Cyfoeth Naturiol Cymru
Natural Resources Wales

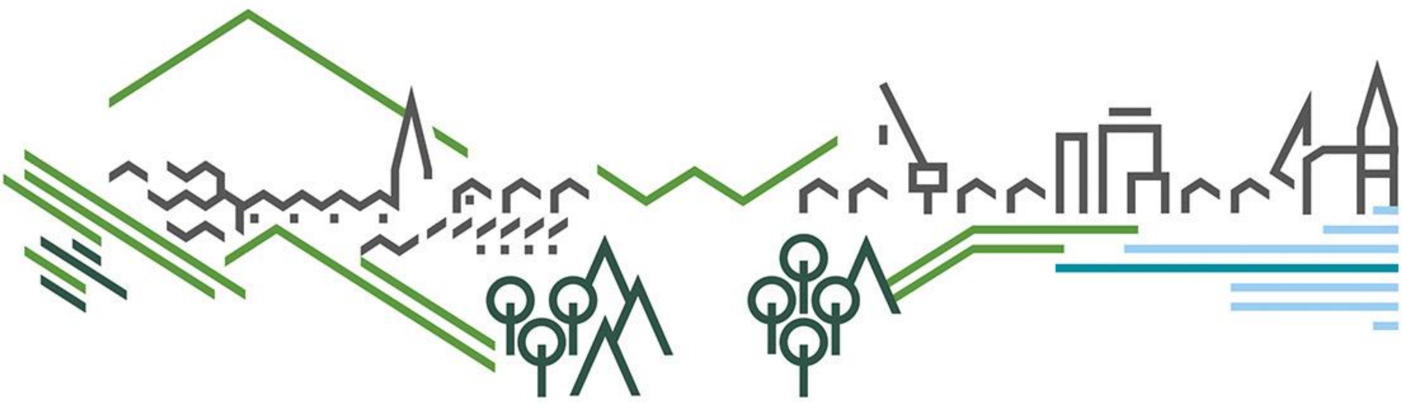
Newborough Phase 1 Dune Rejuvenation Works Topographic Survey Report

Kenneth Pye & Simon J. Blott

Kenneth Pye Associates Ltd

Report No: 95

Date: March 2014



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Natural Resources Wales is the organisation responsible for the work carried out by the three former organisations, the Countryside Council for Wales, Environment Agency Wales and Forestry Commission Wales. It is also responsible for some functions previously undertaken by Welsh Government.

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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We will realise this vision by:

- Maintaining and developing the technical specialist skills of our staff;
- Securing our data and information;
- Having a well resourced proactive programme of evidence work;
- Continuing to review and add to our evidence to ensure it is fit for the challenges facing us; and
- Communicating our evidence in an open and transparent way.

This Evidence Report series serves as a record of work carried out or commissioned by Natural Resources Wales. It also helps us to share and promote use of our evidence by others and develop future collaborations. However, the views and recommendations presented in this report are not necessarily those of NRW and should, therefore, not be attributed to NRW.

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1.0 Job Summary

KPAL Job No:	130314
Report Date:	15/05/2014
Client:	Natural Resources Wales
Client Job Title:	Newborough Phase l Dune Rejuvenation Works
Survey conducted:	13th March 2014
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 Pacific Crest ADL Vantage radio transceiver (430-470 MHz)
No. of data points:	1565
RTK Control Station:	Wooden post surveyed-in using Leica Smartnet GPRS on 16 May 2013 (BM1). No GPRS signal could be obtained on 13 March 2014, so an additional check on the position of BM1 was not possible at this time, but the post was found to be firm in the ground and no movement was considered likely between the surveys: Easting: 242096.666 m Northing: 363312.415 m Height: 21.475 m OD
RTK Backup Station:	Wooden post surveyed-in using Leica Smartnet GPRS on 16 May 2013 (BM2), 25 m NNE of Control Station above (see Table 2).
Fixed profiles:	Thirty existing profile lines (1-30, previously surveyed on 16-17 May 2013) were resurveyed and compared with data surveyed from 2009 LiDAR and 16-17 May 2013 ground survey. Two new profile lines in Area 2 (Profiles 15A and 16A) were surveyed and compared to positions interpolated from the DEM for 16-17 May 2013 and 2009 LiDAR. 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, M. Blott, K. Pye

2.0 Scope and purpose

The requirements for dune rejuvenation trials at Newborough Warren were identified in a report by Pye & Blott (2012). Three areas (referred to as Areas 2, 3 and 4) were subsequently selected for trials which 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, (c) placement of stripped turf blocks in areas on and behind the dune arms, and (d) in the case of Area 3 the placement of excavated sand to create a bare sand mound.

A first topographic monitoring survey was carried out in May 2013 (KPAL, 2013) and was followed by a drone aerial photography survey by ExeGesis Ltd in June 2013. This report provides a summary of the results of a second ground topographic monitoring survey carried out on 13th March 2014.

3.0 Survey methods and error checking

In the March 2014 survey ground surface elevations were determined at 1565 points using Leica RTK GPS SmartRover equipment listed in the Job Summary (Section 1.0) above. The distribution of survey points in relation to the three rejuvenation trial areas is shown in Figures 1 and 2. Many of the survey points were located on profile lines which were also surveyed in May 2013. The limits of defined features, including areas of windblown sand deposition, the main dune crest, and areas of standing water, 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).

The benchmark posts 1 and 2, which were established in May 2013, were still present in March 2014 and were found to be firm with no sign of movement over the intervening period. Re-checking of the position and elevation of the benchmarks using Leica SmartNet corrections was not possible due to very poor GPRS signal in March 2014. However, comparison of data for Benchmark 2 (wooden post) for the May 2013 and March 2014 surveys showed only small differences which are within acceptable limits (Table 2).

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

4.0 Results - profile comparisons

4.1. Area 2

The locations of survey profile lines within Area 2 are shown in Figures 3 and 4. The locations of ground photographs reproduced in this report are shown in Figure 5. Topographic profiles recorded during the March 2014 survey are compared with those of the May 2013 survey in Figure 6.

The changes in elevation along most of the profiles were relatively small, amounting to less than 10 cm on the margins of the deflation troughs and the greater part of the side walls. Greater lowering was evident on parts of the stoss slope, the sacrificial sand heaps around the margin of the deflation trough, and the area where turves and loose sand were deposited on the western side of the dune in during the original excavation works. A thin layer of deposited windblown sand was evident on the NW margin of the trial area, having been transported there from the adjoining upwind area by southwesterly and southerly winds.

4.2. Area 3

The locations of survey profile lines within Area 3 are shown in Figures 7 and 8. The locations of ground photographs reproduced in this report are shown in Figure 9. Topographic profiles recorded during the March 2014 survey are compared with those of the May 2013 survey in Figure 10.

Changes in elevation since May 2013 were again small (0 to 20 cm, depending on location. The main areas of lowering due to deflation ere on some lower parts of the stoss slope of the dune (e.g. Profile 18), and parts of the sacrificial sand heaps around the edge of deflation trough. A layer of wind-deposited sand, 1 – 10 cm thick, was evident on the downwind side of the dune crest, having been transported there by southwesterly winds. Some areas of sand accretion were also evident on parts of the stoss side of the dune (e.g. Profile 19).

4.3. Area 4

The locations of survey profile lines within Area 4 are shown in Figures 11 and 12. The locations of ground photographs reproduced in this report are shown in Figure 13. Topographic profiles recorded during the March 2014 survey are compared with those of the May 2013 survey in Figure 14.

Only very small elevation differences are evident on the higher sand areas around Area 4. Some limited deflation has taken place at the downwind (northeastern) end of the scraped area where the water level had fallen sufficiently to expose bare sand. Sand transported by the wind from the margins of this area and from the artificial sand mound had formed a thin (0-10cm) thick layer on the vegetation on the downwind side of the trial area.

The winter of 2013-14 was relatively wet, with the result that groundwater levels were high at the time of survey and shallow lakes were present in all three areas. At the upwind end of Area 4 the lake was more than 0.8 m deep in places.

5.0 References

KPAL (2013) *Newborough Warren Dune Topographic Monitoring Survey, May 2013*. Kenneth Pye Associates Ltd., Solihull.

Pye, K. & Blott, S.J. (2012) *A Geomorphological Survey of welsh Dune Systems to Determine Best Methods of Rejuvenation. Appendix 3, Newborough Warren.* CCW Contract Science Report 1002.CCW, Bangor.

6.0 Tables

Table 1. Average error reported by the instrument for all 1565 data points

	1-D (height) quality control	2-D (position) quality control
Average	8.6 mm	5.4 mm
StDev	6.5 mm	4.7 mm

Table 2. Measured location and height of Benchmark 2 (wooden post) in May 2014

	Easting	Northing	Height m OD
Surveyed with Smartnet corrections (16 May 2013)	242104.105	363335.967	14.099
Surveyed with base & rover (13 March 2014)	242104.134	363335.932	14.109
Error:	+29 mm	-35mm	+10 mm

7.0 Figures

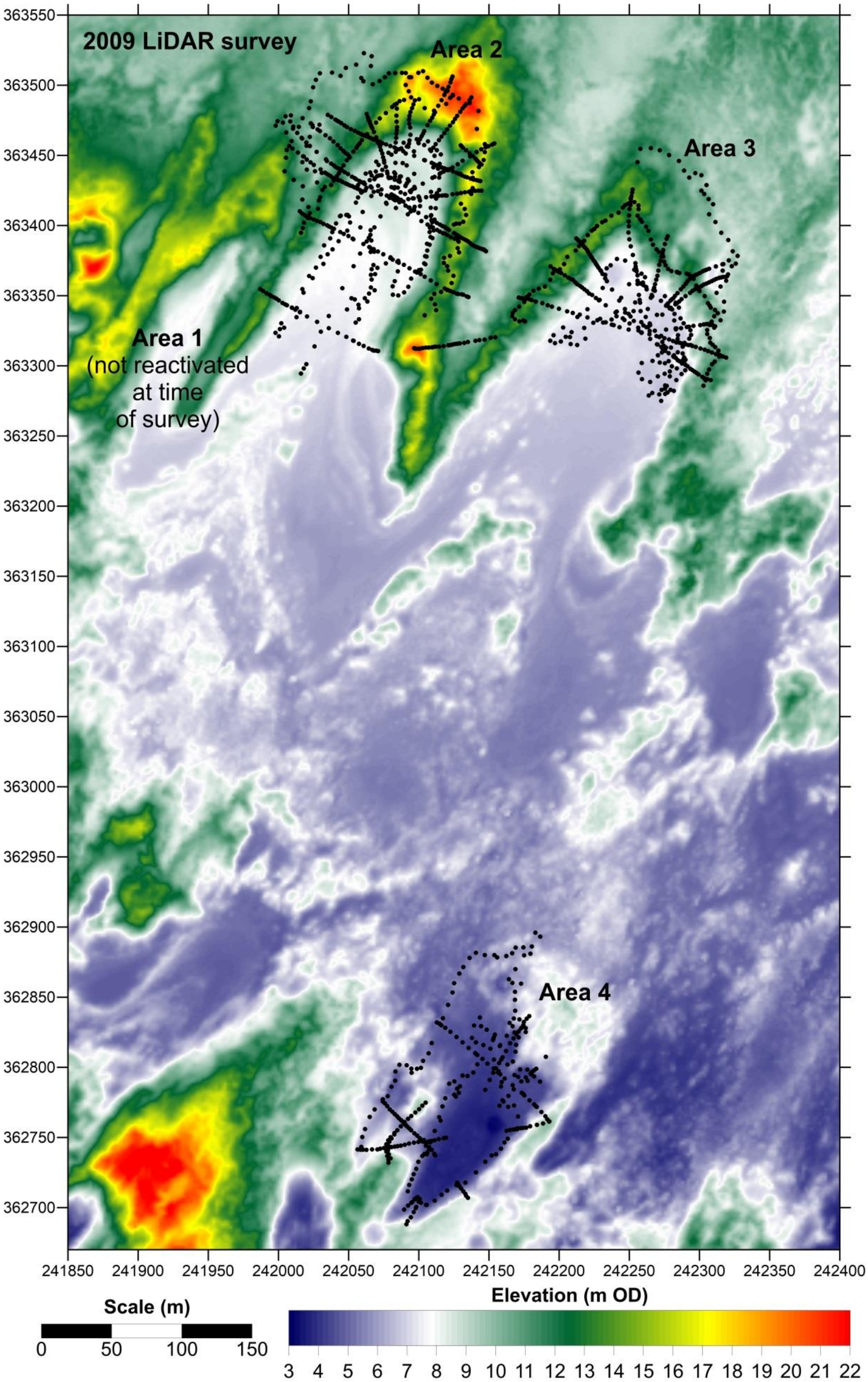


Figure 1. Locations of March 2014 survey data points (black dots) within the three rejuvenation trial areas 2,3 and 4, overlaid on a 2009 LiDAR DEM

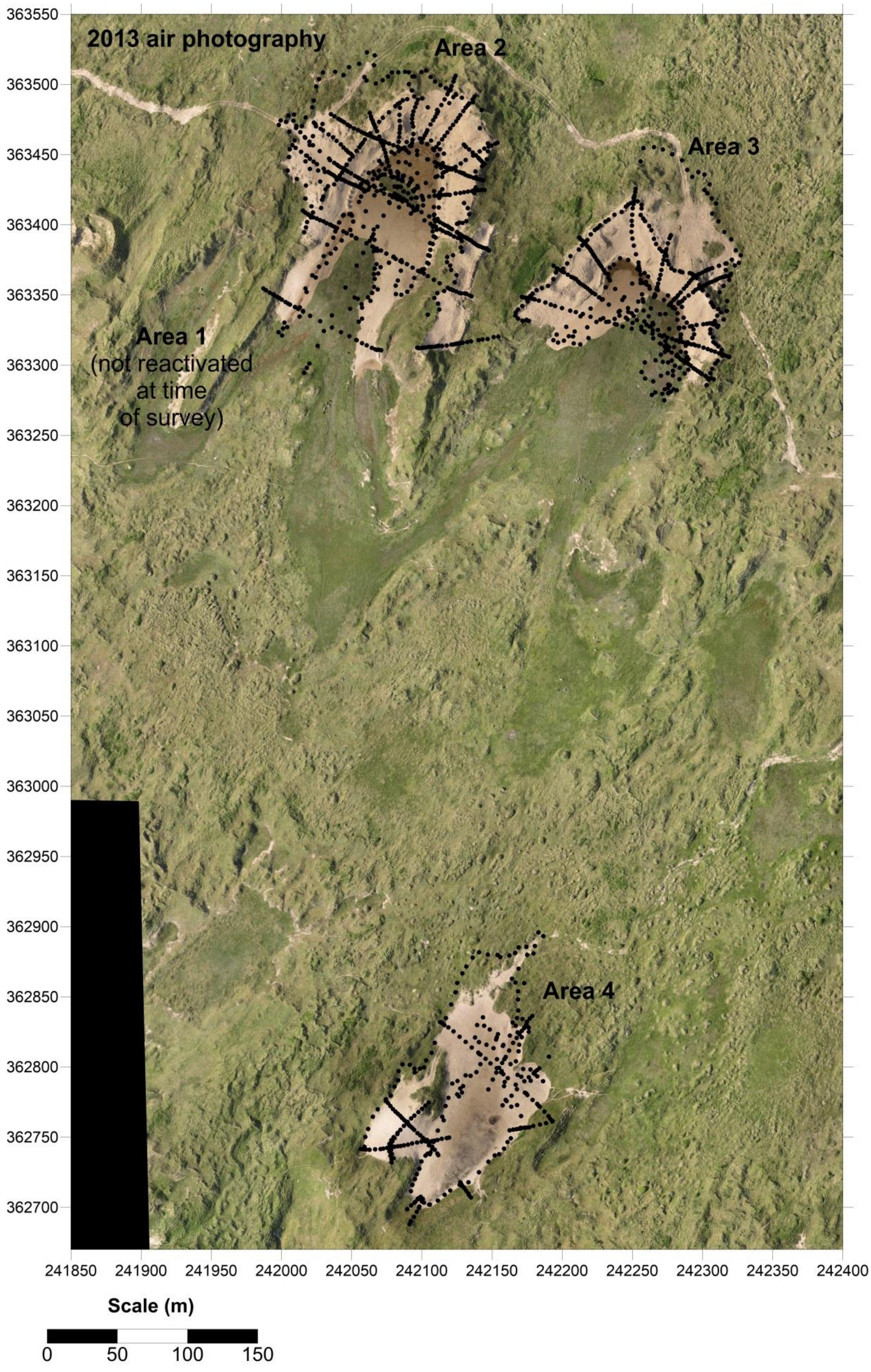


Figure 2. Locations of March 2014 survey data points (black dots) overlaid on June 2013 aerial photographs (flown by exeGesIS).

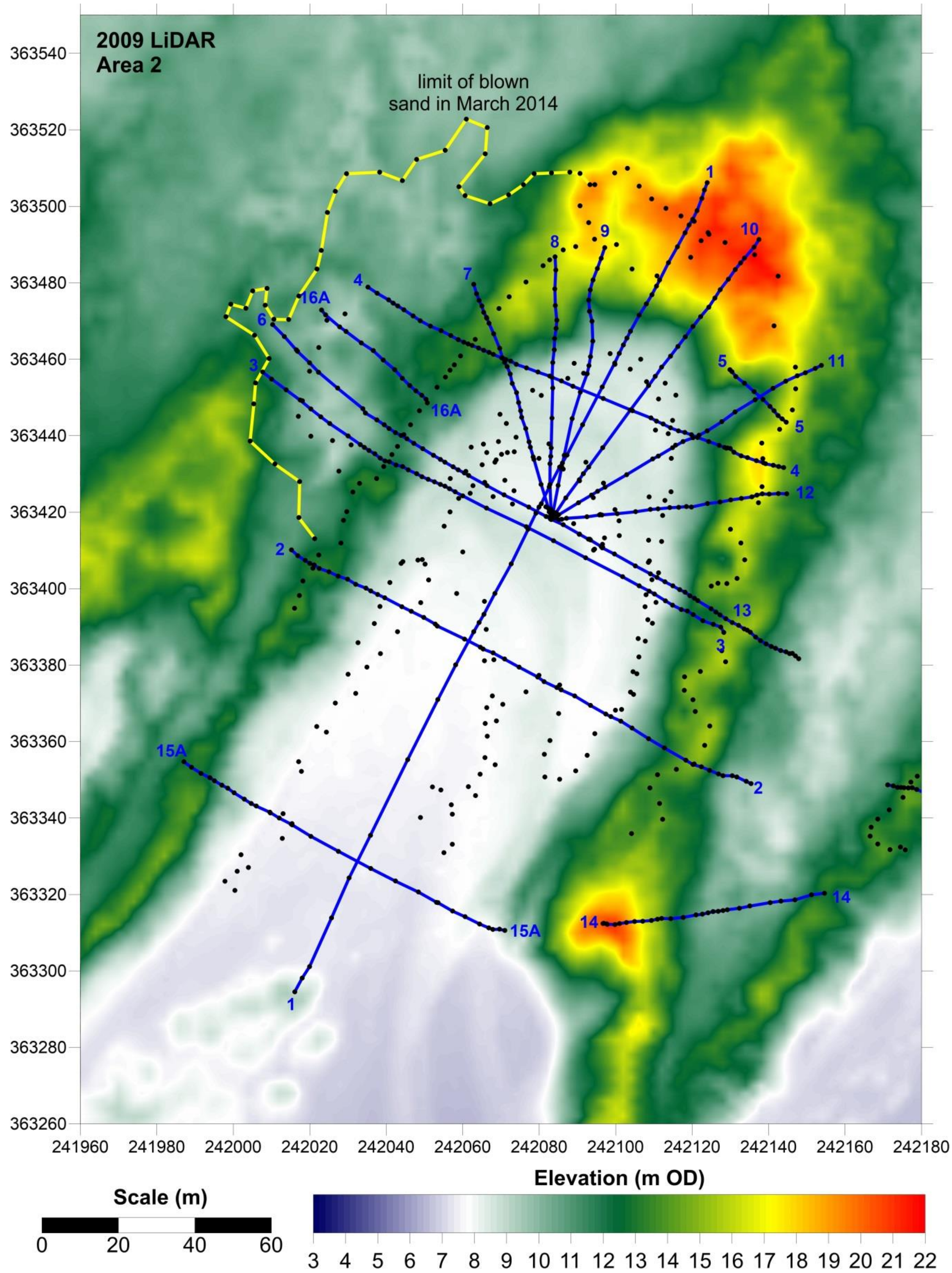


Figure 3. Locations of March 2014 data points (black dots) and cross-profiles (blue lines) in Area 2, overlaid on 2009 LiDAR.

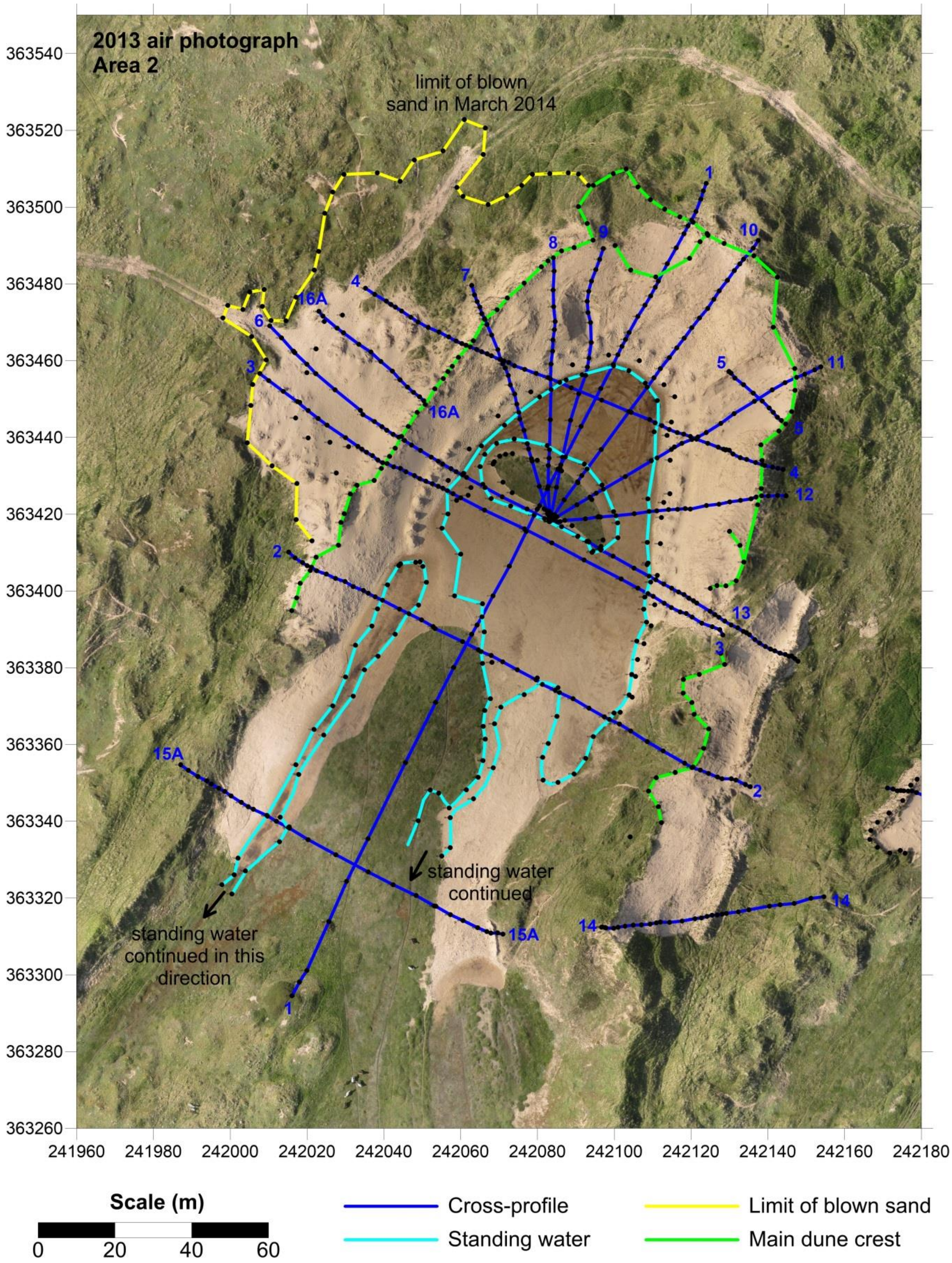


Figure 4. Locations of March 2014 data points (black dots) and cross-profiles (dark blue lines) in Area 2, overlaid on June 2013 aerial photographs (flown by exeGesIS). The limit of blown sand, standing water, and the main dune crest surveyed in March 2014 are also shown.

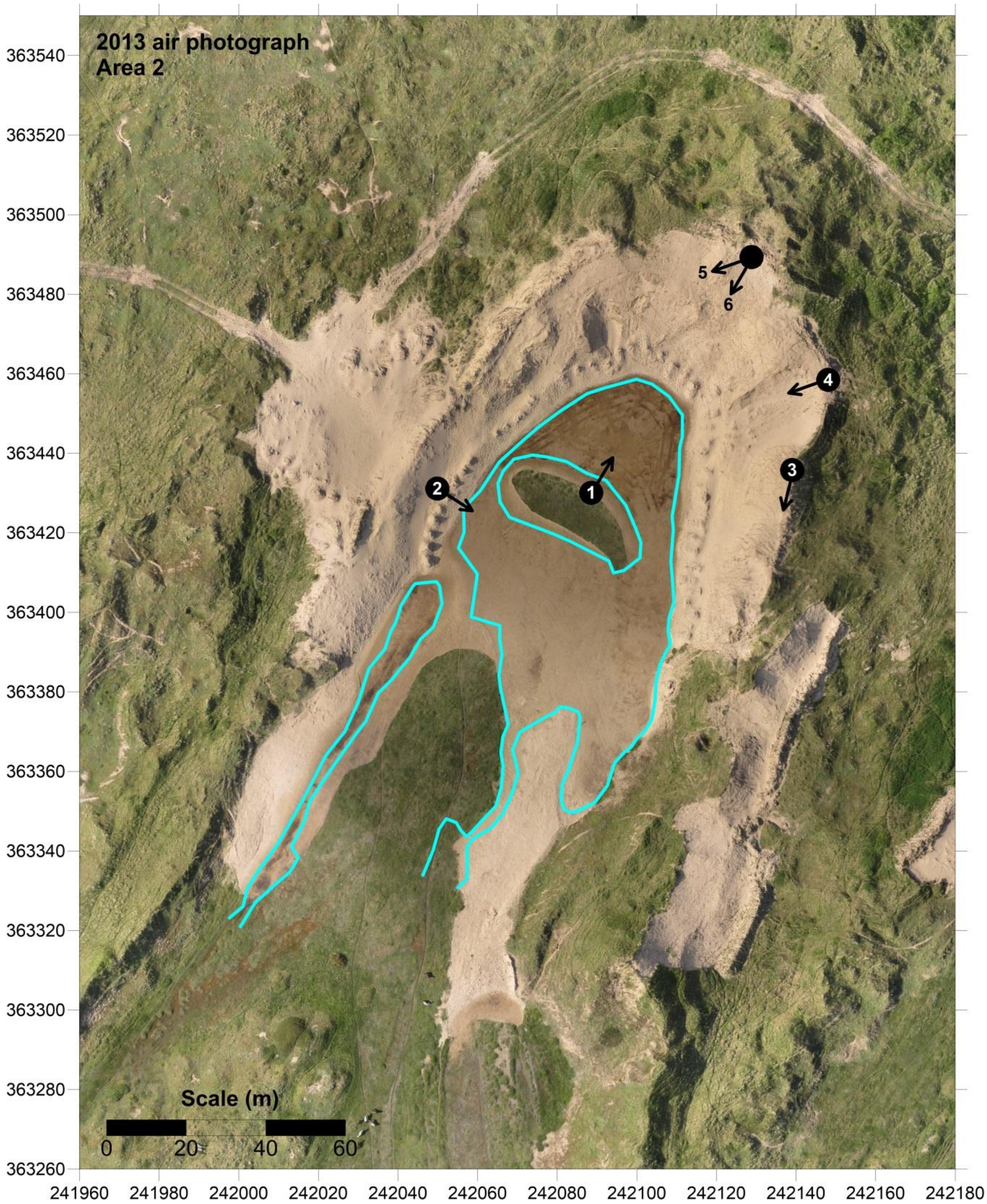
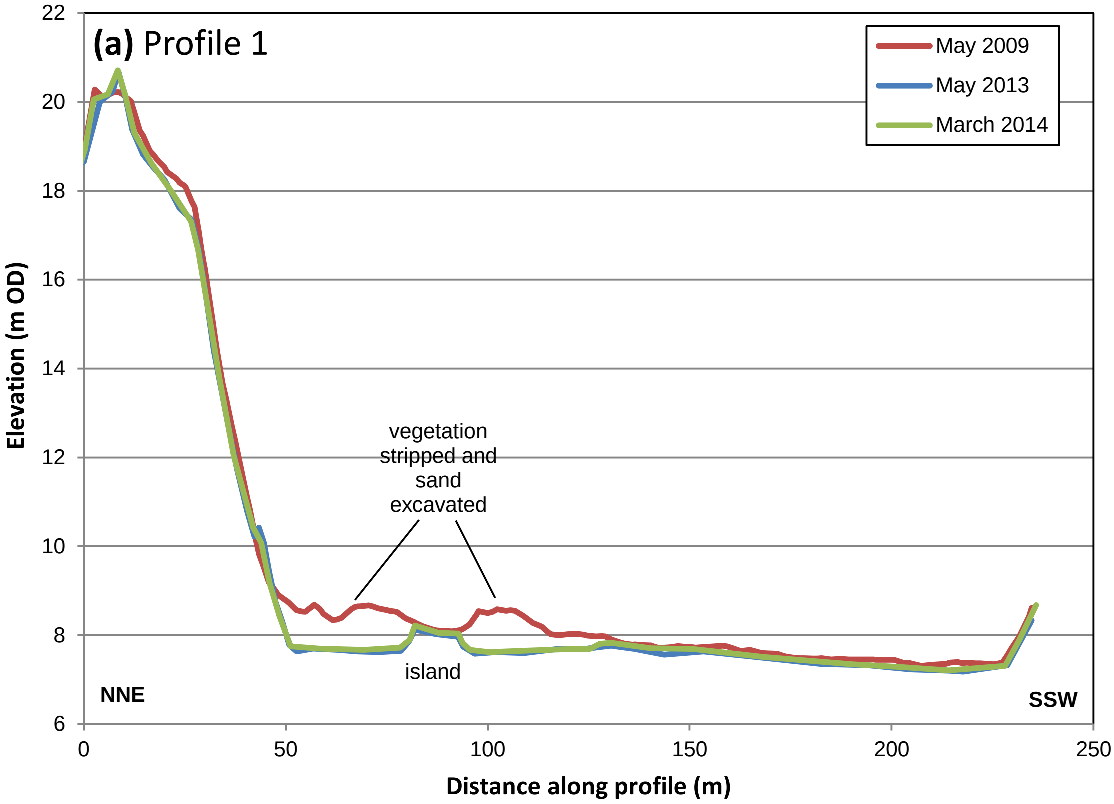


Figure 5. Locations of field photographs 1 to 6 in Area 2 reproduced in this report. Arrows indicate direction of view; base 2013 aerial photography from Google Earth



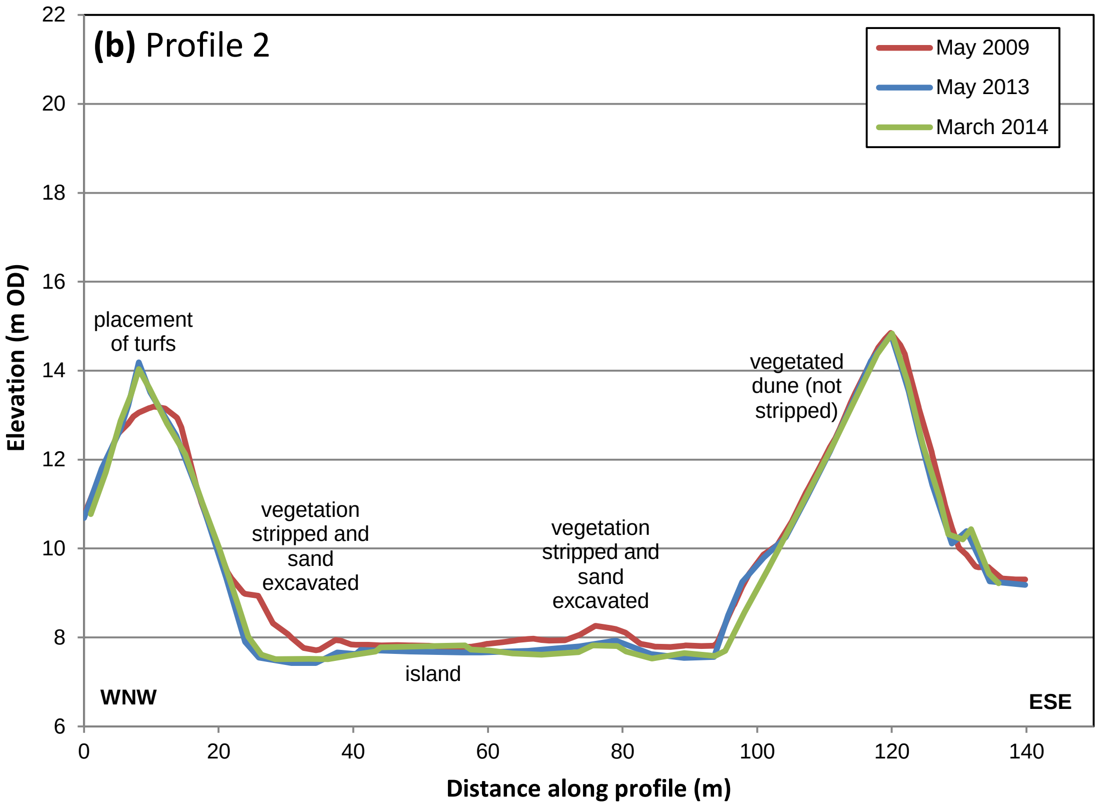
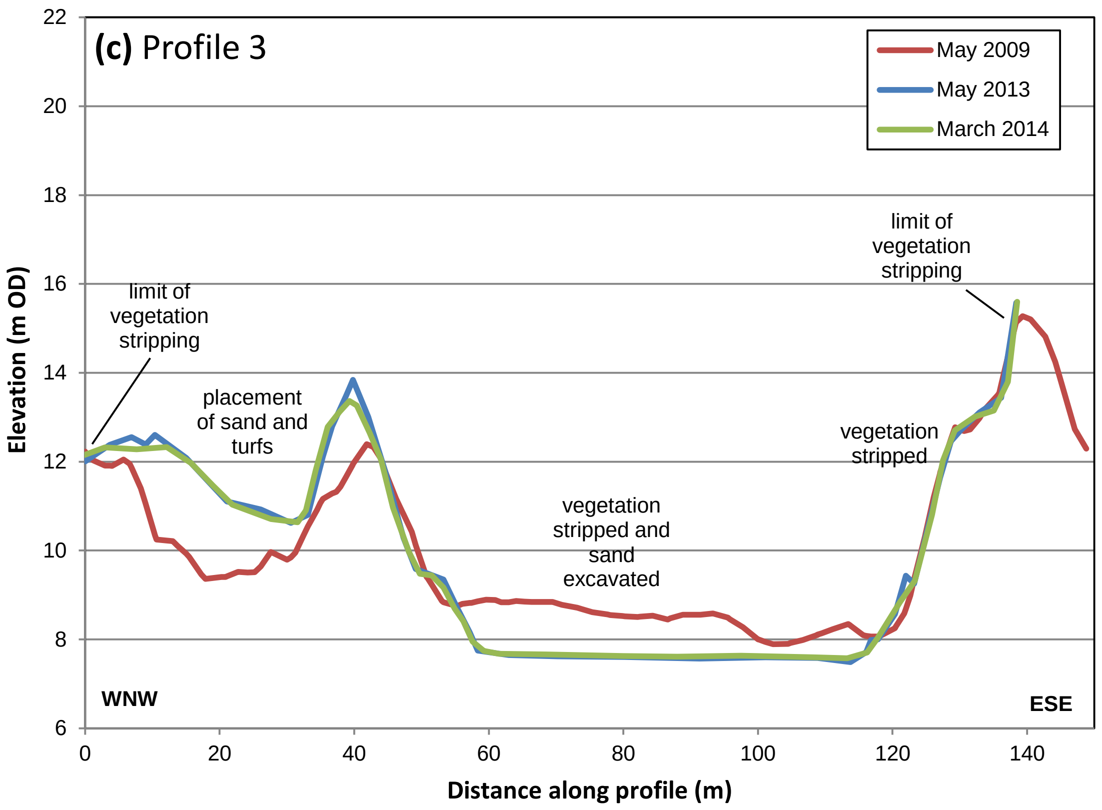


Figure 6. Comparison of surface levels at profiles 1 and 2 in Area 2, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 16 May 2013 and 13 March 2014



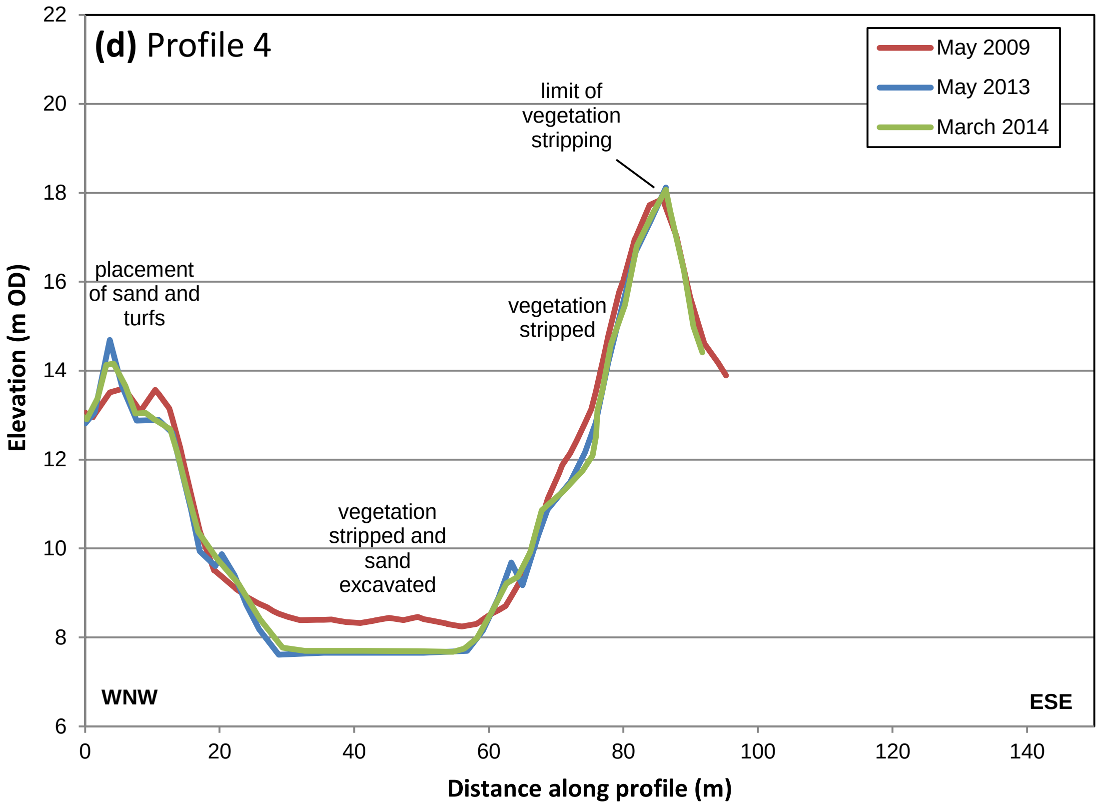
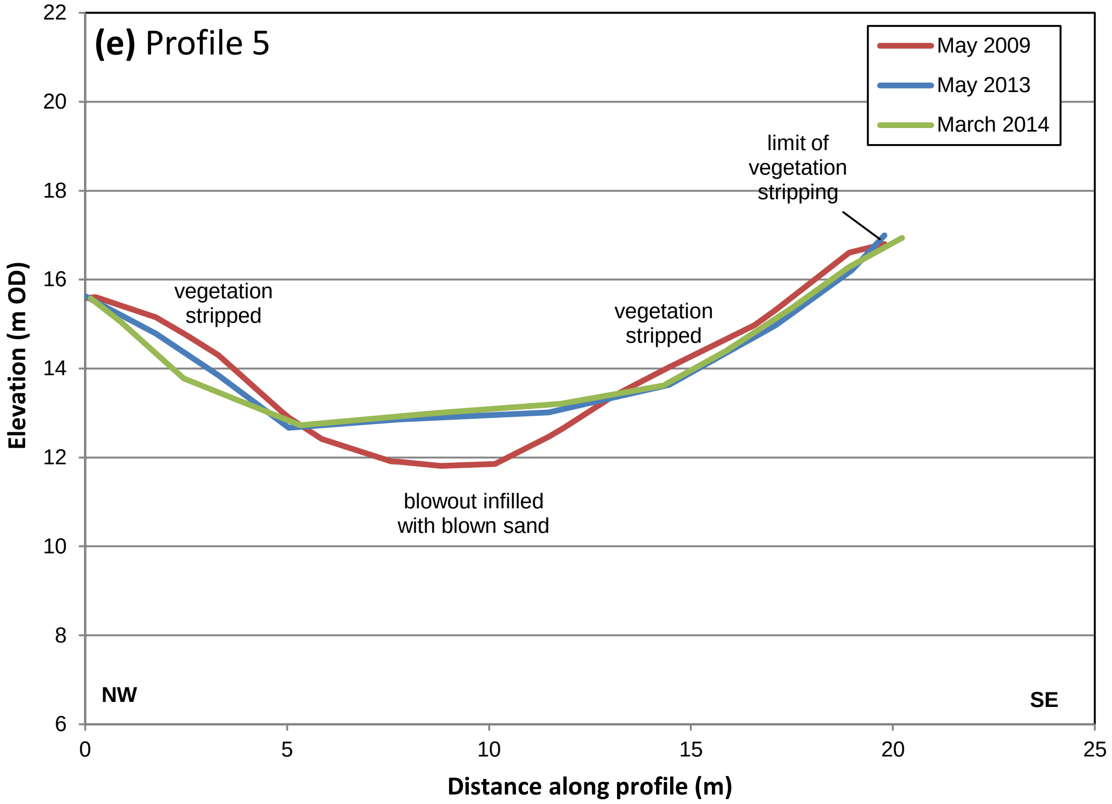


Figure 6. continued. Comparison of surface levels at profiles 3 and 4 in Area 2, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 16 May 2013 and 13 March 2014



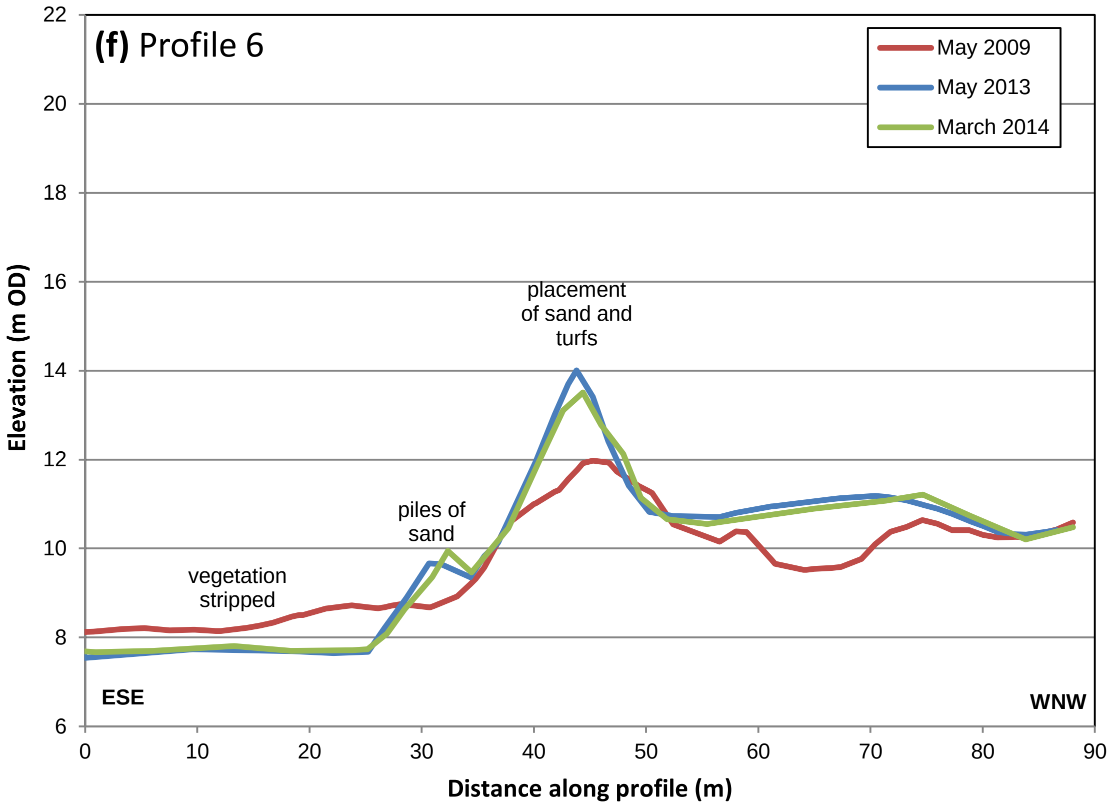
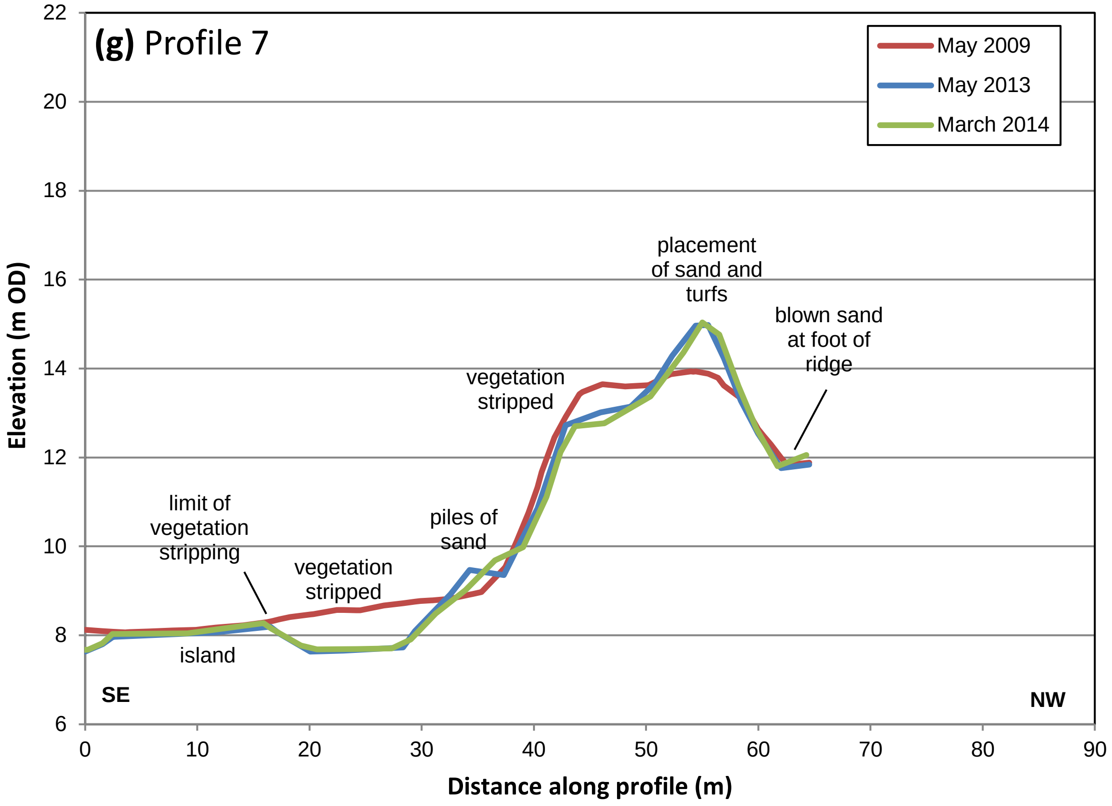


Figure 6. continued. Comparison of surface levels at profiles 5 and 6 in Area 2, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 16 May 2013 and 13 March 2014



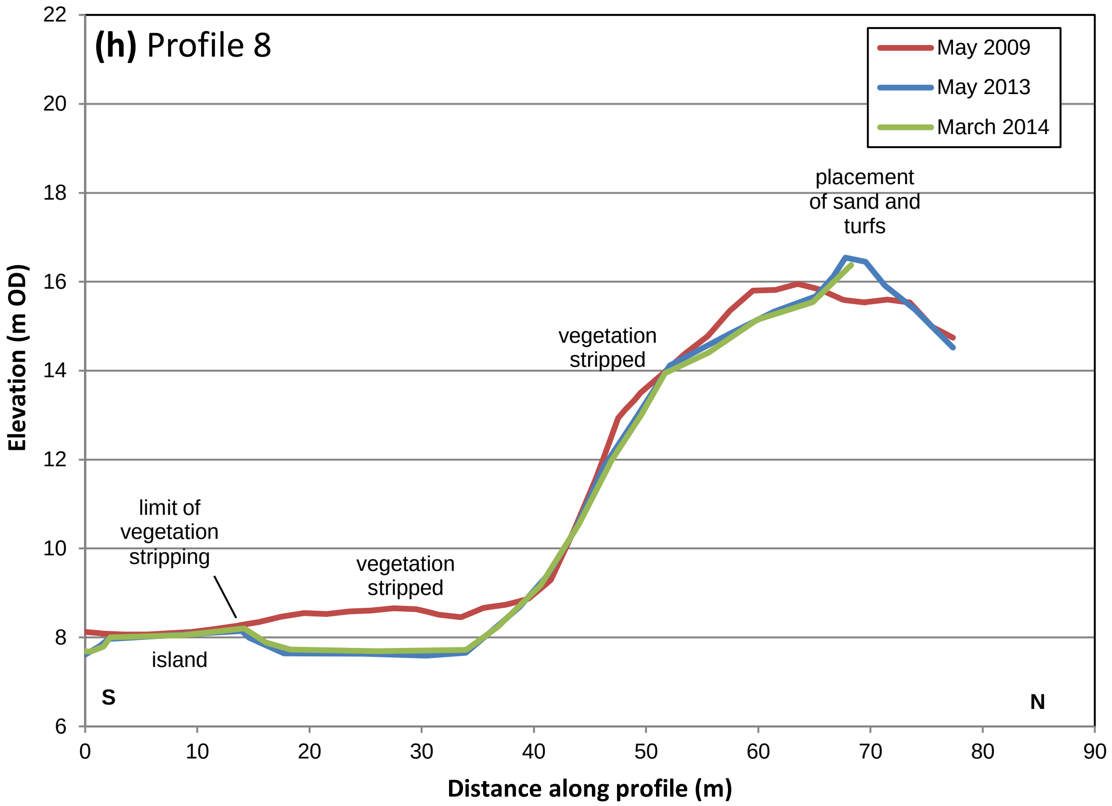
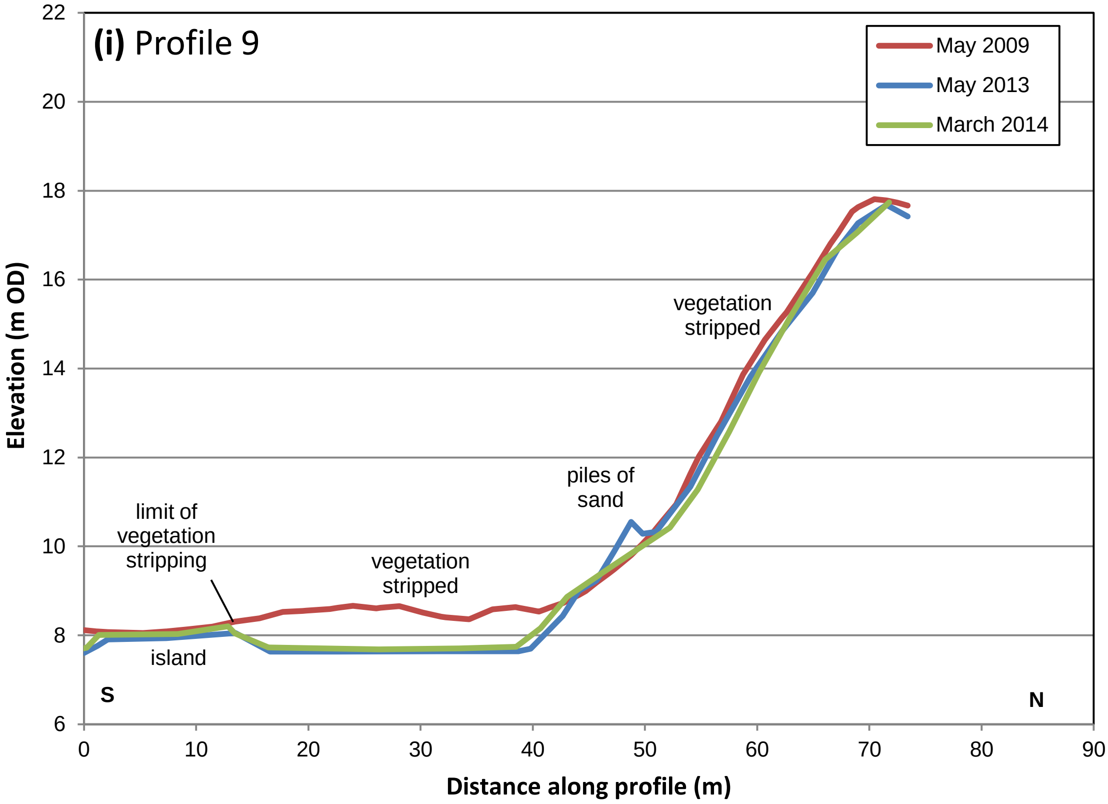


Figure 6. continued. Comparison of surface levels at profiles 7 and 8 in Area 2, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 16 May 2013 and 13 March 2014



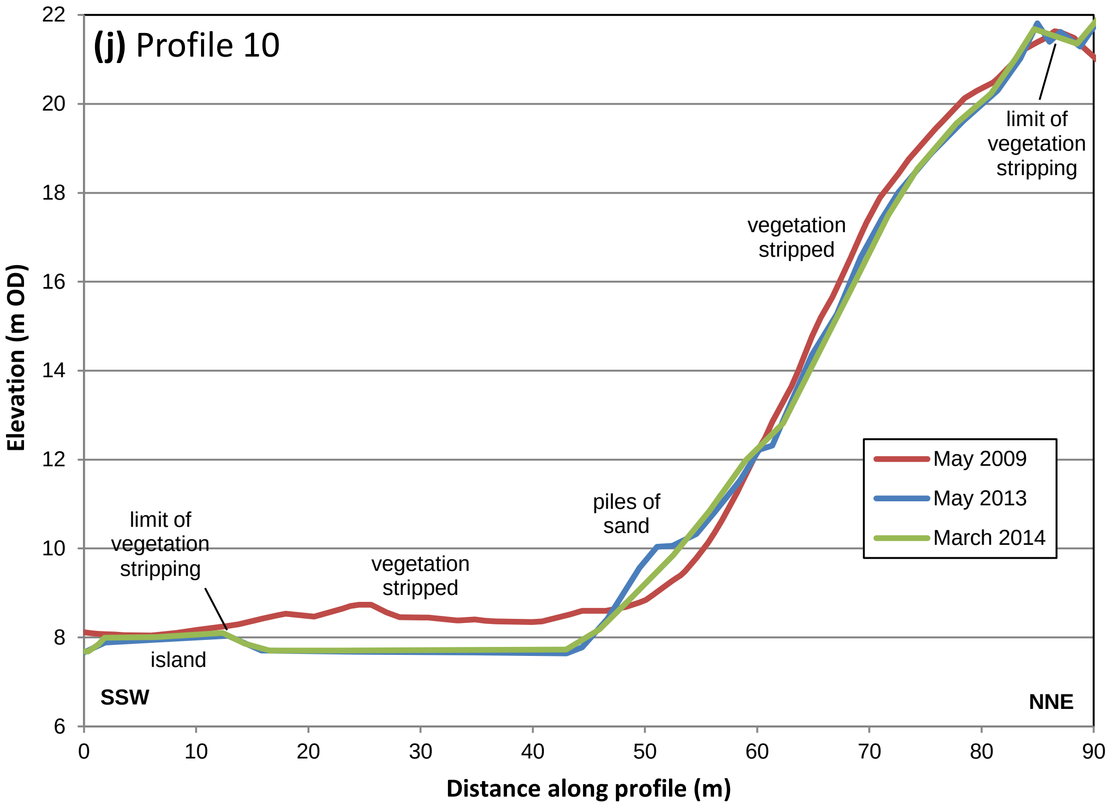
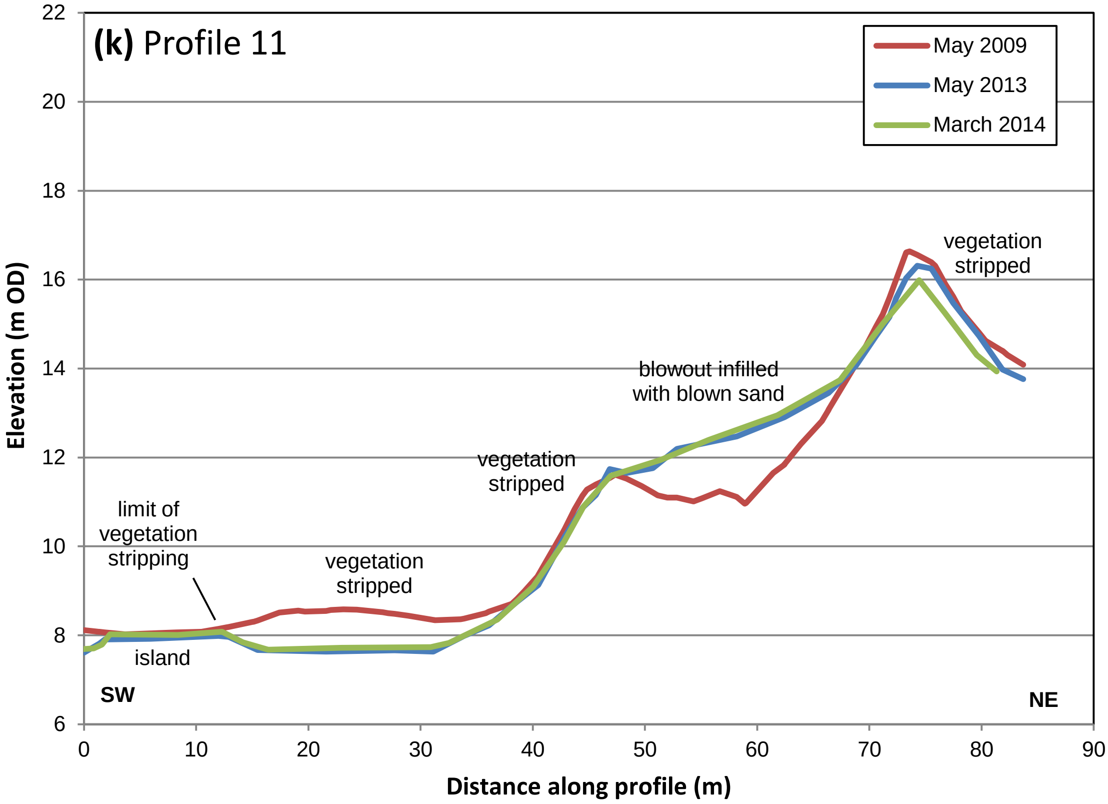


Figure 6. continued. Comparison of surface levels at profiles 9 and 10 in Area 2, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 16 May 2013 and 13 March 2014



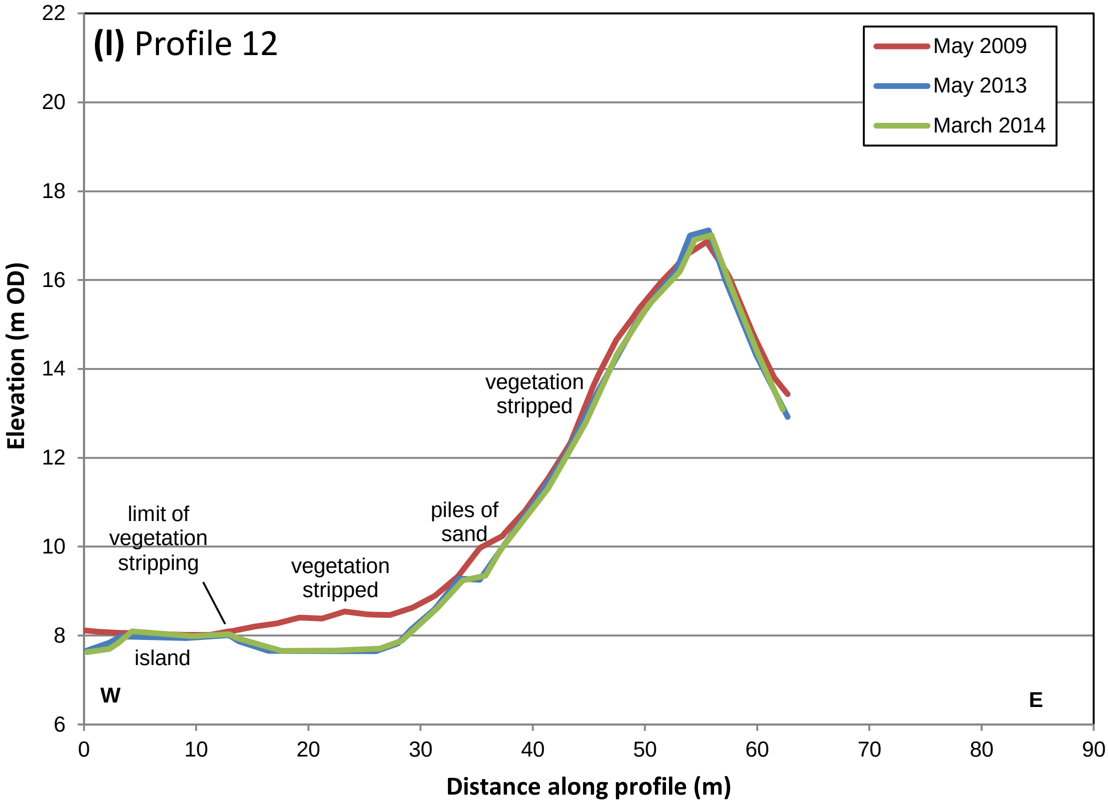
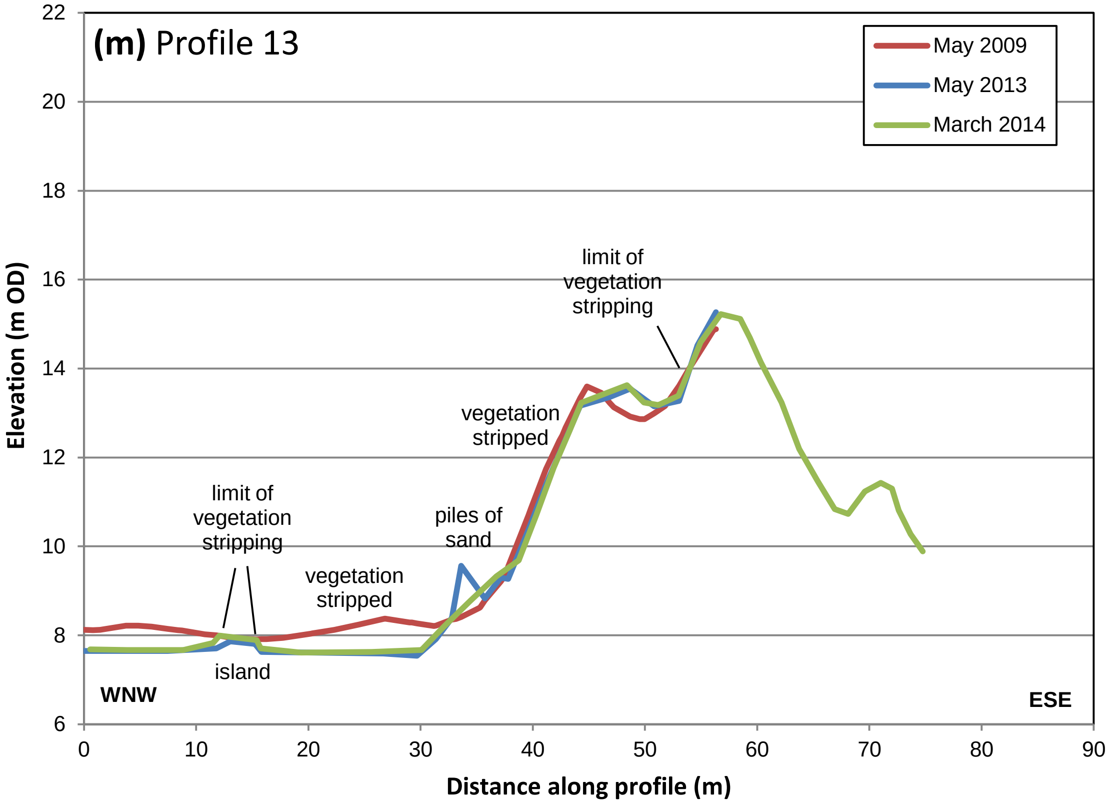


Figure 6. continued. Comparison of surface levels at profiles 11 and 12 in Area 2, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 16 May 2013 and 13 March 2014



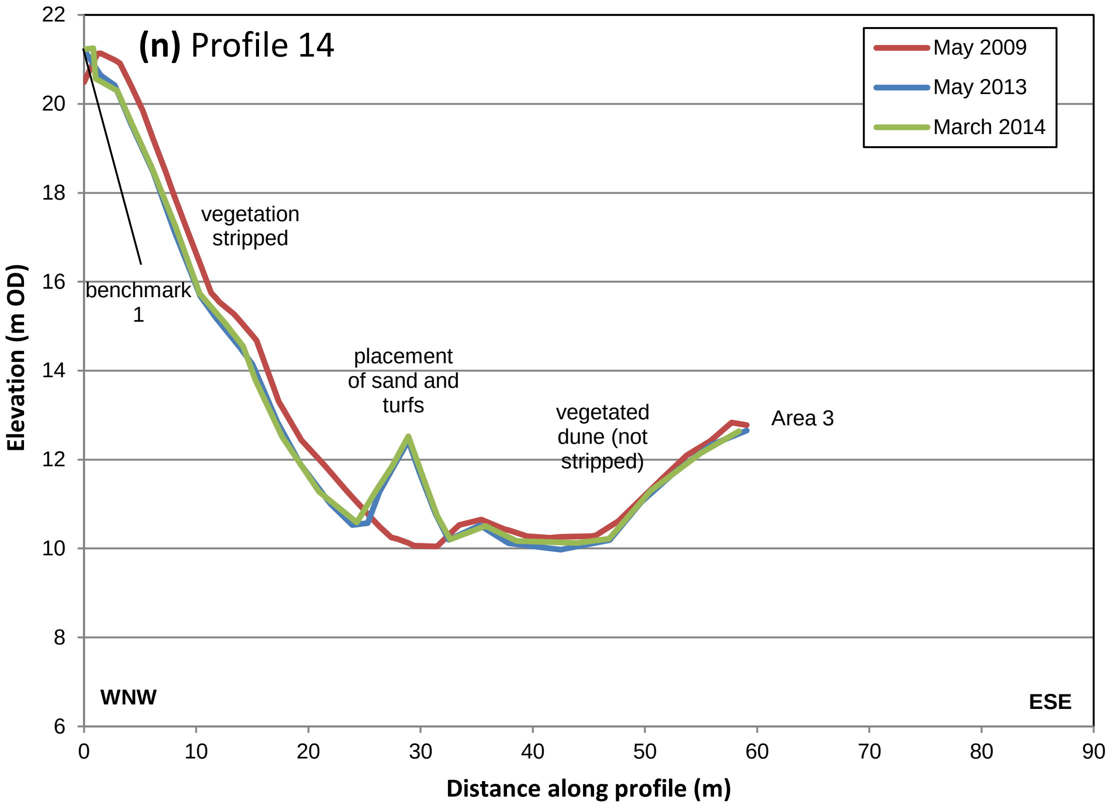
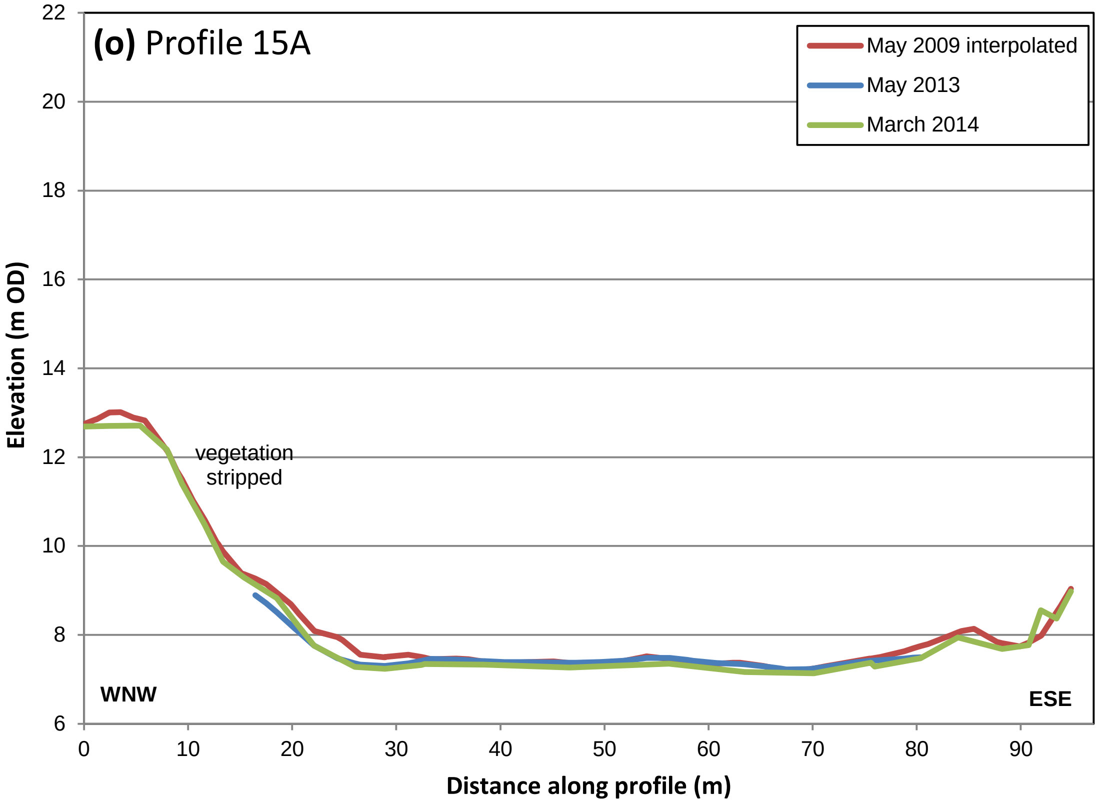


Figure 6. continued. Comparison of surface levels at profiles 13 and 14 in Area 2, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 16 May 2013 and 13 March 2014



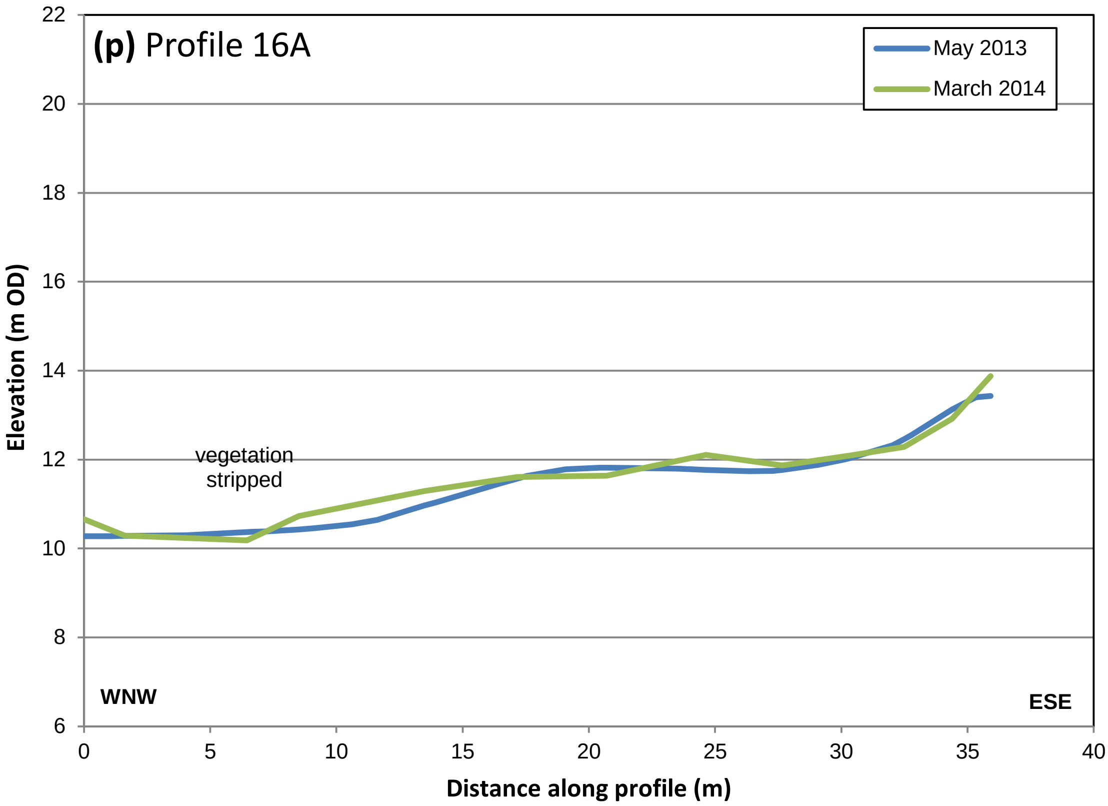


Figure 6. continued. Comparison of surface levels at profiles 15A and 16A in Area 2, indicated by LiDAR survey on 12th May 2009 (pre-works) and 13 March 2014. Data have been interpolated from the ground survey on 16 May 2013 for profile 15A, but was not possible for profile 16A due to a lack of survey points.

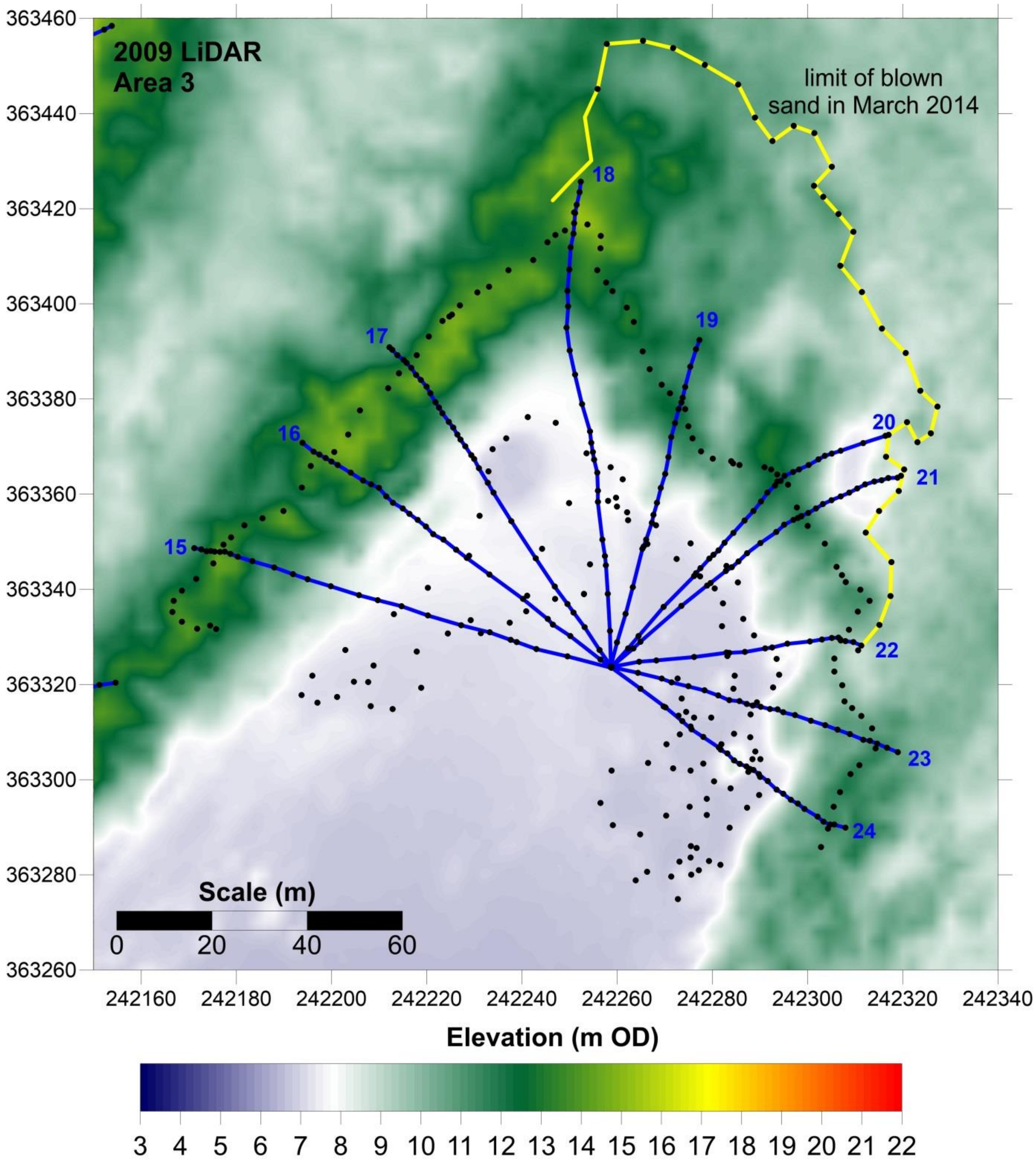


Figure 7. Locations of March 2014 data points (black dots) and cross-profiles (blue lines) in Area 3, overlaid on 2009 LiDAR.

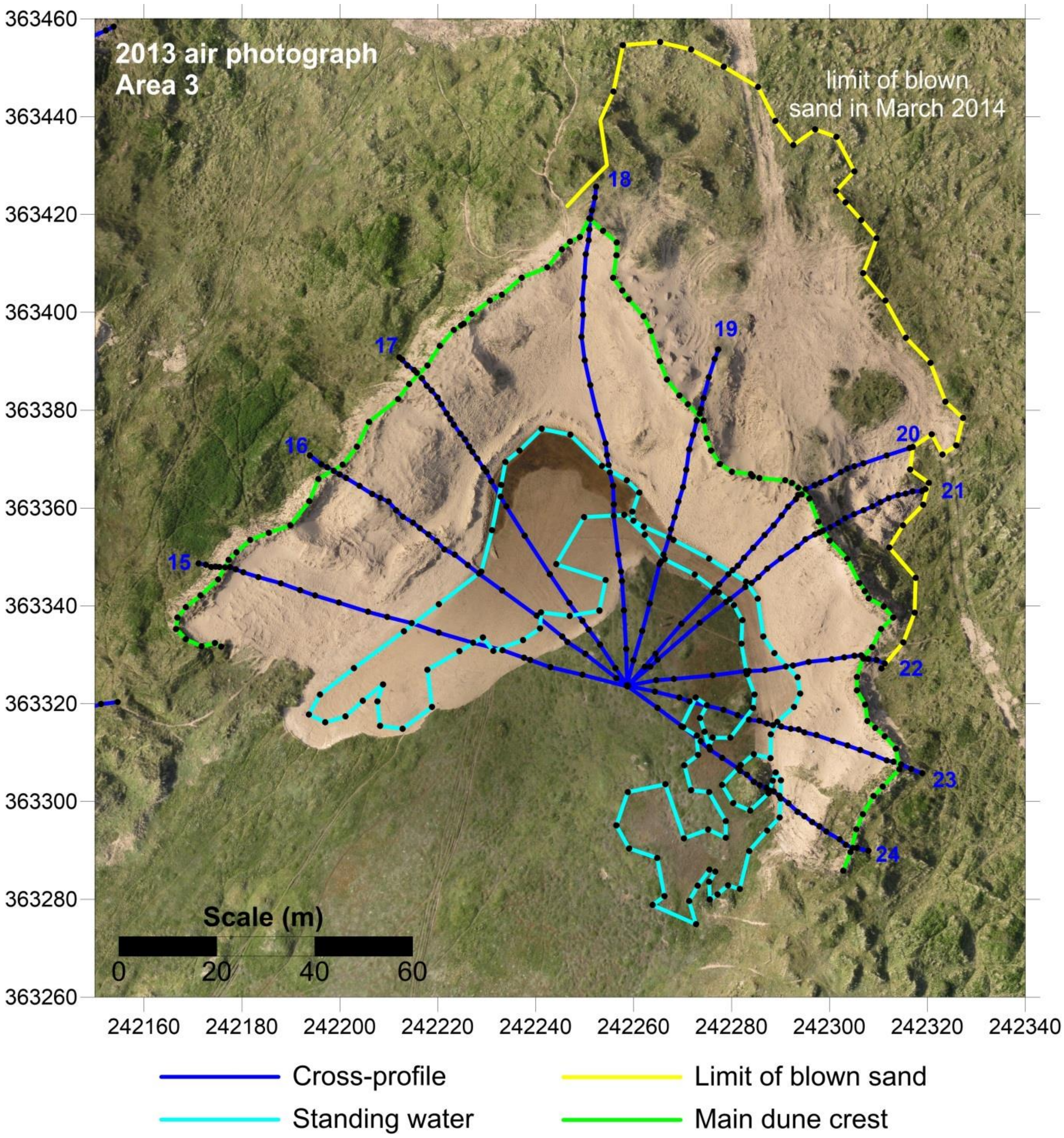


Figure 8. Locations of March 2014 data points (black dots) and cross-profiles (blue lines) in Area 3, overlaid on June 2013 aerial photographs (flown by exeGesIS). The limit of blown sand, standing water, and the main dune crest surveyed in March 2014 are also shown.

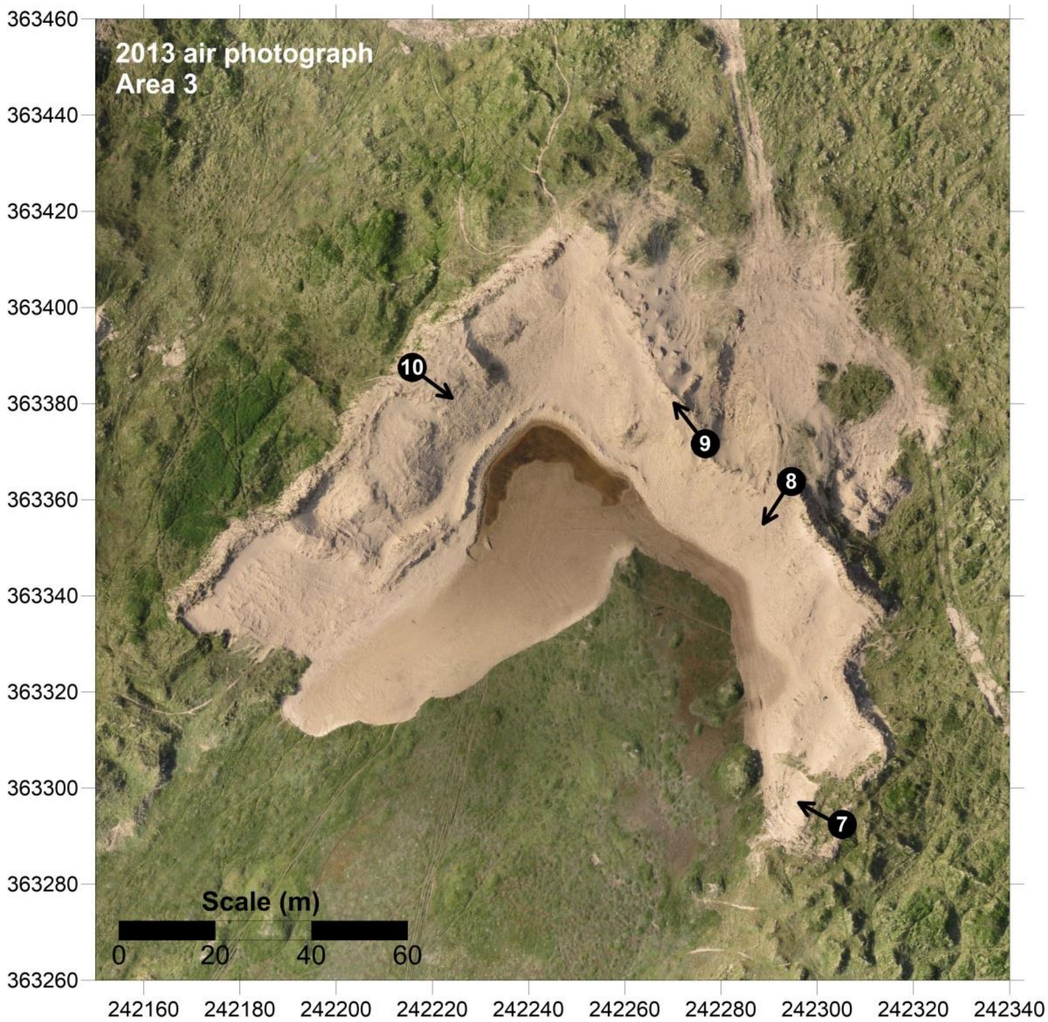
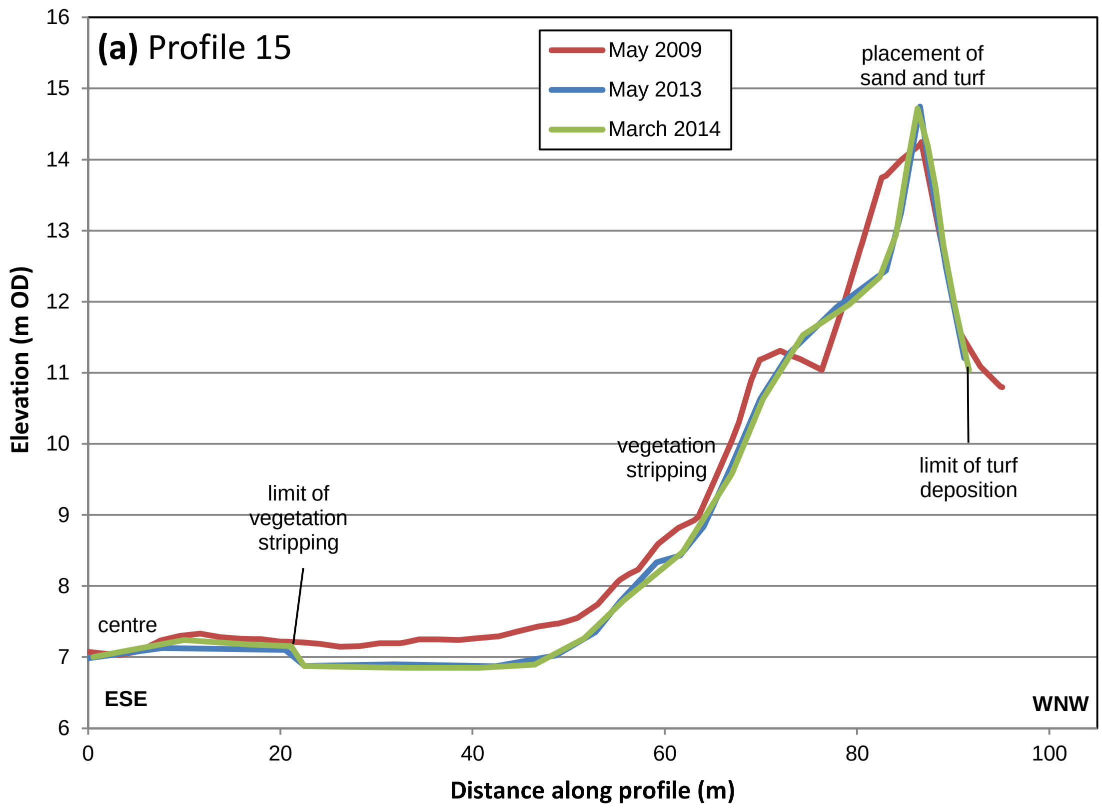


Figure 9. Locations of field photographs 7 to 10 in Area 3 reproduced in this report. Arrows indicate direction of view; base 2013 aerial photography from Google Earth



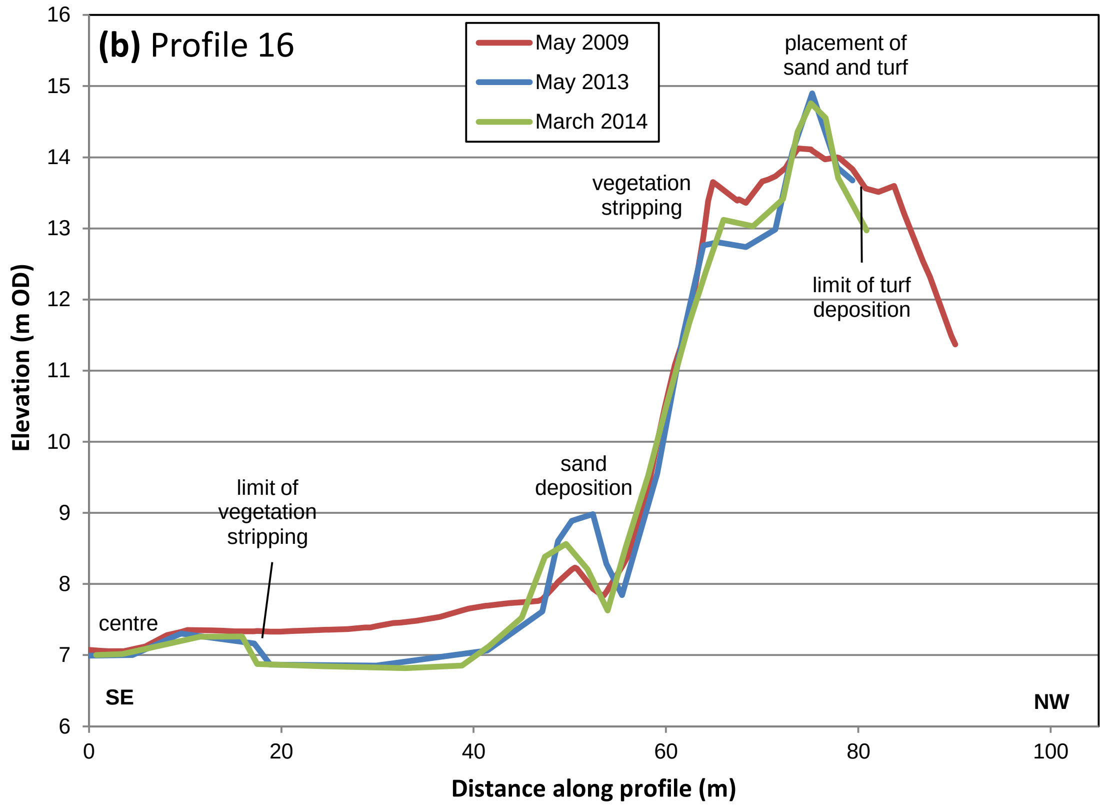
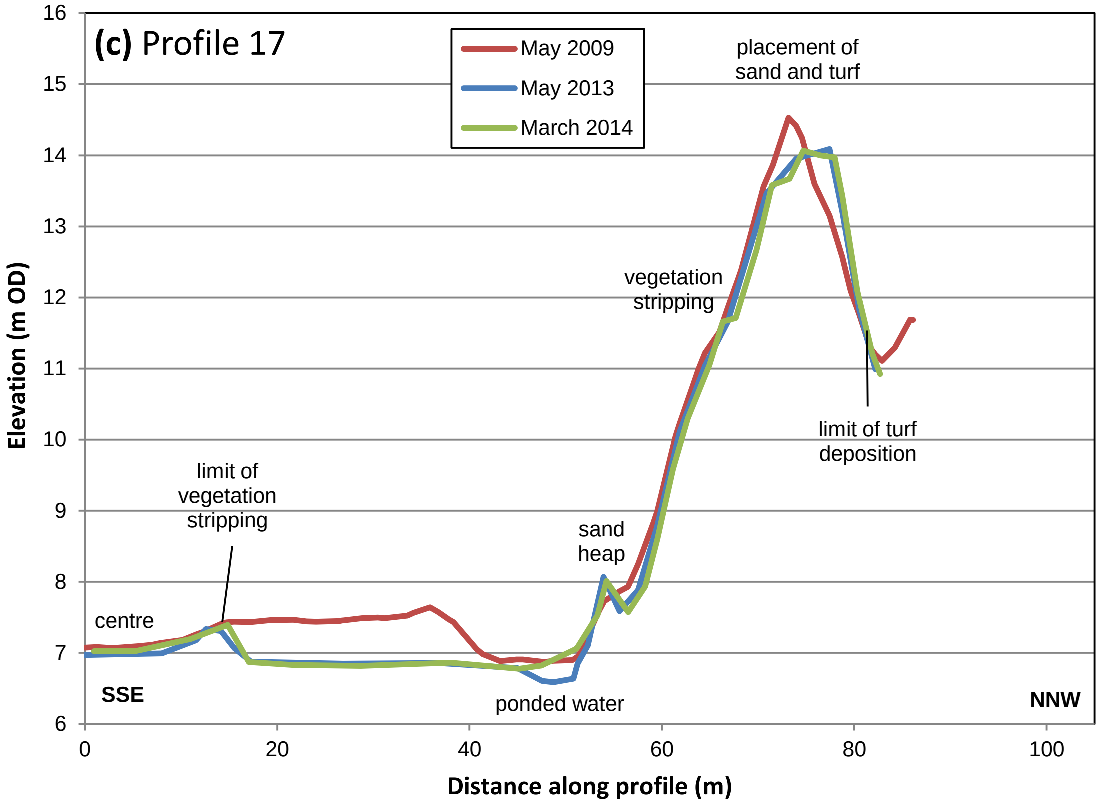


Figure 10. Comparison of surface levels at profiles 15 and 16 in Area 3, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 17 May 2013 and 13 March 2014



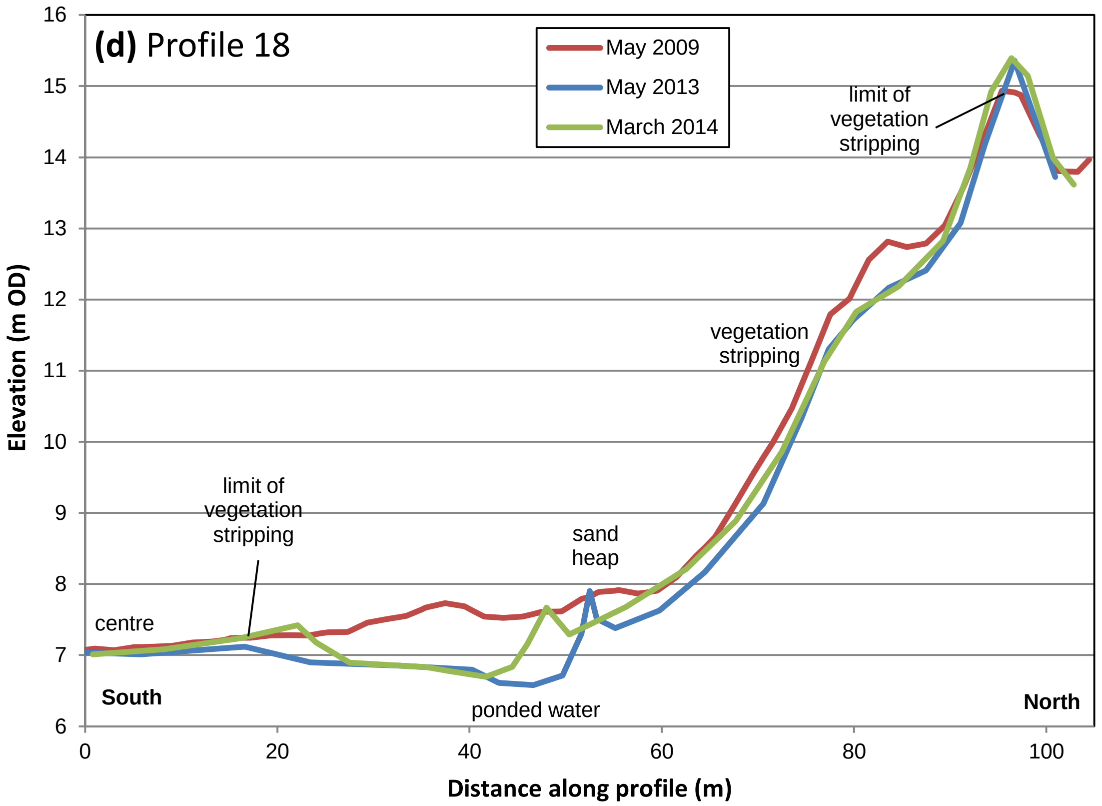
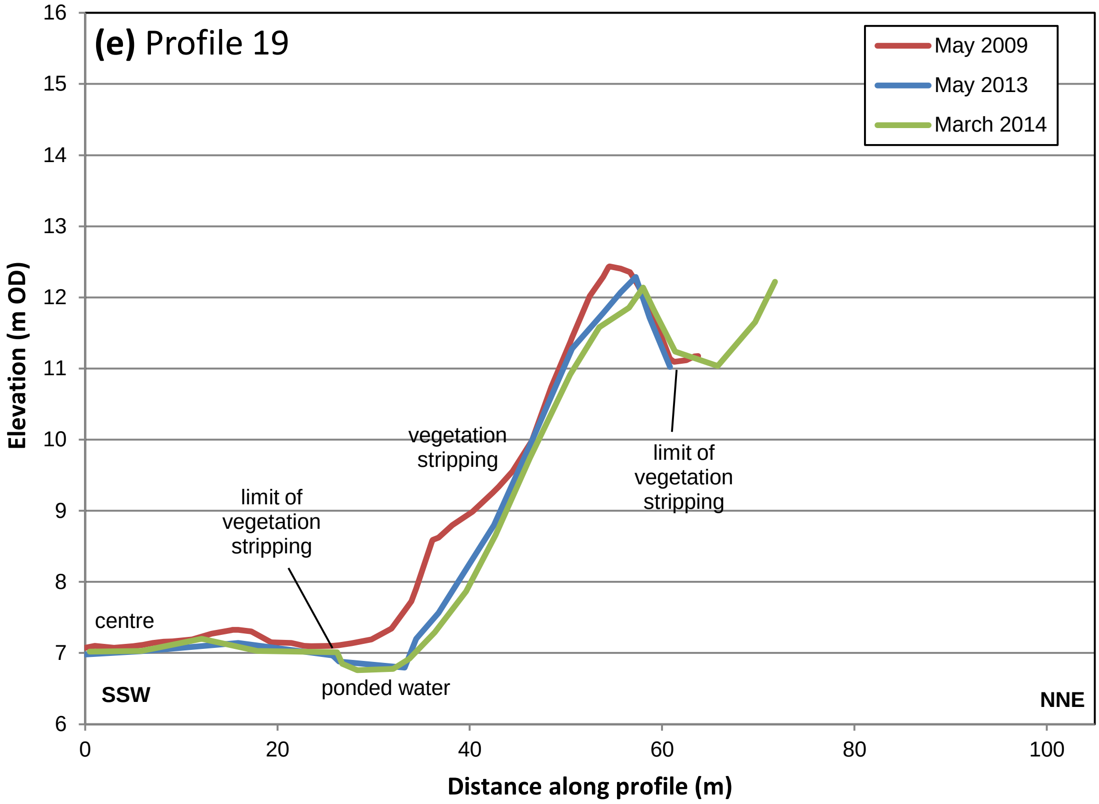


Figure 10. continued. Comparison of surface levels at profiles 17 and 18 in Area 3, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 17 May 2013 and 13 March 2014



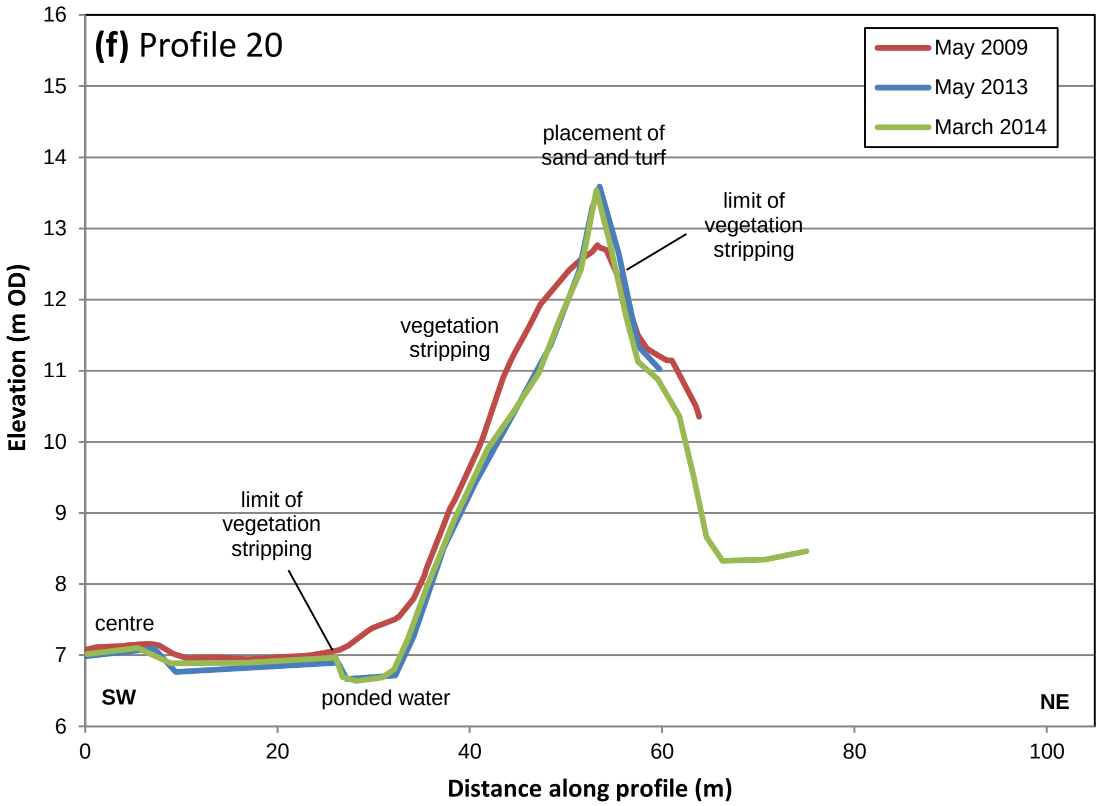
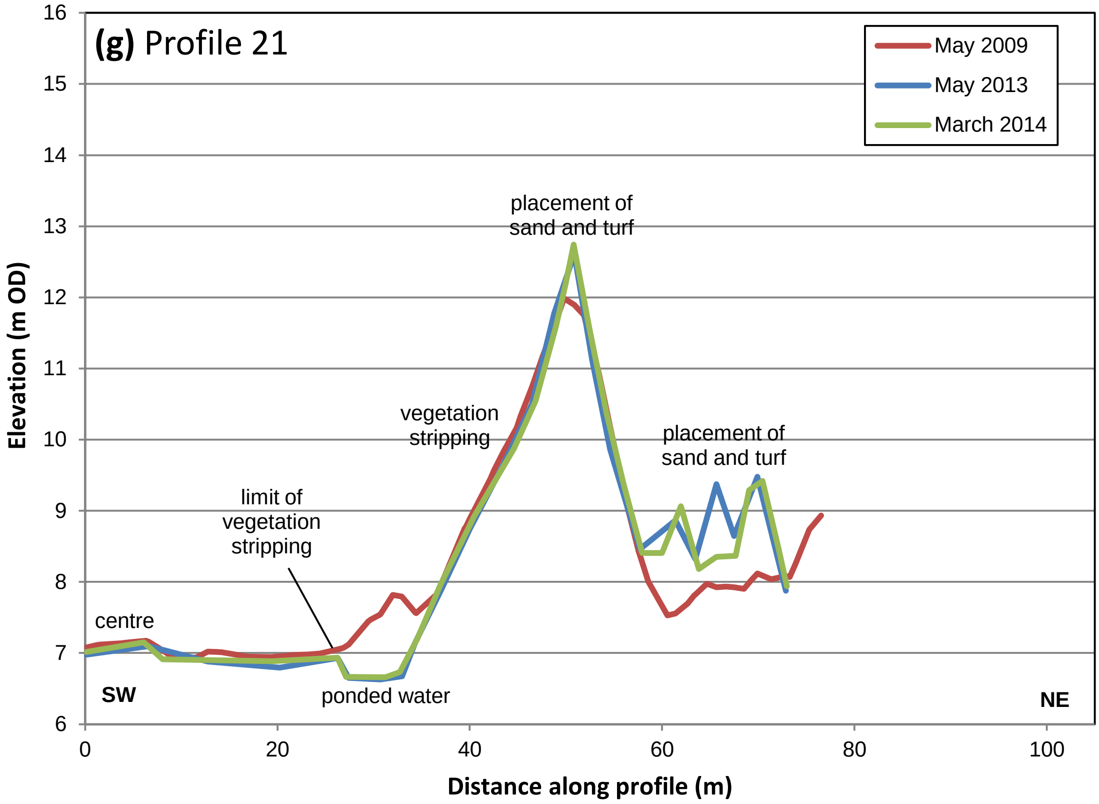


Figure 10. continued. Comparison of surface levels at profiles 19 and 20 in Area 3, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 17 May 2013 and 13 March 2014



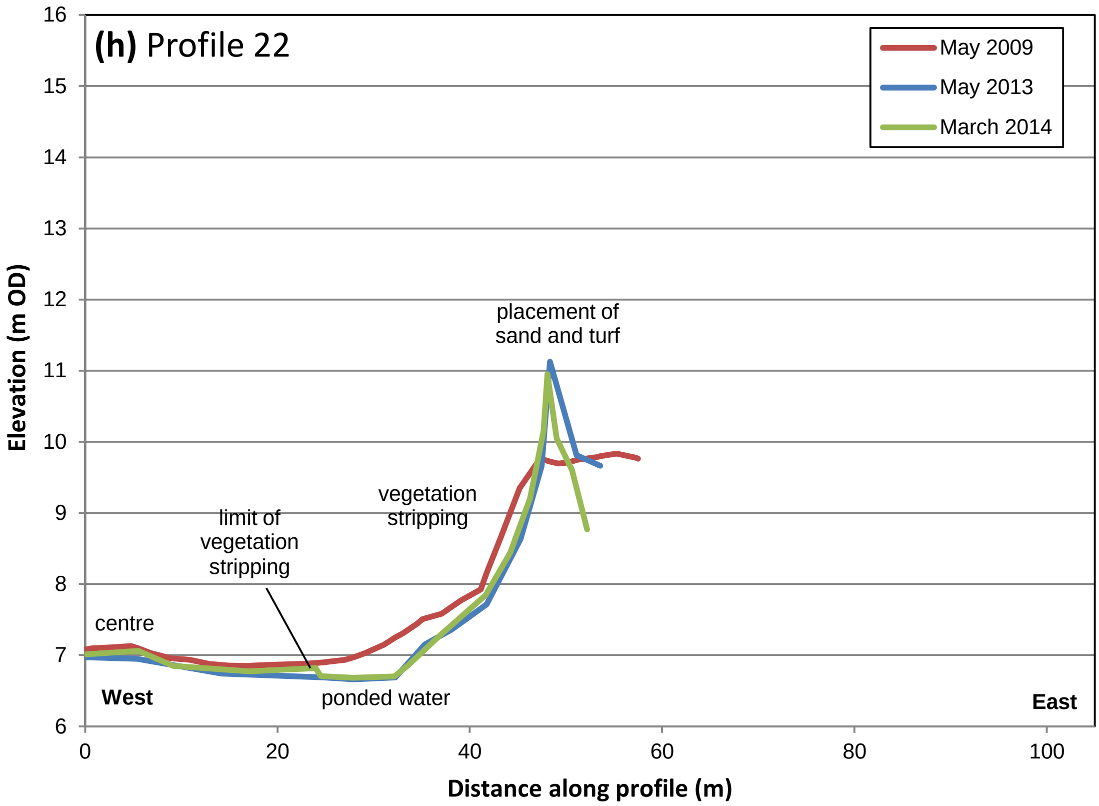
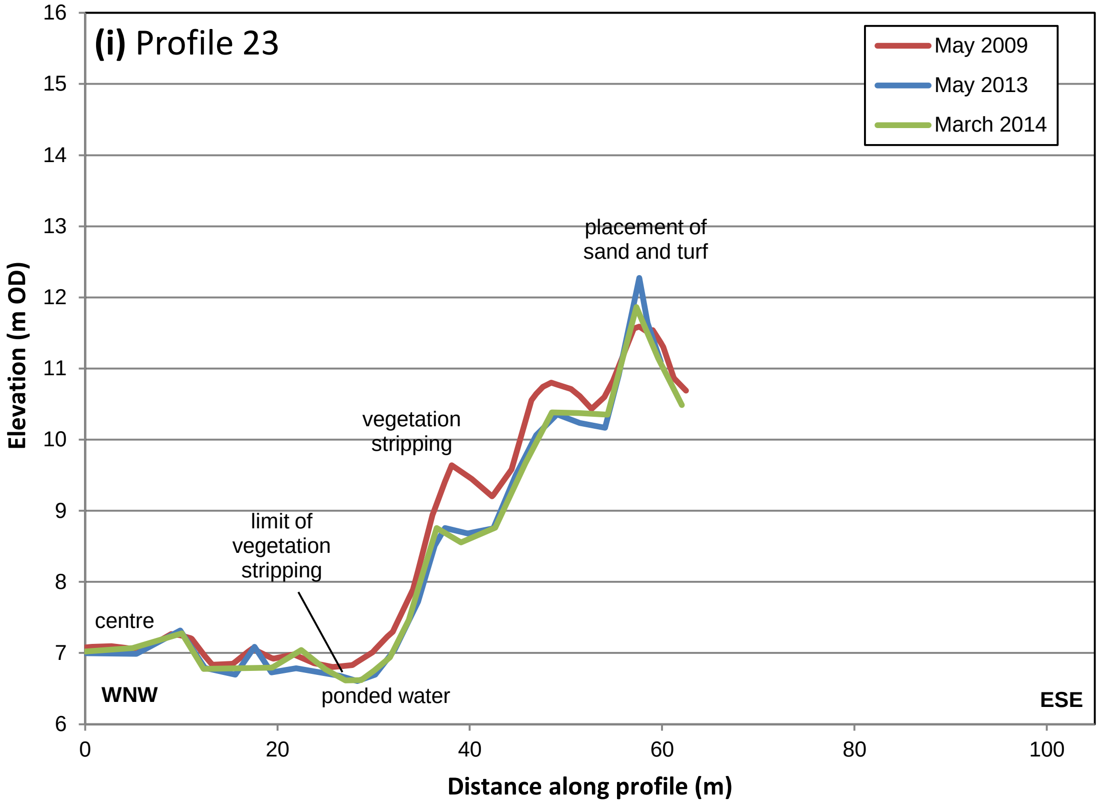


Figure 10. continued. Comparison of surface levels at profiles 21 and 22 in Area 3, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 17 May 2013 and 13 March 2014



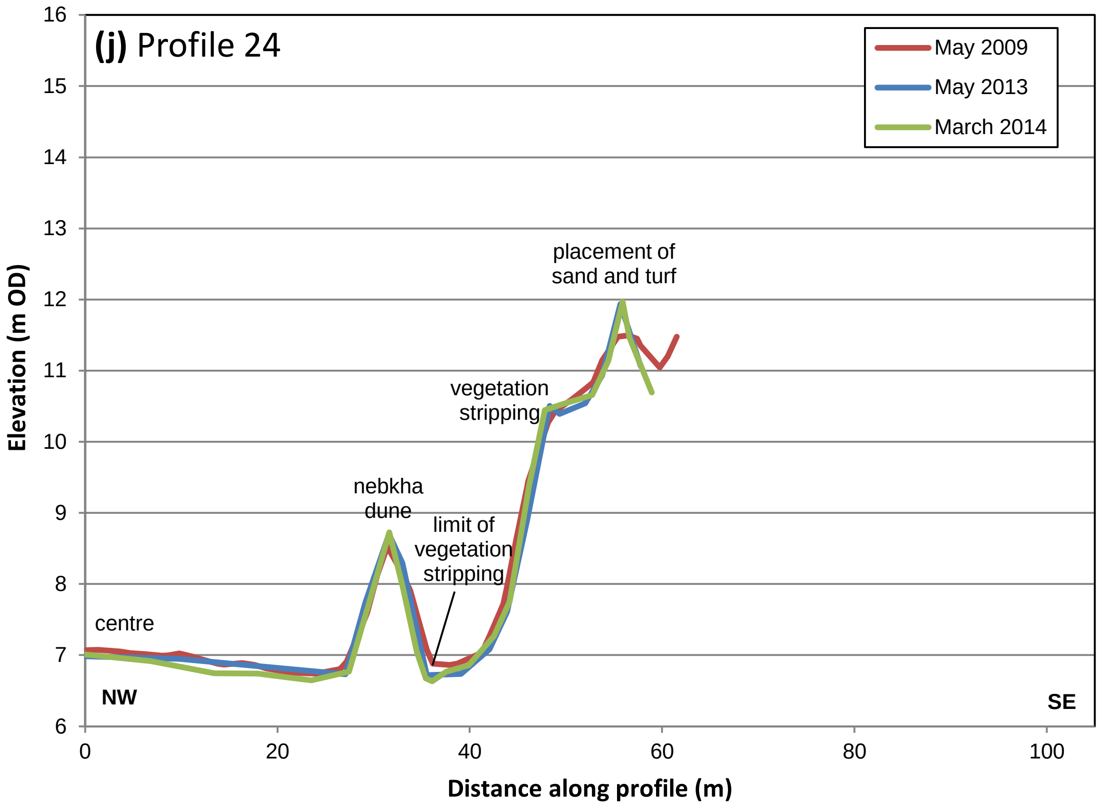


Figure 10. continued. Comparison of surface levels at profiles 23 and 24 in Area 3, indicated by LiDAR survey on 12th May 2009 (pre-works) and ground surveys on 17 May 2013 and 13 March 2014

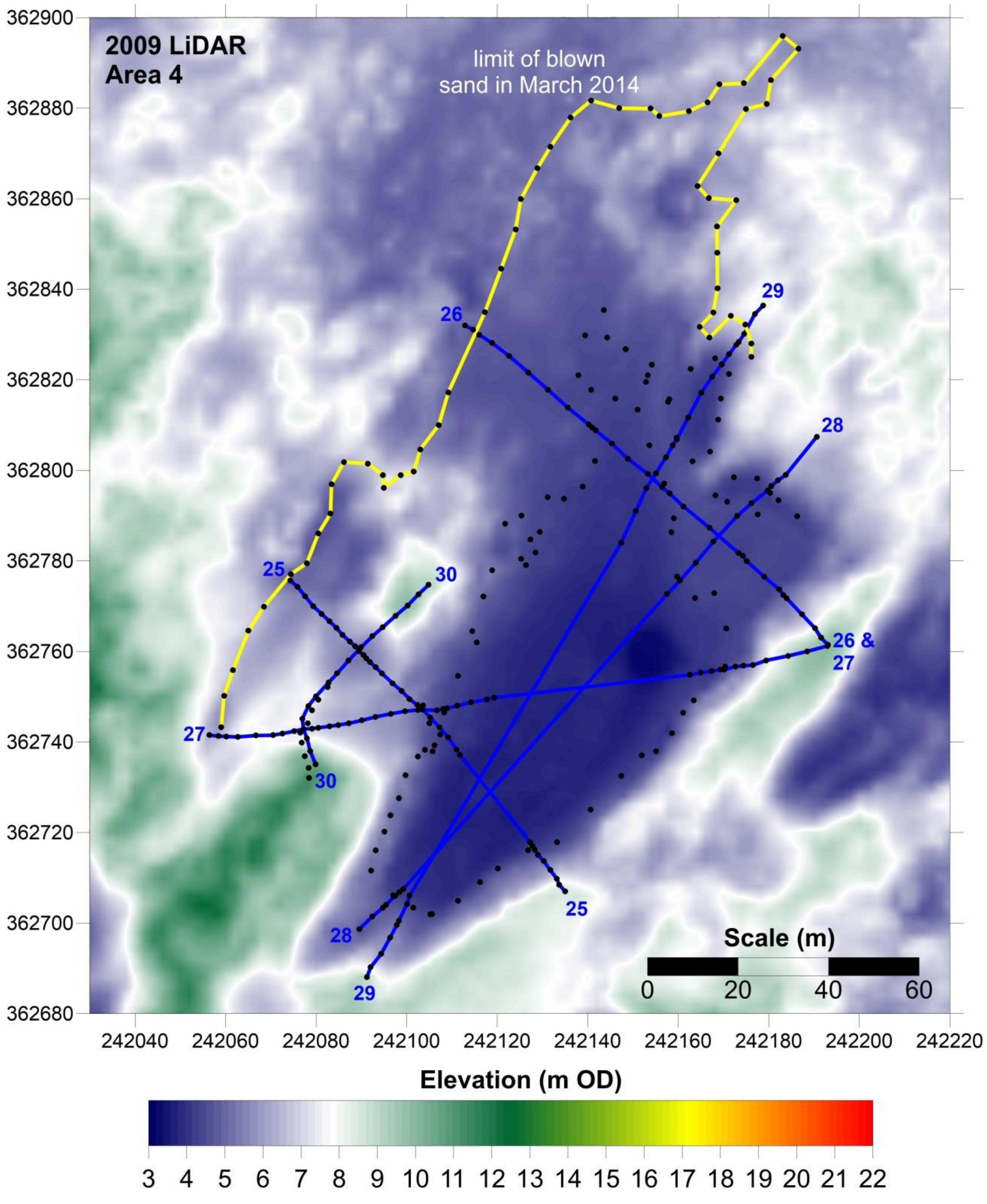


Figure 11. Locations of March 2014 data points (black dots) and cross-profiles (blue lines) in Area 4, overlaid on 2009 LiDAR.

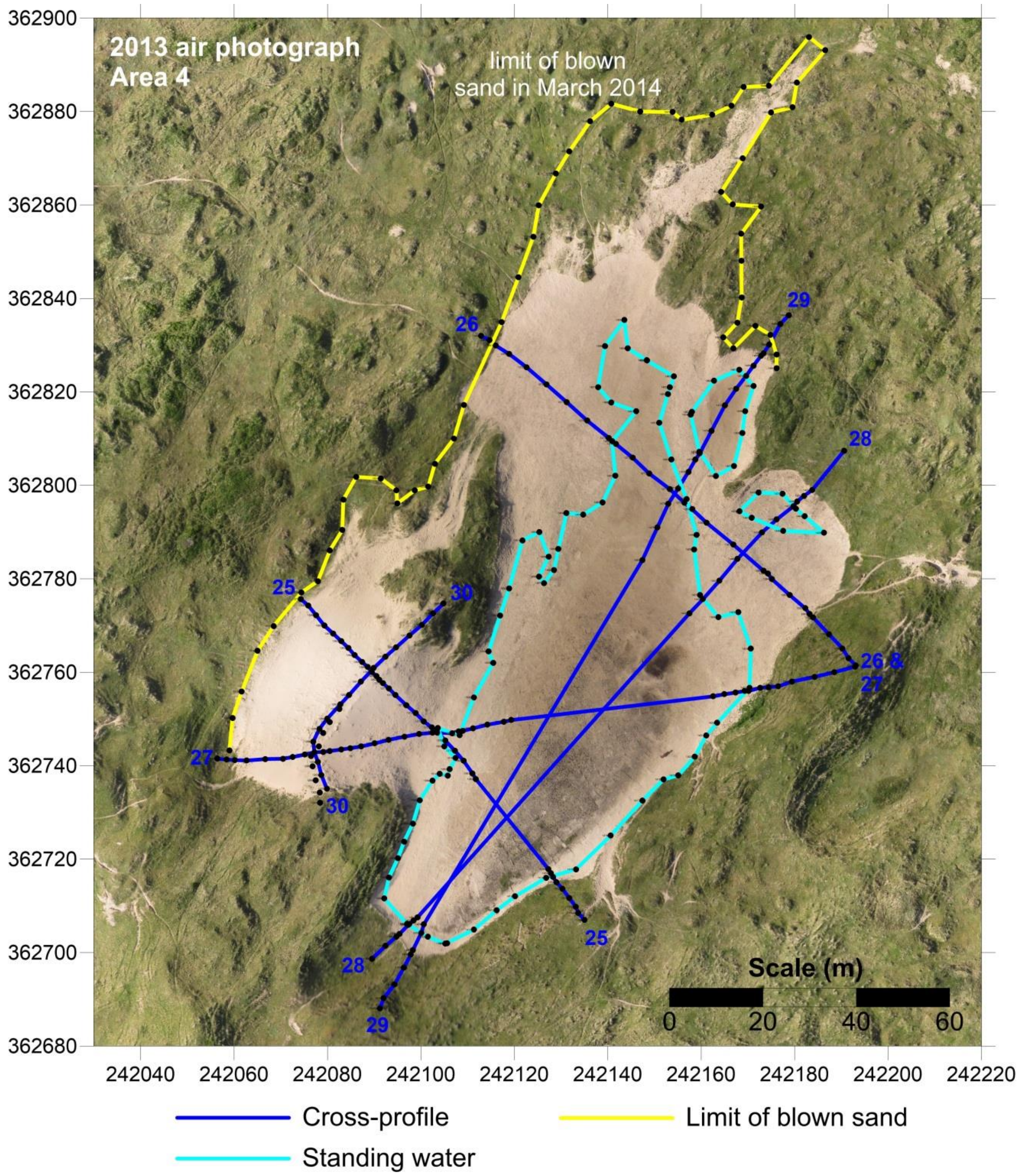


Figure 12. Locations of March 2014 data points (black dots) and cross-profiles (blue lines) in Area 4, overlaid on June 2013 aerial photographs (flown by exeGesIS). The limit of blown sand and areas of standing water surveyed in March 2014 are also shown.

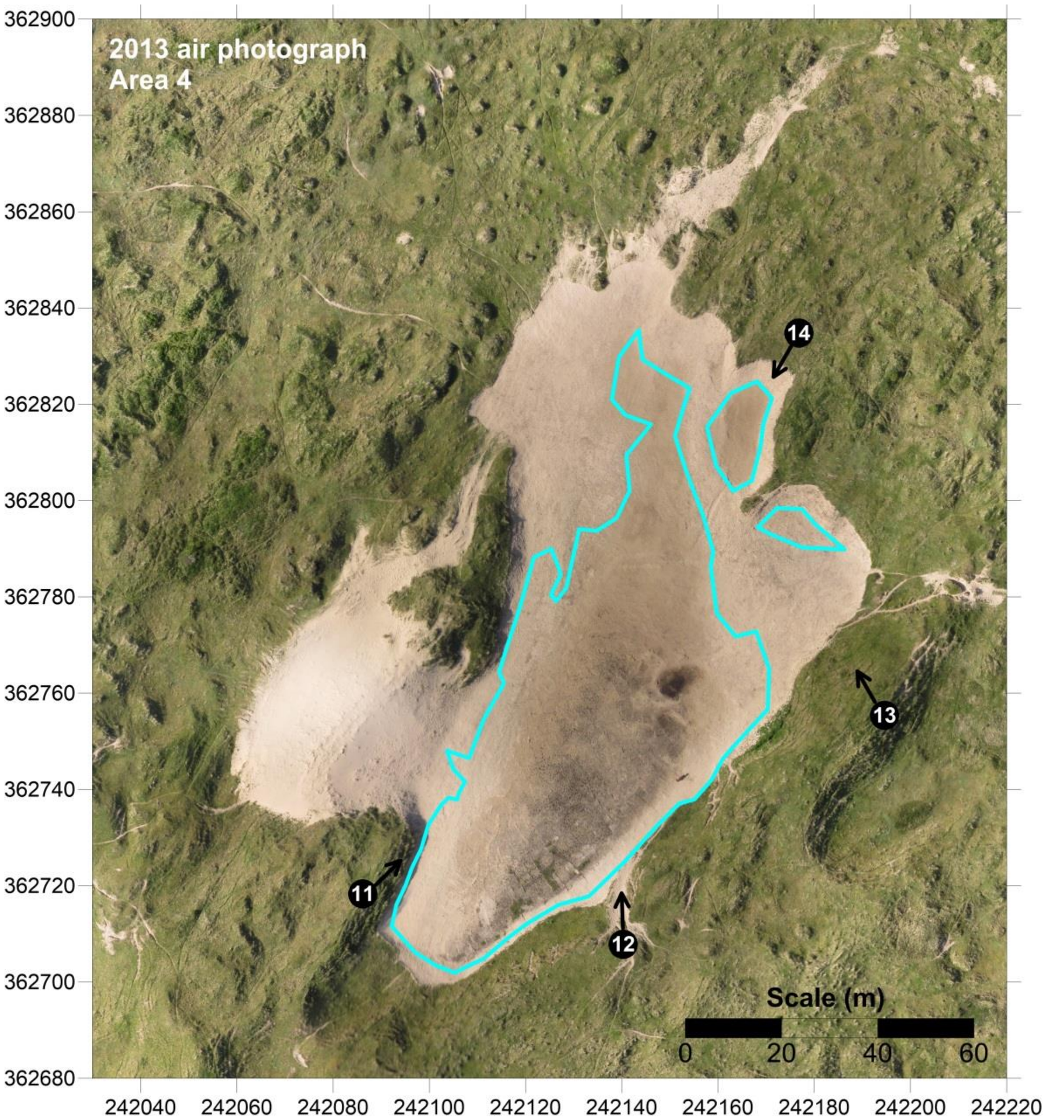


Figure 13. Locations of field photographs 11 to 14 in Area 4 reproduced in this report. Arrows indicate direction of view; base 2013 aerial photography from Google Earth

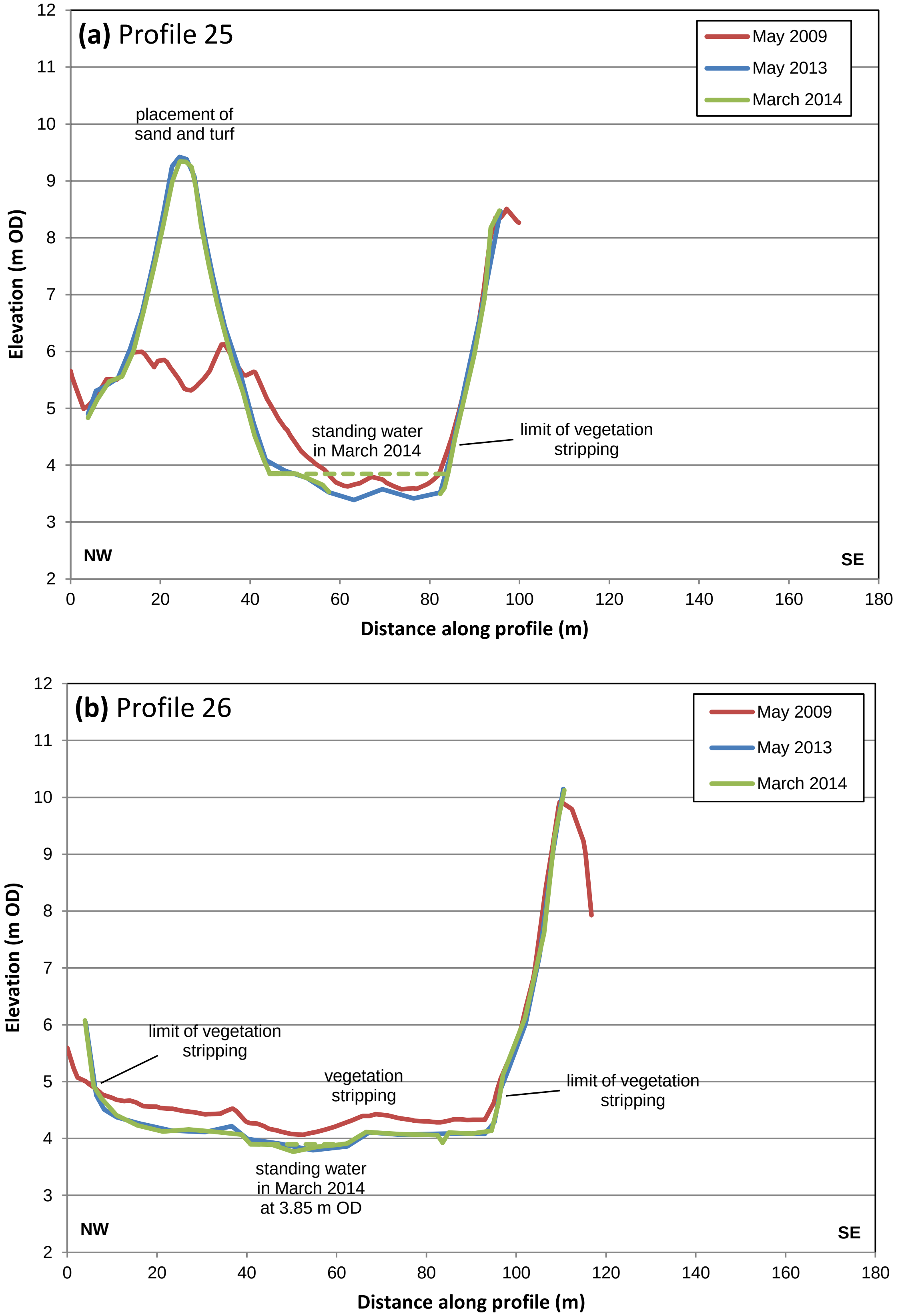
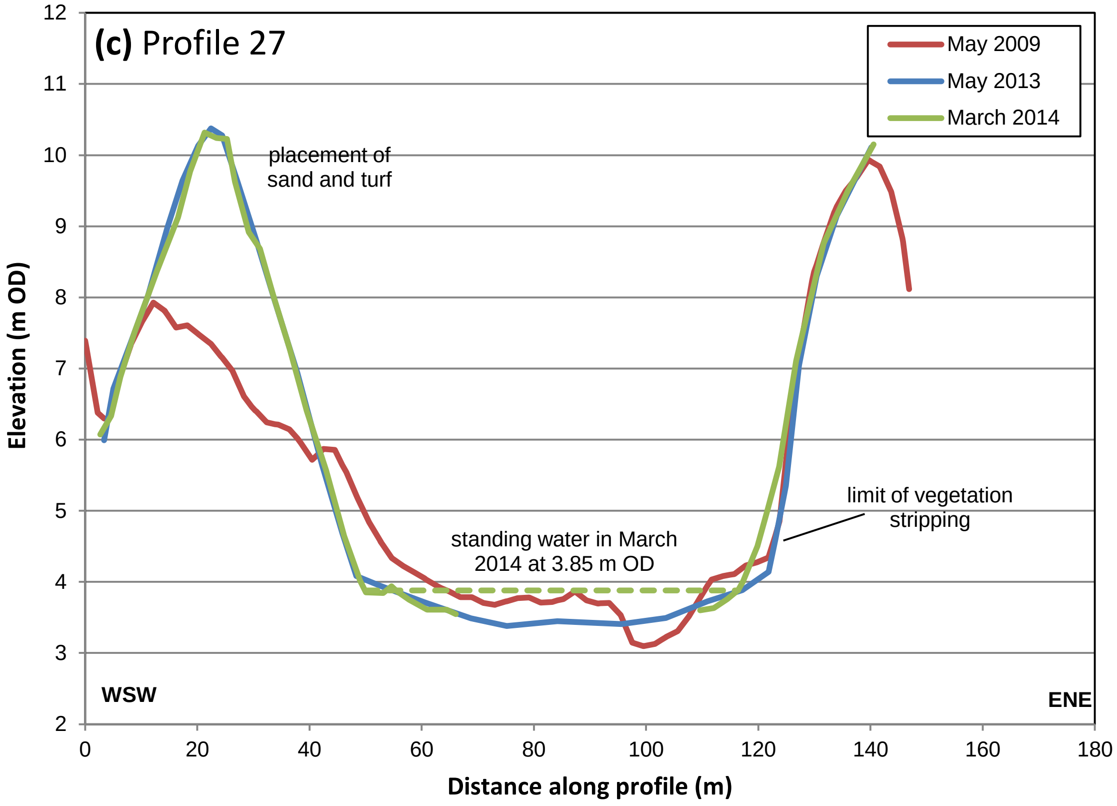


Figure 14. Comparison of surface levels at profiles 25 and 26 in Area 4, indicated by LiDAR survey on 12 May 2009 (pre-works) and ground surveys on 17 May 2013 and 13 March 2014



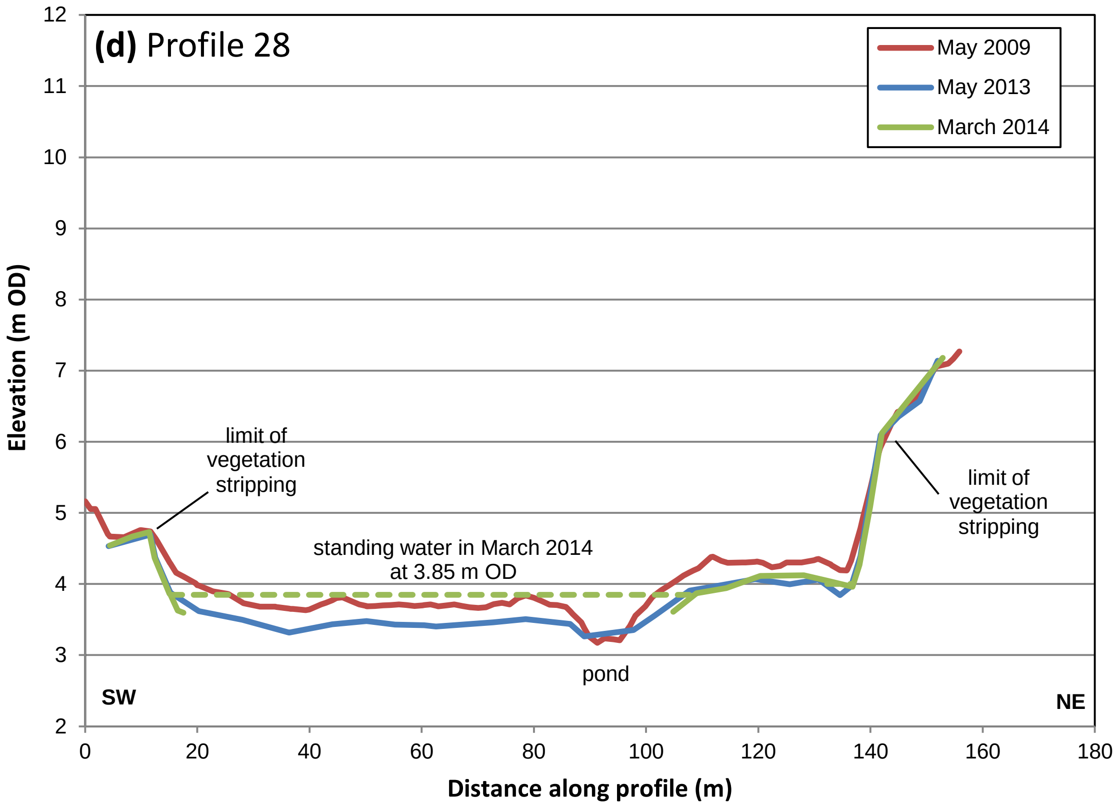
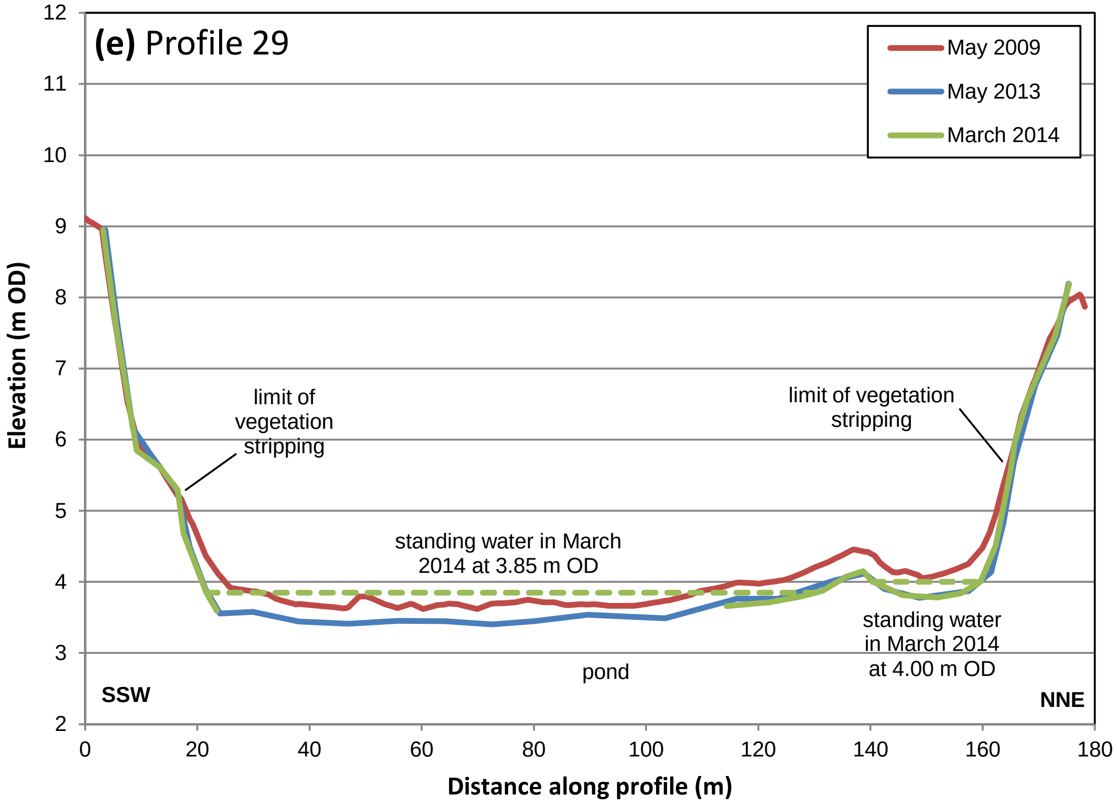


Figure 14. continued. Comparison of surface levels at profiles 27 and 28 in Area 4, indicated by LiDAR survey on 12 May 2009 (pre-works) and ground surveys on 17 May 2013 and 13 March 2014



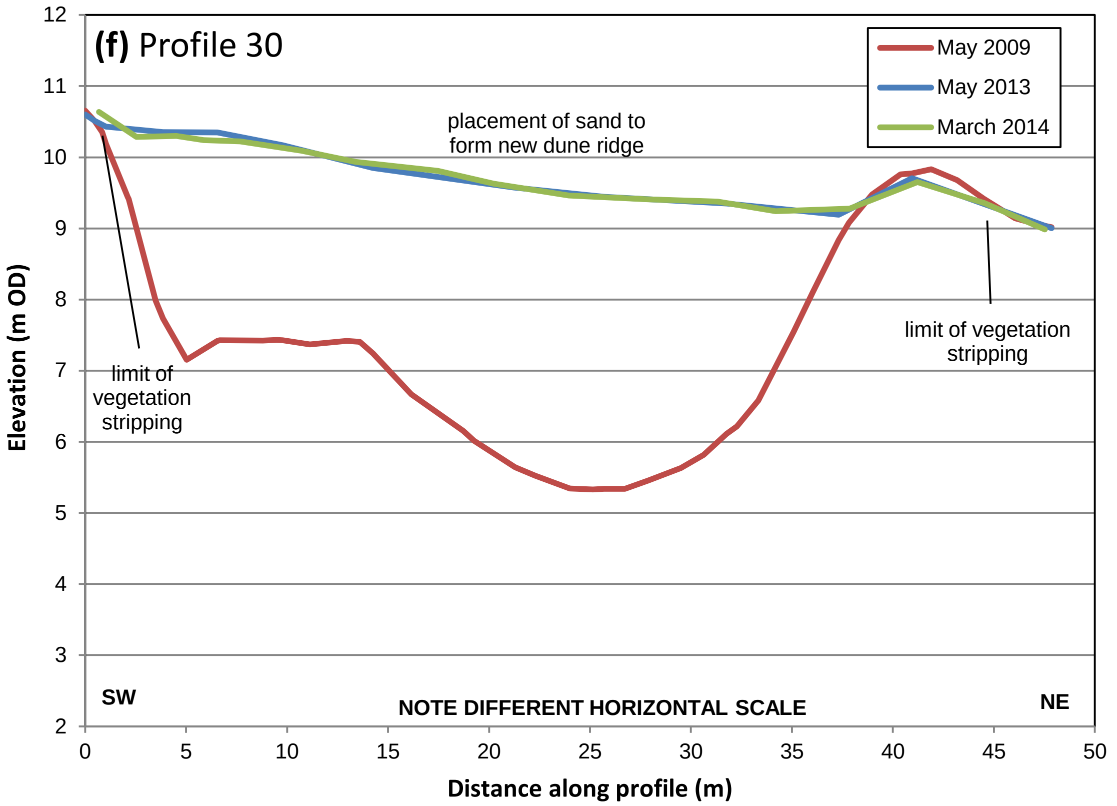


Figure 14. continued. Comparison of surface levels at profiles 29 and 30 in Area 4, indicated by LiDAR survey on 12 May 2009 (pre-works) and ground surveys on 17 May 2013 and 13 March 2014

8.0 Field photographs

Taken 13 March 2014

Photograph 1. Central axis of the Area 2, looking NE

Photograph 2. View across deflation trough of Area 2, looking E

Photograph 3. Southern 'arm' of Area 2, looking seawards

Photograph 4. Deflation corridor of Area 2, looking W

Photograph 5. Central axis of the Area 2, looking SW

Photograph 6. Northern 'arm' of Area 2, looking seawards

Photograph 7. View north across deflation trough of Area 3.

Photograph 8. View seawards along deflation trough of Area 3.

Photograph 9. View north across the dune crest of Area 3.

Photograph 10. Oblique view towards the WSW across the deflation trough of Area 3.

Photograph 11. View west across the flooded 'deflation trough' of Area 4.

Photograph 12. View NE north across flooded 'deflation trough' of Area 4.

Photograph 13. The NE end of the 'deflation trough' of Area 4.

Photograph 14. View east across the inland part of the 'deflation trough' of Area 4.

Data Archive Appendix

Data outputs associated with this project are archived at ‘Newborough Warren Dune Restoration; project 421, media 1489’ 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 13-03-2014.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 [115840]

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