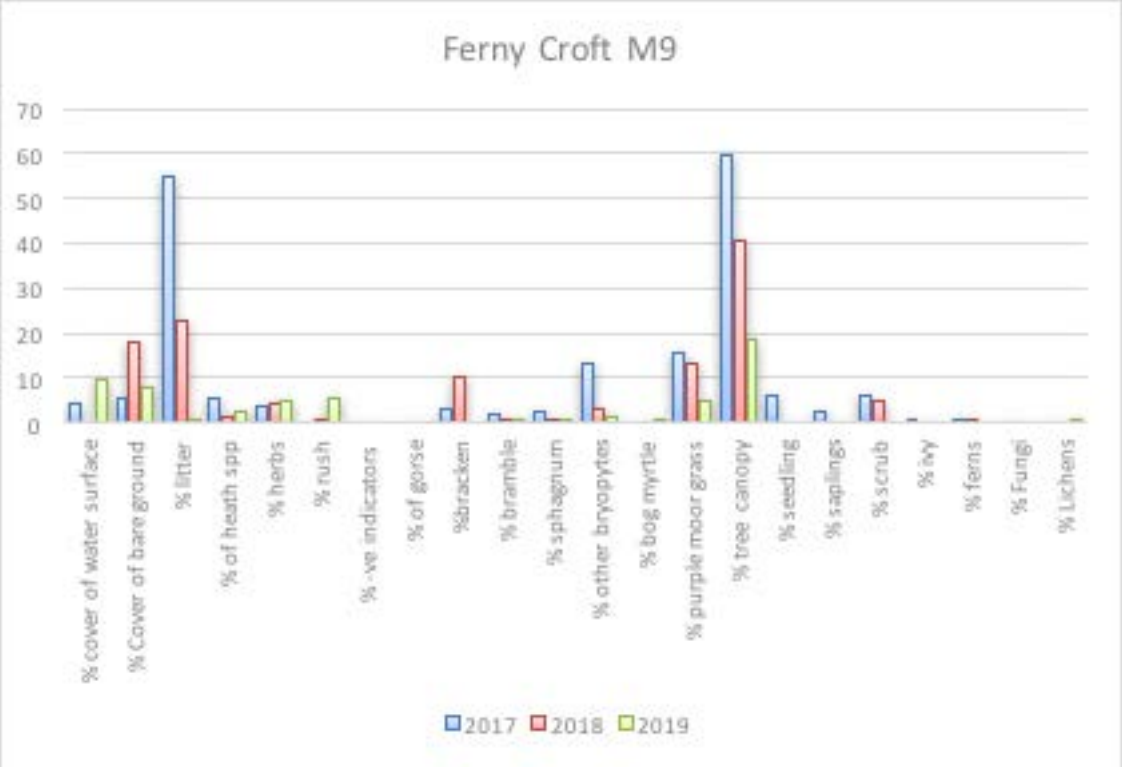
Vegetation Parameter	Observation/trend
Purple Moor Grass	Significant decrease in purple moor grass at Ferny Croft across all transect sites (except downstream control). There is an increase at Parkhill Lawn, The Noads and Wootton. Purple moor grass favours damp, moist soils so it is a positive indicator that it is increasing at several sites but somewhat surprising that it is decreasing at Ferny Croft and this may worth investigating/monitoring further.
Tree Canopy	Changes in the tree canopy are closely related to the amount of vegetation clearance that was carried out as a result of the works. Changes in tree canopy and resulting shade may be influencing the bryophyte community as the trend patterns seem to mirror canopy change e.g. at Wootton and Ferny Croft
Tree Seedlings	No significant changes except at The Noads M5/6 where there has been a similar decrease in tree cover so one would expect recruitment to decrease in accordance.
Tree Saplings	Sapling cover is generally very low <5% at all sites which is fairly typical of the grazed, Open Forest even in wooded habitat. There is potentially a very slight decrease in saplings at restored sites with open habitats (e.g Parkhill Lawn, The Noads) and a slight decrease in others within woodland habitat settings eg, Wootton M9-S3. This pattern would typically be expected but monitoring over future years may show more defined trends.
Scrub	Scrub has significantly decreased at some locations for example The Noads and increased slightly at others e.g. Wootton
Ivy	Cover of ivy is generally very low across all sites although it is present in transects at wooded sites. Where there are decreases this is likely due to removal of tree cover as part of the works.
Ferns	Ferns are generally absent in open sites/transect but are recorded in low percentages in wooded sites. Where they are present cover is starting to increased slightly for example at Wootton (M2-S3, M5/6 – S3), The Noads (M5/6), Parkhill Lawn (M9)
Funghi	Negligible across all sites but due to the time of year for transect surveys it is likely that most funghi species have not emerged.
Lichens	Negligible lichens cover recorded
Negative indicators	Negligible – very low percentage cover or absent over the sites.

Figure 7.2: Ferny Croft Transect Vegetation Cover






Ferny Croft M5/6
60
50
40
30
20
10
0
% cover of water surface
% Cover of bare ground
% litter
% of heath spp
% herbs
% rush
% -ve indicators
% of gorse
%bracken
% bramble
% sphagnum
% other bryopytes
% bog myrtle
% purple moor grass
% tree canopy
% seedling
% saplings
% scrub
% ivy
% ferns
% Fungi
% Lichens
2017
2018
2019


Ferny Croft M9
70
60
50
40
30
20
10
0
% cover of water surface
% Cover of bare ground
% litter
% of heath spp
% herbs
% rush
% -ve indicators
% of gorse
%bracken
% bramble
% sphagnum
% other bryopytes
% bog myrtle
% purple moor grass
% tree canopy
% seedling
% saplings
% scrub
% ivy
% ferns
% Fungi
% Lichens
2017
2018
2019

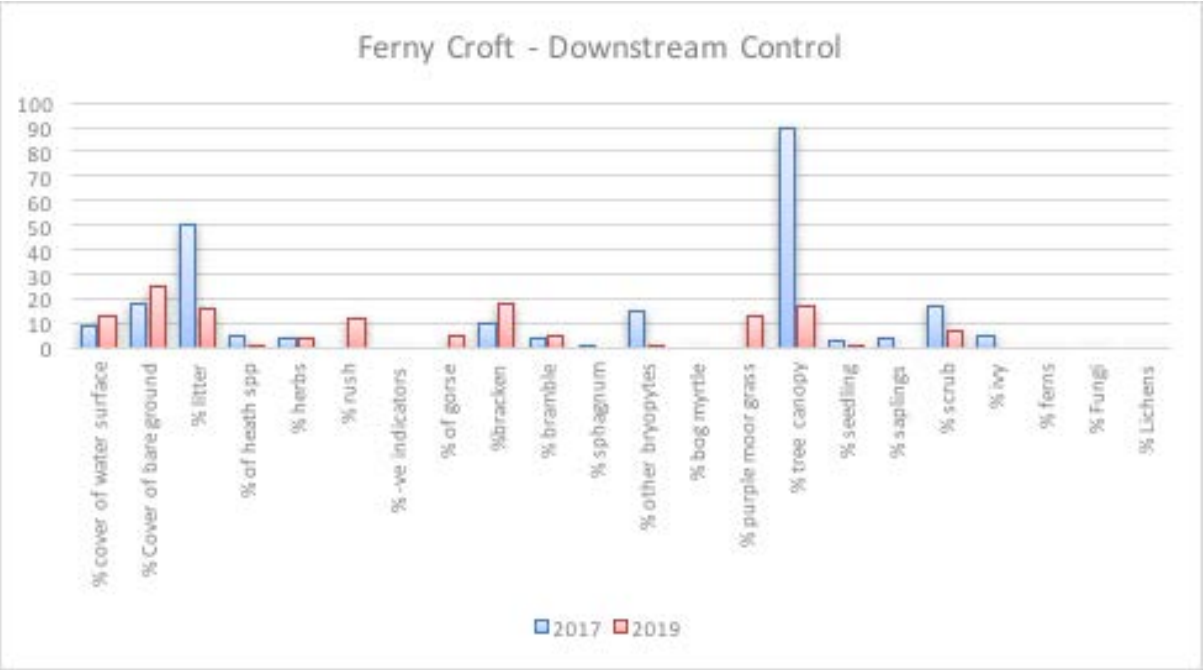

Ferny Croft - Downstream Control
100
90
80
70
60
50
40
30
20
10
0
% cover of water surface
% Cover of bare ground
% litter
% of heath spp
% herbs
% rush
% -ve indicators
% of gorse
%bracken
% bramble
% sphagnum
% other bryopytes
% bog myrtle
% purple moor grass
% tree canopy
% seedling
% saplings
% scrub
% ivy
% ferns
% Fungi
% Lichens
2017
2019

Figure 7.3: Photographic Record of Ferny Croft Vegetation Transects

Ferny Crofts July 2018 (restoration completed) All images facing downstream except for view of transect which is perpendicular to channel.

Left bank					
	View of transect	M2 Q1	M2 Q2	M2 Q3	M2 Q4
Right bank					
	View of transect	M2 Q1	M2 Q2	M2 Q3	M2 Q4

Source: Footprint Ecology

FERNY CROFT CONTROL – M2 **Grid ref: SU3775405532** **Survey Date: 28.08.19**

Right bank to left bank

Left bank to right bank

Downstream

Upstream

Q1/V1

V2 – looking downstream

V3 – looking downstream

*V4- looking **up**stream*

Q5/V5

V6 – looking downstream

V7- looking downstream

V8- looking downstream

Source: Amanda Marler

Ferny Crofts July 2018 (restoration completed) – cont'd

Left bank					
	View of transect	M5/6 Q1	M5/6 Q2	M5/6 Q3	M5/6 Q4
Right bank					
	View of transect	M5/6 Q1	M5/6 Q2	M5/6 Q3	M5/6 Q4

Source: Footprint Ecology

FERNY CROFT CONTROL – M5/6 **Grid ref: SU3781005496** **Survey Date: 29.08.19**

Right bank to left bank

Left bank to right bank

Downstream

Upstream

Q1/V1 (looking upstream)

Q2/V2 – looking downstream

Q3/V3 – looking downstream

*Q4/V4- looking **up**stream*

Q5/V5

V6 – looking downstream

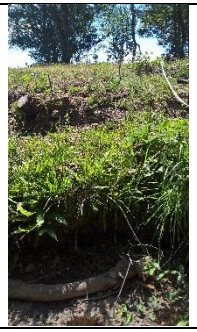
V7- looking downstream

V8- looking downstream

Source:

Amanda Marler

Ferny Crofts July 2018 (before restoration completed) – cont'd

Left Bank					
	View of transect	M9 Q1	M9 Q2	M9 Q3	M9 Q4
Right bank					
	View of transect	M9 Q1	M9 Q2	M9 Q3	M9 Q4

Source: Footprint Ecology

FERNY CROFT CONTROL – M9 **Grid ref: SU3786305458** **Survey Date: 28.08.19**

Right bank to left bank

Left bank to right bank

Downstream

Upstream

Q1/V1

V2 – looking downstream

V3 – looking downstream

V4- looking downstream

Q5/V5

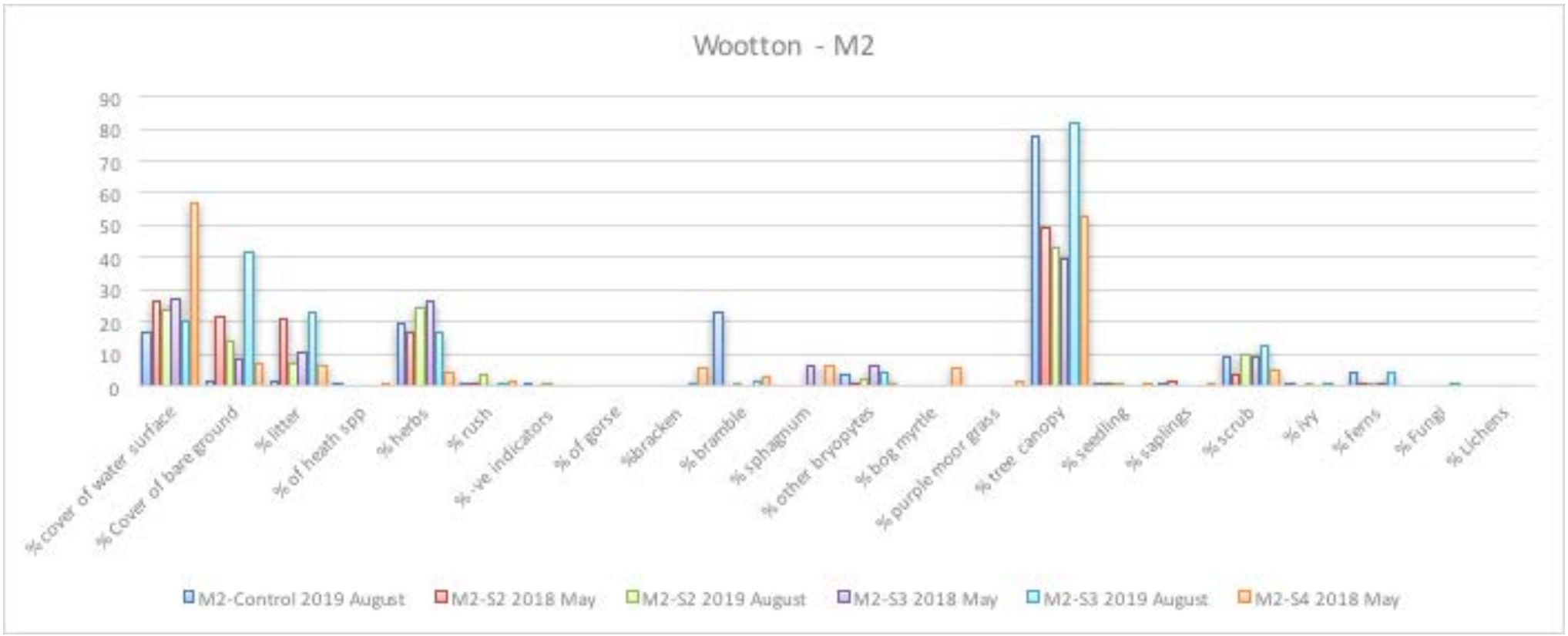
V6 – looking downstream

V7- looking downstream

V8- looking downstream

Source: Amanda Marler

Figure 7.4: Wootton Transect Vegetation Cover & Photographic Record– M2



SITE: WOOTTON CONTROL – M2 **Grid ref: SU23222 00439** **SURVEY DATE: 6.09.19**

(Views restricted by Bramble scrub)

Right bank to left bank

Left bank to right bank

Downstream

Upstream

Q1/V1

V2 – looking downstream/towards stream

V3 – looking downstream

V4- looking downstream

Q5/V5

Q6 and part V6 – looking downstream

V7- looking downstream

V8- looking downstream

Source: Amanda Marler

Wootton May May-June 2018 (before restoration completed)

Section B-C Left bank					
	View of transect	M2 Q1	M2 Q2	M2 Q3	M2 Q4
Section B-C Right bank					
	View of transect	M2 Q1	M2 Q2	M2 Q3	M2 Q4

Source: Footprint Ecology

SITE: WOOTTON SECTION 2 – M2 **Grid ref: SZ25405 99580** **SURVEY DATE: 2.09.19**

Right bank to left bank

Left bank to right bank

Downstream

Upstream

Q1/V1

V2 – looking downstream

V3 – looking downstream

V4- looking downstream

Q5/V5

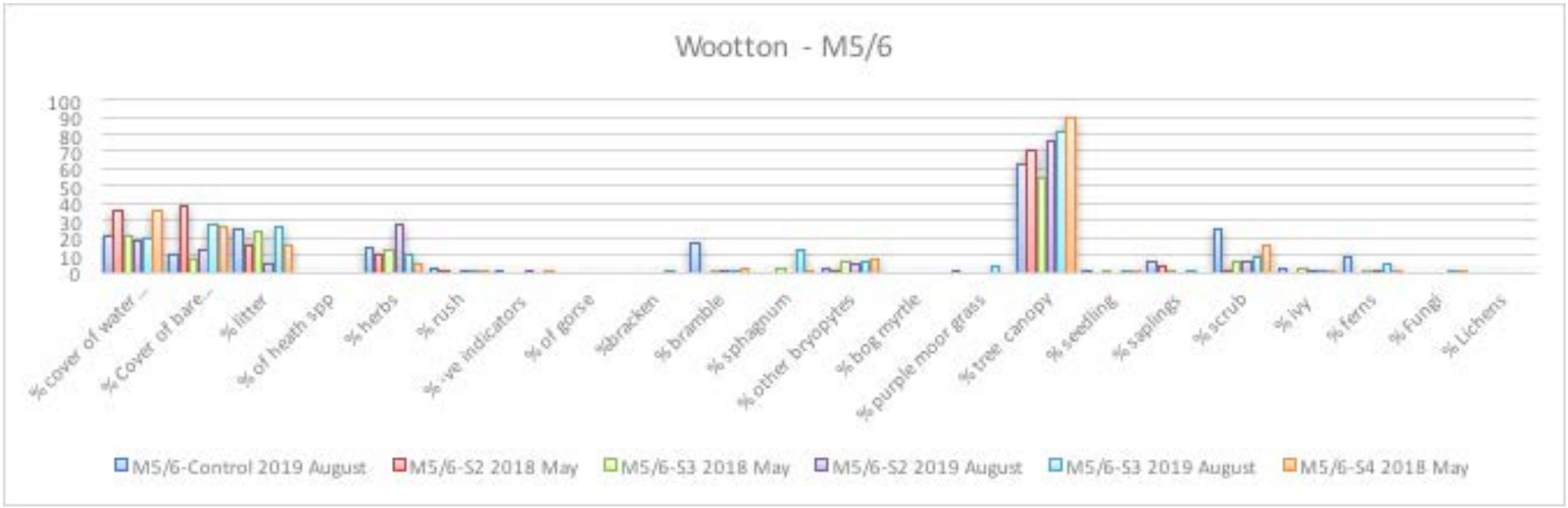
V6 – looking downstream

V7- looking downstream

V8- looking downstream

Source: Amanda Marler

Figure 7.5: Wootton Transect Vegetation Cover & Photographic Record– M5/6



SITE: WOOTTON CONTROL – M5/6 **Grid ref: SU23292 00414** **SURVEY DATE: 7.09.19**

RB to LB

LB to RB

Downstream

Upstream

Q1/V1

*V2 – looking **up**stream*

V3 – looking downstream

V4- looking downstream

Q5/V5

V6 – looking downstream

V7- looking downstream

V8- looking **up**stream

Source: Amanda Marler

Wootton May 08/05/2018 continued

Section B-C Left bank					
	View of transect	M5/6 Q1	M5/6 Q2	M5/6 Q3	M5/6 Q4
Section B-C Right bank					
	View of transect	M5/6 Q1	M5/6 Q2	M5/6 Q3	M5/6 Q4

Source: Footprint Ecology

WOOTTON SECTION 2- M5/6 **Grid ref: SZ25453 99550** **SURVEY DATE: 3.09.19**

Right bank to left bank

Left bank to right bank

Downstream

Upstream

Q1/V1

V2 – looking downstream

V3 – looking downstream

V4- looking downstream

Q5/V5

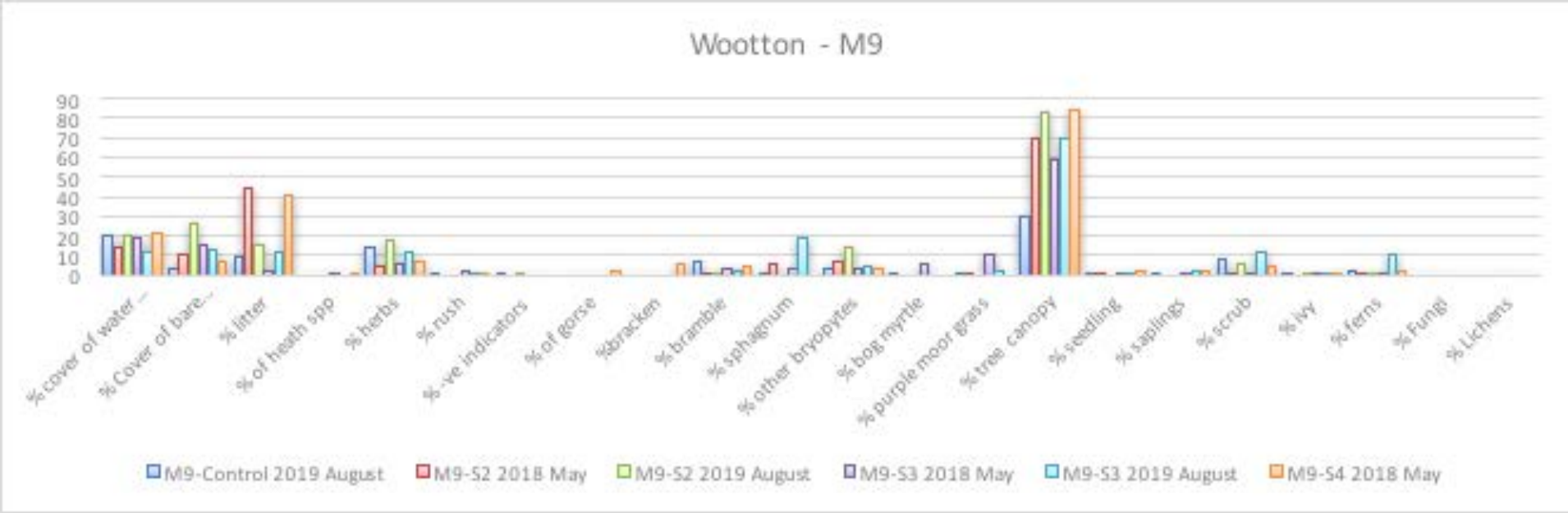
V6 – looking downstream

V7- looking downstream

V8- looking downstream

Source: Amanda Marler

Figure 7.6: Wootton Transect Vegetation Cover & Photographic Record – M9



SITE: WOOTTON CONTROL – M9 **Grid ref: SU23346 00377** **SURVEY DATE: 7.09.19**

Right bank to left bank

Left bank to right bank

Downstream

Upstream

Q1/V1 (plus part Q2)

V2 – looking downstream

V3 – looking downstream

V4- looking downstream

Q5/V5

V6 -looking downstream

V7- looking downstream

V8- looking downstream

Wootton May 08/05/2018 continued

Section D-E Left bank					
	View of transect	M9 Q1	M9 Q2	M9 Q3	M9 Q4
Section D-E Right bank					
	View of transect	M9 Q1	M9 Q2	M9 Q3	M9 Q4

Source: Footprint Ecology

WOOTTON SECTION 2- M9 **Grid ref: SZ25520 99539** **Survey Date: 4.09.19**

Right bank to left bank

Left bank to right bank

Downstream

Upstream

Q1/V1

*V2 – looking **up**stream*

V3 – looking downstream

V4- looking downstream

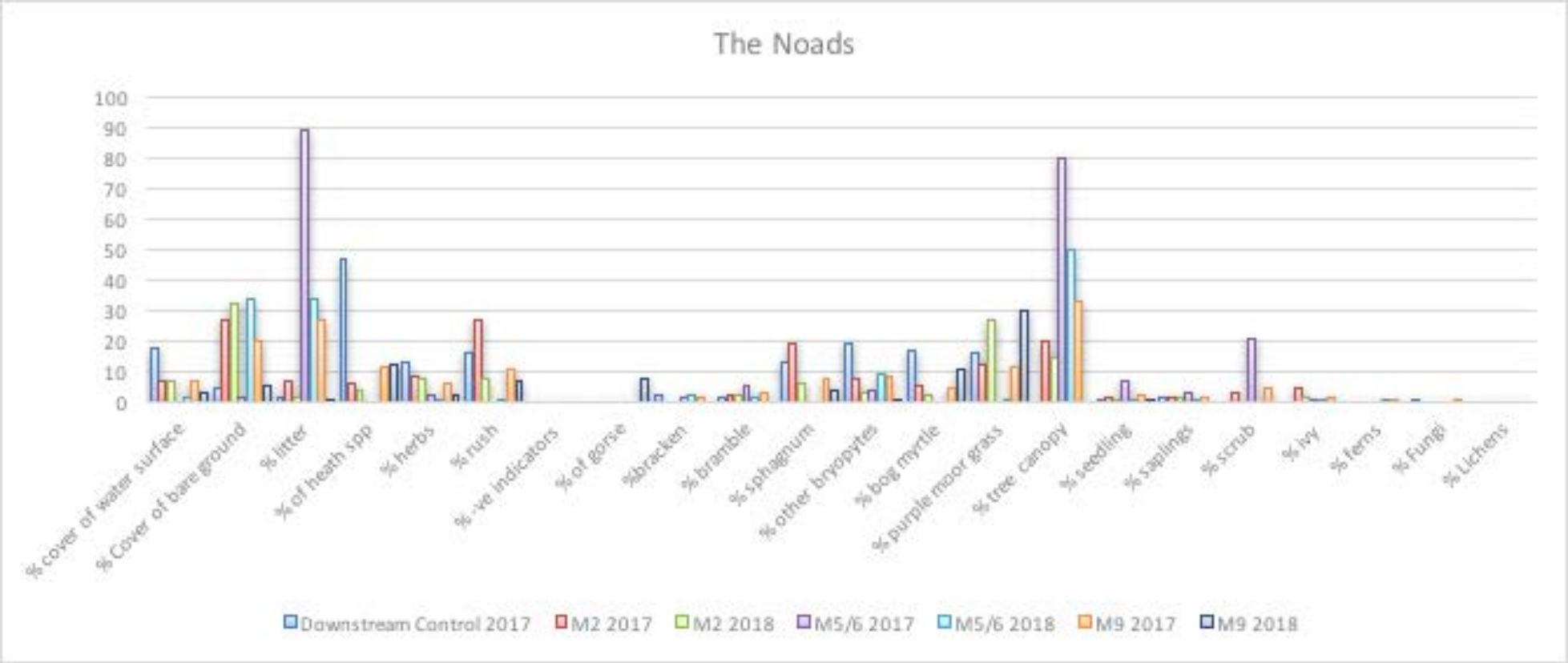
Q5/V5

V6 – looking downstream

V7- looking downstream

V8- looking downstream

Figure 7.7: The Noads Transect Vegetation Cover & Photographic Record



The Noads July 2018 (before restoration completed) All images facing downstream except for view of transect which is perpendicular to channel (unless stated).

Left Bank					
	View of transect	M2 Q1 (facing east)	M2 Q2	M2 Q3	M2 Q4 (facing east)
Right bank		As above (narrow channel therefore only left bank quadrat recorded)			
	View of transect	M2 Q1	M2 Q2	M2 Q3	M2 Q4

Source: Footprint Ecology

The Noads July 2018 (before restoration completed) – cont'd

Left Bank					
	View of transect	M5/6 Q1	M5/6 Q2	M5/6 Q3	M5/6 Q4
Right bank		As above (narrow channel therefore only left bank quadrat recorded)			
	View of transect	M5/6 Q1	M5/6 Q2	M5/6 Q3	M5/6 Q4

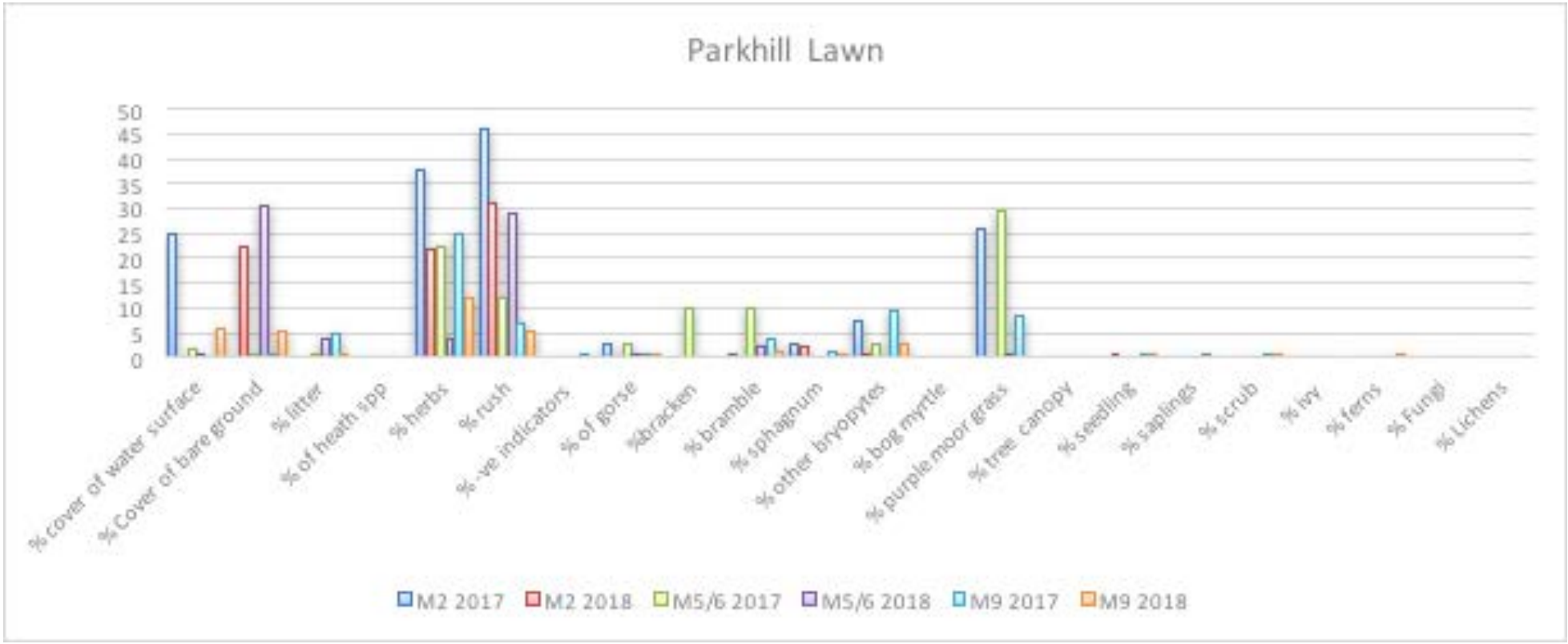
Source: Footprint Ecology

The Noads July 2018 (before restoration completed) – cont'd

Left Bank		 As)			
	View of transect	M9 Q1	M9 Q2	M9 Q3	M9 Q4
Right bank		As above (narrow channel therefore only left bank quadrat recorded)			
	View of transect	M9 Q1	M9 Q2	M9 Q3	M9 Q4

Source: Footprint Ecology

Figure 7.8: Parkhill Lawn - Transect Vegetation Cover & Photographic Record



Parkhill Lawn July 2018 (after restoration) All images facing downstream except for view of transect which is perpendicular to channel (unless stated).

Left Bank					
	View of transect	M2 Q1 (facing east)	M2 Q2	M2 Q3	M2 Q4 (facing east)
Right bank					
	View of transect	M2 Q1	M2 Q2	M2 Q3	M2 Q4

Source: Footprint Ecology

Parkhill Lawn July 2018 (after restoration completed) – cont'd

Left Bank					
	View of transect	M5/6 Q1	M5/6 Q2	M5/6 Q3	M5/6 Q4
Right bank					
	View of transect	M5/6 Q1	M5/6 Q2	M5/6 Q3	M5/6 Q4

Source: Footprint Ecology

Parkhill Lawn July 2018 (before restoration completed) – cont'd

Left Bank					
	View of transect	M9 Q1	M9 Q2	M9 Q3	M9 Q4
Right bank					
	View of transect	M9 Q1	M9 Q2	M9 Q3	M9 Q4

Source: Footprint Ecology

7.6 Wootton Vegetation Recovery – July 2017 to August 2019

Bare ground is one of the key visual indicators of site disturbance, immediately post restoration and is often a concern to stakeholders and the public when a site can appear raw. The transect monitoring showed that most sites have largely re-colonised bare ground within two years but timelapse photography is a useful monitoring tool to visually observe how quickly a site recovers. The sequence of photographs below are captured from a timelapse camera at Wootton – Phase 1 and show images captured a month apart for the timeframes when the camera was operational. The sequence starts from July 2017, immediately after work was completed. Within a month there are signs of recolonization and although there is a gap in footage during July to August 2017, within three months of completion of the work vegetation cover is rapidly increasing. There is a 6 month gap in footage again until March 2018 by which time footage shows the site is saturated from winter flood waters but is almost completely vegetated other than a short stretch of bank. Following another 3 month gap in footage taking time forward to July 2018, almost exactly a year post completion, vegetation is establishing well with micro-habitats developing – rush and sedge appears to be colonising the lower lying damper areas that hold standing water for short periods during flooding and small barer areas are indicative of low spots that pond and hold standing water for longer periods. No doubt close examination on the ground would find a greater diversity of plants, responding to variations in soil moisture and micro-topography. From the spring of 2019 the photographic sequences suggest that the bankside/bank top vegetation is starting to develop and two years on in the last image taken in August 2019 the sward appears to be quite dense and developed across the site. Interestingly, there is a localised high spot on the right bank which has been slow to colonise and is still relatively bare in comparison the rest of the site. It is difficult to determine exactly why this is but it may be related to the substrate or degree of compaction or the fact that this “high spot” rarely floods.

Figure 7.9: Timelapse camera sequence – Wootton Phase 1 – 6th July, 2017 to 6th August, 2019


TLC200 2017/09/06 11:58:43


TLC200 2018/03/06 11:49:15


TLC200 2018/08/06 11:56:27


TLC200 2018/09/06 12:01:36


TLC200 2018/10/06 16:36:22


TLC200 2018/11/06 11:59:23


TLC200 2018/12/06 12:00:10


TLC200 2019/01/06 11:57:34


TLC200 2019/03/06 09:51:03


TLC200 2019/04/09 11:54:22


TLC200 2019/05/06 12:01:57


TLC200 2019/06/21 12:03:34

7.7 Conclusion

Vegetation is generally a good indicator of environmental conditions and can rapidly respond to variations in habitat niches resulting from changes in soil moisture and micro-topography leading to increased diversity across a site. Restoration of flooding can also lead to changes in the nutrient status which can also have an impact on species diversity and response.

Vegetation transect monitoring, giving pre and/or post restoration data is available for 4 sites – Wootton, Parkhill Lawn, Ferny Croft and The Noads. Even though the monitoring timescales are short – either one or two years, there are already clear signs of vegetation response, notably:

- Showing the short-term impact of the works on vegetation cover with transect averages clearly identifying a reduction in tree cover and litter from pre-work site tree clearance. Tree clearance appears to have a knock-on effect on certain species groups, for example where tree cover reduced there appears to be a corresponding decrease in bryophytes.

- Sites tend to have a high percentage of bare soil immediately following restoration especially where a channel has been infilled or spoil banks removed but vegetation cover re-establishes quickly and cover is up to or close to pre-restoration levels within 2 years. This can be identified both from transect surveys and timelapse camera footage.

- Certain species groups appear to be responding more quickly to changes in soil moisture with damp loving species groups such as rushes, ferns and spaghnum increasing in cover at restored sites. Purple Moor Grass (Molinia) also showed a tendancy to increase at restored sites other than at Ferny Croft where there has been a significant decrease although it not clear why this should have occurred. Herb cover is also increasing at restored sites.

- Bramble appears to be decreasing across restored sites. Further monitoring will be required to ascertain whether this is as a result of scrub clearance as part of restoration or a response to changes in soil moisture levels.

Other species groups are not yet showing a marked response but slight trends may be emerging that will no doubt become clearer if monitoring continues for example:

- Small changes that can be identified at some sites suggest heath species appear to have declined slightly. More detailed analysis could be carried out as repeat surveys are carried out to look at the break down of individual species to see whether the response is due to a decline in dry heath species or whether heath species are just slower to recover from disturbance.

Negative indicator species such as Ragwort (pernicious weed), Spear and Creeping Thistle (Eutrophication/soil disturbance), Nettle (Eutrophication/nitrophilous – high soil nutrients), Broad-leaved Dock and Curled Dock (indicative of an underlying problem such as compaction) often indicate that a site that is not in good condition and has underlying problems. Negative indicator species were largely absent from most transects or were present in very small amounts (<0.5%) with no clear trend between restored or unrestored sites to suggest there are any issues.

Future monitoring

It would be valuable to carry out repeat transect surveys within the next 3 years at Ferny Croft, Wootton, Parkhill Lawn and The Noads to re-assess how sites are responding. The current surveys are starting to show some trends but the most obvious ones are often related to how the site has responded to a physical change as a result of the works, e.g. tree felling, scrub clearance or ground disturbance. Over time changes in the vegetation community and response of individual indicator species may be more reflective of how the site is responding to hydrological changes.

Therefore, It can be concluded that the HLS Restoration Objective Traffic Light Status is **Amber** to **Green** with on the basis that:

- Sites appear to be recovering quickly in terms of vegetation cover and showing initial positive trends in terms of the response of some moisture loving species groups such as rushes and sedges. The presence of negative indicator species is currently negligible. However, the data only covers vegetation response within one or two years and more time is required to see how the botanical value of the sites develop particularly in terms of individual indicator species. The current data records such small changes in individual indicator species that it is hard to identify trends or make observations with any degree of confidence.