Case study 62. Poole Bay Beach Replenishment Trial

Author: Eleanor Heron

Main driver: Improved defences and trial of a new approach

Project stage: Trial completed

Photo 1: ***Magni-R*** **discharging at the deposition site (source: S. Terry, Borough of Poole)**

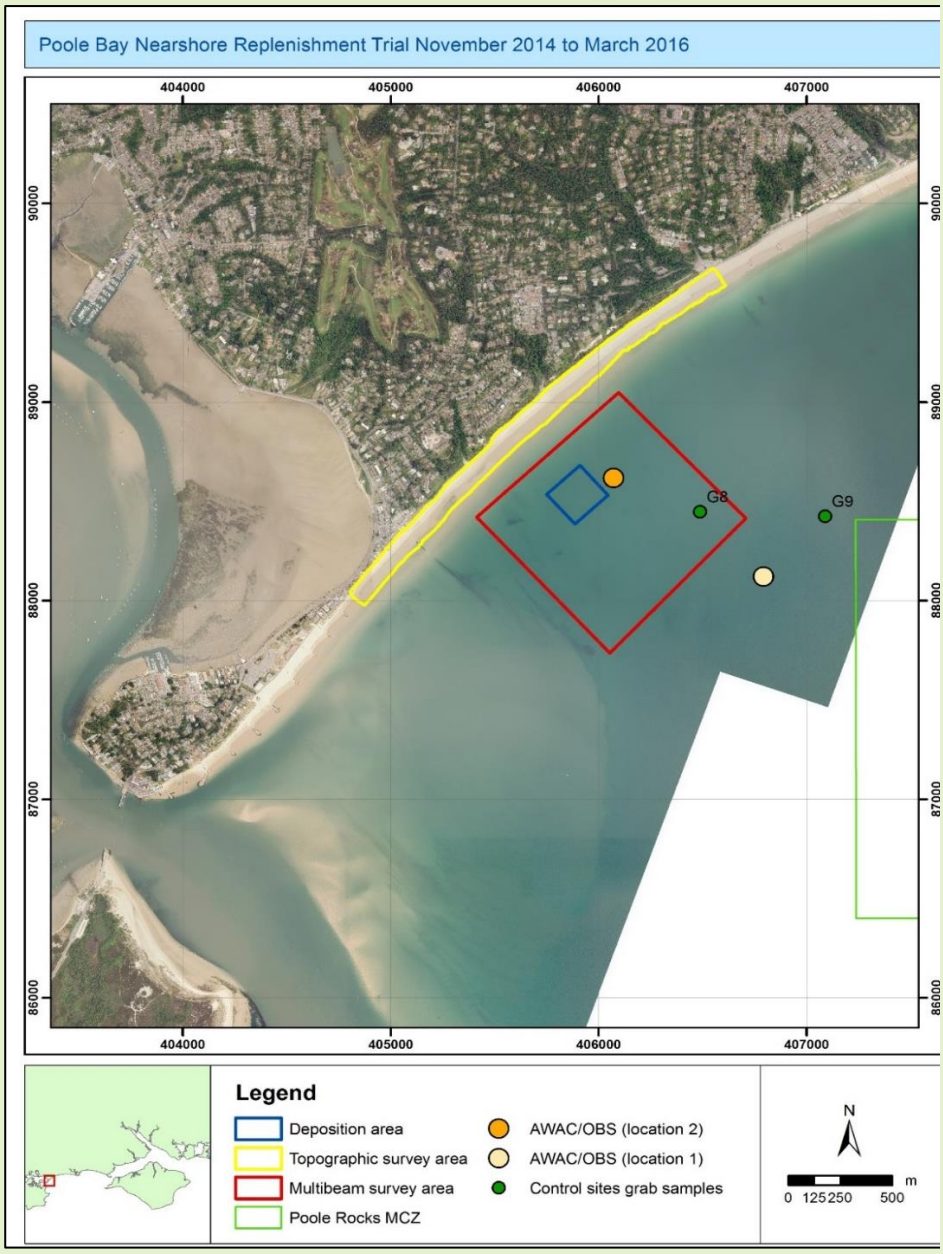
Project summary:

The trial aimed to test a new approach to beach replenishment in Poole Bay on the south coast of England. The concept was to make use of locally dredged sediment and place it in the nearshore, allowing the prevailing waves and tidal currents to move the material toward and along the beach. This approach is used in the Netherlands and more recently in Denmark. The trial is the first of its kind in the UK.

Key facts:

Although it was proven that there is a sediment transport connection between the nearshore and the adjacent beach (that is, nearshore deposition can replenish the beach), it remains difficult to assess the long-term fate of the material.

It is likely that both a larger quantity of material and more time are needed for sediment dispersal at this site to demonstrate the long-term viability of nearshore replenishment as an alternative to traditional methods.



Map 1: Location of Poole Bay beach replenishment trial site and instrumentation (source: Environment Agency 2017)

1. Contact details

Contact details	
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Lead organisation:	Environment Agency
Partners:	Borough of Poole, New Forest District Council (Channel Coastal Observatory) and Standing Conference on Problems Associated with the Coastline (SCOPAC)
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2. Location and coastal/estuarine water body description

Coastal/estuarine water body summary	
National Grid Reference:	SZ0580488389
Town, County, Country:	Poole Bay, Dorset, UK
Regional Flood and Coastal Committee (RFCC) region:	Wessex
Transitional and coastal water body and location:	Poole Harbour
Water Framework Directive water body reference:	GB520804415800
Land use, geology, substrate, tidal range:	Beach

3. Background summary of the coastal/estuarine water body

Socioeconomic/historic context

Poole Bay is a micro-tidal, shallow bay in the English Channel. The western part of the bay is afforded some shelter from the prevailing south-west winds and waves by Durlston Head. Beaches in Poole Bay are generally sandy, in contrast to the extensive shingle and mixed sand/shingle beaches to the west and east respectively. Much of the bay frontage is groyned and backed by a seawall, with extensive beach management and regular large-scale beach replenishment. Poole Bay also contains the recently designated Poole Rocks Marine Conservation Zone, 1km to seaward of the trial area (Environment Agency 2017).

Flood and coastal erosion risk management problem(s)

The standard of flood and coast protection at Bournemouth, Poole Bay and Swanage depends mainly on the level and width of the beaches. The introduction of hard engineering solutions such as seawalls over the last century has prevented the natural supply of beach material from cliff erosion and it is necessary to occasionally replace the loss of beach material lost to longshore drift. Over the past 30 years (between 1970 and 2000), almost 2 million m^3 of sand was used to replenish the beaches at Bournemouth and Poole. The ongoing need for beach replenishment was first identified in the Poole and Christchurch Shoreline Management Plan 1999 and a subsequent report by Halcrow (2004) that suggested that a further 3 million m^3 will be required over the next 50 years to maintain protective beach levels and widths. During the winter of 2005 to 2006, Poole Harbour Commissioners dredged 2 million m^3 of sand from the entrance to Poole Harbour of which 1.1 million m^3 was suitable for beach replenishment. Completed in 2006, the following sand volumes were allocated, 450,000m^3 to Poole, 600,000m^3 to Bournemouth and 90,000m^3 to Swanage.

Other environmental problems

No information provided

4. Defining the problem(s) and developing the solution

What evidence is there to define the flood and coastal erosion risk management problem(s) and solution(s)

No information provided

What was the design rationale?

Nearshore (subtidal) replenishment has been widely employed in the Netherlands and, more recently, in Denmark as a technique to renourish beaches whereby the sediment is deposited typically on an offshore sand bar and, over time, waves transport the sediment to the beach face. The technique promises several advantages over conventional methods of beach renourishment used in the UK, including the potential of being both more economically and environmentally sustainable. Figure 1 shows the sediment mounds once deposited.

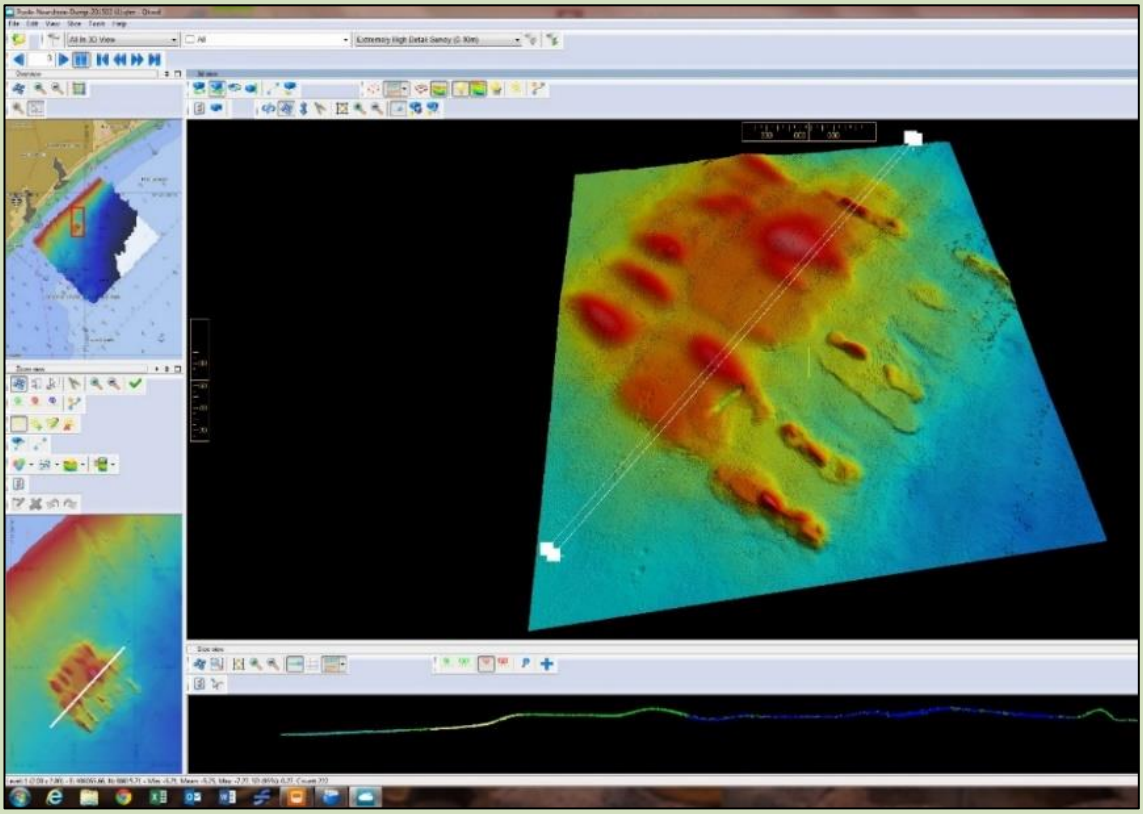

Figure 1: Illustration of sediment mounds on completion of deposition (provisional swath bathymetry data) (source: S. Pearce, Poole Harbour Commissioners)

Project summary	
Area of transitional and coastal water body or length benefiting from project:	Not applicable – the trial was unable to demonstrate the long-term viability of this method over traditional approaches
Types of measures/interventions used (Working with Natural Processes and traditional):	A new approach to beach replenishment that works with natural processes
Numbers of measures/interventions used (Working with Natural Processes and traditional):	Not applicable
Standard of protection for project as a whole:	Not applicable – the trial was unable to demonstrate the long-term viability of this method over traditional approaches.
Estimated number of properties protected:	Not applicable – the trial was unable to demonstrate the long-term viability of this method over traditional approaches

How effective has the project been?

The trial proved that there is a sediment transport connection between the nearshore and the adjacent beach (that is, nearshore deposition can replenish the beach). However, it remains difficult to assess the long-term fate of the material.

It is likely that both a larger quantity of material and more time are needed for sediment dispersal at this site to demonstrate the long-term viability of nearshore replenishment as an alternative to traditional methods.

5. Project construction

How were individual measures constructed?

The area chosen for the nearshore replenishment trial was a $1km^2$ box, ranging in depth from about 4m to 8m Chart Datum (CD). The actual deposition site was to be over about $150m^2$ within the box, depending on weather and tide conditions during the dredge and deposition.

Due to clement sea conditions for the early part of dredging operations, the chosen deposition site was towards the western, shoreward edge of the permitted area, in approximately 5m CD water depth. A total of 33 dredger loads totalling $30,000m^3$ were deposited, forming discernible mounds within the $0.04km^2$ deposition box. After 5 days, dredging activities were suspended by weather but recommenced on 14 February 2015 and the dredger (*Magni-R*; Photo 1) was removed from the site later that day.

How long were measures designed to last?

Not applicable

Were there any landowner or legal requirements which needed consideration?

As a condition of the Marine Management Organisation (MMO) deposition licence, an extensive monitoring programme was required to assess the behaviour of the deposited material. An important secondary requirement was to determine the potential impacts of the nearshore deposition upon sensitive/protected marine features, particularly given the proximity of the Poole Rocks MCZ.

6. Funding

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures	
Year project was undertaken/completed:	2015 to 2016
How was the project funded:	Monitoring was commissioned under the Flood and Coastal Erosion Risk Management R&D Programme (Project Ref. SC130035) funded by Defra, the Environment Agency and the Welsh Government, with additional contributions from Borough of Poole, New Forest District Council (Channel Coastal Observatory) and SCOPAC
Total cash cost of project (£):	As part of this trial, 15 months of intensive monitoring were carried out at a cost of £150,000.
Overall cost and cost breakdown for WWNP/NFM measures (£):	Not applicable
WWNP/NFM costs as a % of overall project costs:	Not applicable

Unit breakdown of costs for WWNP/NFM measures:	Not applicable
Cost–benefit ratio (and timescale in years over which it has been estimated):	Not applicable

7. Wider benefits

What wider benefits has the project achieved?

- It is cheaper. The typical cost of beach replenishment in Poole Bay is £12.50 per m^3 for the usual method of pumping ashore, but £2.70 per m^3 for nearshore replenishment.
- No beach pipeline or operations are needed – this is safer and there is no interruption of beach amenity.
- The local sediment is closer to natural sediment properties.
- The sediment source is sustainable, that is, the trial made use of 30,000m^3 maintenance dredging that would have otherwise been disposed of. Small quantities of dredgings will continue to be available in the future.
- It demonstrates beneficial use of dredgings.
- Poole Bay is a relatively closed system and therefore any recycling of native sediment is useful.
- It aligns the interests of all stakeholder groups (coastal engineers, the Crown Estate, Defra, MMO and dredging industry) who are all seeking to promote sustainable and beneficial use of dredging material.
- It supports the Environment Agency's ambition to work more with natural processes.

How much habitat has been created, improved or restored?

Not applicable

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

Not applicable

Is the project being monitored?

This project included an intensive 15-month monitoring programme (Table 1) designed to help understand what forcing conditions the material had been exposed to and how it had moved both spatially and temporally.

From a scientific and engineering point of view, the primary purpose of the monitoring was to establish whether small volumes of material deposited in the nearshore region can effectively trickle-charge the beach in sufficient quantities to replace the more traditional beach replenishment method.

Monitoring was also required as part of the MMO licence conditions to ensure that the material did not have any adverse effect on the Poole Rocks MCZ, approximately 1km to seaward of the deposition zone.

Table 1: Summary of monitoring programme

What	How	% cost	Lessons learnt
Waves, currents and turbidity	Acoustic wave and current (AWAC) meter 3 months before deposition to 1 year after	41	Expensive Produced vital hydrodynamic information and filled a huge gap in understandings sediment transport
Turbidity	Optical backscatter sensor		Cheap add-on to AWAC but prone to biofouling
Beach change	GPS, laser scan surveys (×6) and profile surveys (×)	7	Effective but survey timing can smooth out short-term sediment transport events
Seabed change	Swath (multi-beam) bathymetric survey (×7) and single beam survey (×1) (see Figure 2)	12	Expensive but crucial to track movement of sediment Difficult to quantify small volumes of change
Sediment movement	Tracer (tracking of fluorescent sand) deposited 2 days before completion of deposition, followed by tracer sweep 3 days and 9 days after tracer insertion (see Figures 3 and 4)	21	Expensive and risky but provided the only definitive proof of concept

Key findings

- Some 14 months after deposition, the mounds remained distinct features, approximately 2m high. The sediment has remained in situ, with only ~1,000 m^3 (~3%) net loss since deposition. Between late December 2015 and April 2016, the mounds rolled forward in a similar manner to the shoreward translation of an offshore bar but, as yet, it is impossible to predict whether the 'bar' will remain as a semi-fixed feature or will migrate onshore.
- Wave-driven (that is, wave shoaling and breaking processes) sediment transport was principally responsible for shoreward translation of the deposition mounds, rather than tidal currents.
- Accordingly, deposition at this site should be as close inshore as practical for sediment to be transported to adjacent shoreline. Deposition in 8m CD is unlikely to be transported cross-shore.
- There is a sediment transport connection between the nearshore and the adjacent beach, that is, nearshore deposition can replenish the beach, but it is difficult to assess the long-term fate of the material.
- Any increased turbidity as a result of the placement of the material was short-lived and highly localised. Turbidity never exceeded naturally occurring turbidity levels.
- The deposition had no discernible or detrimental impact on the Poole Rocks MCZ.

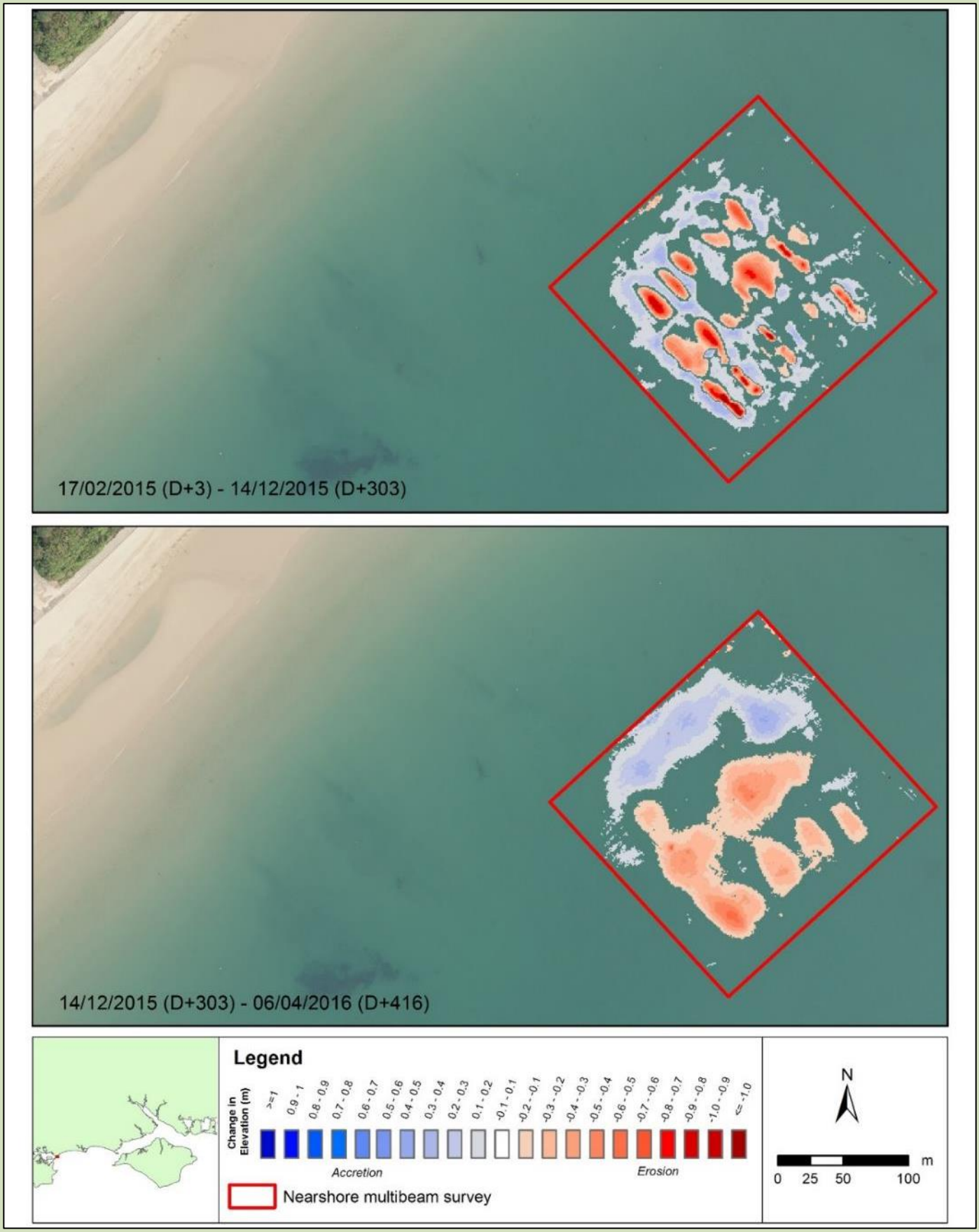

Figure 2: Bathymetric difference models post-deposition to December 2015 (top panel) and December 2015 to April 2016 (bottom panel) (source: Environment Agency 2017)

Figure 1Field-based tracer result, Search 2 (all samples) (source: Environment Agency 2017)

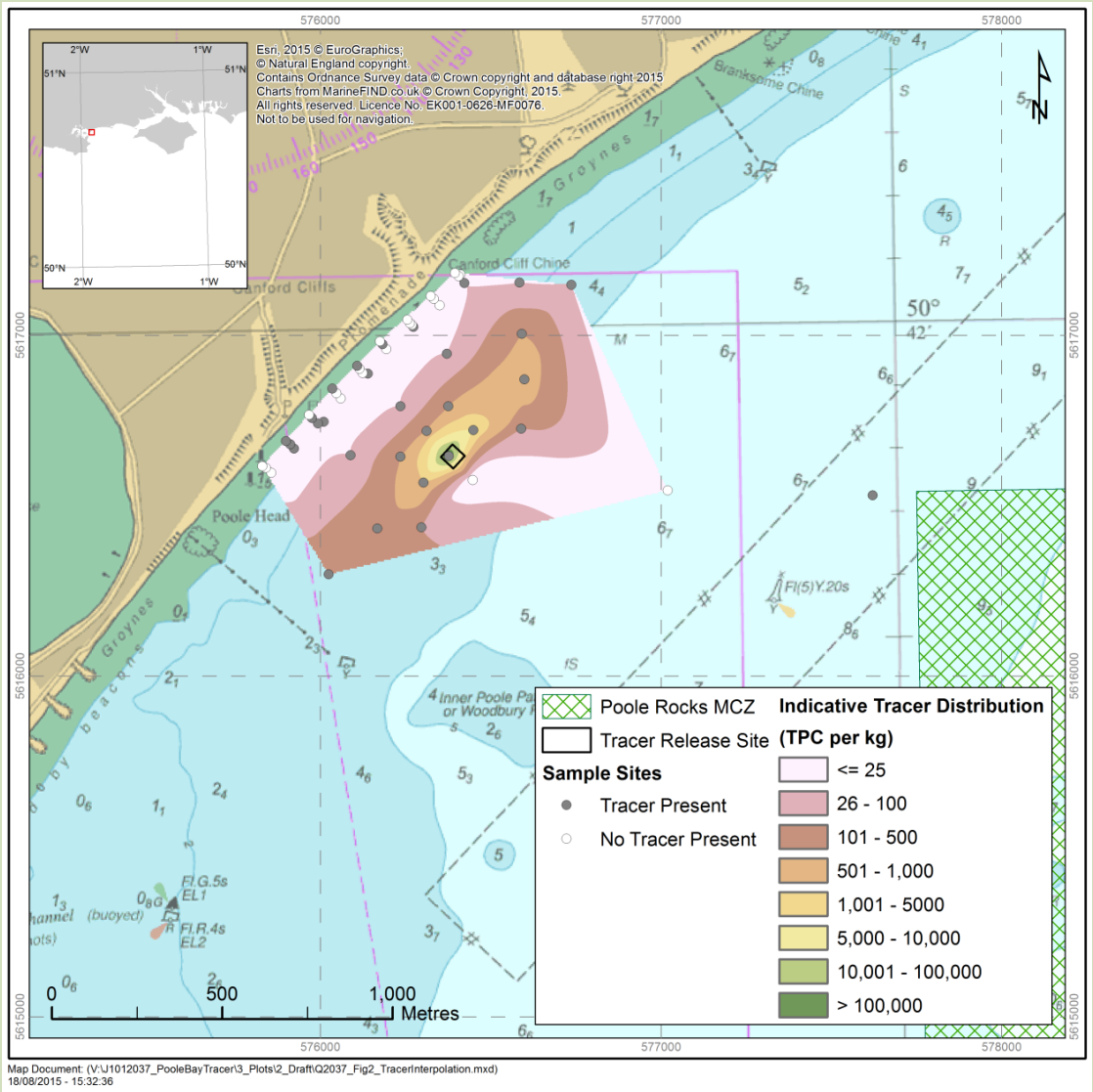

Figure 4: Results from tracer laboratory enumeration (source: Environment Agency 2017)

Has adaptive management been needed?

Not applicable

9. Lessons learnt

The success or otherwise of the technique of nearshore replenishment is clearly dependent on a wide range of site-specific conditions, where even subtle differences in tidal currents, wave period and direction can have a significant influence on net sediment transport in the nearshore region. For example, tidal currents are quite small in Poole Bay and therefore the results may not necessarily be applicable to meso- or macro-tidal coastlines (that is, much of English and Welsh coastline). As a result, it would not be appropriate to extrapolate the results from this study to other coastlines or to draw conclusions on the transferability of the method to other sites. However, it is thought that if this approach was to be trialled elsewhere the preference for shallower deposition (closer to surf zone) is likely to apply widely.

The following lessons were learnt for carrying out similar sediment monitoring.

- Benefits of swath bathymetry results far outweigh cheaper single beam surveys.
- Absolute measurements of turbidity are instrument-dependent.
- Small net volumes of sediment change are difficult to identify even from high precision bathymetric and

topographic surveys.

- If hydrodynamic conditions are needed (for example, for calibrating a sediment transport model), it is thought that a short-term AWAC deployment would be sufficient.
- It is thought that the site-specific results would be representative of much of Poole Bay, so there would be no need for extensive further monitoring, particularly of turbidity.

10. Bibliography

ENVIRONMENT AGENCY, 2017. *Poole Bay nearshore beach replenishment trial report*. Report SC130035. Bristol: Environment Agency.

Project background

This case study relates to project SC150005 'Working with Natural Flood Management: Evidence Directory'. It was commissioned by Defra and the Environment Agency's Joint Flood and Coastal Erosion Risk Management Research and Development Programme.