Cyfoeth Naturiol Cymru
Natural Resources Wales

Kenfig Phase 1
Dune Rejuvenation Works
Topographic Survey Report

Kenneth Pye & Simon J. Blott

Kenneth Pye Associates Ltd

Report No: 98

Date: May 2014

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Contents

1. Job Summary

KPAL Job No:	300514
Report Date:	30/05/2014
Client:	Natural Resources Wales
Client Job Title:	Kenfig Dune Restoration Works – Phase 1
Survey conducted:	27th May 2014
Instruments used:	Leica ATX1230GG SmartRover mounted on GLS30 pole (2 m) Leica GX1230 RTK base station and AS10 antenna mounted on GST20-9 tripod Leica RX1250TC and RX1210T Field Controllers Pacific Crest ADL Vantage radio transceiver (430-470 MHz)
No. of data points:	707
RTK Control Station:	Wooden post surveyed-in using Leica Smartnet GPRS on 13 May 2013 (BM1). Easting: 278274.566 m Northing: 182438.361 m Height: 10.846 m OD
RTK Backup Station:	Wooden stile (BM2) 19 m NW of Control Station above.
Fixed profiles:	Eight existing profile lines (1-8, previously surveyed on 17 July 2012, 9 October 2012 and 8 March 2013) were resurveyed and 2012-2013 ground surveys. Chainages along profile lines were interpolated at positions on a theoretical straight-line between the zero and end points of the profile.

Survey undertaken by: S.J. Blott, K. Pye

2. Scope and purpose

The requirements and opportunities for sand mobility trials at Kenfig were identified in a report published in 2011 (Pye & Blott, 2011). Additional data relating to changes in bare sand area between the 1940s and 2009 were presented in Pye *et al.* (2014).

Phase I dune rejuvenation trials at Kenfig commenced in the winter of 2011-2012 and involved stripping of surface vegetation and topographic modification to expose bare sand and to enhance the potential for sand movement within a 5 ha area. Topographic monitoring surveys were carried out in July and October 2012 (KPAL, 2012a, b) and in March 2013 (KPAL2013a); an overview report was produced in July 2013 (KPAL, 2013b).This report summarises the results of a further field survey undertaken in May 2014.

The Phase II work began in January 2013 and involved vegetation stripping within an approximate 6.5 ha area adjacent to the Phase rejuvenation area. Four notches were also excavated in the frontal dune ridge in order to funnel the wind and encourage transfer of sand blown from the beach, and eroded from the sides and base of the notches, into the area behind the frontal dune ridge. An initial topographic monitoring survey of the Phase II area was undertaken in May 2013 (KPAL, 2013c) and a second survey conducted in March 2014 (KPAL, 2014).

The winter of 2013-14 was wet and stormy. The frontal dunes along southern two thirds of the Kenfig frontage experienced significant wave erosion, although the northern part of the frontage was less affected due to the protective effect of a bank of shingle along the dune toe which became enlarged over the winter by alongshore drift of sediment from the south.

Although there were a number of periods of strong winds during the winter, aeolian transport of sand was restricted by frequent rainfall which kept the surface sand wet for long periods of time. At the time of the field survey in March 2014 large areas of the site remained under water, especially on the landward side of the haul road. Visual observations indicated that wind transport of sand from the west side of the haul road was limited to within a few metres of the fence line on the landward side of the haul road. Sand movement further to the east of the haul road was limited to the higher parts of dunes which had been de-vegetated. By mid-May 2014 the site had largely dried and at the time of survey on 27th May small pools of standing water remained only on the landward side of the haul road.

3. Survey methods and error checking

Elevations were determined at 707 points using Leica RTK GPS SmartRover equipment listed in the Job Summary above. Many of the survey points were on profile lines which were also surveyed in three previous surveys in July and October 2012, and March 2013 (Figure

1). The limits of defined features, including ridge crests, standing water, new vegetation growth and the position of the frontal sand dune toe, were also mapped by survey points.

Average vertical and horizontal errors reported by the instrument during the March 2014 survey were well within the expected range (Table 1).

A nearby stile was used as a secondary benchmark (BM2), and comparison of data from the start and end of the survey showed only small differences which are within acceptable limits (Table 2).

The raw survey data were mathematically 'corrected' to allow direct comparison of straight line profiles derived from the 26 February 2006 LiDAR survey and the 13 May 2013 ground survey. The vertical accuracy of the LiDAR has not been quantified directly but is estimated to be better than 10-15 cm.

Ground photographs were taken at a number of locations around the site; locations and directions of view of selected photographs reproduced in this report are shown in Figure 2. The photographs are presented in Appendix 1. The appendix also contains a number of photographic comparisons between different surveys which provide a qualitative record of changes in the extent of vegetation over time.

In order to inform interpretation of the dune topographic changes, and especially erosion of the dune front, tide gauge data for Mumbles and wave data for the Scarweather waverider buoy were downloaded from the NTSLF and CEFAS Wavenet websites, respectively.

4. Profile comparisons

Figures 3(a) and Figure 3(b) show significant change in the position of the frontal dune ridge between the March 2013 and May 2014 surveys, partly due to wave erosion of the dune front during the winter of 2013-14 and partly due to wind erosion over a longer period. Surveys along the dune toe indicated that recession between March 2013 and March 2014 ranged from 7.1 to 18.2 m, being greatest where the frontal dune height was lower (see also Figure 5).

Figure 3(c) along the central axis of the dune shows that substantial wind scouring and surface lowering occurred near the crest of the first inland dune ridge behind the beach between March 2013 and May 2014. The eroded sand was deposited partly in a lob on the lee side of this ridge and partly as a diffuse layer extending up to the haul road, and within the wet slack / pool on the landward side of the haul road. Only minor changes occurred on the stoss slope and crestal area of the large dune to the east of the haul road.

At profile D there was also lowering and landward movement of the frontal dune ridge, with lowering of the first inland dune ridge crest, although less marked than at Profiles B and C.

Profile E, oriented approximately N-S across the turf-stripped area, shows some wind erosion and surface lowering in the northern half of the profile and significant accumulation of sand within the depression which occupies the central part of the profile.

Profiles F, G and H, which are orientated transverse to the axis of the rejuvenated dune east of the haul road, show slight and spatially variable lowering of the sand surface within the deflation trough of the dune and slight deposition of sand on vegetated parts of the crest and 'arms' of the dune. In May 2014 the level of standing water in the excavated area to the east of the haul road was almost a metre lower than in March 2013 and March 2014. Significant growth of vegetation has occurred within parts of the blowout and on the sides and lower stoss slope of the dune between the two surveys (see photographs in Appendix 1).

The general extent of areas of significant sand deflation and deposition, together with areas of standing water and > 50% vegetation cover, in May 2014 are shown in Figure 4.

Figure 5 provides a comparison of the dune toe positions measured in different surveys since July 2012. Average recession of the dune toe is 10.5 m between 17 July 2012 and 27 May 2014. Most of this occurred during the winter of 2013-14.

5. Preliminary assessment of tidal level and wave data

The Mumbles tide gauge record shows that during the winter of 2013-14 Swansea Bay experienced the highest recorded tides in the period of record, which extends back to January1988. Several significant meteorological surge events coincided with high spring tides, producing high resultant still water levels (Figure 6a). Several of the high tides were also accompanied by high waves from the west-south-west (Figure 6b). There were two notable high wave energy / high tide events in January 2013 and five in February 2014. The combined effect of these storms, and other periods of high wave energy which coincided with lower tides, was to cause significant beach lowering, northward movement of gravel along the dune toe, and recession of the dune front. The wave direction recorded at Scarweather was very constant (Figure 7a & Figure 8). During the most severe erosional event the peak wave period was in the range 10 to 12 seconds, significantly less than in the periods between storms when longer-period swell waves were dominant (Figure 7b).

6. References

KPAL (2012a) *Topographic Survey Report Kenfig Dune Restoration Works*, prepared for Natural Resources Wales, 18th July 2012. Kenneth Pye Associates Ltd., Crowthorne.

KPAL (2012b) *Topographic Survey Report Kenfig Dune Restoration Works*, prepared for Natural Resources Wales, 22nd October 2012. Kenneth Pye Associates Ltd., Crowthorne.

KPAL (2013a) *Topographic Survey Report Kenfig Dune Restoration Works, prepared for Natural Resources Wales, 15th March 2013*. Kenneth Pye Associates Ltd., Solihull.

KPAL (2013b) *Kenfig Dune Restoration Works Phase I Overview Report.* Report prepared for Natural Resources Wales, 30 July 2013. Kenneth Pye Associates Ltd., Solihull.

KPAL (2013c) *Topographic Survey Report Kenfig Dune Restoration Works, Phase 2*. Report prepared for Natural Resources Wales, 7th May 2013. Kenneth Pye Associates Ltd., Solihull.

KPAL (2014) *Topographic Survey Report Kenfig Dune Re Works, Phase II*. Report prepared for Natural Resources Wales, 7th May 2014. Kenneth Pye Associates Ltd., Solihull.

Pye, K. & Blott, S.J. (2011) *Kenfig Sand Dunes - Potential for Dune Reactivation*. CCW Contract Science Report No. 971, 19pp, 2 tables, 31 figures and 2 appendices, Countryside Council for Wales, Bangor.

Pye, K, Blott, S.J. & Howe, M.A. (2014) Coastal dune stabilization in Wales and requirements for rejuvenation. *Journal of Coastal Conservation* 18, 27-54.

7. Tables

Table 1. Average instantaneous error reported by the instrument for all 707 data points

	1-D (height) quality control	2-D (position) quality control
Average	10.5 mm	7.1 mm
StDev	3.7 mm	3.0 mm

Table 2. Measured location and height of Benchmark 1 (wooden post), surveyed using Smartnet corrections during different survey campaigns

	Easting	Northing	Height
Surveyed 13 May 2013	278274.566 m	182438.361 m	10.846 m OD
Instantaneous error (2D and 1D QC):	9 mm	9 mm	16 mm
Surveyed 10 March 2014	278274.575 m	182438.369 m	10.895 m OD
Instantaneous error (2D and 1D QC):	11 mm	11 mm	17 mm
Difference May 2013 to March 2014:	+9 mm	+8 mm	+49 mm
Surveyed 27 May 2014	278274.554 m	182438.388 m	10.852 mOD
Instantaneous error (2D and 1D QC):	8 mm	8 mm	12 mm
Difference May 2013 to May 2014:	-12 mm	+27 mm	+6 mm

Table 3. Measured location and height of Benchmark 2 (stile) on 27 May 20214

	Easting	Northing	Height
Surveyed with Smartnet corrections	278262.750 m	182449.792 m	8.852 m OD
Instantaneous error (2D and 1D QC):	9 mm	9 mm	14 mm
Surveyed with base & rover, start of survey	278262.765 m	182449.789 m	8.842 m OD
Instantaneous error (2D and 1D QC):	6 mm	6 mm	8 mm
Difference from Smartnet:	+15 mm	-3 mm	-10 mm
Surveyed with base & rover, end of survey	278262.778 m	182449.797 m	8.848 m OD
Instantaneous error (2D and 1D QC):	6 mm	6 mm	8 mm
Difference from Smartnet:	+28 mm	+5 mm	-4 mm
Closing error of base and rover survey:	+13 mm	+8 mm	+6 mm

8. Figures

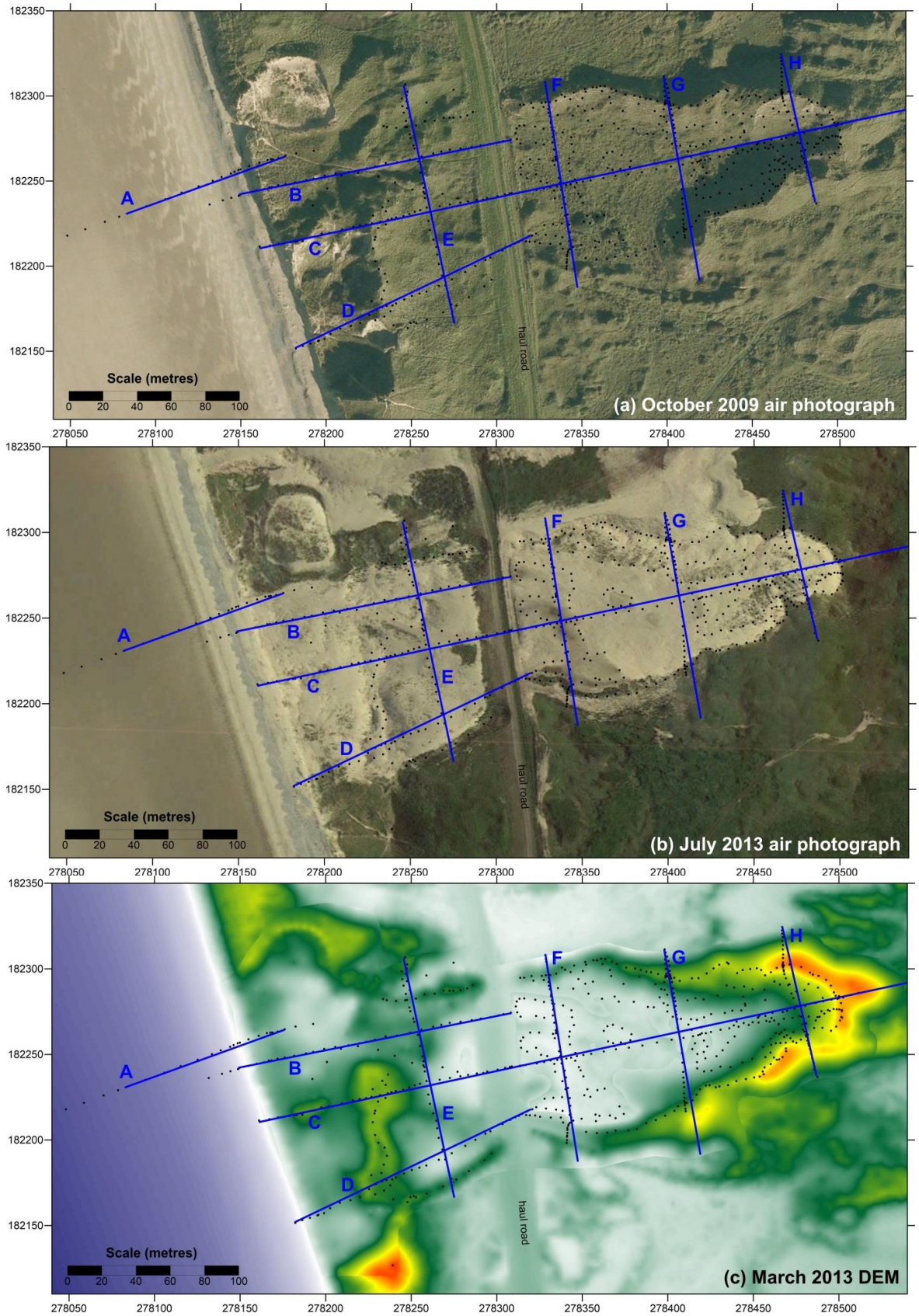


Figure 1. Locations of data points (black dots) and cross-profiles (blue lines), overlaid on air photographs and a DEM generated from March 2013 ground survey and 2006 LiDAR data.

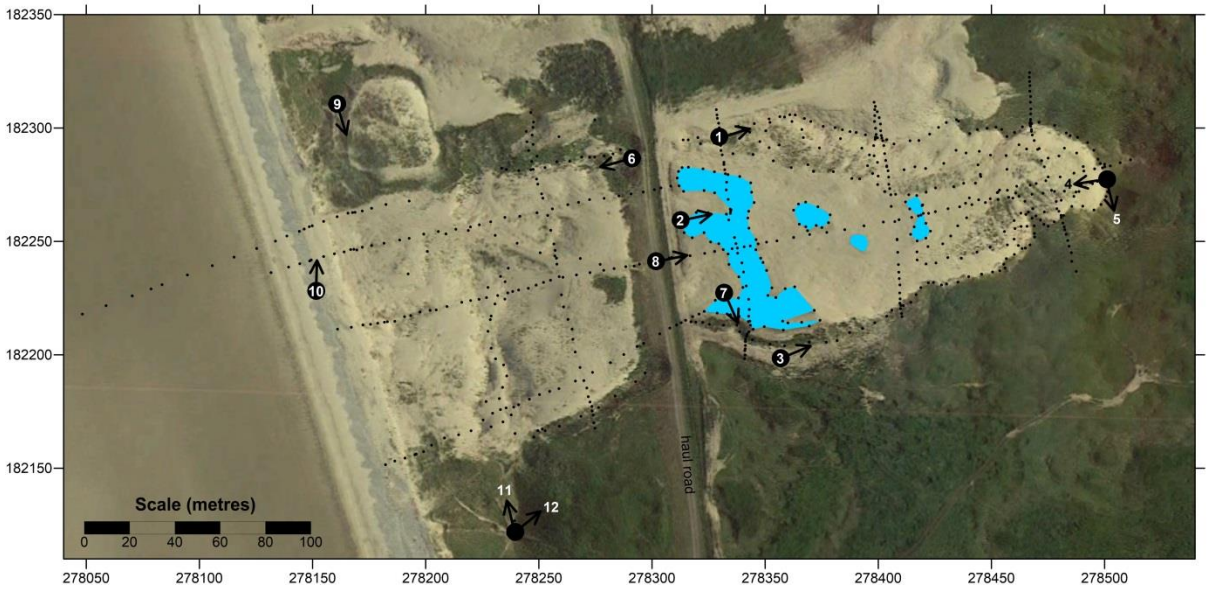


Figure 2. Locations of field photographs 1 to 12 reproduced in this report. Arrows indicate direction of view; base 2013 aerial photography from Google Earth

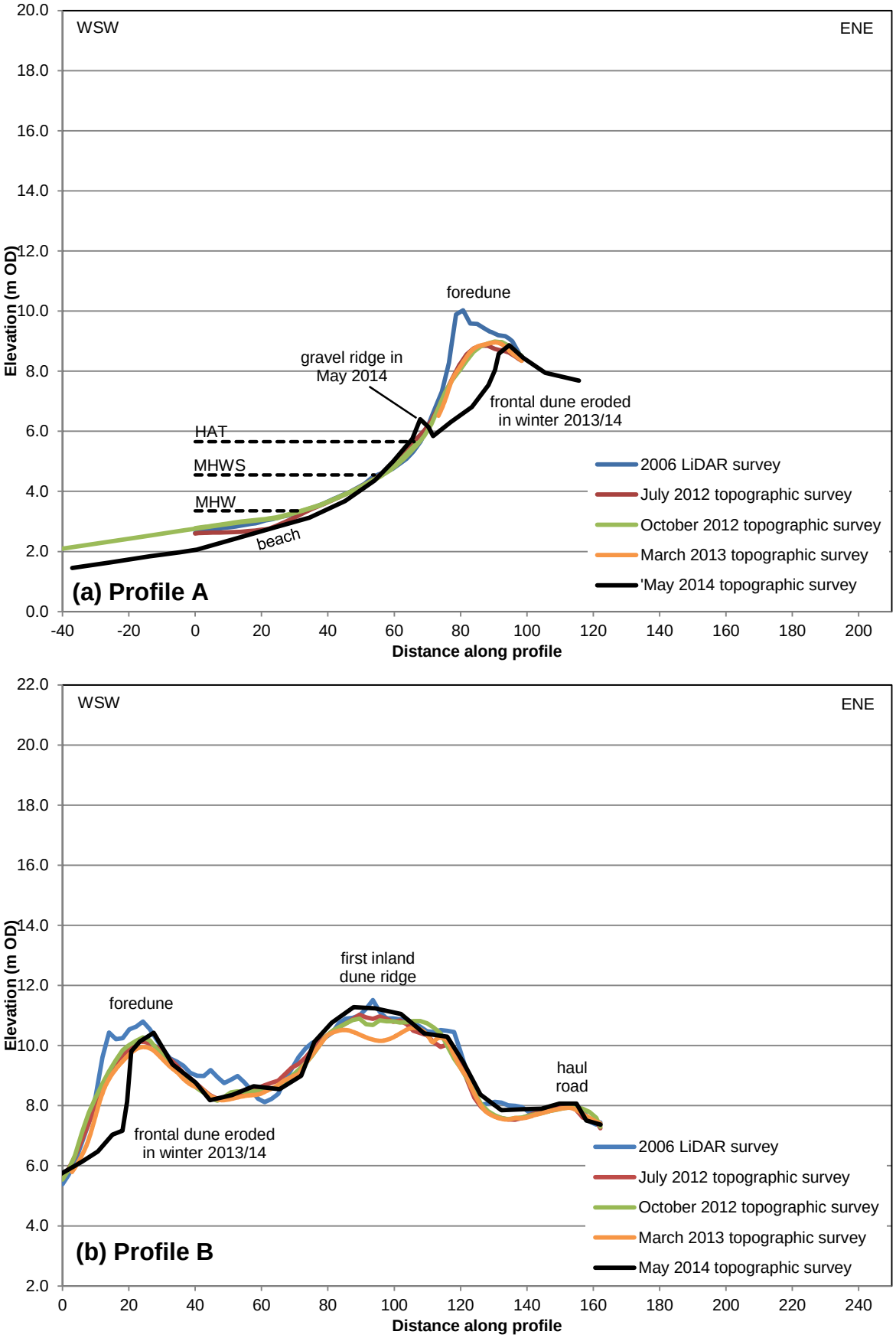


Figure 3. Comparison of surface levels at profiles A and B indicated by LiDAR survey on 26/02/2006 (pre-trials) and ground surveys on 27/07/2012, 09/10/2012, 08/03/2013 and 27/05/2014.

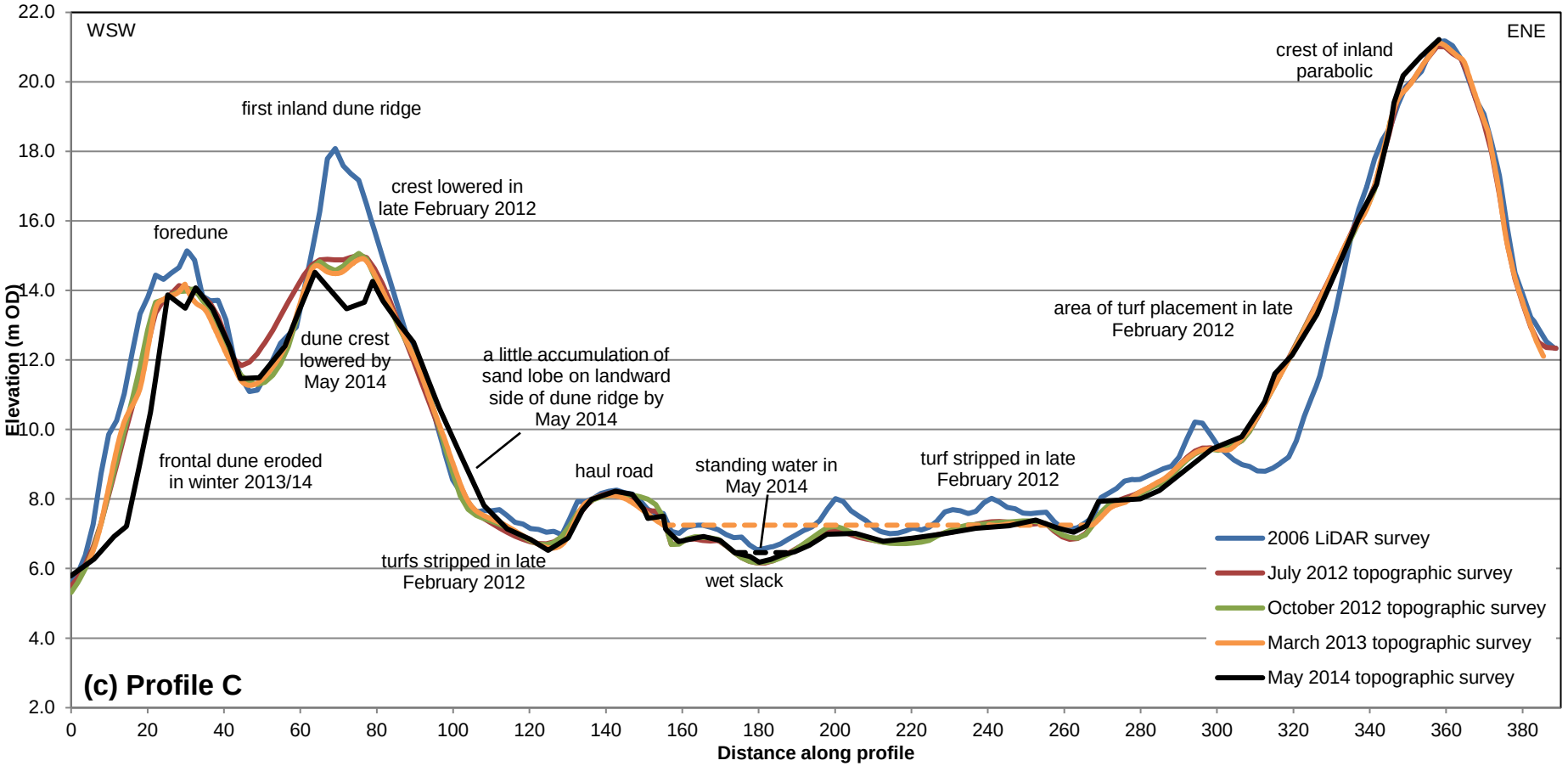
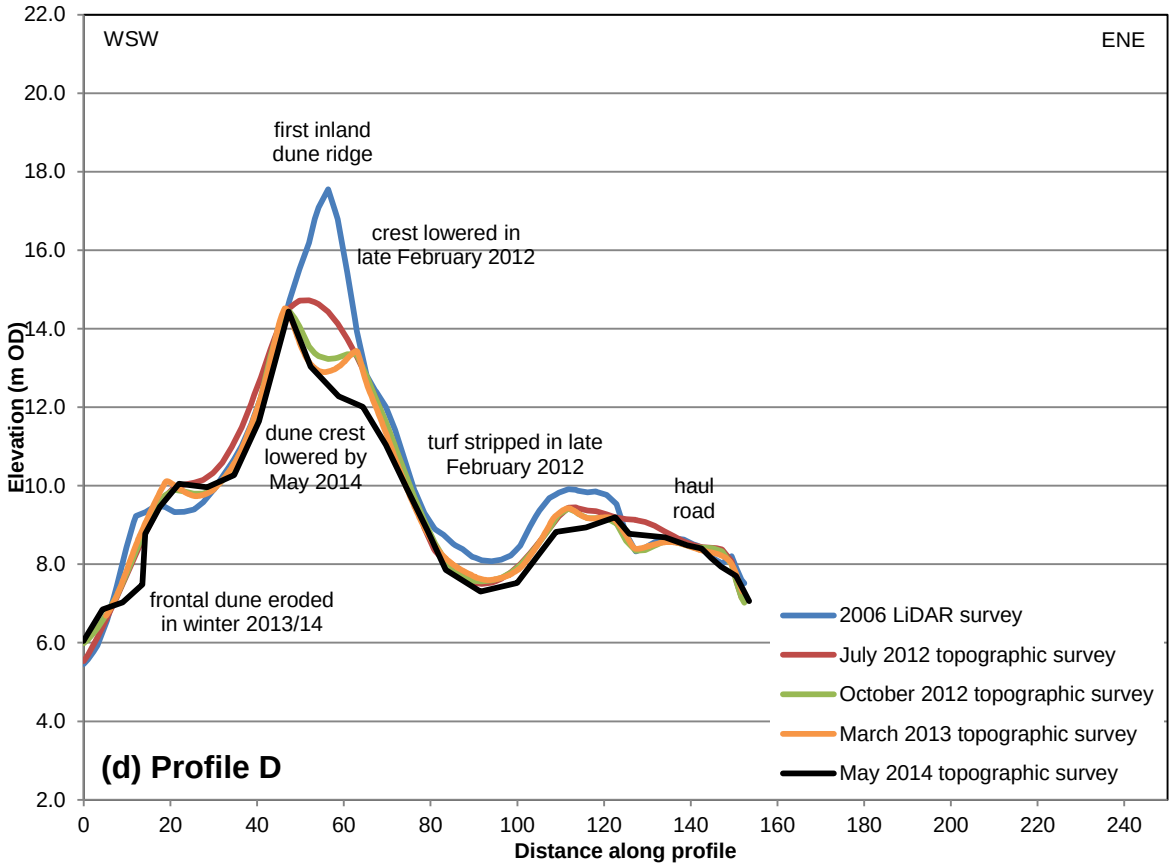


Figure 3. continued. Comparison of surface levels at profile C indicated by LiDAR survey on 26/02/2006 (pre-trials) and ground surveys on 27/07/2012, 09/10/2012, 08/03/2013 and 27/05/2014.



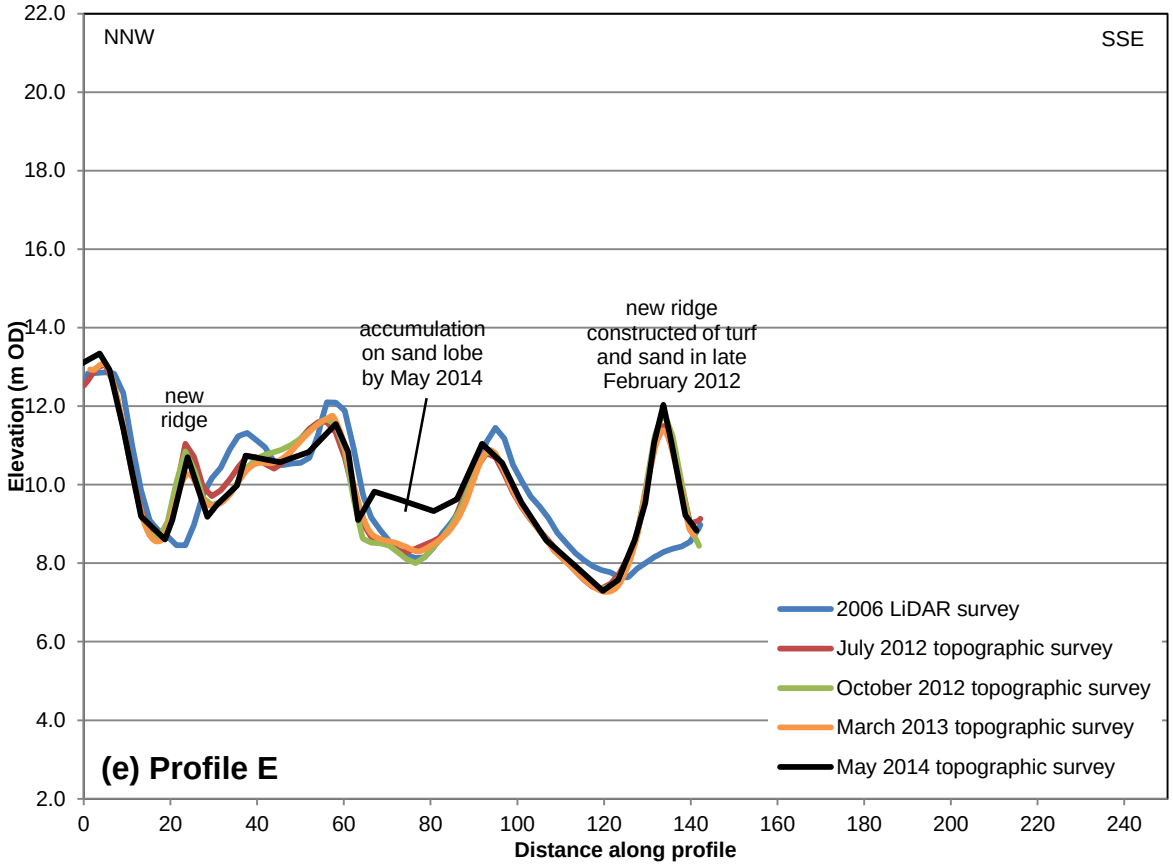
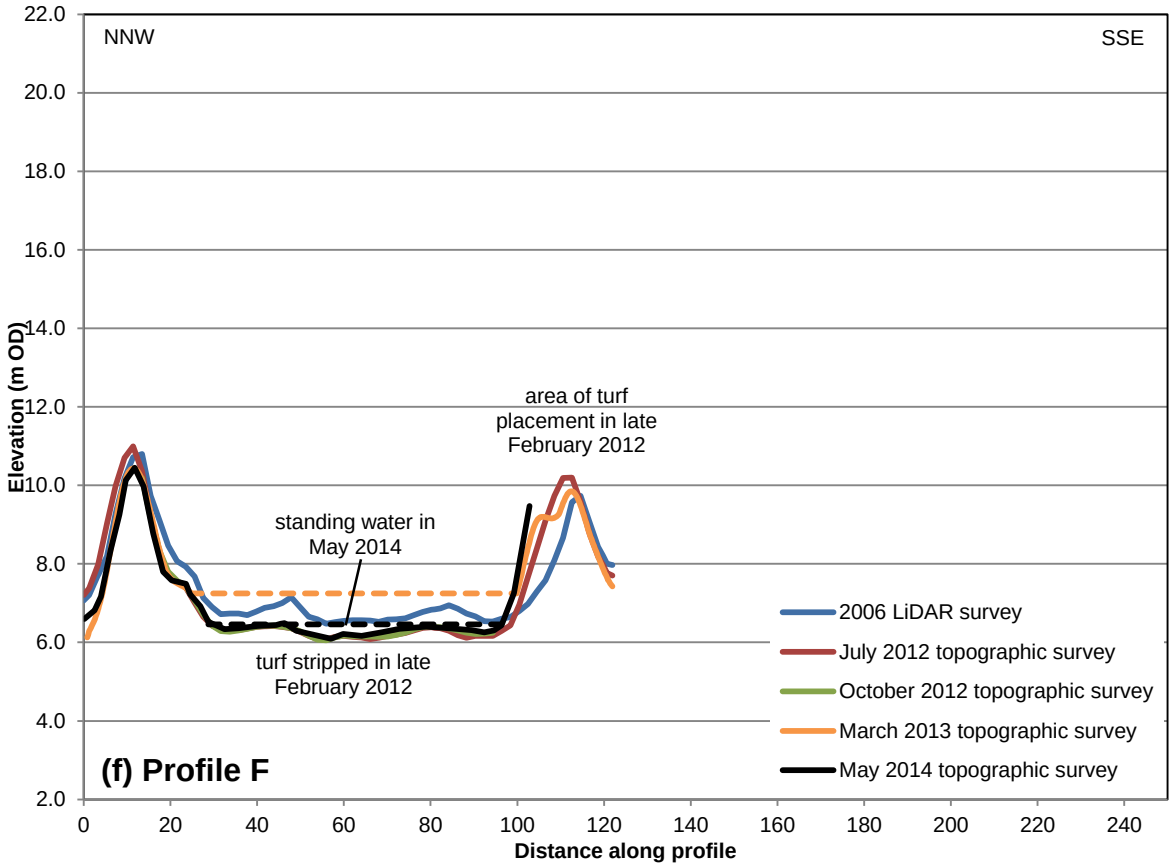


Figure 3. continued. Comparison of surface levels at profiles D and E indicated by LiDAR survey on 26/02/2006 (pre-trials) and ground surveys on 27/07/2012, 09/10/2012, 08/03/2013 and 27/05/2014.



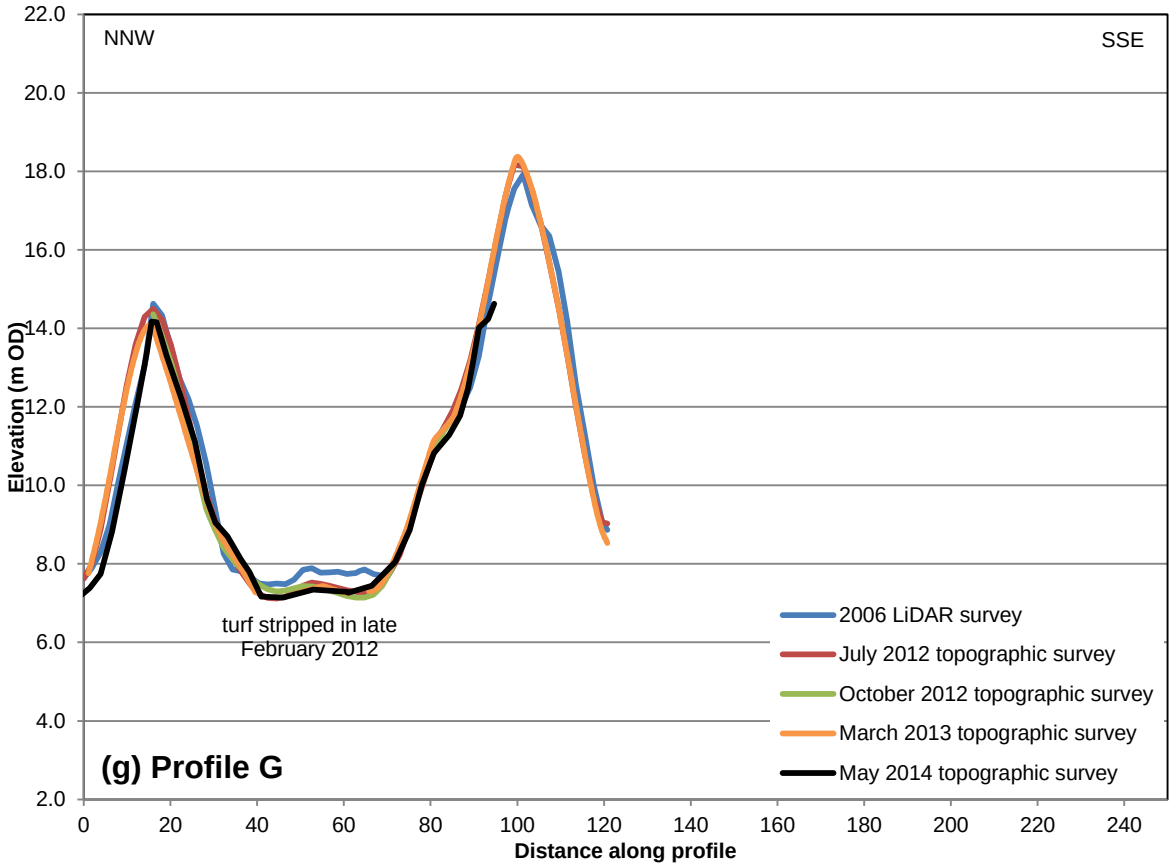


Figure 3. continued. Comparison of surface levels at profiles F and G indicated by LiDAR survey on 26/02/2006 (pre-trials) and ground surveys on 27/07/2012, 09/10/2012, 08/03/2013 and 27/05/2014.

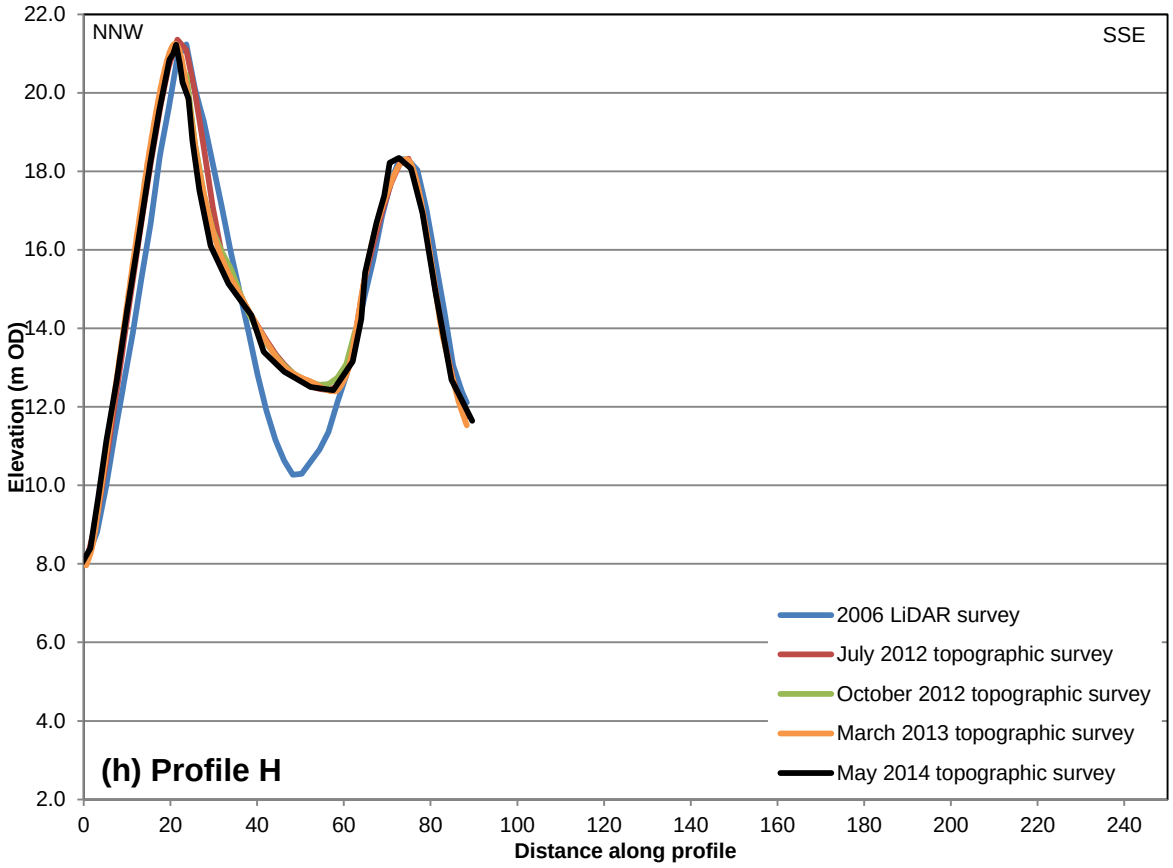


Figure 3. continued. Comparison of surface levels at profile H indicated by LiDAR survey on 26/02/2006 (pre-trials) and ground surveys on 27/07/2012, 09/10/2012, 08/03/2013 and 27/05/2014.

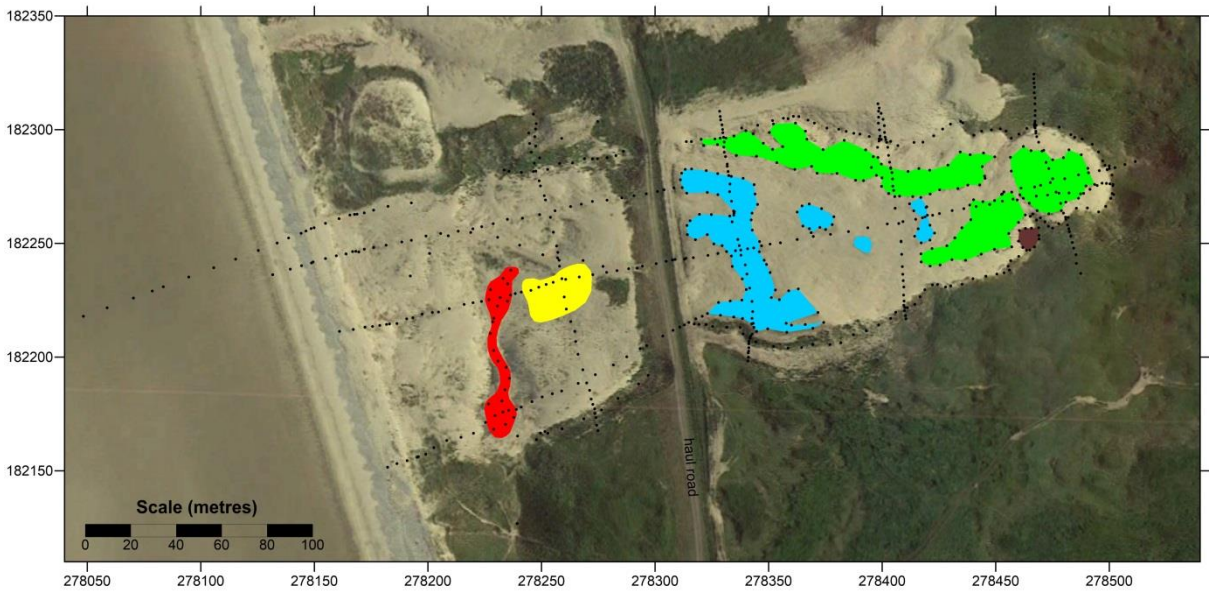


Figure 4. Aerial photograph of the Phase 1 restoration site, with features mapped on 27 May 2014: blue areas indicate standing water; green areas indicate substantial vegetation growth on previously stripped bare sand areas; brown area indicates an areas of detached blocks of vegetation which have slumped down from the edge of the dune crest above; yellow area indicates a new lobe of sand which has accumulated on the landward side of the inland dune ridge; red area indicates wind-scoured area of the inland ridge crest, elevations having dropped by approximately 1 metre between March 2013 and May 2014.

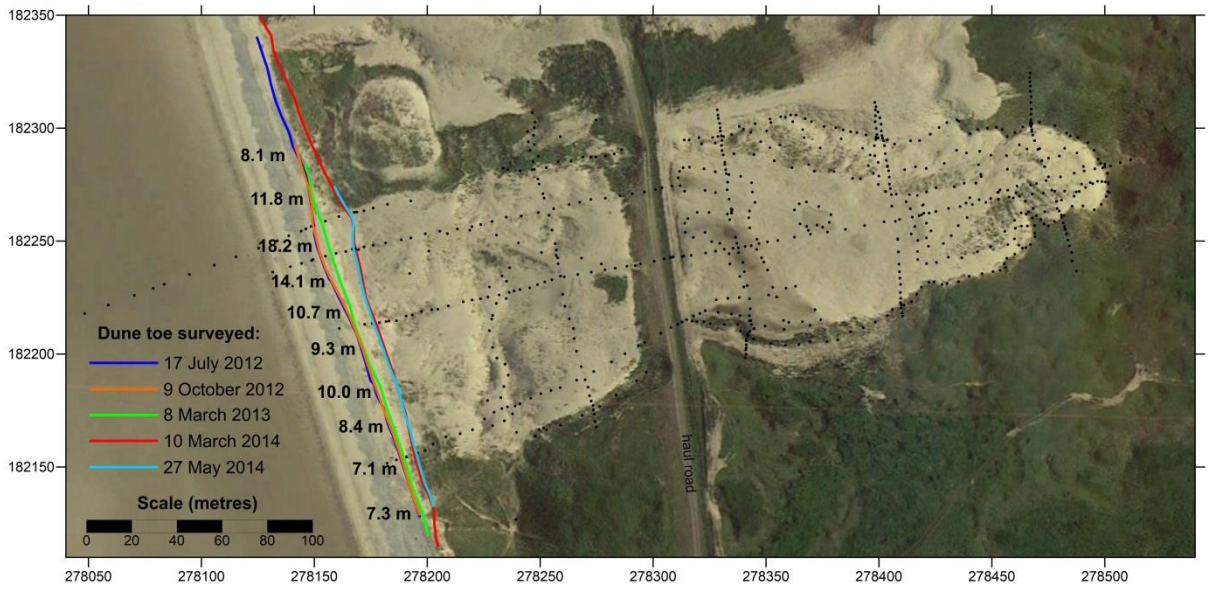


Figure 5. The position of the dune toe surveyed during ground surveys between July 2012 and May 2014. The horizontal distance of erosion between 2012 and 2014 is indicated at 10 points along the coast, ranging from 7.1 to 18.2 metres along the Phase 1 frontage.

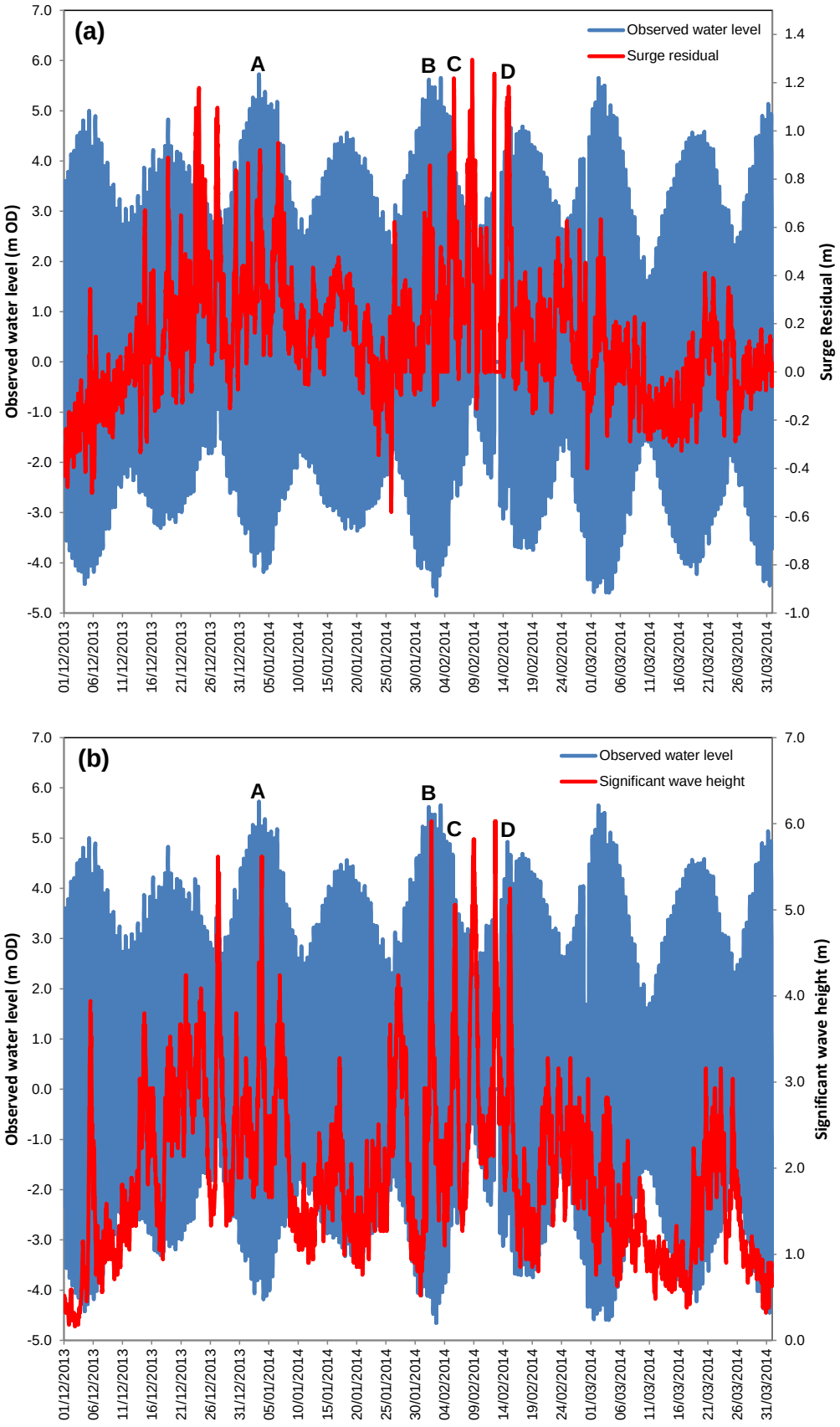


Figure 6. Observed water levels recorded at Mumbles (01/12/2013 to 31/03/2014), compared with (a) surge residual recorded and Mumbles; and (b) significant wave height recorded at Scarweather waverider buoy. The four events most likely to cause frontal dune erosion are indicated A, B, C, and D.

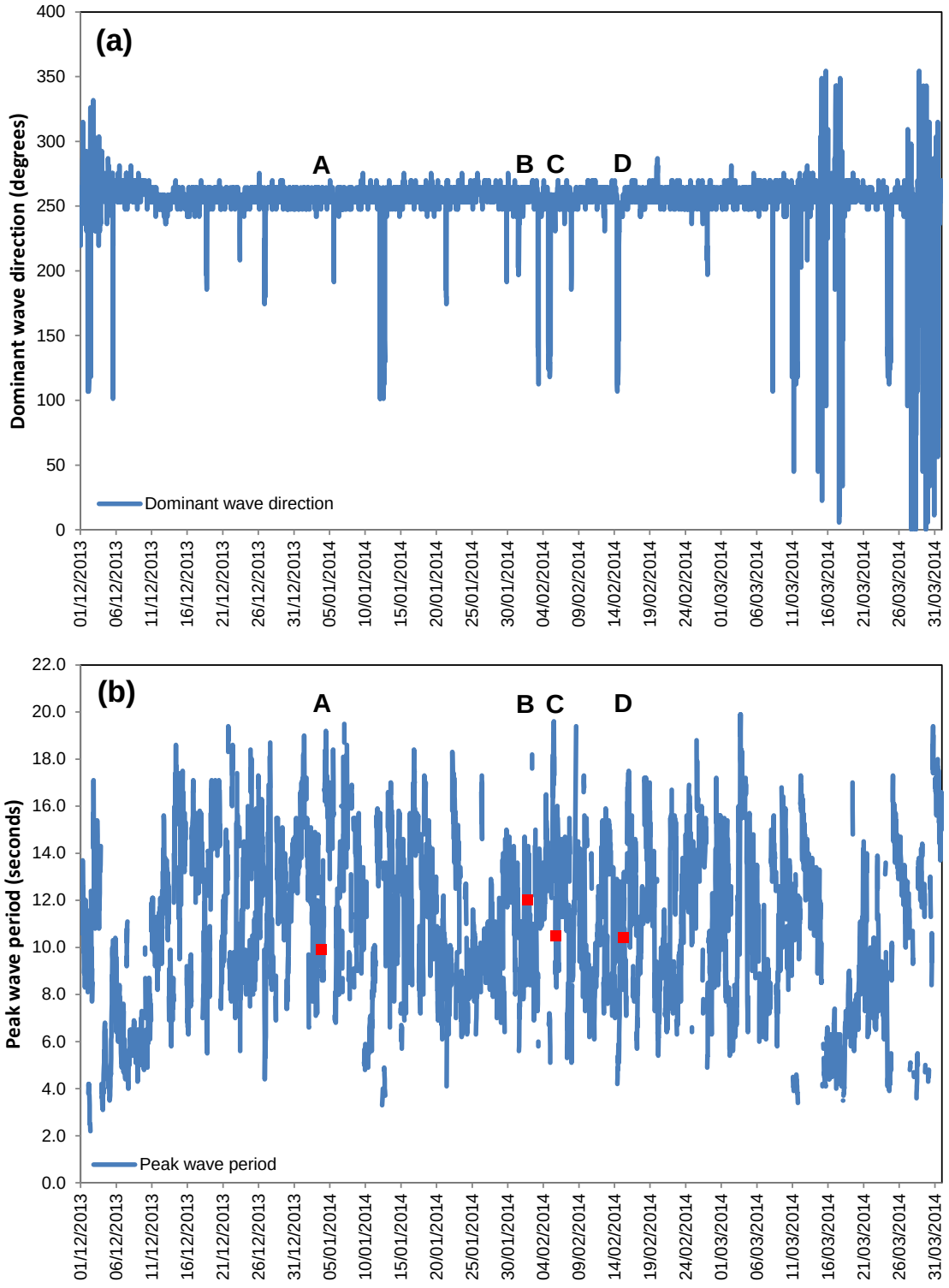


Figure 7. (a) dominant wave direction; and (b) peak wave period, recorded at Scarweather waverider buoy (01/12/2013 to 31/03/2014). The four events most likely to cause frontal dune erosion are indicated A, B, C, and D.

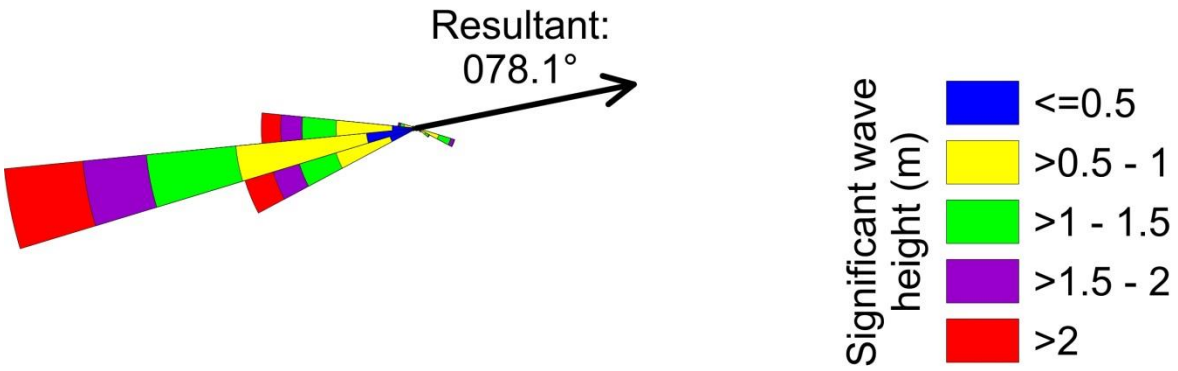


Figure 8. Wave rose, constructed from 30 minute observations of significant wave height recorded at Scarweather waverider buoy (07/09/2005 to 30/05/2014). The resultant wave direction has been scaled by the significant wave height.

9. Field photographs

Taken 27 May 2014

Photograph 1. Slight wave trimming of frontal dunes and gravel upper beach between Notch 1 and Notch 2

Photograph 2. Notch 1 looking inland

Photograph 3. Notch 1 looking seaward

Photograph 4. View inland from landward side of Notch 1

Photograph 5. Notch 2 looking landward

Photograph 6. Notch 2 looking seaward

Photograph 7. View inland from the landward side of Notch 2

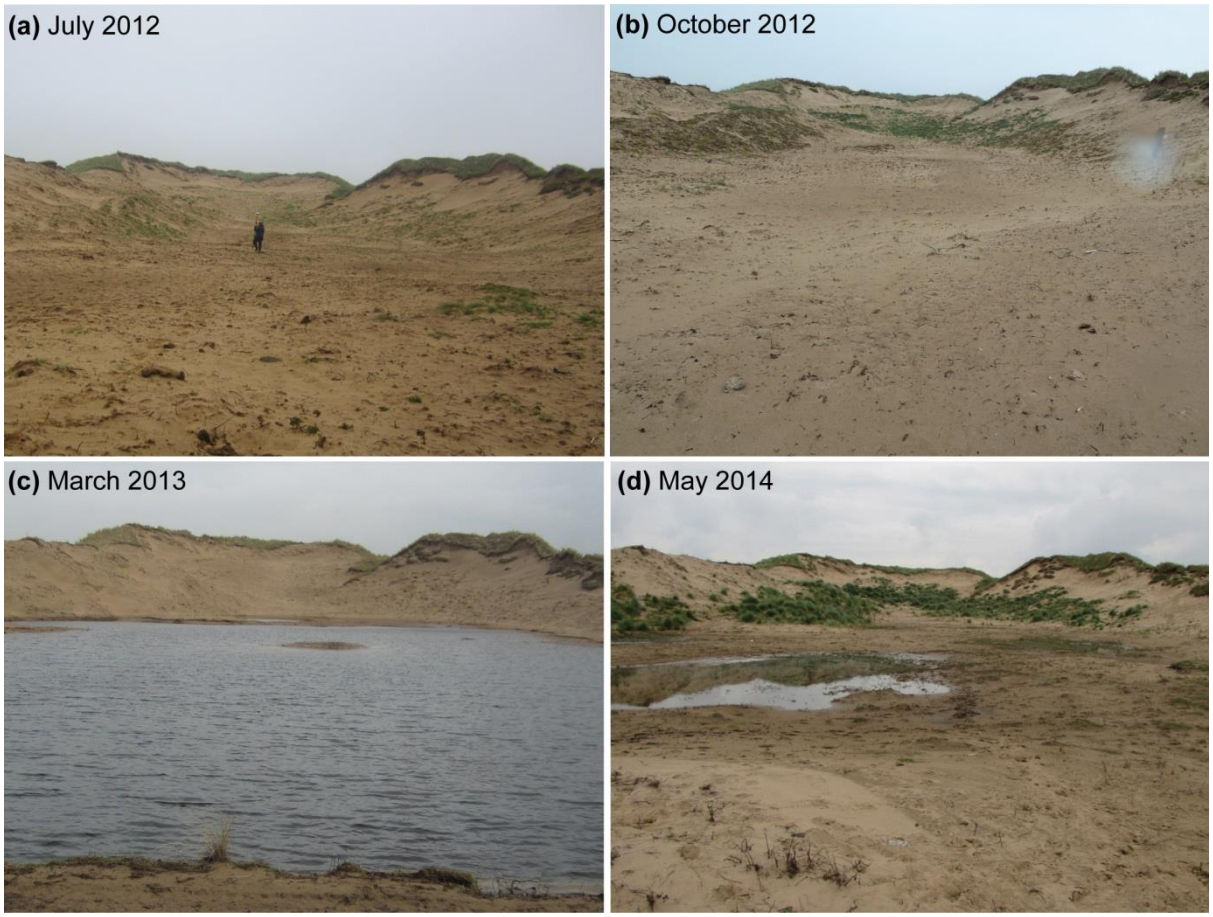
Photograph 8. Wave-eroded dune cliff between Notch 3 and Notch 4.

Photograph 9. Notch 3 looking landward.

Photograph 10. Notch 3 looking seawards

Photograph 11. Notch 4 looking landward

Photograph 12. Notch 4 looking seaward.



Photograph Comparison A. Taken from the haul road looking eastwards along the axis of the parabolic dune: (a) 17 July 2012; (b) 9 October 2012; and (c) 8 March 2013; (d) 27 May 2014.

Photograph Comparison B. Taken from the crest of the inland parabolic dune looking westwards towards the sea: (a) 17 July 2012; (b) 9 October 2012; (c) February 2013; (d) 8 March 2013; (e) 27 May 2014.

Photograph Comparison C. Taken from the crest of the summit of the high dune at the southern end of the site, looking north-west: (a) March 2012, shortly after the works were completed, supplied by David Carrington (Bridgend Council); (b) 17 July 2012; (c) February 2013; (d) 8 March 2013; (e) 27 May 2014.

Photograph Comparison D. Taken from the crest of the summit of the high dune at the southern end of the site, looking north: (a) March 2012; (b) 17 July 2012; (c) 8 March 2013; (d) 27 May 2014.

Data Archive Appendix

Data outputs associated with this project are archived at ‘Kenfig Dune Restoration; project 420, media 1490’ on server–based storage at Natural Resources Wales.

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] An Excel file named (Kenfig Burrows Survey 10-03-2014.xls) of data points (x,y,z)

Metadata for this project is publicly accessible through Natural Resources Wales’ Library Catalogue http://libcat.naturalresources.wales/webview/ (English Version) and http://libcat.naturalresources.wales/cnc/ (Welsh Version) by searching ‘Dataset Titles’. The metadata is held as record no [115776]

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