

## **Northumberland and North Tyneside Rocky Foreshore 'Coastal Squeeze' Study**

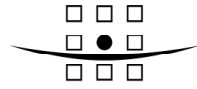
Northumberland County Council  
& North Tyneside Council

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Study Report

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## GLOSSARY OF TERMS AND ABBREVIATIONS

EMS	European Marine Site
GIS	Geographical Information System
ha	Hectares
HTL	Hold the Line (a Shoreline Management Plan policy)
LiDAR	Light Detection and Range
MA	Management Area (a sub-division of a Policy Development Zone)
MLW	Mean Low Water
MLWN	Mean Low Water Neap
MLWS	Mean Low Water Spring
MR	Managed Realignment (a Shoreline Management Plan policy)
NAI	No Active Intervention (a Shoreline Management Plan policy)
PDZ	Policy Development Zone (a sub-division of the coast)
PU	Policy Unit (a sub-division of a Management Area)
SMP	Shoreline Management Plan (produced in 1999)
SMP2	2 <sup>nd</sup> generation Shoreline Management Plan (produced in 2009)
SMP3	3 <sup>rd</sup> generation Shoreline Management Plan (for future production)
SPA	Special Protection Area
UKCP09	United Kingdom Climate Projections 2009

## DEFINITION OF POLICY DEVELOPMENT ZONES (PDZs)

PDZ1	Scottish Border to Bamburgh (including Holy Island)
PDZ2	Bamburgh to Boulmer
PDZ3	Seaton Point to Beacon Hill
PDZ4	Beacon Hill to Beacon Point
PDZ5	Newbiggin Moor to Seaton Sluice
PDZ6	Seaton Sluice to River Tyne

## 1 INTRODUCTION

The Northumberland and North Tyneside *Rocky Foreshore 'Coastal Squeeze' Study* commenced in March 2010 as a means of providing a quantitative assessment of the gains and losses of inter-tidal rocky reef and foreshore habitat associated with implementation of the preferred policies of the second generation *Shoreline Management Plan* (or 'SMP2').

To ensure direct compatibility between the *Coastal Squeeze Study* and the SMP2, the same sub-division of the coast into Policy Development Zones (PDZs), Management Areas (MAs) and Policy Units (PUs) provided the basis for both studies.

In April 2010 a Scoping Report was produced as part of the *Coastal Squeeze Study* which provided detailed information on:

- The study background and its links with the SMP2;
- The principles of 'coastal squeeze' and associated loss of rocky foreshore;
- The study aims and general study methodology;
- Existing information and data that was available for use on the study;
- Consultation approaches adopted and responses received;
- How 'rocky foreshore' across the Northumberland and North Tyneside coastal frontages was defined and mapped;
- What climate change projections were used on the study;
- How the 'coastal squeeze' analysis would be undertaken.

The above information has not been repeated in this report.

One of the key findings from the Scoping Report was that the Environment Agency's Lidar data, which was intended to be used as the key dataset on the study, only covered down to Mean Low Water (MLW) across one Policy Development Zone (PDZ) of the coastal frontage. This was considered insufficient for purposes of the study and, through agreement with the Steering Group it was decided to:

- Use the existing Environment Agency Lidar data across PDZ3 (where coverage down to MLW was attained) as a 'pilot' to demonstrate that the proposed methodology was suitable; and
- Await Lidar data from the Cell 1 Regional Monitoring Programme later in 2010 for use across the other PDZs within the study frontage (including a re-assessment of PDZ3 using the new Lidar data to ensure that a consistent dataset was used across the SMP2 frontage).

The 'pilot' demonstration of the methodology across PDZ3 was completed in July 2010 and proved the methodology to be effective and met with agreement from the Steering Group.

The Cell 1 Regional Monitoring Programme then provided its Lidar data in August 2010 (having been flown in stages between spring and late summer 2010), enabling the 'coastal squeeze' analysis to be completed and this Study Report to be produced.

This Study Report now builds from the earlier Scoping Report and presents the following information:

- (1) **Summary of Methodology** – a brief summary of the methodology used during the study (full details are available in the earlier Scoping Report) and highlighting of the uncertainties in assessment.
- (2) **Results** – the identification and quantification of potential areas of Coastal Squeeze, including an assessment of opportunities for rocky shore habitat creation.
- (3) **Implications for SMP3 and Future Monitoring** – assessment of the implications of the study findings with respect to both the future SMP3 and the future coastal monitoring.

## 2 SUMMARY OF METHODOLOGY

### 2.1 Background

As previously described in detail in the Scoping Report, the analytical methodology involves:

- Defining the **Baseline** (present day):
  - Policy Development Zones (PDZs), Management Units (MUs) and Policy Units (PUs) as contained within the Shoreline Management Plan 2 (SMP2)
  - Shoreline Position
  - Mean Low Water (MLW)
  - Rocky Foreshore areas
- Calculating (in hectares) the **Baseline**:
  - Total Foreshore Area (Shoreline Position to MLW)
  - Rocky Foreshore Area (down to MLW)
  - Other Foreshore Area (e.g. sand or gravel)
- Defining the **future epoch** (2025, 2055 and 2105):
  - Shoreline Management Plan Policy
  - Shoreline Position (under the relevant SMP policy)
  - Mean Low Water (MLW) (taking into consideration sea level rise)
- Calculating (in hectares) the **future epoch** (2025, 2055 and 2105):
  - **Loss** in Total Foreshore Area, Rocky Foreshore Area, and Other Foreshore Area due to submergence caused by sea level rise (i.e. rising MLW)
  - **Gain** in Total Foreshore Area due to landward recession of the cliffs or dunes overlying a hard rock base due to SMP policies of No Active Intervention (NAI) or Managed Realignment (MR) <sup>1, 2</sup>
- Determining the **net change** (loss or gain) in Total Foreshore Area and Rocky Foreshore Area based on the above loss and gain calculations.

As this study is closely linked to the SMP, all calculations are being undertaken on an individual Policy Unit (PU) basis for each epoch and then aggregated across the PDZs in summary form.

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<sup>1</sup> It is assumed that the bedrock underlying the existing cliff or dune (where fronted by a rocky shore platform) will become exposed due to erosion of the cliff or dune under policies of NAI or MR, thereby creating new rocky foreshore area in the area between the baseline Shoreline Position and the 'new' Shoreline Position for that epoch.

<sup>2</sup> Where existing shore platform is partly covered by a veneer of sand, pebble or cobble it has not been assessed as rocky foreshore in the analysis. In reality, as sea level rises, the landward transfer of the 'energy profile' will mobilise this sediment from the foreshore, uncovering presently buried rocky foreshore and thereby creating 'new' exposed rocky foreshore area. It is assumed that any such uncovering is equivalent to the anticipated covering by mobile beach sediment of any newly-created rocky foreshore areas caused by cliff or dune erosion.

## 2.2 Refinement of Methodology

When the previously agreed methodology was applied across the whole SMP2 area, it became apparent that the method for calculating gains in rocky foreshore needed local refinement along some Policy Units in order to avoid over-estimating the value of habitat gains involved. It should be noted, however, that in most Policy Units, the previously agreed methodology remained valid.

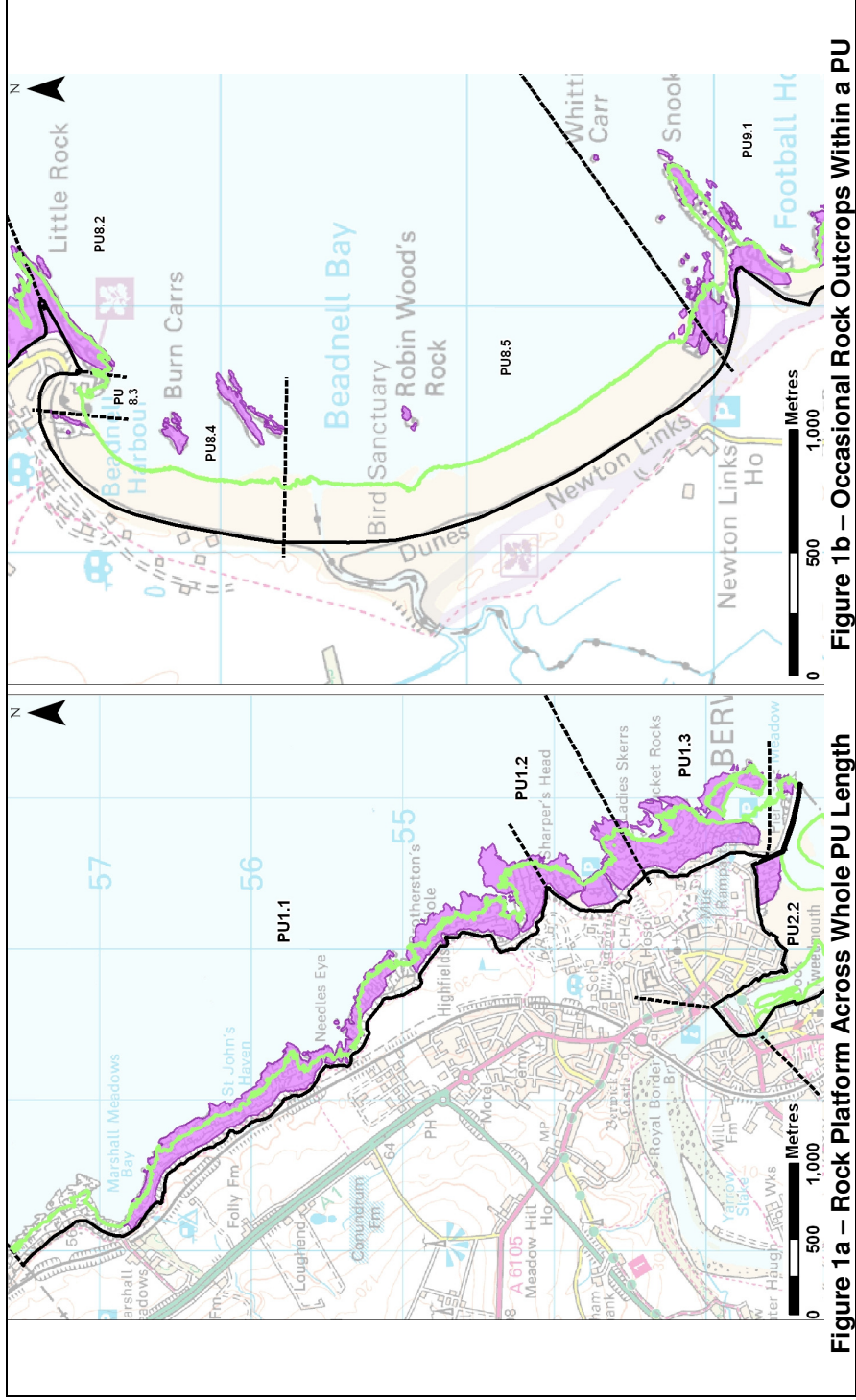
The method for assessing gains in rocky foreshore habitat involved calculating the area of rock that would emerge at the toe of the cliffs or dunes due to coastal erosion under NAI or MR policies. This was based on the previously-defined SMP2 erosion lines for epochs to 2025, 2055 and 2105.

In the majority of Policy Units the assumption that rock would emerge along the whole PU length due to this erosion is realistic because the existing rocky foreshore areas extend along the entirety or majority of the Policy Unit frontage. An example of this is presented in Figure 1a, which shows the continuous extent of rocky foreshore across PU1.1, PU1.2 and PU1.3. Here it is entirely reasonable to assume that as the cliffs erode, then new rock platform will emerge and become part of the rocky foreshore habitat.

In a small number of PUs, however, the extent of existing rocky foreshore habitat is more limited. Figure 1b presents the example of Beadnell Bay where both PU8.4 and PU8.5 possess some rocky foreshore, but only as discrete reefs rather than a continuous uninterrupted extent of foreshore platform. In this example, it is most likely that erosion of the dunes will result in the emergence of occasional rock patches, rather than an uninterrupted extent of new continuous rocky foreshore. To account for this, the PU frontage was subdivided further within the Geographic Information System (GIS) and calculations of potential gains were only performed in those sub-sections of the PU immediately in the lee of such outcrops, with the remaining (longer) sections of PU frontage assumed to erode, but result in no new rocky foreshore gain. Whilst this has introduced a degree of subjective judgement to the analysis, to have adopted the originally agreed approach of assuming that all erosion will result in emerging rocky foreshore would have over-estimated the likely situation.

This refinement to the methodology was only necessary to apply to those PU frontages where the SMP2 policy was NAI or MR and where the existing defined 'rocky foreshore' was predominantly characterised by isolated reefs or outcrops rather than a continuous or near continuous platform within the PU. The following PUs received this subtle refinement of approach:

Policy Unit	General Location
PU8.4	Beadnell Bay
PU8.5	
PU12.1	Foxton
PU14.1	Birling Carrs
PU16.3	Southern end of Amble to High Hauxley
PU17.3	Bondi Carrs and Hadston Carrs



## 2.3 Uncertainties in Assessment

It is important to recognise that uncertainties exist in the assessment. In order that the methodology represents the best possible approach, these uncertainties have been reduced, as far as practicable, by using datasets that are from known and previously reviewed and accepted sources, including:

- **SMP2 Policies** - as defined by the SMP2 for each Policy Unit
- **Baseline Shoreline Position** – as defined by the SMP2.
- **Mean Low Water**<sup>3</sup> – as defined by UK Hydrographic Office and as used in the SMP2.
- **Rocky Foreshore Area (Northumberland)** – as defined by the Northumberland Biodiversity Partnership and used in developing the SMP2.
- **Rocky Foreshore Area (North Tyneside)** – as mapped for this study from recent aerial photographs.
- **Future Epoch (2025, 2055 and 2105) Shoreline Positions** – as defined by the SMP2 under the relevant shoreline management policy for each epoch (the SMP2 based its erosion assessments on a combination of historic map evidence and contemporary monitoring data available from 2001).
- **Sea Level Rise** – based on the 50 percentile value of the medium greenhouse gas emissions scenario as defined by UKCP09.

Recognising that these uncertainties exist is useful because future monitoring can be undertaken to better understand rates of change (for example in sea level rise, coastal erosion, etc.) and monitor the effectiveness or impacts of management decisions in light of this latest scientific information. Further discussion on the implications of the study findings on future monitoring and the future SMP3 are presented in Section 5 of this report.

## 2.4 Application of Methodology to PDZs

The analysis methodology has been applied to each PDZ of the SMP2 in turn. The following outputs are provided:

- Maps of each Policy Unit and Management Area within each PDZ, showing the shoreline position, MLW, and SMP2 policy for the baseline and each of the three future epochs (Appendix A).
- Tabulated results of the study outputs in quantitative form across each PU within the study area (Appendix B).
- Aggregated tabulated results of the study outputs for each PDZ, and for the SMP2 area as a whole (Section 3).

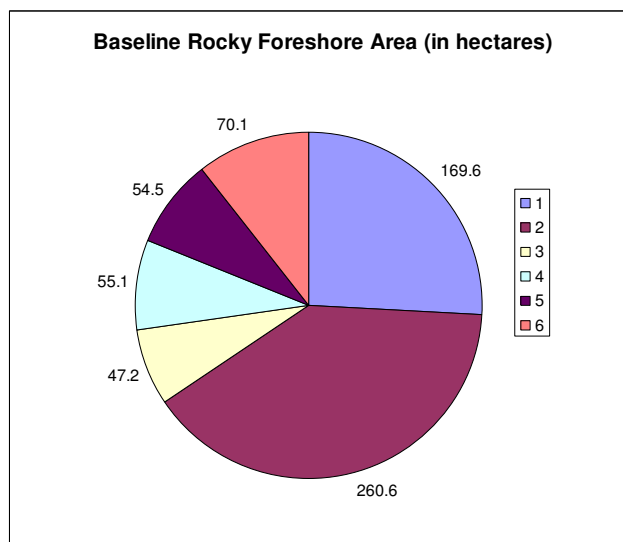
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<sup>3</sup> MLW has been used as the seaward limit of the rocky foreshore area assessment because: (i) this represents an 'average' state between MLWS and MLWN; and (ii) the best possible Lidar data coverage will only extend down to MLW (rather than MLWS).

### 3 RESULTS

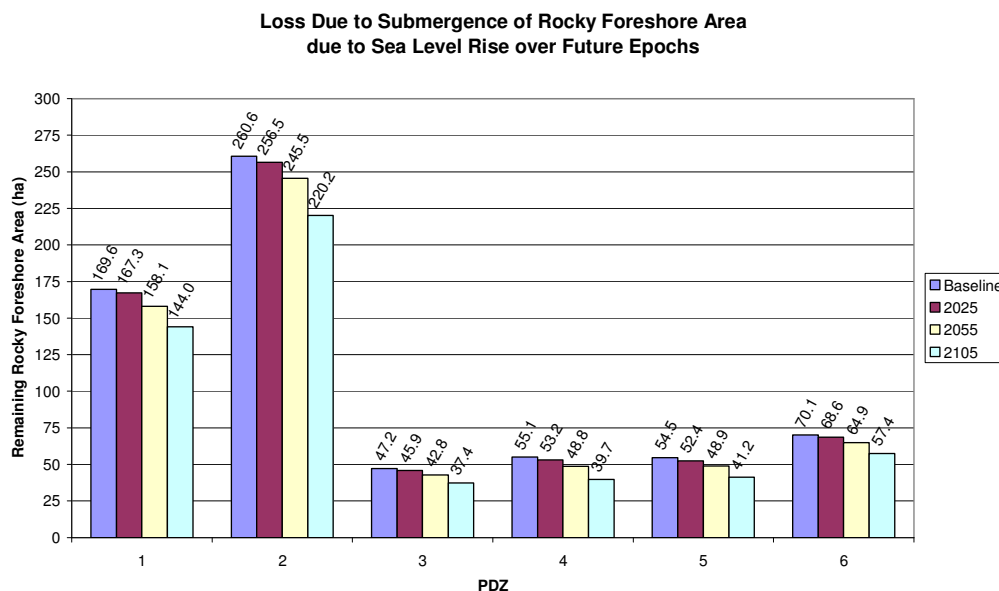
#### 3.1 Baseline Conditions

The present-day extent of rocky foreshore calculated within each of the PDZs is presented below. In total there is some 657.1ha of rocky foreshore within the SMP2 area, with approximately two-thirds located within PDZ2 (40%) and PDZ1 (26%).



#### 3.2 Loss of Rocky Foreshore Due to Submergence

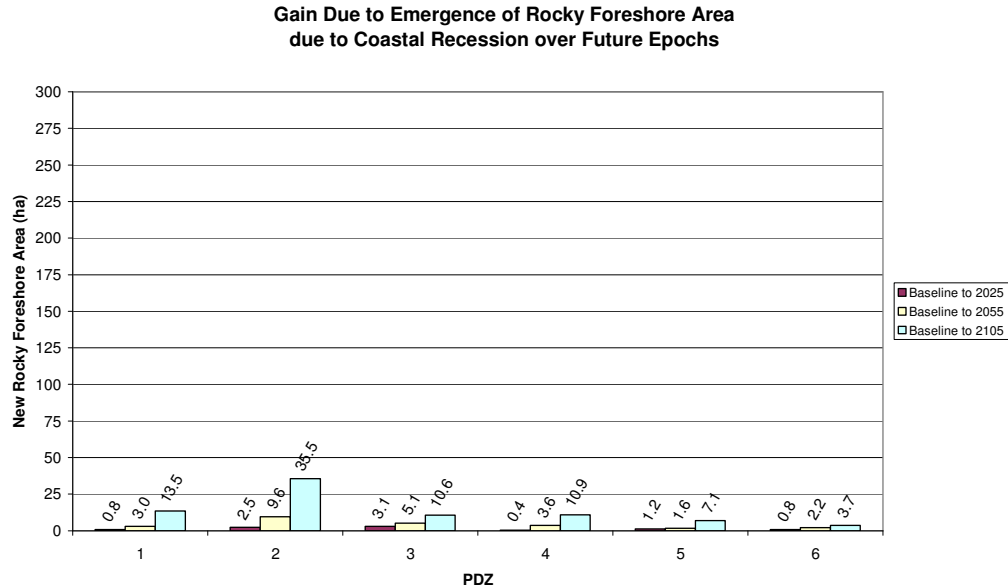
With sea level rise, it has been calculated that all PDZs will lose rocky foreshore area due to submergence under rising sea levels between the baseline and the three future epochs.



Considering the SMP2 area as a whole, the loss due to submergence is 13.2ha by 2025, 48.0ha by 2055 and 117.2ha by 2105.

### 3.3 Gain in Rocky Foreshore Due to Erosion

Based upon the SMP2 erosion lines, it has been calculated that all PDZs will gain rocky foreshore area due to emergence as cliffs and dune erode landwards between the baseline and the three future epochs.



Considering the SMP2 area as a whole, the gain due to erosion is 8.8ha by 2025, 25.2ha by 2055 and 81.3ha by 2105.

The gains in habitat will occur where policies of ‘No Active Intervention’ or ‘Management Realignment’ are applicable. Where ‘Hold the Line’ is the preferred option, no new rocky foreshore will emerge as the cliffs or dunes will be stabilised in position, generally by coastal defence structures.

As part of the study, consideration has been given to whether there are any other areas of opportunities for rocky foreshore creation, beyond that provided by ‘NAI’ or ‘MR’ policies. This only arises if there is an existing ‘Hold the Line’ policy which could be overturned on the basis of providing compensatory habitat for the losses observed elsewhere.

The present ‘Hold the Line’ policies in front of rocky foreshore are at the following Policy Units:

- PU2.1 and 2.2 - foreshore fronting Berwick breakwater and ramparts
- PU2.5 - small outcrop of Bear’s Head along a wider frontage at Spittal
- PU4.4 and 4.5 - small outcrops at Ross and Waren Mill
- PU4.8 - Holy Island harbour
- PU6.2 and 6.3 – Seahouses
- PU8.1 and 8.2 – Beadnell village and harbour
- PU9.2 – Low Newton
- PU10.2 – Craster
- PU11.1 – Boulmer
- PU12.2 – individual outcrop at Fluke Hole
- PU15.5 and 16.1 – Amble
- PU17.2 – Low Hauxley

- PU17.5 – Creswell
- PU20.2 and 20.3 – Newbiggin Point
- PU21.5 – individual outcrop of The Rockers
- PU21.6 – Blyth East Pier
- PU23.4 and 24.1 – Seaton Sluice and Colywell Bay
- PU25.1 – St Mary’s Nature Reserve
- PU25.3 and 25.4 – Whitley Bay
- PU26.2 – Cullercoats (rocky foreshore north of North Pier)
- PU26.4 – Tynemouth Longsands (outcrops at Bear’s Head Rock)
- PU26.6, 26.7 and 26.8 – King Edward’s Bay, Tynemouth headland and Tyne North Pier
- PU27.2 – North Shields Quayside

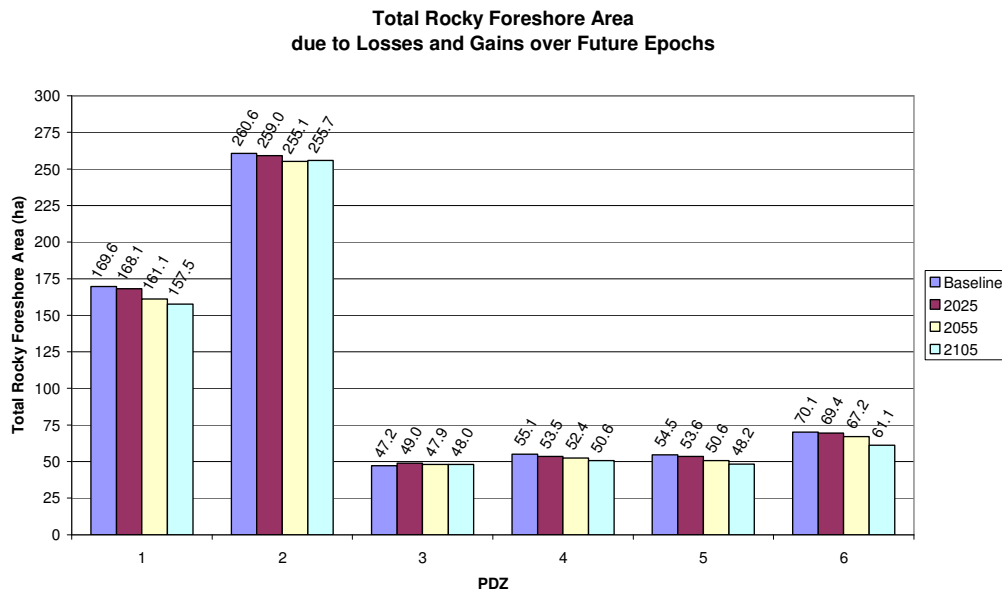
Given the above, it can be seen that the opportunity to alter the ‘Hold the Line’ policy in these PUs is restricted due to either:

- The presence of important assets which require defence, including numerous coastal communities and several assets of high economic value to the region (e.g. Ports of Blyth and Tyne)
- The significant effect that not holding the line of defence would have on other habitats or on larger-scale coastal change (e.g. Berwick Breakwater, Beadnell harbour, etc.)
- The rocky foreshore within some PUs with a policy of ‘Hold the Line’ being limited to isolated reefs (such as Bear’s Head near Spittal and Bear’s Head Rock along Tynemouth Longsands).

Consequently, no further opportunities for rocky foreshore creation beyond those delivered by NAI or MR policies from the SMP2 are identifiable.

### 3.4 Net Change in Rocky Foreshore

The net change in rocky foreshore area in each epoch has been calculated by considering both the losses due to submergence under a rising sea level and the gains from coastal erosion.



Considering the SMP2 area as a whole, there will be a net loss of rocky foreshore of 4.5ha by 2025. This represents 0.7% of the baseline area. By 2055, the loss is projected to have increased to 22.8 ha, representing 3.5% of the baseline, and by 2105 some 35.9ha, or 5.5% of the baseline, will have been lost.

It should be noted, however, that the uncertainty associated with the medium and longer term epochs increases as projections of climate change and estimates of erosion rates become more uncertain. Due to this, monitoring of climate change and coastal change is important.

### 3.5 Implications of Net Change in Rocky Foreshore

Considering the net change in rocky foreshore, the quantitative results presented in this study are similar to the conclusions from the qualitative study that was presented in the SMP2.

The SMP2 states that *“in total there is more designated habitat being lost than gained ... there will be a net loss of rocky shore and intertidal reef habitat”* and that *“a large proportion of this loss occurs in the southern part of the SMP2 from Blyth to Tynemouth”*. Results from the present quantitative study confirm this conclusion of net loss, and indicate that the greatest losses (>10% of the existing habitat) will be lost in PDZ5 and PDZ6 by 2105.

The assessment in the SMP2 also provided a degree of quantification by assessing that the length of designated rocky shore habitat which would be affected by SMP2 ‘Hold the Line’ policies by 2105 was about 5%. Although the SMP2 stated that this would not necessarily equate with a corresponding loss in area, this quantitative study has revealed the area loss by 2105 to be 5.5%.

### 3.6 Summary Statistics

PDZ	Loss due to Submergence			Gain due to SMP Policy			Net Change			Total Area		
	Baseline	Base to 2025	Base to 2055	Base to 2025	Base to 2055	Base to 2105	Base to 2025	Base to 2055	Base to 2105	Baseline	2025	2105
1	169.6	-2.3	-11.5	0.8	3.0	13.5	-1.5	-8.5	-12.1	169.6	168.1	157.5
2	260.6	-4.1	-15.1	2.5	9.6	35.5	-1.7	-5.5	-4.9	260.6	259.0	255.7
3	47.2	-1.3	-4.4	3.1	5.1	10.6	1.8	0.8	0.8	47.2	49.0	48.0
4	55.1	-1.9	-6.3	0.4	3.6	10.9	-1.5	-2.7	-4.4	55.1	53.5	50.6
5	54.5	-2.1	-5.6	1.2	1.6	7.1	-0.9	-4.0	-6.3	54.5	53.6	48.2
6	70.1	-1.5	-5.2	0.8	2.2	3.7	-0.7	-2.9	-9.0	70.1	69.4	61.1
SMP	657.1	-13.2	-48.0	8.8	25.2	81.3	-4.5	-22.8	-35.9	657.1	652.6	621.2

## 4 IMPLICATIONS FOR SMP3 AND FUTURE MONITORING

The findings of the present study reveal that the rocky foreshore habitat losses anticipated by 2025 are very small (<1% of baseline habitat). This is in keeping with Natural England's view that it is the longer term effects of sea level rise along this coastline that will cause greatest concern. Over the long term, to 2105, the SMP2 policies will result in a loss of around 5.5% of the baseline habitat. However, there are two issues to consider associated with this.

- The study has also revealed that the SMP2 has identified every possible opportunity to mitigate for loss of rocky foreshore through its 'No Active Intervention' and 'Managed Realignment' policies in appropriate situations and there remain no further opportunities to change the 'Hold the Line' policies without severe economic, social or environmental consequences.
- There is greatest confidence in the projections of sea level rise and estimates of coastal erosion over the first epoch, to 2025, and greatest uncertainty in these factors over the final epoch, to 2105.

With respect to the former point, the future SMP3 will have difficulties in identifying further areas for rocky foreshore habitat creation beyond that associated with the 'No Active Intervention' and 'Managed Realignment' policies of the SMP2.

Due to the latter point, it is very important that national, regional and local monitoring is continued so that the science of climate change is better understood, especially in relation to longer term projections, and that rates of coastal change are monitored to form the basis for updated estimates of coastal erosion along the frontage in SMP3.

To achieve this, it is recommended that the existing 'Class A' tide gauge at North Shields is maintained as part of the UK National Tide Gauge Network, which is run by the Tide Gauge Inspectorate. Data from this gauge will be used to refine understanding of sea level rise, both nationally and for the SMP frontage.

It is also recommended that the existing aerial photography, beach profile and beach topographic surveying, cliff top surveys and visual inspections of the shoreline along the study area is continued so that a medium term, and eventually a long term, record of coastal change can be captured to inform future assessments of coastal erosion rates.

Finally, the present study has focused exclusively on assessing the loss of rocky foreshore area, a habitat type designated as a key sub-feature of the Northumbria Coast Special Protection Area (SPA) (*rocky foreshore with associated boulder and cobble beaches*), and which also forms part of the Northumbria Coast European Marine Site (EMS). Such habitats support high densities of invertebrates which are important food for waterfowl, in particular internationally important populations of the regularly occurring migratory species purple sandpiper (*Calidris maritima*) and turnstone (*Arenaria interpres*). Natural England has a duty under Regulation 35 of the Conservation of Habitats and Species Regulations 2010 (the Habitats Regulations) to advise relevant authorities on the conservation objectives for an EMS, one of which being to maintain such habitats in favourable condition, *'subject to natural change'*. It will therefore remain important that statutory organisations such as Natural England continue to undertake 'site condition monitoring' duties to assess not only the *quantity* of the habitats affected, but also their *quality*, to allow a better understand the linkages that may exist between habitat extent, quality and their continued importance for bird usage.

## 5 REFERENCES

- Royal Haskoning, 2010. Northumberland and North Tyneside Rocky Foreshore 'Coastal Squeeze' Study: Scoping Report. April 2010.
- Royal Haskoning, 2009. Northumberland and North Tyneside Shoreline Management Plan 2. May 2009.