Lewis Hall

Species richness and the effects of trampling and other management in Fant Wildlife Area, Maidstone, Kent

Abstract

The primary aim?- To see what types of management are most effective for increasing species richness, with particular reference to the Fant Wildlife Area. O S Sheet 188 TQ 745547

What was done?-Transects were taken across a path and random quadrat samples were taken from points within the FWA and % cover of what was found inside them was analysed.

What was found?-There has to be balance between grazing, mowing and trampling in order for more species to thrive; too much or too little of each and only certain species will survive. There is significant decrease in nettle cover between 1-1.5 meters from the path. (Mann Whitney U test P is less than 0.05). 2 years of mowing is not an effective way of increasing species richness. Mowing between 7-9 years and combined with grazing is a good way of reducing nettle dominance and increasing the amount of species. (Mann Whitney U test P is less than 0.05).

Reliable?-Many samples were taken to give a reasonable picture. However there are some actions that could be taken to improve the experiment even such as carrying out the procedure on different paths or in different seasons. This would show if species richness is increased with the same management but in a different season/area.

Aim

To investigate the relationship between the coverage of common nettle *Urtica dioica* and other plant species depending on the severity of trampling that has taken place.
This experiment will use field techniques including random sampling and transects to see if there is any patterns in % cover of organisms such as nettles, grasses and other species in the Fant Wildlife Area and the effect of trampling on them.

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Hypothesis

This aim can be developed by planning to investigate:

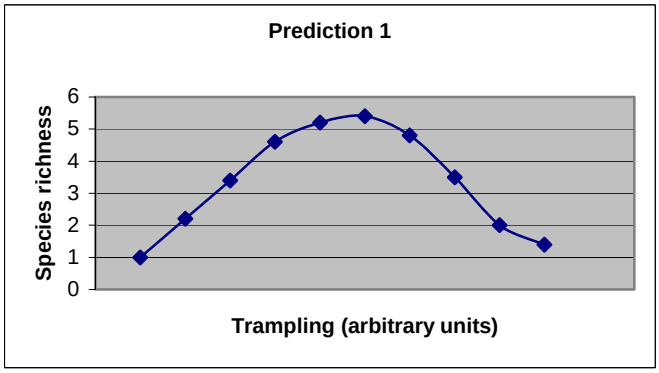
Prediction 1- Species richness will be higher in places where moderate levels of 'management' (that is, in the path borders) are being carried out as there will not be as much competition with nettle.

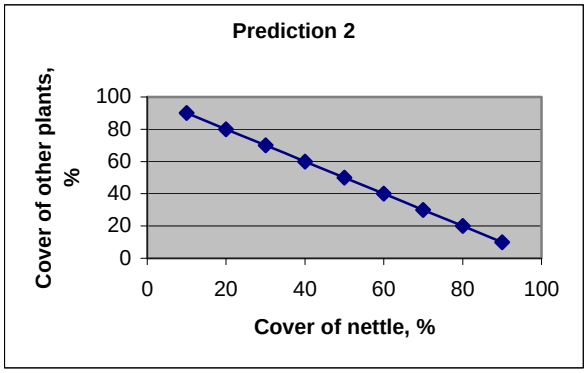
Prediction 2- The cover of other plants in one area will become scarce as the percentage cover of stinging nettles increases.

'Management' is classed as trampling. Other forms include mowing or grazing.

Nettles will be the dominant species because of the many advantages they have. These include being able to grow very tall, with wide leaves blocking light from their competitors and having an extensive underground root system for retrieving lots of nutrients and water, slowing down the growth rate of competing plants. They also release formic acid from their hollow, brittle hairs as a defence mechanism against grazing animals.

Prediction Graphs





Apparatus

-Quadrat (0.25m²)
-Flexible tape measure (60m)
-Gardening gloves
-Calculator for generating random numbers
-Species key (A Field Guide To Wild Flowers Of Britain And Europe – Schauer 1978)

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Procedure

-Using the 60m tape measure mark out 60 meters from one point along the path in the nature reserve to another point (60 meters further away).

-Use the calculator to generate 6 random points between 0-60m on the tape measure

-Carry out a transect through this point on the path that goes 125cm either side of the random point. (e.g. across the path and into the unmanaged border)

-Place the quadrat at each 0.5m point so that you end up with 10 quadrats at right angles to each random point making up a transect.

-At each quadrat record ; percentage cover of nettles, percentage cover of bare ground, percentage cover of other plants, species richness (recording identity where possible-using leaf form to identify).

-Repeat this procedure for each of the 6 random point that the calculator was used to produced so that there is enough quadrats taken to draw some conclusions.

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Risk assessment

Risk		**Likelihood**	**Severity**	**Total risk**	**Strategy**
Stinging nettles (*Urtica dioica)*	Being stung	5	1	5	Where the gardening gloves and be generally careful when around them
Giant Hogweed	UV burns	2	4	8	Avoid and tell FWG management of any finds
Brambles	Prickled by thorns	4	1	4	Where the gardening gloves and be generally careful when around them
Rabbit holes	Tripping or hurting ankle	4	2	8	Keep well aware of where you tread and avoid the holes
Pond	drowning	1	5	5	Stay with someone at all times and work carefully, try to avoid the water.
Stream	drowning	1	5	5	Stay with someone at all times and work carefully, try to avoid the water.

IMPLEMENTATION

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Aim

To investigate the relationship between the coverage of *Urtica dioica* and other plant species depending on the type of management that has taken place.

Hypothesis

This aim can be developed by planning to investigate:

Prediction 1- Species richness will be higher in places where moderate levels management are being carried out as there will not be as much competition with nettle.

Prediction 2- The cover of other plants in one area will become scarce as the percentage cover of stinging nettles increases.

Management is classed as trampling, mowing or grazing (by rabbits in this case).

A likely reason that the nettles will be the dominating species will reflect the number of advantages stinging nettles have, such as;
-They can grow up to 2 meters tall with lots of wide leaves blocking light from other plants so they are inhibited, therefore there is less competition for nutrients and water.
-The leaves and stems are covered with brittle, hollow, silky hairs that release formic acid, causing a 'sting' as a defence against grazing animals. However, further research indicates that rabbits are not affected by this defence mechanism. (wildkids.com).
-Extensive underground root system allowing them to gain more access to water and nutrients.
-A rhizome produces the shoot of the plants and provides it with food stores to help the plant grow throughout it's life cycle. This is also useful as fallen nettle stem inhibit the growth of other plants but not nettles as the plant is continually provided with food from it's stores as seen from observations of Fant Wildlife Area.

Example of rhizome (lots of food + vast root system)

An example of one of the points on the path that a transect was surveyed

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It can be seen in this picture that the path stretches for approximately 1m from the central tape before the border is reached.

Procedure

-Using the 60m tape measure out 60 meters from one point along the path in the nature reserve to another point (60 meters further away).

-Use the calculator to generate 6 random points between 0-60m on the tape measure. The distances were 1.38m, 28.14m, 35.82m, 37.21m, (44.4m not used), 48.48m, 59.34m

-Carry out a transect through this point on the path that goes 125cm either side of the random point. (eg across the path and into the unmanaged border)

-Place the quadrat at each 0.5m point so that you end up with 10 quadrats at right angles to each random point making up a transect. The quadrat used is 0.5m x 0.5m, i.e. 0.25m2, divided into 100 equal squares. The recording of % cover is therefore much more accurate than if an open quadrat had been used.

-At each quadrat record ; percentage cover of nettles, percentage cover of bare ground, percentage cover of other plants, species richness (recording identity where possible-using leaf form to identify).

-Repeat this procedure for each of the 6 random point that the calculator was used to produced so that there is enough quadrats taken to draw some conclusions. The 44.4m point was not used as it was not a fair sample.

Results

-number in top left represents random point chosen along 60m tape measure and would lie in between the E and F points (eg A+J are quadrats furthest from random point on tape measure lying in unmanaged areas)

Point 1.38m	Nettle % cover	Grass % cover	Bare % cover	Other % cover	Species richness
A	47.5	2.5	7.5	42.5	7.0
B	80.0	10.0	2.5	7.5	3.0
C	50.0	25.0	12.5	12.5	6.0
D	0.0	80.0	2.5	17.5	2.0
E	0.0	33.0	1.0	66.0	2.0
F	0.0	30.0	2.5	67.5	2.0
G	30.0	50.0	10.0	10.0	8.0
H	40.0	22.5	22.5	15.0	7.0
I	60.0	20.0	10.0	10.0	6.0
J	65.0	10.0	5.0	20.0	4.0

Point 28.14m	Nettle % cover	Grass % cover	Bare % cover	Other % cover	Species richness
A	90.0	0.0	10.0	0.0	2.0
B	90.0	0.0	10.0	0.0	3.0
C	30.0	10.0	10.0	50.0	5.0
D	35.0	25.0	10.0	30.0	6.0
E	0.0	80.0	2.5	17.5	2.0
F	0.0	25.0	0.0	75.0	1.0
G	5.0	60.0	0.0	35.0	2.0
H	74.0	20.0	1.0	5.0	3.0
I	95.0	0.0	5.0	0.0	2.0
J	72.5	0.0	27.5	0.0	2.0

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Point 35.82m	Nettle % cover	Grass % cover	Bare % cover	Other % cover	Species richness
A	100.0	0.0	0.0	0.0	1.0
B	75.0	0.0	20.0	5.0	5.0
C	65.0	0.0	0.0	35.0	7.0
D	15.0	40.0	5.0	40.0	6.0
E	0.0	60.0	0.0	40.0	1.0
F	0.0	49.0	1.0	50.0	2.0
G	30.0	40.0	10.0	20.0	5.0
H	50.0	27.5	2.5	20.0	4.0
I	90.0	0.0	10.0	0.0	2.0
J	70.0	0.0	30.0	0.0	2.0

Point 37.21m	Nettle % cover	Grass % cover	Bare % cover	Other % cover	Species richness
A	75.0	0.0	10.0	15.0	3.0
B	80.0	0.0	10.0	10.0	2.0
C	75.0	10.0	10.0	5.0	4.0
D	20.0	40.0	0.0	40.0	2.0
E	0.0	25.0	0.0	75.0	1.0
F	0.0	60.0	2.5	37.5	2.0
G	5.0	10.0	5.0	80.0	4.0
H	80.0	0.0	20.0	0.0	2.0
I	20.0	0.0	0.0	80.0	6.0
J	5.0	5.0	0.0	90.0	2.0

Point 48.48m	Nettle % cover	Grass % cover	Bare % cover	Other % cover	Species richness
A	85.0	0.0	15.0	0.0	2.0
B	90.0	0.0	7.5	2.5	2.0
C	25.0	10.0	5.0	60.0	5.0
D	0.0	10.0	0.0	90.0	1.0
E	0.0	70.0	0.0	30.0	1.0
F	0.0	50.0	0.0	50.0	1.0
G	2.5	85.0	2.5	10.0	3.0
H	40.0	47.5	10.0	2.5	8.0
I	27.5	70.0	2.5	0.0	3.0
J	95.0	0.0	5.0	0.0	3.0

**the 48.48 sample was selected after rejecting the previous point, where a different pattern was evident due to the placing of signs and clearance in the Fant Wildlife Area.*

Point	Nettle % cover	Grass % cover	Bare % cover	Other% cover	Species

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59.34m					richness
A	80.0	7.5	5.0	7.5	4.0
B	40.0	10.0	10.0	40.0	8.0
C	30.0	40.0	5.0	25.0	3.0
D	0.0	40.0	0.0	60.0	1.0
E	0.0	10.0	0.0	90.0	1.0
F	0.0	50.0	0.0	50.0	1.0
G	0.0	20.0	2.5	77.5	2.0
H	80.0	5.0	5.0	10.0	3.0
I	72.5	0.0	27.5	0.0	4.0
J	35.0	60.0	5.0	0.0	3.0

This photograph shows how the random position of transect 5, in white, was rejected as the upper border of the path at this point showed a different distribution of plants to that found elsewhere. The actual station is shown by the red quadrat.

Average table

Average	nettle %	grass %	bare %	other %	species

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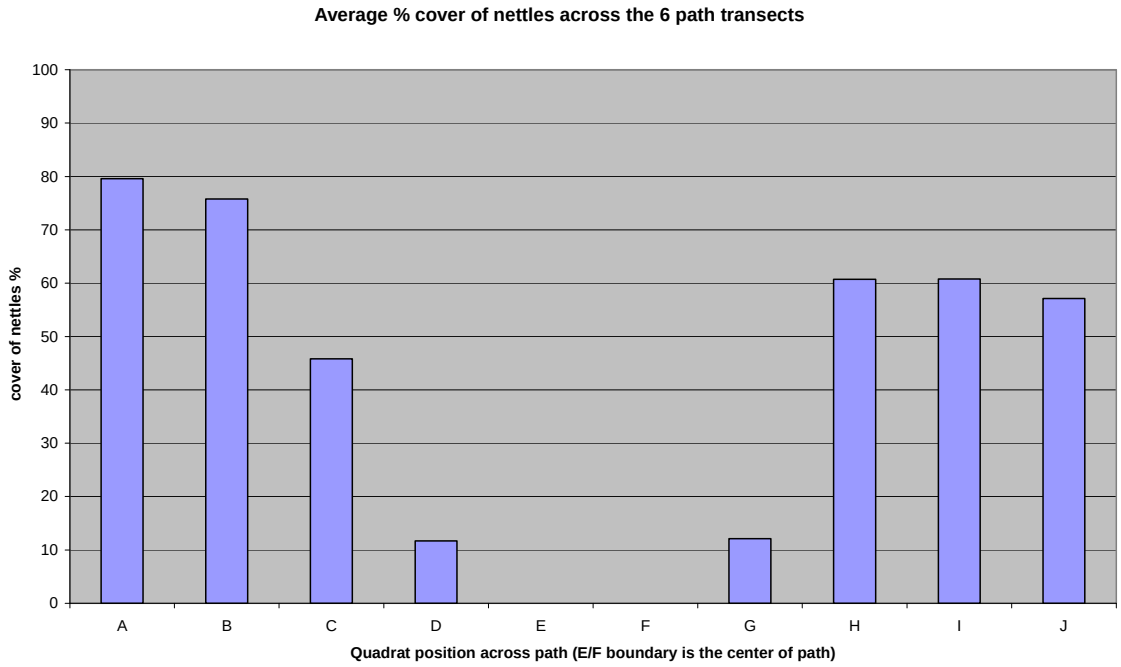
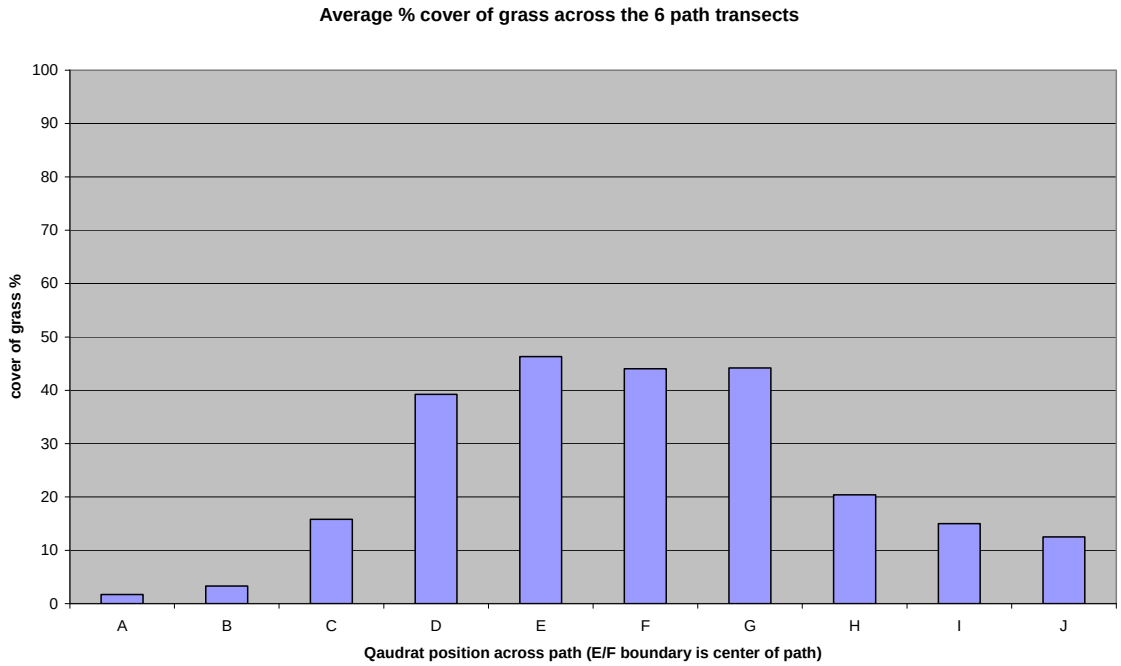
for six transects	cover	cover	cover	cover	richness
A	79.6	0.5	8.5	11.5	3.0
B	75.8	3.3	10	10.8	3.8
C	45.8	15.8	7.1	31.3	5
D	11.7	39.2	2.9	46.3	3
E	0	46.3	0.6	53.1	1.3
F	0	44	1	55	1.5
G	12.1	44.2	5	38.8	4
H	60.7	20.4	10.2	8.8	4.5
I	60.8	15	9.2	15	3.9
J	57.1	12.5	12.1	18.3	2.7

Graphs

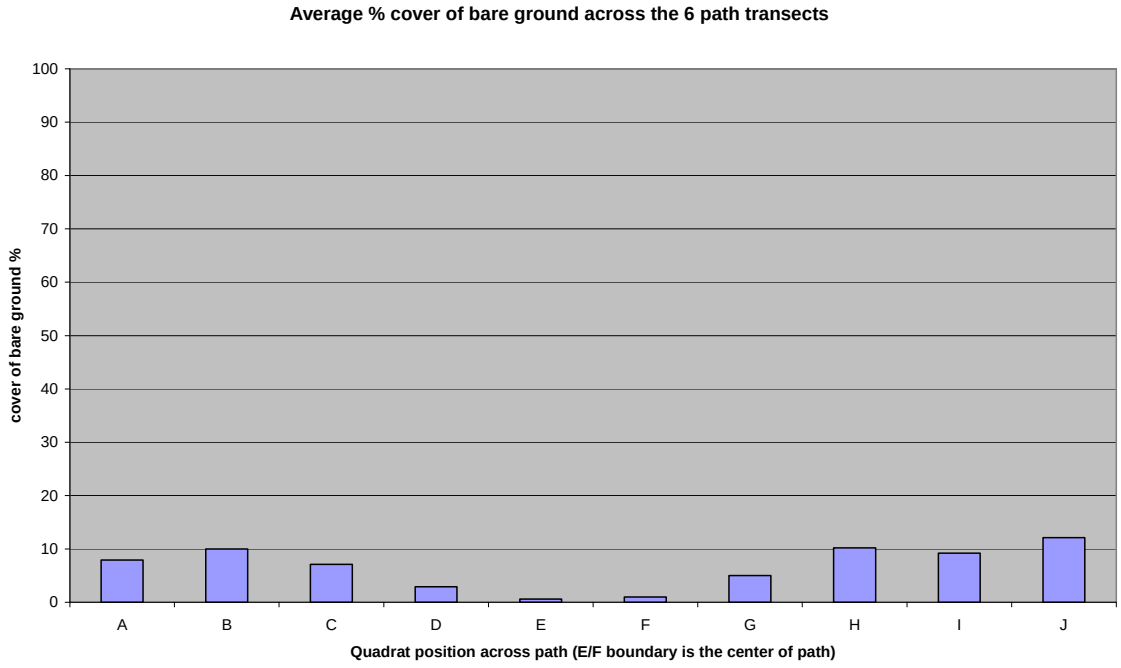
Graph 1.



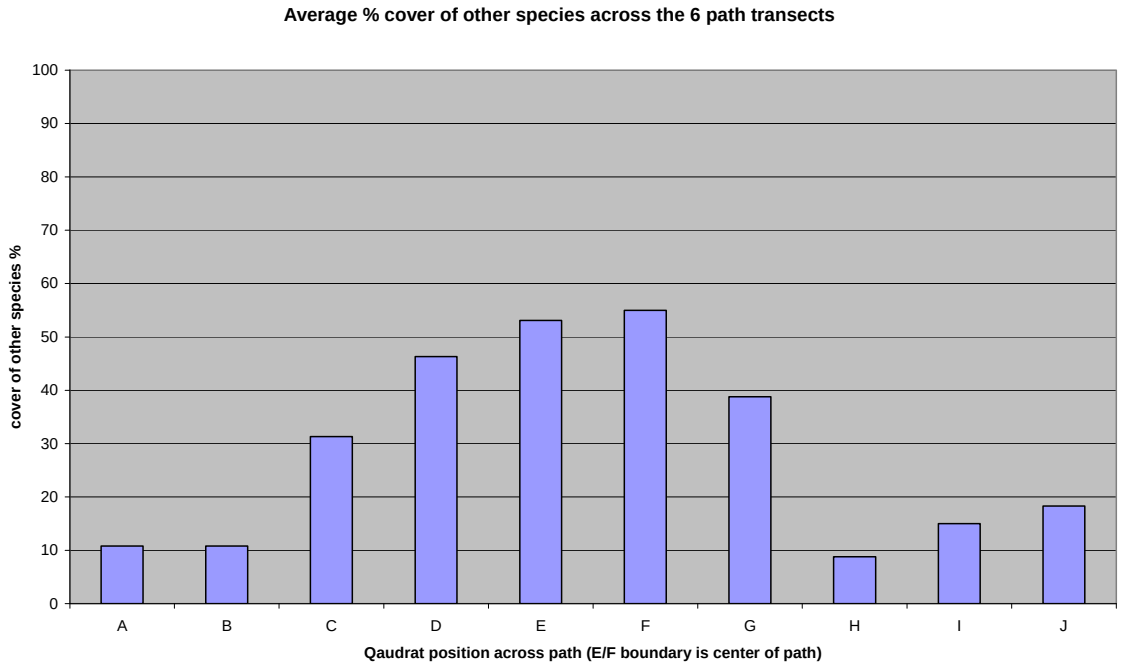
Graph 2.



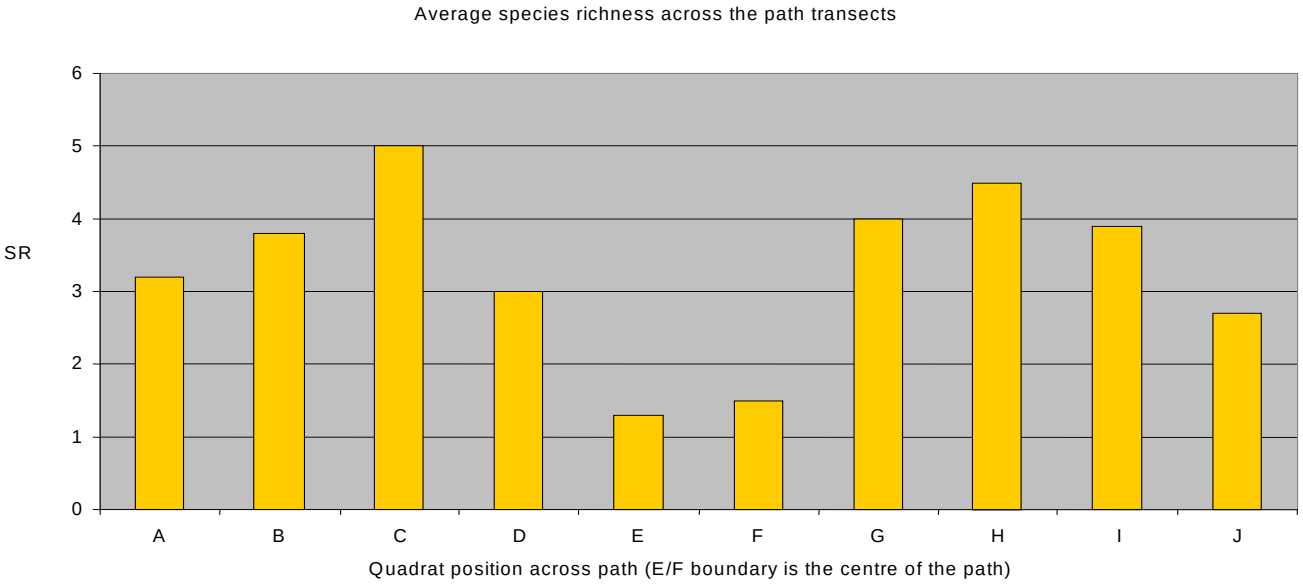
Graph 3.



Graph 4.



Graph 5.



Mann Whitney U statistical analysis tests

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Each transect can be divided into two as it is taken across the path. Transects can be combined across the centre, so A and J are a pair at the extreme, E and F are a pair in the centre, and so on.
Using data collected the aim is to see if there is a significant difference in nettle coverage in the A/J, D/G and C/H quadrats of the data as they all receive different levels of management (trampling) .

Test 1

Hypothesis 1- There is a significant difference in % cover of *U. dioica* in the unmanaged quadrats and the D/G quadrats.

Null hypothesis 1- there is no significant difference in % cover of *U. dioica* in the unmanaged quadrats and the D/G quadrats.

unmanaged	5	35	47.5	65	70	72.5	75	80	85	90	95	100
Rank 1	7	13.5	15	16	17	18	19	20	21	22	23	24

D/G	0	0	0	0	2.5	5	5	15	20	30	30	35
Rank 2	2	2	2	2	5	7	7	9	10	11.5	11.5	13.5

Sum of R1= 215.5
Sum of R2= 82.5

$U1= N1 \times N2 + [(N^1 (N^1+1))\div 2 - \sum R^1]$
$U2= N1 \times N2 + [(N^2 (N^2+1))\div 2 - \sum R^2]$

U1= 6.5
U2= 139.5

6.5 is lower than the test statistic of 37 for 12 pairs of data ($P<0.05$) so the null hypothesis can be rejected meaning that there is a significant difference between % cover of nettles in the unmanaged and D/G quadrats.

Test 2

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Hypothesis 2- there is a significant difference in % cover of *U. dioica* in the unmanaged quadrats and the C/H quadrats.

Null hypothesis 2- there is no significant difference in % cover of *U. dioica* in the unmanaged quadrats and the C/H quadrats.

unmanaged	5	35	47.5	65	70	72.5	75	80	85	90	95	100
Rank 1	1	5	8	11.5	13	14	16.5	19	21	22	23	24

C/H	25	30	30	40	40	50	50	65	74	75	80	80
Rank 2	2	3.5	3.5	6.5	6.5	9.5	9.5	11.5	15	16.5	19	19

Sum of R1= 178
Sum of R2= 122

$U1= N1 \times N2 + [(N^1 (N^1+1))\div 2 - \sum R^1]$
$U2= N1 \times N2 + [(N^2 (N^2+1))\div 2 - \sum R^2]$

U1= 44
U2= 100

44 is not lower than the test statistic of 37 for 12 pairs of data ($P<0.05$) so the null hypothesis can not be rejected meaning that there is no significant difference between % cover of nettles in the unmanaged and C/H quadrats.

Analysis

As seen in the bar graph 1it is clear that the nettles do not appear in quadrats E and F. This is certainly due to the severity of the management in the form of trampling that takes place there: the nettles are not adapted to those high levels of trampling unlike other species such as plantain or grasses which peak under this type of management. However, the grasses may not only be at their highest point here due to how well they are adapted to trampling, but also because they do not have the stinging nettles to compete with. This makes sense because as the percentage cover of nettles increases it can be seen on graph 2 that the grass cover starts to decrease at approximately the same position as the nettles cover increases except at a lower 'rate'. This backs up my prediction number 2 that the cover of other plants will go down as nettle cover increases. Coverage of other plants is inversely proportional to nettle coverage. A likely reason for this is that as the nettle cover increases their many large leaves begin to block out the light from the grass. This then increases the photosynthetic rate of the nettles while that of the grass decreases. Therefore the grass does not have the energy to compete or sustain its health and it gradually dies off. Hence the grass coverage goes down.

Although A and J are the same distance from the random point on the path, A has a higher average percent coverage than J. This is an anomaly. This could be due to the altitude change from A-J, as the transect goes from A through to J it goes down a slight slope. This is strange because it may be expected that water may drain down this slope so that the soil in J had a higher water content, meaning more available water and better growing conditions. Therefore one might expect to see a higher % cover of nettles in J. The reason that the average % cover of grass is higher at J than it is at A is probably due to the water draining down the slope. It could possibly also be put down to other abiotic factors such as soil temperature or sunlight or even just a coincidence.

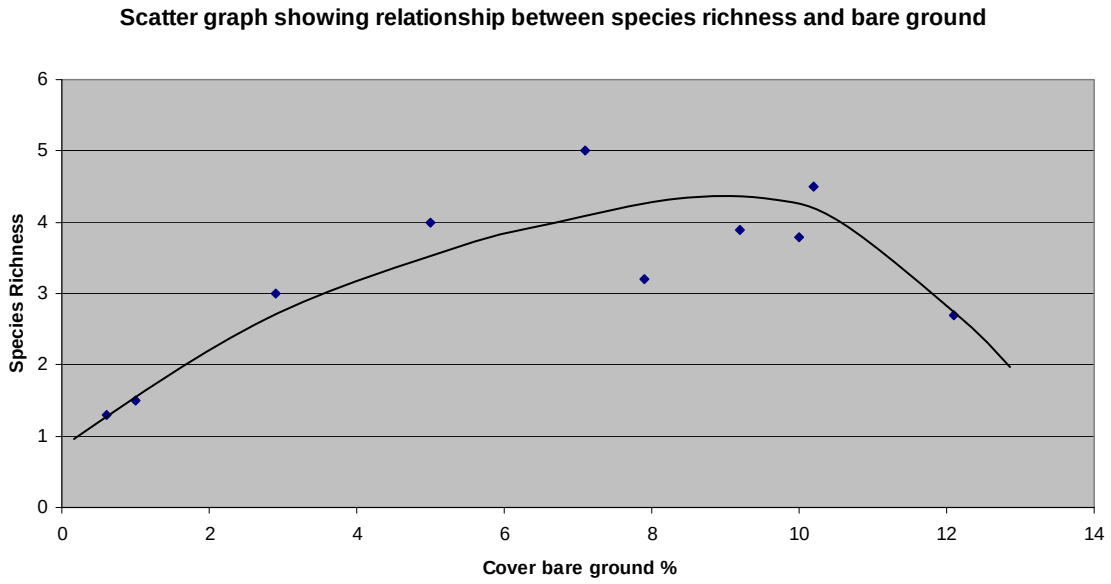
It was also odd in graph 3 that the there is the least bare ground in the centre of the path at E and F as one would expect it to be at it's highest here due to the amount of trampling. A reason for this not being the case could be because other species are adapted to grow here as there will be less competition for them against the nettles. In these areas they have a better chance of surviving the trampling than competing with nettles. Also the grass can spread underground like the nettle but have an added advantage of basal meristems which nettles do not have. However, cover of bare ground was generally quite low in all quadrats so clear conclusions can not easily be drawn from this information. If the experiment was carried out during the drier months later in the year there could be a change in bare ground cover probably due to lack of rain or even increased trampling.

Graph 4 shows that other species thrive mostly in E/F where there is little nettle to compete with. The main species thriving here was Plantain as they are very resistant to trampling due to being adapted with very spongy and springy leaves.

Graph 5 supports prediction number 1 that species richness will be higher in places where moderate levels management are being carried out as there will not be as much competition with nettle. This is because it clearly shows that average species richness is at it's highest at H and C where trampling would have been reduced as they are located on the outskirts of the path and also because the nettles are not yet completely dominant so there is not too much competition. Combined, these factors have seemed to produce ideal conditions for more species to survive and thrive. However, Sritek (1992) describes the major influences evident in areas like the Fant Wildlife Reserve as management e.g. grazing by rabbits (in this case), mowing or 'topping' (Ivins, 1952. topping is rough cutting with a tractor mower several centimetres above the ground), and the addition of nutrients, notably nitrogen by the addition of fertiliser, manure or compost. Tilling of the soil can be added as a management activity. These various forms of disturbance collectively lead to the existing flora of nettles, *U. dioica,* thistles and plantains (wildkids.org). Accounts of the mowing and observation in the Fant Wildlife Reserve show that trampling on established paths eliminates nearly all nettle but mowing has only controlled nettle growth. This suggests that prediction 2 is incorrect because it says that management leads to dominance of *U. dioica* and not an increase in species richness but this could be due to the type of management being mowing and not trampling.. The effect that mowing has on the rate of photosynthesis in grass is explained by the removal of nettles. Without the nettle cover, more light can reach the grass. This will also apply to other low growing species, so species richness will be increased.

The bar graphs showing species richness and % cover of bare ground have a similar pattern in common in that they are both low around E and F but the levels of bare ground and species richness increase as they move closer to A and J. Below is a graph of this data.

Graph 6.



Graph 6 is similar inverted U shape to the prediction 1 graph, therefore backing up prediction 1 which is species richness will be higher in places where moderate levels of management are being carried out as there will not be as much competition with nettle.

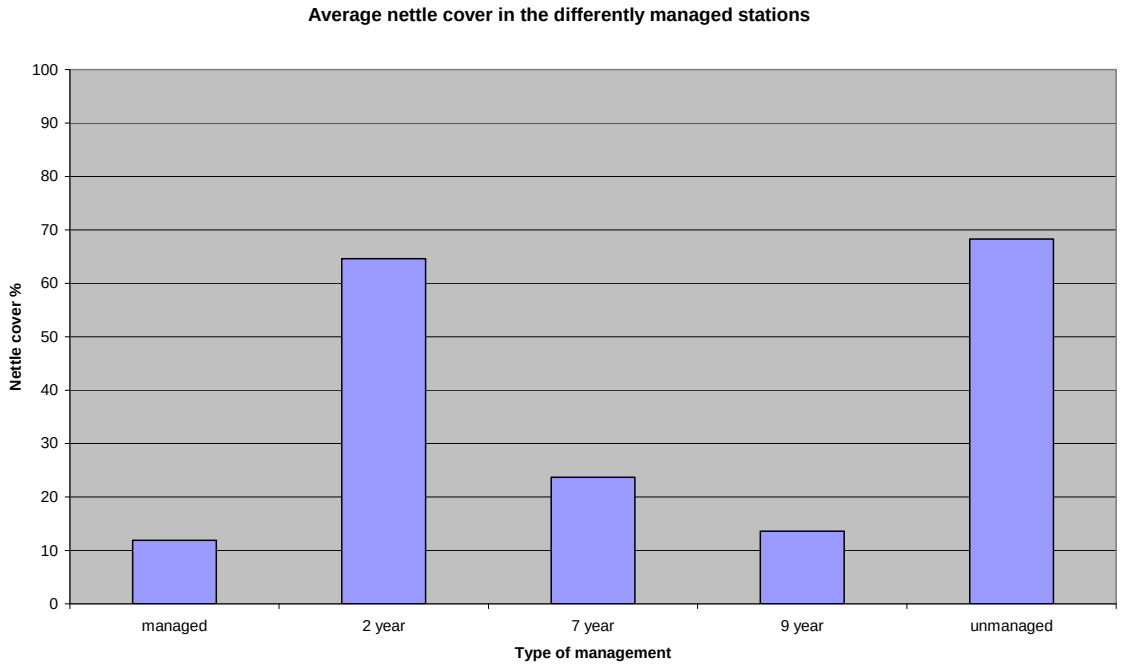
An explanation for this is found in Firbank *et al*, 2000, who report that it is to be expected that arable field margins will consist of a large proportion of bare soil, which will serve to reduce interspecies competition. This is evident in established stands of nettle in the Fant Wildlife Area. This makes it likely that other less hardy species will be able to thrive. This helps to back up prediction number 2 as bare soil can be brought about by trampling or other management and therefore makes species richness increase. Despite this, it must be noted that different circumstances (e.g. different levels of abiotic factors like soil temperature or nutrients) may bring about a rise in species richness and this cannot just be put down to the fact that bare soil is in abundance. However the points do make up an inverted U shape suggesting two things. It suggests that more species thrive around 6% bare ground for reasons such as there being more potential for seeds to germinate and develop due to not being in competition with stronger species such as nettle. Secondly, in places where bare ground rises to 12%+ cover the species richness declines as the conditions are probably becoming too stressful for plants to survive (either due to low rainfall or severe trampling).

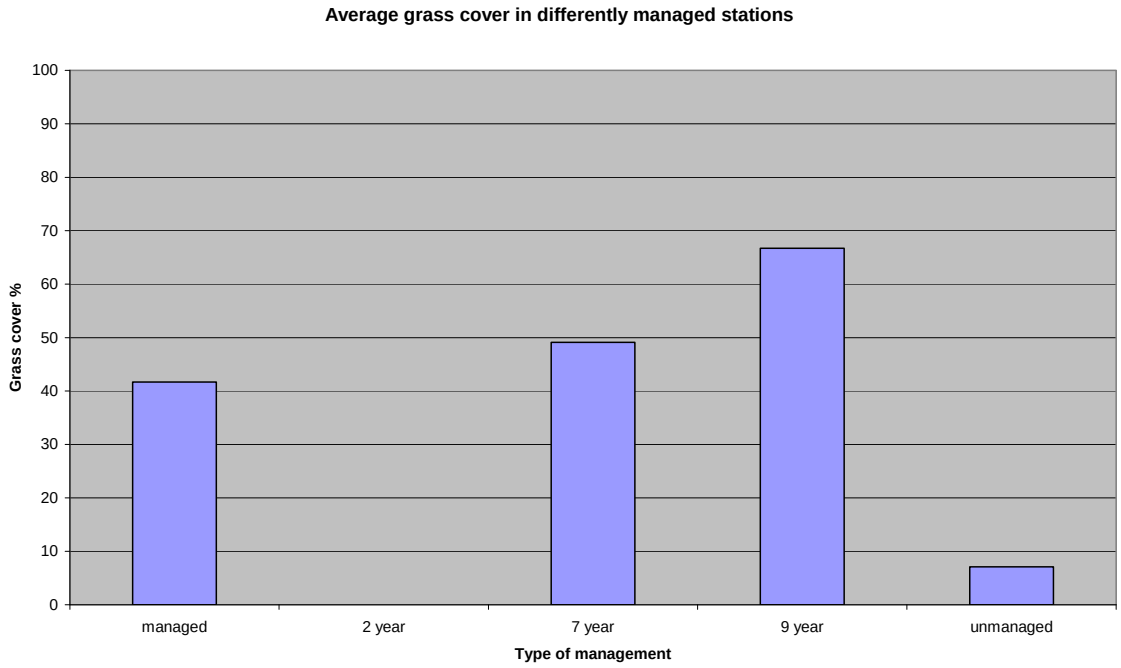
As an extension to the experiment comparison will be made with data collected by others in three areas of FWA where mowing has been done at three different levels. One area has been mown twice, once last year and once this Spring. A

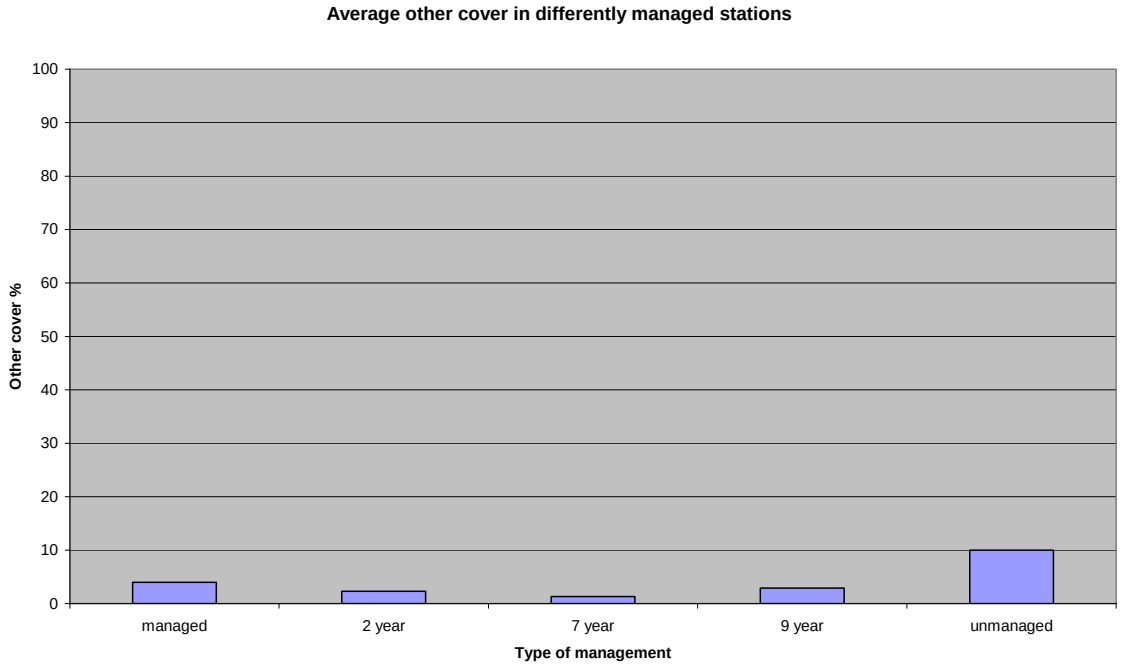
further area has been mown over a 7 year period, while a third has been mown each year for 9 years. Therefore a comparison can be made between trampling and mowing as management styles. We saw rabbit droppings in various places in the mown areas but this effect cannot be controlled.

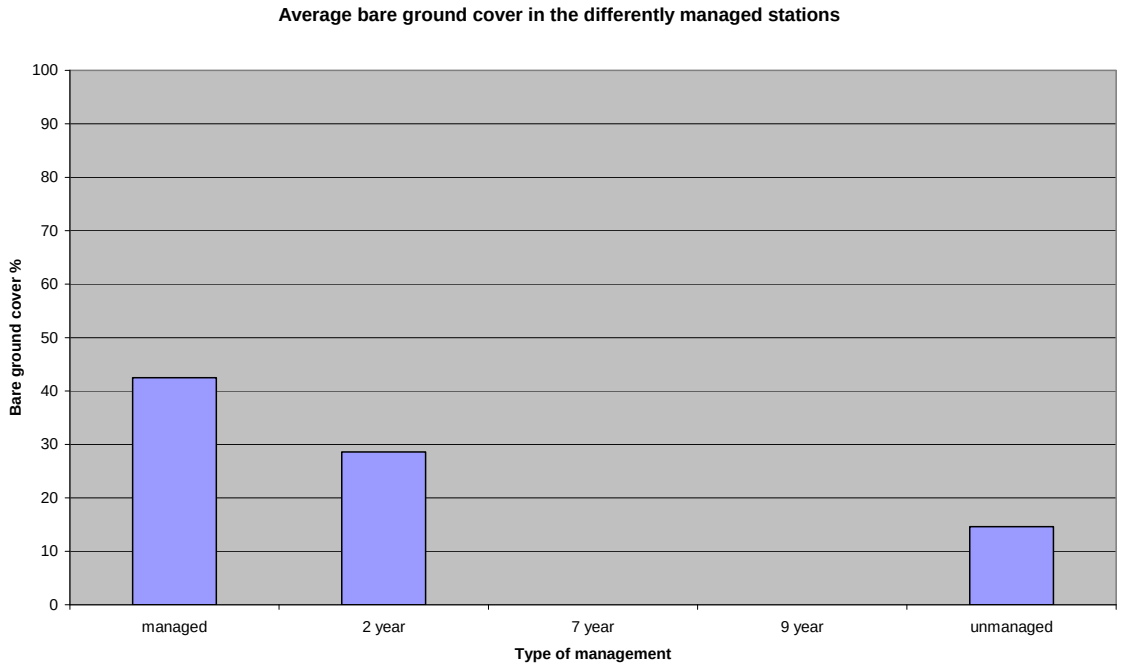
Data table of average % cover in all plots under different management.
***=** *someone elses data*

	Managed(D/G)	2 year*	7 year*	9 year*	Unmanaged(A/J)
Av nettle cover %	11.9	64.6	23.7	13.6	68.3
Av grass cover %	41.7	0.0	49.1	66.7	7.1
Av other cover %	4.0	2.3	1.3	2.9	10.0
Av bare cover %	42.5	28.6	0.0	0.0	14.6




Average grass cover in differently managed stations
Grass cover %
100
90
80
70
60
50
40
30
20
10
0
managed
2 year
7 year
9 year
unmanaged
Type of management


Average other cover in differently managed stations
Other cover %
100
90
80
70
60
50
40
30
20
10
0
managed
2 year
7 year
9 year
unmanaged
Type of management



Mann Whitney U tests comparing data collected from this experiment with other experiments carried out at the same time to see if there is a significant difference in nettle cover when an area experiences different types and levels of management.

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Test 3

Hypothesis 3- There is a significant difference in % cover of *U. dioica* between the 2 year ago mown plot and the unmanaged plots.

Null hypothesis 3- There is no significant difference in % cover of *U. dioica* in the 2 year mown and unmanaged plots.

2 year	31	33	44	60	64	66	68	72	78	81	87	91
rank	2	3	5	7	8	10	11	13	16	18	20	22

unmanaged	5	35	47.5	65	70	72.5	75	80	85	90	95	100
rank	1	4	6	9	12	14	15	17	19	21	23	24

sum of R1=135
sum of R2=165

$U1= N1 \times N2 + [(N^1 (N^1+1))\div 2 \ -\sum R^1]$
$U2= N1 \times N2 + [(N^2 (N^2+1))\div 2 \ -\sum R^2]$

U1=87
U2=57

57 is not lower than the test statistic of 37 for 12 pairs of data ($P<0.05$) so the null hypothesis cannot be rejected, meaning that it can not be proven there is a significant difference between % cover of nettles in the unmanaged and 2 year mown plots.

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Test 4

Hypothesis 4- There is a significant difference in % cover of *U. dioica* between the 7 year ago mown plot and the unmanaged plots.

Null hypothesis 4- There is no significant difference in % cover of *U. dioica* in the 7 year mown and unmanaged plots.

7 year	1	3	7	13	21	21	22	30	31	39	42	54
rank	1	2	4	5	6.5	6.5	8	9	10	12	13	15

unmanaged	5	35	47.5	65	70	72.5	75	80	85	90	95	100
rank	3	11	14	16	17	18	19	20	21	22	23	24

sum of R1=92
sum of R2=208

$U1= N1 \times N2 + [(N^1 (N^1+1))\div 2 - \sum R^1]$
$U2= N1 \times N2 + [(N^2 (N^2+1))\div 2 - \sum R^2]$

U1=130
U2=14

14 is lower than the test statistic of 37 for 12 pairs of data ($P<0.05$) so the null hypothesis can be rejected meaning that there is a significant difference between % cover of nettles in the unmanaged and 7 year mown plots.

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Test 5

Hypothesis 5- there is a significant difference in % cover of *U. dioica* between the 9 year ago mown plot and the unmanaged plots.

Null hypothesis 5- there is no significant difference in % cover of *U. dioica* in the 9 year mown and unmanaged plots.

9 year	0	0	0	0	0	1	5	22	26	26	32	51
rank	2.5	2.5	2.5	2.5	2.5	6	7.5	9	10.5	10.5	12	15

unmanaged	5	35	47.5	65	70	72.5	75	80	85	90	95	100
rank	7.5	13	14	16	17	18	19	20	21	22	23	24

sum of R1=78
sum of R2=214.5

$U1= N1 \times N2 + [(N^1 (N^1+1))\div 2 - \sum R^1]$
$U2= N1 \times N2 + [(N^2 (N^2+1))\div 2 - \sum R^2]$

U1=144
U2=7.5

7.5 is lower than the test statistic of 37 for 12 pairs of data ($P<0.05$) so the null hypothesis can be rejected meaning that there is a significant difference between % cover of nettles in the unmanaged and 9 year mown plots.

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Test 6

Hypothesis 6- there is a significant difference in % cover of *U. dioica* between the 7 year ago mown plot and the 9 year mown plot.

Null hypothesis 6- there is no significant difference in % cover of *U. dioica* in the 9 and 7 year mown plot.

7 year	1	3	7	13	21	21	22	30	31	39	42	54
Rank 1	6.5	8	10	11	12.5	12.5	14.5	18	19	21	22	24

9 year	0	0	0	0	0	1	5	22	26	26	32	51
Rank 2	2.5	2.5	2.5	2.5	2.5	6.5	9	14.5	16.5	16.5	20	23

sum of R1=179
sum of R2=118.5

$U1= N1 \times N2 + [(N^1 (N^1+1))\div 2 - \sum R^1]$
$U2= N1 \times N2 + [(N^2 (N^2+1))\div 2 - \sum R^2]$

U1=43
U2=103.5

43 not lower than the test statistic of 37 for 12 pairs of data ($P<0.05$) so the null hypothesis can not be rejected meaning that it can not be proven that there is a significant difference between % cover of nettles in the 7 year and 9 year mown plots.

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Test 7

Hypothesis 7- there is a significant difference in % cover of *U. dioica* between the 7 year ago mown plot and the 2 year mown plot.

Null hypothesis 7- there is no significant difference in % cover of *U. dioica* in the 2 and 7 year mown plot.

7 year	1	3	7	13	21	21	22	30	31	39	42	54
rank	1	2	3	4	5.5	5.5	7	8	9.5	12	13	15

2 year	31	33	44	60	64	66	68	72	78	81	87	91
rank	9.5	11	14	16	17	18	19	20	21	22	23	24

sum of R1=85.5
sum of R2=235

$U1= N1 \times N2 + [(N^1 (N^1+1))\div 2 - \sum R^1]$
$U2= N1 \times N2 + [(N^2 (N^2+1))\div 2 - \sum R^2]$

U1=136.5
U2=-13

-13 is lower than the test statistic of 37 for 12 pairs of data ($P<0.05$) so the null hypothesis can be rejected meaning that there is a significant difference between % cover of nettles in the 7 year and 2 year mown plots.

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Conclusion

The results suggest that both my predictions were partially correct but lacked specificity. For example prediction 1 is not clear in saying what and how many types of species will become scarce as stinging nettles % cover rises. So although this prediction is backed up by the graph that shows average % cover of grass decline as average % cover of nettles rises it is proven wrong by the graph showing average species richness as this starts to incline in a similar way to the nettles. However, a likely reason for this incline may just be because of the lower levels of trampling because as you can see the average species richness does start to decline again when the nettles are most abundant (in quadrats A and J). Therefore there are two patterns.
The graph (4) that shows average % cover of other species also helps back up prediction 2 as this graph also shows a decline when the nettles are on the rise (graph 1). Furthermore, "other species" may not just be plants but could be animals that are also on the decline because of the nettles. This makes it difficult to distinguish whether prediction 2 is correct or not as one can not be sure that it is actually plants that are decreasing because of the increase in nettle cover or whether animals are affected as well. Overall there is probably enough evidence supporting the hypothesis that other plant species become more scarce as % cover of *U. dioica* increases.
Grazing and mowing have had similar effects on % cover of nettles, grass and other species. However, it is difficult to tell whether the mowing and grazing have had exactly the same effects as it is unknown how long the path has been there.

Overall management conclusions are that there is a significant difference between % cover of nettles 1-1.5 meters from the path and the unmanaged areas (quadrats A/J). This increases the species richness significantly. Mann Whitney U test P is less than 0.05.

Also from comparing the 2 sets of data carried out at the same time in the Fant Wildlife Area it can be concluded that 2 years of mowing is not sufficient way of increasing species richness. However, 7-9 years of mowing, combined with grazing by rabbits is an effective and significant way of reducing nettle cover and increasing the species richness. Mann Whitney U test P is less than 0.05.

Improvements

- Carry out experiment in different seasons so that we can identify other plants, e.g. different grasses by the flowers that they produce. This will help because in graph 5 the number of species depends on the experimenter's ability to distinguish them. This makes it difficult to draw a quantitative conclusion for prediction 1.
- More statistical tests could be done e.g. examine all the different path border regions compared with mowing frequency to see if there is a significant link.
- Repeat experiment on different paths to improve reliability. As the path the experiment was carried out on lies on a slight slope there could be altitude effects influencing the results. This could be why the graphs are not symmetrical. In this case it would be helpful to repeat the experiment on a path situated on flat ground.
- Weigh what is found in each quadrat to get a more accurate idea of how much is there is of each plant rather than % cover. Finding primary productivity is best done by cutting out everything in the quadrat, according to species, and then finding its dry mass. This would only be acceptable for common plants.
- Isolate types of management from each other (e.g. trampling and no mowing or grazing). Rabbit grazing could be isolated by introducing fences to keep them out, however this could only be done on a small scale as would be impractical to put fences up all over the FWA. This would make this analysis fair as there is overlap between the different types of management.
- Survey number of animals found and include graphs on commonly occurring animal species. This could help establish whether animals are affected by the dominance of nettles in particular compared with other plants.

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wildkids.org page: at wildkids.org.uk/teachers/secondgrass4.htm

Article on Stinging nettles in-www.wikipedia.com

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Appendix

Data from other surveys used for comparison in this report. Same date.

			2 year mowing			
Nettles%	Bare%	Grass%	Brambles%	Thistles%	Moss%	Other%
44	50	0	2	0	4	0
91	9	0	0	0	0	0
72	26	0	0	0	0	2
66	29	0	0	0	1	4
81	19	0	0	0	0	0
78	17	0	0	0	2	3
33	67	0	0	0	0	0
68	18	0	0	0	0	15
60	37	0	0	0	0	0
64	34	0	0	0	0	0
31	75	0	3	0	0	1
87	12	0	1	0	0	0
average65	average 33	average 0	average 1	average 0	average 1	average 2

	7 year mowing		
Nettle%	Grass%	Thistle%	Moss%
39	10	11	33
21	70	6	3
54	30	12	4
13	20	9	58
7	33	8	53
42	48	3	7
1	86	10	3
30	39	6	21
31	43	16	8
21	63	3	9
22	70	1	6
3	77	4	2
average 24	average 49	average 7	average 17

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	9 year mowing			
Nettle%	Grass%	Thistle%	Moss%	Other%
0	67	6	15	8
22	68	0	8	0
1	72	1	23	0
51	39	0	2	3
0	91	4	0	4
0	89	6	3	0
26	22	1	31	0
32	54	2	10	0
26	56	0	1	13
0	88	7	1	0
5	82	6	1	0
0	74	9	4	7
average 14	average 67	average 4	average 8	average 3