Candidate B

To study the dynamic coastal psammosere of Studland Bay

Introduction to Investigation:

Aim of Investigation:

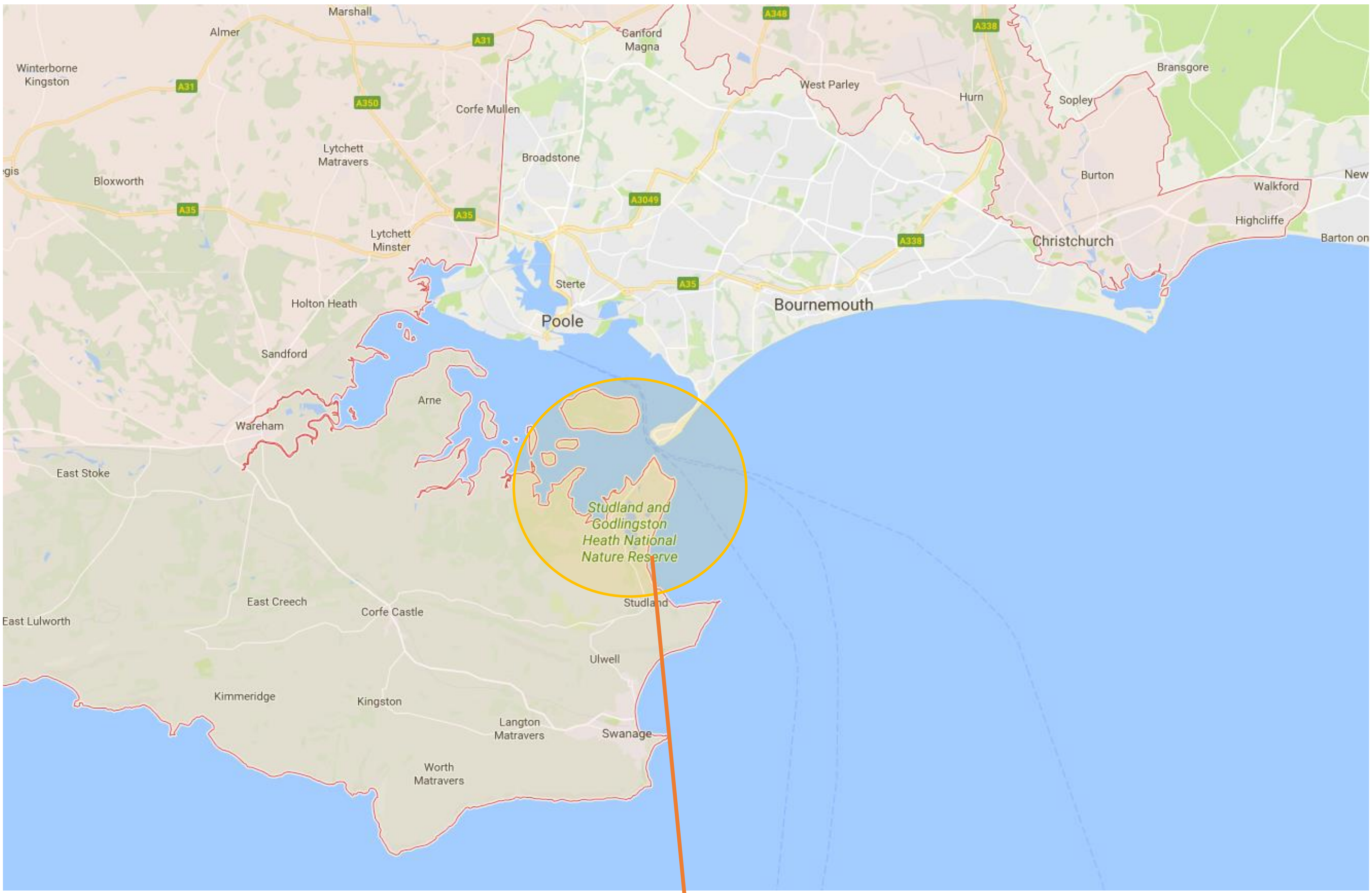
To study the dynamic coastal psammosere of Studland Bay – particularly the dune systems - and assess the extent to which human interference, natural ecosystems and biodiversity can coexist in this location. I aim to conclude to what extent the interference needs to be modified or monitored, for the continued prosperity of the psammosere.

Hypotheses: - These will be tested in Data Analysis:

- 1) Alternate: H_1: Proximity to the 'Honey Pot Site' (HPS) (and hence more human interference) is directly correlated to reduced percentage vegetation cover in the Studland Bay psammosere.
- 1) Null: H_0: Proximity to the HPS (and hence more human interference) has no correlation with percentage vegetation cover in the Studland Bay psammosere.
- 2) Alternate: H_1: Proximity to the HPS (and hence more human interference) is directly correlated to increased size of blowouts in the Studland Bay psammosere.
- 2) Null: H_0: Proximity to the HPS (and hence more human interference) has no correlation with the size of blowouts in the Studland Bay psammosere.

Studland bay is located on the south coast of England in the county of Dorset. It is near to the city of Bournemouth and has the OS Map grid reference: SZ 0344 8349. It is accessible via the A35, and the M3 extends the sphere of influence as far as London. The area benefits from the World Heritage site status of the Jurassic coast which brings international attention to the coastline.

Figure 1 (Continued overleaf): Maps to show the location of Studland bay on the south coast of England, in the county of Dorset.


Marshall
Almer
Winterborne Kingston
Canford Magna
West Parley
Hurn
Bransgore
Sopley
Corfe Mullen
Lytchett Matravers
Broadstone
Bloxworth
Burton
Walkford
Highcliffe
Barton on
Lytchett Minster
Christchurch
Sterte
Holton Heath
Poole
Bournemouth
Sandford
Arne
Wareham
East Stoke
Studland and Godlingston Heath National Nature Reserve
East Creech
Corfe Castle
Studland
East Lulworth
Ulwell
Kimmeridge
Kingston
Langton Matravers
Swanage
Worth Matravers


Cherbourg, FR - Poole, UK
Ferry Rd
Studland and Godlingston Heath National Nature Reserve
St Peter Port, GG - Poole, UK
Knoll Beach Café and Amenities – referred to as HPS
Studland
Swanage Rd

Theory and Issues of Investigation Location and Justification for Investigation:

I have chosen to investigate this area, as it is a dynamic landscape under pressure from many factors. The perceived main factor is human interference and the resulting erosion of vegetation. Vegetation plays a key role in stabilising the psammosere, and so if vegetation and plant succession is impeded or otherwise adversely affected by humans, the dune system becomes more vulnerable. Studland Bay is an especially precarious example, as it experiences up to '1 million visitors' per year, and at peak times, can experience 25,000 visitors during one day. The sheer volume of tourists, places strain on the entire littoral cell. The attractiveness of Studland Bay's sand dunes, has resulted in the landform becoming a victim of its own success, as humans bring with them litter, the power to erode and the danger of dune fires. The area is managed by the National Trust, who have strict polices in place to preserve the ecosystem, whilst also keeping intervention to a strict minimum to allow natural processes to pervade. The problem of human interference on the sand dune system is a devise issue, as the National Trust attempts to preserve the sand dunes; however, the underlying argument to any staunch conservationist is that any human interaction with natural processes and ecosystems will inevitably lead to disruption to these processes and damage to the ecosystem.

Sand Dune succession is initiated at the strand line on a beach. Succession can be defined as the process by which varying vegetation in an ecosystem successively gives way to another until a stable climax is reached. My area of study is the Studland Bay psammosere – a psammosere is a seral community, or ecological succession, that began life on newly exposed coastal sand. The origins of the Studland Bay psammosere began being deposited on the eastern shore of the Studland peninsula approximately 400 years ago [6]. The process likely began after a storm, which left the strand line above the normal high tide line, and therefore it was unaffected for long periods of time. Sand accumulated on the strand line as it was carried landwards by saltation from the sea, and this process lead to the formation of an embryo dune. Hsu (1974) devised an equation to measure the rate of sediment deposition on sand dunes, and I calculated an estimate for the Studland Bay psammosere, that sand is deposited at a rate of 0.015 kg/m/s. The embryo dune is especially vulnerable to erosion, and only begins to consolidate after pioneer species, such as clover, sea couch or marram grass begin to colonise the embryo dune. The vegetation holds the loose sediment together with its roots. The pioneer species are a mixture of xerophytes and halophytes, meaning the species are adapted to thrive in the extremely dry, warm and salty conditions found near the strand line. As well as the marram grass, the embryo dunes are home to an array of wildflowers throughout the summer, with dandelions, heath bed straw and white clover all common [6].

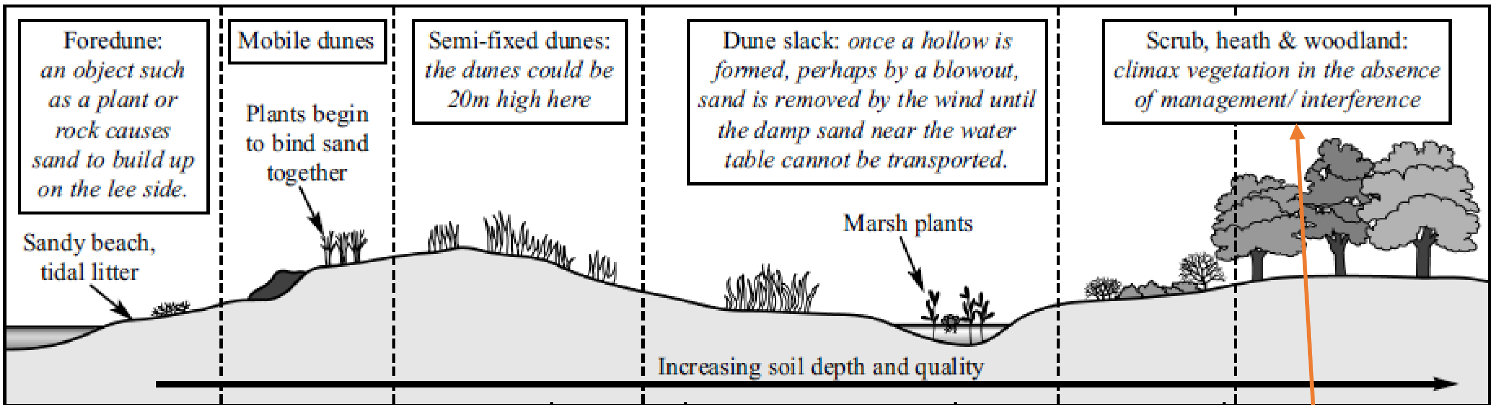
Progressing inland, many abiotic characteristic features change and help determine the natural succession of the dunes. For instance, the drainage slows down as the land becomes more compact and has better soils – due to a build-up of humus from decaying, outcompeted vegetation - and the pH drops as the proportion of seashell fragments reduces and the amount of humus increases. The Studland dunes themselves are unusual, because they are made of acidic sand with very low shell content. This acidity means that after about 60 years, when the roots of the marram grass have anchored the sand in place, they become colonised by heather, and most of the Studland dune system is characterised by dune heath. This section of the psammosere is known as the Yellow/ semi-fixed dune. With more than 75 hectares, Studland is the largest area of dune heath on the South Coast [4]. The dune heath is home to all six native UK reptiles, as well as birds including Breeding Nightjars and Dartford Warblers (7% of the UK's population of Dartford Warblers are found at Studland) [4]. This unique biodiversity has resulted in the Studland Peninsula being recognised as a SSSI (Sight of Specific Scientific Interest) and a NNR (National Nature Reserve).

The first trees that appear are typically fast-growing trees such as Silver Birch, Willow or Scots Pine. These trees outcompete the heathers and the resulting grey dune is characterised by woodland. These trees will be supplemented by slow-growing, larger trees such as Ash and Oak, and this is the climax community, defined as the point where a plant succession does not develop any further because it has reached equilibrium with the environment. If there was to be no human intervention, the Dorset coastline would naturally reach a climax of dense deciduous woodland. However, human intervention in the coastal zone has resulted in a plagioclimax community, in which further succession is prohibited and so the dune system is forced into an artificial equilibrium. Some estimates suggest there has been an 80% decrease in heather covering in the Studland psammosere as Bournemouth has grown in size over the past 100 years. Human interference in the psammosere has associated problems both inadvertently, such as species disturbance, and advertently, such as littering - as well as isolated disastrous events such as a fire in 2001, caused by a discarded cigarette. The psammosere vegetation continues to struggle to re-establish in the scar.

Figure 2: Photograph to show the scarred dunes in the Studland psammosere, following a wildfire caused by a discarded cigarette in 2001.

Given the threats to this dynamic and rare environment, I think it is vitally important for the economic success of the coastal communities, and the continued prosperity of the psammosere, to assess whether humans and the psammosere can coexist. The results of my investigation could perhaps be used to reassess the National Trust's stance on the accessibility of the Studland Bay psammosere, and it could be that restricted access is the only sustainable solution for the long-term prosperity of the psammosere. Any empirical evidence I collect can be used and tested in other psammoseres to individually assess to what extent human interference in dune systems worldwide needs to be controlled.

Figure 3: Diagram to show a hypothesised psammosere succession [5].



Site number/description	Strand line (1)	Embryo dunes (2)	Fore dunes (3)	White/yellow dunes (4)	Fixed dunes (5)	Dune slack (6)	Dune scrub (7)	Dune heath (8)	Woodland (9)
Distance from the sea (m)	0 - 20	20 - 80	80 - 150	150 - 300	300 - 500	500 - 700	(400) variable	700 - 2500	2500+
Approximate age (years)	-	0 - 50	50 - 100	100 - 125	125 - 150	150 - 250	-	250 - 400	>400
Soil colour	-	Yellow			Yellow / Grey		Grey	Brown	
Soil surface pH	8.5	8.0	7.5	7.0	6.5		6.0		4.5
% Calcium carbonate	10	8	8	5	1	<0.1			
% Humus	<1			2.5	5	10	20		>40
Dominant plant species	Sea Rocket, Saltwort	Sand, Couch, Lyme Grass	Marram Grass, Sea Holly	Marram, Sand Sedge	Harebell, Willow	Creeping Willow, Common Sallow	Birch, Brambles	Heather, Gorse	Pines, Oaks

My 800m transect was conducted approximately 50m landwards of the strand line. Therefore, in theory I would have expected to have encountered plentiful Couch and Lyme Grass. However, the dominant species across the transect was heather, and this shows that the Studland psammosere doesn't fit the hypothesised dune succession diagram above. My wider reading revealed that approximately 60m from the strand line, the dominant vegetation should be heathers.

Furthermore, the pH at the start of the transect was 4.81, which is nearly half of the prediction at this distance. This can be attributed to the low amount of shells in the Studland psammosere. This distinction was also derived from wider reading and secondary data collection.

The key to my investigation is the balance between interference and management and the effect this has on the psammosere's ability to reach climax vegetation. There is a constant conflict between the National Trust and tourists, and I aim to assess how these two main stakeholders, along with others, can coexist with the psammosere and preserve the interests of all involved.

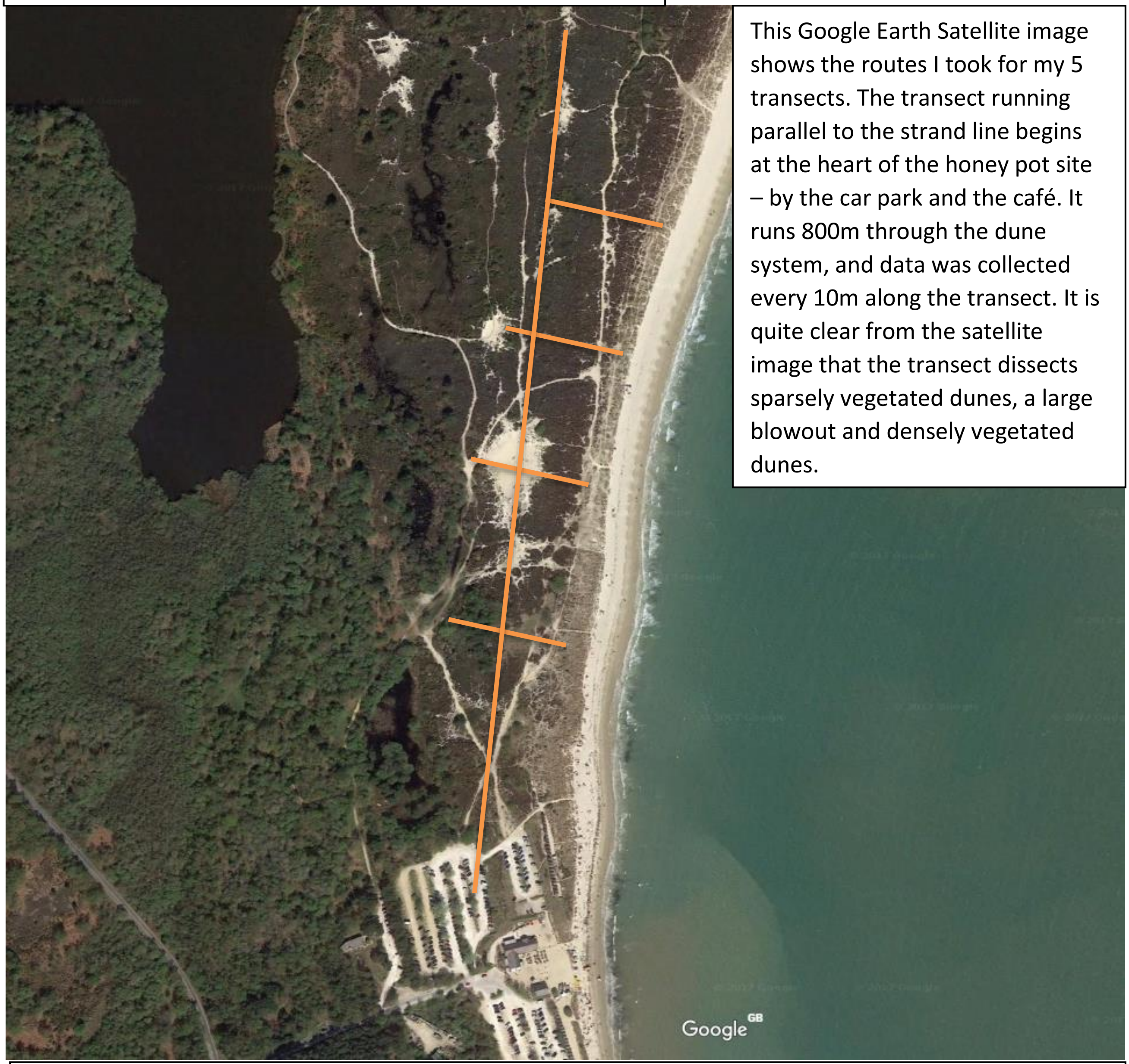
Literature Review:

Source:	Advantages:	Limitations:	Summary/ Improvements:
http://somegeographyannalikes.blogspot.co.uk [10]	This blog is dedicated to Geography case studies and had a very detailed evaluation of the methodology used, this allowed me to plan my own methodology and where necessary, evaluate the ways in which I could improve it.	The blog didn't report any data and so I cannot compare my findings to their results. The blog didn't feature any analysis of data nor did it come to a conclusion of any clear hypothesis. Additionally, the hypothesis was subtly different to my hypothesis and so the results wouldn't have been directly comparable anyway.	The blog lacked a clear aim, it focussed more on fieldwork techniques rather than answering a hypothesis. Nevertheless, the fact that other people are investigating the Studland psammosere affirms its prominence as a coastal landscape, in need of investigation.
http://www.rgs.org [11]	The source had a useful overview of the Studland Psammosere and was helpful in explaining that when using a quadrat to measure vegetation cover, the value can be greater than 100%, as the quadrat reading is in 3 dimensions and so incorporates ground vegetation as well as any overhanging vegetation. It also provided context to the wider course.	The website lacked any data or methodology and the hypotheses suggested weren't relevant to my study.	The source provided detailed information in some aspects, but this detail wasn't consistent throughout and its use was therefore heavily limited. The Royal Geographical Society is dedicated to the development of geographical knowledge, and through promoting Studland Bay as an area ideal for fieldwork, it proves the prominence of the psammosere as a landscape of great significance.
The Geography of Coastal Sand Dunes – Geo Factsheet 119	This source provided much of the theoretical grounding for my investigation. It detailed plant succession as well as the characteristics of each section of a theorised psammosere. This was useful to then compare my findings.	Unfortunately, the Geo Factsheet only provides evidence for a hypothetical psammosere, and does not provide any specific case study information for Studland Bay.	A case study on the Studland bay psammosere would have been very useful, however there was plentiful information which helped me understand the theory and the issues surrounding my area of investigation.

Source:	Advantages:	Limitations:	Summary/ Improvements:
French, P. (1997) Coastal and Estuarine Management, Routledge, P148-169	This source had a very detailed analysis of the impacts of tourism on sand dune coastlines, and also provided further useful citations covering the effects of human intervention on a large scale.	The source focussed largely on the coastlines of the Caribbean and the Mediterranean, as these seem to be hotspot areas for research, therefore there was little direct analysis or data for Studland Bay.	The amount of citations in this source, and the breadth of the research of psammoseres worldwide gives credence to my investigation and shows how tourism and wildlife attempt to coexist in many locations, not least the Studland Bay psammosere.
Hordern, B. (2006) Rivers and Coasts, Phillip Allan Updates, P 79-86	This textbook covered many aspects of my investigation, from theory, to diagrams and statistical tests.	Unfortunately, as a textbook it was largely content focussed, and didn't feature any fieldwork data/ citations from Studland Bay.	A useful source to clearly present the theory that my investigation aimed to prove.
Carter, C. Geographical Investigation into sub session on the Studland Heath Land	This online publication covered many questions such as: 'How does plant cover change through the succession?' and 'How and why does vegetation change along a psammosere succession?' These questions are like my sub-questions and the methodology of this investigation was very similar to my own. This shows that my hypothesis is one that others are actively trying to assess, which shows its relevance.	The content was published on a website that required payment to access the full investigation write up, which was a serious limitation. Furthermore, from the data and analysis that was able to preview, the investigation focussed more on abiotic factors and its relationship with succession, and it focussed less on human interference as a factor in succession.	It would be useful to have read the entire investigation, but it proved that Studland Bay psammosere is a topical location in which to pose an important hypothesis. Perhaps its lack of focus on human interference suggests that the investigator believes human interference has already been researched enough or they omitted it as a factor of succession in order to focus more on abiotic factors.

Methodology and Data Collection:

Figure 4: Google Earth satellite image of the Studland Bay psammosere showing the Knoll Beach café and car park. Overlaid with 5 transect routes.



This Google Earth Satellite image shows the routes I took for my 5 transects. The transect running parallel to the strand line begins at the heart of the honey pot site – by the car park and the café. It runs 800m through the dune system, and data was collected every 10m along the transect. It is quite clear from the satellite image that the transect dissects sparsely vegetated dunes, a large blowout and densely vegetated dunes.

The 4 transects which ran perpendicular to the coastline and bisected the psammosere were chosen systematically, every 150m along the coastline, and data was collected every 10m along the transect route. This meant that I collected data that was free from location bias. Another advantage of systematic sampling over stratified sampling is the assurance that the data set (location) will be evenly sampled. There exists a chance in stratified sampling that allows a clustered selection of data, which isn't representative of the entire data set (the psammosere). This chance is systematically eliminated in systematic sampling [13].

The orange line shows the route of my transect. The overlaid grid system attempts to show how moving across the psammosere can reduce the area's application to my hypothesis. For example, the areas highlighted blue would return near useless data for me as they are too far from the honey pot site, which is the focus of my question. These areas feature either simply woodland or sea, whereas the area highlighted pink – my transect area – shows a number of key sub groups, such as the honey pot site, heathland vegetation, gorse and blowouts, these therefore strengthen the relevance of my data.

Figure 5: Google Earth satellite image of the Studland Bay psammosere showing the Knoll Beach café and car park. Overlaid with my 800m parallel transect route, and grid system.

A key feature that was captured within the transect was the honey pot site – characterised by the Knoll Beach Café, Car Park and other amenities – all in close proximity. This was vital to my data collection as my transect was directly affected by the honey pot site and the level of human activity in the immediate area. For example, if I had carried out my transect 100m away from the honey pot site, it gives less credence to my data collection as tourists are unlikely to venture away from this location.

The transect – whilst the route was determined by stratification – was used to collect systematic data. I recoded the percentage of vegetation every 10 metres along the transect, and this data collection method allowed me to systematically assess the vegetation throughout the psammosere. Effectively, any section of the dune system along the transect route had the same probability of being selected, this prevented me, as the researcher, from collecting biased data.

Method:	Justification:	Successes:	Limitations:
Questionnaire – I produced my questionnaire the night before I would be collecting my primary data. I arrived at my questions based on aspects of geographical theory and secondary sources I wanted to test. I knew that I could statistically test the geographical issues in the Studland psammosere, and I wanted some qualitative data to offer reasons for any empirical trends that I might find. I composed questions for both National Trust wardens and Tourists, as this would enable me to critically evaluate the empirical data from the perspective of the two main stakeholders in the psammosere.	This is a qualitative data collection method and I believed that is would help to supplement my quantitative data. I developed my line of questioning hoping to utilise the answers to gain a further understanding of the interrelationship between humans and the psammosere.	I gleaned some in depth information from the National Trust warden, which certainly wasn't published on the National Trust website, or any other secondary sources. It was a great addition to my investigation to see how the implementation of National Trust policies are carried out on the ground, and their relative success. From the tourists, I gained an insight into their reasoning behind their behaviour in the psammosere.	The main limitation of my questionnaire was the sample size. Given that Studland Bay has circa. 1 million visitors per year, my results may be far from characteristic of the tourist population and so this makes it unreliable to base conclusions solely on this qualitative data.
800m Transect (Parallel to strand line) – A transect is a line across a habitat, along which data can be collected and a profile of the ecosystem can be generated. It is a quantitative data collection method. I used a 1m x 1m quadrat (broken up into 10cm x 10cm squares) to measure the percentage vegetation at regular 10m intervals along an 800m section of dune which I mapped out using Google Earth satellite imagery so that I wouldn't deviate from my path. At each point along the transect, both vegetation cover and bare ground were recorded. This method of data collection means that often there is more than a 100% covering of the sample as the vegetation grows in three dimensions and often moss can be overlaid with heather which can be overlaid by the leaves of a tree. The process was simply to measure out 10m and then lay the quadrat down and record the vegetation. Recording the vegetation involved identifying the species using a handbook given to me by a Fieldwork Coordinator, and then counting how many times this vegetation featured in the quadrat – which would give me a percentage value. This process had to be altered for the first 150m of the transect as this is a National Trust exclusion zone, and in the interest of sustainability and abiding to the rules, we had to record vegetation in this area holding up the quadrat and viewing the vegetation from a profile view as opposed to a birds-eye view, as we couldn't enter the exclusion zone.	This method was to be my main source of quantitative data, and I believed the empirical results would help me to directly answer my hypothesis.	The transect covered a very large sample of the psammosere and the data was easily adaptable into graphical form.	As the transect covered such a large distance I didn't have enough time to produce any more transects of this length that could be used to make comparisons. Additionally, it was hard to distinguish between some types of vegetation, and so this could have resulted in miss identification, leading to inaccuracies.

Method:	Justification:	Successes:	Limitations:
4 x 100m Transects (Perpendicular to strand line) – These transects were 100m in length and were spread every 150m along the strand line, from the honey pot site. I repeated the process to establish the vegetation covering, whilst additionally measuring the angle of the dune profile. This allowed me to build up an even more precise dune transect. To record this data, I placed two ranging poles in the ground 10m apart (measured by a tape measure for accuracy), and used a clinometer to measure the angle, which meant I could detail the elevation of the dune along the transect, and see if this differed along the coastline.	I wanted to have some more detailed dune transects which would allow me to analyse the effects of human interference on not just vegetation cover, but also topography. Additionally, I could compare the results from each of the 4 transects to see how vegetation cover changed moving away from the honey pot site. These transects would effectively increase my sample size and hence improve the validity of my conclusions.	These transects were easily adaptable into graphical form and they allowed for statistical tests.	The sample size was large enough to allow for comparisons and valid conclusions, but if time had allowed, I would have liked to have conducted transects every 100m along the strand line to add increasing validity.
Photography – As a useful qualitative tool, I took photos of interesting features in the psammosere. Some of these were human and others were natural in origin. The data is stratified as I attempted to choose key sub-groups within the psammosere and analyse them, rather than take photos objectively at given increments. This ensured that all my photography is focused on important topic areas linking directly to my hypothesis. Before taking the photographs, I conducted wider reading to give me an idea as to what issues are most prevalent and how geographical theory can be seen in practice. For example I was keen to photograph National Trust boardwalks to illustrate the theory and perhaps justify my conclusions.	This qualitative data would be helpful in illustrating any empirical trends that the quantitative data showed.	I encountered many interesting features throughout the psammosere, many of which could be used to explain empirical trends, and further validates conclusions.	My sample size was largely limited to the immediate area of the psammosere around my transects, and I likely fell foul of researcher bias, whereby I only photographed areas of the psammosere that I thought would help validate my hypothesis and so the data wasn't impartial and is not representative of the entire psammosere.

Risk Assessment:

Before leaving the classroom, we were briefed on the dangers of Studland Bay Sand dunes by the Leeson House staff, and we were encouraged to take sufficient precautionary measures. What follows is an assessment of the dangers and the strategies I used to stay safe whilst collecting my primary data.

Hazard	**Perceived Threat**	**Control Measures**	**Success**
Adders	Quite low as Adders can detect movement from long range and usually leave the area.	I was informed what Adders looked like and their most likely locations. Strong boots and thick trousers were recommended as a precautionary measure.	No Adders were encountered.
Naturists	Very low, as I am unlikely to be offended by nudity and the National Trust has a naturist zone which my transects didn’t enter.	My plan was to stay away from the naturist areas but if a naturist was present in my location I was given the beach warden’s number or advised to call Swanage Police.	No Naturists were encountered.
Unexploded Shells	The threat from an unexploded shell, whilst a rare event, would have devastating consequences.	Any metallic objects or foreign looking items were to be left and if a serious threat was perceived, the wardens were to be contacted.	No objects encountered raised cause for concern.
Dune Jumping	It may be tempting as a ‘short cut’ to jump off a dune or from one section of dune to the other. The potential for broken limbs is high if I was to fall heavily, despite landing on sand.	This practice was seriously discouraged by the Leeson House staff, and they made it clear that taking extra time to walk around an obstacle would be better than trying to jump over it.	I jumped off the edge of a blowout to retrieve my bag and the heavy fall reminded me that I shouldn’t be attempting any jumps and from then on I was more vigilant.
Sand in Eyes	Consulting the weather forecast showed relatively high winds and the potential for fast moving sand through saltation in the wind.	As it was a sunny day I chose to wear sunglasses on and off. Additionally, I sheltered from windblown sand in exposed areas.	Despite the blustery conditions, I was relatively unaffected by windblown sand.

Ranging Poles	Ranging poles feature large spikes to enable them to be thrust into the ground. I was handling them all day and so the threat was high, not only to myself but to those around me.	Keeping the spike downwards reduced the threat to my head and body. I was briefed to position the spike behind me pointing towards the floor to avoid stabbing myself or others in the feet. Strong footwear was utilised as a final protection mechanism.	It was a quiet day in the dunes so harming passers-by was less of an issue. On occasion, I was wary that when putting the ranging pole in the ground it was quite close to my feet, but solid footwear and due diligence prevented the threat developing into an incident.
Tape Measures	Tangling on bushes or tripping over the tape measure were both threats, as well as cutting hands when reeling the tape in.	A demonstration of how to handle the tape measure was sufficient to nullify the threats.	It was easy to see the tape measure as the white contrasted against the brown of the dune heather and so I experienced no incidents.
Gorse	The gorse posed a constant threat with its spines, especially when my transect crossed a gorse bush.	Simply avoiding gorse bushes was the remedy to this threat. Plasters were on hand to treat wounds if necessary.	Very little gorse was encountered on my transect due to my position within the dune system. When sampling an area with gorse in it, I used the quadrat to record the data in profile instead of climbing into the gorse bush.
Weather	The weather forecast predicted high temperatures >20°C and the potential for sun burn and heat stroke were therefore high due to the hours spent out in the exposed sand dune system.	Liberally applying factor 50 sun cream prevented a sun burn risk. Wearing a cap and carrying 2 litres of water would help against heat stroke.	The back of my neck was a little bit burnt, likely due to over exposure and lack of reapplication of sun cream. The water was sufficient to prevent dehydration and heat stroke.
General Vegetation	Marram grass and heather posed a minor threat, and their frequency over the sand dune meant that this threat was nearly ever present.	Strong boots and long trousers would protect against scratches to legs, and not touching the marram grass/ attempting to uproot the marram grass limited the threat of 'paper cuts'.	I chose not to wear trousers due to the hot temperatures and thus I suffered extensive scratching on my legs from the heather. These had to be treated with antibacterial cream once back at the centre. Marram grass was less of an issue as I would never attempt to uproot such a vital plant to the sand dune system.

Weaver Fish	The most venomous fish found in the English Channel. Often, they bury themselves along coastal areas in sand. They are usually docile; however, they are aggressive when aggravated.	This was difficult to safe guard against due to the way in which the weaver fish conceals itself. However, knowledge of the threat meant I was more vigilant. Having a contact number in case of emergencies was sufficient protection.	No weaver fish were encountered during data collection.

Ethical Considerations of Methodology:

Method:	**Problems:**	**Problems Encountered:**	**Solutions:**
Photography	Safeguarding of children and invasion of privacy of the public must be considered when taking images in a public place.	The days of my fieldwork collection were quite quiet and as a result it was easy to photograph the psammosere. On only a few occasions did I have to refrain from taking photographs until people had moved on from the location.	Simply waiting for people to move was sufficient. I never had to ask anyone to move, but if this situation had have arisen, asking politely and explaining the situation is as much as one can do.
Questionnaire	Asking for sensitive data could illicit an unwanted response from members of the public, it can also appear intrusive and distasteful.	I encountered no real problems when carrying out my questionnaire. I encountered nobody who declined to answer.	If my questionnaire had included sensitive questions, or perhaps tough questions, then warning the participant before they agree to answer the questionnaire is effective in preventing any unwanted invasion of privacy. Perhaps removing any questions that could be ‘unanswerable’ would help make a questionnaire more accessible for the participants and hence return better data.
Transects	The quadrat could cause damage to vegetation and ranging poles leave scars in the soil.	My quadrat was very lightweight and I didn’t notice it cause any damage to vegetation. The ranging poles did make pronounced holes in the soil.	I attempted to repair the hole in the soil after every insertion, but if I didn’t plant my ranging pole over vegetation, it was unlikely to impact the psammosere, as soil is mobile, and itself isn’t a living organism.

Secondary Data Collection:

For the duration of my fieldwork collection I was based at the Leeson House educational centre. They have a wealth of collated data from previous fieldwork collections and I could access this to supplement my primary data and hopefully provide more credence to my own results. Where possible throughout this document I have referenced information that was given to me through the annotation [6]. Usually information was passed on orally and so these are vague citations.

Leeson House Field Studies Centre

I accessed data that details the size and characteristic features of the blowouts in the Studland Bay psammosere. A blowout is an unvegetated depression in the psammosere where wind has eroded an unstable section of dune [3].

Blowout number	Distance from honeypot site (m)	Circumference (m)	Depth (m)	Number of entrance paths
1	366	119	1	3
2	454	250	4.3	7
3	578	100	4	6
4	730	30	1.5	3
5	751	56	1	3
6	795	36	1	3
7	824	26	1	2
8	830	17	1	2

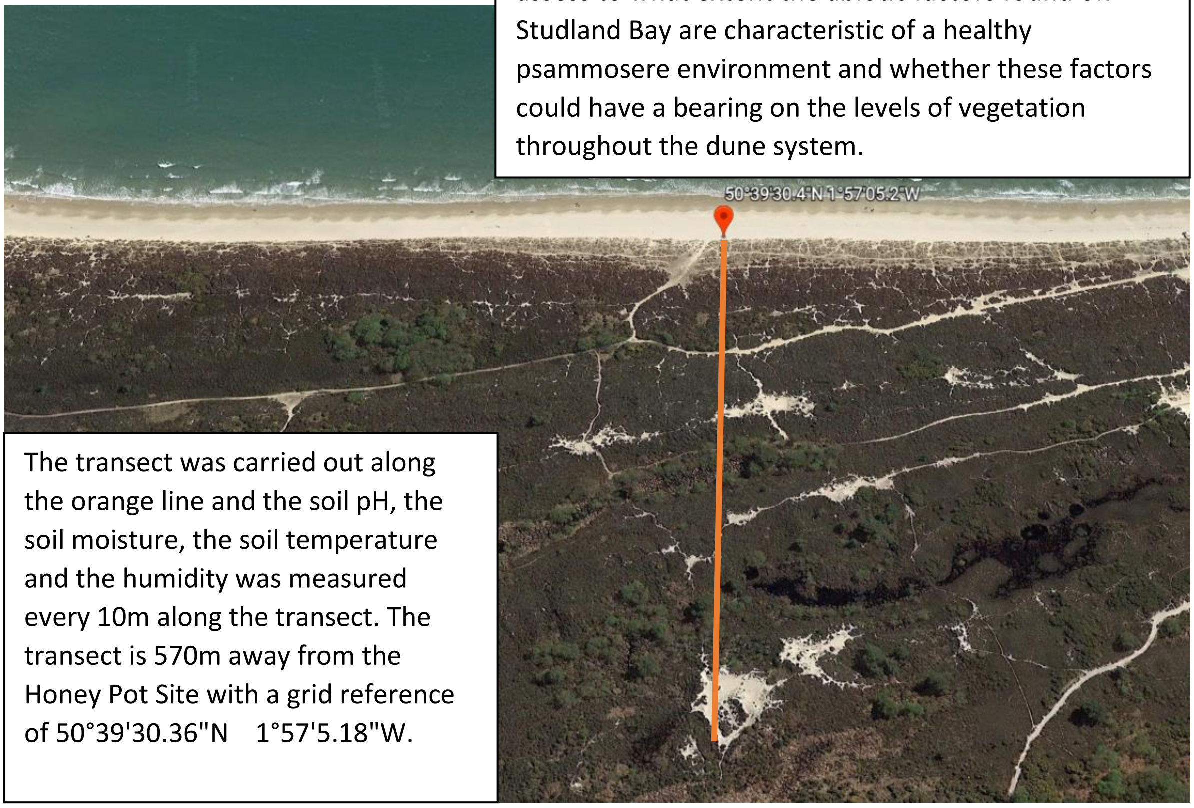
The distance figures were worked out using a GPS.

The circumference figures were measured using a GPS.

The depth was measured by placing a ranging pole in the bottom of the blowout, and one on the outer circumference, using a clinometer to measure the angle between the two points, Pythagoras's theorem could be used to measure the vertical distance between the points.

The number of entrance paths was observed by eye.

Further secondary data came in the form of a dune transect conducted to measure the abiotic factors present along a characteristic stretch of the Studland psammosere. This is useful data as it allows me to assess to what extent the abiotic factors found on Studland Bay are characteristic of a healthy psammosere environment and whether these factors could have a bearing on the levels of vegetation throughout the dune system.



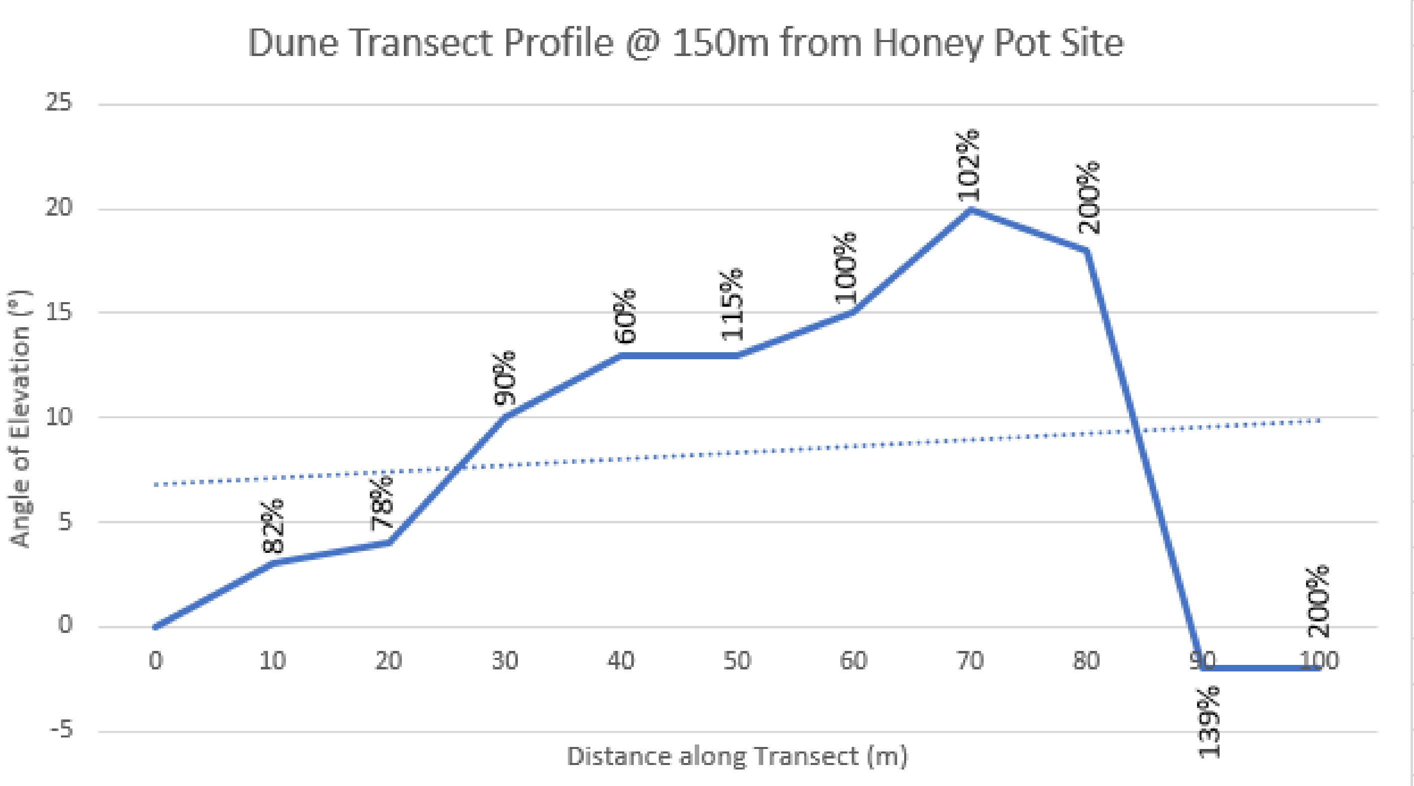
The transect was carried out along the orange line and the soil pH, the soil moisture, the soil temperature and the humidity was measured every 10m along the transect. The transect is 570m away from the Honey Pot Site with a grid reference of 50°39'30.36"N 1°57'5.18"W.

Figure 6: Google Maps satellite image of the Studland Bay psammosere showing an area approximately 500m to 700m away from the Honey pot site.

Distance (m)	pH	Soil moisture (%)	Soil Temperature (◦)	Humidity (%)
0	7.96	5	14.5	44.8
10	6.66	4.8	14.8	42.8
20	5.63	5.6	14.6	44.2
30	6.05	5.8	15.1	45
40	4.72	6.1	13	46.9
50	4.81	6	14.3	46.2
60	4.91	7.6	13.8	42.3
70	3.91	10.4	14.3	43
80	4.15	12.8	16.7	45.8
90	4.86	58.4	15.4	38
100	3.91	33.9	14	42.8
110	4.9	18.6	18	36.9
120	4.4	2.5	14.9	37.9

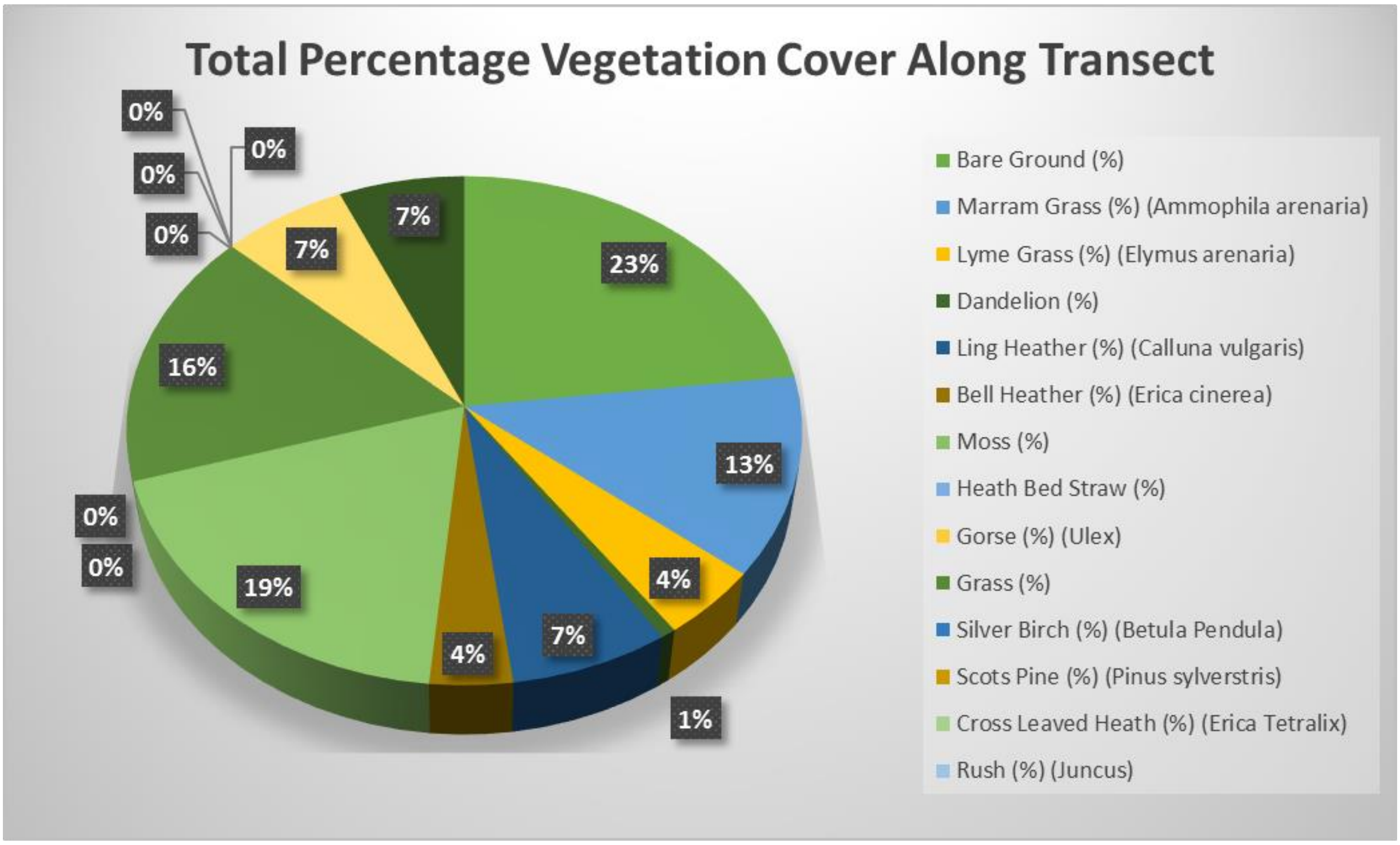
Data Presentation:

Figure 7: Dune Transect Profile for the dune transect 150m away from the honey pot site showing compound elevation along the dune - featuring trendline. Percentage values show total percentage vegetation cover at that point.



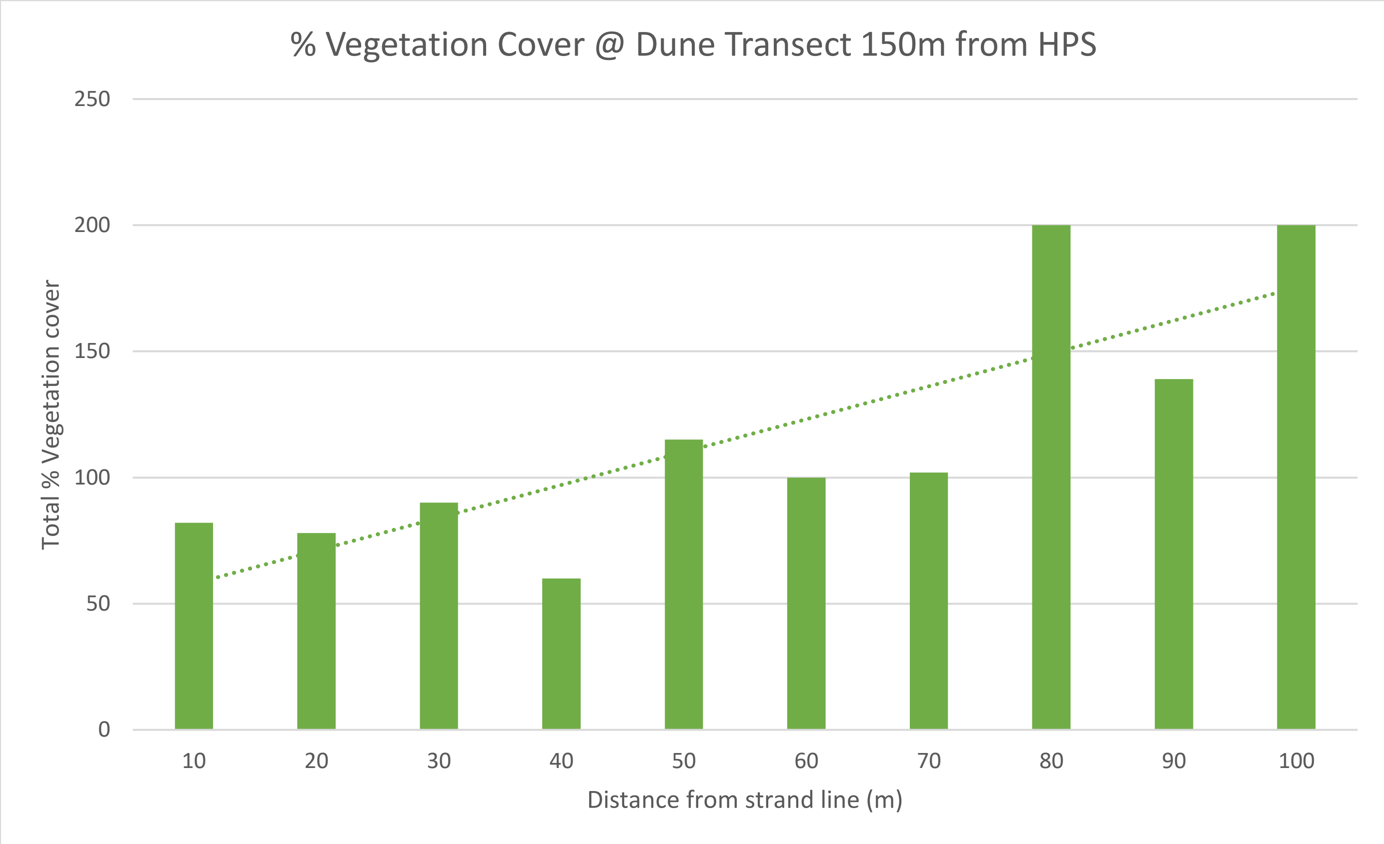
This is a characteristic dune profile. Vegetation increases as the transect moves inland, however the topography is somewhat extreme, with a dramatic dip into what we would expect to be a dune slack, I could find no evidence for this severe elevation, and despite being close to the honey pot site, it is likely to just be an anomaly.

Figure 8: Pie chart to show the breakdown of species cover along the transect 150m from the honey pot site



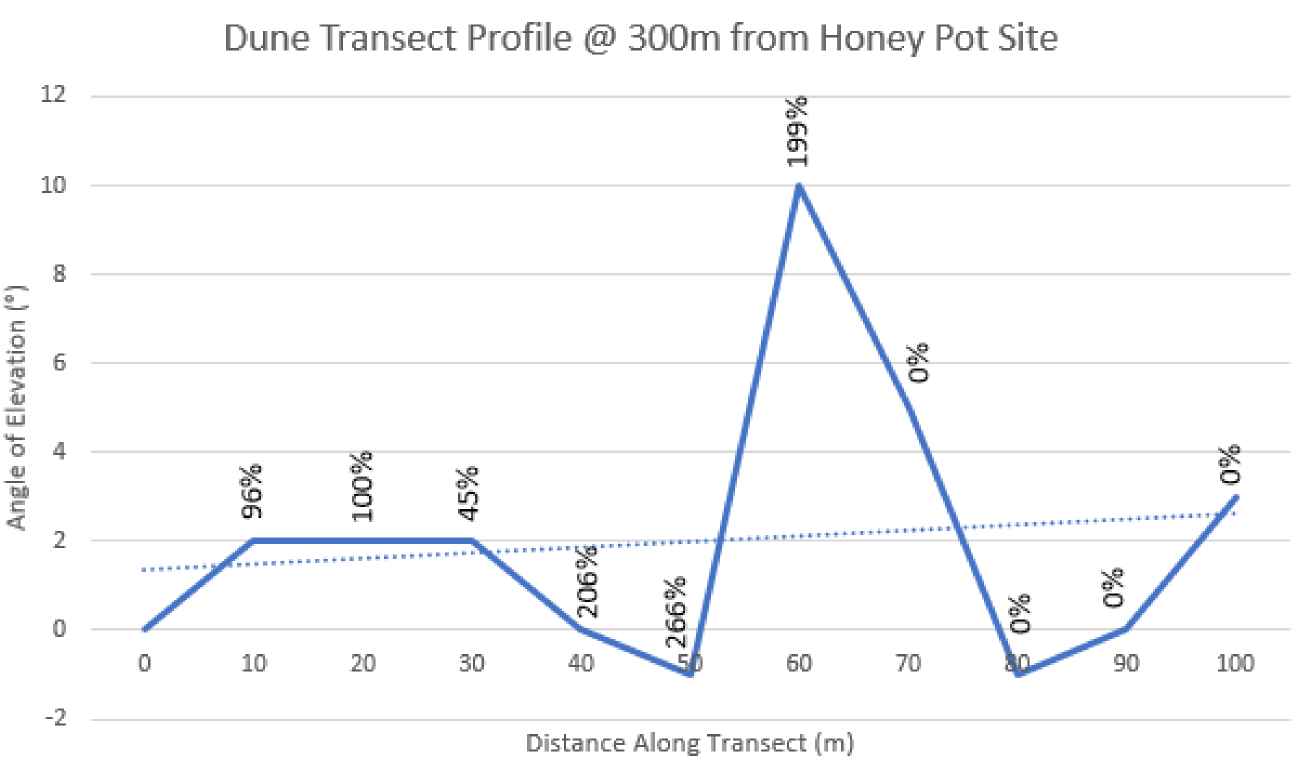
This pie chart shows that there are 10 different species found along this transect, which was the most along all 4 transects. Being closest to the honey pot site has also resulted in a large percentage of bare ground, which is the most dominant feature, followed by grass and moss at 16% and 19% respectively. The appearance of these species shows that the ground is frequented by tourists and the sparsity of dense vegetation coupled with the wide variety of vegetation shown, suggests that succession is affected in this section of the dune.

Figure 9: Bar chart for total percentage vegetation cover along the dune transect at 150m away from the honey pot site



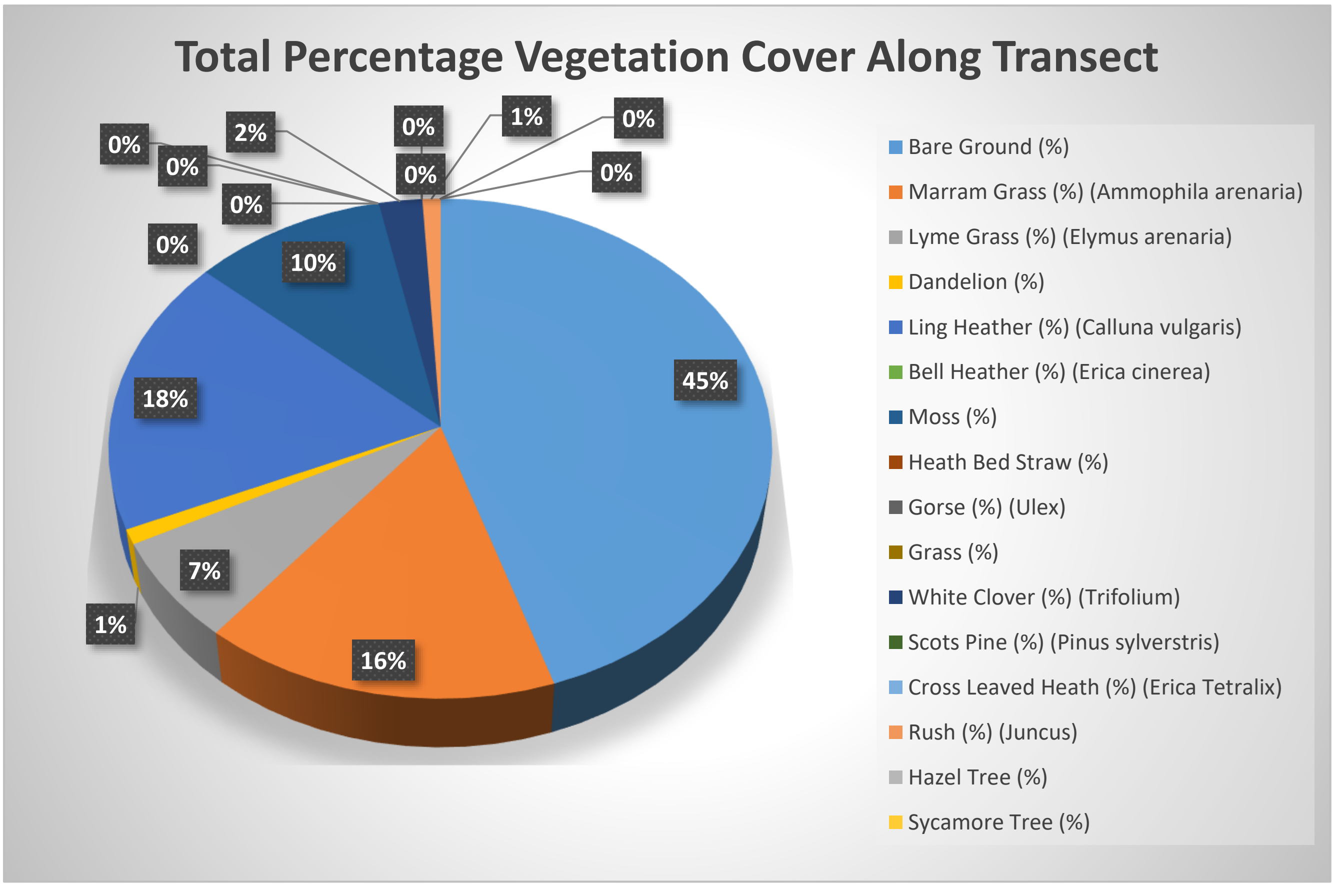
Despite being close to the honey pot site, vegetation levels increase along the transect which is the progression we would expect to see based on the theory of psammosere succession. However, it is of note that there are very low levels of vegetation close to the strand line and this could be due to heavy human interference, resulting in erosion of pioneer species.

Figure 10: Dune Transect Profile for the dune transect 300m away from the honey pot site showing compound elevation along the dune featuring trendline. Percentage values show total percentage



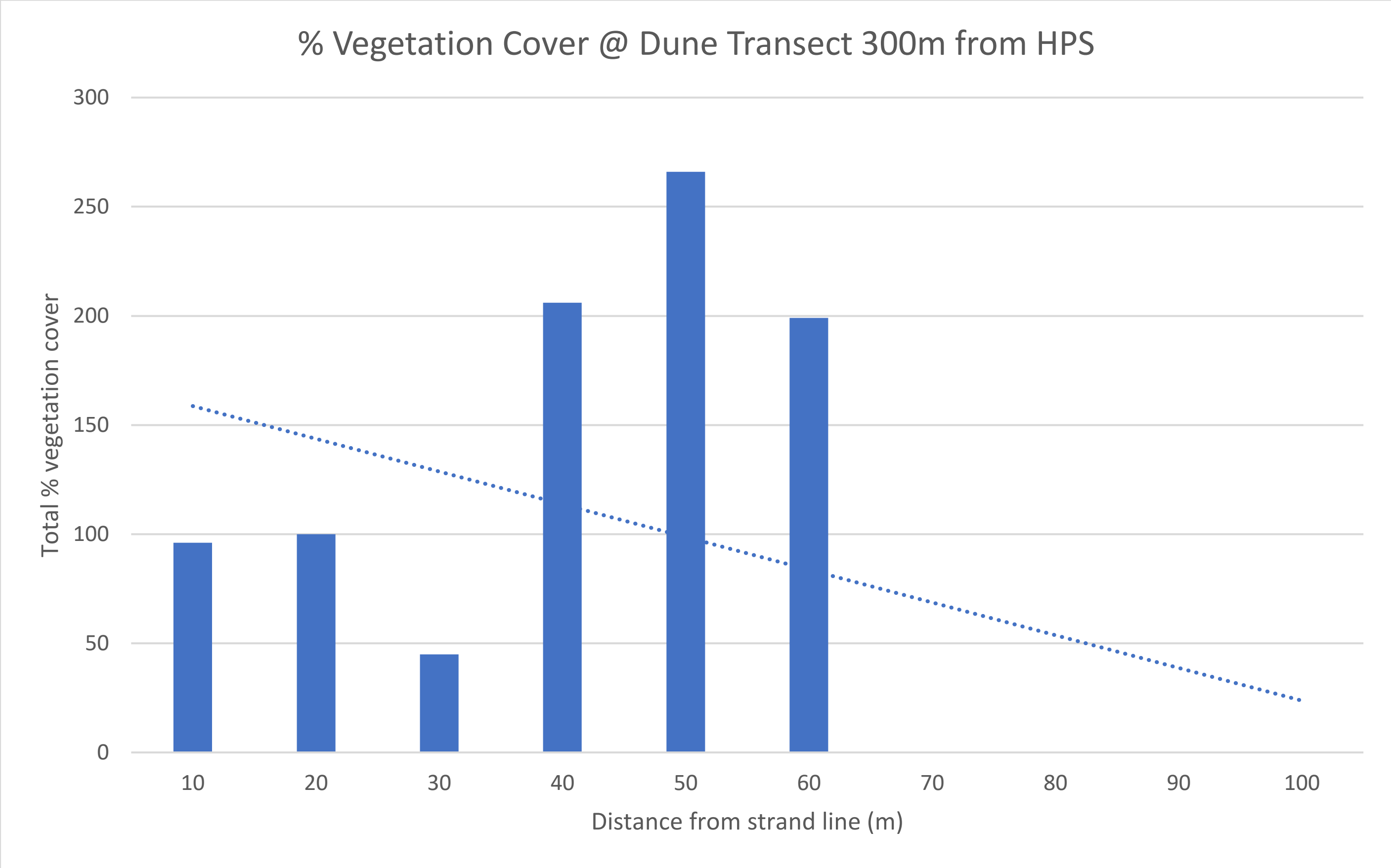
This dune profile is far from characteristic. Vegetation peaks to very high levels halfway along the transect before the transect enters a blowout. The dramatic change in elevation is due to the sides of the blowout being so pronounced, and due to tourist popularity, the depth of the blowout continues to be eroded deeper, further distorting the dune profile. Of course, human interference in this area has eroded all vegetation for 40m along the transect.

Figure 11: Pie chart for breakdown of percentage species cover along the transect 300m from the honey pot site



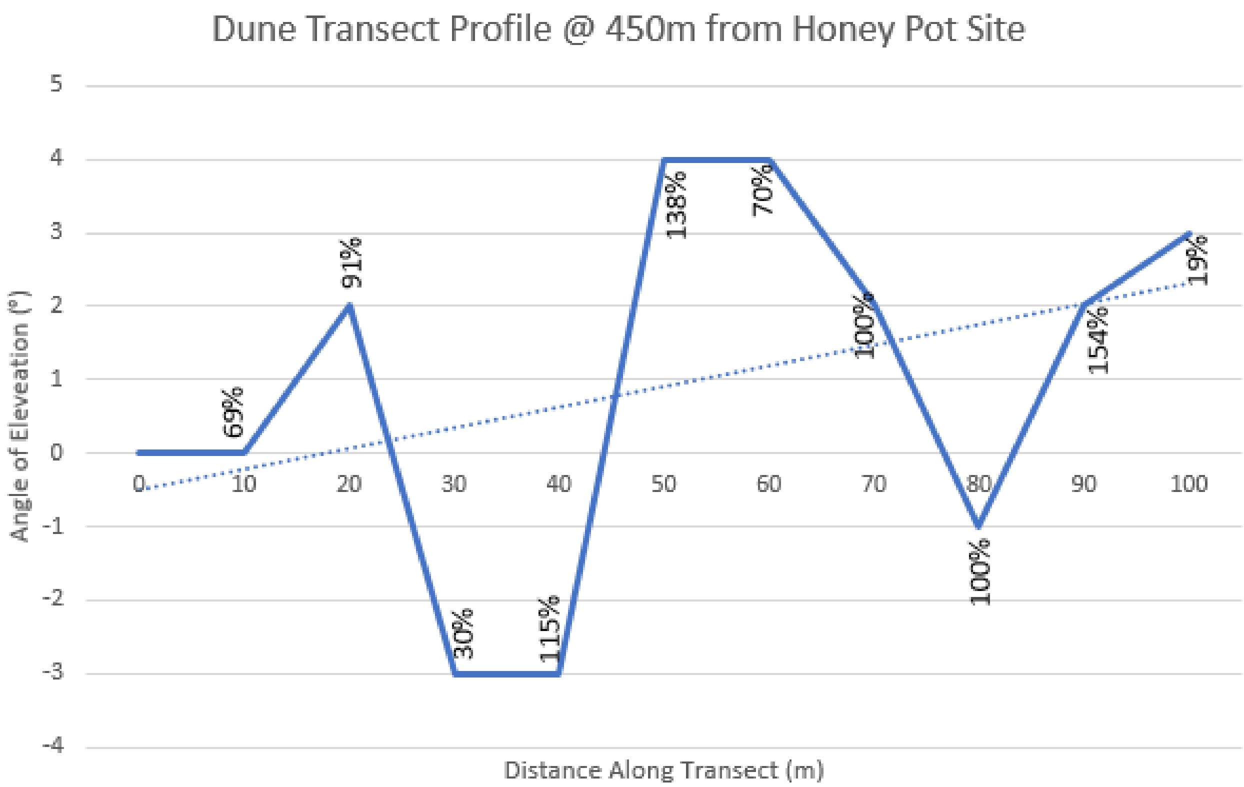
Despite being further away from the HPS than the 150m transect, the percentage of bare ground has nearly doubled due to the presence of the blowout. This is a clear example of how human interference affects succession.

Figure 12: Bar chart for total percentage vegetation cover along the transect at 300m away from the honey pot



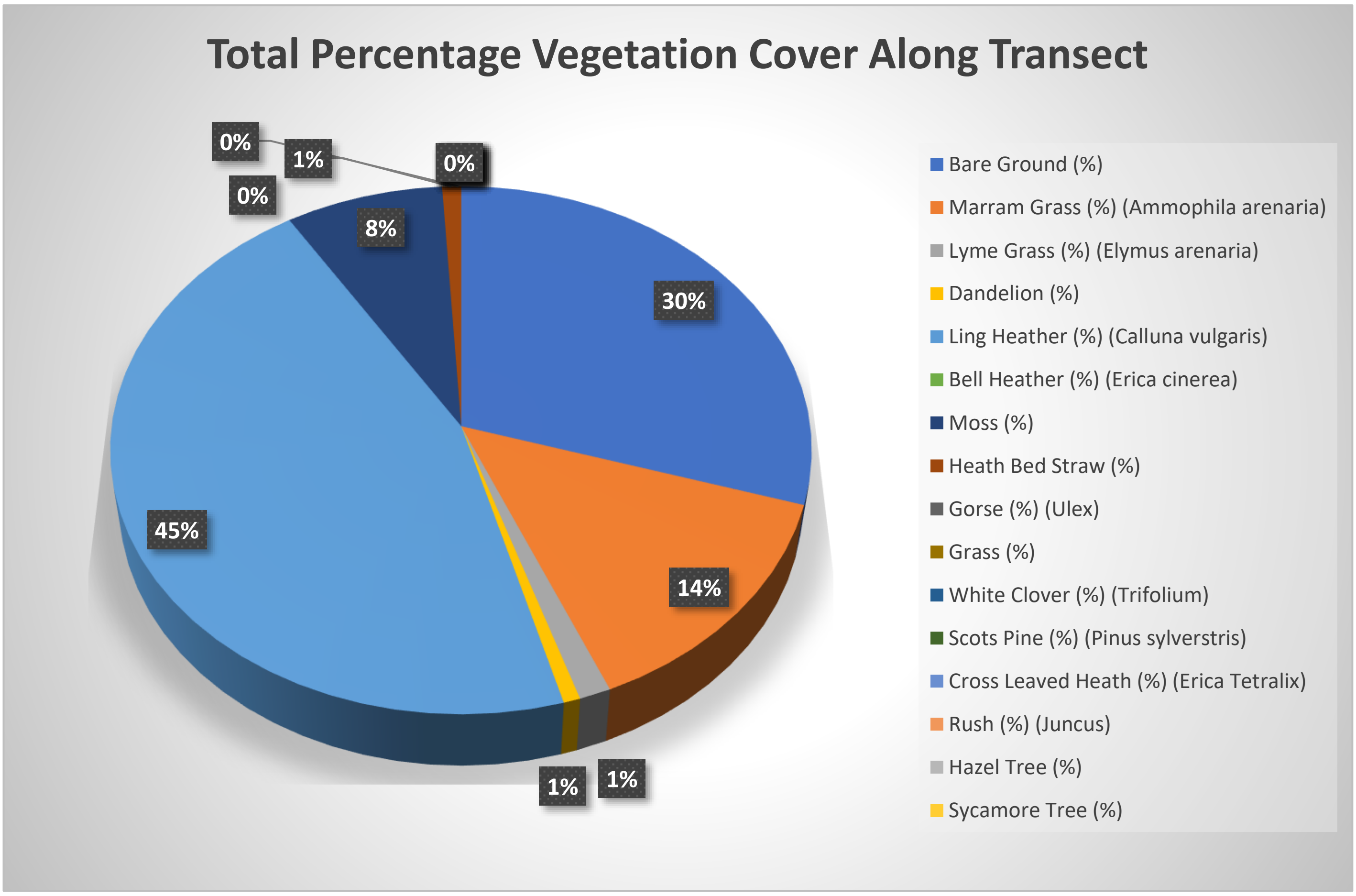
The bar chart shows a far from characteristic trendline for vegetation covering, almost entirely against what the theory predicts. Such intense human activity and associated erosion completely stops colonisation, let alone succession along this transect.

Figure 13: Dune Transect Profile for the dune transect 450m away from the honey pot site showing compound elevation along the dune featuring trendline. Percentage values show total percentage vegetation cover at that point.



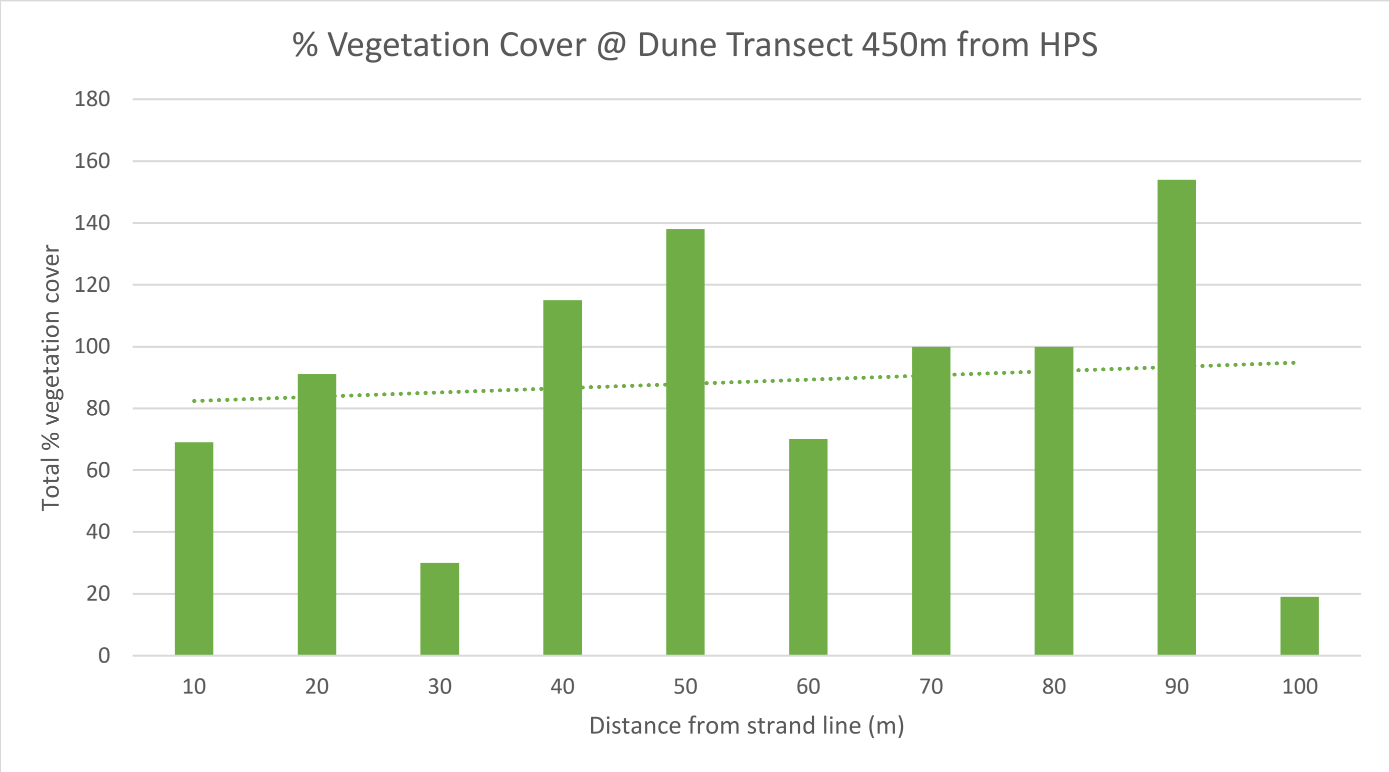
This dune profile shows the effect of human traffic. The elevation change between 30 and 40 metres is where a National Trust path runs through the psammosere and human activity along this path has resulted in the formation of a small gulley and has also reduced vegetation cover.

Figure 14: Pie chart for the breakdown of percentage species cover along the dune transect at 450m away from the honey pot site



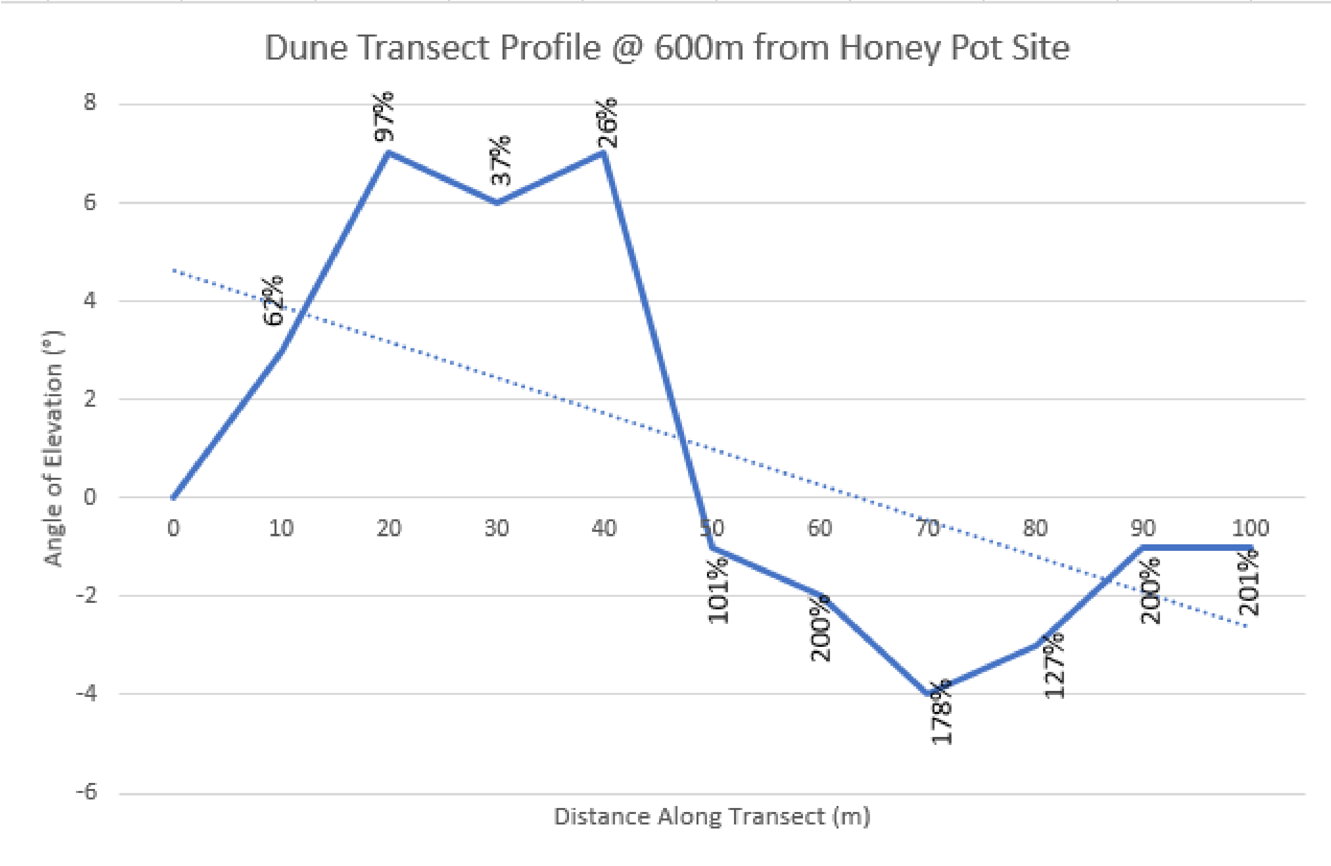
The level of bare ground has reduced from the 300m transect, suggesting that tourists are less willing to stray too far from the HPS, and certainly not past the attractive blowout location. This transect was more dominated by ling heather, which shows how a characteristic succession has taken place along this transect, such that we now see more climax vegetation. Interestingly along this transect there was the least species diversity, this is likely to be the lack of human interference, meaning that natural selection can take place unimpeded, and few non-native species are introduced to the psammosere through tourists or pets.

Figure 15: Bar chart for the total percentage vegetation along the dune transect at 450m away from the honey pot site



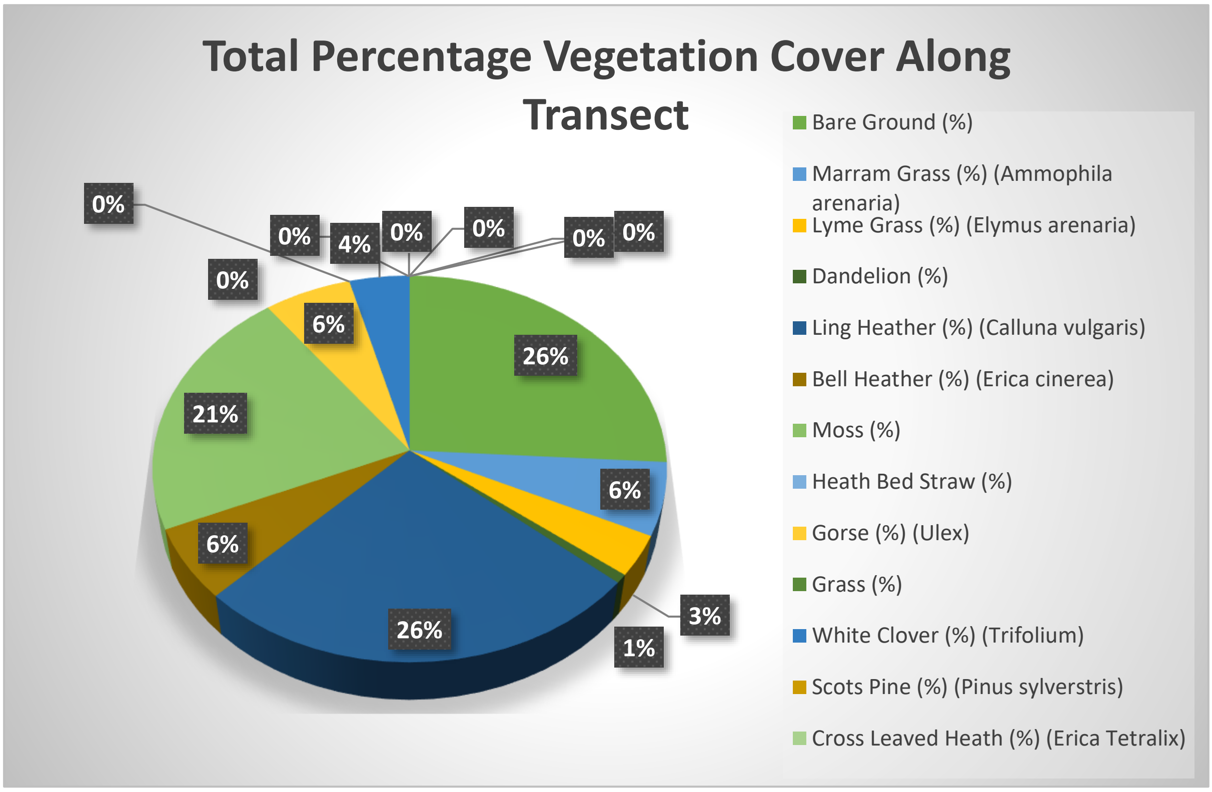
Quite interestingly, vegetation cover is more consistent along this transect. The usual sparsity closer to the strand line is less prevalent, and this is likely to be because the area is well pathed, at 30m and so most tourists that venture to this point, remain on the National Trust pathway, hence preventing as much erosion, which allows greater colonisation of the dunes.

Figure 16: Dune Transect Profile for the dune transect 600m away from the honey pot site showing compound elevation along the dune featuring trendline. Percentage values show total percentage vegetation cover at that point.



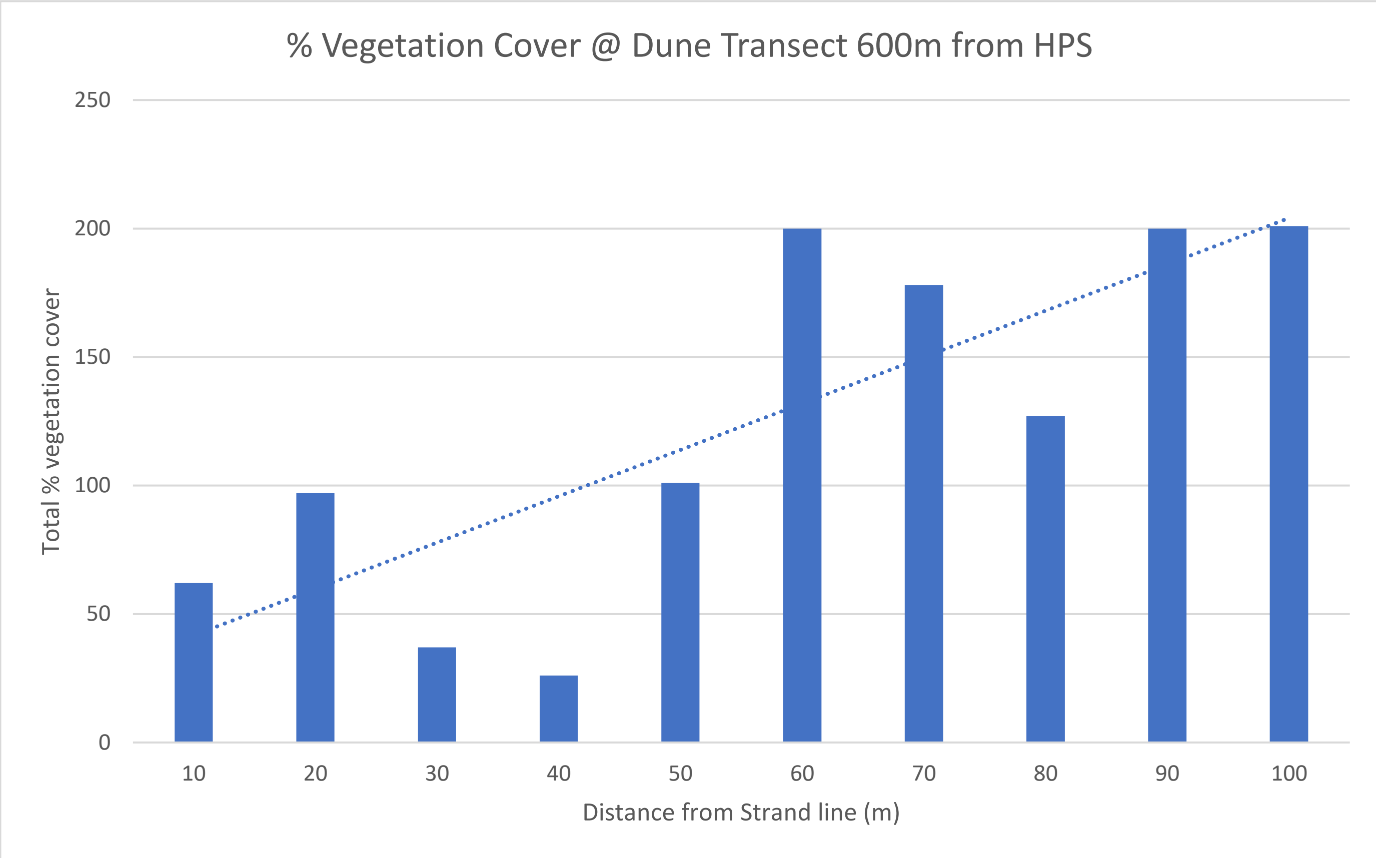
This dune transect is the closest example which I collected in the Studland Bay psammosere to that detailed in the theory. The transect rises, and then dips back down into a dune slack where vegetation is increased dramatically when going further inland, due to the increased humus content of the ground.

Figure 17: Pie chart for the breakdown of percentage species cover along the dune transect at 600m away from the honey pot site



Much of the vegetation along this transect is near climactic vegetation such as ling and bell heather and gorse, as well as the addition of Scots Pine. This shows how succession is unimpeded along this transect, showing that when there is less human interference, the psammosere conforms to the suggested characteristics.

Figure 18: Bar chart for the total percentage vegetation along the dune transect at 600m away from the honey pot site



Despite being this far away from the HPS there is still a path running through this area of the psammosere, where vegetation cover is reduced, however, the transect in the main is the most densely covered transect, proving that there is a correlation between human interference (i.e. proximity to the honey pot site) and vegetation cover.

Spearman's Rank Statistical Analysis:

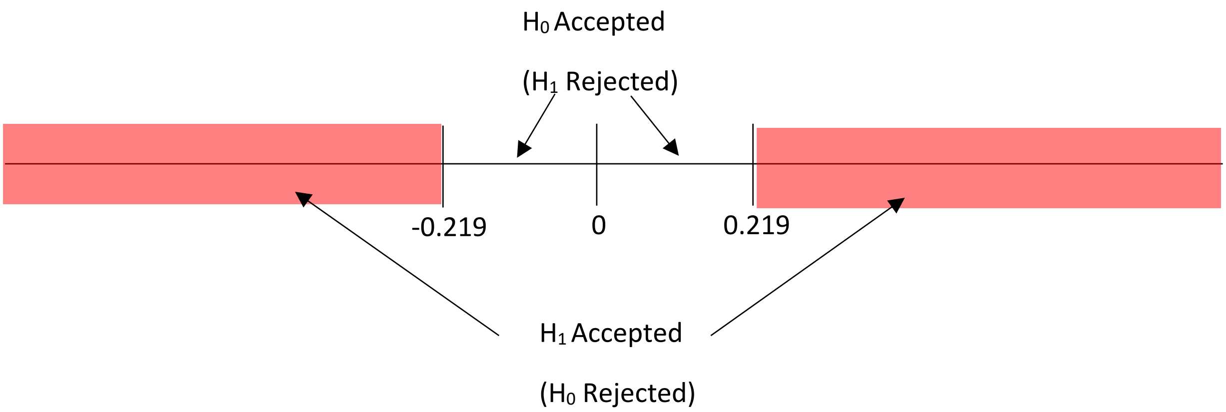
Alternate Hypothesis (H_1): Proximity to the 'Honey Pot Site' (and hence more human interference) is directly correlated to reduced percentage vegetation cover in the Studland Bay psammosere.

Null Hypothesis (H_0): Proximity to the 'Honey Pot Site' (and hence more human interference) has no correlation with percentage vegetation cover in the Studland Bay psammosere.

Equation [8]:
$$r_s = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}.$$

Critical Values of the Spearman's Ranked Correlation Coefficient (r_s)
Taken from Zar, 1984 Table B.19

α(2):	0.50	0.20	0.10	0.05	0.02	0.01	0.005	0.002	0.001
α(1):	0.25	0.10	0.05	0.025	0.01	0.005	0.0025	0.001	0.0005
n									
51	0.096	0.182	0.233	0.276	0.326	0.359	0.390	0.426	0.451
52	0.095	0.180	0.231	0.274	0.323	0.356	0.386	0.422	0.447
53	0.095	0.179	0.228	0.271	0.320	0.352	0.382	0.418	0.443
54	0.094	0.177	0.226	0.268	0.317	0.349	0.379	0.414	0.439
55	0.093	0.175	0.224	0.266	0.314	0.346	0.375	0.411	0.435
56	0.092	0.174	0.222	0.264	0.311	0.343	0.372	0.407	0.432
57	0.091	0.172	0.220	0.261	0.308	0.340	0.369	0.404	0.428
58	0.090	0.171	0.218	0.259	0.306	0.337	0.366	0.400	0.424
59	0.089	0.169	0.216	0.257	0.303	0.334	0.363	0.397	0.421
60	0.089	0.168	0.214	0.255	0.300	0.331	0.360	0.394	0.418
61	0.088	0.166	0.213	0.252	0.298	0.329	0.357	0.391	0.414
62	0.087	0.165	0.211	0.250	0.296	0.326	0.354	0.388	0.411
63	0.086	0.163	0.209	0.248	0.293	0.323	0.351	0.385	0.408
64	0.086	0.162	0.207	0.246	0.291	0.321	0.348	0.382	0.405
65	0.085	0.161	0.206	0.244	0.289	0.318	0.346	0.379	0.402
66	0.084	0.160	0.204	0.243	0.287	0.316	0.343	0.376	0.399
67	0.084	0.158	0.203	0.241	0.284	0.314	0.341	0.373	0.396
68	0.083	0.157	0.201	0.239	0.282	0.311	0.338	0.370	0.393
69	0.082	0.156	0.200	0.237	0.280	0.309	0.336	0.368	0.390
70	0.082	0.155	0.198	0.235	0.278	0.307	0.333	0.365	0.388
71	0.081	0.154	0.197	0.234	0.276	0.305	0.331	0.363	0.385
72	0.081	0.153	0.195	0.232	0.274	0.303	0.329	0.360	0.382
73	0.080	0.152	0.194	0.230	0.272	0.301	0.327	0.358	0.380
74	0.080	0.151	0.193	0.229	0.271	0.299	0.324	0.355	0.377
75	0.079	0.150	0.191	0.227	0.269	0.297	0.322	0.353	0.375
76	0.078	0.149	0.190	0.226	0.267	0.295	0.320	0.351	0.372
77	0.078	0.148	0.189	0.224	0.265	0.293	0.318	0.349	0.370
78	0.077	0.147	0.188	0.223	0.264	0.291	0.316	0.346	0.368
79	0.077	0.146	0.186	0.221	0.262	0.289	0.314	0.344	0.365
80	0.076	0.145	0.185	0.220	0.260	0.287	0.312	0.342	0.363
81	0.076	0.144	0.184	0.219	0.259	0.285	0.310	0.340	0.361
82	0.075	0.143	0.183	0.217	0.257	0.284	0.308	0.338	0.359
83	0.075	0.142	0.182	0.216	0.255	0.282	0.306	0.336	0.357
84	0.074	0.141	0.181	0.215	0.254	0.280	0.305	0.334	0.355
85	0.074	0.140	0.180	0.213	0.252	0.279	0.303	0.332	0.353
86	0.074	0.139	0.179	0.212	0.251	0.277	0.301	0.330	0.351
87	0.073	0.139	0.177	0.211	0.250	0.276	0.299	0.328	0.349
88	0.073	0.138	0.176	0.210	0.248	0.274	0.298	0.327	0.347
89	0.072	0.137	0.175	0.209	0.247	0.272	0.296	0.325	0.345
90	0.072	0.136	0.174	0.207	0.245	0.271	0.294	0.323	0.343
91	0.072	0.135	0.173	0.206	0.244	0.269	0.293	0.321	0.341
92	0.071	0.135	0.173	0.205	0.243	0.268	0.291	0.319	0.339
93	0.071	0.134	0.172	0.204	0.241	0.267	0.290	0.318	0.338
94	0.070	0.133	0.171	0.203	0.240	0.265	0.288	0.316	0.336
95	0.070	0.133	0.170	0.202	0.239	0.264	0.287	0.314	0.334
96	0.070	0.132	0.169	0.201	0.238	0.262	0.285	0.313	0.332
97	0.069	0.131	0.168	0.200	0.236	0.261	0.284	0.311	0.331
98	0.069	0.130	0.167	0.199	0.235	0.260	0.282	0.310	0.329
99	0.068	0.130	0.166	0.198	0.234	0.258	0.281	0.308	0.327
100	0.068	0.129	0.165	0.197	0.233	0.257	0.279	0.307	0.326



Calculation:

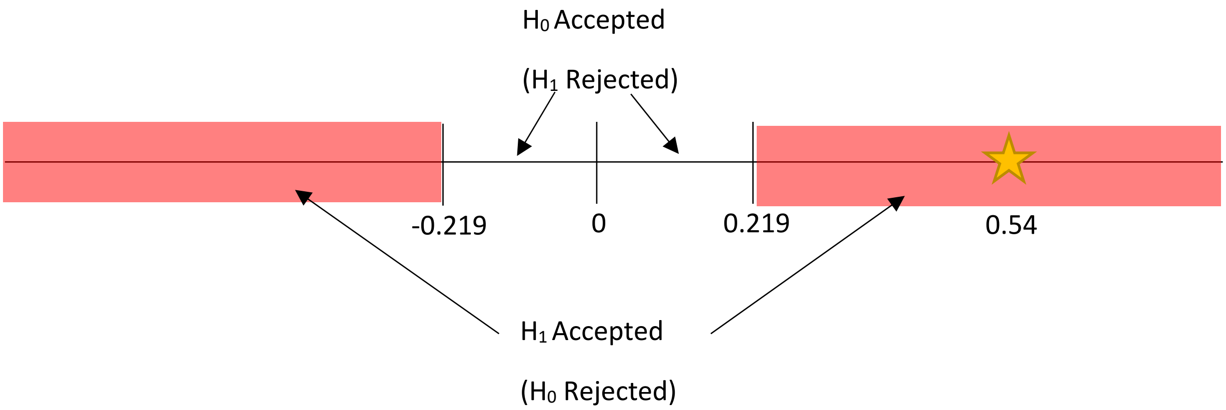
Distance from Honey Pot Site (m)	Rank 1	Percentage Vegetation (%)	Rank 2	Difference (d)	d^2
0	1	96	36	-35	1225
10	2	138	57	-55	3025
20	3	245	79	-76	5776
30	4	139	58	-54	2916
40	5	100	40.5	-35.5	1260.25
50	6	17	18.5	-12.5	156.25
60	7	170	64	-57	3249
70	8	68	29	-21	441
80	9	45	25	-16	256
90	10	30	22	-12	144
100	11	50	26	-15	225
110	12	0	7.5	4.5	20.25
120	13	0	7.5	5.5	30.25
130	14	38	24	-10	100
140	15	100	40.5	-25.5	650.25
150	16	32	23	-7	49
160	17	83	31.5	-14.5	210.25
170	18	103	43.5	-25.5	650.25
180	19	15	16.5	2.5	6.25
190	20	15	16.5	3.5	12.25
200	21	0	7.5	13.5	182.25
210	22	20	20	2	4
220	23	17	18.5	4.5	20.25
230	24	0	7.5	16.5	272.25
240	25	0	7.5	17.5	306.25
250	26	0	7.5	18.5	342.25
260	27	0	7.5	19.5	380.25
270	28	0	7.5	20.5	420.25
280	29	0	7.5	21.5	462.25
290	30	0	7.5	22.5	506.25
300	31	0	7.5	23.5	552.25
310	32	0	7.5	24.5	600.25

320	33	0	7.5	25.5	650.25
330	34	21	21	13	169
340	35	65	28	7	49
350	36	112	48	-12	144
360	37	74	30	7	49
370	38	84	33	5	25
380	39	90	34	5	25
390	40	108	46	-6	36
400	41	99	38	3	9
410	42	100	40.5	1.5	2.25
420	43	137	55.5	-12.5	156.25
430	44	200	70.5	-26.5	702.25
440	45	97	37	8	64
450	46	182	66	-20	400
460	47	155	62	-15	225
470	48	147	61	-13	169
480	49	103	43.5	5.5	30.25
490	50	137	55.5	-5.5	30.25
500	51	164	63	-12	144
510	52	200	70.5	-18.5	342.25
520	53	94	35	18	324
530	54	200	70.5	-16.5	272.25
540	55	118	49.5	5.5	30.25
550	56	181	65	-9	81
560	57	200	70.5	-13.5	182.25
570	58	200	70.5	-12.5	156.25
580	59	120	51.5	7.5	56.25
590	60	200	70.5	-10.5	110.25
600	61	100	40.5	20.5	420.25
610	62	58	27	35	1225
620	63	0	7.5	55.5	3080.25
630	64	13	15	49	2401
640	65	83	31.5	33.5	1122.25
650	66	125	53	13	169
660	67	120	51.5	15.5	240.25
670	68	144	60	8	64
680	69	109	47	22	484
690	70	220	78	-8	64
700	71	130	54	17	289
710	72	269	80	-8	64
720	73	105	45	28	784
730	74	142	59	15	225
740	75	118	49.5	25.5	650.25
750	76	204	75.5	0.5	0.25
760	77	200	70.5	6.5	42.25
770	78	204	75.5	2.5	6.25
780	79	200	70.5	8.5	72.25
790	80	217	77	3	9
800	81	278	81	0	0
					$\Sigma d^2 = 40497.5$

Equation:

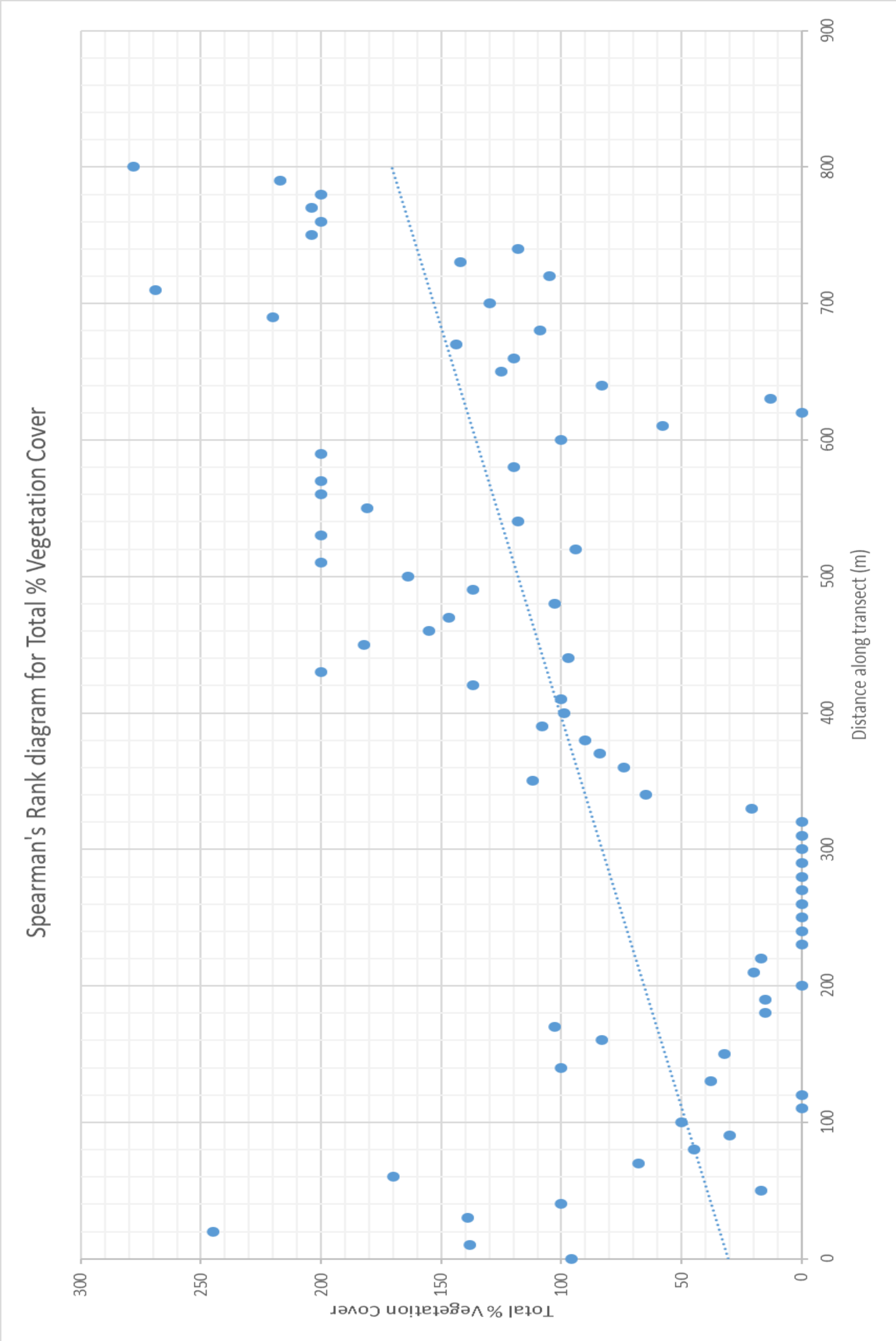
$$r_s = 1 - [6(40497.5) \div 81(81^2 - 1)]$$

$$r_s = 0.542711156 \text{ (0.54 2d.p)}$$



The scatter graph overleaf (Figure 19) is a graphical representation of the percentage levels of vegetation along the 800m transect. The regression line maps the Spearman's rank correlation coefficient showing a positive correlation of 0.54.

Figure 19: Scatter Graph for the total percentage vegetation cover along the 800m transect – including linear regression line to represent Spearman's rank coefficient (tabulated data included at end of document for reference)



The regression line shows the Spearman's Rank coefficient of 0.54. This proves that there is a correlation between my two variables, and that it is quite strong. One of the interesting features along this chart is the lack of vegetation between 230m and 320m due to a large blowout. It is also relatively clear that before the blowout, vegetation cover rarely exceeds 100%, whereas after the blowout, vegetation cover rarely dips below 100%. In this way, the blowout may be the limit for the distance that most tourists are willing to travel through the psammosere.

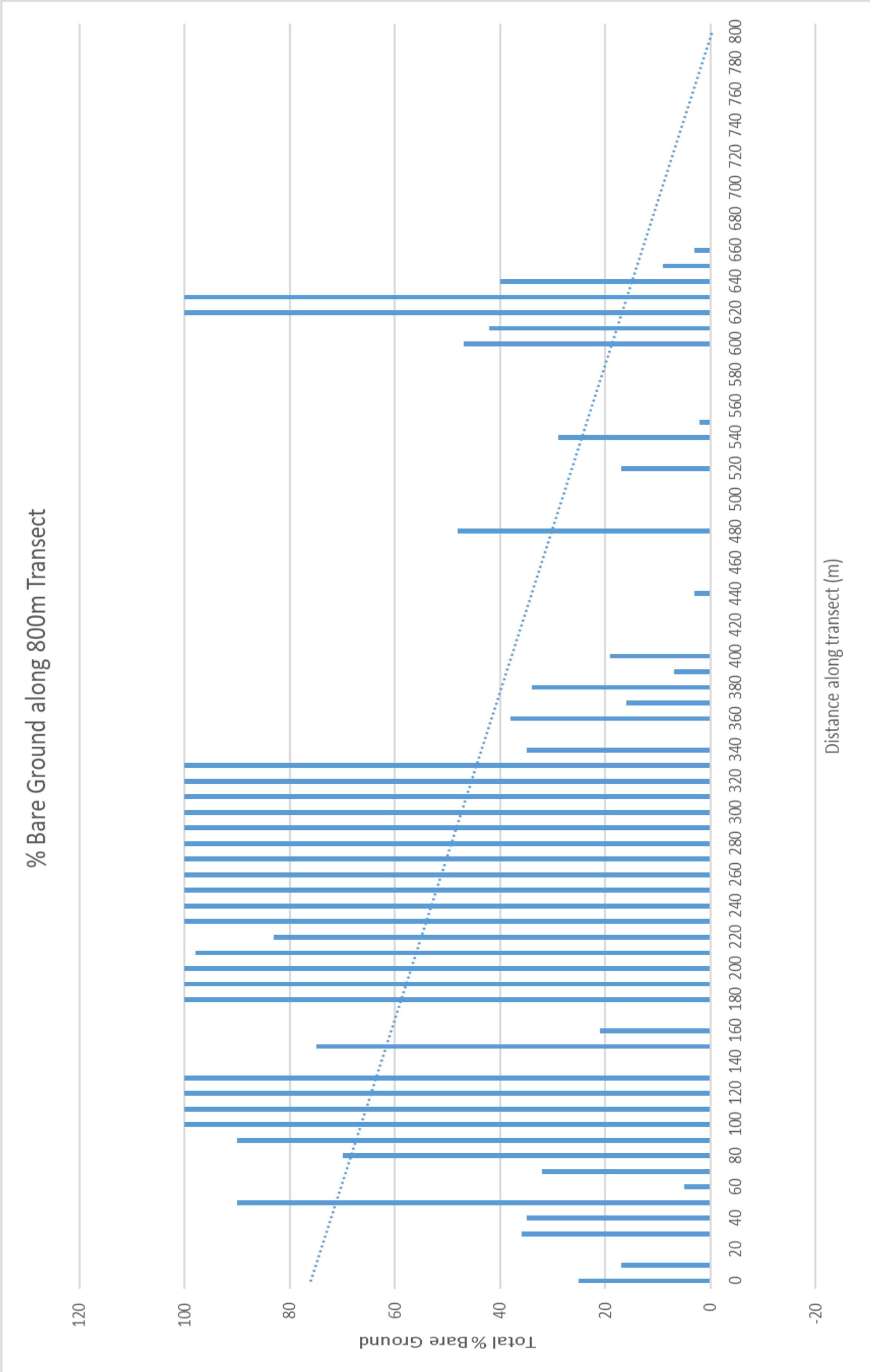


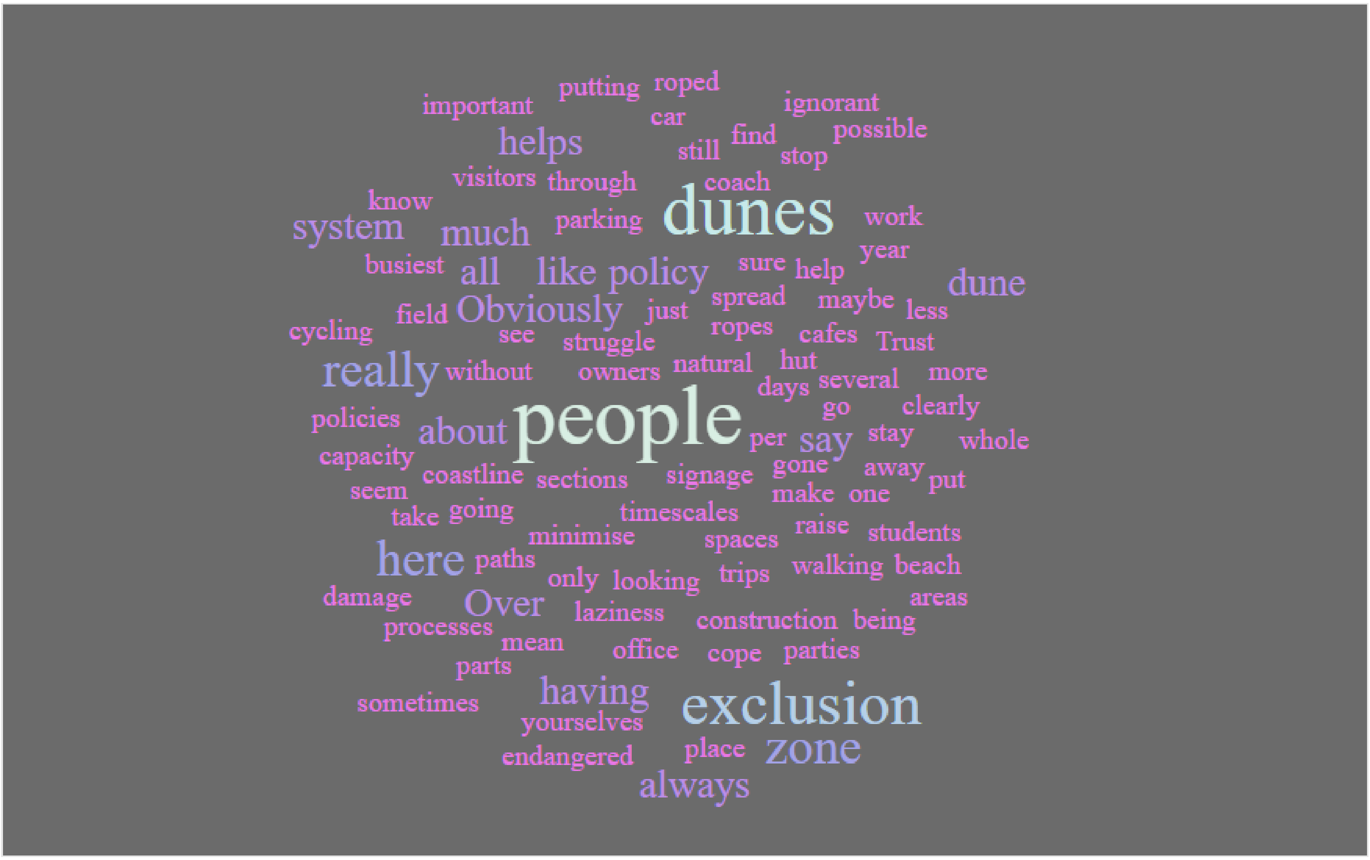
Figure 20: Bar chart for the total percentage bare ground cover along the 800m transect – including line of best fit

The line of best fit on the chart is particularly revealing, it clearly shows how proximity to the honey pot site, and hence more human interference, increases the amount of bare ground due to erosion. Following the end of the blowout at 320m, there is rarely any bare ground, and more importantly, only 1 example of complete bare ground which signifies a blowout/ scar or a path.

Figure 21: Questionnaire for National Trust Warden and Tourists – answers have been modified in certain cases into full sentences to aid with clarity **Interview Transcript included in appendix**

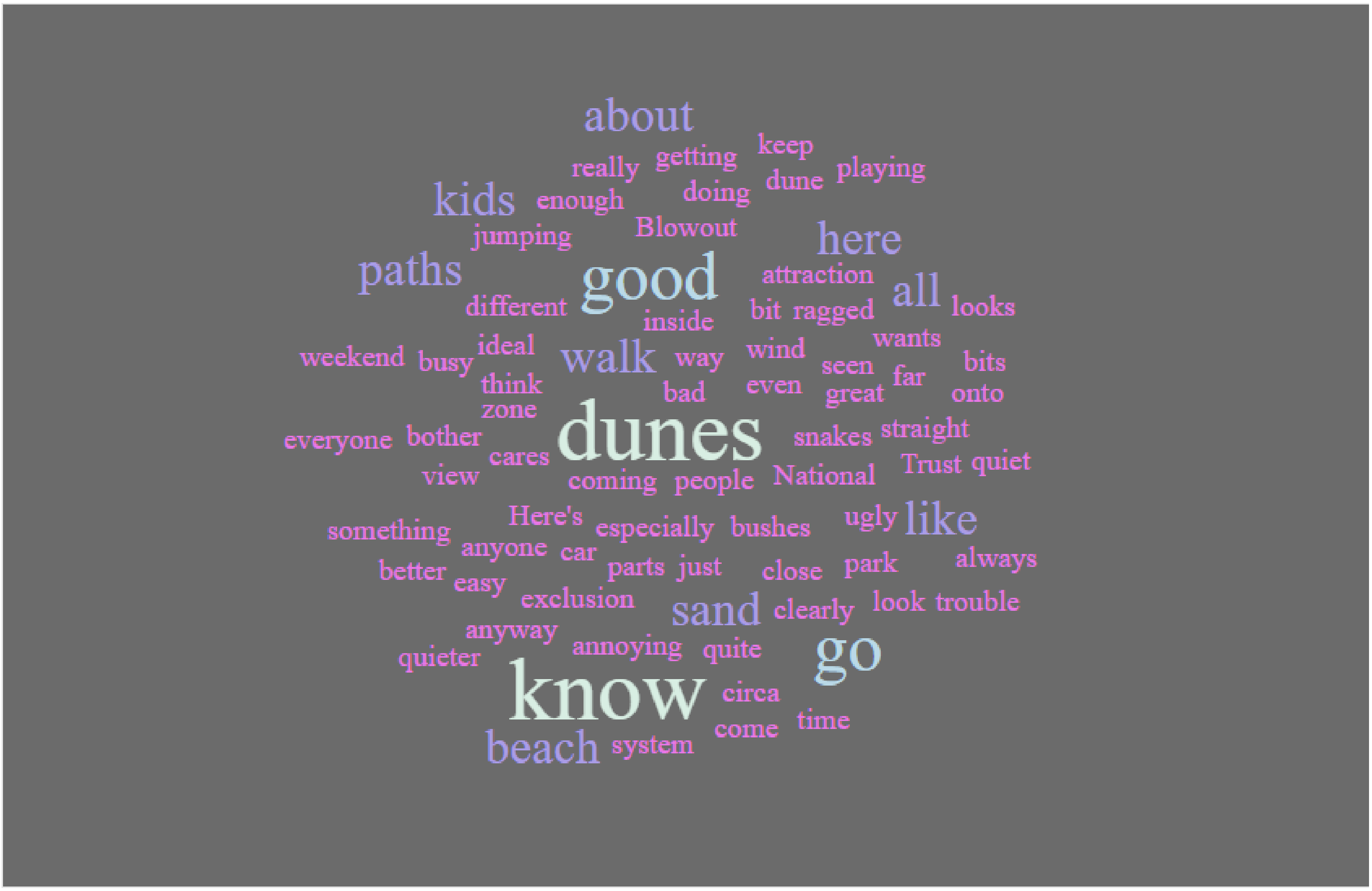
It is interesting to see how the National Trust warden was quite defeatist, suggesting that the best they can do is stop a bad situation turning into a disaster. It does seem to be clear that tourists have little regard for the psammosere, whether that be through a lack of education or just ignorance is unclear, but what is undeniable is the attraction of the psammosere for tourists. Their limited desire to branch too far away from the honey pot site and focal points in the psammosere, such as the embryo dunes or the blowouts, leads to intense erosion in these areas.

Figure 22: Word Cloud to highlight results of the National Trust Warden Questionnaire Answers. The larger the font, the more frequently this word featured in the response, and hence, likely how important the word is to the psammosere.



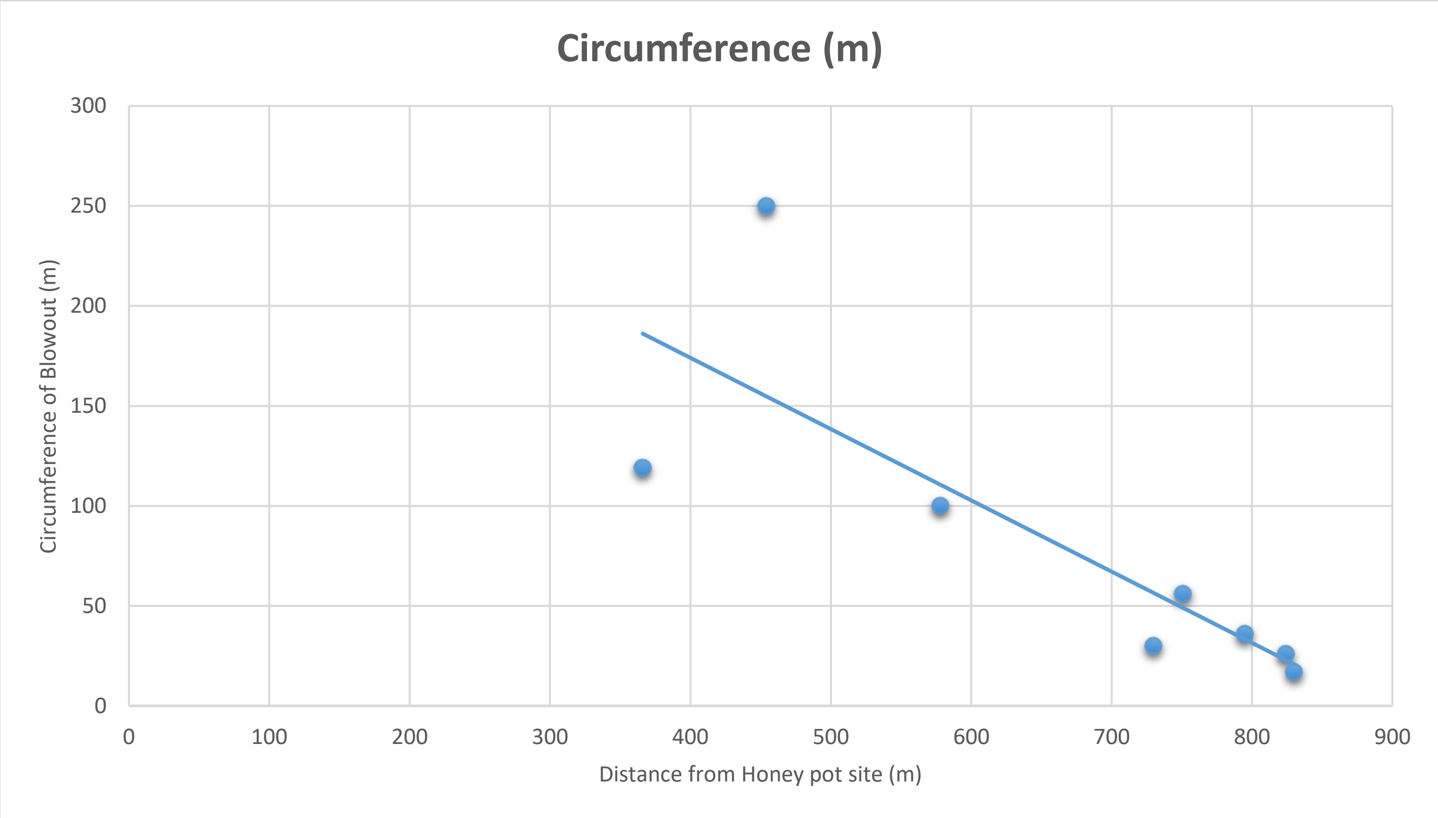
‘People’ play a key role in the psammosere, if people weren’t allowed to interfere with the psammosere, succession would be unimpeded and directly follow the theory. Increasing levels of human intervention can alter the dune system and so the presence of people is a key contributing factor in the health of the psammosere. Most effects of human interference are negative such as erosion or litter, but the National Trust Wardens are beneficial ‘people’ for the health of the psammosere. ‘Exclusion’ is another key word, the exclusion zone is nearly ever present for the areas of the psammosere surrounding the honey pot site, and it is clear that this is the policy that the National Trust feels is most effective.

Figure 23: Word Cloud to highlight results of the Tourists in Dunes Questionnaire Answers. The larger the font, the more frequently this word featured in the response, and hence, likely how important the word is to the psammosere.



In both word clouds, 'dunes' are a primary focus. For tourists, dunes are the location associated with words such as 'good', 'attraction' and 'great'. This popularity leads to erosional processes and an interference in natural succession within the psammosere. It is also interesting that 'know' is a prominent word – perhaps a lack of knowledge leads to unnecessary practices in the psammosere such as dune jumping, which result in further erosion and prevent succession.

Figure 24: Scatter Graph for blowout secondary data – including linear regression line to show Spearman's rank coefficient



This secondary data locates the blowouts in the Studland Bay psammosere. Two patterns are clear, there are no blowouts close to the honey pot site, and the further away the blowout is from the honey pot site, the smaller it is. The first trend can be explained as the exclusion zone restricts human interference in the psammosere and hence reduces erosion. The second trend can be explained, through the attraction of the Knoll beach café and amenities. Tourists aren't willing to walk too far away from the honey pot site, and so blowouts further away from the HPS are visited less frequently and so they experience less erosion. Strangely, a large blowout that I encountered along my transect from 230m to 320m hasn't been recorded in this secondary data, however if I was to input the blowout, it would still conform to the trend as I recorded the blowout as having a circumference in excess of 260m.

Simpson's Diversity Index Statistical Test:

Because I am dealing with a large amount of data collected from the psammosere - and the levels of variation between this data are hard to establish when assessing the trends by eye from tabulated data - a Simpson's diversity test will reveal whether there is a true level of variety between my data or whether there just appears to be a trend. The index will result in a value 'D' between 0 and 1.

This statistical test will allow me to assess whether proximity to the Honey Pot Site has any bearing on the species diversity throughout the psammosere. The result can provide evidence to suggest the effects of human interaction with the psammosere and its effects on vegetation succession.

Simpson's Diversity Index Equation:

$$D = \frac{\Sigma\, n(n-1)}{N(N-1)}$$

	Location @ 150m			Location @ 300m		
Species:	n (number of individuals)	n-1	n(n-1)	n (number of individuals)	n-1	n(n-1)
Marram Grass (%) (Ammophila arenaria)	192	191	36,672	265	264	69960
Lyme Grass (%) (Elymus arenaria)	68	67	4,556	109	108	11772
Dandelion (%)	10	9	90	16	15	240
Ling Heather (%) (Calluna vulgaris)	106	105	11,130	298	297	88506
Bell Heather (%) (Erica cinerea)	55	54	2,970	0	-1	0
Moss (%)	285	284	80,940	170	169	28730
Heath Bed Straw (%)	0	-1	0	0	-1	0
Gorse (%) (Ulex)	0	-1	0	0	-1	0
Grass (%)	250	249	62,250	0	-1	0
Silver Birch (%) (Betula Pendula)	0	-1	0	0	-1	0
White Clover (%) (Trifolium)	0	-1	0	38	37	1406
Cross Leaved Heath (%) (Erica Tetralix)	0	-1	0	0	-1	0
Rush (%) (Juncus)	0	-1	0	16	15	240
Hazel Tree (%)	100	99	9,900	0	-1	0
Sycamore Tree (%)	100	99	9,900	0	-1	0
N (Total Number of Individuals)	1166			912		
		Σ	218,408		Σ	200854

	Location @ 450m			Location @ 600m		
Species:	n (number of individuals)	n-1	n(n-1)	n (number of individuals)	n-1	n(n-1)
Marram Grass (%) (Ammophila arenaria)	175	174	30450	101	100	10100
Lyme Grass (%) (Elymus arenaria)	17	16	272	57	56	3192
Dandelion (%)	9	8	72	12	11	132
Ling Heather (%) (Calluna vulgaris)	573	572	327756	436	435	189660
Bell Heather (%) (Erica cinerea)	0	-1	0	100	99	9900
Moss (%)	100	99	9900	354	353	124962
Heath Bed Straw (%)	12	11	132	0	-1	0
Gorse (%) (Ulex)	0	-1	0	100	99	9900
Grass (%)	0	-1	0	0	-1	0
Silver Birch (%) (Betula Pendula)	0	-1	0	0	-1	0
White Clover (%) (Trifolium)	0	-1	0	69	68	4692
Cross Leaved Heath (%) (Erica Tetralix)	0	-1	0	0	-1	0
Rush (%) (Juncus)	0	-1	0	0	-1	0
Hazel Tree (%)	0	-1	0	0	-1	0
Sycamore Tree (%)	0	-1	0	0	-1	0
	886			1229		
N (Total Number of Individuals)		Σ	368582		Σ	352538

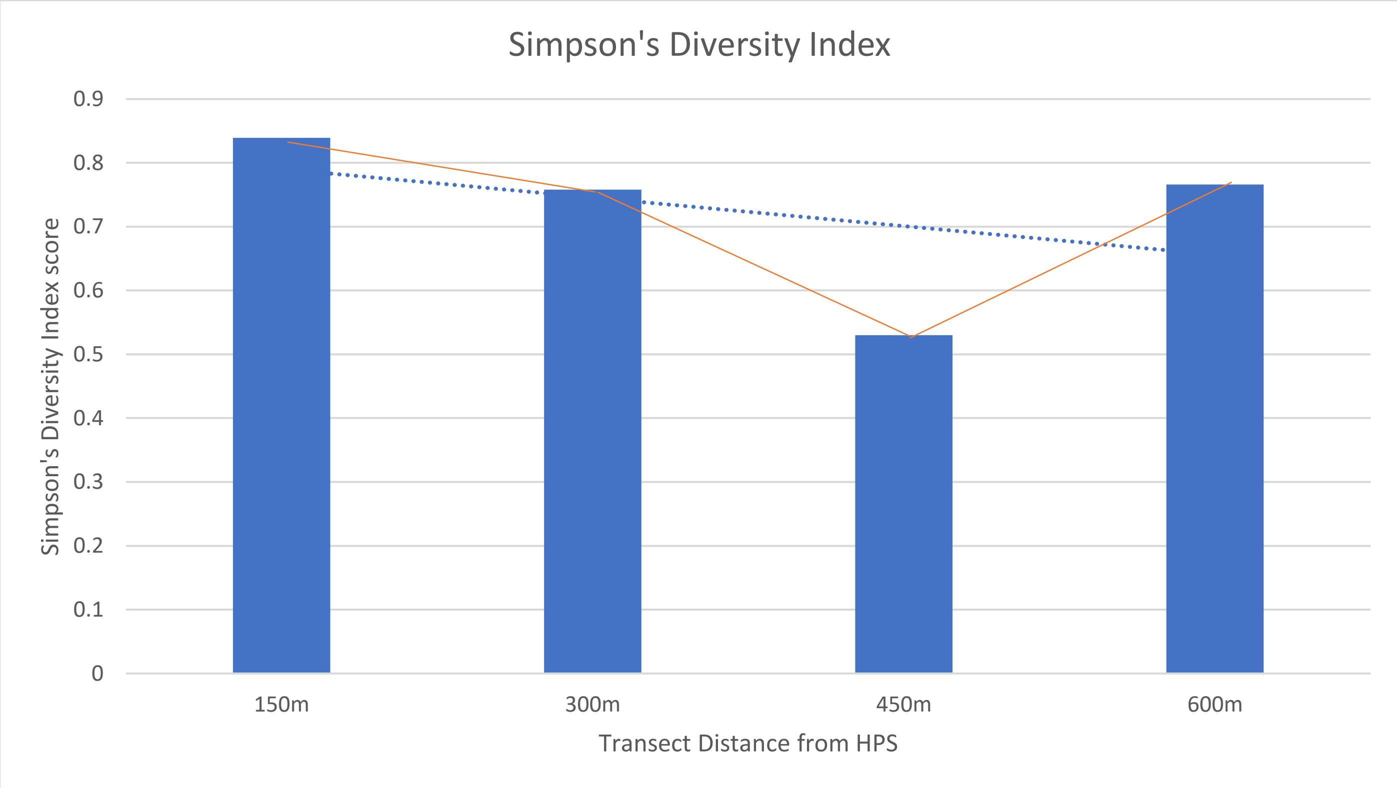
Index Values:

Location @ 150m	D = 1 - (218408 ÷ 1166 x 1165)	D = 0.839
Location @ 300m	D = 1 - (200854 ÷ 912 x 911)	D = 0.758
Location @ 450m	D = 1 - (368582 ÷ 886 x 885)	D = 0.530
Location @ 600m	D = 1 - (352538 ÷ 1229 x 1228)	D = 0.766

From the Diversity Index values, I can conclude that vegetation diversity decreases when there is less human activity. However, the data set is small and therefore perhaps not entirely reliable, considering that diversity increases dramatically from 450m to 600m, and so perhaps the first to locations are anomalous.

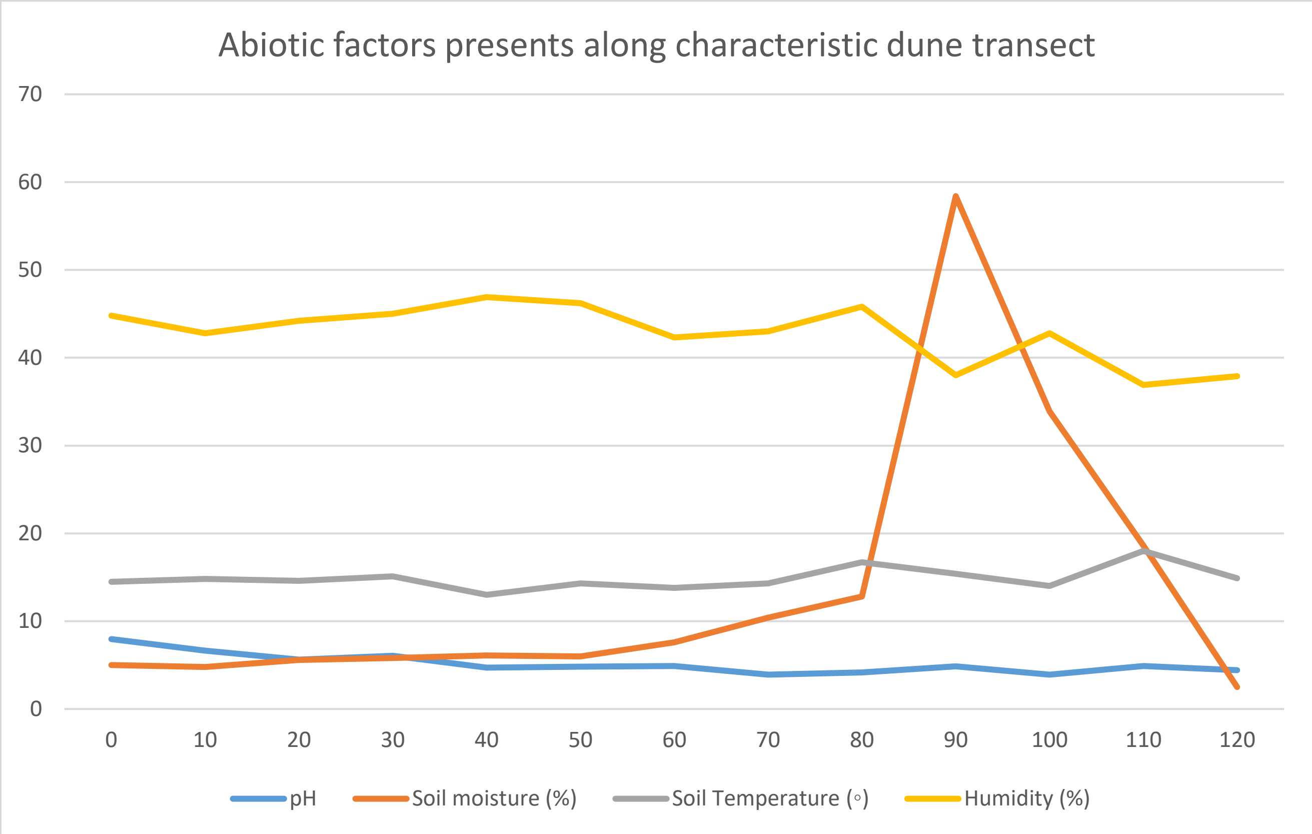
The graph overleaf (Figure 25) shows this data in graphical form, and the trendline shows the correlation between increased distance from the honey pot site - and hence less human interference - and decreased vegetation diversity, which implies that succession has occurred unimpeded.

Figure 25: Simpson's Diversity Index bar chart and trendlines for species diversity along 4 transects



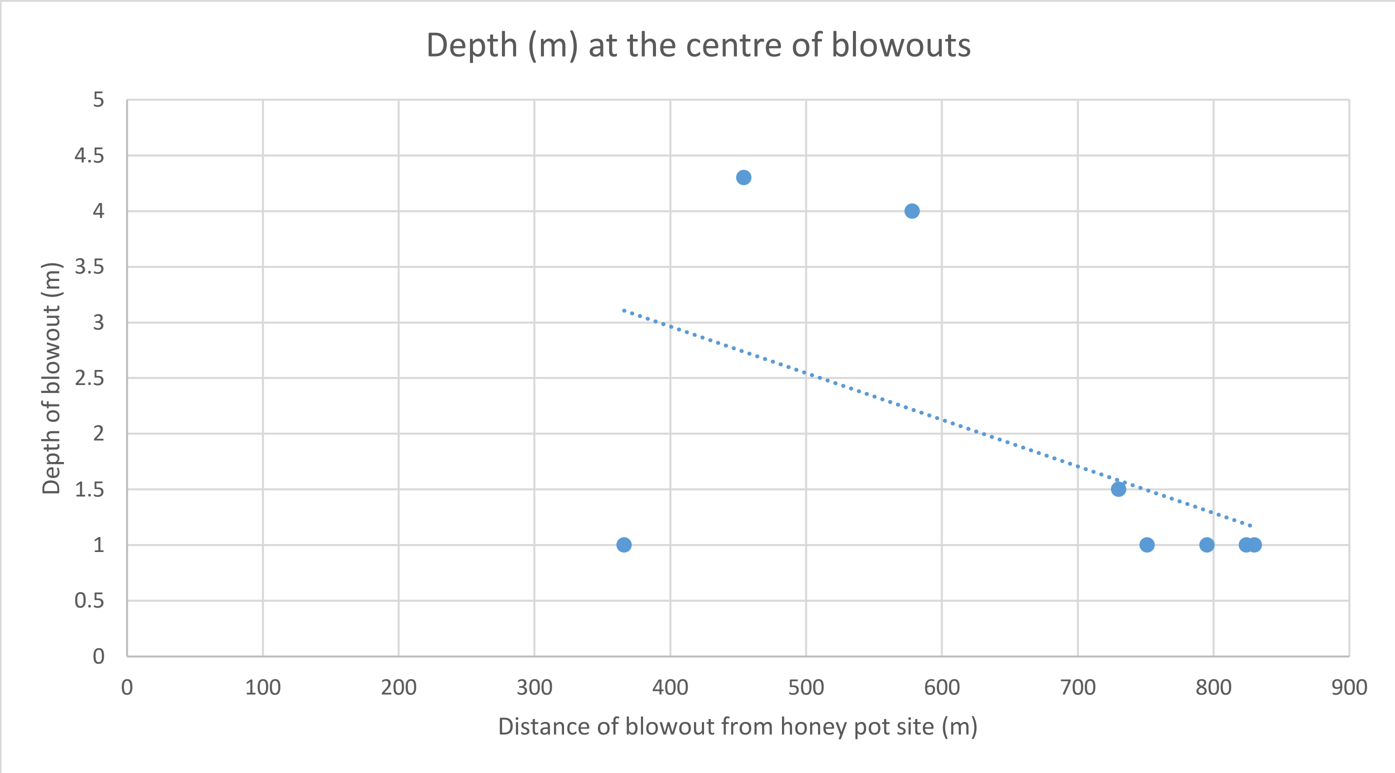
Species diversity is highest closest to the HPS, which may seem counter intuitive, but with more human activity comes greater erosion and a greater chance of introducing non-native species to the psammosere. This is because erosion may remove heather from an area of dune, and this now unvegetated ground may have the humus content to support many species, all of which have a chance of competing. Further away from the honey pot site, there is little human interference, and so the vegetation is left to compete strictly on abiotic factors and doesn't have to adapt to the introduction of non-native species or erosion.

Figure 26: Collated line graph to show the abiotic factors present along a characteristic transect - 570m away from the honey pot site



This secondary data presents the characteristic abiotic factors present in the Studland Bay psammosere and this can help to determine why vegetation changes along the transects. From 70m the ground becomes more moist, as the dune dips down towards sea level and we find a dune slack, this was represented only in my transect 600m from the HPS. pH decreases as we move away from the strand line, and this makes it easier for species that aren't xerophytes or halophytes to colonise, and this is a contributing factor as to why we find more vegetation the further inland we go – due to the greater humus content of the ground.

Figure 27: Scatter graph to show the depth at the centre of blowouts – including trend line



This secondary data shows how the depth of the blowouts located in the Studland Bay psammosere decreases with increasing distance from the HPS. This negative relationship is due to the lack of human traffic away from the HPS, and so downward erosion is reduced.

Figure 28: Hand-drawn Kite Diagram for percentage vegetation cover along the 800m transect (Diagram attached at end of document for reference)

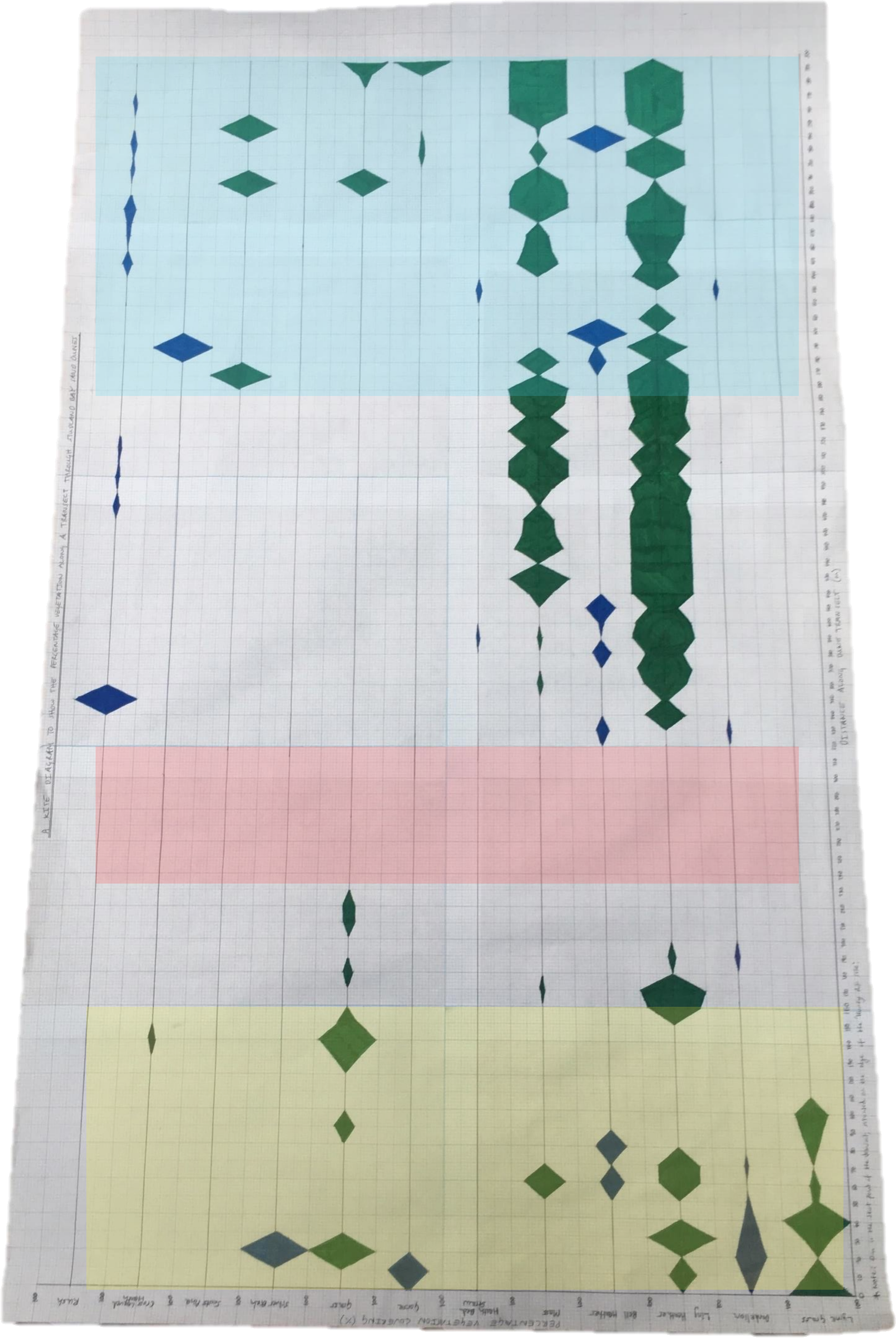
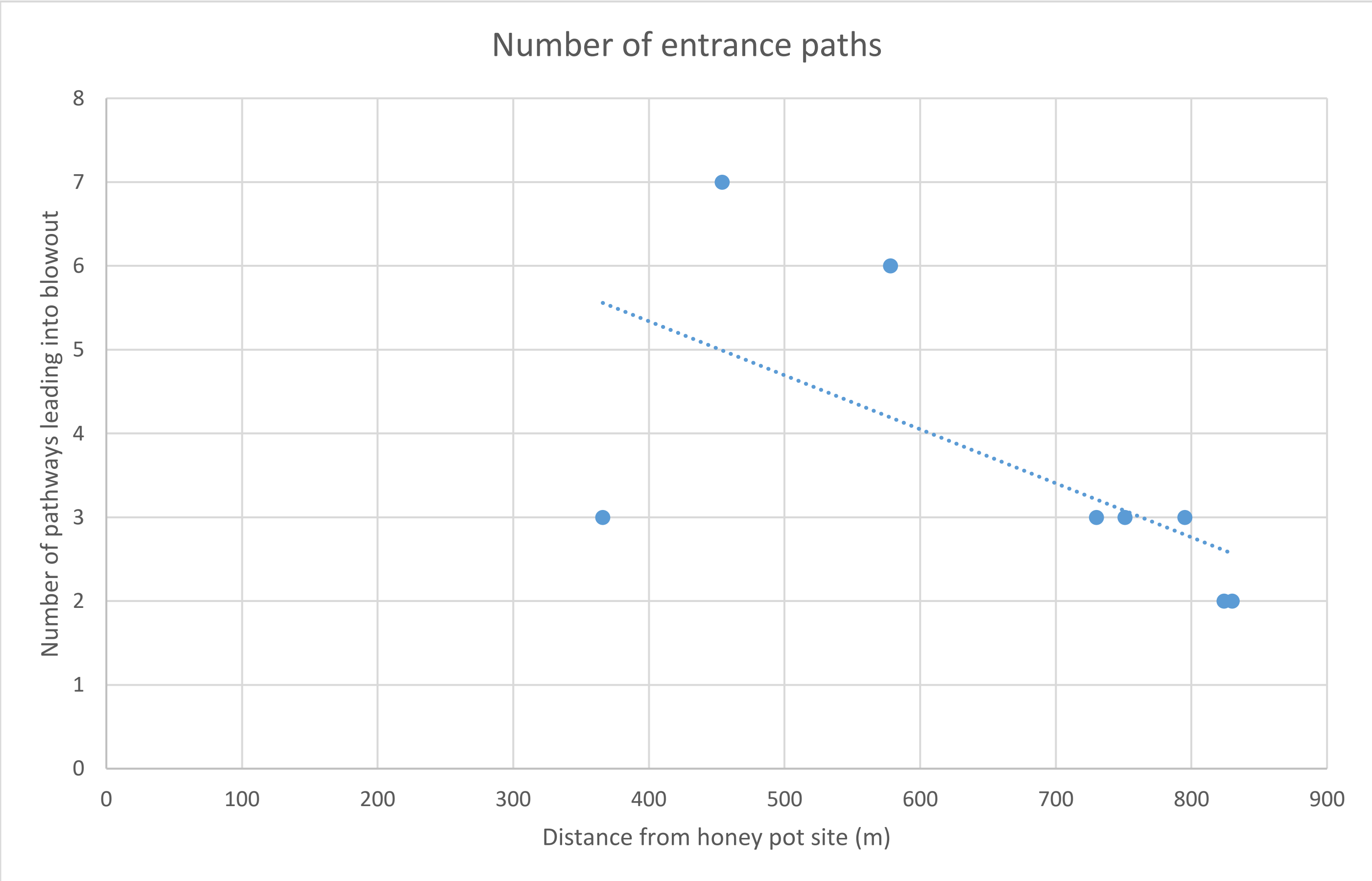


Figure 28 is very useful in showing three major sections within the psammosere. The yellow section is the exclusion zone and this area has the greatest species diversity, featuring Lyme grass, Gorse, Ling Heather and even Silver Birch. Theoretical sand dune succession would never result in this sort of combination, and a likely cause is the revegetation of an area under heavy human interference, in which succession is controlled to a certain extent by which vegetation survives erosion, and not just competition from other species. The red section highlights a large blowout which features no vegetation at all. Usually blowouts take decades to revegetate [3], but this dune is continually eroded as it is a popular tourist destination due to its proximity to the honey pot site. This was revealed in the questionnaire, and the fact that the blowout has 6 entrance pathways, showing the sphere of influence it has. The blue section is far away from the honey pot site. It shows a more characteristic psammosere environment, with an abundance of heathers and moss. Some early climax vegetation is starting to outcompete, as we would expect, and crucially at this stage of the dune system, all pioneer species have been outcompeted and therefore there is no Lyme grass or Marram grass, and only finite numbers of dune flowers such as dandelions or heath bed straw which are characteristically found towards the foredunes.

Figure 29: Scatter graph to show the number of pathways entering the blowouts recorded in the Leeson House secondary data – including trend line



From my questionnaire, I deduced that it was deliberate policy by the National Trust to centre all its amenities in a limited number of places, as this allowed for a higher concentration of tourists in one area, which would help to protect other areas of the psammosere. The amenities have developed into a honey pot site, so successful that people are rarely willing to stray from it, and as such, the number of pathways the National Park needs to create/maintain dwindles as we get further away from the HPS. This inverse relationship is clear to see from the graph – locations further away from the HPS are less attractive, and so less paths are required.

Chi-Squared Statistical Analysis:

Alternate Hypothesis (H1): The further away the transect is from the 'honey pot site', there is a significant correlation with increasing levels of total vegetation cover in the Studland bay sand dunes.

Null Hypothesis (H0): There is no significant correlation between increasing distance from the 'honey pot site' and total vegetation cover in the Studland bay sand dunes.

Chi-Squared Formula:

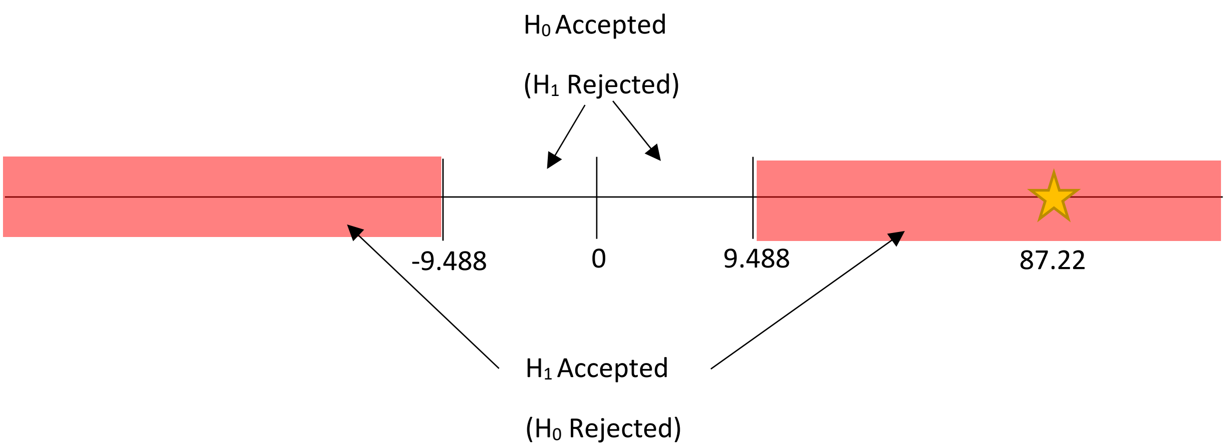
$$X^2 = \sum \frac{(o-e)^2}{e}$$

	P										
DF	**0.995**	**0.975**	**0.20**	**0.10**	**0.05**	**0.025**	**0.02**	**0.01**	**0.005**	**0.002**	**0.001**
1	0.0000393	0.000982	1.642	2.706	3.841	5.024	5.412	6.635	7.879	9.550	10.828
2	0.0100	0.0506	3.219	4.605	5.991	7.378	7.824	9.210	10.597	12.429	13.816
3	0.0717	0.216	4.642	6.251	7.815	9.348	9.837	11.345	12.838	14.796	16.266
4	0.207	0.484	5.989	7.779	9.488	11.143	11.668	13.277	14.860	16.924	18.467
5	0.412	0.831	7.289	9.236	11.070	12.833	13.388	15.086	16.750	18.907	20.515

	Transect @150m	Transect @300m	Transect @450m	Transect @600m	
O	1166	912	886	1229	
E	1048.25	1048.25	1048.25	1048.25	
O-E	117.75	-136.25	-162.25	180.75	
$(O-E)^2$	13865.06	18564.06	26325.06	32670.56	
$(O-E)^2 \div E$	13.23	17.71	25.11	31.17	Σ=87.22

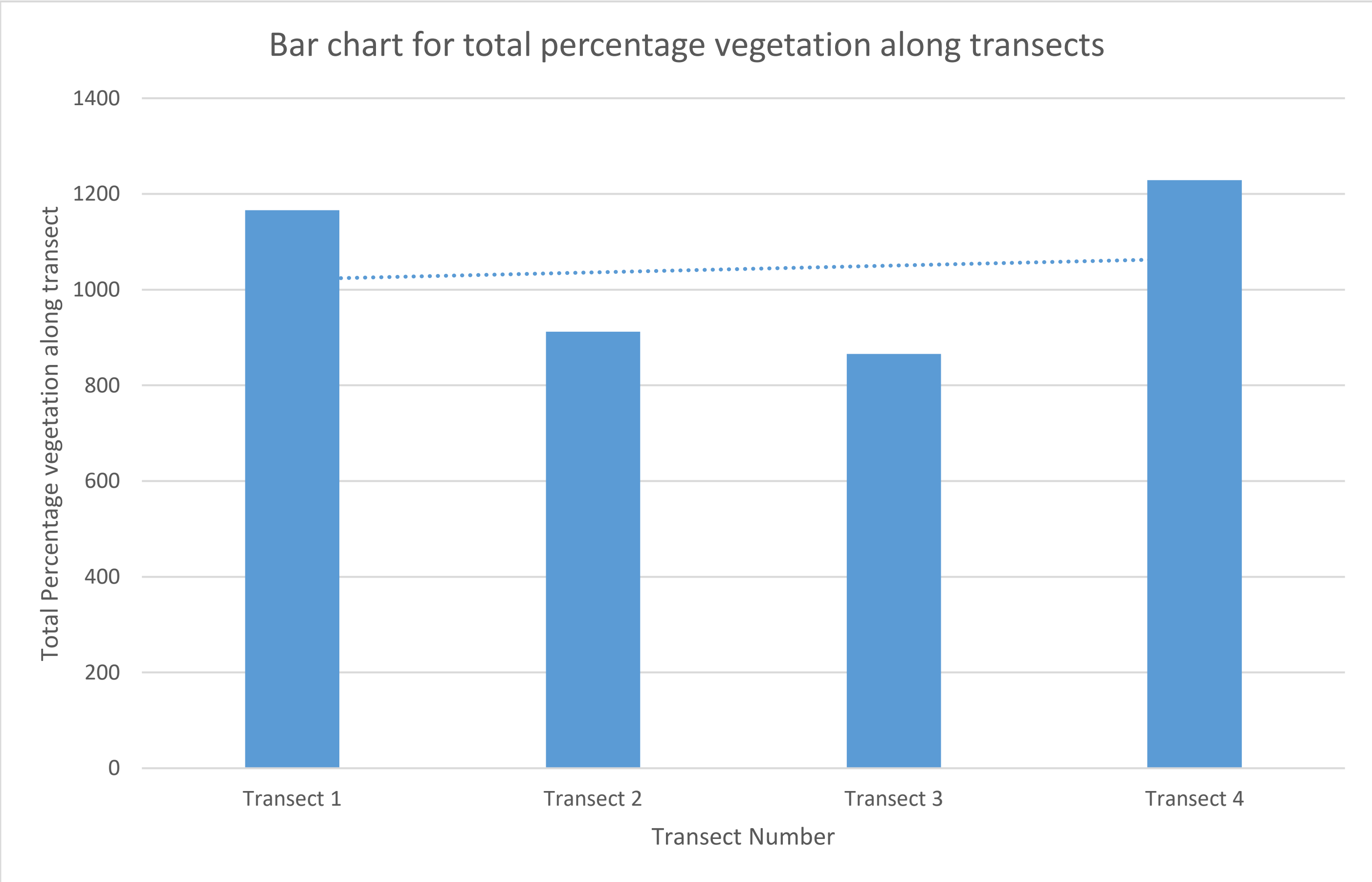
Chi-Squared Value: $X^2 = 87.22$

This value is considerably larger than the critical value of 9.488, and so I can accept my alternate hypothesis.



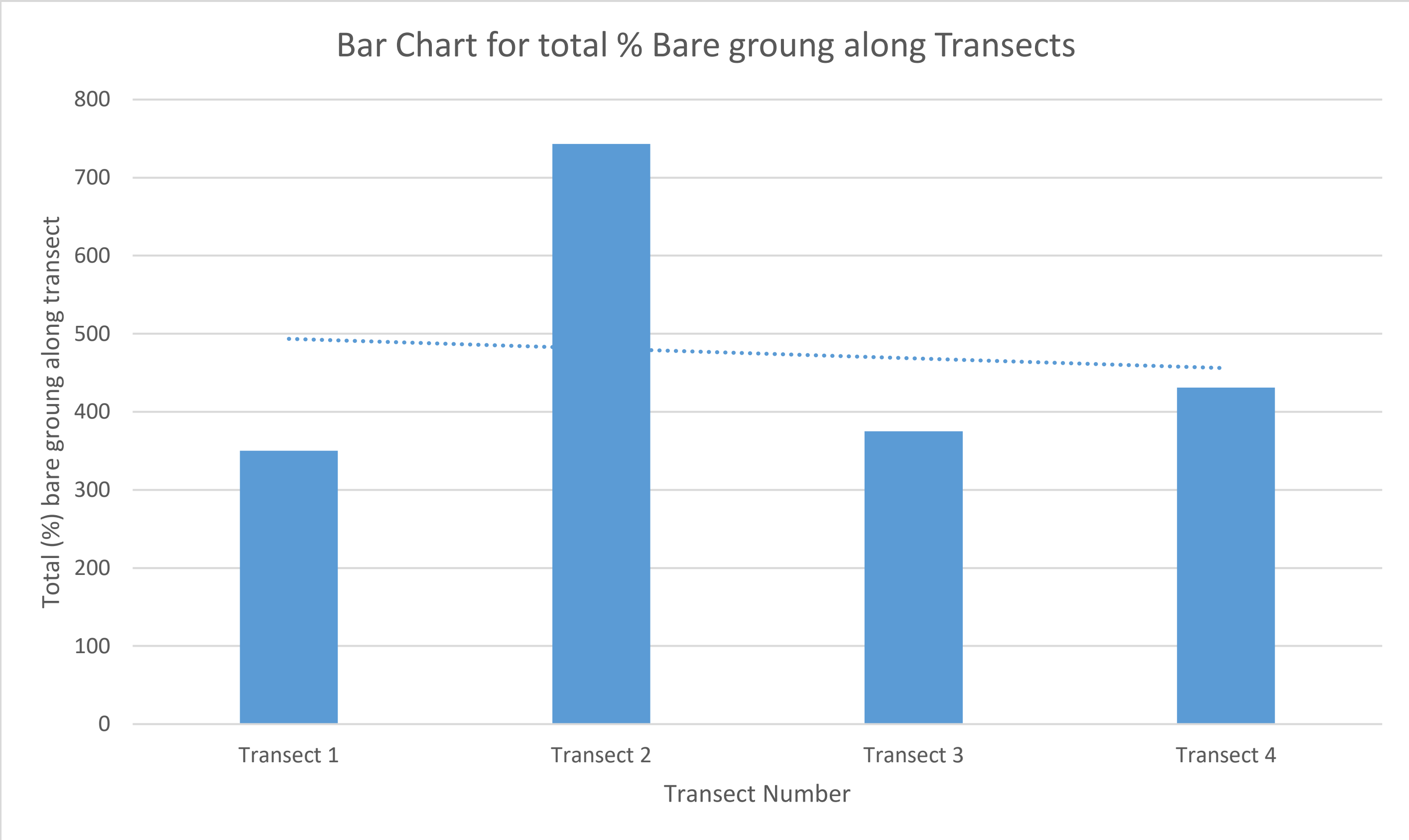
The bar chart overleaf (Figure 30) is a graphical representation of the levels of vegetation recorded along the 4 transects.

Figure 30: Bar chart to show the total % vegetation along 4 transects (150m apart) along the psammosere - including trendline.



The trendline shows that in general, vegetation cover increases as the transect moves further away from the honey pot site. This shows that human interference generally reduces the levels of vegetation. Especially in the case of transect 2 which crossed a blowout which had no vegetation, and similarly for transect 3, this transect crossed two paths which due to erosion had little/no vegetation. This trend is confirmed by the Chi-squared statistical test, which proves empirically that the further away the transect is from the honey pot site, the more vegetation it has.

Figure 31: Bar chart to show the total (%) bare ground along 4 transects (150m apart) along the psammosere - including trendline.



The trendline shows that in general bare ground decreases as the transect moves further away from the honey pot site. This shows that human interference generally increases the amount of bare ground. Especially in the case of transect 2 which crossed a blowout which had lots of bare ground, and similarly for transect 3, this transect crossed two paths which due to erosion were similarly just bare ground. The trend isn't entirely conclusive – due to the small sample size - and the fact that bare ground increases dramatically between transect 1 and 2, however the trend is one that is repeated in figure 20, giving it more credence.

Photograph Analysis:

This image was taken at the strand line looking into the sand dunes which are included in the National Trust exclusion zone. Winter storms on the 14th & 15th of December 2012 resulted in up to 2 metres of dune erosion, leaving sheer 4 foot drops from the dune system onto the beach [9]. Not only can this be unsafe, but it is also unsightly, as affirmed by a participant in my questionnaire.

Figure 32:

The National Trust exclusion zone helps to reduce erosion to these vulnerable dunes, and in nearly 4½ years, some early recolonization has begun.

The National Trust implements exclusion zones to protect especially vulnerable areas of the dune system. However, the findings of my questionnaire reveal that the programme has had limited success due to the ignorance/ information failure of the tourists.

The National Trust offers little in the way of education concerning dune restoration, and perhaps this is a key factor in the limited success of the exclusion zones.

Figure 33:

One can just see the colonisation of some Ling Heather on the dune which suggests that dune succession is occurring, albeit at an impeded rate. It is equally clear that the outskirts of the exclusion zone still suffer from erosion and as a result, vegetation is sparse.

To an extent, Studland Bay has become a victim of its own success. Huge visitor numbers peaking at around 25,000/day exceed the carrying capacity of the beach and tourists are forced into the dune system. Additionally, the National Trust has a small presence in the area, and when faced with thousands of tourists along miles of coastline, it is difficult to maintain the integrity of

This area of the exclusion zone appears to have been very successful, so much so that the vegetation has begun to breach the exclusion zone itself.

Figure 34:

The path leads to a number of beach huts, and we might suggest that beach hut owners, being more invested in the integrity of the beach and dune system, tend to adhere to the exclusion policy, and as a result, dune succession is uninterrupted.

This image of a blowout, shows a dramatic human impact on the sand dune system. Erosion of colonising vegetation leaves bare sand, which is liable to further erosion, and the resulting crater, is a barrier to any further colonisation and succession in the area.

It is clear to see that dune succession has been impeded by the blowout, as the lip of the blowout is covered in Ling Heather, Marram Grass and Gorse.

Figure 35:

Interestingly, the National Trust has laid a boardwalk to allow improved access to this blowout. This may be unusual practice as it can lead to an exacerbation of the blowout and an increasing barrier to sand dune succession.

Figure 36:

This dramatic blowout was the result of a controlled explosion of unexploded WW2 bombs. Whilst this is human intervention, it is somewhat of an anomalous cause of erosion.

The blowout, due to its size, is effectively a beach set back from the strand line, and during peak times, it can be full of tourists who couldn't find space on the beach itself. I am stood taking this photo from one of the 6 paths (3 shown in blue) which lead into the blowout. These paths were constructed by the National Trust, and clearly, they feel it is appropriate to attract people to the area, despite the blowout being an eye sore, visible from satellite images from Google Earth.

Once again, dune succession has been interrupted, as the surrounding Gorse and Ling Heather demonstrates the type of vegetation we should expect at this part of the dune system.

Figure 37:

This image is typical of the exclusion zones in the Studland Dunes System. The Café is just visible, about 150m away and this is one of the main pathways leading to the car park. Heavy traffic has resulted in a bare scar running through the otherwise densely vegetated dune system. The pervading Ling Heather and climax vegetation of Silver Birch trees have been prevented from further colonisation due to the concentration of tourists resulting in very heavy localised erosion, which is far from conducive for dune succession.

This image is important, as it neatly shows the impact of humans on the Studland sand dune system. Tourists are kept to designated paths, which often are very small and wind in-between dense vegetation i.e. gorse bushes.

Figure 38:

The National Trust has gone as far as laying down a board walk, to aid access to the path and subsequent dune system. This is potentially a double-edged sword, as the boardwalk helps to prevent erosion of the path and surrounding vegetation, but it can attract more tourists to an area and hence result in increased erosion.

This image captures many elements of the Dune system at Studland Bay. The National Trust provides these large boulders to accommodate portable barbecues. This policy was implemented after $10km^2$ of dune system was burnt due to residual heat from a portable barbecue.

The policy not only helps to protect wildlife and vegetation from fires, but it also reduces the need for tourists to venture into the dune system. The amenities provided, such as a stable base for the barbecue and a rubbish bin for any waste, are all incentives for tourists to avoid entering the vulnerable dunes.

Figure 39:

This image also shows the extent of erosion experienced in the 2012 winter storms. The dunes lack stabilisation as much vegetation was removed, and has yet to fully re-colonise.

This image shows how easily erosion spreads throughout the dune system. There is a clearly marked path to the left of the photograph, however to the right of the path, there is a distinct lack of vegetation and only sparse covering of common grass and some Lyme Grass.

Figure 40:

Importantly, this was an otherwise well vegetated area of the dune system, as shown by the dense Ling Heather. Therefore, human intervention has had a large affect in eroding and prohibiting growth of heather in the area.

Data Analysis:

To assess the relationship between distance from the honey pot site and levels of percentage vegetation, I can utilise the Spearman's rank statistical test to determine to a 95% level of accuracy, whether there is a correlation between the two variables.

My Spearman's rank coefficient for this transect was 0.54 and is greater than the 95% confidence critical value of 0.219 and hence I can approve my alternate hypothesis – in that there is significant correlation between distance from the honey pot site and percentage vegetation cover in the Studland Bay psammosere, in that as distance is decreased, so too is the percentage vegetation cover [8]. This general trend is illustrated in figure 28.

However, the correlation index value is far from a perfect correlation value of 1 [7]. The linear regression line shown in figure 13 has a shallower gradient than we would see if there was perfect correlation. Though in the psammosere environment, we are unlikely to ever obtain a perfect correlation as there are simply too many contributing factors - not least the role of human interference. Beyond the general trend, figure 19 also shows that the first 150m of my transect are more densely vegetated than we perhaps might have expected, given the Spearman's rank value. This is because the Studland Bay psammosere is managed by the National Trust, and in their attempts to preserve the ecology, they have introduced exclusion zones along the dune system. One of these exclusion zones begins at the honey pot site and extends for the first 150m of my transect. The exclusion zone is illustrated in figures 32, 33, 34 and 37. Figure 22 also shows the importance of the exclusion zone, as the National Trust warden used this term repeatedly during my questionnaire (figure 21.) Figure 28 illustrates a larger than expected vegetation covering for the first 150m of the transect, due to the protection from human interference offered by the exclusion zone.

In the exclusion zone, human interference is limited, and thus vegetation cover is higher than in the immediate areas outside of the exclusion zone. Additionally, as shown in figure 17, my transect on the edge of the exclusion zone (at 150m) shows that this area has the highest species diversity across my transect samples. This can be explained through the plagioclimactic nature of this area. Before humans started to interfere with this area of the psammosere it was vegetated to near climax vegetation with an abundance of gorse and heather. The induction of the Knoll beach café and associated amenities (which I refer to as the honey pot site) acted to attract more visitors to the area and the sphere of influence of the Studland Bay psammosere stretched as far as London – approximately 3 hours drive away. This was deliberate policy by the National Trust, as revealed in my questionnaire (figure 22). These tourists - often uneducated and ignorant to the precarious dynamic equilibrium of the psammosere ecology – favoured the more stable yellow dunes as a direct route to the beach as they provided easy access through their more compact soils as opposed to walking along the heavy sand of the beach [1,2]. I even experienced this attraction whilst conducting my questionnaire and I myself was attracted to walking along the dunes rather than the beach. This human traffic results in erosional processes which kills most of the climax vegetation. The National Trust then had to intervene to protect the dune system and so excluded tourists from the area. This gave the opportunity for re-colonisation of the dune. The difference being that there was still existing heather and gorse on the dune, yet now, marram and Lyme grasses – usually pioneer species – were seen to be growing within the dense vegetation. This trend is presented in figure 8 as 13% of the transect area is covered in marram grass, whilst ling heather, bell heather and gorse combine to cover 15% of the transect area.

Further away from the honey pot site there are simply less tourists. This relationship is explained by the attraction of the honey pot site to tourists. Simply put, tourists aren't willing to deviate from the honey pot site. Having all the amenities of Knoll beach centred in one location, means that the spatial distribution of human activity and its associated impact is condensed. This equates to less erosion further away from the honey pot site and so natural succession can take place, in which pioneer species are outcompeted by later colonisers, and the resulting abiotic factors make it impossible for pioneer species to thrive in the latter dune seral stages [5]. We can see from the trend line in figure 25 that species diversity is reduced the further away from the honey pot site the dune transect was. This is likely a result of the reduced potential for human interference within the psammosere, by way of introducing invasive species, and hence the vegetation further away from the honey pot site is more conforming to the succession theory outlined in the introduction. The trend is by no means absolute. From 150m to 300m, and then to 450m the transects lost diversity, however from 450m to 600m the transect increased in diversity. This could be due to freak invasive species, or simply because my sampling technique resulted in a narrow sample area with a potential for anomalous results.

Revisiting the Spearman's rank value for the 800m dune transect; it is clear from figure 13 that this is far from a perfect linear relationship. The transect encounters a large blowout - as identified in the Leeson House secondary data – which means that from 230m to 320m there is no vegetation at all. This blowout, due to its size, acts as a natural shelter from the wind, and therefore attracts intense usage from tourists. It is suggested that it can take decades for a blowout to recolonise and the human interference in this blowout prolongs the initiation of this colonisation [2].

Figure 13. shows another interesting trend, in that between the honey pot site and 400m along the transect, total vegetation cover rarely exceeds 100%, whereas between 400m and 800m, total vegetation cover rarely dips below 100%. This trend can be contributed to the fact that very few tourists are willing to walk so far away from the Knoll beach honey pot site, and the next nearest café

is the Shell beach café, which is a 3.09km walk away from the 400m location on my transect as shown in the map below.

Figure 41: Google Earth satellite image and overlaid construction lines from 'Where's The Path 3' showing the distance (3.09km) from a blowout near Knoll beach café to the Shell beach café. Additional construction lines highlight the sphere of influence of the two cafes as well as highlighting the broad changes in vegetation over the section of the psammosere between the two cafes.

Even from the aerial photographs, it is clear to see that the area of the psammosere between the two cafes highlighted red is more densely vegetated, featuring a characteristic brown heather population. The two blue circles represent a 400m sphere of influence of the two honey pot sites, and we can see that these areas are noticeably barer and both feature visible blowouts. This illustrates the trend line shown in figure 20 where the average percentage bare ground cover from 0m to 400m is 60% whereas from 400m to 800m the average value is circa. 20%.

To further critique the relationship between distance from the honey pot site and levels of percentage vegetation, I can utilise the Chi-squared statistical test to determine to a 95% level of accuracy, whether there is a correlation between the two variables. This test, and the relative strength of the index coefficient will help to answer my hypothesis.

My Chi-Squared value of 87.22 is greater than the 95% confidence critical value of 9.488 and hence I can approve my alternate hypothesis – in that there is significant correlation between distance the transect is from the honey pot site and percentage vegetation cover in the Studland Bay psammosere, in that as distance is decreased, so too is the percentage vegetation cover.

Despite vegetation dropping from the 150m transect to the 300m transect, and again further to the 450m transect, vegetation once again increases from the 450m transect to the 600m transect. The overall trend line shown in figure 30. Shows that throughout my sample of transects, vegetation increases as the location of the transect moves away from the honey pot site. The dip from 150m to 300m can be explained by the National Trust exclusion zone preserving the area of the psammosere up to this point. The 300m transect encounters a large blowout, which by nature has no vegetation, hence reducing the overall vegetation along this transect. The 450m and 600m transects are more characteristic of the psammosere with limited human interference as the sphere of influence of the honey pot site is unlikely to extend this far as reflected by the tourists' opinions in figure 23. This makes sense, as tourists intend to enjoy the coast rather than undertake an arduous walk throughout the psammosere.

As a contributing hypothesis to help answer my investigation title, the secondary data on the blowouts in the Studland bay psammosere will help me to assess whether the characteristics such as size and number of paths leading into the blowout change with distance from the HPS. Blowouts are a dramatic feature of the psammosere, usually caused by storms and/or human interference [1]. Regardless of the origin of the blowout, they are attractive to tourists and experience quite intensive usage, particularly on busy days [1]. The linear regression line in figure 24 illustrates the negative Spearman's rank correlation coefficient between distance from the honey pot site, and circumference of blowouts. In total, 8 blowouts were recorded, and the 3 largest blowouts were all within 600m of the honey pot site. The following 5 blowouts failed to reach a circumference of larger than 55m, and compared to the blowout at 450m from the HPS with a circumference of 250m, these blowouts were very negligible in size. Figure 29 is pivotal in explaining the trend presented in figure 24. As the scatter graph shows, the further away the blowout is from the HPS, the less pathways it has leading to it. The largest blowout at 450m, has 7 pathways, whist the smallest blowout at 830m only has 2 pathways. The number of pathways is directly proportional to the circumference of the blowout, and I can therefore deduce that more human interference, (i.e. popularity with tourists results in more pathways which results in more interference) the larger the blowout is. Figures 35 and 36 show how the National Trust is encouraging tourists to enter the blowouts through laying down boardwalks to aid access. This exacerbates the erosional processes in the blowout and hence increases its size. As an additional piece of evidence, the trend line in figure 27 shows that as distance from the honey pot site is increased, the depth of the blowout also decreases, due to less human interference and hence less erosion.

These three charts, present a clear trend: as proximity to the honey pot site decreases, all the blowout characteristics: circumference, number of pathways and depth decrease. In essence, human interference makes for a larger, more pronounced and more easily accessible blowout. To illustrate this, I have overlaid the outline of a blowout 230m away from the honey pot site in 2014 onto a google earth satellite image of the exact same location from 1945.

2014: The blowout is a clear eyesore even from a satellite image taken 1km above the earth.

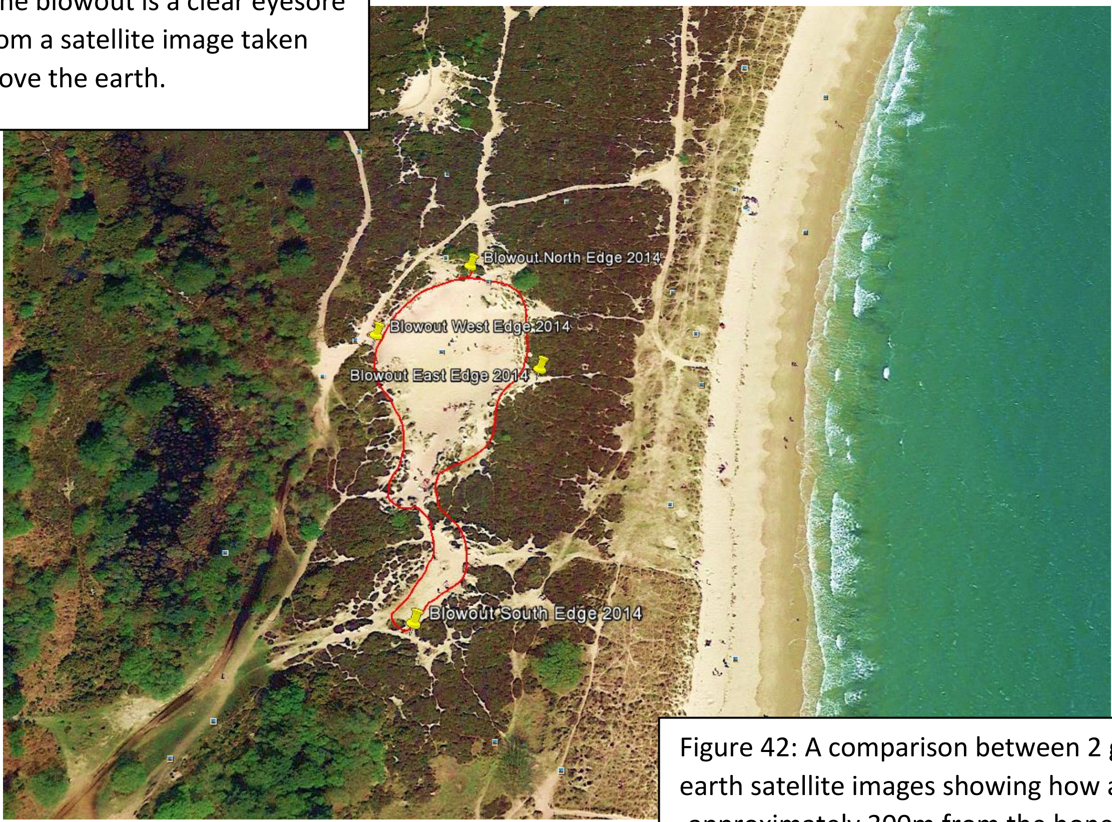
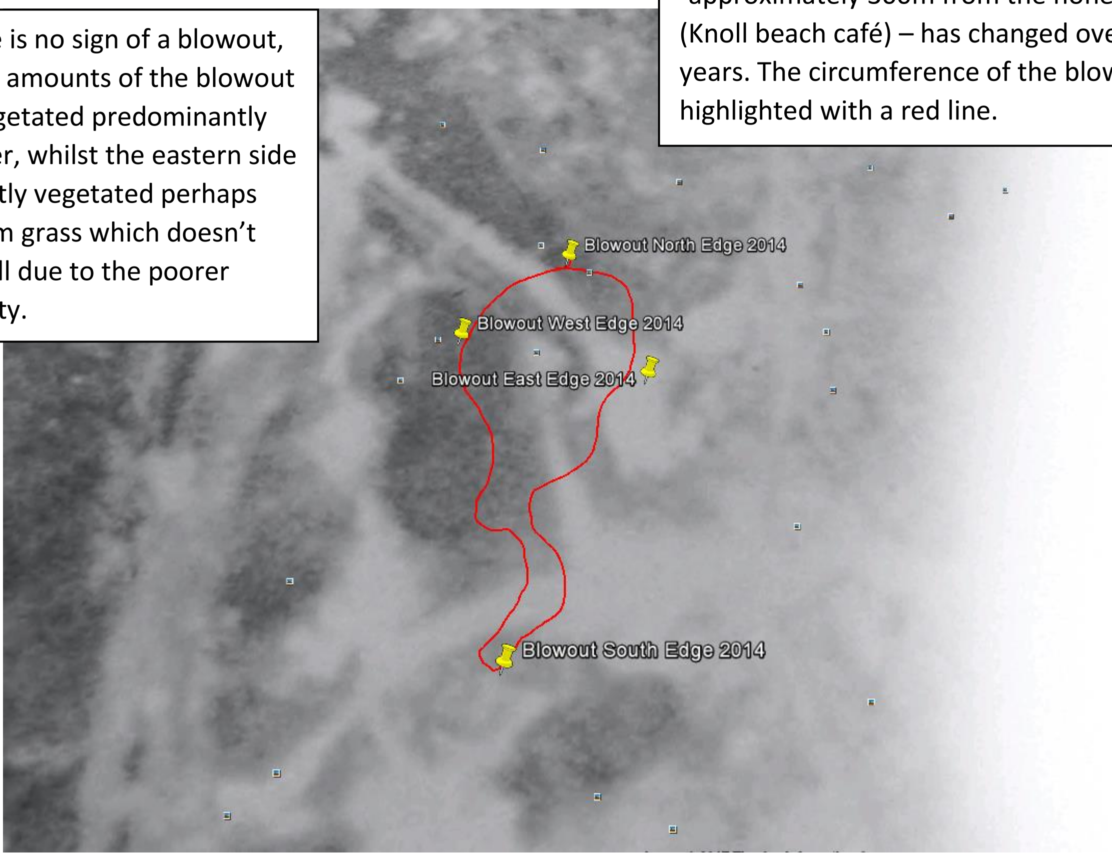


Figure 42: A comparison between 2 google earth satellite images showing how a blowout -approximately 300m from the honey pot site (Knoll beach café) – has changed over 69 years. The circumference of the blowout is highlighted with a red line.

1945: There is no sign of a blowout, in fact large amounts of the blowout area are vegetated predominantly with heather, whilst the eastern side is more lightly vegetated perhaps with marram grass which doesn't show as well due to the poorer image quality.



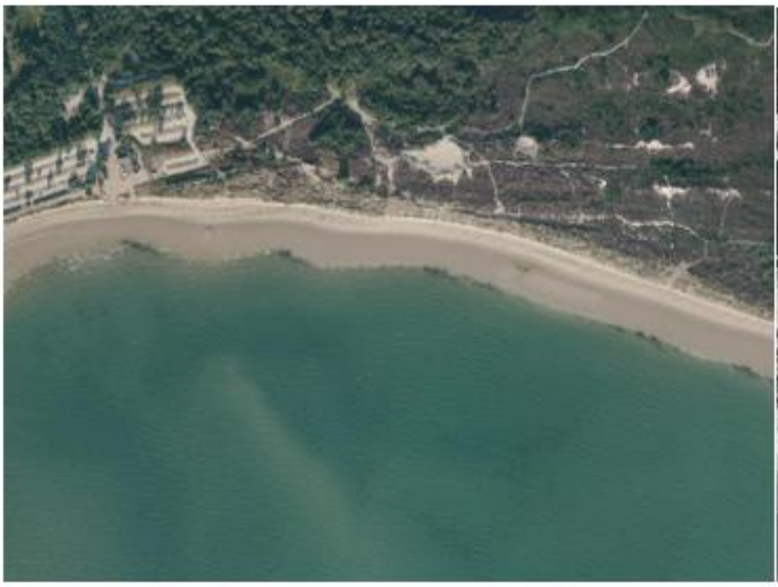
Figures 7, 10, 13 and 16 make for an interesting comparison of the 4 perpendicular transects taken at 150m, 300m, 450m and 600m respectively. The only transect not to follow normal dune succession, as outlined in the introduction is the transect at 300m. This is because it encounters a blowout, and the last 40m of the transect have no vegetation. Figure 10 therefore shows that this dune has a negative correlation between distance into the psammosere and vegetation. This is far from characteristic, as we would expect the embryo dunes at 10-20m from the strand line to feature bare ground with swathes of marram and Lyme grass and then the inner yellow and grey dunes from 60m should feature dense heather variations. The other 3 transects have characteristic profiles whereby total percentage vegetation cover increases with distance from the strand line.

We can also help to explain this trend not just through abiotic factors, but also through the influence of human interference. The honey pot site is situated approximately 20m – 30m from the strand line. This means that the majority of tourists are attracted into the foredunes and this is where the majority of erosional processes take place. It may also be worth adding that due to isostatic adjustment of the southern coast of the UK, and rising sea levels, the dune system is at increasing threat from coastal erosion, particularly during winter storms. This is an indirect impact from humans upon the psammosere, as global warming is a human process [14].

The dune profiles highlight the difference in topography in the psammosere. I recorded the angle of the slope along the four perpendicular transects so that I may be able to assess whether proximity to the honey pot site has any bearing on the topography of the dune system. Theory suggests that as I move along my transect, the dunes should keep rising for 100m-150m before the dune system enters a dune slack which returns down to sea level. As my transects only covered 100m I should expect to see a continual incline. This was far from the case. For the transects at 150m, 300m, and 450m, the average angle was positive, resulting in an average rate of incline. However, within this there was examples of dramatic topography where I might experience a very steep section, followed by a gentler incline which would result in a more characteristic average. Particularly for the 300m transect, which encountered a blowout, as I approached the blowout at 50m there was a very severe incline, then following this for the next 10m was a very severe decline as the transect entered the blowout. The transect at 450m crossed a path between 30m and 40m along the transect, and not only did this result in low vegetation readings, it also meant that instead of an incline, the dune profile dipped down into the path, as tourists using this path results in downwards erosion, which continually deepens the trench cutting through the psammosere. These two features are the only characteristics of the dune profiles that concur with human interference. I can confidently say that human interference has resulted in these features, and continued interference continues to exacerbate them. The transect at 150m from the honey pot site – whilst considerably steeper than any of my other transects – follows the theory with more precision than even the 600m transect which I would expect to be near textbook due to the little amount of human interference. I have therefore proven to some extent that there is a correlation between proximity to the honey pot site and altered dune topography.

Investigation Conclusions:

The empirical evidence I have accumulated has helped to reveal through statistical tests that both of my alternate hypotheses were in fact true. My evidence points to human interference as the prime cause of reduced vegetation, impeded succession and altered topography, in the Studland Bay psammosere. Conversely, human interference can be a prime cause of increased vegetation and species diversity as shown from the results inside the National Trust exclusion zone. The success of this policy is shown nicely by photograph comparison from Channel Coast Discovery Online [15]. The black and white photograph dates to circa. 1900 and exemplifies the dramatic effects that unimpeded access can have on the psammosere. This is a useful macro view of the psammosere over an extended period which reflects the overall impacts humans have on the psammosere. The photo predates Studland Bay's accreditation as a Nature Reserve, and so nothing was done to stop human behaviour in the psammosere. The result is a heavily eroded dune system with huge numbers of pathways and vast swathes of the psammosere reduced to blowouts.



It is clear, that for the continued prosperity of the Studland Bay psammosere, human interference will need to be further reduced to maintain natural biodiversity and to allow unimpeded dune succession. Perhaps the area of the exclusion zone could be extended to decrease the spatial distribution of tourists within the psammosere. The National Trust could implement an education policy to alleviate the ignorance of some tourists, or perhaps an increased warden presence would prevent many tourists from disregarding the rules. Key areas within the psammosere such as the blowouts at 220m and 450m from the honey pot site and the system of pathways throughout the psammosere may need revisiting by the National Trust as they are extremely detrimental to the natural succession of the dune system, as they focus a large amount of human interference in an isolated space, which heightens the erosive effects of human presence. A further hotspot is the area identified in figure 40, just outside of the Exclusion Zone. Tourists throng to this area as it is the closest area of the psammosere to the honey pot site that is accessible, and hence erosional forces are concentrated on this area, which as a result is void of most vegetation bar a thin covering of grass. Despite being set back some 40m from the strand line - and hence we would expect to see heather varieties - succession has been impeded by human interference.

In practical terms, human interference in the psammosere will always affect natural processes. If the National Trust was to have one pathway throughout the psammosere this pathway would be eroded deeper and wider and would completely alter the topography and vegetation succession along this section of the dune. Alternatively, a larger series of small pathways throughout the psammosere, as demonstrated in figure 38, increases the spatial impact of human interference and may impede succession and alter topography to a lesser extent, but on a greater scale. Therefore, the challenge for the National Trust is to mitigate against total devastation by way of unimpeded access to the psammosere or by way of fires, without sealing off the psammosere to tourists. Perhaps having a rolling section of the psammosere under exclusion would allow for areas to recover whilst others bore the brunt of human interference and vice versa. However, my data alone cannot be used to justify these measures as more complex social and economic affects need to be assessed. What can be concluded however, is that human interference in the Studland Bay psammosere reduces percentage vegetation cover, increases the size of blowouts, alters the topography of the dunes and impedes natural succession. These trends are reflected across my entire data set, and have been deduced conclusively from statistical tests. Wider literature has reflected the importance of assessing human impact in the psammosere, and my data mirrors current literature drawing links between altered psammosere vegetation and human interference.

Evaluation:

Technique:	Successes:	Limitations:	Summary/Improvements:
800m Parallel Transect	The transect produced plentiful data that I used to draw out many of my conclusions. It was a simplistic technique that had only small margins for human error – a failure from me as the researcher to collect 100% accurate data.	The human error came in two main forms. Either, straying from the 10m increments via incorrect measurement, this error was introduced when the tape had to go over vegetation and thus wasn't as taught as it should have been. The other form of human error was miscounting the vegetation within the transect. This itself could be in two forms: incorrect identification of vegetation – especially species that are similar such as marram/ Lyme grass and Ling/Bell heather – as well as miscounting the vegetation within the transect. This was easily done, especially when entering an area of dense vegetation with several layers of vegetation impeding my view. An additional error/ difficulty was maintaining my straight course throughout the dune system. I aligned myself with a large tree behind the Honey Pot Site, however once in the dune system, it was easily possible to deviate from this line, due to obscured vision.	Overall this was a largely successful sampling technique. The systematic nature allowed for simplistic collection and a useful data spread, objectively sampling the psammosere without bias. My deviation from the transect route I believe was minimal, and I was meticulous in measuring out the 10m increments. The biggest pitfall was having to rely on counting the species within the transect. To limit the inaccuracy, I made sure that I counted the species myself instead of my fieldwork partner. This meant that if I was counting with any consistent error, this error would be constant throughout the transect and therefore wouldn't adversely affect the trends that the data would show. To improve this data, I would have worked with my fieldwork partner to count the number species to gain accuracy, I would have also asked for more help on identifying species, rather than solely relying on my handbook.
100m Perpendicular Transects	All the above successes apply, in addition to the following: The main benefit of these transects was to assess if the topography of the dune system had any noticeable change as I moved away from the honey pot site.	All the above limitations apply, in addition to the following: The clinometer I was using was old and through years of fieldwork usage, one could safely predict that there would be some non-zero (systematic) error with this piece of equipment. There was also substantial human error in reading the scale. The ranging poles had to be thrust into the ground to support them, and I had no mechanism to ensure that they were always the same depth in. This would therefore affect the slope reading, and lead to inaccuracies.	This was again a successful sampling technique. The basic structure of sampling remained in place, and the systematic nature of the data meant that I have a well distributed, and even spread of data from the psammosere. Additionally, whilst the depth at which the ranging poles were pushed into the ground varied, it varied by such a small amount, that I think it is unnecessary to suggest that it had a bearing on the data collected. However, the inaccuracies caused by using/reading the clinometer scale wrong are more detrimental, and I would suggest that there are inaccuracies within my data of perhaps +/- 1°, and so this perhaps lends less credibility to the conclusions drawn from the impact of human interference on the topography of the dune system. To improve this data I could have simply used a more modern clinometer.

Technique:	Successes:	Limitations:	Summary/Improvements:
SECONDARY DATA: Leeson House Blowout Data	This data covered the same sample area as my primary data and therefore it was of direct use. The accuracy of the GPS is hard to critique, meaning the data is reliable. The stratified sampling method meant that a key sub-group of the psammosere could be isolated.	The sampling method relies on the researcher to encounter all the blowouts in the sample space and to correctly identify these areas as such. For example, small blowouts may look like National Trust pathways. The measurements of depth require the use of Pythagoras' theorem, and this can result in inaccuracies when rounding. Another cause of inaccuracies could be the researcher incorrectly identifying the edge of the blowout and hence collecting circumference data that was too big/small. Additionally, the number of paths is quite a subjective category, and so inaccuracies are likely.	This secondary data was very useful in allowing me to test my hypothesis from another perspective, and it strengthens my conclusions. I am wary that some of the data may have inaccuracies, however, I would suggest that due to the size of blowouts, and the contrast between the surrounding vegetation, it is highly unlikely that the researcher has calculated the circumference with anything greater than a 5% inaccuracy and so I have confidence in the data. To improve this data the researcher could have asked a colleague to repeat the fieldwork and take an average, this would help to reduce the error by way of working out averages.
SECONDARY DATA: Leeson House Abiotic Factors Data	This data provided information which I didn't have the capacity to collect due to a lack of specialist equipment. The researcher chose the transect route specifically as it was a 'normal transect', and hence more likely to be representative of the entire psammosere.	There was only one transect taken, meaning that the values for pH and soil moisture etc. are only completely accurate in one location and may not be characteristic of other locations in the psammosere; this makes it hard to draw conclusions from. The abiotic factors in a psammosere are a result of natural selection and plant succession and hence the abiotic factors are a result of the vegetation in that location. I cannot therefore conclude that there is little vegetation in a section of the dune just because the soil is too dry. The soil is dry because these are the conditions for marram grass etc. and due to its nature, results in a sparser vegetation covering compared to a species such as ling heather.	The researcher reported that this transect was a 'normal transect' and so I could suggest that the abiotic factors shown are characteristic of the psammosere, but this is a tenuous link, and doesn't provide validity to any conclusions solely based on this evidence. The main use of this data was comparing the perceived characteristics of the Studland psammosere to those of the hypothesised diagram which outlines what one should expect in a theoretical psammosere. To improve this data, I would simply require the researcher to conduct more transects, so that an increased sample size could be used to perhaps draw out averages for the psammosere.

Technique:	Successes:	Limitations:	Summary/Improvements:
Questionnaire	This was a useful way to gain some qualitative data and this supplemented my empirical data when drawing out conclusions. It was particularly useful to see how National Trust policies were carried out in practice.	The main limitation of my questionnaire was the sample size. As the bulk of my day was spent measuring transects, I only had a small amount of time to approach tourists. This means that the views expressed, particularly by the tourists may not be characteristic of the entire tourist population, especially seeing as I conducted 2 interviews and Studland Bay experiences up to 1 million visitors/year.	I gleaned some very useful and divisive information from the questionnaire. The views expressed complemented the empirical evidence and theory nicely and added credence to my conclusions. To improve this data, I would have to conduct the questionnaire on a larger scale, and work out what percentage of people held different views.
Photography	Another qualitative technique that was useful in detailing what the empirical evidence showed. It was particularly useful to show National Trust management strategies in action and their implications.	As I was the photographer I was unduly influenced by location bias. I would only take photos that I believed would contribute to my evaluation of the hypothesis. I didn't systematically take photos of the dune system and so my photograph selection is by no means representative of the entire psammosere.	My investigation didn't require a systematic analysis of the psammosere through photography, and so my photographs have the purpose of illustrating quirks in the data and/or any characteristic of the psammosere that relates directly to the hypothesis and therefore may lend further evidence for conclusions. I largely took photographs along my transects, and so to improve the data, I would have liked to branch out further from the transects to collect photographs from a greater sample area of the psammosere, to build up a more detailed image.
Ethical Practices and Sustainability	I adhered to the National Trust exclusion zones at all times, which meant that I wasn't damaging the endangered areas of the psammosere. My questionnaire was very general and required no personal data to be collected so the tourists I asked felt comfortable to answer.	As a result of conducting 5 transects throughout the dune system, I will have caused erosion throughout the psammosere. Due to the nature of my transects, they rarely followed the course of a National Trust path, which meant that I was nearly always treading on vegetation. This reduces the sustainability of my investigation, as if it was to be repeated by hundreds more students or academics, then the Studland Bay psammosere would start to suffer from the increased human traffic.	It seems unfortunate, but the only way to record data in an attempt to help understand more about protecting the psammosere is to potentially damage the psammosere in acquiring that data. Maybe if drone footage could be utilised this may reduce the need for as much direct damage to the dunes. However, for the foreseeable future, if investigations are to continue in the psammosere, researchers must be sure to adhere to the exclusion zones and try and limit their impacts as thoroughly as possible.

Investigation Evaluation

Reliability

My data primary data sets are small and hence trends are limited. Repeating transects would have benefitted the investigation. Data collection could have been made more precise, however data analysis produces significant results.

Limitations

A huge limitation was time. This would have allowed me to conduct more transects, increase my sample size and allow for greater comparisons. Further limitations were human and systematic error. Perhaps greater knowledge was required, as well as more modern accurate technology.

Extension of Investigation

Moving forward, the same data could be collected in any psammosere, not just along the south coast of England, but also in other hot spots for dune research such as the Mediterranean and the Caribbean.

Context

My literature review shows that the coexistence of tourists and the psammosere is extensively studied. Tourism is a large part of many economies, and as such, human interference in the psammosere needs to be maximised for revenue, but managed so that the industry is sustainable, and little ecology risks being lost.

Improvements

There is clear room for improvement in sample size, as well as incorporating greater secondary data. The methodology was quite sound for the equipment available, perhaps more accurate clinometers, laser range finders and vegetation recognition could have all improved accuracy of the results.

Validity

I believe that my investigation is relevant and fits well into the context of much wider research. It's certainly not in-depth enough to influence geographical thinking; however, it does suggest that the trends shown are so prevalent, that even a teenage student can recognise them through one day of fieldwork.

Overview:

Successes:	Limitations:	Summary/Improvements:
Given my limited time and resources I was able to collect substantial data – admittedly in a concentrated area – which I could then use in statistical tests to conclusively answer my hypotheses within the given sample area of the psammosere. My conclusions are validated to the extent that my data collection was as accurate as possible and my analysis was equally as accurate. The results mirror those both in literature and wider studies related to psammosere degradation via human interference. Thus, my results are both accurate and relevant in the wider geographical context.	My investigation lies under a shadow of doubt, simply due to its size. Whilst I worked hard to collect as much data as I could, my investigation can merely be a suggestion of what results can be found in the Studland Bay psammosere. My sample size was enough to provide accurate statistical tests; however, the results are far from conclusive and for my investigation title to be truly answered, much more research needs to be carried out in the psammosere. A perfect example of this can be seen in my dune profile analysis: having 4 transects allowed for comparison in a localised area, however it is near impossible for me to extrapolate conclusions for the psammosere from just 4 transects. Additionally, when comparing my data to the theory, there will always be anomalies. My transects running at 150m, 300m, 450m, and 600m could have all been anomalies, whereas if I had carried out more transects, this would be clear to see.	My conclusion that humans have a very large and multi-faceted impact on the sand dune succession in Studland Bay psammosere can be evidenced by my investigation data, but the extent of this impact is still unclear as my investigation doesn't have enough breadth to be able to cast such broad conclusions for the entirety of the psammosere. My investigation sits well in a wider geographical context and complements existing studies and literature on the topic, proving that this was a worthwhile investigation. My methodology and analysis techniques were appropriate and accurate to the best of my ability, and as such my investigation conclusion, that human interference in the psammosere results in reduced vegetation, exacerbated blowouts and altered topography, as well as impeded/altered succession can be accredited.

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