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Extended essay cover

Candidates must complete this page and then give this cover and their final version of the extended essay to their supervisor.			
Candidate session number			
Candidate name			
School number			
School name			
Examination session (May or November)	May	Year	2012

Diploma Programme subject in which this extended essay is registered: Geography

(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: To what extent is Biodiversity being managed successfully at Braunton Burrows?

Candidate's declaration

This declaration must be signed by the candidate; otherwise a grade may not be issued.

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

This is the final version of my extended essay.

Candidate's signature: [redacted] Date: 28/01/2012

Supervisor's report and declaration

The supervisor must complete this report, sign the declaration and then give the final version of the extended essay, with this cover attached, to the Diploma Programme coordinator.

Name of supervisor (CAPITAL letters) _____

Please comment, as appropriate, on the candidate's performance, the context in which the candidate undertook the research for the extended essay, any difficulties encountered and how these were overcome (see page 13 of the extended essay guide). The concluding interview (viva voce) may provide useful information. These comments can help the examiner award a level for criterion K (holistic judgment). Do not comment on any adverse personal circumstances that may have affected the candidate. If the amount of time spent with the candidate was zero, you must explain this, in particular how it was then possible to authenticate the essay as the candidate's own work. You may attach an additional sheet if there is insufficient space here.

This declaration must be signed by the supervisor; otherwise a grade may not be issued.

I have read the final version of the extended essay that will be submitted to the examiner.

To the best of my knowledge, the extended essay is the authentic work of the candidate.

I spent [5] hours with the candidate discussing the progress of the extended essay.

Supervisor's signature: _____ Date: 27/1/12

Supervisor's report and declaration

performance in the Extended Essay is impressive. She has worked hard at all stages of the project and completed the written report within the word limit and within the internal deadlines set by the school. The idea for enquiry began from fieldwork undertaken in March 2011 in North Devon with other IB Diploma students and was developed through background reading of Geography texts and journals researched within the Department Library and from online sources. re-visited the Braunton Burrows site the following month and explored the sand dune ecosystem more extensively, with a particular focus on management strategies. This enabled her to focus her research question on the evaluation of management of the Burrows to sustain biodiversity.

employed an appropriate strategy of stratified sampling, using random number placement, for primary data collection along a longitudinal transect across the least disturbed area of the dune system. She undertook her fieldwork in the central, less accessible section of a sizeable psammosere and justified her methodology. In her Viva Voce, she was able to draw on her wider exploration of Braunton Burrows to consider a greater range of impacts on the ecosystem at different pressure points. In particular, she considered the least defensible section of dunes near Saunton with their open public access and the challenge of managing species diversity here. also developed her explanation of the relatively low Diversity Index that she had identified for the dune pasture, in her primary data location, through a consideration of the anomalous mobility of the bare 'flagpole' dune, 1000 metres inland from the embryo dunes. She considered that advancement of this dune encroaches on the species-rich dune pasture whose very biodiversity needs to be sustained to preserve rare dune and slack communities. She also clearly understood how conflicting management approaches, that resulted in a 6-year removal of conservation status, had impacted on species diversity and how secondary succession brought on scrub invasion within such a short time. was aware of the complexity of the issue and of the need to resolve conflict between stake-holders in order to achieve effective management. Research into archived material from the North Devon Journals allowed her to explore this further. Online access to the most recent condition reports of this SSSI by Natural England enabled her to acquire an overview of the whole psammosere in the time since her initial fieldwork was conducted. This added depth to investigation and facilitated an informed conclusion.

The presentation of written report was of a high standard with appropriate maps, sketches and annotated diagrams. She spoke confidently in her Viva Voce, developing her responses and made considered suggestions to extend her investigation. I am convinced that the Extended Essay she has submitted is her own work and that thoughtful and intelligent approach demonstrate how much she has gained from such an investigation.

Assessment form (for examiner use only)

Candidate session number	

Criteria	Achievement level				
	Examiner 1	maximum	Examiner 2	maximum	Examiner 3
A research question	2	2	2	2	
B introduction	2	2	2	2	
C investigation	3	4	3	4	
D knowledge and understanding	4	4	4	4	
E reasoned argument	3	4	3	4	
F analysis and evaluation	3	4	3	4	
G use of subject language	4	4	4	4	
H conclusion	2	2	2	2	
I formal presentation	3	4	3	4	
J abstract	2	2	2	2	
K holistic judgment	3	4	3	4	
Total out of 36	31		31		

ıe of examiner 1: _____ Examiner number: _____
PITAL letters)

ıe of examiner 2: _____ Examiner number: _____
PITAL letters)

ıe of examiner 3: _____ Examiner number: _____
PITAL letters)

IB Cardiff use only: **B:** _____

IB Cardiff use only: **A:** LW1837 **Date:** 3/5/04

Extended Essay

Session: May 2012

Subject: Group 3, Geography

Management of Ecosystems

Research Question: 'To what extent is Biodiversity being managed successfully at Braunton Burrows?'

Name:

Candidate Number:

Supervisor:

Centre Name

Centre Number: 004199

Justification not clear
↳ but theory sound

Clear evaluation of the options for conservationists

sampling technique described

Good analysis & data

needs more mapping

Date: 10th November 2011

Word Count: 3,935

Good choice & study

Abstract (Word count: 261)

My research question is 'To what extent is Biodiversity being managed successfully at Braunton Burrows?' I visited Braunton Burrows, a psammosere in the United Kingdom, which is known for its rare plant species and biodiversity, in March 2011 to investigate biodiversity and management. The process of succession gave me an understanding of the increase in biodiversity from the strand line to the dune pasture and woodland. The investigation was undertaken by doing a transect across the dunes from the strand line at Saunton Sands to Sandy Lane car park. Ten sites were chosen using a stratified sampling strategy. I calculated the percentage frequency of plant species in a 50cm x 50cm quadrat and then used this data to calculate Simpson's Diversity Index, which showed that generally biodiversity increased from the yellow dunes to the grey dunes. I was particularly interested in the management of the dunes, investigating the issues concerning the damage of parts of the psammosere and the decline of biodiversity. I visited the dunes for a second time to take photographs for evidence of human impact and existing management. Through investigation into management it became clear that conflicts between stake-holders impacted upon the management and consequently the biodiversity. The area is a Site of Special Scientific Interest and UNESCO Biosphere Reserve which helps the biodiversity to be successfully managed. However, the number of visitors to the Burrows and the surrounding area impacts upon the vegetation, therefore further management strategies need to be implemented to secure the status of the site and protect the rare plant species for future generations.

sampling

paragraphs please

✓ ✓

J 4/2

CONTENTS

Introduction (word count: 1293)

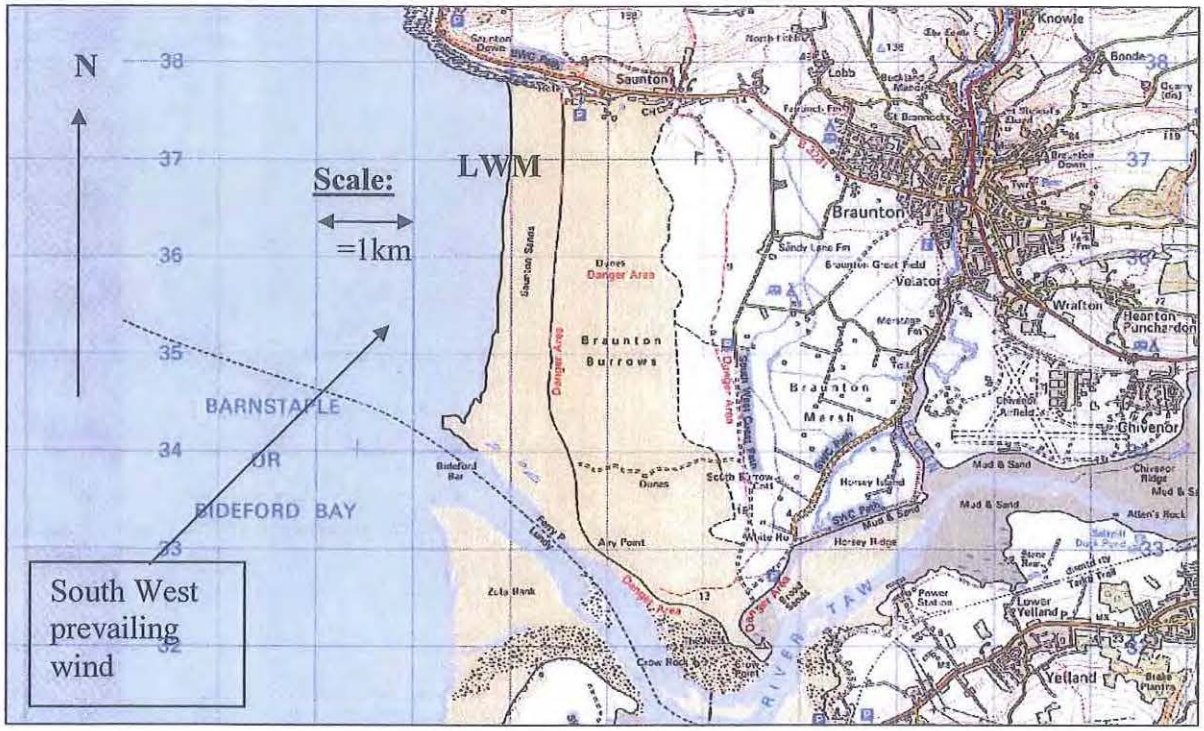
Research Question: **'To what extent is Biodiversity being managed successfully at Braunton Burrows?'**

Braunton Burrows is a sand dune system in North Devon, 51 ° 05'N and 04 ° 12' W, north of the Taw-Torridge Estuary, (Fig.1) in the United Kingdom and is recognised by UNESCO for its biodiversity. This psammosere which is one of the largest in the UK is fragile. I visited the area in March 2011 to investigate the biodiversity within the Burrows and to examine potential issues and conflicts that need managing. Braunton Burrows comprises a set of parallel dune ridges and intervening slacks over a distance of 1500m (fig.2).

I will investigate and then evaluate the management of the biodiversity at Braunton Burrows. Biodiversity is 'the variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable.' (Oxford Dictionary). Braunton Burrows is known to have over 400 different species of flora recorded. Succession is 'the process by which a plant or animal community successively gives way to another until a stable climax is reached.'(Oxford Dictionary). At Braunton Burrows the process of succession is important in understanding how the biodiversity increases.

Why do you think this is worthy of investigation?

Fig.1a OS. Map of Braunton Burrows and the surrounding area, North Devon



my holiday 2011 was here!

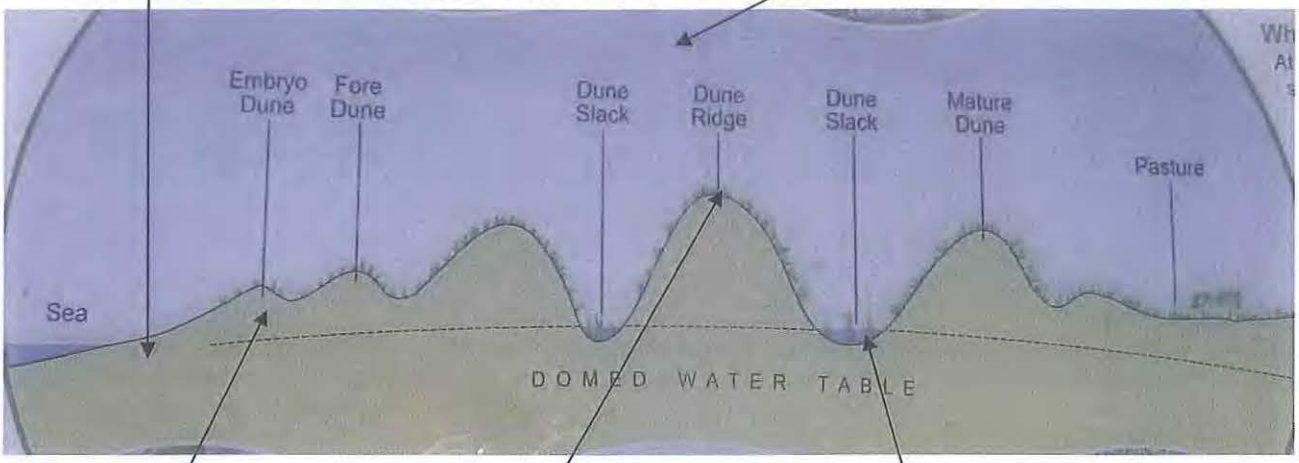
Fig.1b Map of the United Kingdom

Sawke?

Fig.2. The structure of the dune system at Braunton Burrows. Source: Sandy Lane Car park information board. (Education for visitors)

A macro-tidal environment is needed to form the dunes. Beach sediment dries out at low tide and is blown inland by wind. At low tide Saunton Sands is approximately 500 metres in width with 2,500,000 square metres of sand exposed to the prevailing onshore and westerly winds (Fig.1). These move the particles of sand by saltation and surface creep past the high tide water mark.

These dunes formed by wind in conjunction with vegetation are called impeded dunes.



The movement of sediment is stopped above the high water mark by obstacles such as seaweed, litter and other natural and human objects.

The winds control the form and height of the dunes. Erosion of the dunes occurs on the windward slopes whereas deposition is on the leeward slopes.

Dune ridges are eroded by wind forming depressions and dune slacks.

good annotation

Succession results from bare sand being exposed for a period of time. At first pioneer species colonise the exposed sand at the relatively nutrient-rich strand line (fig.4). The environment of the nutrient-deficient sand is enriched by the dead biomass of these colonising species, making the environment suitable for other plants, which then succeed the pioneer species due to competitive exclusion. There is competition between different species for the same resources. Species which are able to survive best dominate and eventually competitively exclude other species. New plants

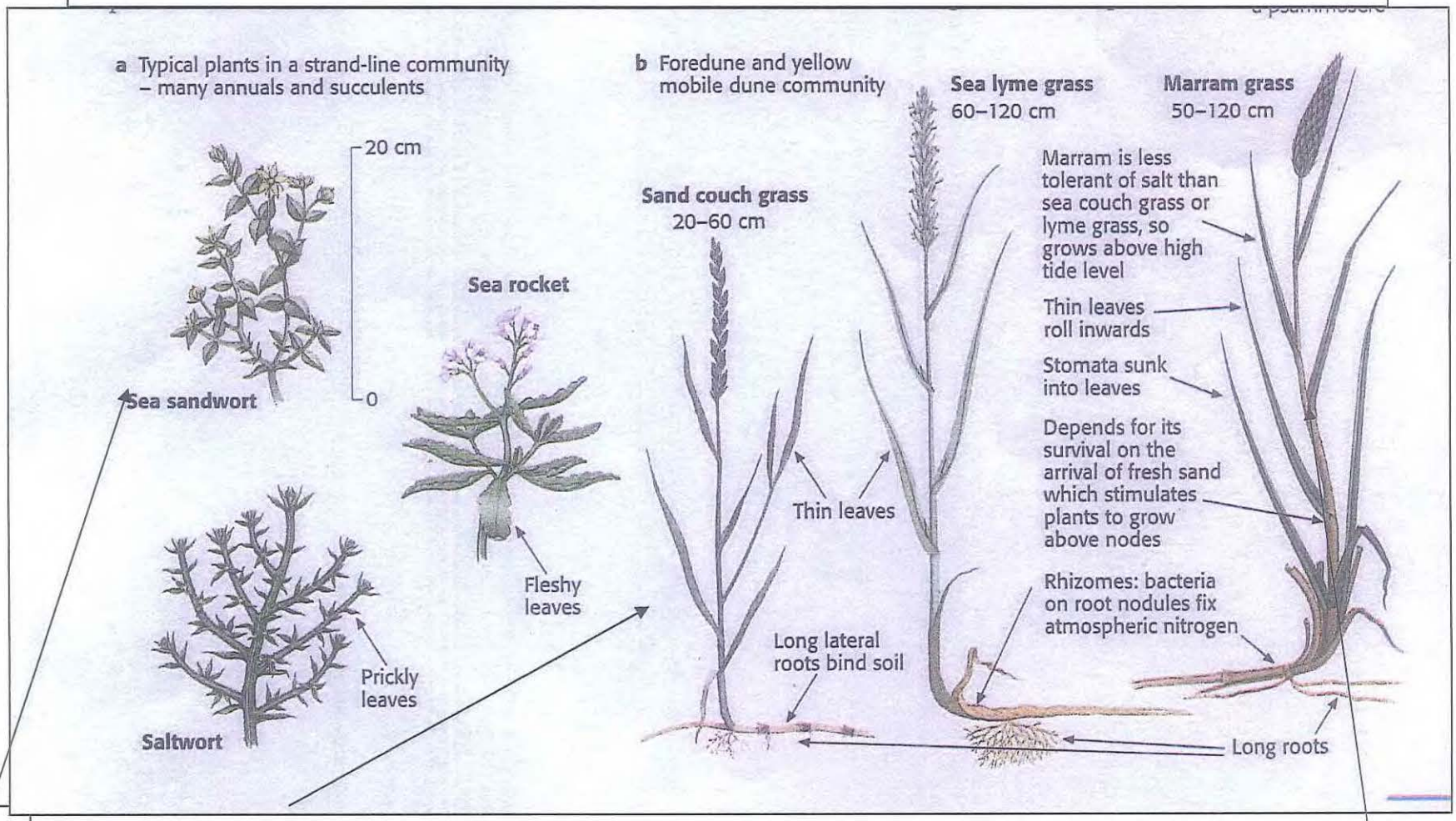
continue to succeed others because of changing abiotic factors such as wind speed, temperature, soil pH, shade and shelter. This process of autogenic succession is a natural process, in which environmental conditions change over time as the plants are changing them.

Primary succession has influenced the biodiversity at Braunton Burrows because sand has little ability to maintain life in the embryo and fore-dunes; specialised pioneer species (fig.3) colonise this barren accumulation of sand, creating an ecosystem which progressively changes, in terms of species diversity, size and the environment they can survive in. Marram grass, the dominant dune-stabilising species, cannot adapt to the new habitat further inland on the fixed dunes and is therefore replaced by mosses, lichens, grasses and shrubs (Fig.3 and 4).

The final stage of succession in most British psammoseres is a climax community, for example deciduous woodland. However the dune pasture (fig.2) at Braunton Burrows is managed to prevent succession to scrubland and deciduous woodland. This is because the dune pasture is the most biodiverse part of the psammosere and many rare species are located at this part of the Burrows (fig.6).

Flora

Fig. 3. Typical plants on a strand-line and yellow-dune community. (Geography for AS: Hart, 2000)



Bare sand is colonised by halotolerant pioneer species (sea sandwort)

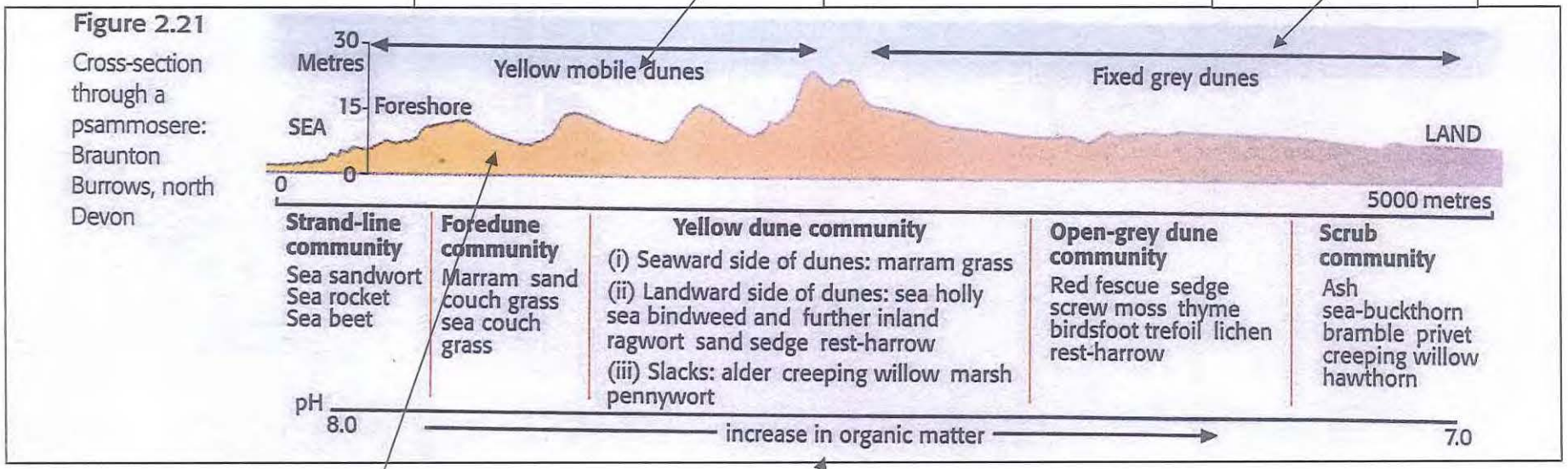
Sand couch and lyme grass struggle to grow at the rate of sand deposition and become smothered.

Marram Grass, a xerophyte, will succeed these species because it can be buried under deposited sand and grow back through. The water table can be some distance from the dune surface, but it has long roots and has the ability to reach moisture.

Fig.4 Braunton Burrows vegetation cross-section (Hart, 2000 :Geography for AS)

Yellow dunes with variable plant cover tend to be more mobile and unstable. The soil is purer nutrient-deficient sand.

Grey dunes, which are richer in nutrients and are completely covered by plant species, are fixed.



Dune slacks are close to the water table, species here are hydrophytic.

The moisture and organic matter increase in the soil and the pH decreases because beach shells are leached away. Humus from the dead plant biomass becomes part of the soil and changes the pH balance.

Good annotations

As a result of this sand dune system being so fragile, there are many threats to the biodiversity of the Burrows. 2.4 million visitors a year are attracted to this part of North Devon for the wildlife at the Burrows, surfing, visiting Saunton Sands and the golf course. Many walkers use the footpaths on Braunton Burrows, which includes the South-West coastal path (fig.1). This leads to the trampling of vegetation, which results in bare sand as plant species die, therefore decreasing the biodiversity.

Ministry of Defence training poses a significant threat to vegetation and wildlife in this area. The MOD use vehicles on the Burrows and I noticed a number of tyre tracks in the sand from heavy vehicles. This can destroy the vegetation, causing blow outs, which decreases the biodiversity because bare sand can only be colonised by pioneer species.
Devon Christie Estates Trust (DCET) has owned Braunton Burrows for hundreds of years. The area has been used by the military since 1942 and after World War Two part of the Burrows was leased from DCET by the Ministry of Defence in order for troops to train and practise on the terrain. In 1964 a part was sub-leased from the MOD by English Nature. It was then designated as a National Nature Reserve and has received many more designations including 'North Devon Area of Outstanding Natural Beauty' and was made part of the 'North Devon Heritage Coast' in 1992. In 2002 Braunton Burrows was recognised internationally for its outstanding natural beauty and need for conservation when it was made one of the few 'UNESCO Biosphere Reserves' in Britain. This has allowed it to be acknowledged as an area in need of protection and management because of the biodiversity and rare plant species which inhabit the area. Indeed, today the Burrows have also been selected as an EU designated 'Special Area of Conservation'.
In 1996 conflict between the owners DCET and English Nature arose when both parties disagreed about the way to manage the Burrows. EN (now Natural England) had to renew their lease on the land and wanted to make some adjustments to the contract, to introduce grazing of cattle and sheep onto the Burrows, in order to maintain its biodiversity. DCET, however, refused to accept this change in use and consequently Braunton Burrows no longer held National Nature Reserve status. Following public arguments the conflicting parties and only began new discussions in 2002, which lead to the Burrows, Braunton Marsh and Northam Burrows being reinstated as a National Nature Reserve.
The dune pasture is the most biodiverse part of the dune system with the most and rarest plant species e.g. Fen Orchid. It is a plagio-climax community, managed to ensure its biodiversity and to prevent it from reaching its climax community. If this dune pasture was

not managed, succession would naturally continue and the area would become initially scrub and then woodland, both being less bio-diverse than the dune pasture.

The Burrows is a place of outstanding natural beauty and is one of the largest sand dune systems in the UK. Therefore, in order to preserve the area for future generations, effective sustainable management is needed to control plant succession and human impact.

Method of Investigation (Word count: 267+22 +11)

In March 2011 I visited the Burrows to investigate its biodiversity. I used stratified random sampling to collect biotic data, along a transect from Sandy Lane car park to Saunton Sands (fig.5), because this was the least impacted zone of the dune system. A stratified sampling strategy was used to choose 10 sites which were either on a dune ridge, slack or the pasture because this showed the contrasts in species and biodiversity between the different environments within the psammosere at the Burrows. At each site I walked the number of steps selected from a random numbers table and placed the 50 x 50cm quadrat down, to reduce the risk of bias. A 50cm x 50cm quadrat was used because it gave a sufficient area to see many plant species (fig.15). At each site I counted the percentage frequency of plant species in a quadrat, with the aid of an identification key (fig.8). Percentage frequency 'is the proportion of ground covered by aerial parts of a plant species.' (Hallsannery Field Centre 2003). The biotic data that I collected was used to calculate Simpson's Diversity Index (a measure of biodiversity) at each site. Using this sampling strategy and method of investigation has allowed for my primary data collected to be representative, bias free and as reliable as possible. I visited the site for a second time in April 2011 and took photographs for evidence of conservation management at the Burrows. Information boards in the area gave me secondary data (fig.13), which demonstrated what the current owners and stake-holders are doing to manage Braunton Burrows. I did further research on the internet, to investigate conflicts in management.

Fig. 5 A sketch map of Braunton Burrows

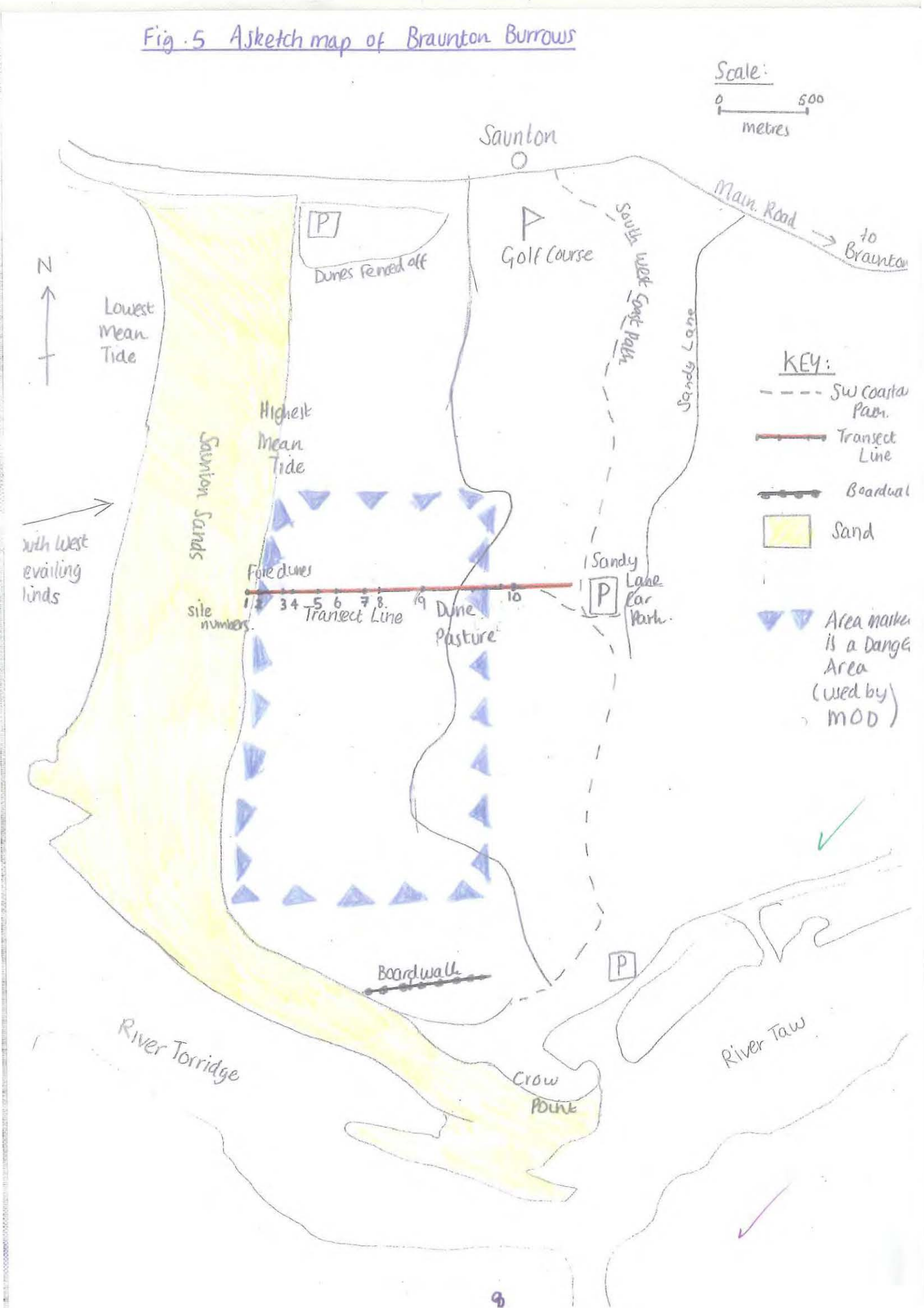


Fig 6. Table of rare plants on Braunton Burrows (Hallsannery Field Centre 2004)

Species	Status	Habitat	UK distribution
Water germander (Teucrum scordium)	Specially protected by law	Open edges of dune slacks and ponds	One of only 3 sites in the UK
Clustered club-rush (Scirpus holoschoenus)	Nationally rare	Open, wet slacks	The more important of the only 2 sites in the UK
Fen orchid (Liparis loesellii)	Internationally threatened. UK BAP.	Wet slacks	Now known from only 4 UK sites. Not found on Burrows since 1988
Shore dock (Rumex rupestris)	Internationally threatened. UK BAP.	Wet slacks	Not recorded on Burrows since mid 1970s
Early gentian (Gentiana anglica)	Endemic but declining throughout UK. UK BAP.	Wet slacks	Now known from only 49 sites in UK
Sharp rush (Juncus acutus)	Nationally rare	Damp, open dune grassland	One of only 5 sites in UK
Sea stock (Matthiola sinuata)	Nationally rare	Open shifting sand	One of only 3 sites in UK
Round-leaved wintergreen (Pyrola	Nationally scarce	Wet slacks	Only site in Devon
Variegated horsetail (Equisetum	Nationally scarce	Wet slacks	Only site in Devon
Scrambled-egg lichen (Fugensia	Very rare	Bare, open ground	Known from only 10 other UK sites
Petalwort (Petalophyllu m ralfsii)	Internationally threatened. Specially protected by law. UK BAP.	Damp slacks	Known from only 19 other UK sites

Fig.7 Biotic Data collected

Species	Quadrat No.	1	2	3	4	5	6	7	8	9	10
	Dune Location	Beach	Fore Dune	Dune Ridge	Dune Slack	Dune Ridge	Dune Slack	Dune Ridge	Dune Slack	Dune Pasture	Woodland
	Distance from beach (m)	0	5	20	50	400	500	650	725	1000	1500
Bare Sand		100	70							1	
Marram Grass			60	100		16		80		12	
Ragwort			24	8	4					4	
Sand Couch			8								
Evening Primrose				24							
Rough Hawkbit				4					4		
Dandelion					4				4		
Bramble					4			32			100
Red Fescue					100			64			
Sedge					12	16					
Rest Harrow					16						
Willow						4	100		8		
Dandelion						8					
Woodruff						8					
Yorkshire Fog							100		100		
Sphagnum Moss							50		24	100	
Plantain							4			28	
Buttercup							4			24	
Creeping Bent grass											
Ivy											100
Privet											50
Hartstongue fern											50
Hawthorn											100
Moss											20

Key % frequency:
100 means that species occurs in all squares of the divided quadrat.

Bigger species (for example Hawthorn) may take up all squares in one quadrat with just one plant, therefore percentage frequency is more.

Figure. 8 Identification Key (Field Studies Council)

Analysis (Word count:1601 + 11)

There are 3 options for the management of biodiversity which I will evaluate.

- Do nothing to the Burrows and allow succession to naturally progress.
- Close the site to the public and all recreational use.
- Manage the site, so that tourism and conservation are seen to be equally the most important factors to the area.

Allowing succession to occur naturally is effective in terms of maintaining a natural process. However, this would result in a decrease in biodiversity because plants in the dune pasture will be outcompeted by shrubs and trees. In terms of the management of biodiversity this option is not feasible because the growth of woodland and scrub continue to threaten rare species found at the Burrows. If the trees and shrubs were not managed, they can smother important and rare species (fig.6) of plant. It is said that the dunes have already become drier as a result of trees and shrubs invading and this has led to plants such as rare Fen Orchids becoming extinct. A decline in the number of several plant species has been seen, in particular Water Germander and Petal Wort. Therefore a threat to the variety of plants on the dune pasture and in dune slacks is the natural process of succession. The option of allowing succession to naturally progress could decrease the number of school groups and visitors coming to the area, which in turn will significantly decrease the amount of money these visitors provide to Saunton, Braunton and the surrounding area (fig.1). Human impact could also increase resulting in a significant reduction in the variation of plant species, due to the Burrows no longer having a conservation status. Visitors may not understand the importance of keeping to footpaths and could trample the rare species found there.

Closing the site to the public and inhibiting recreational use could maintain the biodiversity of the dune pasture and aid the survival of the rare species (fig.6). Conservation of the site would be most important and therefore biodiversity would be managed by DCET and Natural England in the best way possible because of a reduced threat to human impact. However many visitors to the site come to appreciate the uncommon plant species and bring a sizeable income to the area. Visitors and local residents also use the site for dog walking and access to the beach. In this way, it would not be realistic to close the site because of the large number of people who appreciate and use the Burrows for recreation. The fact that the site is used by the Ministry of Defence for

training purposes also shows that it would be unfeasible to close it to all forms of recreation and use, because it is a valuable asset to the UK's resources.

Balancing conservation and tourism would be beneficial to the local economy because both the biodiversity and natural beauty of the Burrows and Saunton Sands (fig1) attract many tourists to the local area.

The conflicts in the past between different stake-holders have caused a negative impact on the biodiversity because of a disagreement in the way to manage the Burrows. The Burrows lost its conservation status as a National Nature Reserve which resulted in a decrease in biodiversity in just a few years, as secondary succession began to change the ecosystem. The area had less protection to ensure biodiversity at the site was high and that rare plant species continued to survive. In order to maintain biodiversity on this psammosere, stake-holders and the DCET need to work together to have the best plan for the area as a whole. This should concern conservation, recreation and tourism. Before the conflict the psammosere was managed by English Nature, who employed a warden to supervise the cutting, grazing and burning of the scrub. These techniques effectively allowed biodiversity to be maintained, because the area was kept under close surveillance and all management techniques were used in the interest of maintaining biodiversity.

With the option to balance conservation and tourism, there is still a threat to biodiversity and rare plant species, because humans will still impact on the area. The immature, therefore fragile soil allows the psammosere to be susceptible to human impact. Issues such as footpath erosion, the creation of blowouts and vehicle tracks on the dune ridges and slacks will continue to threaten wildlife at the site.

There are several different strategies that have been used to maintain the biodiversity and protect the vegetation at the Burrows.

The area of Braunton Burrows closest to Saunton Sands car park (Fig.1) is threatened by tourists using Saunton Sands for leisure, e.g. surfing, windsurfing and general beach activities. The number of tourists visiting the area exceeds the carrying capacity, the number who can visit the area without harming the environment. Braunton Burrows has been fenced off from the car park to reduce the number of tourists walking on the dunes (thus trampling the vegetation) and to stop cars from driving on the dunes (fig.14 and 16). This therefore helps to preserve the rare plant species.

The flagpole placed close to Sandy Lane Car Park which is close to where I did the transect has caused dune erosion because the people walking in the Burrows naturally walked towards the flagpole. This created a path towards the flagpole, formed by the

walkers, destroying vegetation. The wind eroded the sand away, causing a blowout because the dune was no longer protected by the roots of vegetation. The fragility of the soil means that it takes a long time for vegetation to grow back. To allow dune-recovery, removal of the flagpole was trialled, resulting in widespread damage. It was decided that the flagpole would be reinstated, reducing the overall impact of footpath erosion across the dunes and limiting the threat to biodiversity to one small part. Since 1999 management techniques such as excavation and removal of bushes and small trees has been used to maintain the biodiversity at the Burrows. Excavation of the dune slacks has made them closer to the water table, allowing plant species which previously couldn't survive in the increasingly dry micro-climate to re-colonise.

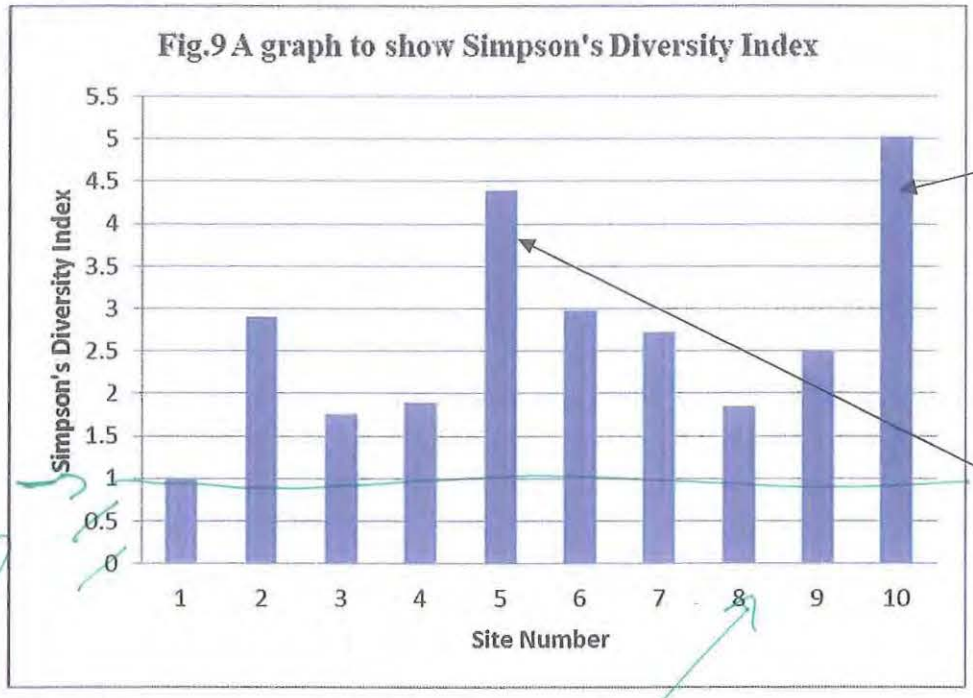
The lowering of the water table is a large threat to diversity of plant species at the Burrows. Dune slacks naturally flooded each winter up until the 1960s. This flooding of the slacks has become less and less common because of improvements made to agricultural land drainage. Consequently the slacks have been invaded by many coarser species of vegetation which can survive desiccation. The increase in scrub has also increased evapo-transpiration and threatened rare, slack species which cannot survive without large quantities of moisture. The water table was lowered again in the building of a golf course by the Saunton Sands Hotel (fig.1); this put biodiversity of the dune slacks at risk. To manage the lowering water table DCET, the Environment Agency and Braunton Marsh Commissioners installed sluices which are used to drain or irrigate water in order to increase the water levels in the slacks in the summer.

The selective removal of the scrub, such as Hawthorn and Creeping Willow, and saplings were put in place to prevent the loss of species such as thyme, lady's bedstraw and orchids from the Burrows because their space was becoming invaded by the larger flora.

Grazing has also been used as a method for controlling further succession of the herb-rich grassland. On May 1st 2008 as an SSSI (Site of Special Scientific Interest) the Burrows became part of an Environmental Stewardship Scheme in conjunction with Natural England. Grazing was reintroduced gradually from 2008 and compartments were created to control which parts of the Burrows the livestock such as sheep and cattle do graze.(fig.13)

When visiting the site I noticed information boards, used to inform the public about the importance of the psammosere and its conservation. There were also boards to explain what the DCET and Natural England are doing to manage the conflict between conservation and tourism.

In order to gauge the effectiveness of the management currently in place at the Burrows I will use Simpson's Diversity Index to analyse the biotic data collected at each site.



The first site has an index of 1; this is because it is bare beach sand has no vegetation. My research suggests that biodiversity should increase inland and reach maximum biodiversity in the dune pasture (site 9). However, it seems that the highest biodiversity is found in the woodlands and on the 2nd dune ridge (site 5). This may be because I visited the site in March, when the plants were not in flower or tall in height, therefore making it difficult to identify and differentiate species. Site 9 is an anomaly because the graph shows it to be less biodiverse than other sites; the presence of sand (fig.7) suggests degradation of the dune (fig.10). Figure 7 shows species identified at each site; however there is no correlation between the biodiversity in either the dune slacks or the dune ridges. Biodiversity increases and then decreases, suggesting a limitation in data collection and the influence of other factors (fig.11 and 12) in more accessible areas.

Fig.10 SSSI condition summary (Compiled: 03 Oct 2011, Braunton Burrows)

% Area meeting PSA target	% Area favourable	% Area unfavourable recovering	% Area unfavourable no change	% Area unfavourable declining	% Area destroyed / part destroyed
92.88%	22.58%	70.30%	0.00%	7.13%	0.00%

Fig.10 shows that only 22.58% of Braunton Burrows is being conserved in the best way possible. 70.3% of the unfavourable area is recovering, which suggests that the conflict between Natural England and DCET lead to the area not being conserved properly. The small percentage of the area which is unfavourable and still declining suggests that new management strategies are needed to protect the rare species (fig.6). I also noticed issues such as; tyre tracks from heavy vehicles (fig.12), footpath erosion, and visitors to the beach using body boards to slide down the dunes (fig.11) when investigating the Burrows.

Photographs of Investigation

Fig. 11

Evidence of Dune destruction by body boards on fore dunes

marram grass

Fig. 12

Fig. 13 Information Board about conservation

Fig 14 Saunton Sands Car Park

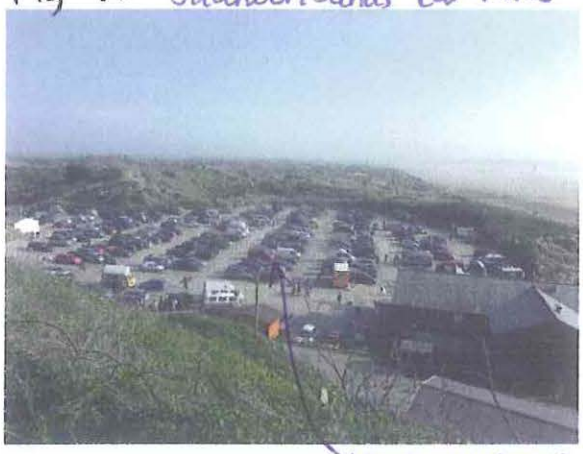


Fig 15

50x50 cm Quadrat

Fig 16.

Presentation of a Summary (Words: 498)

Management methods such as grazing have been successfully implemented at Braunton Burrows to aid the management of biodiversity. The conservation status of the site is the most important factor in protecting vegetation because it allows for biodiversity to be monitored and management strategies to be put in place. It is clear that in the past DCET neglected the management of the Burrows and, through poor decisions, allowed the decline of rare species (fig.6) and overall biodiversity. However, the designation of World Biosphere Reserve by UNESCO has positively impacted on the management of biodiversity because it has given DCET money to promote the importance of conservation to visitors and protect plant species from succession through grazing of cattle on the land. Information boards have been installed in order to convey to the public the special nature of this Biosphere Reserve.

Natural England has also contributed to the successfully managed area. Their analysis of data about conservation (fig.10) shows how effectively the Burrows are managed. The Government's Public Service Agreement (PSA) target to have '95% of the SSSI area in favourable or recovering condition by 2010' (Natural England Glossary) The fact that only 92.88% of Braunton Burrows is meeting the PSA target, means that it did not meet the target for 2010 and further suggests that management of the Burrows should be improved.

Tourism and conservation should be seen as equally the most important factors, because tourism contributes money to the local economy and it is similarly essential to conserve rare plant species and the psammosere from adverse human impact. Human impact is mostly negative on the psammosere. Although there have been successful management techniques in recent years, figure 10 suggests that biodiversity can be increased and conservation can improve further. I suggest that an education centre could be built by Saunton Sands car park (fig.1 & 5) to inform tourists, visitors and residents the need to conserve the Burrows. It should be built at the northern end, because the majority of the tourists access the Burrows from the Saunton side, to avoid impact in the most protected central part of the psammosere and because the MOD operate the part closest to the Taw-Torridge River Estuary. An increase in wardens would allow for greater removal of scrub, monitor grazing and other management techniques, to encourage maximum biodiversity and the survival of rare plants. Although this may attract more tourists to visit the Burrows, visitors protect the area as well as contribute to the local economy, maintaining both biodiversity and local revenue. Local residents could also form a committee, which will allow their ideas for protecting the Burrows to be heard.

In conclusion, to a sizeable extent Braunton Burrows is managed successfully to maintain biodiversity. Its status as an SSSI and UNESCO Biosphere Reserve allows for the rare species to be protected and management techniques to be implemented. However, the area as a whole needs to be conserved to the same standard, therefore more targeted action needs to be taken to manage biodiversity at Braunton Burrows more successfully.

any suggestions ?

Evaluation (227 words)

As a result of using a stratified random sampling strategy I believe the data I collected to be reliable, bias-free and representative of the least visited section of the Burrows.
However, it was difficult identifying plants in March before species were in flower. This could be improved by visiting later in the spring, to make identification of plants easier. This may improve the reliability of the Simpson's Diversity Index data, making it more representative of the different parts of the dunes and might demonstrate that biodiversity increases from the yellow dunes to the grey dunes in a psammosere. I would repeat the dune transect with parallel transects to compare data across the dunes. For example, I could do a transect further north towards the Saunton Sands car park, because this is an area with more human impact. Through comparison with other parallel transects, this could show more clearly the affect of human impact upon biodiversity. I would collect abiotic data for each site and investigate how different abiotic factors affect biodiversity. Using this data I would consider ways of controlling abiotic factors to maintain diversity of plant species. I would also focus on collecting more primary data for the management of the Burrows, for example I could interview stake-holders to gain a better understanding of the conflicts between them and the best ways of managing the area.

this could be an entirely different question

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Acknowledgements

Hallsanery Field Centre (2003 and 2004) Resource sheet

Skern Lodge Field Studies Centre (2009) Simpson's Diversity Index Resource Sheet

Appendix I

Sand Dune Recording Sheet

Random Numbers

14620 95430 12951 81953 97310 78209
51263 52399 62804 26939 64531 25950
85189 69374 37904 82973 16405 81497
20863 09724 85125 48477 42783 56919

Simpson Diversity Index

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

N=total number of organisms of all species
n=total number of organisms of a particular species

Some Common Names for Sand Dune plants

Bird's Foot Trefoil	Marram Grass	Sand Couch
Bog Pimpernal	Marsh helleborine	Screw Moss
Clover	Marsh Orchid	Sedge
Common centuary	Marsh Pennywort	Silverweed
Cranesbill	Mouse-ear	Storksbill
Creeping Bent grass	Prickly Saltwort	Vetch
Creeping Willow	Red Fescue	Water Mint
Evening Primrose	Restharrow	Wild thyme
Hawthorn	Ribwort Plantain	Wintergreen
Ladies Bedstraw	Rough Hawkbit	Yorkshire Fog

Recording Method = Dune Pasture

Quadrat No.	1	2	3	4	5	6	7	8	9	10
Dune Location	Beach	Fore Dune	Dune Ridge	Dune slack	Dune Ridge	Dune Slack	Dune Ridge	Dune Slack	Dune Ridge	Woodland
Distance from beach (m)	*0*	*5*	*20*	*50*	*400*	*500*	*650*	*725*	*1000*	*1190*
Species	**Notes**									
Bare Sand		100%	70						1	
Marram Grass			80	100		16		80		12
Ragwort			24	8	4					4
Sand Couch			8							
Evening Primrose				24						
Rough Hawkbit				4				4		
Dandelion					4			4		
Bramble					4		32			100
Red Fescue					100		64			
Sedge					12	16				
Rest harrow					16					
Willow						4	100		8	
Dandelion					8	8				
Woody Vff						8				
Yorkshire Fog							100		100	
Sphag moss							50		24	100
Plantane							4			28
Buttercup							4			24
Creeping Bent grass										
Ivy										100
Privet										50
leaf litter to fem										50
Hawthorn										100
Moss										20

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Appendix II

Simpson's Diversity Index Calculations : Appendix

Calculated using Simpson's Diversity sheet (also in Appendix)

Site 1	Beach **Abundance (n)**		
Species	**% frequency**	**n-1**	**n(n-1)**
Bare Sand	100	99	990
	N = 100	∑n(n-1) =	990
		d = 1	

Site 2	Fore Dune **Abundance (n)**		
Species	**% frequency**	**n-1**	**n(n-1)**
Bare Sand	70	69	4830
Marram Grass	60	59	3540
Ragwort	24	23	552
Sand couch	8	7	56
N=	162	∑n(n-1) =	8978
		d= 2.91	

Site 3	Dune Ridge **Abundance (n)**		
Species	**% frequency**	**n-1**	**n(n-1)**
Marram Grass	100	99	9900
Ragwort	8	7	56
Evening Primrose	24	23	552
Rough Hawkbit	4	3	12
N=	136	∑n(n-1) =	10520
		d= 1.75	

Site 4	Dune Slack **Abundance (n)**		
Species	**% frequency**	**n-1**	**n(n-1)**
Ragwort	4	3	12
Dandelion	4	3	12
Bramble	4	3	12
Red Fescue	100	99	9900
Sedge	12	11	132
Rest Harrow	16	15	240
N=	140	∑n(n-1) =	10308
		d=1.89	

Site 5	Dune Ridge		
	Abundance (n)		
Species	**% frequency**	**n-1**	**n(n-1)**
Marram Grass	16	15	240
Sedge	16	15	240
Willow	4	3	12
Dandelion	8	7	56
Woodruff	8	7	56
N=	52	∑n(n-1) =	604
		d=4.39	

Site 6	Dune Slack		
	Abundance (n)		
Species	**% frequency**	**n-1**	**n(n-1)**
Willow	100	99	9900
Yorkshire Fog	100	99	9900
Saphag Moss	50	49	2450
Plantane	4	3	12
Buttercup	4	3	12
N=	258	∑n(n-1) =	22274
		d=2.98	

Site 7	Dune Ridge		
	Abundance (n)		
Species	**% frequency**	**n-1**	**n(n-1)**
Marram Grass	80	79	6320
Bramble	32	31	992
Red Fescue	64	63	4032
N=	176	∑n(n-1) =	11344
		d=2.72	

Site 8	Dune Slack		
	Abundance (n)		
Species	**% frequency**	**n-1**	**n(n-1)**
Rough Hawkbit	4	3	12
Dandelion	4	3	12
Willow	8	7	56
Yorkshire Fog	100	99	9900
Saphag Moss	24	23	552
N=	140	∑n(n-1) =	10532
		d=1.85	

Site 9	Dune Pasture		
	Abundance (n)		
Species	**% frequency**	**n-1**	**n(n-1)**
Bare Sand	1	0	0
Marram Grass	12	11	132
Ragwort	4	3	12
Saphag Moss	100	99	9900
Plantane	28	27	756
Buttercup	24	23	552
N=	169	∑n(n-1) =	11352
		d=2.50	

Site 10	Woodland		
	Abundance (n)		
Species	**% frequency**	**n-1**	**n(n-1)**
Bramble	100	99	9900
Ivy	100	99	9900
Privet	50	49	2450
Heartstongue Fern	50	49	2450
Hawthorn	100	99	9900
Moss	20	19	380
N=	420	∑n(n-1) =	34980
		d=5.03	

Diversity Index
(Simpson's)

Diversity is a measure of the number of different species present in a habitat and the evenness of spread of individuals amongst these species.

There are a number of indices to determine diversity, Simpson's Index is one.

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

N is the total number of organisms of all species.
n is the total number of organisms of a particular species.

A value near to 0 indicates low diversity, whereas a high value indicates a high diversity.

Station 1			
Species	Abundance (% frequency) (n)	n - 1	n(n-1)
Marram grass	40	39	1560
Hawkbit	35	34	1190
Dandelion	35	34	1190
Red Fescue	40	39	1560
	N = 150		$\sum n(n-1) = 5500$

1. Add up the abundances for all the species present at station1. This is N.
2. Calculate **n – 1** for each species, e.g. for Marram grass this is 40 – 1 = 39
3. Calculate **n x (n – 1)** for each species, e.g. for Marram grass this is 40 x 39 = 1560
4. Sum all the values you calculated for **n(n – 1).** This is $\sum$ **n(n – 1).**
   In this case 1560 + 1190 + 1190 + 1560 = 5500
5. Put these values into the formula ⟶ $d = \frac{150\,(150-1)}{5500} = 4.06$

Station 1			
Species	Abundance (% frequency) (n)	n - 1	n(n-1)
Marram grass	100	99	9900
Hawkbit	15	14	210
Dandelion	15	14	210
Red Fescue	20	19	380
	N = 150		$\sum n(n-1) = 10700$

$$d = \frac{150\,(150-1)}{10700} = 2.09$$

Station 2 is less diverse because even though there are the same number of species Marram grass dominates.