

ELIE AND EARLSFERRY BEACHES STUDY



Elie Beach

**Report to: Elie and Earlsferry Beach
Working Group**

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ELIE AND EARLSFERRY BEACH STUDY

1.0 SCOPE OF THE STUDY

It is widely recognised that soft engineering and natural accretion of coastal dunes can protect properties and land from coastal flooding and sand inundation and is a sustainable response to climate change which is increasing sea levels. For the first time since the last Ice Age rising sea levels exceed the rate of isostatic rebound¹⁺² making this a matter of some urgency. The Elie and Earlsferry dunes are part of a wider dynamic East Coast coastline and one of Fife's most valuable habitats, for its nature conservation interest and its educational and recreational value. This evolving and mobile coastline is in continual flux with sand accretion and erosion constantly changing the profile of dune systems.

The only current management for the Elie and Earlsferry Beaches is to re-profile the eastern sector of Earlsferry Beach, at Fountain Road, when sand builds up against owners' walls and to remove sand from adjacent roads, property and gardens. Wind borne sand affects a wide area including the Main Street, Links Place and Bank Street as well as South Street, The Toft and The Granary.

An Elie residents' working group (ERWG) has been set up and has agreed to seek guidance and best practice with recommendations for the long term future management of the dune area. This will require an independent environmental survey and assessment considering:

- the nature of the coastline
- its origins and its composition
- its controlling and forcing mechanism
- its behavioural characteristics
- the current impact human activity is having on the dunes

The aim of this initial study is to provide an ecological baseline for measuring change in the terrestrial and inter-tidal environment within the land enclosed by the red line boundary on Figure 1.

¹ <http://www.snh.org.uk/publications/on-line/advisorynotes/73/73.html>

² <http://www.snh.gov.uk/about-scotlands-nature/rocks-soils-and-landforms/coasts/climate-change/>

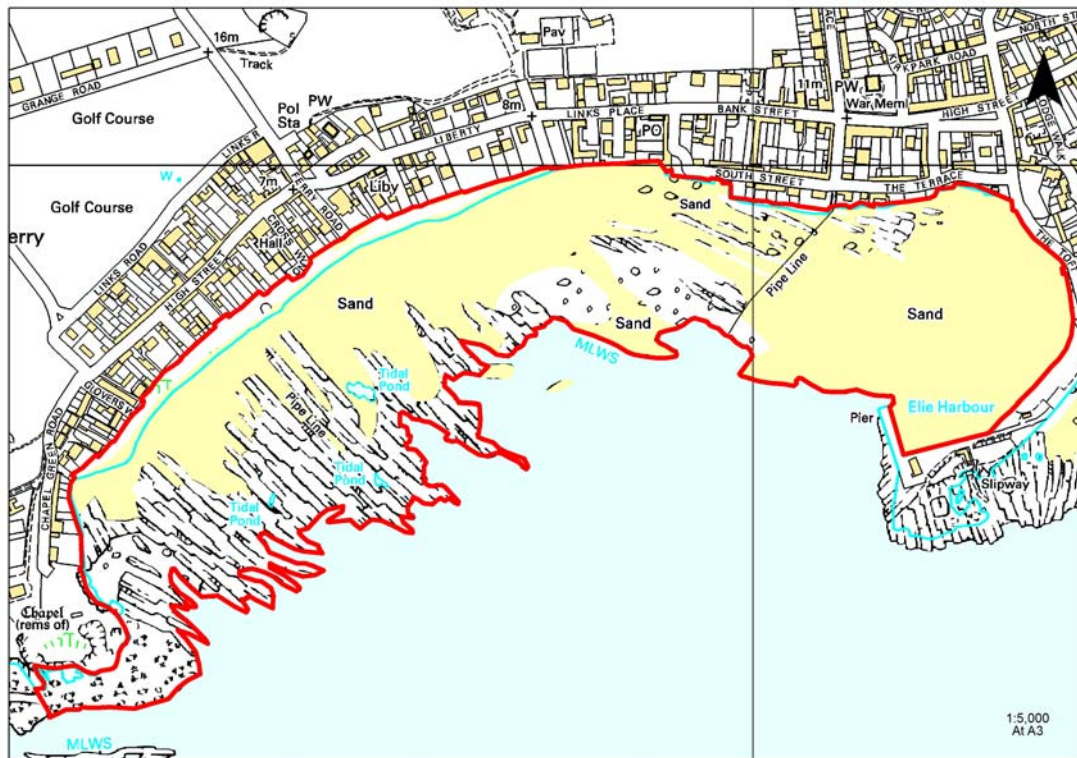


Figure 1. Study area

2.0 A HISTORICAL PERSPECTIVE

A fascinating history of the villages is provided by the Elie and Earlsferry Conservation Area Appraisal and Conservation Area Management Plan.

http://publications.1fife.org.uk/uploadfiles/publications/c64_ElieandEarlsferry-final.pdf

However, the Earlsferry and Elie Beaches have not been closely studied, primarily because the dunes are relatively young and to date have not attracted scientific interest beyond the geology of the area.

Today Earlsferry and Elie Beaches are greater in area and height than they have ever been, and a major factor has been the recent capture of sand within the Bay by the causeway and Harbour, see Image 1. The causeway linked Eilean Ardrross with the adjacent headland in the 1850's and it should be assumed that this is the date of establishment of Elie Beach, and the beginning of a dune building phase along Earlsferry Beach. Notably, Mouchel³ do not consider this to be an adverse factor influencing sediment transport or balance, see Box 1.



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Image 1. Aerial photo taken 2010

Box 1. Abstract from Mouchel³

Earlsferry is further east and is located within yet another bay comprising a sand beach enclosed by two rock headlands in the east and west. Dune formations comprise the backshore at Earlsferry and the sand beach foreshore appears to have a balanced sediment budget. Contained within the same bay is the Town of Elie where private residential marine defences are causing significant coastal squeeze. Sediment appears to be held in the bay, however due to rising sea levels and coastal squeeze, the sediment is becoming ineffective as a natural defence. The eastern extent of the bay is dominated by Elie Harbour which is integrated into the rock headland. As a result of the harbour structure being constructed around the rock headland, it is not expected that it would have any significant influence on the sediment transport or balance.

A key factor in sediment transport is the prevalence of south-westerly winds, which have such a fetch over the Forth that wave height can exceed 1.2m and bring a significant sand supply that is, at least, in balance at present and has been positive for a considerable period of time.

2.1 Historic Environment Scotland (HES)

The National Collection of Aerial Photography (NCAP) is held by HES and it provides snapshots into the dynamics of Earlsferry dune and two images record features of importance to the study.

³Mouchel. (2011). Fife Shoreline Management Plan Appendix C1

Image 2 shows the extent of Earlsferry Beach on 14th March 1950 and it confirms the open and embryonic nature of the dunes at that time. Clearly the dunes were still very open and mobile, the vegetated dune only just reaching Siward Lane. Wind borne sand was obvious in gardens beyond the dune and most marked around Telfer Wynd. The issue of sand transport on to properties is not a recent event.



Image 2. Licensed RCAHMS-NCAP archive image, 14th March 1950

Image 3, from 2003 and just over 50 years later, shows fresh rock armour at the west end of the Earlsferry dune with embryonic and fore dune formation in front of the armour marking a phase when the dune was growing not only eastwards but also southwards increasing the depth of the dune to the point we have reached in 2010 with a significant strandline, embryo and fore dune developing a succession not present elsewhere on the Earlsferry dunes. Immediately prior to the rock armour emplacement by residents this had been a local erosion hotspot.



Image 3. Licensed RCAHMS-NCAP Image, 25 August 2003

2.2 Beaches of Fife Study 1978, published 1979

In 1978 Professor Bill Ritchie, Aberdeen University, studied the beaches of Fife under contract to the Countryside Commission for Scotland. At Elie he highlights the variable sand cover, which is shallow at lower beach levels rising to 6 degrees near the HWMS, with variability in part due to rock outcrops lying at right angles to the Earlsferry Beach. On the latter the dune platform was 20-70m, the edge being undercut and he makes note of open patches of sand, paths and beach huts on the coastal edge. His view was that erosion was not an issue with a backshore sand supply capable of replacing any sand removed by wind erosion. Earlsferry Beach is described as 3-4m high, prograding and broken by numerous paths. In relation to land use he states “hundreds of visitors and holidaymakers use the attractive beach and dune areas...Beach huts and donkey rides epitomise the traditional forms of beach use at Elie, and there is no reason or justification for advocating change”.

Professor Ritchie’s report contains two useful images which are reproduced below with similar images from 2016 for comparison. Images 4 and 5 show obvious physical changes which are the continued growth in height and breadth over the intervening 38 years. The houses in the background provide qualitative reference for Elie beach.



Image 4. Elie beach (from Ritchie 1979)



Image 5. ECOS image July 2016

A similar comparison can be made for Earlsferry Beach showing that it had a more natural appearance in physical shape and vegetative cover and it lacked today's "gardening".



Image 6. Earlsferry Beach (from Ritchie 1979)



Image 7. ECOS image July 2016

2.3 Fife Shoreline Management Plan, December 2011

Elie lies within the Firth of Forth Catchment Group area and 124 properties, between Anstruther and Elie, have been identified within the local Flood Warning Area. Details are provided in the Fife Shoreline Management Plan, published in December 2011 and prepared for Fife Council by Mouchel. see link and abstracts below.

http://publications.1fife.org.uk/uploadfiles/publications/c64_SMP2_V5.pdf

Box 2. Abstract from Fife Shoreline Management Plan 2011, p134

Policy Unit 38 Earlsferry to Elie		
Description of Policy Unit		
<p>This Policy Unit comprises the rocky headland at Chapel Ness and the harbour at Elie which forms a sheltered bay. The coastline is backed by the large residential areas of Earlsferry and Elie with agricultural hinterland further. There are a number of water based recreational activities that occur within this Unit with golf and tourism being important to the area.</p> <p>The Chapel at Earlsferry is a SAM with a further three ASRIs in this policy unit.</p> <p>The Unit falls within the Firth of Forth SSSI, Ramsar site and SPA.</p> <p>There are a number of manmade coastal defence structures, some of which are integrated in to the rock platform. Elie Harbour has been identified as a Blue Flag Beach meeting European standards for cleanliness.</p>		
SMP1 Policy (MU23) – Selectively Hold the Line		
SMP2 Policy (38)		
Years 0-20	Years 20-50	Years 50-100
Hold the Line	Hold the Line	Hold the Line
(currently defended areas)	(currently defended areas)	(currently defended areas)
Justification of SMP2 Policy		
<p>The recommended policy option for this Unit is to Hold the Line for the currently defended areas. This is because there are a large number of properties backing onto the coastline, the eastern half are affected by both flooding and erosion where as the western side of the bay is accreting and therefore the properties are only at risk of flooding.</p> <p>The majority of the coastline is currently defended though many of the defences are likely to be privately owned. The harbour and pier are likely to provide some additional protection to the bay, though the causeway and access road will need to be maintained as there are high rates of erosion to the eastern side.</p>		

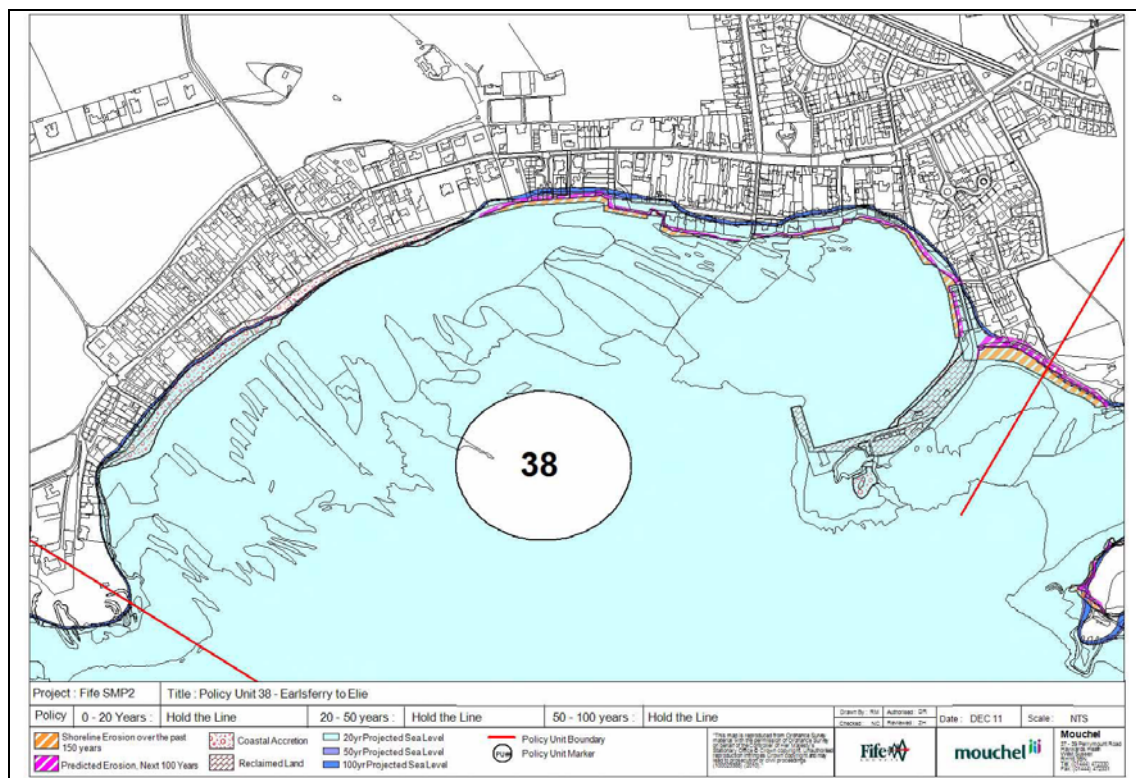


Figure 2. Abstract from Fife Shoreline Management Plan 2011, p135

3.0 CURRENT ECOLOGICAL BASELINE

3.1 Sites

Statutory designated sites, a Site of Special Scientific Interest (SSSI) and a Geological Conservation Review Site (GCR), have been declared over the inter-tidal habitat, surprisingly the dune area has no known designation, see Figure 3. Full details are provided in Appendix 2.

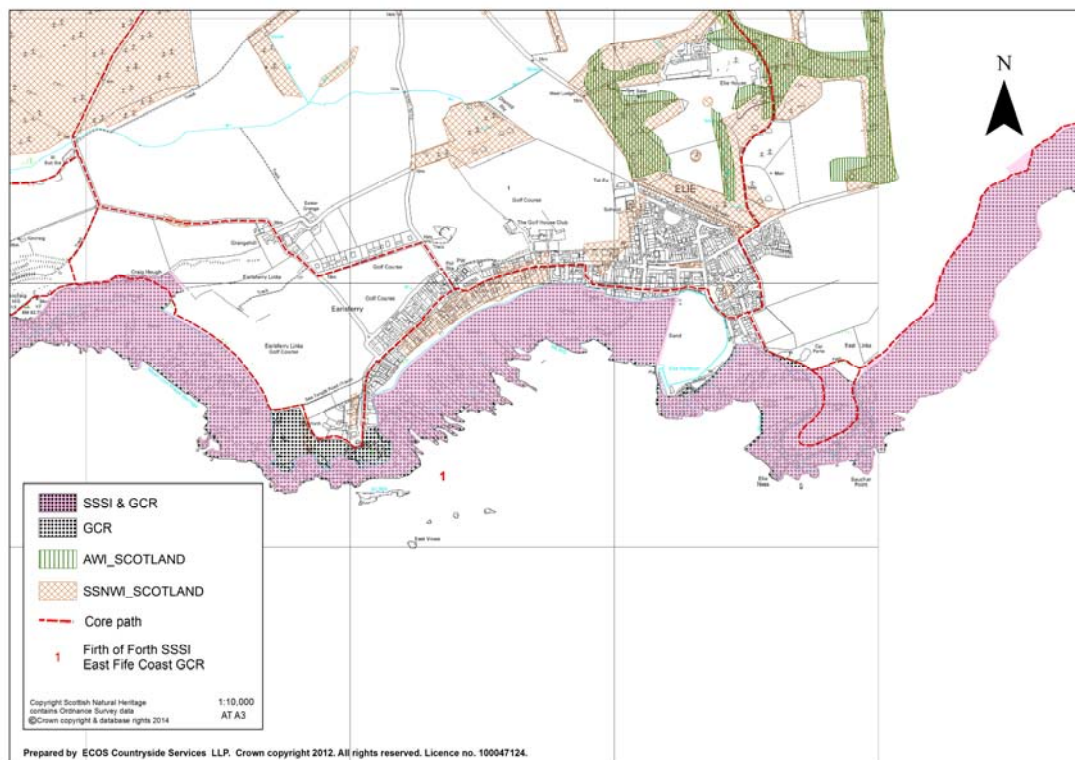


Figure 3. Location and extent of statutory designated sites

3.2 Scottish Semi-natural Woodland Inventory (SSNWl)

SSNWl listed woodland is present from Elie Library to Telfer Wynd, primarily enclosing garden ground with mature trees.

3.3 Intertidal and phase 1 habitats, July 2016

For the purpose of classifying the habitats present at Elie, mapping was undertaken in July 2016 according to the Phase 1 Habitat survey methodology

- *JNCC (2010) Handbook for Phase 1 Habitat Survey*

A total of nine habitats and habitat mosaics were recorded showing the dominance of bare sand and the sub-dominance of bare rocks, see Table 1 and Figure 4. The extent of rock and cobble exposure has decreased since the Ritchie survey, especially in proximity to Elie Beach, see Appendix 1.

List of recorded habitats, according to handbook alphanumeric codes and description

A2.2	Scrub, scattered
H1.1	Inter-tidal, mud/sand
H1.2	Inter-tidal, cobbles
H1.3	Inter-tidal, rocks
H6.5	Dune grassland
H6.8	Sand dune, open dune
J1.2	Amenity grassland
J4	Bare ground, sand
Other	Elie Watersports buildings and storage area

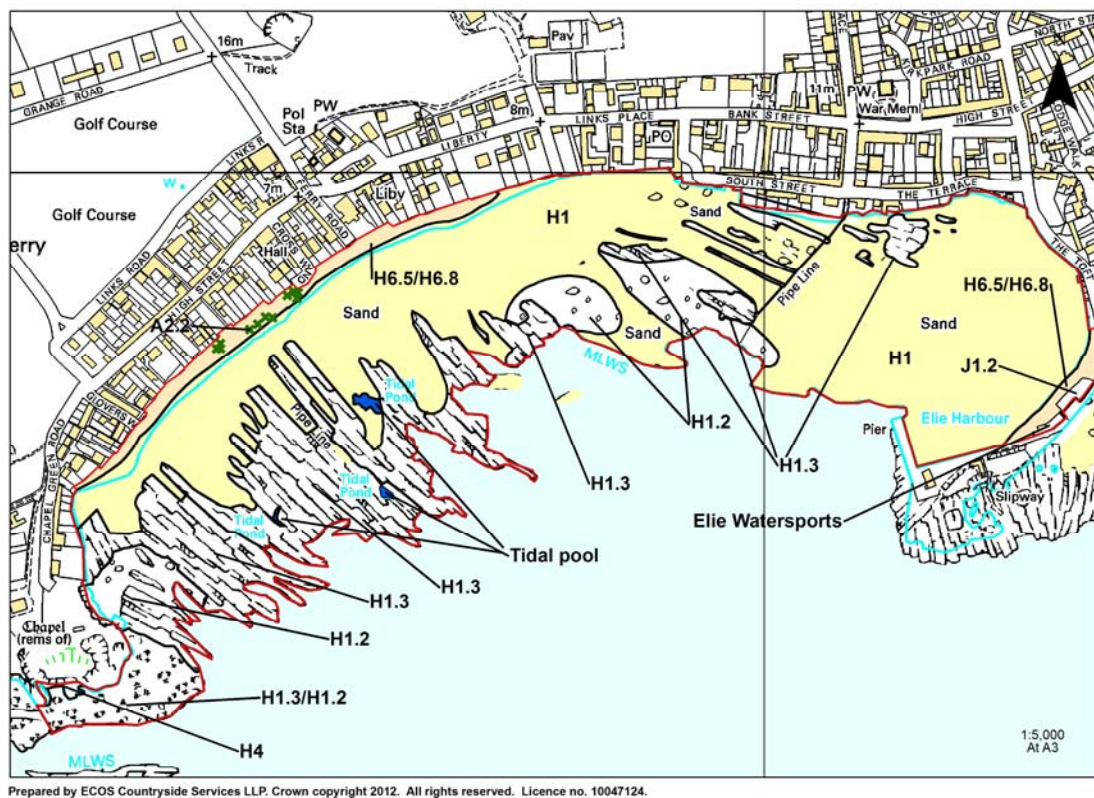


Figure 4. Habitats, as surveyed, July 2016

The extent of each habitat illustrated in Figure 4 is summarised below, as calculated between the MLWS and MHWS, including dunes and exposed rock above the HWMS.

Table 1. Extent of mapped habitats

Habitat code Code	Description	Area (ha)
H1.1	Inter-tidal, mud/sand	23.95
H1.2	Inter-tidal, cobbles	3.35
H1.3	Inter-tidal, rocks	9.49
H1.3/H1.2	Inter-tidal, rocks/cobbles	1.41
H4	Boulders and rocks above HWMS	0.08
H6.5/H6.8	Dune grassland/Open dune	1.59
J1.2	Amenity grassland	0.09

Habitat code Code	Description	Area (ha)
G2	Tidal pools	0.08
Other	watersports area	0.05
Total		Approx. 40.1

3.4 National Vegetation Classification (NVC)

3.4.1 National Sand Dune Survey of Scotland, 1999

The SNH commissioned survey of the sand dunes of Scotland⁴ included surveys of both Elie and Earlsferry beaches in 1999 classifying them both as mobile dunes. Dargie, using the Rodwell⁵ classification, recorded two sub-communities of SD5 on Elie Beach, both indicative of mobile dunes, whilst at Earlsferry he attributed all of the dune area to SD7c, see Table 2, indicative of a semi-fixed mobile dune.

At Earlsferry Beach there is notably no mention of pioneering dunes with SD4 or SD5 nor strandlines with SD2. Were these absent due to local erosion perhaps as a result of over aggressive beach cleaning?

Table 2. From Dargie (1999)

Beach	NVC code	Community	Sub-community
Elie	SD5	<i>Leymus arenarius</i> mobile dune community	SD5a. Species-poor sub-community
			SD5b. <i>Elymus farctus</i> sub-community
Earlsferry	SD7	<i>Ammophila arenaria</i> - <i>Festuca rubra</i> semi-fixed dune community	SD7c. <i>Ononis repens</i> sub-community

⁴Dargie, T (1999) Sand Dune Survey of Scotland Site Reports 16-28 Fife.pp 157

⁵Rodwell, J.S. (ed.) 2000. *British plant communities. Volume 5. Maritime communities and vegetation of open habitats*. Cambridge University Press.5

3.4.2 ECOS surveys June-July 2016

The aim of the updating NVC surveys was to provide a current vegetation map which showed the distribution and extent of communities and sub-communities according to Rodwell. Alphanumeric codes were assigned by an experienced surveyor and are based on the observed vegetation polygons. Data are summarised in Table 3 and illustrated in Appendix 3.

Table 3. Recorded NVC communities and sub-communities and their area (ha) on Earlsferry and Elie Beaches

Community Code	Community/sub-community	Elie (ha)	Earls-ferry (ha)	Total
SD2*	<i>Honkenya peploides</i> - <i>Cakile maritima</i> strandline community	0.003	*	
SD4*	<i>Elymus farctus</i> ssp. <i>boreali-atlanticus</i> fore dune community	*	*	*
SD5	<i>Leymus arenarius</i> mobile dune community			0.17
	SD5a Species-poor sub-community	0.12	0.05	0.17
SD6	<i>Ammophila arenaria</i> mobile dune community			0.88
	SD6a <i>Elymus farctus</i> sub-community	0.56		0.56
	SD6c <i>Leymus arenarius</i> sub-community		0.32	0.32
SD7	<i>Ammophila arenaria</i> - <i>Festruca rubra</i> semi-fixed dune community			0.67
	SD7a Typical sub-community	0.10		0.10
	SD7M Modified – non NVC sub-community		0.57	0.57
SD9	<i>Ammophila arenaria</i> - <i>Arrhenatherum elatius</i> dune grassland			0.19
	SD9a Typical sub-community	0.19		
MOSAICS				0.87
	SD7M/SD6c/SD5a		0.87	0.87
OTHER				
	J1.2	0.11		0.11
	J4		0.1	0.1
	Non-classified		0.006	0.006
Approx. Total		0.58	1.91	2.59

*Too small in area to measure

Elie Beach is smaller (approximately 0.58ha) and shows greater diversity resulting from its greater sand supply, and lack of human intervention. It is continuing to accrete north westwards into the Bay. Current dune height appears to be in equilibrium with sand supply allowing succession to SD9a fixed dune adjacent to the road. The SD5 is highly dynamic, compressed into a very narrow and steep ridge with lush sea lyme grass, see Image 8, behind which SD6 and SD9 are well established. Scattered small patches of SD2 and SD4 are present along the fore dune. Seaweed and other beach matter is trapped in the eastern corner and form temporary pioneering SD2, also evident on Image 8.



Image 8. Pioneering SD2 and SD4, in front of the SD5a ridge

Earlsferry Beach is approximately 0.7km long and covers an area of approximately 1.91ha dominated by semi-fixed, modified SD7c. This community lies behind the active dune face and is largely the result of intervention by residents. Planting hortals and mowing is commonplace. Car parking and tracks account for 0.1 ha of bare ground (J4), see Image 9.



Image 9. Modified SD7

Dune form is slightly concave with an increasingly steep face as the dune has grown eastwards, see Image 10. This face being influenced by the SW gales transporting sand to a narrowing and highly energised dune extremity. This eastern sand face shows recent signs of erosion creating a vertical cliff of approximately 2m in height. SD2, SD4 and SD5 are pioneering at the base of the dune and are indicators of a new building phase. The collapse can be attributed to a floodwater event in the first few days of 2014 (Andrew Forgan pers comm, see Image 11)



Image 10. Eastern sand cliff with pioneering vegetation, including *Cakile maritima*



Image 11. Collapsed dune ridge, 3rd January 2014. Photo: Andrew Forgan

There is clear evidence of dune growth in front of the rock armour at the west end and this is supported by the view of local residents and may be attributable to the cessation of beach cleaning. The best SD2 and SD5a is present at the Chapel Green Road access, with three species of *Atriplex*, namely, *Atriplex prostrata*, *A. littoralis* and *A. glabriuscula*, see Image 12.



Image 12. West end SD2 and SD5a

3.5 Evaluation of habitats

The ten evaluation criteria used below are derived from Ratcliffe⁶, and are a standard method of evaluating a site with natural habitats.

1. Size.

A dune area of 2.59ha is relatively small in comparison to other dunes in Fife e.g. Tentsmuir and Earlsferry, but share common features with the West Sands at St Andrews, both being narrow, popular with visitors and subject to adverse anthropomorphic effects.

2. Diversity.

A total of 8 habitats were recorded supporting a native higher plant list of 90 species, 87 on the Earlsferry dune and 63 species on the Elie dune, see Appendix 4. This number of species lies at the lower range associated with dunes and it reflects their low nature conservation interest and the limiting factors of size and diversity of micro-habitat, for example there is no wet dune slack. A relatively small size also limits the potential number of breeding birds with high levels of public disturbance a further factor.

⁶ Ratcliffe, DA (ed). (1977) A Nature Conservation Review. CUP.

3. Naturalness.

The processes creating and maintaining the dunes are natural and dependent upon the tidal supply of sand transported to Elie by the River Forth. Deposition in the Bay results in beach formation and, through the establishment of very specialised plants, the creation of dunes and stabilisation of the mobile sand. Rates of dune formation and erosion are dependent on the volume of sand supply and subsequent wind borne inland sand transport to raise the dune height and encourage a succession of plants increasing stability landwards.

4. Rarity.

The dunes are relatively impoverished with a typical assemblage of coastal plants. No rare plants were noted and a few scarce plants, such as *Geranium sanguineum* are presumed to be introductions, perhaps from Kincaig Head. Non-native species, for example, *Rosa rugosa* and introductions e.g. *Hedera helix* are locally frequent. Invertebrate populations have not been studied and uncommon species are likely to be recorded. During the survey one pair of yellowhammer attempted to breed at Earlsferry dune. House sparrow and common linnet were noted feeding on lyme grass seed at Elie Beach. Fife's only Kentish Plover record comes from Elie Beach, reported as a spring passage bird on 21st April 1966. Common blue and meadow brown butterflies are resident on Elie Beach.

5. Fragility.

The longevity of any dune system is dependent upon freedom from disturbance and any breach of vegetation cover can result in blow outs, or breaches, especially if gales combine with spring tides. Erosion of beaches along the east coast of Scotland is currently a matter of national concern with issues and significant financial investment at St Andrews, Broughty Ferry, Montrose and Aberdeen, amongst others. Recent rises in sea level and a short term change in the direction of spring storms has focussed attention on sea defences, especially maintaining cost effective dune defences.

6. Typicalness.

Both dune areas of Elie follow a textbook succession of plants and are typical of the habitats and species present in the dunes of Eastern Scotland.

7. Recorded history.

Only two beach studies have been completed to date, as reported in Section 2.0.

8. Position as an ecological unit.

Earlsferry and Elie Beaches form part of a network of larger dunes and smaller beach-head dunes present around the Fife coast.

9. Potential value.

Subject to positive intervention management, the ecological, economic and recreational value of the area could be increased, with greatest short term impacts achievable through positive management to increase the extent of dune habitat. However further use would continue to be detrimental without an integrated management plan to redress adverse aspects of use.

10. Intrinsic appeal.

Local residents and visitors use the dunes for a wide variety of activities both formal and informal. Watersports are popular and the dunes attract large numbers of people to bathe and picnic in summer, when the scene can resemble a mediaeval fair with numerous gazebos and smoking BBQs. Colourful beach huts have long been a feature of Earlsferry Beach and its bay is an excellent safe open water resource for beginner watersports.

4.0 MAIN FINDINGS

1. Early aerial photographs confirm the increasing size and stability of the dunes to create the habitats surveyed in 2016.
2. It is likely that the cessation of beach cleaning has been a significant factor in promoting dune growth at the west end of Earlsferry Beach. The accumulation of debris combined with wind blown sand encourages embryo dune formation and is essential to the ephemeral strandline community SD2.
3. Mechanical sand removal at the bottom of Fountain Road aims to reduce the level of wind blown sand but is unlikely to make a significant difference as the sand is then dumped below the high water mark and it migrates to Elie Beach.
4. There is no coordinated dune management at this site and intervention has either been driven by commercial and visitor needs on Elie Beach or resident action on Earlsferry Beach.
5. Local intervention, such as tree and shrub planting and dune grass mowing does not promote dune sustainability in the longer term.
6. Wind borne sand transport has been a long term issue and a major source of complaint from local residents.
7. Within the older parts of the dune, there are lines of erosion connecting to the foreshore and these are caused by public access. There is a total of 1.46km of unmade, eroded, access paths on Earlsferry Beach, quite out of proportion to the size of dune.
8. Car parking is associated with adjacent properties, and some of it is formal with gravel parking areas, or better still, flexible geotextiles that allow grasses to grow within the matrix. Overall the impact is acceptable compared to the adverse impacts of gardening, however parking could be more attractively designed and managed.
9. On busy beach days The Toft and The Granary cannot cope with the demand for parking space.
10. Much of the original fixed back dune has been gardened, with a reduction in the area of dune supporting dune grasses and consequently less protection for the stability of the dunes. Beneath these shallow rooted plants e.g. ground ivy, the dune grasses die back and their deep penetrating rhizomes no longer bind the sand and place the locality at greater risk of erosion, especially where they are close to the fore dune.

5.0 DUNES AS NATURAL ASSETS

5.1 Maintaining your assets

Dunes are a natural method of flood protection and are a cost effective solution to the current trend of erosion along the east coast of Scotland. This is one reason why so much effort is being put into maintaining the West Sands dune system at St Andrews, see Image 13.

Both beaches are immensely popular with visitors who contribute to the success of local businesses and are an economic asset. The dune backdrops add value to the landscape softening residential impact as well as creating a locally diverse habitat for public enjoyment. All of the foregoing are important resources to be maintained and enhanced for the benefit of residents and users.

In terms of biodiversity, dunes are a national priority habitat in UK, Scottish and Fife Local Biodiversity Action Plans.



Image 13. Dune reconstruction in progress at the Swilken Burn, St Andrews

5.2 Enhancing your assets

Residents have set up a working group with a view to collating information and sharing it with the community as a first step in promoting active dune management. A key objective of this early report was to review the available beach data in order to suggest management options that could be considered by the local community and these are presented in Sections 6.0 and 7.0.

6.0 DUNE MANAGEMENT OBJECTIVES

6.1 Option objectives

Objective 1.

No intervention

Objective 2

To maintain the integrity of the dunes for coastal defence

Objective 3

To reduce the number of anthropomorphic factors denigrating the dunes

Objective 4

To tackle wind borne sand issues for residents between Telfer Wynd and South Street

Objective 5

To address parking in the dunes, The Toft and The Granary roads

Objective 6

To enhance the biodiversity of the site in accordance with the UK, Scottish and Fife Local Biodiversity Action Plans

6.2 Factors influencing objectives

Details are not available to this report, however there are obvious management constraints all of which require clarification prior to considering any action.

- Land ownership
- Cost of management options
- Responsibility for delivery and maintenance of actions
- Legal obligations in relation to public safety
- Local Development Plan Policy obligations
- Economic impacts
- Biodiversity considerations

7.0 MANAGEMENT OPTIONS SUMMARY

7.1 An outline plan

The plan is a short list of projects with no programme for delivery as this should be determined by residents according to their priorities and available resources.

	Objective	Management Option	Rationale	Key Elements
Objective 1.	No intervention	Do nothing	Dunes are naturally growing in extent and do not require management	<p>ECOS view is that Objective 1 is untenable for the reasons cited below.</p> <p>This is a very short term view which does not acknowledge the fragility of dunes and the extent to which they are vulnerable to severe weather events.</p> <p>A switch from accretion to erosion is highly likely to take place very soon due to rising sea levels. Should the dunes begin to erode then management efforts made now to maximise, protect and strengthen their floodwater capability will lessen the impact, or at least potentially slow the rate of dune loss. This buys time to review other engineered options.</p> <p>It is better to lead the dune process rather than try to follow it, especially after an event when it is likely that available resources in Fife may be stretched by multiple requests for help.</p>
Objective 2.	To maintain the integrity of the dunes for coastal defence	Continue with the cessation of beach cleaning on Earlsferry Beach	Dunes will naturally achieve their dynamic maxima without intervention in the early dune building process	Dunes will be more robust and more capable of withstanding storm events and any adverse effects of climate change if they develop naturally.
		Review options for removing garden plants and shrubs	To reduce the likelihood of blow outs and storm breaches	A consensus should be reached whereby no further plant introductions will take place. Non-native planting will weaken the ability of the dune to resist. Dune grasses have deep roots, in the case of marram grass several metres long, that bind and stabilise loose sand. Most hortals are poorly rooted, or surface-rooted, offering no cohesiveness to the dune and would be unlikely to offer structural defence.

	Objective	Management Option	Rationale	Key Elements
				Removal would be subject to resident approval and should at least maintain the current baseline by preventing further spread of non-native invasive plant species e.g. Japanese rose.
		Reduce the number and extent of access paths from the current baseline of 1.46km	To allow replanting and closure of those that break the line of the fore dune, rising tidal rip	<p>Agree a footpath plan identifying preferred access points and routes onto both beaches. Preferred dune access points may focus on street ends.</p> <p>Agree signage for the signage access.</p> <p>Protect main agreed access points with very limited flat rolling boardwalk.</p> <p><i>Note: mown paths are provided for access from the toilet block/picnic area on Elie Beach and these may be preferable if they can be established. Creeping fescue mixes are best for this type of access management.</i></p>
		Extend the current dune eastwards by 25 metres planting dune grasses between the end of the current dune and Telfer Wynd	Greater extent of protection and reduction in wind borne sand	Agreed section of dune to be fenced and planted with sea lyme grass according to standard techniques, see Appendix 5.
Objective 3.	To reduce the number of anthropomorphic factors denigrating the dunes	Review options for siting beach huts	Locally there are erosion hotspots where there are beach huts at the edge of and within the dunes	These huts are an integral part of the history of Earlsferry Beach and there should be no intention to reduce levels of use, only to minimise erosion. This might include moving huts out of the dune to the front of the fore dune and agreeing access arrangements for their introduction and removal.

	Objective	Management Option	Rationale	Key Elements
Objective 4.	To tackle wind borne sand issues for residents at Telfer Wynd, South Street and The Toft/Granary	Introduce measures to reduce available sand	This will underpin sand-levelling that takes place twice a year and is currently organised by the residents.	<p>Feedback from residents suggests that sand-levelling does work, however it may require review to maximise its benefit.</p> <p>Additional sand could be removed by a local golf course, or courses, for use on their bunkers. At present the local club removes approximately 250 tonnes/year, which appears to have no adverse effect on dunes, nor does it diminish the volumes being transported inland by wind. It could also be re-used for dune repairs.</p> <p>Baffles, single and/or double, on seawalls, walls and at road ends. Wooden walls at the road ends should be set at angles to maximise deflection. These deflector walls could also double as visitor shelters in summer months. Minimising the movement of sand into the lanes where turbulence encourages the airborne wind to deposit its load should be a priority. If the wind can be encouraged to leave its load on the beach then there will be less sand to move out of the residential areas. This element will have an experimental component, but installations will be easily removed/moved if they prove unsuccessful or need to be re-sited.</p> <p>Sand gates on road ends to be closed on stormy days, or when sand transport is evident. Gate closure has to be linked to a responsive sand removal contingency.</p> <p>The Toft/ Granary road is a different scenario which may require another approach. Dune height at the east end of Elie Beach encourages wind borne sand on to the road. Consideration should be given to mechanically reducing the height of the active section of dune i.e. the narrow SD5 and</p>














	Objective	Management Option	Rationale	Key Elements
				a small eastern seaward part of the SD9. Post intervention management will be required to re-stabilise the dune. A sand gate at the public access to The Toft could also be beneficial.
Objective 5.	To address the issues of parking in the dunes and at The Toft and The Granary roads	Identify a remote car park for visitor use during the peak tourist season	To reduce dune damage and congestion	Agreement over land to be allocated for voluntary parking.
		Consider appropriate solutions for residents' parking	Good design will reduce the parking footprint	Agreement of residents. Funding for implementation of new designs or layouts.
Objective 6.	To enhance the biodiversity of the site in accordance with the UK, Scottish and Fife Local Biodiversity Action Plans	Encourage residents to agree a new protocol for gardening that is sympathetic to the dune flora and fauna	To maintain the integrity of dune and to underpin Objective 1 To return the dunes to a more natural condition	The current level of gardening is detrimental to biodiversity. Provision of information on the types of native dune plants and practices that would be beneficial for wildlife. There should be a control programme for non-native invasive plant species.

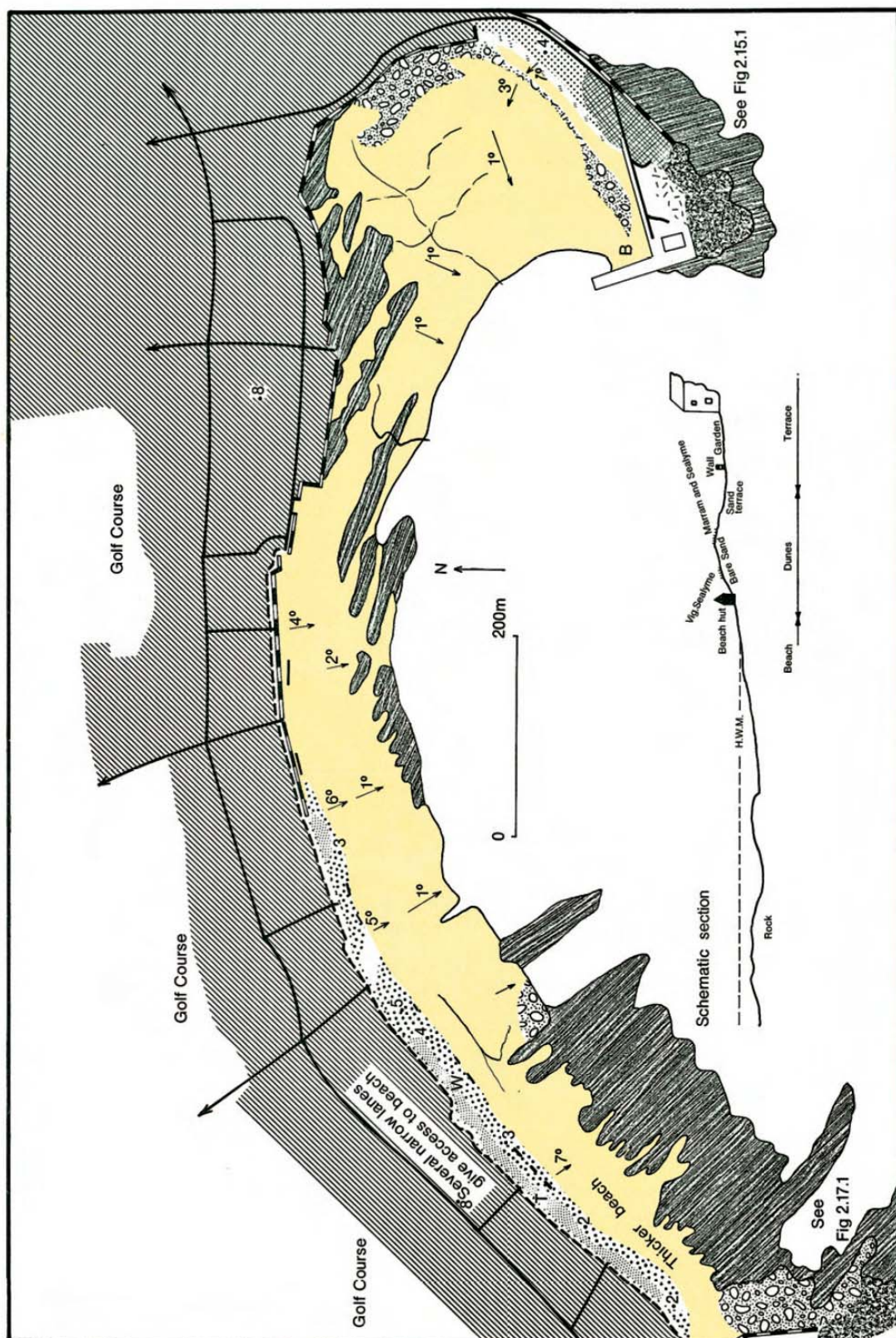
8.0 DEVELOPING A PROTOCOL

Delivery of the management objectives will require a mechanism and perhaps this is best achieved by a constituted group who have responsibility for implementing an agreed action plan which is supported by the Community Council and, where necessary, approved by the local authority. The group should seek to engage stakeholders e.g. Scottish Natural Heritage, SEPA and Fife Coast and Countryside Trust. It would have responsibility for raising and distributing funds, procuring contractors, meeting action deadlines and generating further support for proactive dune management. An important role would be maintaining the momentum of a programme which would be likely to require regular updating and revision.

APPENDIX 1. Abstract from Ritchie (1979)

Key for Figure 2.16.1

-  Strongly ribbed low rock platform
-  Higher sloping rock platform
-  Shingle and gravel
-  Prominent rock knoll
-  Low, irregular dunes 3-4m O.D.
-  Low, rounded dunes. Many paths on sloping coastal edge. Heavy use. Marram or Sea Lyme tussocks.
-  Narrow links surface terrace
-  Area used as car and boat parks
-  Boundary walls
-  Vertical sea wall of various heights usually stone-built
-  Beach drainage
-  Prograding vegetation
-  Beach huts
- W** Bushes and trees
- T** Tracks and parking
- B** Small boats (dries at low tide)



APPENDIX 2. Designated Sites Citation

Firth of Forth SSSI and Geological Conservation Review Site

CITATION

FIRTH OF FORTH
SITE OF SPECIAL SCIENTIFIC INTEREST
Fife, Clackmannanshire, Stirling,
Falkirk, West Lothian, City of Edinburgh, East Lothian

Site code :8163

NATIONAL GRID REFERENCE : NS 851934 to NO 632087 & NT 678792

OS 1:50 000 Sheet NO : Landranger Series 58, 59, 65, 66, 67
 1:25 000 Sheet NO : Explorer Series 349, 350, 351, 366, 367, 370, 371

AREA : 7423.19 hectares

NOTIFIED NATURAL FEATURES

Geological :

Stratigraphy : **Lower Carboniferous [Dinantian – Namurian part]**
 : **Upper Carboniferous [Namurian (part) - Westphalian]**

Igneous petrology : **Carboniferous – Permian Igneous**

Mineralogy : **Mineralogy of Scotland**

Palaeontology : **Arthropoda (excluding insects & trilobites)**
 : **Palaeozoic Palaeobotany**
 : **Permian - Carboniferous Fish/Amphibia**

**Quaternary geology
and geomorphology** : **Quaternary of Scotland**

Geomorphology : **Coastal Geomorphology of Scotland**

Biological :

Coastlands : **Maritime cliff**
 : **Saltmarsh**
 : **Sand dunes**

**Intertidal marine
habitats and saline
lagoons** : **Mudflats**
 : **Saline lagoon**

Lowland grassland : **Lowland neutral grassland**

Fens : **Transition grassland**

Vascular plants : **Vascular plant assemblage**

Invertebrates : **Beetle assemblage**

Butterflies : **Northern brown argus (*Aricia artaxerxes*)**

Birds : **Red-throated diver (*Gavia stellata*), non-breeding**
 : **Great crested grebe (*Podiceps cristatus*), non-breeding**

- : Slavonian grebe (*Podiceps auritus*), non-breeding
- : Cormorant (*Phalacrocorax carbo*), non-breeding
- : Pink-footed goose (*Anser brachyrhynchus*), non-breeding
- : Shelduck (*Tadorna tadorna*), non-breeding
- : Mallard (*Anas platythynchos*), non-breeding
- : Wigeon (*Anas penelope*), non-breeding
- : Scaup (*Aythya marila*), non-breeding
- : Eider (*Somateria mollissima*), non-breeding
- : Long-tailed duck (*Clangula hyemalis*), non-breeding
- : Common scoter (*Melanitta nigra*), non-breeding
- : Velvet scoter (*Melanitta fusca*), non-breeding
- : Goldeneye (*Bucephala clangula*), non-breeding
- : Red-breasted merganser (*Mergus serrator*), non-breeding
- : Oystercatcher (*Haematopus ostralegus*), non-breeding
- : Ringed plover (*Charadrius hiaticula*), non-breeding
- : Golden plover (*Pluvialis apricaria*), non-breeding
- : Grey plover (*Pluvialis squatarola*), non-breeding
- : Lapwing (*Vanellus vanellus*), non-breeding
- : Knot (*Calidris canutus*), non-breeding
- : Dunlin (*Calidris alpina alpina*), non-breeding
- : Bar-tailed godwit (*Limosa lapponica*), non-breeding
- : Curlew (*Numenius arquata*), non-breeding
- : Redshank (*Tringa totanus*), non-breeding
- : Turnstone (*Arenaria interpres*), non-breeding
- : Sandwich tern (*Sterna sandvicensis*), non-breeding
- : Eider (*Somateria mollissima*), breeding
- : Shelduck (*Tadorna tadorna*), breeding
- : Ringed plover (*Charadrius hiaticula*), breeding

The Firth of Forth Site of Special Scientific Interest (SSSI) is an extensive coastal area located on the east coast of Scotland. It stretches from Alloa to Crail on the north shore and to Dunbar on the south shore. It includes the estuary upriver from the Forth bridges and the firth east of the bridges. It is of importance for a variety of geological and geomorphological features, coastal and terrestrial habitats, vascular plants, invertebrates, breeding, passage and wintering birds.

GEOLOGY

Stratigraphy: Lower Carboniferous

The coastal margins of the Forth demonstrate an exceptional variety of rocks and fossils that have been crucial in understanding the palaeogeography and palaeoecology of Scotland

during the Carboniferous geological period. At St Monans, between Elie and Anstruther on the Fife coast and on the southern margin of the Forth at South Queensferry, coastal exposures provide an insight into the Lower Carboniferous, or Dinantian sequences, beneath and surrounding the Forth. The Abden, Burdiehouse and Seafeld Tower Limestones, the Pumpherston Shell Bed and Oil Shale, and the Dunnet Sandstones are all examples of names given to Lower Carboniferous rock layers, some of which (particularly the oil-shales, thicker limestones and coals) had economic significance.

Stratigraphy: Upper Carboniferous

Westphalian rock layer sequences on the coast at Buckhaven and at Joppa help illustrate the palaeogeography and palaeoenvironment of the area during the Upper Carboniferous, when the great coal forests flourished around 308 million years ago, and document the start of desert conditions over the area as a prelude to the Permian period.

Igneous Petrology

In intimate association with the Lower Carboniferous sedimentary rocks are various nationally significant volcanic rocks. Between East Wemyss and Anstruther and at North Berwick there are exceptional exposures of volcanic vents and igneous intrusions that document crustal instability and magmatic processes at the start of the Carboniferous. The vents at North Berwick are of particular note in that they contain blocks of rock that were derived from the lower levels of the crust. These have allowed an understanding of the structure of the lower crust in eastern Scotland. Burntisland, the east Fife coast, South Queensferry and Gullane all provide exposures illustrating a range of other nationally important volcanic features and structures.

Mineralogy

Elie Ness in Fife is of note mineralogically for the occurrence of xenocrysts of pyrope garnet, the famous 'Elie Ruby', found in a volcanic neck. The 'rubies', together with a range of other unusual minerals, provide an insight into the conditions under which the host rock, an alkali basalt, crystallised.

Palaeontology

Although of importance in understanding the Lower Carboniferous geology of the Forth area, and of Scotland as a whole, the sedimentary rock sequence has world-wide significance for fossil remains. At Burntisland in Fife, the Abden Bone Bed has yielded a rich and diverse fish fauna; other 'fossil fish' localities include Ardross Castle, also in Fife, Cheese Bay near Gullane, and Wardie Shore. Wardie is of international importance, yielding at least eighteen species of fish, including sharks, which are generally complete and in a fine state of preservation. Wardie and Cheese Bay have also yielded some of Europe's earliest amphibian remains. Granton Shore yielded the first ever recognised body fossils of the conodont animal, an eel-like fish, the remains of which have been used worldwide in dating rock layer sequences. A rich and diverse fossil flora has been found at Pettycur in Fife, Oxroad Bay near North Berwick and at Weak Law near Gullane. The Pettycur locality yields one of the best preserved Lower Carboniferous plant petrification fossil floras known in the world.

Quaternary Geology & Geomorphology

Kincaig Point demonstrates an exceptionally well-displayed sequence of raised shorelines, eroded in the volcanic agglomerate bedrock following the retreat of the last ice sheet between about 16,000 and 13,000 radiocarbon years ago. The erosional character of the shorelines is unusual and, as striking landforms, they complement the detailed sedimentary records of coastal change during the late glacial and postglacial periods that occur in more enclosed estuary situations in eastern Scotland.

At Dunbar, the coast is notable for a series of extensive shore platforms, including features that predate the last glaciation. Three of the platforms occur above present sea level, the highest with a crag and tail formation on its surface. These landforms are representative of the suite of erosional features found along the east coast of Scotland and demonstrate former sea-level

changes and different phases of marine erosion. Dunbar is one of the best examples in eastern Scotland illustrating the development of multiple shore platforms, as well as highlighting the contribution of older elements to the form of the present coastal landscape.

Geomorphology

The coastline at Dunbar is also of note for the outstanding complexity of rocky coastal landforms which it exhibits. Of particular interest is a series of rock platforms representing different relative sea levels in the area but the associated cliffs, stacks, skerries and beaches are also of value. The exceptional diversity and intricacy of the landforms is related to the variety of sedimentary and volcanic rock types found here combined with structural weaknesses in these rocks and local variations in exposure and altitude.

HABITATS

The Firth of Forth SSSI comprises an extensive mosaic of intertidal and coastal habitats. Extensive mudflats make up much of the intertidal zone with areas of sand, shingle, rock and boulders. Associated coastal habitats include saltmarsh, grassland and sand dunes.

The site is considered to be of special interest for the following habitats and species:

Maritime cliff

Maritime cliff grassland is of limited occurrence, but between Burntisland and Kirkcaldy is the largest and most diverse coastal grassland in the SSSI, with abundant areas associated with the cliffs and rock outcrops. Thrift *Armeria maritima*, kidney vetch *Anthyllis vulneraria* and distant sedge *Carex distans* are typical species. Maritime cliff grassland also occurs along the East Wemyss to Anstruther coastline and on the Dunbar coast. In these grasslands, abundant rock rose *Helianthemum nummularium* is typical, with species such as thyme *Thymus polytrichus*, crested hair-grass *Koeleria macrantha*, burnet saxifrage *Pimpinella saxifraga*, agrimony *Agrimonia eupatoria* and purple milk-vetch *Astragalus danicus*.

Saltmarsh

Important areas of saltmarsh are supported at Skinflats, Tynninghame and Aberlady. Dumbarnie Links contains the largest area of saltmarsh on the north shore of the Firth of Forth. The largest area of pioneer saltmarsh in the Forth occurs on Alloa Inch. Saltmarsh communities in the Forth are characteristically zoned from low to high water mark and are dominated by sea aster *Aster tripolium*, common saltmarsh grass *Puccinellia maritima*, saltmarsh rush *Juncus gerardii*, and sea club-rush *Bolboschoenus maritimus*. Several of the saltmarsh plant communities are scarce on the east coast of Scotland.

Beach head saltmarsh occurs at scattered localities at Blackness Bay, Burntisland Bay, Torry Bay, and Ruddons Point. Here, greater sea-spurrey *Spergularia media*, sea plantain *Plantago maritima*, glasswort *Salicornia europaea* and sea arrowgrass *Triglochin maritimum* are common.

Sand dunes

The main areas of sand dune vegetation occur in the outer Firth. Between Gullane and Broad Sands is the largest and most complex sand dune system in the Lothian area, with its noteworthy lichen-rich dune slacks. Neighbouring Aberlady Bay contains the most extensive complex of sand dune, saltmarsh and mudflat in SE Scotland. The largest area of calcareous sand dunes in Fife, including representative areas of damp dune slack, herb-rich pasture, and intact foredune ridge occurs at Dumbarnie Links, which supports many local rarities and several 'southern' species which are rare in Scotland. Calcareous sand dunes are also found at Ruddons Point and its herb-rich dune pasture is of a type not found elsewhere in Fife.

Dune grassland has developed between East Wemyss and Anstruther, Aberlady, Tynninghame and the North Berwick coast, with characteristic species lyme-grass *Leymus*

arenarius, marram grass *Ammophila arenaria*, cowslip *Primula veris*, lesser meadow-rue *Thalictrum minus*, bloody crane's-bill *Geranium sanguineum* and restharrow *Ononis repens*. Mineral enriched grasslands are an unusual habitat in East Lothian.

Mudflats

The Firth of Forth contains large areas of mudflats which while not the of particular importance for their invertebrate populations are important because of the large populations of birds which they support. Good examples can be found at Skinflats, Kinneil Kerse and Torry Bay.

Saline lagoon and Transition grassland

The intertidal bays of Skinflats and Kinneil Kerse support a range of other estuarine habitats and plant communities including brackish fen and coastal sluiced saline lagoons. The lagoons and brackish fen are characterised by transition zone species such as common reed *Phragmites australis*, sea club-rush *Bolboschoenus maritimus*, false fox-sedge *Carex otrubae*, common spike-rush *Eleocharis palustris* and abundant spiked water-milfoil *Myriophyllum spicatum*. Coastal lagoons are a rare habitat in SE Scotland and brackish fens are uncommon.

Extensive freshwater fen transition communities, uncommon elsewhere on the Forth, occur in the upper Forth estuary with reed sweet-grass *Glyceria maxima*, meadowsweet *Filipendula ulmaria*, yellow iris *Iris pseudacorus* and hemlock water-dropwort *Oenanthe crocata*.

Lowland neutral grassland

Extensive tall herb-rich neutral grassland occurs between Burntisland and Kirkcaldy where meadow crane's-bill *Geranium pratense*, false brome *Brachypodium sylvaticum* and the locally rare hemp agrimony *Eupatorium cannabinum* are common. Neutral grasslands also occur at Skinflats and Kinneil Kerse.

Species-rich coastal and semi-improved grassland is also found at Blackness Bay, where it forms the most diverse coastal grassland in West Lothian and Falkirk.

SPECIES

Vascular plant assemblage

The diversity of habitats within the Forth supports a high number of vascular plants, many of which are nationally or locally rare. Nationally scarce species include two eelgrasses – narrow-leaved eelgrass *Zostera marina* and dwarf eelgrass *Z. noltei*, which are supported on the extensive intertidal mudflats. The locally rare sea wormwood *Seriphidium maritimum*, wild cabbage *Brassica oleracea*, and purple ramping fumitory *Fumaria purpurea* are also found on drier coastal habitats.

The grasslands are particularly rich in flowering plant species and support many locally rare species such as shining crane's-bill *Geranium lucidum*, bulbous buttercup *Ranunculus bulbosus*, yellow horned-poppy *Glaucium flavum*, pyramidal orchid *Anacamptis pyramidalis*, viper's bugloss *Echium vulgare* and wild clary *Salvia verbenaca*. Nationally scarce thyme broomrape *Orobancha alba* and maiden pink *Dianthus deltoides* are also located in some grasslands.

Several sand dune areas hold the nationally scarce rush-leaved fescue *Festuca arenaria* and variegated horsetail *Equisetum variegatum*.

Beetle assemblage and Northern brown argus (*Aricia artaxerxes*)

Large numbers of insects occur throughout the site, reflecting the range of habitats encountered. Several nationally scarce species of invertebrates occur, including the sand dart moth *Agrotis ripae*, and the northern brown argus butterfly *Aricia artaxerxes*, scarce and declining in Britain, which has two Fife colonies, between Burntisland and Kirkcaldy, and

East Wemyss and Anstruther. Several species of beetles are rare or very local in Scotland, including *Cleonis pigra*, *Lebia (Lamprias) chlorocephala*, *Microplontus rugulosus* and *Scymnus (Scymnus) schmidtii*.

Birds: Wintering

The Firth of Forth supports abundant wildfowl and waders and is particularly important for its wintering bird species. The Firth of Forth is the second most important estuarine area for wintering birds in Scotland, and eleventh in the UK, and is significant both in terms of waterfowl density and abundance. Most of the wildfowl and waders in the Firth of Forth are found at internationally or nationally important levels.

The invertebrate-rich mudflats and sandflats are used for feeding at low tide whilst higher ground, including saltmarsh, is used for high tide roosts and feeding sites. The largest expanses of mud are in the inner Forth at Kinneil Kerse, Skinflats, Torry Bay and Alloa Inches while large sandflats are found in the outer Forth at Drum Sands, Tynninghame and Aberlady Bay. Rocky shorelines in the outer Forth are an important resource both for feeding and roosting birds. Lagoons at Kinneil Kerse, Torry Bay and Musselburgh are used by large numbers of birds for feeding and roosting.

The internationally important wintering species within the Forth are shelduck *Tadorna tadorna*, which includes an important post-breeding moult flock in the inner Forth; bar-tailed godwit *Limosa lapponica*; knot *Calidris canutus*; golden plover *Pluvialis apricaria* and redshank *Tringa totanus*, using the mud and sandflats; and turnstone *Arenaria interpres*, which are commonly found on shingle or rocky shorelines. Pink-footed geese *Anser brachyrhynchus* roost at Aberlady Bay while red-throated diver *Gavia stellata* and Slavonian grebe *Podiceps auritus* use offshore areas but also come close inshore at times.

The intertidal areas support nationally important numbers of grey plover *Pluvialis squatarola*, ringed plover *Charadrius hiaticula*, oystercatcher *Haematopus ostralegus*, dunlin *Calidris alpina* and curlew *Numenius arquata*, while offshore, particularly in the outer Forth, there can be found large numbers of common scoter *Melanitta nigra* and velvet scoter *Melanitta fusca*, goldeneye *Bucephala clangula*, scaup *Aythya marila*, long-tailed duck *Clangula hyemalis*, red-breasted merganser *Mergus serrator*, eider *Somateria mollissima*, great crested grebe *Podiceps cristatus* and cormorant *Phalacrocorax carbo*.

An important post-breeding population of Sandwich terns *Sterna sandvicensis* uses the Forth whilst on passage. The coast just east of Edinburgh is a particularly important area for this species.

Wigeon *Anas penelope*, Mallard *Anas platyrhynchos*, and lapwing *Vanellus vanellus* are also found in important numbers in a variety of habitats.

Birds: Breeding

There are several breeding birds of importance in the Forth. Nationally important numbers of breeding eider occur at Aberlady Bay, on the North Berwick Coast, and between Gullane and Broad Sands where there are also important moulting eider flocks. Important breeding colonies of shelduck *Tadorna tadorna* occur at Aberlady Bay, Alloa Inch and Skinflats, with a large flock of post-breeding moulting shelduck, a rare feature in Britain, occurring at Kinneil Kerse. Nationally important breeding ringed plover occur at Gullane to Broad Sands, Tynninghame, Skinflats and Torry Bay.

NOTIFICATION HISTORY

The Firth of Forth SSSI includes 18 former SSSIs notified under the Wildlife and Countryside Act 1981, parts of which were previously notified under the National Parks and Access to the Countryside Act 1949. Dates of notification are listed below:

Aberlady Bay	1952, 1977	15 August 1983
Alloa Inches	1971	06 October 1988 ¹
Blackness Bay		24 August 1987
Burntisland - Kirkcaldy Coast	1955, 1971	16 November 1989 ¹
Dumbarnie Links	1955, 1971	11 October 1982 ²
Dunbar Coast		30 April 1984
East Wemyss to Anstruther Coast	1953, 1971	07 May 1991 ¹
Forth Bridge - Granton Shore	1965, 1971, 1974	24 April 1986 ¹
Gosford Bay to Port Seton	1978	30 April 1984 ¹
Gullane to Broad Sands	1967, 1978	15 August 1983 ¹
Kinneil Kerse	1978	18 January 1988 ¹
Leith - Prestonpans	1972	24 April 1986 ¹
North Berwick Coast	1957, 1972, 1978	30 April 1984
Ruddons Point		21 February 1984
Skinflats	1973	10 March 1988 ¹
Torry Bay	1978	12 December 1991 ²
Tynninghame Shore	1952, 1972, 1978	30 April 1984 ²
Wardie Shore		30 November 1987

¹ Site boundary amended with net increase in area

² Site boundary amended with net decrease in area

Notified under the 1981 Act as Firth of Forth SSSI : 15 August 2000 with a 495 ha increase in area. (Notification confirmed on 10 May 2001 with a 90 ha reduction in area).

Notification reviewed under the 2004 Act: 29 March 2011

REMARKS

Measured area of site corrected (from 7420 ha).

Part of the Firth of Forth SSSI is designated as part of the Firth of Forth special protection area (SPA) for the birds listed below.

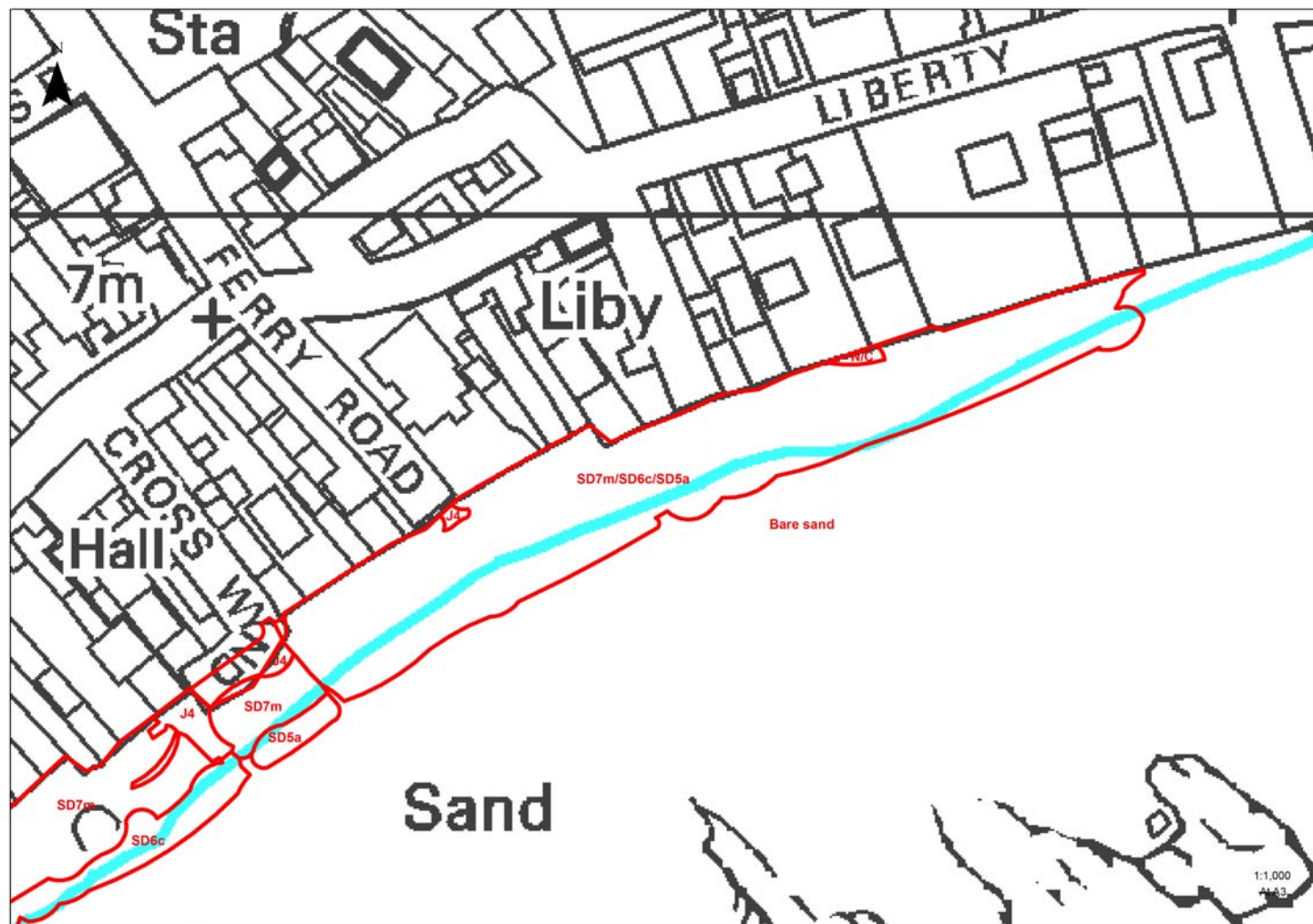
- Birds:
- Red-throated diver (*Gavia stellata*), non-breeding
 - Great crested grebe (*Podiceps cristatus*), non-breeding
 - Slavonian grebe (*Podiceps auritus*), non-breeding
 - Cormorant (*Phalacrocorax carbo*), non-breeding
 - Pink-footed goose (*Anser brachyrhynchus*), non-breeding
 - Shelduck (*Tadorna tadorna*), non-breeding
 - Mallard (*Anas platyrhynchos*), non-breeding
 - Wigeon (*Anas penelope*), non-breeding
 - Scaup (*Aythya marila*), non-breeding
 - Eider (*Somateria mollissima*), non-breeding
 - Long-tailed duck (*Clangula hyemalis*), non-breeding
 - Common scoter (*Melanitta nigra*), non-breeding
 - Velvet scoter (*Melanitta fusca*), non-breeding
 - Goldeneye (*Bucephala clangula*), non-breeding
 - Red-breasted merganser (*Mergus serrator*), non-breeding
 - Oystercatcher (*Haematopus ostralegus*), non-breeding

Ringed plover (*Charadrius hiaticula*), non-breeding
Golden plover (*Pluvialis apricaria*), non-breeding
Grey plover (*Pluvialis squatarola*), non-breeding
Lapwing (*Vanellus vanellus*), non-breeding
Knot (*Calidris canutus*), non-breeding
Dunlin (*Calidris alpina alpina*), non-breeding
Bar-tailed godwit (*Limosa lapponica*), non-breeding
Curlew (*Numenius arquata*), non-breeding
Redshank (*Tringa totanus*), non-breeding
Turnstone (*Arenaria interpres*), non-breeding
Sandwich tern (*Sterna sandvicensis*), passage
Waterfowl assemblage, non-breeding

APPENDIX 3. NVC Maps, July 2016

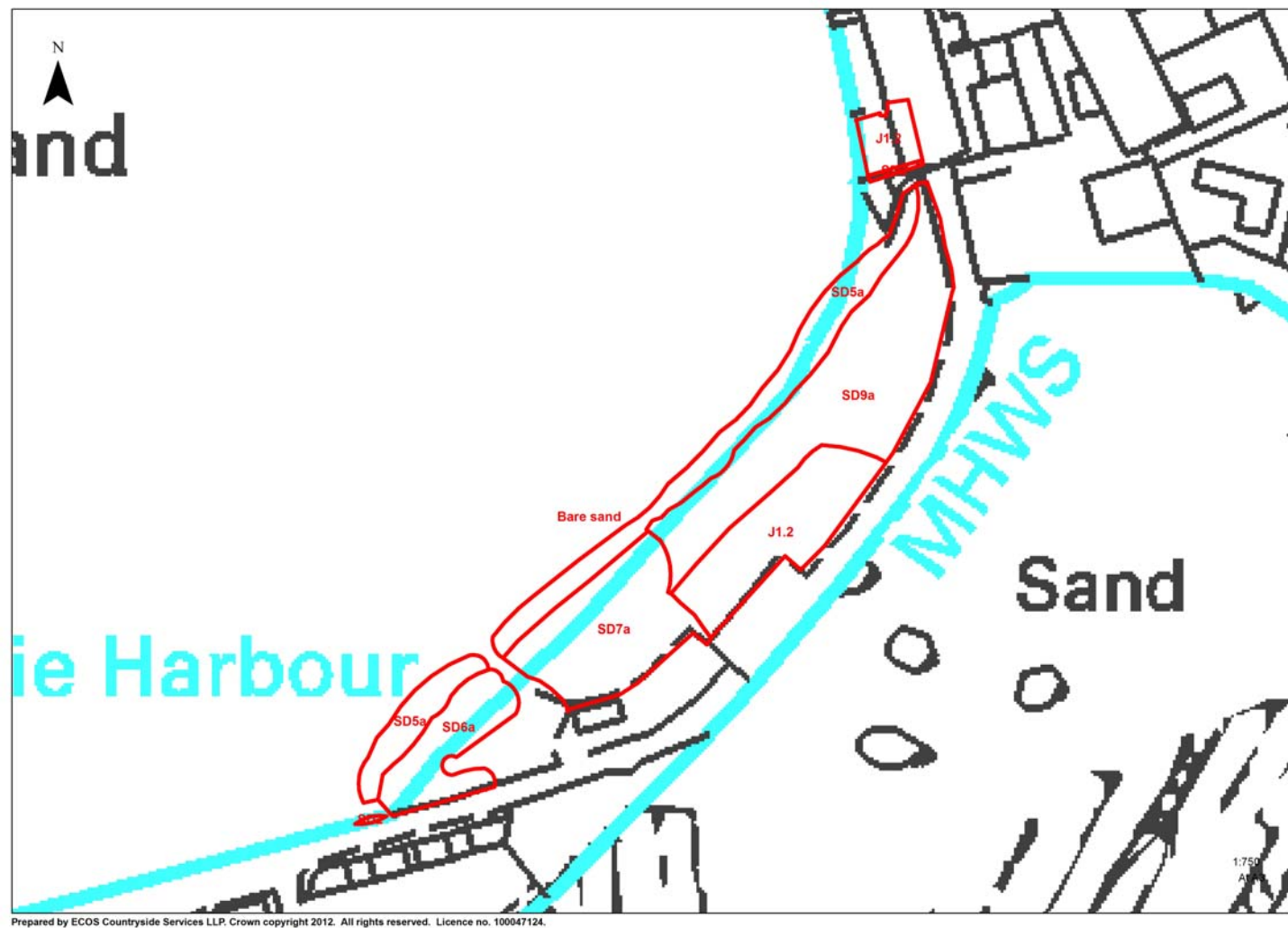
(a) Earlsferry Beach





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(b) Elie Beach



APPENDIX 4. Higher Plant Species List, July 2016

Relative abundance on the site is recorded on a DAFOR scale where:

D= dominant
A= abundant
F= frequent
O= occasional
R= rare

Prefix L = locally

Species			
Latin Name	Common Name		
		Earlsferry Beach	Elie Beach
<i>Achillea millefolium</i>	Yarrow	R	R
<i>Aegopodium podagraria</i>	Ground Elder	LO	R
<i>Agrostis capillaris</i>	Common Bent	O	O
<i>Ammophila arenaria</i>	Sea Marram Grass	F	LF
<i>Arrhenatherum elatius</i>	False Oat-grass	R	LO
<i>Atriplex lacciniata</i>	Frosted Orache	LF	LR
<i>Atriplex littoralis</i>	Grass-leaved Orache	LR	LR
<i>Atriplex prostrata</i>	Spear-leaved Orache	LO	LO
<i>Bellis perennis</i>	Daisy	R	R
<i>Briza media</i>	Quaking Grass	-	VR
<i>Cakile maritima</i>	Sea Rocket	LR	LR

Species			
Latin Name	Common Name		
		Earlsferry Beach	Elie Beach
<i>Campanula rotundifolia</i>	Harebell	VR	VR
<i>Cardamine flexuosa</i>	Wavy Bittercress	R	R
<i>Cardamine hirsuta</i>	Hairy Bittercress	R	R
<i>Carex arenaria</i>	Sand Sedge	VR	R
<i>Centaurea nigra</i>	Black Knapweed	VR	VR
<i>Cerastium fontanum</i>	Common Mouse-ear	R	R
<i>Cerastium glomeratum</i>	Sticky Mouse-ear	R	R
<i>Cerastium arvense</i>	Field Mouse-ear	R	R
<i>Chamerion angustifolium</i>	Rosebay Willowherb	R	R
<i>Cirsium arvense</i>	Creeping Thistle	LF	R
<i>Cirsium vulgare</i>	Spear Thistle	R	R
<i>Cochlearia officinalis</i>	Common Scurvy Grass	R	VR
<i>Cynosurus cristatus</i>	Crested Dogs-tail	R	R
<i>Dactylis glomerata</i>	Cocksfoot	LO	R
<i>Elymus farctus</i>	Sand Couch	LO	LO
<i>Elymus repens</i>	Common Couch	R	-
<i>Epilobium montanum</i>	Broad-leaved Willowherb	R	R
<i>Equisetum arvense</i>	Field Horsetail	R	R
<i>Erodium cicutarium</i>	Common Storksbill	R	R
<i>Erophila verna agg</i>	Common Whitlowgrass	R	R

Species			
Latin Name	Common Name		
		Earlsferry Beach	Elie Beach
<i>Euphrasia agg.</i>	Eyebright	R	R
<i>Festuca rubra</i>	Red Fescue	LF	LO
<i>Gallium verum</i>	Ladies Bedstraw	VR	R
<i>Gallium aparine</i>	Cleavers	VR	-
<i>Galium saxatile</i>	Heath Bedstraw	VR	VR
<i>Geranium mole</i>	Dovesfoot Cranesbill	R	VR
<i>Heracleum sphondylium</i>	Common Hogweed	R	R
<i>Hieraceum agg</i>	Hawkweed	R	R
<i>Holcus lanatus</i>	Yorkshire Fog	LO	R
<i>Honkenya peploides</i>	Sea Sandwort	VR	-
<i>Hypochaeris radicata</i>	Common Cat's Ear	R	R
<i>Lamium album</i>	White Dead Nettle	R	-
<i>Lapsana communis</i>	Nipplewort	R	-
<i>Lathyrus pratensis</i>	Meadow Vetchling	VR	-
<i>Leucanthemum vulgare</i>	Ox Eye Daisy	VR	-
<i>Leymus arenarius</i>	Lyme Grass	F	F
<i>Lolium perenne</i>	Perennial Rye Grass	LF	LF
<i>Lotus corniculatus</i>	Common Birdsfoot Trefoil	R	R
<i>Luzula campestris</i>	Field Woodrush	R	R
<i>Matricaria matricoides</i>	Pineappleweed	VR	-
<i>Myosotis discolor</i>	Changing Forget-me-not	R	R
<i>Myosotis arvensis</i>	Field Forget-me-not	-	VR

Species			
Latin Name	Common Name		
		Earlsferry Beach	Elie Beach
<i>Odonites verna</i>	Red Bartsia	R	R
<i>Ononis repens</i>	Rest Harrow	R	-
<i>Plantago coronopus</i>	Buckshorn Plantain	VR	VR
<i>Plantago lanceolata</i>	Ribwort Plantain	R	R
<i>Plantago major</i>	Greater Plantain	R	R
<i>Poa annua</i>	Annual Meadow Grass	R	R
<i>Poa pratensis</i> agg.	Smooth Meadow Grass	R	R
<i>Polygonum aviculare</i>	Knotgrass	VR	-
<i>Prunella vulgaris</i>	Selfheal	R	R
<i>Ranunculus ficaria</i>	Lesser Celandine	VR	-
<i>Ranunculus repens</i>	Creeping Buttercup	R	R
<i>Rhinanthus minor</i>	Yellow Rattle	VR	-
<i>Rosa</i> spp.	Wild Rose	VR	-
<i>Rubus fruticosus</i> agg.	Bramble	VR	-
<i>Rumex acetosa</i>	Sorrel	R	-
<i>Rumex acetosella</i>	Sheep's Sorrel	VR	-
<i>Rumex crispus</i>	Curled Dock	R	R
<i>Rumex obtusifolius</i>	Broad-leaved Dock	O	R
<i>Salix viminalis</i>	Osier	LF	-
<i>Sambucus nigra</i>	Elder	VR	-
<i>Senecio jacobaea</i>	Common Ragwort	O	R
<i>Senecio viscosus</i>	Sticky Groundsel	VR	-
<i>Silene dioica</i>	Red Campion	VR	-
<i>Sinapsis arvensis</i>	Charlock	VR	-

Species			
Latin Name	Common Name		
		Earlsferry Beach	Elie Beach
<i>Sonchus arvensis</i>	Corn Sow-thistle	R	R
<i>Stellaria media</i>	Chickweed	R	-
<i>Taraxacum vulgare</i> agg.	Dandelion	R	R
<i>Tragopogon pratensis</i>	Goatsbeard	-	VR
<i>Trifolium pratense</i>	Red Clover	R	R
<i>Trifolium repens</i>	White Clover	R	R
<i>Tripleurospermum inodorum</i>	Scentless Mayweed	LR	LR
<i>Tussilago farfara</i>	Coltsfoot	R	-
<i>Urtica dioica</i>	Stinging Nettle	VR	-
<i>Veronica chamaedrys</i>	Germander Speedwell	R	-
<i>Vicia cracca</i>	Hairy Tare Vetch	R	-
<i>Vicia sativa</i>	Common Vetch	R	VR
<i>Viola riviniana</i>	Common Dog Violet	R	-
TOTAL		87	63

APPENDIX 5. Dune Grass Planting Methodology

Abstracted from:

<http://www.snh.org.uk/pdfs/publications/heritagemanagement/coastalerosion.pdf>.

Summary 2: DUNE GRASS PLANTING

APPROPRIATE LOCATIONS	Above normal limit of wave run-up at any location with available blown sand. Unlikely to succeed where erosion is severe.
COSTS	Low, but labour intensive with on-going management (£200 - £2000/100m length for each visit).
EFFECTIVENESS	Enhancement to natural dune recovery. Reservoir of sand held in planted foredunes will provide a buffer to resist storm erosion.
BENEFITS	Compliments natural system. Can be used to improve other management options. Potentially self sustaining.
PROBLEMS	Normally requires dune fencing or thatching to achieve success. May be completely lost to storm erosion.

General description

Vegetation encourages dune growth by trapping and stabilising blown sand. Transplanting marram grass (*Ammophila arenaria*) to the face of eroded dunes will enhance the natural development of yellow dunes above the limit of direct wave attack. Sand couchgrass (*Elymus farctus*) or Lyme grass (*Leymus arenarius*) can be transplanted to encourage the growth of new foredunes along the toe of existing dunes, as these species are tolerant to occasional inundation by seawater. Planting grasses from seed can be undertaken but will not normally be successful in the very active foredune environment.

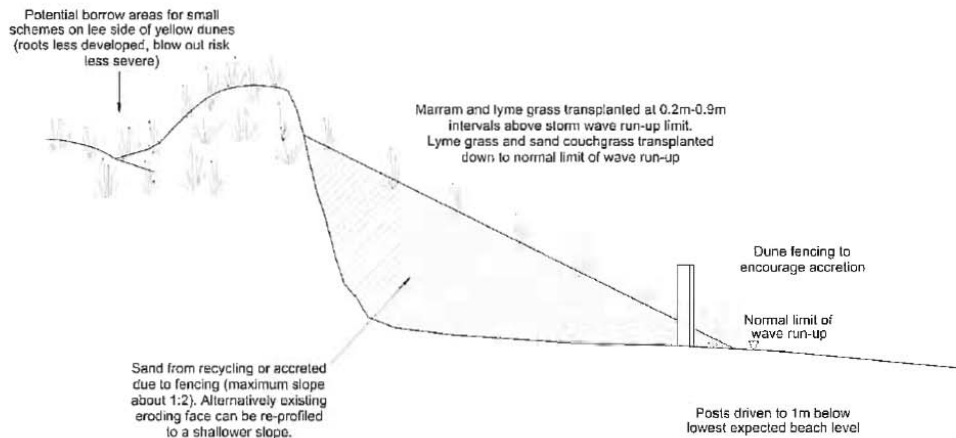
These natural dune grasses act to reduce wind speeds across the surface, thereby trapping and holding sand. They grow both vertically and horizontally as the sand accumulates. Marram grass is particularly effective as it positively thrives on growing dunes, and is perhaps the easiest to transplant.



Dune stabilisation using marram and Lyme grass transplants.

Function

Transplanting vegetation will not prevent erosion, but it will accelerate natural recovery after storm damage creating a reservoir of sand within the foredunes that will make the dunes better able to withstand the next period of erosion. Additional works are often necessary to increase the potential for success. Thatching (Summary 3), fencing (Summary 4) and beach recycling (Summary 5) will assist in the accretion of sand, will provide minor protection from waves and will reduce damage due to trampling. Once grasses are well established they may well become self-sustaining, although any storm erosion damage will need to be rapidly made good.



Transplanting dune grasses to an eroded dune face

Transplanting can also be used to enhance the appearance and effectiveness of built erosion defences. Rock, timber or gabion structures can provide a fixed defence line but are incongruous along a natural dune coast: partial burial of these structures using recycled sand, followed by transplanting, will create a more natural dune appearance if conditions are favourable. However transplanting to inappropriate locations can be a waste of resources, as illustrated in the photograph below.

Methods

The subject of dune vegetation transplanting is covered in detail within various publications, including the British Trust for Conservation Volunteers "Sand Dunes Handbook". It is common practice in the management of wind erosion and recreational pressures and has been undertaken at many sites. Essentially, vigorous plants are pulled or dug up from a suitable borrow area, and are replanted on an eroded face, where they will be immediately effective in trapping blown sand. Where stock, such as sheep or cattle, can gain access to the replanted site these may cause considerable damage through grazing and trampling of the transplanted grasses. Growth and stabilisation will often only be realised once these have been excluded, for instance through fence construction. Additional works such as re-profiling of steep or unstable faces, fencing or thatching should be done in advance to avoid damaging the transplants. These complimentary approaches are discussed in Summaries 3 to 5. Without these works, transplanting is unlikely to be successful unless natural recovery is well underway. The basic principles of transplanting are illustrated above.

Marram grass is tolerant of salt spray but not immersion, and should be planted above the expected run-up limit of storm waves. Lyme grass can tolerate occasional inundation and can be transplanted down to the beach dune interface. In practice there is little point in trying to extend the vegetation cover too far as wave damage may quickly remove the lowest transplants before they have a chance to take root.



a) marram grass



b) lyme grass

Common dune grasses.

Transplanting should not be seen as a one-off operation. Regular maintenance is required to replace unhealthy plants, apply fertilisers, prevent trampling and extend cover to adjacent areas. Work can be undertaken at any time of year, but early spring is generally considered to be the optimum to avoid frosts, storm erosion, drought or trampling. Even assuming no storm erosion, it is likely that it will take two or three years before transplants begin to thrive and spread.

For small schemes transplants may be taken locally, ensuring that the borrow area is not denuded to the extent that blow outs may form. Larger schemes require a commercial supply or a managed nursery area within the dune system. Forward planning is required to ensure that sufficient seedlings and/or mature plants are available for transplanting. Sowing dune grass seeds is not a practical solution to marine erosion, but can be applied successfully to more stable backshore dunes, if considered necessary.

Costs for transplanting are dependent on labour, sources of transplants, extent of works, the need for ongoing management and the cost of ancillary works to help stabilise the dune face. Small schemes implemented by volunteer labour using local transplants may cost almost nothing, while extensive schemes using commercial nursery transplants and contracted labour may cost up to £20,000/km, plus ongoing management costs. Cost assessment should allow for the possibility that the transplant scheme may be substantially damaged by the first storm event following the works.

Marram planted to landward of a large rock revetment lacks vigour as it is starved of blown sand.



Impacts

Transplanting and management of appropriate dune grasses to the dune face will have no damaging impact on the natural environment of the receiving area, but can be harmful to the borrow area. Over harvesting of transplants from any area can give rise to increased local erosion. This may be most significant for sand couch grass, as the borrow area will necessarily be a foredune susceptible to wave over-washing and wind erosion. Construction of fences or thatching will disrupt public use of the beach, so provision must be made for controlled access.

Five years on from planting, marram is thriving on this dune face.



