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Newborough Phase 2 Site: Zone 1 East Dune Rejuvenation Works Topographic Survey Report

Kenneth Pye & Simon J. Blott

Kenneth Pye Associates Ltd

Report No: 102

Date: March 2015



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Our purpose is to ensure that the natural resources of Wales are sustainably maintained, used and enhanced, now and in the future.

We work for the communities of Wales to protect people and their homes as much as possible from environmental incidents like flooding and pollution. We provide opportunities for people to learn, use and benefit from Wales' natural resources.

We work to support Wales' economy by enabling the sustainable use of natural resources to support jobs and enterprise. We help businesses and developers to understand and consider environmental limits when they make important decisions.

We work to maintain and improve the quality of the environment for everyone and we work towards making the environment and our natural resources more resilient to climate change and other pressures.

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Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 East) Topographic Survey, March 2015

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1. Job Summary

KPAL Job No: 270315
Report Date: 24/08/2015
Client: Natural Resources Wales
Client Job Title: Newborough Dune Rejuvenation Works: Phase 2 Zone 1 East

Survey conducted: 26th March 2015
Instruments used: Leica Viva NetRover controller and GS08 SmartAntenna mounted on GLS30 pole (2 m)
Leica RX900 controller and ATX900 antenna mounted on GLS30 pole (2 m)
Leica GX1230 RTK base station mounted on GST20-9 tripod
Leica RX1210T Field Controller

No. of data points: 850
RTK Control Station: Wooden post surveyed-in using Leica Smartnet GPRS on 26 March 2015 (BM6), positioned on the highest vegetated (i.e. not stripped) part of the frontal dune in the area, between Notches A and B:
Easting: 240775.551 m
Northing: 363248.476 m
Height: 14.079 m OD

RTK Backup Station: Wooden post surveyed-in using Leica Smartnet GPRS on 25 March (BM2) (see Table 2).

Fixed profiles: Nine profile lines were surveyed, and compared with data surveyed before the restoration works using airborne LiDAR survey on 9 April 2014. Chainages along profile lines were interpolated at positions on a theoretical straight-line between the zero and end points of the profile. Note that the eastern continuation of Profile 9 covers the adjacent Phase 3 site.

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

2. Scope and purpose

Phase 1 dune rejuvenation trials at Newborough Warren commenced in January 2013 and involved (a) stripping of vegetation from the windward dune slopes, crests and parts of the arms and deflation corridors, (b) excavation of sand to deepen parts of the deflation corridors to encourage the development of wet slack habitat, and (c) placement of stripped turf blocks in areas on and behind the dune arms. Phase 2 works commenced in areas identified in the Newborough Forest Management Plan as Zone 1 West and Zone 1 East (see Figure 1) during 2014. Some additional work in Zone 1 East was undertaken in early 2015. The works at Zone 1 East (Traeth Llandwyn) have involved (a) the creation / enlargement of three 'notches' in the frontal dune to allow wind flow and sand movement from the beach into the back dune area, (b) removal of areas of coniferous pine plantation (including de-stumping), and (c) localised turf stripping. A baseline airborne LiDAR survey was undertaken in April 2014. This report provides a summary of a post-works ground topographic survey carried out at Zone 1 East in March 2015, and comparisons which have been made with the April 2014 LiDAR survey.

3. Survey methods and error checking

In the March 2015 survey ground surface elevations were determined at 850 points using Leica RTK GPS SmartRover equipment listed in the Job Summary (Section 1.0) above. The distribution of survey points is shown in Figures 2 and 3. Many of the survey points were located on profile lines, chosen to measure elevations along the axes of the new notches, across the frontal dune between the notches, and along transects across the new notches. The limits of defined features, including areas stripped of vegetation, areas of windblown sand (where present), the main dune crest and base of slopes, any areas of standing water, and the position of the dune toe, were also mapped by survey points.

Average vertical and horizontal errors reported by the instrument during the March 2015 survey were well within the expected range (Table 1).

Measuring of the position and elevation of Benchmark 2 using the two instrumental set-ups (using Leica SmartNet corrections and using the base and rover set-up) showed a vertical difference of just 12 mm, which is within the errors expected for RTK GPS technique, due largely to atmospheric effects (Table 2).

Ground photographs were taken at a number of locations around the site; a selection is reproduced in Appendix 1.

4. Sediment particle size analysis

During the topographic survey a number of surface sand samples were collected for particle size analysis by dry sieving. Two samples of upper beach sediment were collected (NW35 and NW39) for comparison with the dune sands. Sampling locations are shown on Figure 4. The particle size data were processed using Gradistat software (Blott & Pye, 2001) and the

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sediments classified using the statistical summary parameters and terminology proposed by Folk (1954), Folk & Ward (1957) and Blott & Pye (2012).

5. Results - particle size analysis

All of the dune samples collected can be classified as very well sorted or well sorted fine sand (Tables 3 & 4). Only one sample contained a small quantity (< 0.1% of) silt. The median size showed a narrow range of variation (187 to 214 microns). Material of this size is easily moved by the wind.

One sample of upper beach sand (NW35) was found to be finer grained than the dune sands (a well sorted fine sand with D50 of 150 microns), and one sample (NW39) was found to be coarser than the dune sands (a poorly sorted coarse sand containing 16.2% gravel).

6. Results - profile comparisons

The locations of survey points and profile lines selected for comparison with April 2014 LiDAR are shown in Figure 5. The profiles themselves are shown in Figure 6. Areas of turf stripping and sand deposition are also demarcated on Figure 5.

Prior to commencement of the works, the frontal dune along the Zone 1 East frontage was relatively continuous with a crest height ranging between 8m and 12 m OD (Figures 6a to 6f). The lowest points in the ridge were at the western end where paths had been created by pedestrians seeking access to the beach (Figure 6b). Comparison of the 2009 and 2014 LiDAR coverage available for the northwestern part of Zone 1 East clearly shows the significant extent of erosion which occurred in the intervening period, and particularly during the stormy winter of 2013-14. The erosion completely removed a 20 to 30 m wide foredune platform present along frontage before 2013 and caused cliffing of the higher frontal dune ridge behind near profiles 5 and 6 (e.g. Figure 6f).

Notches A, B and C were created within a formerly continuous section of frontal dune ridge. Profile 3 along the axis of notch A shows that this notch was created with a relatively gently sloping, slightly convex long profile with a crest located at the back of the frontal dune ridge (Figure 6c). Notch B was created with a steeper seaward slope, a crest mid-way along the notch, and a long gently sloping landward slope (Figure 6d). Notch C was created with a markedly convex long profile with a crest position towards the back of the notch (Figure 6e). All three notches as created were relatively wide in relation to their depth (Figures 6g and 6h).

The area behind the frontal dune ridge in Zone 1 East consists of a series of low parabolic dune ridges (reaching 8 to 10 m OD) with intra-dune deflation corridors. During clearance of the forest only a small thickness of surface sand was disturbed and the nature of the pre-existing dune topography was generally well preserved (Figure 6i).

By the time of survey in March 2015 only relatively minor post-works changes were evident at Zone 1 East. These include some apparent widening of the notches, deposition of sand in lobes behind the notches, remobilization of the surface sand from parts of the clear-felled and de-stumped areas, and accumulation of blown sand as thin (< 30 cm) sheets and low

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mounds at the back of the site, including just within the new forest boundary (see photographs in Appendix 1).

The total area of substantially bare sand at the time of survey was approximately 3.54 ha (Table 5).

7. References

Blott, S.J. and Pye, K. (2001) GRADISTAT: a grain size distribution and statistics package for the analysis of unconsolidated sediments. *Earth Surface Processes and Landforms*, 26, 1237-1248.

Blott, S.J. & Pye, K. (2012) Particle size scales and classification of sediment types based on particle size distributions: review and recommended procedures. *Sedimentology*, 59, 2071-2096.

Folk, R.L. (1954) The distinction between grain size and mineral composition in sedimentary-rock nomenclature. *Journal of Geology*, 62, 344-359.

Folk, R.L. and Ward, W.C. (1957) Brazos river bar: a study in the significance of grain size parameters. *Journal of Sedimentary Petrology*, 27, 3-26.

8. Tables

Table 1. Average error reported by the instrument for all 850 data points

	1-D quality control (height)	2-D quality control (position)	3-D quality control (position and height)
Average	9.5 mm	6.2 mm	11.3 mm
StDev	2.8 mm	1.5 mm	3.1 mm

Table 2. Measured location and height of Benchmark 2 (wooden post)

	Easting (m)	Northing (m)	Height (m OD)
Surveyed with Smartnet corrections (25 March 2013)	241080.456	363100.465	14.023
Surveyed with base & rover start of survey (25 March 2013)	214080.457	363100.470	14.011
Difference:	+1 mm	+5 mm	-12 mm

Table 3. Particle size characteristics of dune samples collected at the Zone 1 East site on 26 March 2015. Statistics are calculated using GRADISTAT software (Blott & Pye, 2001), mean and sorting using the formulae of Folk & Ward (1957). NW35 and NW39 are upper beach sediment samples.

ID	Mean (μm & class)	D50 (μm)	Mode (μm)	Mean (phi)	Sorting (phi & description)	Gravel (%)	Sand (%)	Mud (%)
NW30	211 FS	211	215	2.25	0.27 VWS	0.0	100.0	0.0
NW31	189 FS	196	215	2.40	0.30 VWS	0.0	100.0	0.0
NW33	207 FS	207	215	2.27	0.23 VWS	0.0	100.0	0.0
NW35	150 FS	149	152.5	2.74	0.42 WS	0.0	100.0	0.0
NW36	187 FS	193	215	2.42	0.31 VWS	0.0	100.0	0.0
NW37	193 FS	199	215	2.38	0.35 VWS	0.0	100.0	0.0
NW38	195 FS	201	215	2.36	0.39 WS	0.0	99.9	0.1
NW39	546 CS	319	302.5	0.87	1.91 PS	16.2	83.8	0.0
NW40	205 FS	208	215	2.29	0.30 VWS	0.0	100.0	0.0
NW41	214 FS	213	215	2.22	0.40 WS	0.0	100.0	0.0

Mean Size Classification:

VCG (very coarse gravel)
 CS (coarse sand)
 MS (medium sand)
 FS (fine sand)
 VFS (very fine sand)

Sorting Descriptions:

VWS (very well sorted)
 WS (well sorted)
 MWS (moderately well sorted)
 MS (moderately sorted)
 PS (poorly sorted)
 VPS (very poorly sorted)

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Table 4. Sediment textural classifications, according to Folk (1954) and Blott & Pye (2012), from the samples collected on 25-26 March 2015.

ID	Easting	Northing	Folk (1954)	Blott and Pye (2012)
NW30	240789	363363	Sand	Sand
NW31	240738	363276	Sand	Sand
NW33	240715	363258	Sand	Sand
NW35	240752	363233	Sand	Sand
NW36	240742	363364	Sand	Sand
NW37	240762	363271	Sand	Sand
NW38	240785	363338	Sand	Sand
NW39	240858	363173	Gravelly Sand	Slightly gravelly sand
NW40	240878	363242	Sand	sand
NW41	240904	363312	Sand	sand

Table 5. Areas of bare sand at Zone 1 East. Note that small areas of blown sand entering the forest were not surveyed due to the lack of GPS signal beneath the trees. Small remaining clumps of unstripped vegetation have also not been included.

Bare sand type	Area (ha)
Vegetation-stripped	3.50
Significant sand deposition in heaps	0.00
Blown sand	0.03
Total	3.54

9. Figures

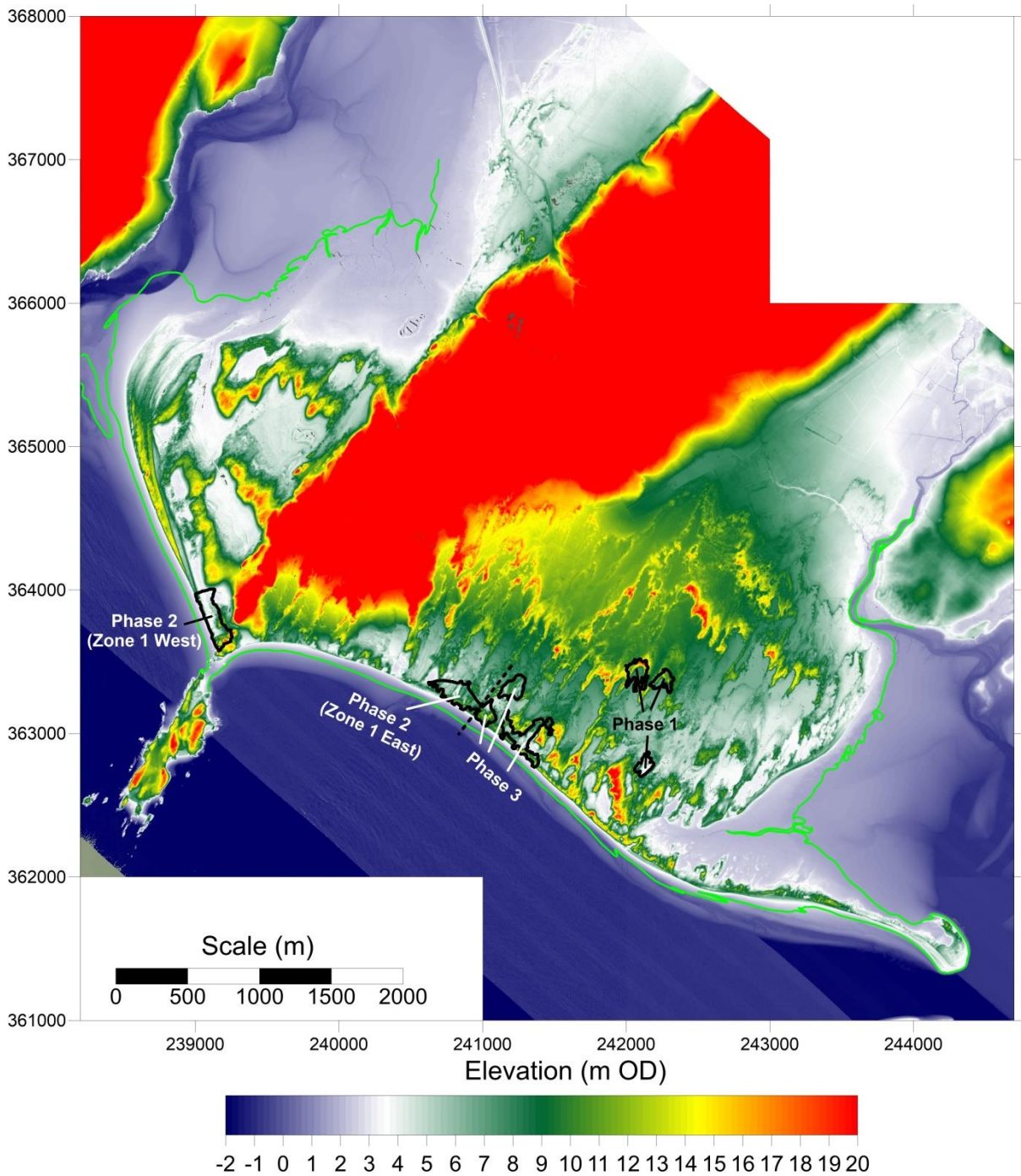


Figure 1. Locations of Phases 1, 2 and 3 dune rejuvenation works at Newborough Warren, overlaid on LiDAR DEM flown on 9 April 2014.

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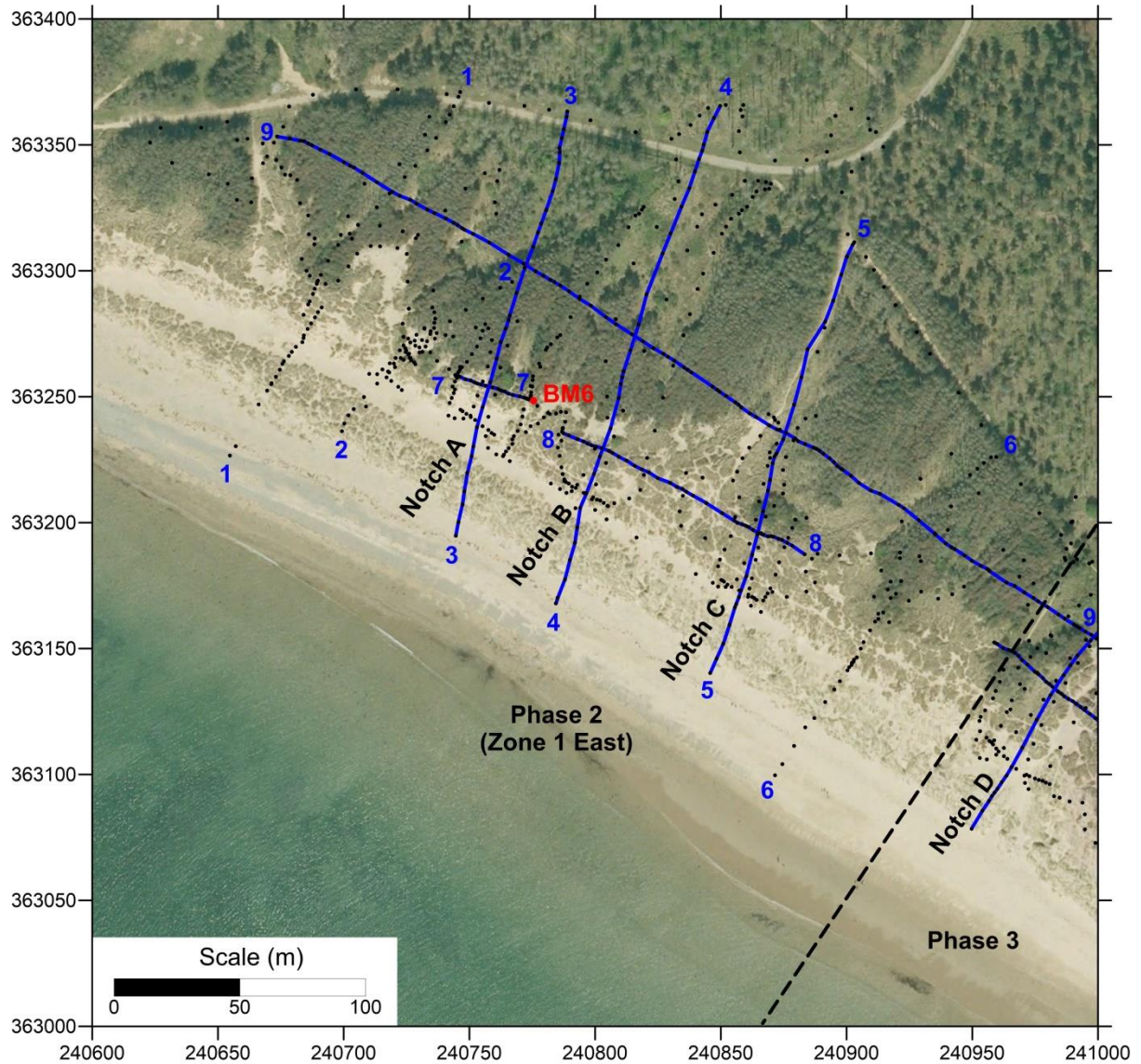


Figure 2. Locations of March 2015 data points (black dots), benchmark BM6 (red dot) and cross-profiles (blue lines) in the Phase 2 area (Zone 1 East), overlaid on air photographs flown 11 May 2009.

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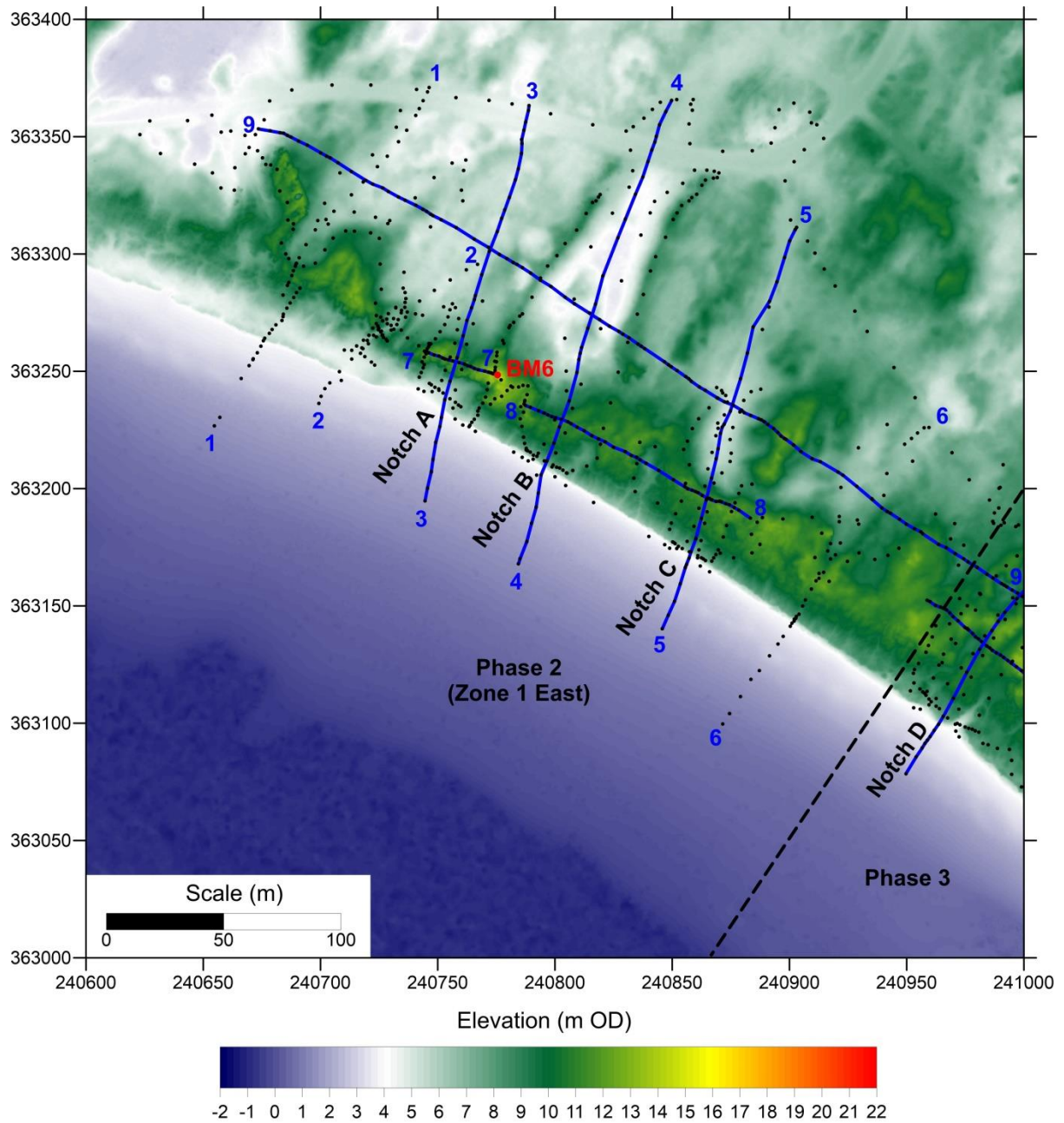


Figure 3. Locations of March 2015 data points (black dots), benchmark BM6 (red dot) and cross-profiles (blue lines) in Phase 2 area (Zone 1 East), overlaid on LiDAR DEM flown on 9 April 2014.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 East) Topographic Survey, March 2015

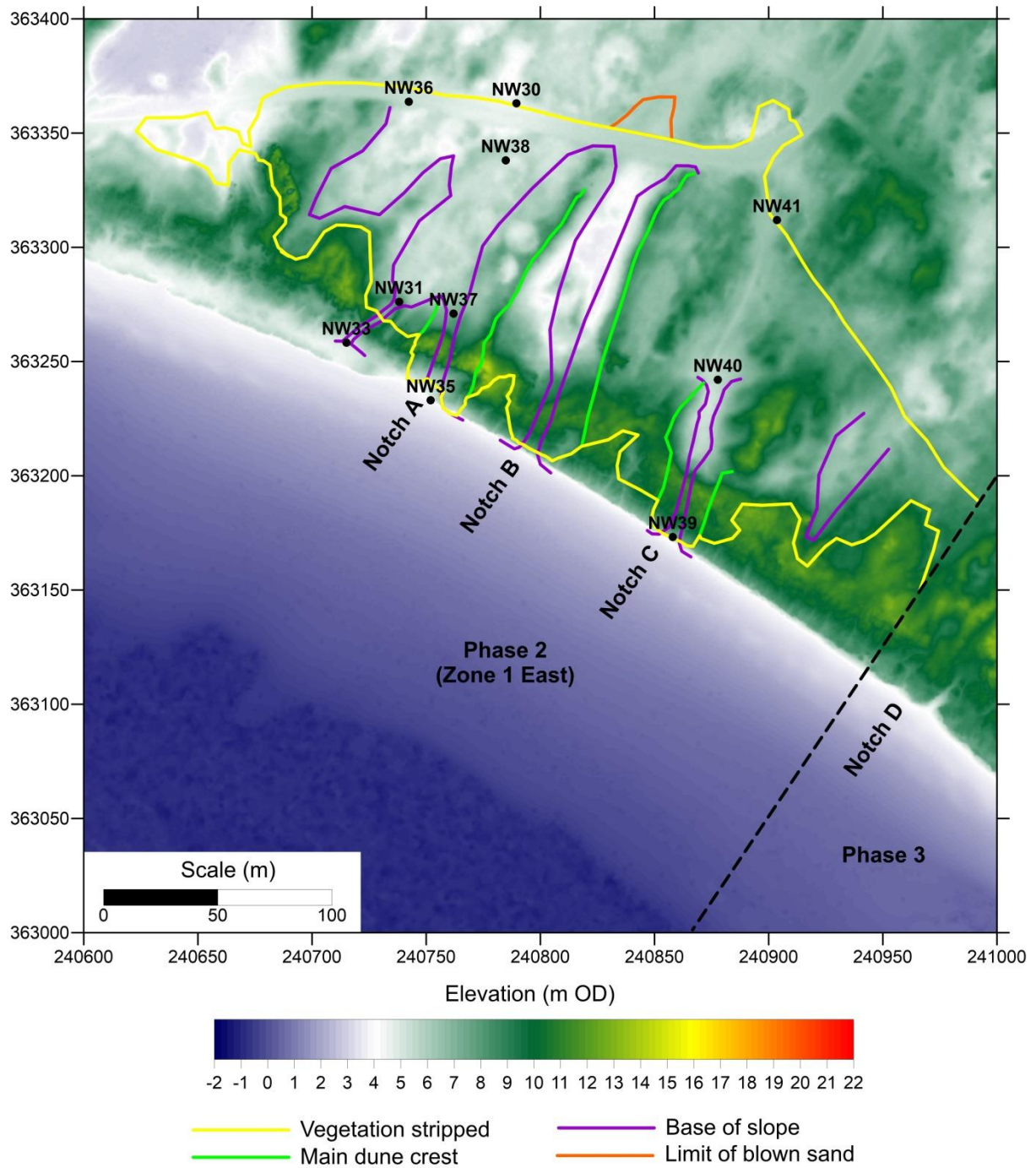


Figure 4. Locations of sediment samples collected in the Phase 2 area (Zone 1 East), overlaid on LiDAR DEM flown on 9 April 2014, with features mapped from Figure 5.

Newborough Dune Rejuvenation Works: Phase 2 (Zone 1 East) Topographic Survey, March 2015

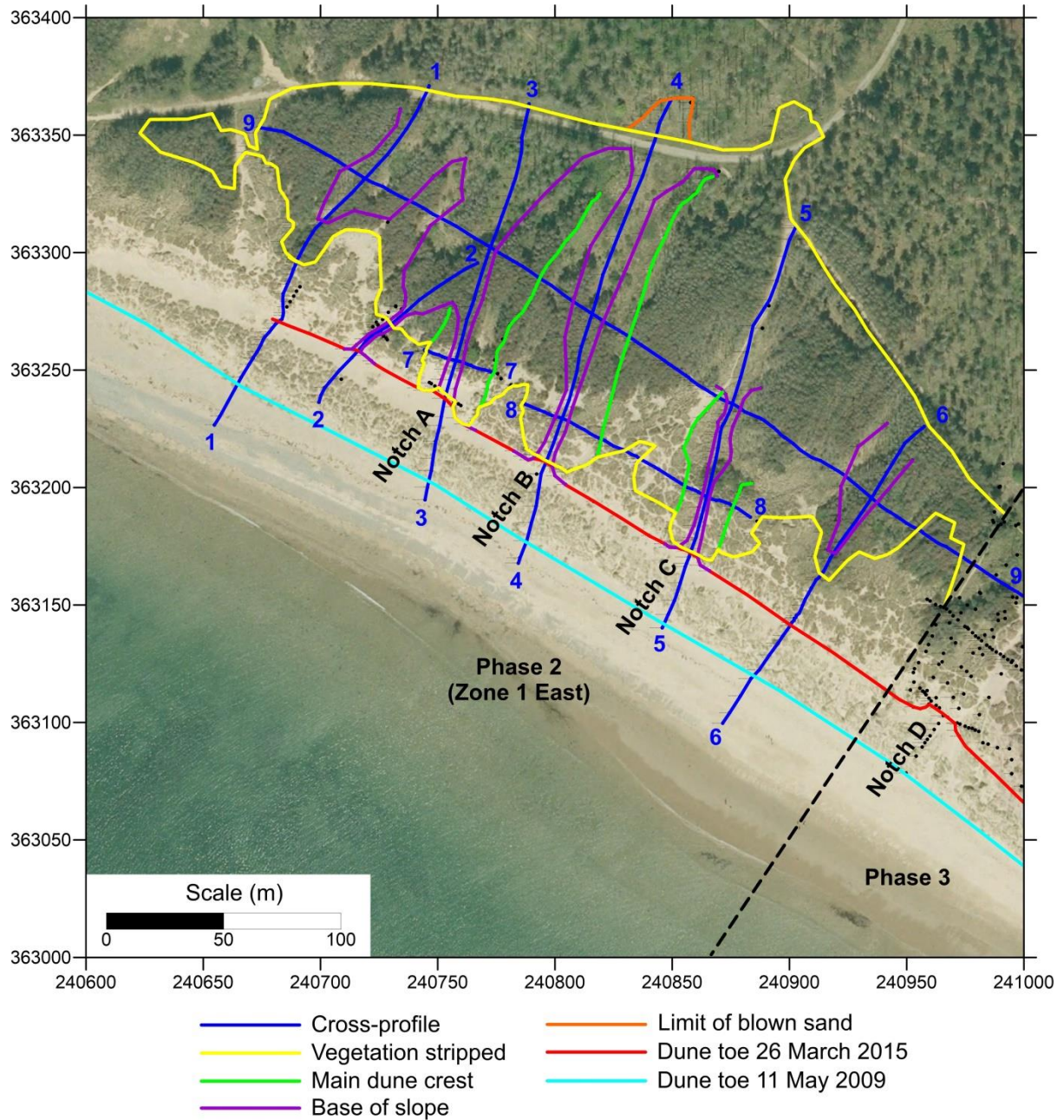


Figure 5. Locations of March 2015 data points (black dots) and cross-profiles (dark blue lines) in Area 2, overlaid on May 2009 aerial photographs. The limit of vegetation stripping, blown sand, the main dune crests base of slopes and positions of the dune toe surveyed in March 2015 are also shown. For comparison, the position of the dune toe from the 2009 air photographs is also shown.

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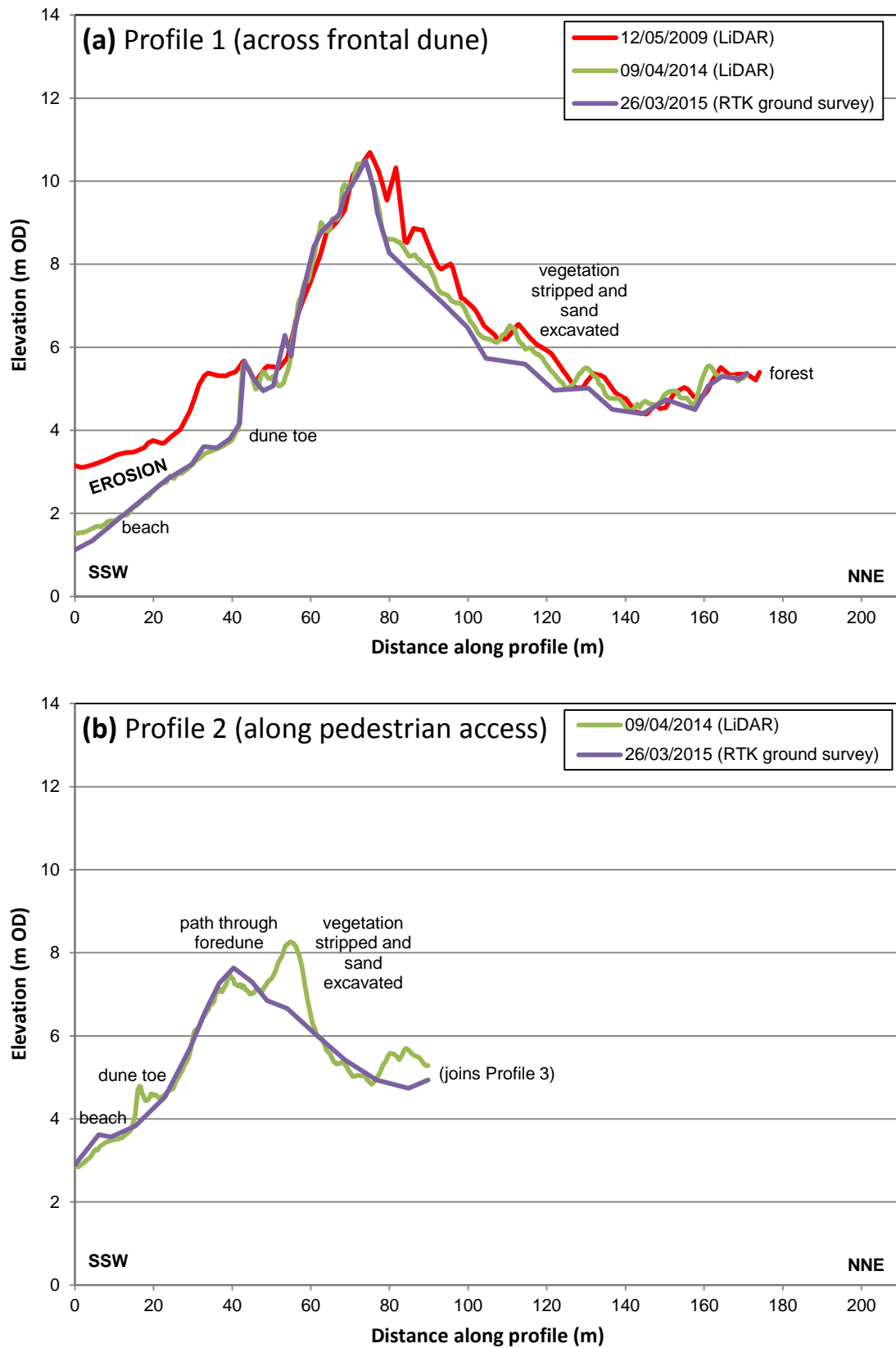


Figure 6. Comparison of surface levels at profiles 1 and 2, indicated by LiDAR survey on 9 April 2014 (pre-works) and ground survey on 26 March 2015. To illustrate the effect of coastal erosion during the 2013-14 winter, Profile 1 is also compared to LiDAR data surveyed on 12th May 2009.

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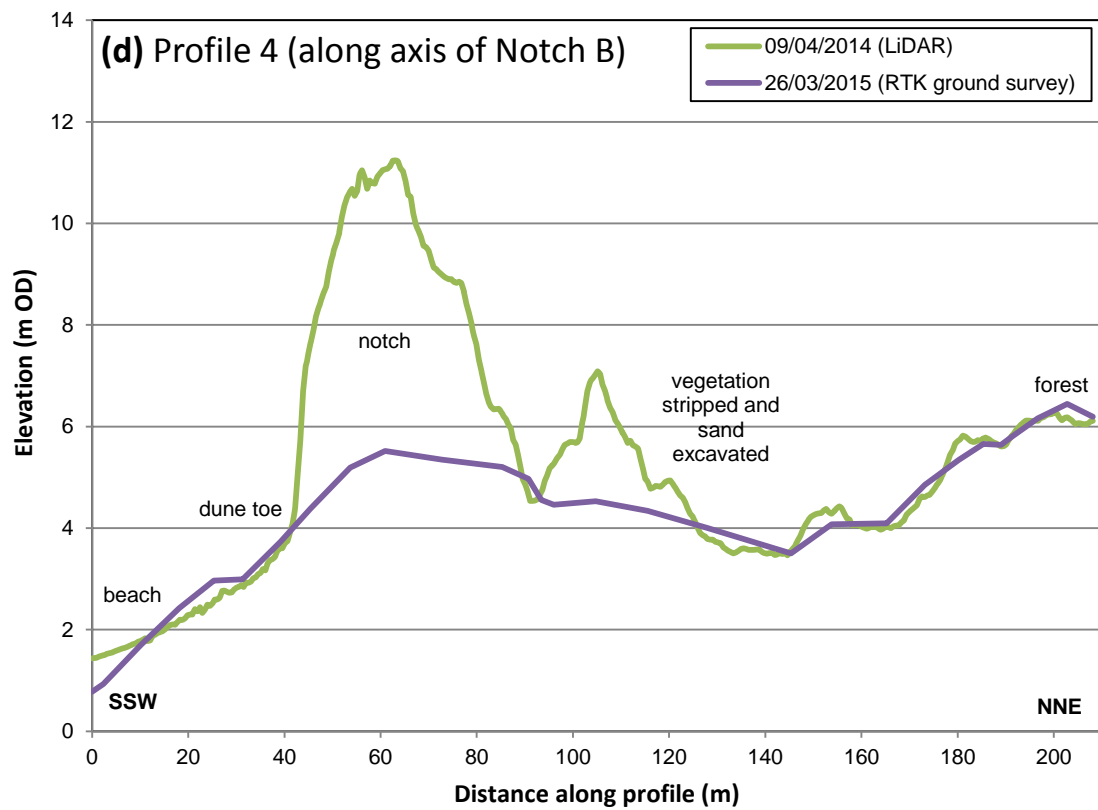
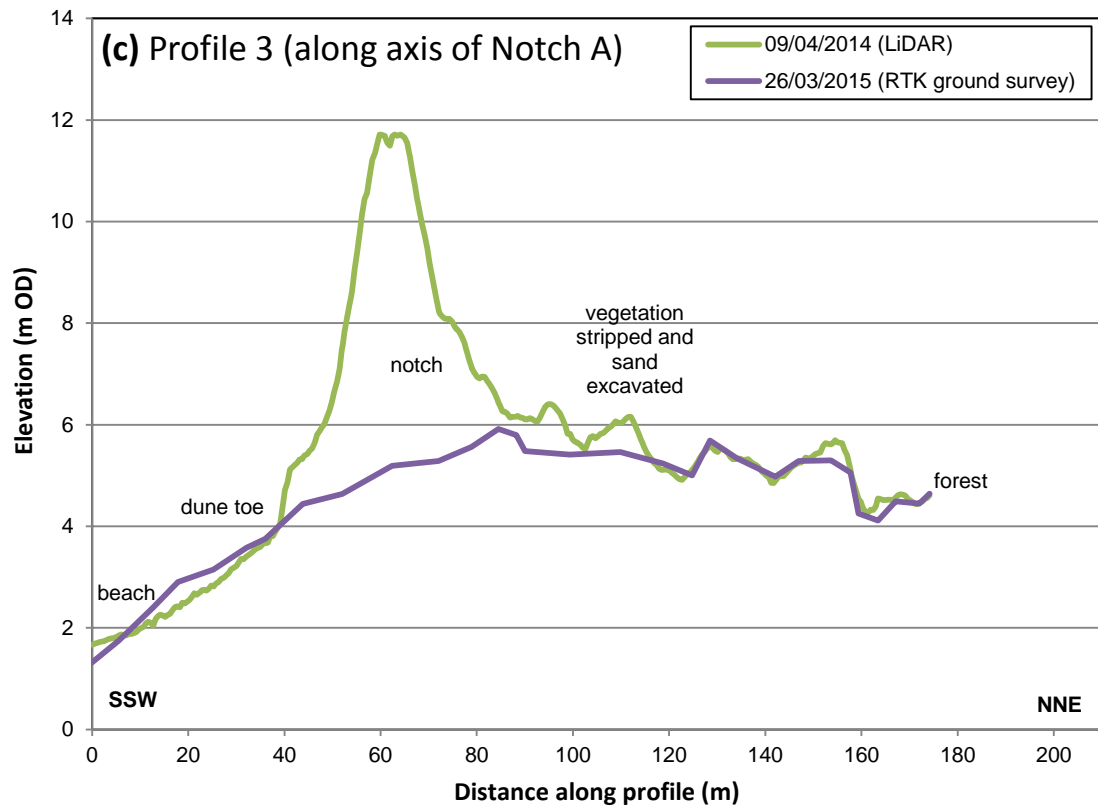


Figure 6 (continued). Comparison of surface levels at profiles 3 and 4, indicated by LiDAR survey on 9 April 2014 (pre-works) and ground survey on 26 March 2015.

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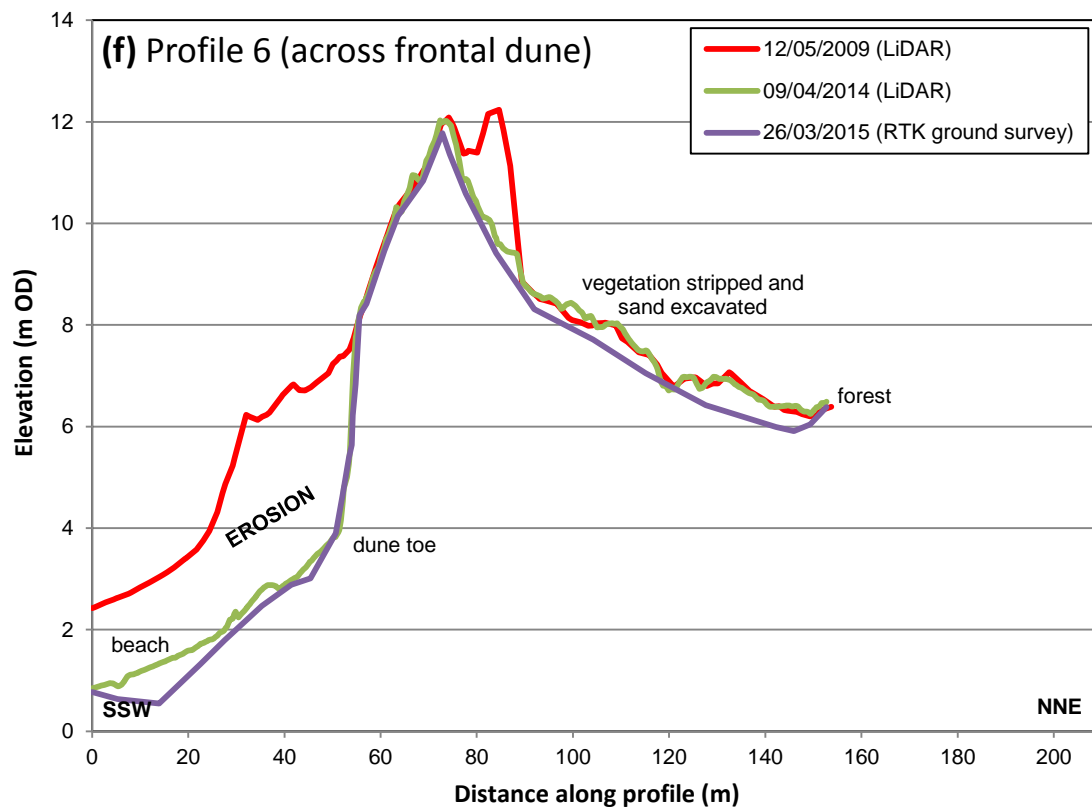
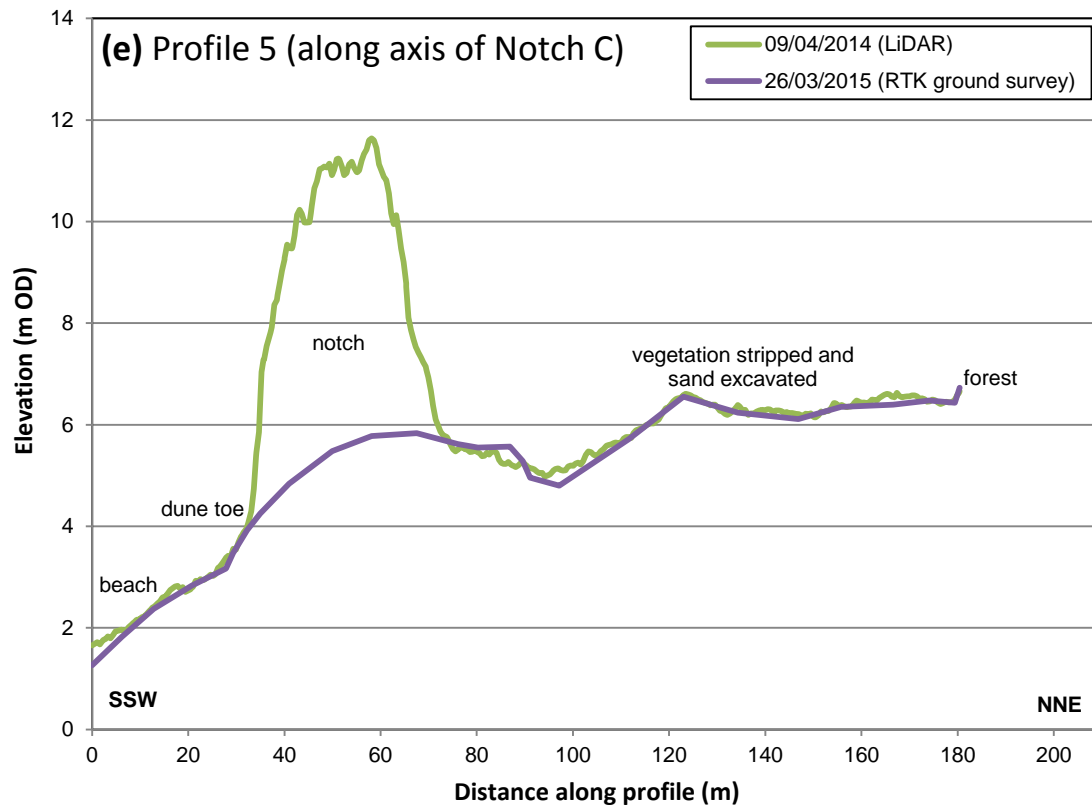


Figure 6 (continued). Comparison of surface levels at profiles 5 and 6, indicated by LiDAR survey on 9 April 2014 (pre-works) and ground survey on 26 March 2015. To illustrate the effect of coastal erosion during the 2013-14 winter, Profile 6 is also compared to LiDAR data surveyed on 12th May 2009.

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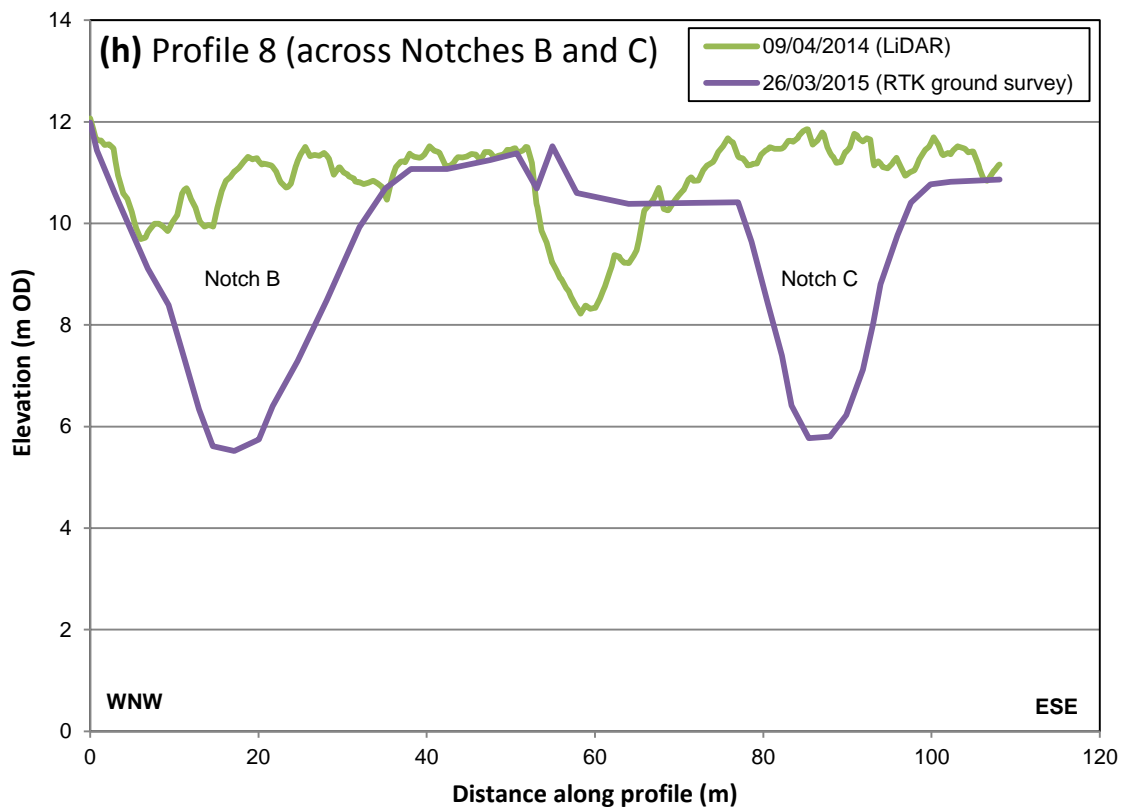
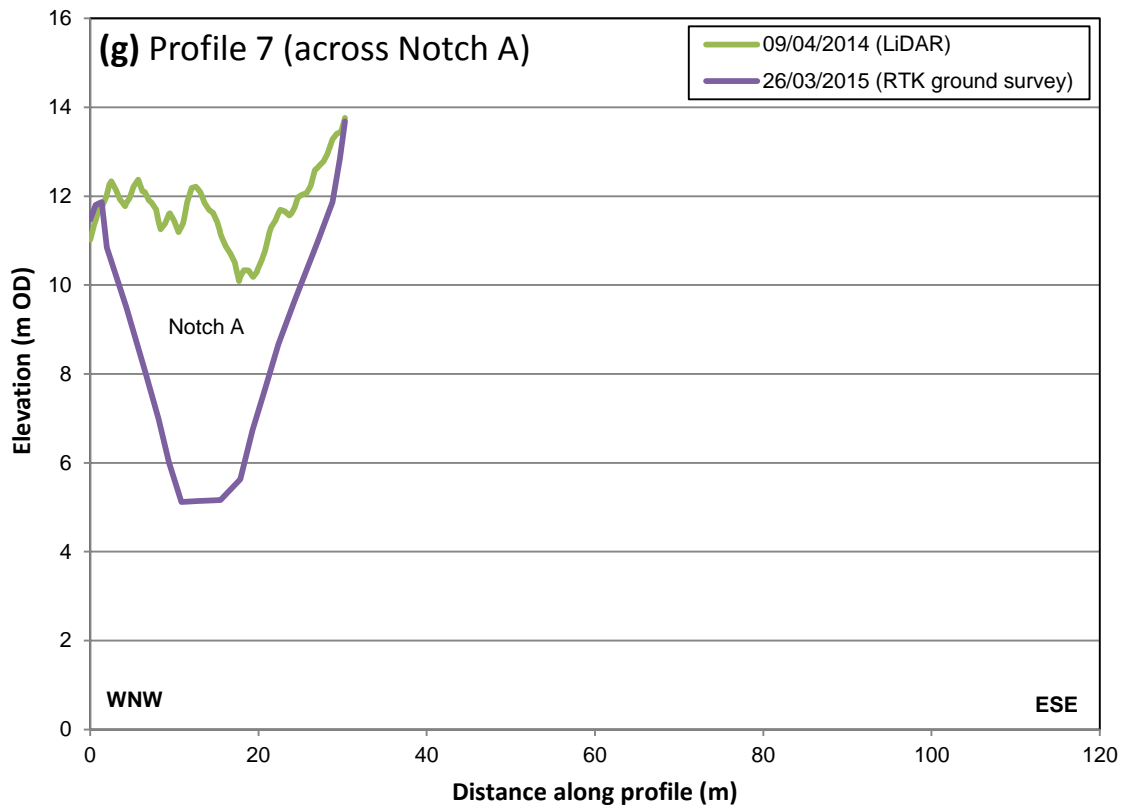


Figure 6 (continued). Comparison of surface levels at profiles 7 and 8, indicated by LiDAR survey on 9 April 2014 (pre-works) and ground survey on 26 March 2015.

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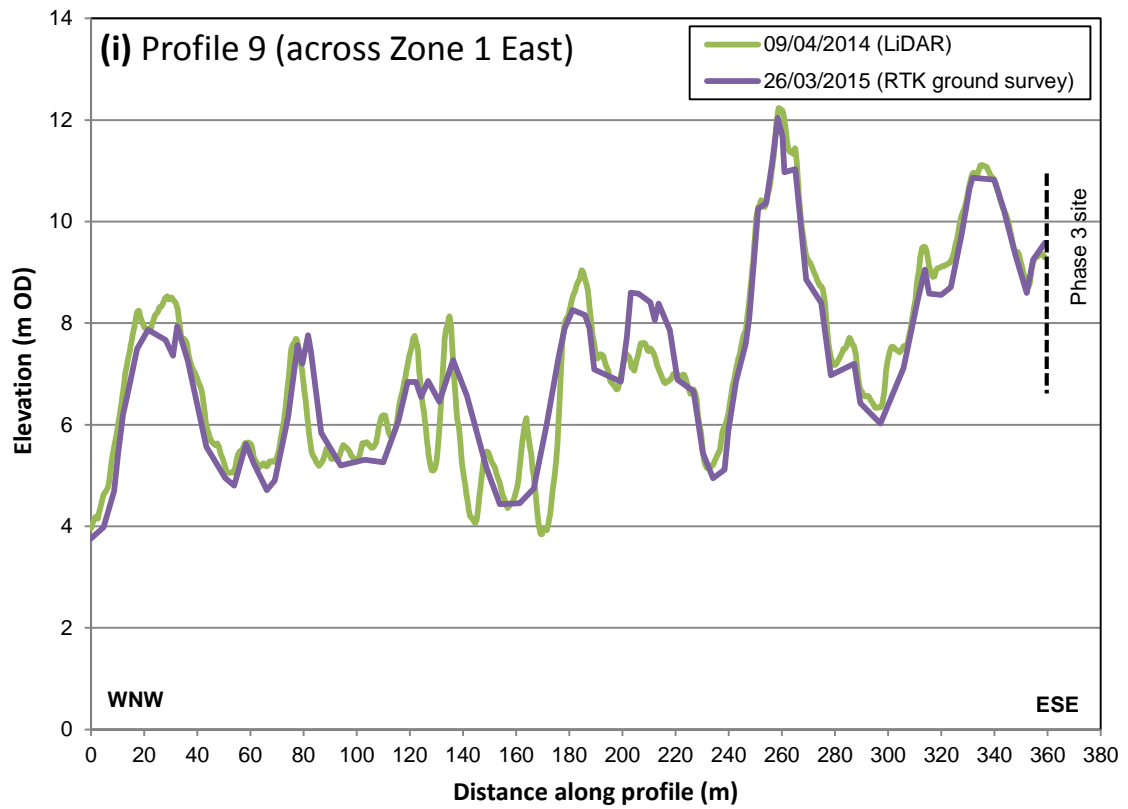


Figure 6 (continued). Comparison of surface levels at profile 9, indicated by LiDAR survey on 9 April 2014 (pre-works) and ground survey on 26 March 2015.

10. Field photographs

Taken 26 March 2015

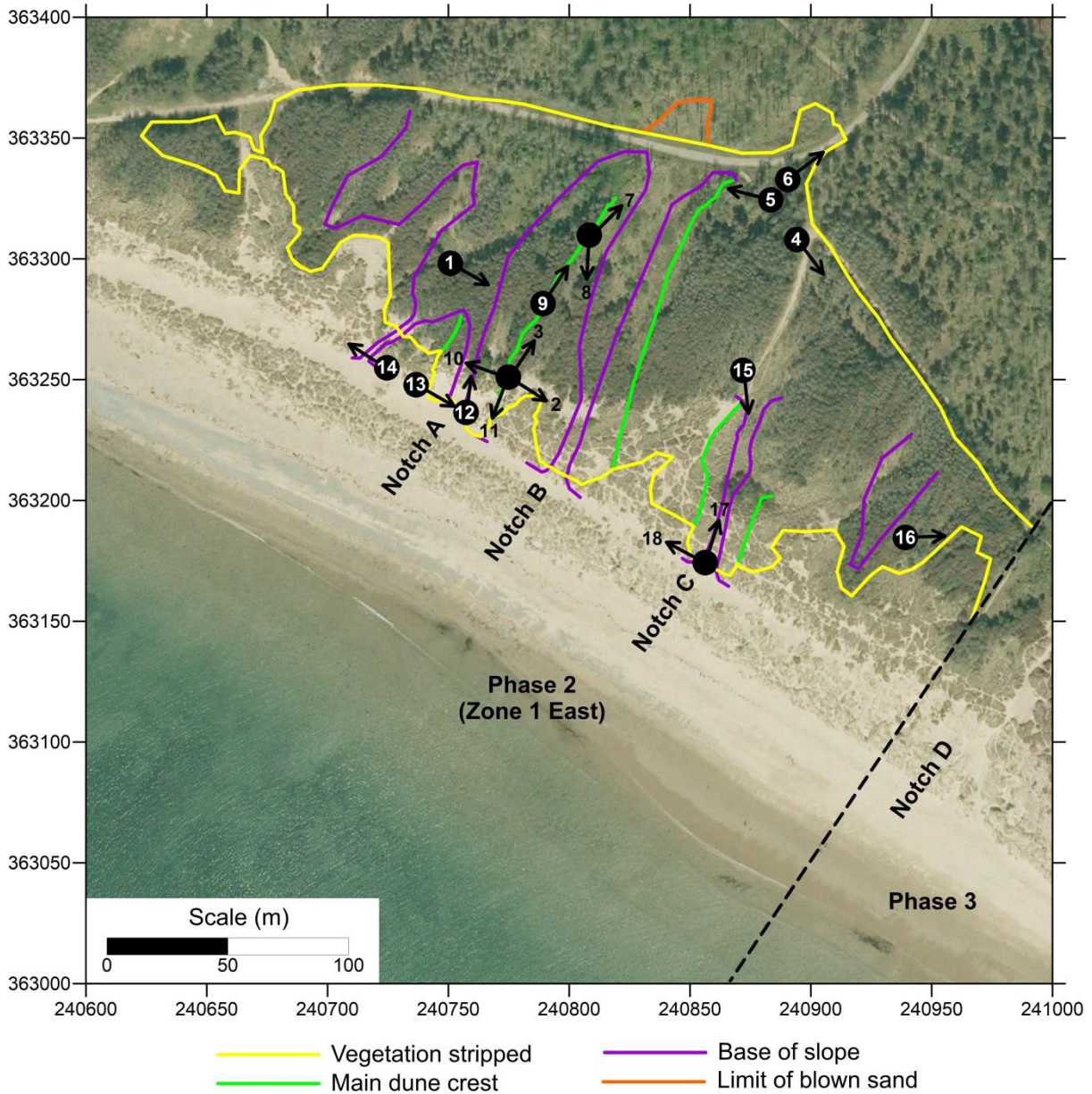


Figure A1. Locations of field photographs 1 to 18 in Zone 1 East. Arrows indicate direction of view; base 2009 aerial photography

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Photograph 1. View along vegetation-stripped area, looking SE



Photograph 2. View across Notch B, looking SE

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Photograph 3. View across vegetation-stripped area, with RTK-GPS base station in the foreground, looking NNE



Photograph 4. View along the rear of the de-forested, vegetation-stripped area, looking SE

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Photograph 5. View along the rear of the de-forested, vegetation-stripped area, looking WNW



Photograph 6. View inland at the rear of the de-forested, vegetation-stripped area, looking NE

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Photograph 7. View inland at the rear of the de-forested, vegetation-stripped area, looking NE



Photograph 8. View seawards along the axis of Notch B, looking S

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Photograph 9. View inland at the rear of the de-forested, vegetation-stripped area, looking NE



Photograph 10. View across Notch A, looking WNW

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Photograph 11. View seawards from the GPS base station, looking SSW



Photograph 12. View landwards along the axis of Notch A, looking NNE

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Photograph 13. View along the eroded dune toe, looking ESE



Photograph 14. View along the eroded dune toe, looking WNW

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Photograph 15. View seawards along the axis of Notch C, looking S



Photograph 16. The remaining SE corner of Newborough forest, at the eastern end of Zone 1 East, looking E

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Photograph 17. View landwards along the axis of Notch C, looking NNE



Photograph 18. View along the eroded dune toe, looking WNW

Data Archive Appendix

Data outputs associated with this project are archived at 'Topographical Survey of Newborough Dune Rejuvenation project 421, media 1535' 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 (Newborough Warren Survey Data 25-27 March 2015.xlsx) of data points (x,y,z)
- [C] A zip file named (Newborough March 2015 profiles.zip) containing excel files of profile data contained within the report.
- [D] A zip file named (Newborough March 2015 Zone 1 East shapefiles.zip) containing a series of GIS layers on which the maps in the report are based.

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 [115840]

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