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# Understanding the likely scale of deterioration of Marine Protected Area features due to coastal squeeze: Volume 2- Results and discussion

Report No: 789

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# Acronyms, abbreviations and glossary of key terms used in assessment

| Term | Acronyms, abbreviations description |
|---|---|
| ABPmer | ABP Marine Environmental Research Ltd |
| AS | Accommodation Space |
| ATL | Advance The Line – SMP2 Policy |
| CSAT | Coastal Squeeze Assessment Tool |
| DTM | Digital Terrain Model |
| GIS | Geographic Information System |
| GN | Guidance Note |
| HRA | Habitats Regulations Assessment |
| HTL | Hold The Line - SMP2 Policy |
| MCZ | Marine Conservation Zone |
| MLWS | Mean Low Water Springs |
| MPA | Marine Protection Area |
| MR | Managed Realignment - SMP2 Policy |
| NAI | No Active Intervention - SMP2 Policy |
| NRW | Natural Resources Wales |
| PU | Policy Unit |
| RCP | Representative Concentration Pathway |
| SAC | Special Area of Conservation |
| SLR | Sea Level Rise |

| | |
|---|---|
| SMP | Shoreline Management Plan |
| SMP2 | Second iteration of the Shoreline Management Plans |
| SPA | Special Protection Area |
| SSSI | Site of Special Scientific Interest |
| TFE | Tidal Frame Extent |
| UKCP18 | UK Climate Projections 2018 |
| WG | Welsh Government |

| **Term** | **Glossary description** |
|---|---|
| 70th percentile | Higher central allowance for sea level rise projections. |
| 95th percentile | Upper end allowance for sea level rise projections. |
| Accommodation Space | The low-lying area behind anthropogenic structures / natural frontage that could become intertidal if the structure/frontage was not maintained. |
| Assessment Unit | Represents an anthropogenic structure / natural frontage, that lies within an SMP2 Policy Unit. At their largest scale an Assessment Unit may represent a single SMP2 Policy Unit, however, where there are different structures, and/or a combination of anthropogenic structures and natural frontages, or multiple Accommodation Spaces along a SMP2 Policy Unit, smaller Assessment Units are defined. |
| Cliffs | Natural cliff frontages along the open coast that are not protected by an anthropogenic structure. |
| Foreshore Area | The intertidal area in front of an anthropogenic structure or natural frontage, which extends from present day MLWS to HAT +1 m in 2155. |
| Habitat Group | An amalgamation of designated habitat features into a single habitat type. Seven Habitat Groups are defined for the national scale assessment. |
| High Ground | Natural high ground that limits any inundation of the tide into the hinterland. |

| | |
|---|---|
| Hypsometric Analysis | Analysis based on the distribution of different elevations. |
| Management Scenario | The assessment of coastal squeeze and natural squeeze is undertaken assuming three different management scenarios:<br>• Defences Maintained: assumes all existing structures remain in place;<br>• No Defences: assumes all existing structures have been removed or breached, and<br>• SMP2 Policy: Presence of structures is informed by SMP2 Policy. |
| Natural Ridge | A Natural Ridge, such as shingle / dune ridge that has low lying land behind that could be inundated by the tide if the ridge is breached. |
| Ramsar sites | Wetlands of international importance designated under the Ramsar Convention. |
| Structure | A man made structure that prevents landward migration of the intertidal zone such as a sea defence or railway embankment. |
| Tidal Frame | The tidal range over which the extent of intertidal habitat is considered. Three Tidal Frames are examined:<br>• Lower to Mid Intertidal (MLWS to MHWN)<br>• Upper Intertidal (MHWN to MHWS)<br>• Supralittoral (MHWS to HAT +1 m) |
| Tidal Frame Extents | Extent of intertidal area calculated through hypsometric analysis. |

# Crynodeb Gweithredol

Mae gwasgfa arfordirol yn golygu colli cynefinoedd naturiol neu ddirywiad yn eu hansawdd, sy'n deillio o strwythurau neu weithredoedd anthropogenig, sy'n atal cynefinoedd rhag symud i gyfeiriad y tir mewn ymateb i lefel y môr yn codi. Mae'n bwysau ac yn fygythiad hysbys i Ardaloedd Morol Gwarchodedig (MPAau) ac mae'n achosi (neu'n debygol o achosi) dirywiad neu golli nodweddion arfordirol a rhynglanwol o amgylch arfordir Cymru. Nod y prosiect hwn oedd gwella dealltwriaeth o leoliad, amseriad a graddfa debygol colli cynefinoedd mewn MPAau yng Nghymru oherwydd gwasgfa arfordirol. Mae angen hyn er mwyn cynllunio'n effeithiol ar gyfer adfer ac ail-greu nodweddion cynefinoedd a gollir drwy wasgfa arfordirol, ac felly cynnal cydlyniad rhwydwaith yr Ardaloedd.

Cynlluniodd y prosiect hwn fethodoleg er mwyn rhoi dealltwriaeth o effeithiau posibl gwasgfa arfordirol ar nodweddion dynodedig o'r MPA o amgylch arfordir Cymru. Roedd hyn yn cynnwys nodi pa fathau o gynefinoedd a'u nodweddion MPA cysylltiedig a allai fod yn destun gwasgfa arfordirol, a gweithredu modelau rhagfynegol i fesur colli cynefinoedd posibl. Defnyddiodd y prosiect ddadansoddiad hypsometrig rhagfynegol safonol i gyfrifo newidiadau yn fframwaith y llanw o amgylch arfordir Cymru o ganlyniad i lefel y môr yn codi. Yna defnyddiwyd mapiau cynefinoedd cyfredol i roi asesiad mwy safle-benodol o'r cynefinoedd a oedd yn bresennol, ac felly sut y gallant newid dros amser.

Defnyddiodd y fethodoleg haenau data newydd eu creu, dadansoddiad System Gwybodaeth Ddaearyddol (GIS) a dadansoddiadau taenlen i gwblhau'r asesiadau o wasgfa arfordirol. Darperir y dadansoddiadau taenlen yn yr Offeryn Asesu Gwasgfa Arfordirol (CSAT) atodol. Cedwir y rhain gan CNC fel allbynnau prosiect (gweler yr Atodiad Archif Data).

Cyfrifwyd gwasgfa arfordirol a gwasgfa naturiol (a ddiffinnir fel colli cynefin yn erbyn unrhyw ffryntiad naturiol sy'n cyfyngu ar ddychweliad cynefinoedd rhynglanwol) ar raddfa genedlaethol ar gyfer arfordir Cymru gyfan, yn ogystal ag ar gyfer dyluniadau llai o'r arfordir. Yna, adroddwyd ar raddfa dirywiad posibl nodweddion yr MPA oherwydd gwasgfa arfordirol:

- Yn genedlaethol;
- Yn erbyn MPAau unigol; ac
- Yn erbyn dynodiadau MPA wedi'u cyfuno ledled Cymru:
    - ACAau;
    - SoDdGAau;
    - AGAau; a
    - Safleoedd Ramsar.

Mae gwasgfa arfordirol wedi'i hasesu ar gyfer tri chyfnod (epoc):

- 2025 i 2055 (30 mlynedd) – Yn cyd-fynd ag epoc tymor canolig Cynllun Rheoli Traethlin 2 (SMP2);
- 2055 i 2105 (50 mlynedd) – Yn cyd-fynd ag epoc hirdymor SMP2; a
- 2105 i 2155 (50 mlynedd) – Epoc hir dymor newydd.

Ym mhob achos, cyfrifir gwasgfa arfordirol ar gyfer dau amcanestyniad o gynnydd yn lefel y môr (SLR):

- Llwybr Crynodiad Cynrychioliadol (RCP) Amcanestyniadau Hinsawdd y DU18 (UKCP18) 8.5, lwfans SLR 70ain canradd; a
- Llwybr Crynodiad Cynrychioliadol (RCP) Amcanestyniadau Hinsawdd y DU18 (UKCP18) 8.5, lwfans SLR 95ain canradd.

Er mwyn deall goblygiadau gwasgfa arfordirol yn seiliedig ar yr hyn sy'n digwydd ar y ddaear mewn gwirionedd ar unrhyw adeg ar hyd yr arfordir, archwiliwyd y senarios rheoli canlynol hefyd:

- Amddiffynfeydd a Gynhelir: mae'r holl strwythurau sy'n bodoli ar hyn o bryd yn parhau i fod mewn grym (h.y., ni all cynefinoedd ymestyn i'r gefnwlad isel sydd y tu ôl iddynt);
- Dim Amddiffynfeydd: ystyrir bod pob strwythur wedi'i dynnu (h.y., gall cynefinoedd ymestyn i unrhyw gefnwlad isel sydd y tu ôl iddynt); a
- Polisi SMP2: mae presenoldeb strwythurau yn seiliedig ar weithredu polisi SMP2, sy'n cynnwys:
    - Cynnal y Llinell (HTL): mae strwythurau'n cael eu cynnal/gwella ar hyd yr aliniad presennol;
    - Adlinio Wedi'i Reoli (MR): caniateir i'r arfordir encilio mewn ffordd a reolir;
    - Dim Ymyrraeth Weithredol (NAI): ni wneir unrhyw ymyriadau i gynnal y strwythurau ac aliniad y draethlin bresennol; ac
    - Nid yw categori arall, sef Symud y Llinell (ATL), yn cael ei ystyried yn yr asesiad gan nad yw'r polisi hwn wedi'i gynnig yn SMP2 ar gyfer Cymru, er ei fod yn cael ei nodi fel opsiwn amgen posibl yn Aberystwyth.

Ar gyfer asesiad ar raddfa genedlaethol, nid yw ymchwilio i ffactorau safle-benodol yn ymarferol nac yn realistig. Felly, mae nifer o ragdybiaethau a symleiddio wedi'u mabwysiadu o fewn y dull. Os oes angen asesiad o wasgfa arfordirol ar raddfa cynllun neu brosiect mwy lleol, yna efallai y bydd angen data ac asesiadau ychwanegol i wella hyder yn y canlyniadau ar y raddfa honno.

Mae'r adroddiad hwn yn rhoi trosolwg o ganlyniadau allweddol y dadansoddiad. Mae'n ffurfio Cyfrol 2 o Adroddiad dwy ran. Mae Cyfrol 1 yn rhoi disgrifiad manwl o'r fethodoleg sydd wedi'i chynllunio a'i rhoi ar waith i nodi effaith bosibl gwasgfa arfordirol ar gynefinoedd rhynglanwol Cymru mewn MPAau

O ran y risg o wasgfa arfordirol i fathau penodol o gynefinoedd a nodweddion MPA, ystyrir bod morfeydd heli yn un o'r rhai mwyaf agored i niwed. Ar lefel genedlaethol, rhagwelir colled o 21% i 25% erbyn 2155 (yn dibynnu ar ba amcanestyniad SLR a ddefnyddir). O fewn MPAau mae'r ffigurau yn debyg ar y cyfan, ond mae maint y golled yn ddibynnol ar yr MPA penodol a ffactorau fel senarios rheoli ac argaeledd cefnwlad. Dangosir bod gwastadeddau llaid a gwastadeddau tywod yn llai agored i wasgfa arfordirol, er y rhagwelir colledion ar raddfa gymharol fach o hyd (hyd at tua 6% erbyn 2155 yn dibynnu ar amcanestyniad SLR). Mae'n aml yn wir fod ardaloedd lle bu morfa heli yn y gorffennol yn trosi'n wastadeddau llaid a gwastadeddau tywod dros amser. Mae hyn yn lleihau'r golled o wastadeddau llaid a gwastadeddau tywod i ryw raddau, ac mewn rhai achosion mae'n arwain at gynnydd ym maint y cynefin.

Rhagwelir colledion cymharol fawr, hyd at 14% fel cyfran o'r cynefinoedd presennol, hefyd ar gyfer gwaddod bras morlannol ledled Cymru erbyn 2155. Rhagwelir hefyd y bydd y riff rhynglanwol hefyd yn gostwng cymaint â 10% oherwydd gwasgfa arfordirol ar raddfa genedlaethol. Fodd bynnag, cyfyngiad pwysig o'r astudiaeth yw na roddir ystyriaeth i'r mathau o swbstrad sy'n angenrheidiol er mwyn i riffiau ffurfio wrth i gynefinoedd fudo tua'r

tir wrth i lefel y môr godi (ac felly efallai na fydd newidiadau a ragwelir yn cael eu gwireddu).

Er y rhagwelir y bydd maint colledion llwyr o dwyni a graean bras â llystyfiant sy'n gysylltiedig â gwasgfa arfordirol yn fach, mae colledion yn weddol fawr o'i gymharu â maint cynefinoedd presennol; hyd at 40% ac 20% erbyn 2155, yn y drefn honno. Fodd bynnag, mae'r fethodoleg ar gyfer asesu effeithiau gwasgfa arfordirol ar dwyni a graean bras â llystyfiant yn wahanol i fathau eraill o gynefinoedd. Tybiwyd y bydd y cynefinoedd hyn yn dychwelyd tan iddynt gyrraedd tir uchel, ond ni roddir cyfrif am unrhyw gynnydd posibl yn eu maint (h.y., mae maint y twyni a'r graean bras â llystyfiant yn yr asesiad naill ai'n cael ei gynnal neu ei golli). Felly, nid yw cymariaethau uniongyrchol â mathau eraill o gynefinoedd yn briodol.

Mae'r amseriad a rhagwelir ar gyfer holl golled y cynefinoedd yn ddibynnol iawn ar leoliadau penodol o amgylch Cymru, ond fel arfer mae colledion yn cynyddu (neu enillion yn lleihau) tuag at 2155 wrth i lefel y môr godi.

Mae rheolaeth yr arfordir yn dylanwadu'n fawr ar ddifrifoldeb gwasgfa arfordirol ar wahanol fathau o gynefinoedd. Byddai senario Dim Amddiffynfa'n atal unrhyw wasgfa arfordirol rhag digwydd o gwbl gan nad yw'n dod o fewn y diffiniad o wasgfa arfordirol. Felly, dyma'r senario orau ar gyfer cyfyngu ar effeithiau cynnydd yn lefel y môr ar gynefinoedd arfordirol. Y senario waethaf ar gyfer effeithiau gwasgfa arfordirol yw lle mae Amddiffynfeydd yn cael eu Cynnal. Y tir canol o ran canlyniadau pob senario reoli yw lle mae Polisi SMP2 yn cael ei weithredu. Pe bai polisïau SMP2 yn cael eu gweithredu ar hyd arfordir Cymru, yna mae'n bosibl y byddai effeithiau gwasgedd arfordirol yn gymharol gyfyngedig. Fodd bynnag, mae heriau sylweddol o ran cyflawni'r canlyniad hwn. Er enghraifft, lle nodir polisïau adlinio wedi'u rheoli, gall gweithredu cynlluniau o'r fath fod yn anodd iawn. Mae rhwystrau i gynlluniau adlinio wedi'u rheoli'n cynnwys cyfyngiadau peirianyddol, costau uchel a bod cyllid ar gael, a materion yn ymwneud â chymryd tir, seilwaith cymunedol a'r broses gydsynio. Nid oes unrhyw un o'r materion hyn wedi'u hystyried yn yr astudiaeth hon. Mewn gwirionedd, lle nodir cynlluniau adlinio rheoledig, mae 'agor' llawer mwy cymedrol o'r gefnwlad ar gyfer cynefin rhynglanwol yn fwy tebygol. Felly, gall yr asesiad hwn oramcangyfrif enillion (neu danamcangyfrif colledion) yn y lleoliadau hyn.

Ffactor rheoli allweddol arall o ran maint colli cynefinoedd a achosir gan wasgfa arfordirol yw maint y cynnydd yn lefel y môr a fydd yn digwydd yn y dyfodol. Felly, mae amcanestyniadau newid yn yr hinsawdd a ddefnyddir yn yr asesiad yn dylanwadu'n sylweddol ar y canlyniadau. Yn yr astudiaeth hon, canfuwyd bod y lwfans SLR 95ain canradd yn cynyddu colledion rhagweledig o ganlyniad i wasgfa arfordirol hyd at 50% erbyn 2155, o'i gymharu â'r hyn a ragwelir gan ddefnyddio'r lwfans 70ain canradd. Felly, mae'n bwysig cydnabod sensitifrwydd y canlyniadau i amcanestyniadau SLR.

Yn gyffredinol, mae'r canlyniadau'n dangos bod newidiadau i faint cynefinoedd a briodolir i wasgfa arfordirol a gwasgfa naturiol yng Nghymru yn fregus o ran cydbwysedd ac yn benodol iawn i bob achos. Mae'r ffactorau llywodraethu allweddol yn cynnwys y math o ffryntiad ar hyd yr arfordir, rheolaeth yr arfordir, maint y gefnwlad sydd ar gael i gynefinoedd ddychwelyd iddi, yn ogystal â maint y cynnydd yn lefel y môr (a'r amcanestyniad cynnydd SLR a ddefnyddiwyd yn yr asesiad).

Gellir defnyddio allbynnau data'r prosiect i helpu i lywio'r mesurau rheoli y bydd eu hangen er mwyn mynd i'r afael â'r mater ledled Cymru. Dylid ystyried yr argymhellion canlynol wrth ddefnyddio allbynnau'r asesiad gwasgfa arfordirol hwn ar gyfer unrhyw gais posibl yn y dyfodol:

- Dylai gweithredu’r canlyniadau ar raddfa leol ystyried cyfyngiadau'r asesiad ar raddfa genedlaethol;
- Dylid cydnabod ac ystyried y cyfyngiadau ymarferol o ran gwireddu’r enillion a ragwelir o ran cynefinoedd, a hyfywedd y lle sydd ar gael i waddod a ddefnyddir i gynnal cynefinoedd arfordirol, wrth wneud penderfyniadau rheoli arfordirol; a
- Dylai'r amcanestyniadau SLR a ddefnyddir i lywio’r broses o wneud penderfyniadau ystyried sensitifrwydd rhagfynegiadau colli cynefinoedd i godiad yn lefel y môr.

# Executive summary

Coastal squeeze constitutes the loss of natural habitats or deterioration of their quality arising from anthropogenic structures, or actions, preventing landward transgression of habitats in response to sea level rise. It is a known pressure and threat to Marine Protected Areas (MPAs) and is causing (or likely to cause) the deterioration or loss of coastal and intertidal features around the coast of Wales. This project aimed to improve the understanding of the location, timing and likely scale of habitat loss occurring in Welsh MPAs due to coastal squeeze. This is required to plan effectively for restoration and re-creation of habitat features lost through coastal squeeze, and as such maintain the coherence of the MPA network.

This project designed a methodology to provide an understanding of the potential effects of coastal squeeze on the MPA designated features around the Welsh coast. This involved identifying which types of habitats and their associated MPA features are potentially subject to coastal squeeze, and the application of predictive models to quantify potential habitat loss. The project applied standard predictive hypsometric analysis to calculate changes in the tidal frame around the Welsh coast as a result of sea level rise. Present-day habitat maps were then used to provide a more site-specific assessment of the habitats present, and hence how they may change over time.

The methodology used newly created data layers, Geographic Information System (GIS) analysis and spreadsheet analyses to complete the coastal squeeze assessments. The spreadsheets analyses are provided in the accompanying Coastal Squeeze Assessment Tool (CSAT). These are held by NRW as project outputs (see Data Archive Appendix).

Coastal squeeze and natural squeeze (defined as the loss of habitat against any natural frontage that restricts the rollback of intertidal habitats) was calculated for habitats at a national scale for the whole of the Welsh coastline, as well as for smaller delineations of the coastline. The potential scale of habitat deterioration due to coastal squeeze was then reported:

- Nationally;
- Against individual MPAs; and
- Against MPA designations amalgamated across Wales:
    - SACs;
    - SSSIs;
    - SPAs; and
    - Ramsar sites.

Coastal squeeze has been assessed for three timeframes (epochs):

- 2025 to 2055 (30 years) – Equivalent to SMP2 medium-term epoch;
- 2055 to 2105 (50 years) – Equivalent to SMP2 long-term epoch; and
- 2105 to 2155 (50 years) – New long-term epoch.

In each case coastal squeeze is calculated for two sea levels rise (SLR) projections:

- UKCP18 Representative Concentration Pathway (RCP) 8.5, 70th percentile SLR allowance; and
- UKCP18 Representative Concentration Pathway (RCP) 8.5, 95th percentile SLR allowance.

In order to understand coastal squeeze implications based on what actually happens on the ground at any point along the coast, the following management scenarios were also examined:

- Defences Maintained: all structures that currently exist remain in place (i.e., habitats cannot extend into low lying hinterland that lies behind them);
- No Defences: all structures are considered to have been removed (i.e., habitats can extend into any low-lying hinterland that lies behind them); and
- SMP2 Policy: presence of structures is based on the implementation of SMP2 policy, comprising:
    - Hold The Line (HTL): structures are maintained/improved along existing alignment;
    - Managed Realignment (MR): coast is allowed to retreat in a managed way;
    - No Active Intervention (NAI): no interventions are made to maintain the existing structures and shoreline alignment; and
    - A further category, to Advance The Line (ATL), is not considered in the assessment as this policy is not proposed in SMP2 for Wales, although it is noted as a potential alternative option at Aberystwyth.

For a national scale assessment, the investigation of site-specific factors is not practical or realistic. Therefore, a number of assumptions and simplifications have been adopted within the approach. If a coastal squeeze assessment is required at a more local plan or project scale, then additional data and assessments may be required to improve confidence in the results at that scale.

This report provides an overview of the key results of the analysis. It forms Volume 2 of a two-part Report. Volume 1 provides a detailed description of the methodology that has been designed and applied to identify the potential impact of coastal squeeze on Welsh intertidal habitats in MPAs.

In terms of the risk of coastal squeeze to specific habitat types and MPA features, saltmarsh is considered one of the most vulnerable. At a national level, 21% to 25% loss is predicted by 2155 (depending on which SLR projection is used). Within MPAs the figures are generally similar, but the scale of loss is dependent on the specific MPA and factors such as management scenarios and availability of hinterland. Mudflats and sandflats are shown to be less vulnerable to coastal squeeze, though relatively small-scale losses are still predicted (up to approximately 6% by 2155 depending on SLR projection). It is often the case that areas previously occupied by saltmarsh transition to mudflats and sandflats through time. This moderates the loss of mudflats and sandflats to some degree, and in some cases results in gains in habitat extent.

Relatively large losses, up to 14% as a proportion of current habitat extents, are also predicted for littoral coarse sediment across Wales by 2155. Intertidal reef is also predicted to decrease by as much as 10% due to coastal squeeze at a national scale. However, an important limitation of the study is that no consideration is given to requisite substrate types for reef to form as habitats migrate landward as sea levels rise (and therefore predicted changes may not be realised).

Whilst the scale of absolute losses of dunes and vegetated shingle associated with coastal squeeze is predicted to be small, losses are fairly large relative to current habitat extents; up to 40% and 20% by 2155, respectively. However, the methodology for the assessment of coastal squeeze impacts on dunes and vegetated shingle differ from other habitat types. It was assumed these habitats will roll-back until they meet high ground, but any potential

increases in their extent are not accounted for (i.e., the extent of dunes and vegetated shingle within the assessment is either maintained or lost). Therefore, direct comparisons with other habitat types are not appropriate.

The predicted timing of all habitat loss is very dependent on specific locations around Wales, but it is usually the case that losses increase (or gains decrease) towards 2155 as sea levels rise.

Management of the coast has a large influence on the severity of coastal squeeze on different habitat types. A No Defence scenario would prevent any coastal squeeze occurring at all as it does not fall within the definition of coastal squeeze. This therefore represents the best-case scenario for limiting the impacts of sea level rise on coastal habitats. The worst-case scenario for coastal squeeze impacts is a Defences Maintained scenario. The middle ground in terms of the outcomes of each management scenario is where the SMP2 Policy is implemented. If the SMP2 policies were implemented along the Welsh coastline, then coastal squeeze impacts have the potential to be relatively limited. However, there are significant challenges in achieving this outcome. For instance, where managed realignment policies are identified, implementing such schemes may be extremely difficult. Barriers to managed realignment schemes include engineering constraints, high costs and funding availability, and issues associated with land-take, community infrastructure and the consenting process. None of these issues have been taken into account in this study. In reality, where managed realignment schemes are identified, a much more modest 'opening up' of the hinterland for intertidal habitat is more likely. Therefore, this assessment may overestimate gains (or underestimate losses) in these locations.

Another key controlling factor in the extent of coastal squeeze induced habitat loss is the magnitude of sea level rise that will occur in the future. Climate change projections that are applied in the assessment therefore significantly influence the results. In this study, the 95th percentile SLR allowance was found to increase predicted losses from coastal squeeze by up to 50% by 2155, compared with that predicted using the 70th percentile allowance. It is therefore important to recognise the sensitivity of the results to SLR projections.

Overall, the results show that changes to habitat extent attributed to coastal squeeze and natural squeeze in Wales are delicately balanced and very case specific. Key governing factors include the type of frontage along the coast, management of the coast, the extent of hinterland available for habitats to roll-back into, as well as the magnitude of sea level rise (and the SLR rise projection used in the assessment).

The data outputs of the project can be used to help inform the management measures that will be required to address the issue across Wales. The following recommendations should be considered when using the outputs of this coastal squeeze assessment for any potential future application:

- The applicability of the results at a local scale should take into account the limitations of the national scale assessment;
- The practical constraints in realising predicted habitat gains, and the viability of Accommodation Space to be used to support coastal habitats, should be recognised and be considered in coastal management decisions; and
- The SLR projections used to inform decision making should take into account the sensitivity of habitat loss predictions to sea level rise.

# 1 Introduction

This project aims to improve understanding of the location, timing and likely scale of habitat loss occurring in Marine Protected Areas (MPAs) due to coastal squeeze in Wales.

Coastal squeeze constitutes the loss of natural habitats or deterioration of their quality arising from anthropogenic structures, or actions, preventing the landward transgression of habitats in response to sea level rise (see Section 2.1). Coastal squeeze is a known pressure and threat to MPAs and is causing (or likely to cause) the deterioration or loss of coastal and intertidal features around the coast of Wales. For example, in the Severn Estuary Special Area of Conservation (SAC) coastal squeeze is noted as a reason for several features of the site being in unfavourable condition (NRW, 2018). The Habitats Regulation Assessments (HRA) undertaken for the second iteration of the Shoreline Management Plans (SMP2) (NRW, 2024a) concluded that the SMP2 would lead to adverse effects on the integrity of one or more MPAs due to anticipated coastal squeeze.

Under the Conservation of Habitats and Species Regulations 2017 (the 'Habitats Regulations'), the natural range of Annex 1 habitat features, and the areas covered by the habitat features within that range, should be stable or increasing. Loss of Annex 1 habitat due to coastal squeeze would therefore be contrary to the objectives of sites and constitute deterioration under Regulation 64. Loss of supporting habitat on which Special Protection Area (SPA) species depend would also be considered contrary to the conservation objectives.

Therefore, there is a need to understand the likely scale, location and timing of this deterioration across relevant MPA features over the short, medium and long term. This is required to plan effectively for restoration and re-creation of habitat features lost through coastal squeeze, and so maintain the coherence of the MPA network. Positive management of the MPA network is a priority in contributing to resilient marine ecosystems under the Environment (Wales) Act 2016, and as set out in NRW's Marine Area Statement (NRW, 2024b). This work also provides the opportunity to update the existing coastal squeeze assessments that were undertaken for the SMPs using a consistent methodology and best available data.

This project covers marine SACs, SPAs, Ramsar sites and Sites of Special Scientific Interest (SSSIs) within Wales, with features which have the potential to be, or are already being, impacted by coastal squeeze. There are 139 MPAs in Wales, twelve of which were scoped out of the assessment (see section 2.2) because the habitats or supporting habitats within these sites would not be affected by coastal squeeze.

ABPmer was commissioned by Natural Resources Wales (NRW) to design a method and undertake analysis to understand the location and likely scale of habitat loss occurring in MPAs due to coastal squeeze in Wales.

The project goals were to:

- Design a methodology to gain insight into the location, timing and extent of future habitat loss (and gain), resulting from coastal squeeze and natural squeeze (refer to definitions in Section 2 below) around the Welsh coast;
- Design a methodology which can provide an understanding of the potential effects of coastal squeeze on the MPA designated features around the Welsh coast;

- Apply those methodologies to identify the potential impact of coastal squeeze on Welsh intertidal habitats (and MPA features through the consideration of those habitats that occur within MPAs);
- Gain an understanding of how the presence of structures and SMP2 policies influence coastal and natural squeeze at various spatial scales, using two sea level rise (SLR) scenarios over three time periods or epochs; and
- Report and communicate the outcomes.

This report provides an overview of the key results of the analysis. It forms Volume 2 of a two-part Report. Volume 1 provides a detailed description of the methodology that has been designed and applied to identify the potential impact of coastal squeeze on Welsh intertidal habitats in MPAs.

This Report is structured as follows:

- Section 2: Methodology – brief explanation of the methods used to predict habitat loss and gain attributed to coastal squeeze within Welsh MPAs;
- Section 3: Results and discussion – high level overview of the key results of the analysis, reported at a national scale and for each type of MPA and Habitat Group; and
- Section 4: Summary and conclusion – a summary of the key findings of the assessment.

# 2 Methodology

This section of the report provides a brief overview of the methodology that has been designed and applied to the coastal and natural squeeze assessments. The Volume 1 Report should be consulted to provide a more detailed description of the methodology.

## 2.1 Coastal and natural squeeze definitions

Coastal squeeze is defined in Environment Agency (2021) and is provided below. This definition is also used in NRW Guidance Note GN062 – Assessment of Coastal Squeeze (NRW, 2022).

Coastal Squeeze is *"The loss of natural habitats or deterioration of their quality arising from anthropogenic structures, or actions, preventing the landward transgression of those habitats that would otherwise naturally occur in response to sea level rise in conjunction with other coastal processes. Coastal Squeeze affects habitat on the seaward side of existing structures."*

For this national scale assessment, the general principles and definition of coastal squeeze as defined by the Environment Agency (2021) have been adopted. A number of simplifications to this definition have been introduced to enable the practical completion of the assessment at a national level. The scope of the study has also been extended to cover the whole of the Welsh coast, quantifying the likely loss of coastal habitat in areas outside MPAs.

For this study the following clarifications and amendments are therefore made in relation to the definition of coastal squeeze:

- Coastal squeeze will be assessed where intertidal habitat exists in front of an anthropogenic structure which prevents landward migration of the habitat;
- Coastal squeeze is not restricted to areas that lie within the existing MPA Network and will be assessed for all intertidal areas lying seaward of anthropogenic structures / managed defence line;
- Coastal squeeze is to be assessed based on the loss of intertidal habitat as determined from present-day bed levels and SLR allowances – the assessment excludes any consideration as to how coastal processes, bed levels and coastal/estuary morphology may change in the future;
- The assessment of coastal squeeze is restricted to assessing the extent of habitat loss and does not examine the condition of that habitat;
- Areas not fronted by intertidal habitats such as quayside locations, where the toe of the defences are below Mean Low Water Springs (MLWS) and dock areas such as Port Talbot Docks, Cardiff Bay Docks and Alexandra Dock (River Usk) are excluded from the assessment of coastal squeeze;
- Assessment of supporting terrestrial habitats for SPA / Ramsar sites bird species are excluded (other than dunes and vegetated shingle);
- Assessment of subtidal habitat extents which will generally increase as a result of SLR are excluded; and
- The boundaries of the MPA designations are considered fixed and will not change for the purposes of this coastal squeeze assessment.

Natural squeeze is defined as the loss of habitat against any natural frontage that restricts the rollback of intertidal habitats. Two types of natural frontage are considered within the assessment of natural squeeze:

- Natural Ridge – e.g., a shingle / dune ridge or a natural bank that has an area of low-lying land behind that could be inundated by the tide if the ridge is breached; and
- High ground – naturally high ground that limits any inundation of the tide into the hinterland.

Natural squeeze is calculated and examined in the same way as coastal squeeze. The only difference being that coastal squeeze will be assessed where an anthropogenic structure exists, whilst natural squeeze will be assessed where a natural frontage exists.

Natural squeeze is also attributed to instances where an SMP2 policy for a frontage is either managed realignment (MR) or no active intervention (NAI). In these cases, it is assumed inundation would occur into the hinterland and any existing defence will not prevent this. In these instances, natural 'squeeze' is often a gain in habitat extent rather than a loss provided there is sufficient space in the hinterland for habitat to roll-back.

Within this report, ‘total squeeze’ is reported alongside the results for coastal squeeze. This is simply the addition of coastal squeeze and natural squeeze and reflects the overall losses and gains for Habitat Groups/MPA features.

## 2.2 Scoping intertidal habitats and MPAs subject to coastal squeeze and natural squeeze

Seven broad intertidal Habitat Groups have been identified as being subjected to coastal squeeze, which are assessed within this study. Other habitat types, not affected by coastal squeeze, were scoped out of the study.

The seven broad Habitat Groups are:

- Saltmarsh;
- Mudflat and sandflat;
- Intertidal reef;
- Vegetated shingle;
- Dunes;
- Littoral coarse sediment; and
- Coastal lagoons.

A ‘non-defined’ Habitat Group has also been included in the assessment to capture areas of the foreshore that could be impacted by coastal squeeze but are not identified to a defined Habitat Group.

The Habitat Groups (with the exception of the non-defined Habitat Group) have been related to the habitat features and supporting habitats (for bird features) that exist within Welsh MPAs. It should be noted that vegetated shingle and dune habitats are not technically part of the MPA network in Wales and are considered terrestrial habitats rather than marine features.

For SACs and SSSIs, these Habitat Groups have been mapped to habitat features associated with individual MPAs using details provided in Annex 1 of the Welsh Government (2018) – Marine Protected Area Network Management Framework for Wales (2018-2023).

For SPA and Ramsar sites, Welsh Government (2018) lists the bird species the sites are designated for, rather than the associated marine habitats. Habitat Groups have therefore been attributed to individual SPA / Ramsar sites if an associated habitat is listed in the Natura 2000 – Standard Data Form (for SPA), and Information Sheet on Ramsar Wetlands form (for Ramsar sites). Where a Habitat Group is described / referenced in the supporting information on these forms this has also been captured within the assessment.

Any MPAs that did not contain these Habitat Groups and the corresponding habitat features were scoped out of the study.

A single Marine Conservation Zone (MCZ) exists in Wales, however, this is scoped out of the assessment as the frontage associated with it is not considered to be subject to coastal squeeze. Furthermore, the location of MPAs (e.g., where they are located offshore) was taken into account in the scoping process. This left a total of 127 MPAs with associated habitats and features that are in scope for this project. It should also be noted that 28 MPAs included in the assessment returned no habitat changes due to coastal squeeze because they typically contained cliff frontages which are not affected by coastal squeeze. Therefore, 99 MPAs are included in the outputs for this project which are shown in Figure 1.

The following three generic physiographic MPA features could also be subjected to coastal squeeze:

- Large shallow inlets and bays;
- Estuaries; and
- Intertidal.

It is recognised that many of the broad Habitat Groups may fall under these three MPA features, including mudflats and sandflats, saltmarsh and intertidal reef. They may also include other intertidal habitats that are not a feature in their own right (e.g., littoral coarse sediment, mixed sediment shores, stoney/gravelly substrates). However, each individual Habitat Group may not always be present where an MPA is designated for one of these three marine features. Therefore, these three physiographic features are not directly captured within the present assessment, and the assessment is restricted to assessing the seven broad Habitat Groups that can be directly associated with an MPA. Further details on this process and the scoping rationale can be found in the Volume 1 Report.

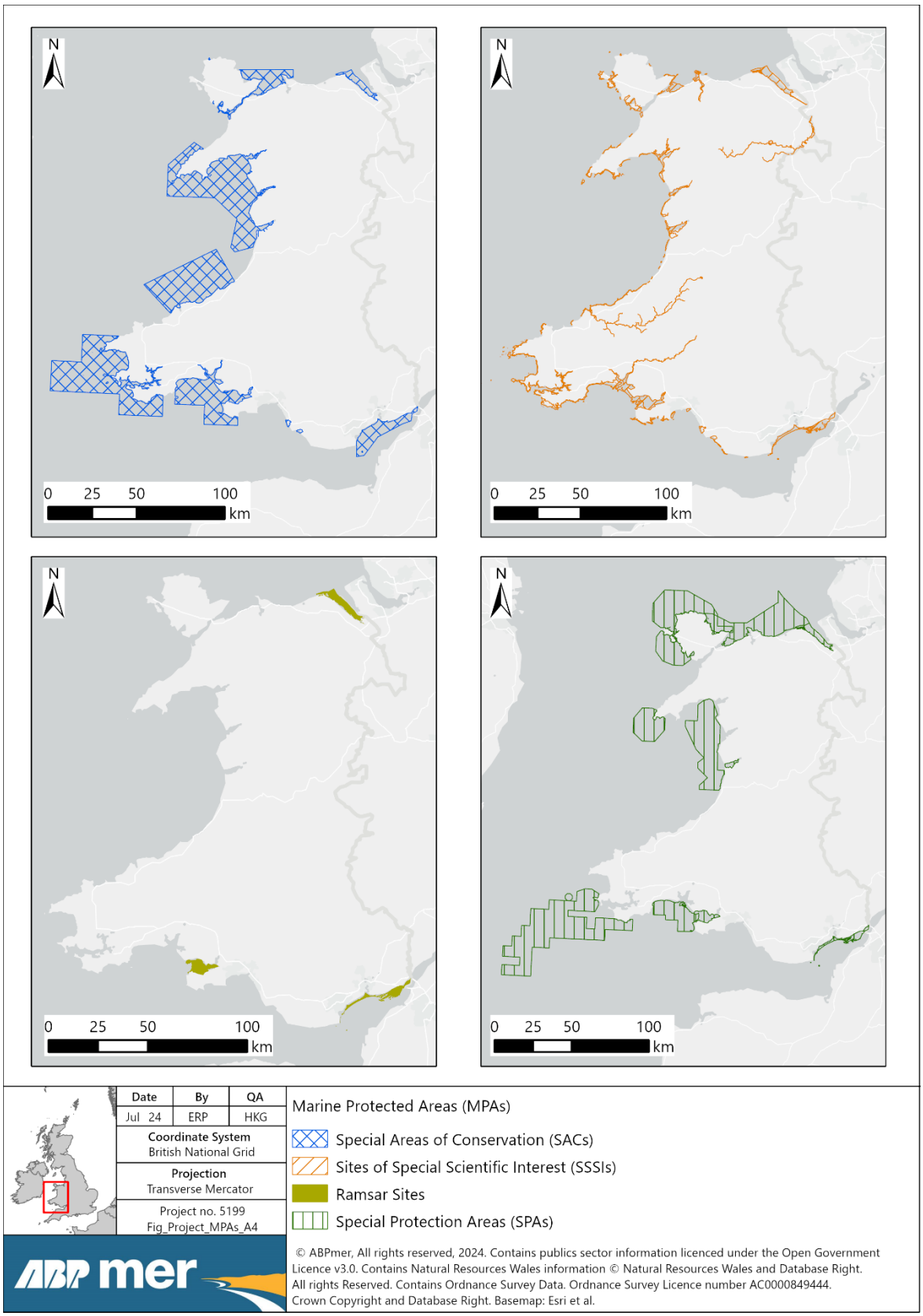


Figure 1. Marine Protected Areas in Wales included in outputs of this coastal squeeze assessment

## 2.3 Assessment of coastal squeeze and natural squeeze on intertidal Habitat Groups

To complete the assessment, the entire Welsh coastline has been delineated into a series of Assessment Units. For each Assessment Unit, the area seaward of an anthropogenic structure or natural frontage is defined as the Foreshore Area. All low-lying areas (i.e., liable to coastal inundation) behind an anthropogenic structure or natural frontage is defined as the Accommodation Space.

Within the assessment, coastal squeeze is considered to occur in front of anthropogenic structures providing the habitat would be able to roll-back into the Accommodation Space if the structure was removed (i.e., the availability of Accommodation Space is therefore a requirement/necessity for coastal squeeze to occur and be recognised as a loss-process). Natural squeeze is then considered to occur in front of Natural Ridges and high ground. Natural squeeze may also occur in front of an anthropogenic structure, if the extent of the Accommodation Space is unable to accommodate the losses observed in front of a structure. This is visually represented in Figure 2.

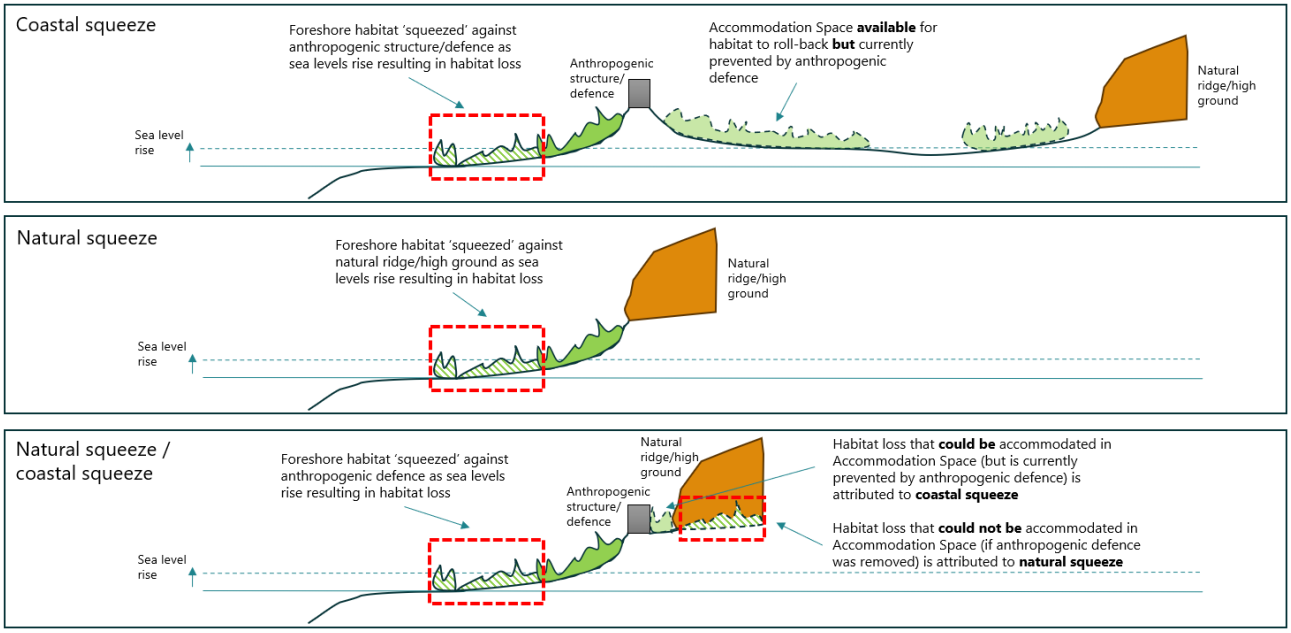


Figure 2. Coastal squeeze and total squeeze definitions

The seven Habitat Groups scoped into the study will be affected slightly differently by SLR. As such, different methodologies have been adopted for the following Habitat Groupings:

- The four intertidal Habitat Groups of saltmarsh, mudflat and sandflat, intertidal reef and littoral coarse sediment.
- Dunes and vegetated shingle, since these habitats are typically located higher up the foreshore and respond differently to SLR; and
- Coastal lagoons.

The project has derived a three-step process for completing the national scale assessment for **saltmarsh**, **mudflat and sandflat**, **intertidal reef** and **littoral coarse sediment**, which are assessed based on a site-specific assessment. This three-step process comprises a hypsometric analysis and, at a basic level, consists of:

1. Calculating the intertidal area across different tidal frames (termed the tidal frame extents) taking account of SLR for different epochs across the Foreshore Area and Accommodation Space;
2. Identifying the potential habitat extents for each epoch across the Foreshore Area and Accommodation Space, based on the present-day (2025) habitat coverage across each tidal frame (see Volume 1 Report for further information on data layers); and
3. Calculating the loss/gain in potential habitat extent for future epochs across the Foreshore Area and Accommodation Space, and assigning this to either coastal squeeze or natural squeeze based on the type of frontage and management scenario adopted.

These steps are shown in Figure 3 and described in further detail within the Volume 1 Report. It should be noted that the assessment of habitat loss and gain is based on the spatial extents in the intertidal area across different tidal frames, as well as present day habitat extents within each tidal frame. No consideration is given to other factors that may affect the distribution and extents of habitats, such as whether requisite substrates would be present on different areas of the foreshore (e.g., rocky shores for reef features).

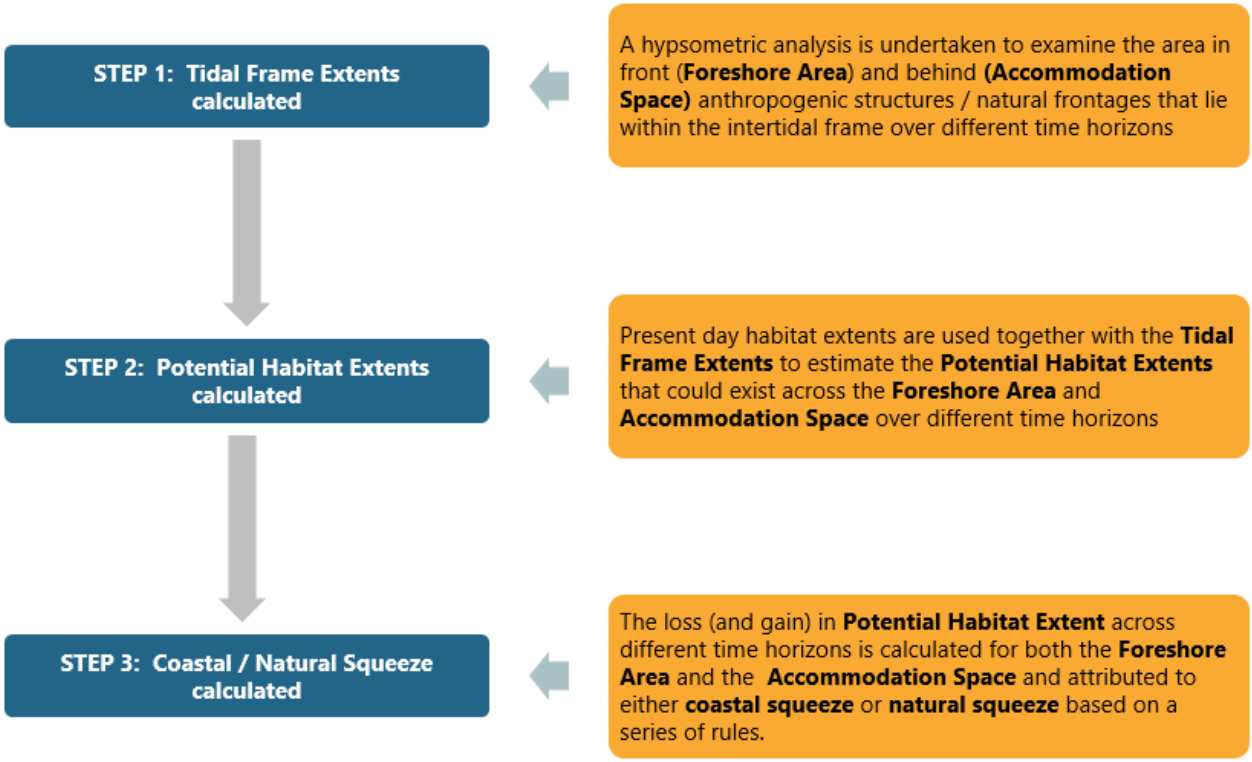


Figure 3. Schematic diagram showing the three-step process used in the assessment

The rules applied within Step 3 of the assessment are slightly different for **dunes and vegetated shingle**, as these habitats are typically located higher up the foreshore and respond differently to SLR. Ideally coastal squeeze and natural squeeze for these systems should be completed using a local geomorphological assessment, but this is not considered practical for the present assessment. In the case of dunes and vegetated shingle, only habitat located on the foreshore is assessed and not the present-day extents of these habitats in the hinterland. Where these habitats are backed by a defence, it is assumed these habitats will be squeezed up against the structure. Where no structure is maintained, and there is room within the Accommodation Space, it is assumed these habitats will roll-back until they meet high ground, but any potential increases in their extent within the Accommodation Space are not accounted for (i.e., the extent of dunes

and vegetated shingle within the assessment is either maintained or lost). This is because gains in dunes and vegetated shingle are associated with geomorphological change which cannot be assessed through hypsometic analysis.

**Coastal lagoons** typically lie behind anthropogenic structures and Natural Ridges; therefore, they are not generally subject to coastal squeeze (or natural squeeze if the Natural Ridge remains intact and functioning). This is consistent with Environment Agency (2021), which only considers saline lagoons in front of structures to be subject to coastal squeeze. However, a coastal lagoon within the hinterland may still be subject to loss and gain as a result of SLR if a defence is not maintained or a Natural Ridge were to roll-back. Given the complexity of these features it was not appropriate to assess these features at a national scale using the hypsometric analysis-based approach. A separate, high-level desk-based assessment has instead been undertaken to examine the potential loss of coastal lagoon habitat as a result of SLR.

## 2.4 Overview of methodology

For a national scale assessment, the investigation of site-specific factors is not practical or realistic. This study has, therefore, focused upon:

- Identifying which Habitat Groupings and their associated MPA features are potentially subject to coastal or natural squeeze; and
- The application of predictive models to quantify potential coastal squeeze and natural squeeze.

The project applies standard predictive hypsometric analysis to calculate the changes in tidal frame around the Welsh coast as a result of SLR. These tidal frames are calculated from a newly created national Digital Terrain Model (DTM). Present-day habitat maps are then used to provide a more site-specific assessment of the habitats present, and hence how they may change over time. Further information on the habitat data layers used in the assessment can be found in the Volume 1 Report.

The coastal squeeze and natural squeeze assessments are then undertaken. The quantification of coastal squeeze and natural squeeze is calculated:

- Nationally;
- Against SMP2 Policy Unit (PU); and
- Against individual Assessment Units.

In each case, coastal squeeze and natural squeeze is calculated for defined Habitat Groups (see Section 2.2). An assessment of coastal and natural squeeze across the MPA network has then been undertaken. The potential scale of deterioration of MPAs due to coastal squeeze is reported against:

- Individual MPAs; and
- MPA designations amalgamated across Wales:
    - SACs;
    - SSSIs;
    - SPAs; and
    - Ramsar sites.

Results are not reported against MCZs as there is only one Welsh MCZ which has been scoped out of the assessment.

The methodology uses newly created data layers, Geographic Information System (GIS) analysis and spreadsheet analyses to complete the coastal squeeze and natural squeeze assessments. The spreadsheets analyses are undertaken in the Coastal Squeeze Assessment Tool (CSAT). These are held by NRW as project outputs (see Data Archive Appendix). The CSAT uses hypsometry data from the DTM to quantify the changes in the tidal frame extents at five yearly intervals and according to SMP2 policy.

Coastal squeeze and natural squeeze are subsequently assessed for three timeframes (epochs):

- 2025 to 2055 (30 years) – Equivalent to SMP2 medium-term epoch;
- 2055 to 2105 (50 years) – Equivalent to SMP2 long-term epoch; and
- 2105 to 2155 (50 years) – New long-term epoch.

In each case coastal squeeze and natural squeeze are calculated for two climate change scenarios (see Volume 1 Report for further detail):

- UKCP18 Representative Concentration Pathway (RCP) 8.5, 70th percentile SLR allowance; and
- UKCP18 Representative Concentration Pathway (RCP) 8.5, 95th percentile SLR allowance.

In order to understand coastal squeeze implications based on what actually happens on the ground at any point along the coast (within any Assessment Unit), the following management scenarios are also examined:

- Defences Maintained: all structures that currently exist remain in place (i.e., habitats cannot extend into low lying hinterland that lies behind them);
- No Defences: all structures are considered to have been removed (i.e., habitats can extend into any low-lying hinterland that lies behind them); and
- SMP2 Policy: presence of structures is based on the implementation of SMP2 policy, comprising:
    - Hold The Line (HTL): structures are maintained/improved along existing alignment;
    - Managed Realignment (MR): coast is allowed to retreat in a managed way;
    - No Active Intervention (NAI): no interventions are made to maintain the existing structures and shoreline alignment; and
    - A further category, to Advance The Line (ATL), is not considered in the assessment as this policy is not proposed in SMP2 for Wales, although it is noted as a potential alternative option at Aberystwyth.

It should be noted that SMP2 policies have not been defined for the new long-term epoch (2105 to 2155). Therefore, for the purposes of this assessment, the SMP policy defined for the end of SMP2 long-term epoch (2055 to 2105) was applied.

Within the assessment a ‘defence’ is generally considered to be an anthropogenic structure. However, in several instances the SMP2 policy along a natural frontage is HTL. In the instances where this occurred, the sites were examined individually by NRW, and on some occasions the natural frontage was re-defined as a defence.

# 3 Results and discussion

This section and the following sub-sections of this report provide a high-level overview of the outputs of the coastal and natural squeeze assessments for Wales. Section 3.1 provides an explanation of the results and how they should be interpreted. Appendix A also provides examples of some nuances within the dataset that should be taken into account when interpreting the results presented in this section.

Section 3.2 presents a national overview of the potential impact of coastal squeeze on Welsh intertidal habitats. The purpose of this section is to consider losses at a high level across Wales to gain a broad understanding of the results for different management scenarios, timeframes, and SLR projections, before looking in detail at losses within Welsh MPAs. The report then primarily focusses on the impact of coastal squeeze within Welsh marine SACs in Section 3.3. Finally, Sections 3.4 to 3.6 provide a high level review of results within Welsh SSSIs, SPAs and Ramsar sites, respectively.

It should be noted that the coastal and natural squeeze assessments undertaken for this project have produced a large amount of complex data. This can be packaged and presented in many different ways depending on the use of the data. As such, this report does not attempt to cover the full range of data outputs but focusses on key results at a high-level.

As explained in Section 2, the full set of analyses are provided as a series of spreadsheets termed the CSAT which are held by NRW as project outputs (see Data Archive Appendix). This provides results at a very high-resolution based on individual and discrete anthropogenic structures or natural frontages (Assessment Units) along the Welsh coast. These can then be interrogated at different scales, for example for specific SMP2 policy units, specific MPAs or nationally. Results for different management scenarios are also included in the spreadsheets, as well as results based on a higher central allowance for SLR (70th percentile) and an upper end allowance (95th percentile) for comparison. The CSAT can therefore be used in the future by NRW to investigate changes in habitats in more detail, and to inform potential management measures to address coastal squeeze impacts. It is anticipated that this will be a useful optioneering tool for the management of MPAs going forward.

## 3.1 Interpreting the results

To aid interpretation of the results provided in this report, a series of tables and figures have been produced in the sections that follow. These summarise a small sub-set of the full set of data outputs available in the CSAT. A coloured scaling has been used to represent the scale of habitat losses and gains in hectares (ha). On the figures, red represents habitat losses and blue represents habitat gains, with darker shades representing losses/gains of a higher magnitude, and lighter shades representing smaller changes. Within the tables, both absolute habitat loss/gain is presented, alongside percentage change in habitat extent. Coloured scaling has been used within the tables to represent percentage change, with green corresponding to percentage increases, and orange corresponding to percentage decreases.

Results shown in the figures and tables are presented for different Habitat Groups, epochs, and management scenarios. The report primarily focusses on coastal and total (coastal + natural) squeeze within Welsh marine SACs in Section 3.3. Within this section, the implications of different management scenarios on coastal squeeze impacts are

examined in further detail. Coastal squeeze impacts within SSSIs (Section 3.4), and SPA/Ramsar sites (Sections 3.5 and 3.6) are also briefly summarised. Impacts to saltmarsh, mudflat and sandflat and intertidal reef Habitat Groups are reported in these sections given they are the key habitat types that align with the designated features of these MPAs.

Dunes and vegetated shingle habitat require a modified approach to assessing habitat loss caused by coastal and natural squeeze, compared with the hypsometric analysis undertaken for saltmarsh, mudflat and sandflat, and intertidal reef (see Section 2.3). Furthermore, these habitats are not technically part of the MPA network in Wales and are considered terrestrial habitats rather than marine features. However, these habitats are vulnerable to coastal squeeze, and several marine SPAs, Ramsar sites, SACs and SSSIs note dunes and vegetated shingle within their respective citations. The results for these habitat types are therefore presented separately in Sections 3.2.4 and 3.2.5.

As noted in Section 2.3, coastal lagoons typically lie behind anthropogenic structures and Natural Ridges and are therefore not generally subject to coastal squeeze (or natural squeeze if the Natural Ridge remains intact and functioning). However, a coastal lagoon within the hinterland may still be subject to loss and gain as a result of SLR, if a defence is not maintained or a Natural Ridge were to roll-back. The implications of SLR on coastal lagoons are therefore considered separately in Section 3.2.7.

It should be reiterated, as explained in Section 2.2, that Habitat Groups used in this project are not the same as designated MPA features. The seven broad Habitat Groups have been aligned to designated MPA features, and therefore provide a useful indication of impacts of MPA features but results should be interpreted within that context.

As noted above, coastal squeeze assessment results are available for a higher central allowance for SLR (70th percentile) and an upper end allowance (95th percentile) (the latter representing a worst case in terms of impacts associated with SLR). The 95th percentile results are only presented at a national scale in Section 3.2 of this report to aid comparison. The rest of the report focusses on results for the 70th percentile as a central estimate in accordance with WG Guidance (NRW, 2022). Results for the 95th percentile, if required, are available in the CSAT outputs that are held by NRW as project outputs (see Data Archive Appendix).

Appendix A provides further detail on key observations and nuances in the data outputs that help with the interpretation of the results. As noted at the beginning of this section, it is recommended that this information is taken into account when interpreting the results presented in Sections 3.2 to 3.6.

### 3.1.1 Assumptions and limitations

In order to undertake this assessment at a national scale a number of assumptions and simplifications have been adopted within the approach as mentioned in Section 2. Further detail is also provided in Section 6 of the Volume 1 Report. If a coastal squeeze assessment is required at a more local plan or project scale, then additional data and assessments may be required to improve confidence in the results at that scale. The following additional comments should therefore also be noted when reviewing the results:

- The assessment is primarily based on a hypsometric analysis, which identified potential habitat extents based on present day bed levels in the foreshore and hinterland. No consideration is given to how these bed levels may change due to geomorphological process over time.
- Similarly, no consideration is given as to how coastal processes may change with climate change and SLR (i.e., processes of accretion will potentially reduce the impact of SLR and related coastal squeeze, whereas erosion will potentially accelerate the losses on the foreshore).
- SLR projections used on the assessment are based on UKCP18 projections. These are subject to uncertainties, and future updates to SLR projections may differ from those used in this assessment.
- The assessment assumes that the entire Accommodation Space is available for habitats to roll-back into, if there is no defence present to prevent this. It, therefore, ignores the presence of any built infrastructure in the Accommodation Space and whether it is likely that this would be 'let go' to allow colonisation of marine habitats to take place.
- Similarly, no consideration is given to any habitats that may already lie in the Accommodation Space, for example, an MPA may cover a large part of the hinterland, and there could be terrestrial habitats lost in this region when the marine habitats roll-back.
- The assessment assumes intertidal reef features lost due to coastal squeeze will not be replaced by subtidal reef features (i.e., as noted above, the assessment is based on a hypsometric analysis applied to the whole intertidal reef layer). Furthermore, where gains in intertidal reef are predicted, no consideration is given to whether requisite substrates are present for reef habitat to form (e.g., rocky shores).
- As already noted in Section 2, under the SMP2 management scenario in the CSAT, losses and gains in habitat associated with existing defences with an SMP2 policy of NAI or MR are not considered to constitute coastal squeeze in this assessment (instead being attributed to natural squeeze). This aligns with Welsh Government policy on how existing defences are considered under the Habitats Regulations and the compensation requirements under the National Habitat Creation Programme (which only relates to provision of habitat against HTL policy areas).
- When assessing coastal squeeze within an MPA it is assumed that the MPA boundary is fixed. However, a loss in the Foreshore Area can only be classed as coastal squeeze if there is room in the Accommodation Space, to offset the predicted loss. Hence, the available space in the Accommodation Space is examined even if it lies outside of the MPA boundary. Associated gains of habitat within the Accommodation Space are also reported even if they lie outside the MPA.
- On the open coast, including the open coast of the Severn Estuary, tidal levels are prescribed with a reasonable level of accuracy. However, with other estuaries, there was very limited reliable information on tidal level variations through the estuary, so tidal levels at the entrance of estuaries have been applied upstream to the study boundary. This is a significant simplification which, whilst reasonable for a national level assessment will affect results locally.
- On several frontages there are areas of the foreshore that are not assigned to a defined Habitat Group, although in many cases these areas would fall into one of the other defined Habitat Groups. To ensure these areas are captured in the assessment, a 'non-defined' Habitat Group has been included. Loss and gains are calculated for this non-defined Habitat Group using the same approach adopted for primary Habitat Groups (saltmarsh, mudflats and sandflat, intertidal reef and littoral

coarse sediment). At a local level it may be possible to align the losses and gains to a specific Habitat Group, e.g., mudflats and sandflats, but this is not possible at a national scale and the results for the non-defined Habitat Group are recorded separately. Under the national scale assessment and results, these loss and gains are included when the coastal, natural and total squeeze is summed across all Habitat Groups. When coastal, natural and total squeeze is summed across all Habitat Groups within an MPA, only those Habitat Groups associated with the MPA are summed. As the non-defined Habitat Group, may, or may not, be associated with the MPAs, two set of results are created in CSAT, one with the non-defined habitat being included in the all-habitat totals and one without.

- Cliffs, without defined defences at their toe are typically assumed to be scoped out of the assessment as they have the potential to roll-back and will not be subject to coastal squeeze or natural squeeze. However, there are exceptions to this where significant infrastructure (typically a railway line), exist across the top of the cliffs and the SMP2 policy for the frontage in HTL. In these cases, the frontage is typically defined as a defence and loss and gains are calculated accordingly.

## 3.2 Coastal squeeze analysis – national results

This section of the report provides a national overview of the outputs of the coastal squeeze analysis across Wales, as well as for total squeeze (i.e., coastal and natural squeeze). The results are presented separately for each Habitat Group included in the assessment (Sections 3.2.1 to 3.2.7). For each Habitat Group, results are presented for each epoch and for each management scenario. The management scenarios consist of a scenario where the respective SMP2 Policy is implemented, a scenario where all existing defences are removed (No Defences), and one where all existing defences are maintained (Defences Maintained) into the future. These are presented to indicate, at a high level, the potential implications different management scenarios may have on changes in habitat extent across Wales. Two sets of results are presented; one set that applies a higher central allowance for SLR (70th percentile) and another that applies an upper end allowance (95th percentile) for comparison, and the implication of these different SLR projections are considered in Section 3.2.8.

### 3.2.1 Saltmarsh

#### Coastal squeeze

Table 1 shows results for **coastal squeeze** (70th percentile and 95th percentile) for saltmarsh under each management scenario and epoch. There is no coastal squeeze loss associated with a No Defences scenario as this does not meet the definition of coastal squeeze (see Section 2.1).

Under the SMP2 Policy scenario, losses of around 2% are predicted in 2055, increasing to 9% by 2155 applying the 70th percentile SLR allowance. These predicted losses increase to 4% by 2055 and 12% by 2155 when applying the 95th percentile.

Saltmarsh losses are predicted to increase under a Defences Maintained scenario compared with the respective SMP2 Policy scenario being implemented. Losses of 21% (70th percentile) or 25% (95th percentile) are projected by 2155. This increase in loss is

because, under a Defences Maintained scenario, coastal squeeze would also occur around the coastline in locations that are currently assigned NAI/MR under the SMP2.

## Total squeeze

Table 2 shows results for **total squeeze** (70th percentile and 95th percentile) for saltmarsh under each management scenario and epoch. These results combine both coastal squeeze and natural squeeze results. The CSAT tool provides further details for natural squeeze separately.

Under a No Defences scenario, large gains in saltmarsh habitat are expected. By 2055, a 202% increase in extent is predicted under the 70th percentile SLR allowance. A 194% increase in extent is predicted by 2055 under the 95th percentile SLR allowance. Increases of around 141% (70th percentile) and 111% (95th percentile) are predicted by 2155, meaning some of the earlier gains in 2055 are expected to reduce under the total squeeze assessment.

Gains in saltmarsh extent under the total squeeze assessment are also expected under the SMP2 Policy scenario, though these gains are less pronounced than under the No Defences management scenario. Increases of around 47% (70th percentile) or 42% (95th percentile) are projected by 2055. By 2155, a 22% increase in extent is predicted under the 70th percentile SLR allowance. A very small gain in saltmarsh (0.3%) is predicted under the 95th percentile SLR allowance. This suggests that, across Wales, SMP2 policies of either NAI or MR will allow saltmarsh to roll-back and colonise the Accommodation Space behind defences. However, it should be noted that the scale of these gains in habitat decrease as sea levels continues to rise throughout the century.

Losses in saltmarsh are predicted under the Defences Maintained management scenario for total squeeze. Modest gains in saltmarsh extent in 2055 (7% and 3% for the 70th percentile and 95th percentile, respectively) are projected to reduce to losses by 2105. By 2155, losses of 21% and 35% are projected for the 70th percentile SLR allowance and 95th percentile SLR allowance, respectively. Under the Defences Maintained management scenario, those areas that are not defended are able to accommodate the roll-back of habitats. Therefore, by 2055, there is a small gain in saltmarsh. However, by 2155, the overall losses in the foreshore are significantly greater than the available space in the un-protected hinterland, leading to a net loss of saltmarsh.

Table 1. Coastal squeeze saltmarsh habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 7159.36 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| No Defences - 95th percentile SLR allowance | 7159.36 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| SMP2 Policy - 70th percentile SLR allowance | 7159.36 | -175.26 | -2 | -479.08 | -7 | -676.93 | -9 |
| SMP2 Policy - 95th percentile SLR allowance | 7159.36 | -321.44 | -4 | -578.43 | -8 | -847.21 | -12 |
| Defences Maintained - 70th percentile SLR allowance | 7159.36 | -284.22 | -4 | -1113.48 | -16 | -1521.31 | -21 |
| Defences Maintained - 95th percentile SLR allowance | 7159.36 | -463.16 | -6 | -1348.26 | -19 | -1770.47 | -25 |

Table 2. Total (coastal and natural) squeeze saltmarsh habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 7159.36 | 14440.36 | 202 | 11941.16 | 167 | 10063.99 | 141 |
| No Defences - 95th percentile SLR allowance | 7159.36 | 13910.40 | 194 | 11293.75 | 158 | 7923.31 | 111 |
| SMP2 Policy - 70th percentile SLR allowance | 7159.36 | 3330.26 | 47 | 2638.94 | 37 | 1564.70 | 22 |
| SMP2 Policy - 95th percentile SLR allowance | 7159.36 | 3019.96 | 42 | 2180.36 | 30 | -23.38 | 0 |
| Defences Maintained - 70th percentile SLR allowance | 7159.36 | 484.54 | 7 | -787.36 | -11 | -1510.56 | -21 |
| Defences Maintained - 95th percentile SLR allowance | 7159.36 | 225.14 | 3 | -1207.29 | -17 | -2495.87 | -35 |

### 3.2.2 Mudflat and sandflat

## Coastal squeeze

Table 3 shows results for coastal squeeze (70th percentile and 95th percentile) for mudflat and sandflat under each management scenario and epoch. There is no coastal squeeze loss associated with a No Defences scenario as this does not meet the definition of coastal squeeze (see Section 2.1).

Under the SMP2 Policy scenario, small losses of mudflat and sandflat (relative to current extents) are expected due to coastal squeeze in 2055 and 2105 (<2% loss under both the SLR allowances). By 2155, the SMP2 Policy scenario is expected to lead to losses of around 3% (70th percentile) and 6% (95th percentile) of extents.

Under a Defences Maintained scenario, loss of mudflats and sandflats due to coastal squeeze is expected to be less than under the SMP2 Policy scenario (though, overall, percentage changes are similar between the two management scenarios across each epoch). This is because there are several frontages where there is a gain of mudflat and sandflat in front of an existing defence, with mudflat and sandflat extending into the area presently occupied by saltmarsh. Under the SMP2 policy scenario, where these frontages have an MR or NAI policy, this habitat gain is attributed to natural squeeze instead of coastal squeeze. Therefore, these gains are not accounted for in the coastal squeeze results for the SMP2 Policy but are accounted for in the Defences Maintained scenario.

## Total squeeze

Table 4 shows the results for total squeeze (70th percentile and 95th percentile) for mudflat and sandflat under each management scenario and epoch. These results combine both coastal squeeze and natural squeeze results. The CSAT tool provides further details for natural squeeze separately.

As with saltmarsh (reported above), under a No Defences scenario, gains in mudflat and sandflat habitat are expected for total squeeze across Wales. By 2055, a 27% increase in extent is predicted under the 70th percentile SLR allowance. A 28% increase in extent is predicted by 2055 under the 95th percentile SLR allowance. These gains are predicted to continue to increase over the next century; by 2155, mudflat and sandflat are projected to increase by 41% (70th percentile) and 44% (95th percentile).

Gains in mudflat and sandflat across Wales are also predicted for the SMP2 Policy scenario, though these are more modest than that predicted for the No Defence scenario. Mudflat and sandflat habitat is projected to increase by 14% by 2105. In 2155, a 13% (70th percentile) and 11% (95th percentile) increase is expected (a slight decrease from 2105).

Like the other management scenarios, total squeeze results show gains in mudflat and sandflat under the Defences Maintained scenario, though the extent of these gains is smaller than predicted for the other management scenarios. Percentage increases in habitat extent of around 5% to 7% are predicted in 2055 and 2105 under both SLR allowances. By 2155, under the 70th percentile SLR allowance, a small increase (2%) is predicted for mudflat and sandflat, whereas a small decrease (-2%) is predicted in 2155 under the 95th percentile SLR allowance.

Table 3. Coastal squeeze mudflat and sandflat habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 30802.33 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| No Defences - 95th percentile SLR allowance | 30802.33 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| SMP2 Policy - 70th percentile SLR allowance | 30802.33 | -107.64 | 0 | -370.26 | -1 | -1031.59 | -3 |
| SMP2 Policy - 95th percentile SLR allowance | 30802.33 | -38.53 | 0 | -568.78 | -2 | -1700.78 | -6 |
| Defences Maintained - 70th percentile SLR allowance | 30802.33 | -60.60 | 0 | -174.40 | -1 | -841.27 | -3 |
| Defences Maintained - 95th percentile SLR allowance | 30802.33 | 18.34 | 0 | -346.36 | -1 | -1620.42 | -5 |

Table 4. Total (coastal and natural) squeeze mudflat and sandflat habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 30802.33 | 8215.00 | 27 | 10956.68 | 36 | 12512.94 | 41 |
| No Defences - 95th percentile SLR allowance | 30802.33 | 8632.16 | 28 | 11681.64 | 38 | 13590.75 | 44 |
| SMP2 Policy - 70th percentile SLR allowance | 30802.33 | 3124.20 | 10 | 4260.26 | 14 | 3957.26 | 13 |
| SMP2 Policy - 95th percentile SLR allowance | 30802.33 | 3289.75 | 11 | 4246.92 | 14 | 3514.54 | 11 |
| Defences Maintained - 70th percentile SLR allowance | 30802.33 | 1947.11 | 6 | 1710.60 | 6 | 648.10 | 2 |
| Defences Maintained - 95th percentile SLR allowance | 30802.33 | 2027.84 | 7 | 1386.92 | 5 | -463.34 | -2 |

### 3.2.3 Intertidal reef

As explained in Section 3.1.1, the assessment for intertidal reef assumes features lost due to coastal squeeze will not be replaced by subtidal reef features (i.e., the assessment is based on a hypsometric analysis applied to the whole intertidal reef layer). Furthermore, where gains in intertidal reef are predicted, no consideration is given to whether requisite substrates are present for reef habitat to form (e.g., rocky shores). These assumptions should be borne in mind when interpreting the results presented in this section.

#### Coastal squeeze

Table 5 shows results for coastal squeeze (70th percentile and 95th percentile) for intertidal reef under each management scenario and epoch. There is no coastal squeeze loss associated with a No Defences scenario as this does not meet the definition of coastal squeeze (see Section 2.1).

Under the SMP2 Policy scenario, small losses (relative to current extents) of intertidal reef are expected due to coastal squeeze in 2055 (1% loss under both the 70th percentile and 95th percentile SLR allowances). By 2155, the scale of loss increases for SMP2 Policy scenario to around 5% (70th percentile) and 7% (95th percentile) of intertidal reef extents.

Under a Defences Maintained scenario, the loss of intertidal reef due to coastal squeeze increases compared with the respective SMP2 Policy scenario being implemented. In 2055 and 2105, the scale of loss is similar to the SMP2 Policy scenario. However, by 2155, losses of 7% (70th percentile) and 10% (95th percentile) are predicted. As with saltmarsh coastal squeeze losses, this increase in loss is because, under a Defences Maintained scenario, coastal squeeze would also occur around the coastline in locations that are currently assigned NAI/MR under the SMP2.

#### Total squeeze

Table 6 shows results for total squeeze (70th percentile and 95th percentile) for intertidal reef under each management scenario and epoch. These results combine both coastal squeeze and natural squeeze results. The CSAT tool provides further details for natural squeeze separately.

Under a No Defences scenario, gains in intertidal reef habitat are expected. By 2055, a 23% increase in extent is predicted under both the 70th and 95th percentile SLR allowances. These gains in intertidal reef under the total squeeze assessment are predicted to stay relatively stable (22% to 25%) across the next century for both SLR allowances.

Under the SMP2 Policy scenario, gains in intertidal reef extent under the total squeeze assessment are only expected in 2055. By 2105, little change is predicted (1% increase for the 70th percentile and 1% decrease for the 95th percentile), and by 2155, a 4% (70th percentile) and 9% (95th percentile) decrease is predicted. Therefore, any gains in habitat under the SMP2 Policy scenario are likely to be short lived.

Modest increases in intertidal reef extent under the total squeeze assessment are predicted under the Defences Maintained scenario in 2055 (2% increase for the 70th percentile and 1% increase for the 95th percentile). However, these small gains are likely

to turn to overall losses across Wales by 2105 and 2155. In 2155, an 11% decrease and 17% decrease is predicted under the 70th percentile and 95th percentile SLR allowances, respectively. This is as a result of coastal squeeze occurring around the coastline in locations that are currently assigned NAI/MR under the SMP2.

Table 5. Coastal squeeze intertidal reef habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 3431.78 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| No Defences - 95th percentile SLR allowance | 3431.78 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| SMP2 Policy - 70th percentile SLR allowance | 3431.78 | -34.19 | -1 | -100.04 | -3 | -186.47 | -5 |
| SMP2 Policy - 95th percentile SLR allowance | 3431.78 | -42.35 | -1 | -131.38 | -4 | -244.99 | -7 |
| Defences Maintained - 70th percentile SLR allowance | 3431.78 | -38.07 | -1 | -129.85 | -4 | -241.59 | -7 |
| Defences Maintained - 95th percentile SLR allowance | 3431.78 | -47.09 | -1 | -171.15 | -5 | -330.96 | -10 |

Table 6. Total (coastal and natural) squeeze intertidal reef habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 3431.78 | 789.60 | 23 | 763.67 | 22 | 764.36 | 22 |
| No Defences - 95th percentile SLR allowance | 3431.78 | 774.47 | 23 | 762.03 | 22 | 861.12 | 25 |
| SMP2 Policy - 70th percentile SLR allowance | 3431.78 | 158.08 | 5 | 36.12 | 1 | -144.47 | -4 |
| SMP2 Policy - 95th percentile SLR allowance | 3431.78 | 138.03 | 4 | -40.72 | -1 | -309.57 | -9 |
| Defences Maintained - 70th percentile SLR allowance | 3431.78 | 53.00 | 2 | -141.40 | -4 | -375.66 | -11 |
| Defences Maintained - 95th percentile SLR allowance | 3431.78 | 30.08 | 1 | -243.00 | -7 | -594.91 | -17 |

### 3.2.4 Dunes

## Coastal squeeze

Table 7 shows results for coastal squeeze (70th percentile and 95th percentile) for dunes under each management scenario and epoch. The present-day extents of dune habitat in the tables relates to the extent of dune habitat within the Foreshore Area across Wales and does not consider the extent of dunes that are already present in the hinterland. The loss and gain of the latter is excluded from the assessment as it cannot be assessed through hypsometric analysis (see Volume 1 Report for further information, Section 3.2).

There is no coastal squeeze loss associated with a No Defences scenario as this does not meet the definition of coastal squeeze (see Section 2.1).

The largest coastal squeeze losses are associated with a Defences Maintained scenario. This is because dune habitat within the Foreshore Area is prevented from rolling back. Losses occur at the fastest rate under this management scenario, with losses steadily increasing from 2055 to 2155. A 17% (70th percentile) and 20% (95th percentile) loss of dune habitat is projected by 2155.

A reduced loss is projected where the SMP2 Policy is implemented. Some of the defences backing these frontages have an MR or NAI policy under the SMP2 Policy scenario, and therefore will not be subject to coastal squeeze. A 12% (70th percentile) and 14% (95th percentile) decrease in dune habitat is predicted by 2155.

## Total squeeze

Table 8 shows results for total squeeze (70th percentile and 95th percentile) for dunes under each management scenario and epoch. These results combine both coastal squeeze and natural squeeze results. The CSAT tool provides further details for natural squeeze separately.

Under a No Defences scenario, losses in dune habitat are predicted, though these are relatively small scale (3% decrease in 2155 under both SLR allowances). As highlighted in Section 2.3, the assessment of dunes (and vegetated shingle) follow a different method to other habitat types. Potential increases in these habitats as they roll-back under this management scenario is associated with geomorphological change, thus the potential for the habit to increase within the hinterland cannot be examined through a hypsometric analysis. This means the assessment only examined whether the present day extent of dune habitat within the foreshore is either maintained or lost.

Total squeeze losses for dunes under the SMP2 Policy scenario and the Defences Maintained scenario show a similar pattern to the results for coastal squeeze. However, total squeeze losses are approximately 3% to 4% greater than coastal squeeze by 2155. This is because, as noted above, potential increases in extent are not accounted for in the methodology for assessing dune habitats.

Table 7. Coastal squeeze dune habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 283.51 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| No Defences - 95th percentile SLR allowance | 283.51 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| SMP2 Policy - 70th percentile SLR allowance | 283.51 | -4.22 | -1 | -23.73 | -8 | -33.39 | -12 |
| SMP2 Policy - 95th percentile SLR allowance | 283.51 | -4.94 | -2 | -27.09 | -10 | -40.10 | -14 |
| Defences Maintained - 70th percentile SLR allowance | 283.51 | -12.11 | -4 | -35.15 | -12 | -48.32 | -17 |
| Defences Maintained - 95th percentile SLR allowance | 283.51 | -12.85 | -5 | -40.79 | -14 | -57.96 | -20 |

Table 8. Total (coastal and natural) squeeze dune habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 283.51 | -2.26 | -1 | -8.02 | -3 | -9.05 | -3 |
| No Defences - 95th percentile SLR allowance | 283.51 | -2.57 | -1 | -8.20 | -3 | -9.84 | -3 |
| SMP2 Policy - 70th percentile SLR allowance | 283.51 | -6.48 | -2 | -31.75 | -11 | -42.44 | -15 |
| SMP2 Policy - 95th percentile SLR allowance | 283.51 | -7.52 | -3 | -35.29 | -12 | -49.95 | -18 |
| Defences Maintained - 70th percentile SLR allowance | 283.51 | -14.37 | -5 | -43.17 | -15 | -57.37 | -20 |
| Defences Maintained - 95th percentile SLR allowance | 283.51 | -15.42 | -5 | -48.99 | -17 | -67.80 | -24 |

### 3.2.5 Vegetated shingle

## Coastal squeeze

Table 9 shows results for coastal squeeze (70th percentile and 95th percentile) for vegetated shingle under each management scenario and epoch. The present-day extents of vegetated shingle habitat in the tables relates to the extent of habitat within the Foreshore Area across Wales and does not consider the extent of vegetated shingle that is already present in the hinterland. The loss and gain of the latter is excluded from the assessment as it cannot be assessed through hypsometric analysis (see Volume 1 Report for further information, Section 3.2).

There is no coastal squeeze loss associated with a No Defences scenario as this does not meet the definition of coastal squeeze (see Section 2.1). The largest coastal squeeze losses are associated with a Defences Maintained scenario. This is because vegetated shingle habitat within the Foreshore Area is prevented from rolling back as sea levels rise. Losses occur at the fastest rate under this management scenario, with losses steadily increasing from 2055 to 2155. A 27% (70th percentile) and 40% (95th percentile) loss of dune habitat is projected by 2155.

A reduced loss is projected where the SMP2 Policy is implemented. Some of the defences backing these frontages have a MR or NAI policy under the SMP2 Policy scenario, and therefore will not be subject to coastal squeeze. A 16% (70th percentile) and 27% (95th percentile) decrease in vegetated shingle is predicted by 2155.

## Total squeeze

Table 10 shows results for total squeeze (70th percentile and 95th percentile) for vegetated shingle under each management scenario and epoch. These results combine both coastal squeeze and natural squeeze results. The CSAT tool provides further details for natural squeeze separately.

Under a No Defences scenario, losses in vegetated shingle habitat are predicted, though these are relatively small scale (3% decrease in 2155 under both SLR allowances). As with dune habitats described above, the assessment of vegetated shingle follows a different method to other habitat types. Potential increases in these habitats as they roll-back under this management scenario is associated with geomorphological change, thus the potential for the habitat to increase within the hinterland cannot be examined through hypsometric analysis. This means the assessment only examined whether the present day extent of vegetated shingle habitat within the foreshore is either maintained or lost (see Section 2.3).

Total squeeze losses for vegetated shingle under the SMP2 Policy scenario and the Defences Maintained scenario show a similar pattern to the results for coastal squeeze. However, total squeeze losses are approximately 2% to 4% greater than coastal squeeze by 2155. This is because, as noted above, potential increases in extent are not accounted for in the methodology for assessing vegetated shingle habitats.

Table 9. Coastal squeeze vegetated shingle habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 12.31 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| No Defences - 95th percentile SLR allowance | 12.31 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| SMP2 Policy - 70th percentile SLR allowance | 12.31 | -0.31 | -2 | -1.10 | -9 | -1.91 | -16 |
| SMP2 Policy - 95th percentile SLR allowance | 12.31 | -0.39 | -3 | -1.52 | -12 | -3.34 | -27 |
| Defences Maintained - 70th percentile SLR allowance | 12.31 | -0.68 | -6 | -2.03 | -17 | -3.29 | -27 |
| Defences Maintained - 95th percentile SLR allowance | 12.31 | -0.80 | -7 | -2.67 | -22 | -4.93 | -40 |

Table 10. Total (coastal and natural) squeeze vegetated shingle habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 12.31 | -0.06 | 0 | -0.25 | -2 | -0.34 | -3 |
| No Defences - 95th percentile SLR allowance | 12.31 | -0.07 | -1 | -0.29 | -2 | -0.38 | -3 |
| SMP2 Policy - 70th percentile SLR allowance | 12.31 | -0.37 | -3 | -1.35 | -11 | -2.25 | -18 |
| SMP2 Policy - 95th percentile SLR allowance | 12.31 | -0.46 | -4 | -1.81 | -15 | -3.72 | -30 |
| Defences Maintained - 70th percentile SLR allowance | 12.31 | -0.74 | -6 | -2.29 | -19 | -3.63 | -29 |
| Defences Maintained - 95th percentile SLR allowance | 12.31 | -0.88 | -7 | -2.96 | -24 | -5.31 | -43 |

### 3.2.6 Littoral coarse sediment

## Coastal squeeze

Table 11 shows results for coastal squeeze (70th percentile and 95th percentile) for littoral coarse sediment under each management scenario and epoch. There is no coastal squeeze loss associated with a No Defences scenario as this does not meet the definition of coastal squeeze (see Section 2.1).

Under the SMP2 Policy scenario, losses of around 2% are predicted in 2055 (under both SLR allowances), increasing to 7% (70th percentile) or 9% (95th percentile) by 2155.

Littoral coarse sediment losses are predicted to increase under a Defences Maintained scenario compared with the respective SMP2 Policy scenario being implemented. Losses of 12% (70th percentile) or 14% (95th percentile) are projected by 2155. This increase in loss is because, under a Defences Maintained scenario, coastal squeeze would also occur around the coastline in locations that are currently assigned NAI/MR under the SMP2.

## Total squeeze

Table 12 shows results for total squeeze (70th percentile and 95th percentile) for littoral coarse sediment under each management scenario and epoch. These results combine both coastal squeeze and natural squeeze results. The CSAT tool provides further details for natural squeeze separately.

Under all management scenarios, there are large gains predicted for littoral coarse sediment. This occurs because shingle beaches are typically associated with littoral coarse sediment on natural frontages. Thus, irrespective of the management scenario, the Accommodation Space becomes available as sea levels rise. With relatively high land levels in the Accommodation Space, large gains of littoral coarse sediment are predicted. In reality, it is more likely that the shingle beach would roll-back in these instances, and there would not be large immediate gains in littoral coarse sediment. Therefore, the gains seen are partly as result of adopting a simplified hypsometric approach within the assessment. The results described below should therefore be interpreted with an appropriate degree of caution.

The results show that, under a No Defences scenario by 2055, a 444% increase in extent is predicted under the 70th percentile SLR allowance. A 459% increase in extent is predicted by 2055 under the 95th percentile SLR allowance. Gains in littoral coarse sediment under the total squeeze assessment are predicted to continue to increase through to 2155, with predicted increases of around 526% (70th percentile) and 512% (95th percentile).

Gains in littoral coarse sediment extent under the total squeeze assessment are also expected under the SMP2 Policy scenario, though these gains are less pronounced than under the No Defences management scenario. Increases of around 174% (70th percentile) and 175% (95th percentile) are projected by 2055. By 2155, a 203% increase in extent is predicted under the 70th percentile SLR allowance, and a 186% increase under the 95th percentile SLR allowance.

Large gains in littoral coarse sediment are also predicted under the Defences Maintained management scenario for total squeeze, and these gains remain relatively stable across all epochs.  By 2155, a 127% increase in extent is predicted under the 70th percentile SLR allowance, and a 110% increase under the 95th percentile SLR allowance. These large increases are still predicted under the Defences Maintained management scenario, as frontages with littoral coarse sediment are more typically non-defended, and thus the habitat is still able to roll-back.

Table 11. Coastal squeeze littoral coarse sediment habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 485.90 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| No Defences - 95th percentile SLR allowance | 485.90 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| SMP2 Policy - 70th percentile SLR allowance | 485.90 | -7.93 | -2 | -18.68 | -4 | -32.17 | -7 |
| SMP2 Policy - 95th percentile SLR allowance | 485.90 | -9.93 | -2 | -25.57 | -5 | -42.43 | -9 |
| Defences Maintained - 70th percentile SLR allowance | 485.90 | -11.95 | -2 | -35.56 | -7 | -56.46 | -12 |
| Defences Maintained - 95th percentile SLR allowance | 485.90 | -15.22 | -3 | -46.27 | -10 | -68.78 | -14 |

Table 12. Total (coastal and natural) squeeze littoral coarse sediment habitat loss/gain across epochs associated with different management scenarios (no defences, assuming SMP2 Policy is implemented, and assuming all existing defences are maintained) across Wales (70th percentile and 95th percentile SLR allowances)

| Management Scenario and SLR allowance | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| No Defences - 70th percentile SLR allowance | 485.90 | 2159.32 | 444 | 2445.82 | 503 | 2555.56 | 526 |
| No Defences - 95th percentile SLR allowance | 485.90 | 2228.12 | 459 | 2483.66 | 511 | 2485.37 | 512 |
| SMP2 Policy - 70th percentile SLR allowance | 485.90 | 847.23 | 174 | 1001.67 | 206 | 987.70 | 203 |
| SMP2 Policy - 95th percentile SLR allowance | 485.90 | 849.80 | 175 | 995.02 | 205 | 902.87 | 186 |
| Defences Maintained - 70th percentile SLR allowance | 485.90 | 619.61 | 128 | 649.11 | 134 | 617.35 | 127 |
| Defences Maintained - 95th percentile SLR allowance | 485.90 | 624.43 | 129 | 630.38 | 130 | 536.73 | 110 |

### 3.2.7 Coastal lagoons

The Environment Agency (2021) identifies that a coastal lagoon will only be vulnerable to coastal squeeze if it is located in front of a defence (i.e., anthropogenic structure). Coastal lagoons would also be vulnerable to natural squeeze where they sit in front of a natural frontage.

Table 13 lists all 15 coastal lagoons in Wales and identifies which are vulnerable to SLR, either because they are located on the foreshore in front of a defence or natural frontage or are located behind a defence which will not be maintained. It should be noted that only five coastal lagoons listed in Table 13 are designated features of an SAC (these are indicated in Table 13 by an asterix). However, all lagoons are discussed in this section of the report. A series of figures have been produced to show the location of coastal lagoons with respect to Foreshore Areas and Accommodation Space. These are provided in Appendix B. It should be noted that for some coastal lagoons the Accommodation Space is extensive and, therefore, the full extent of the Accommodation Space may not be shown on all figures in Appendix B.

Under the SMP2 Policy scenario, seven coastal lagoons in Wales are considered less vulnerable to SLR as they are located behind a defence that will be maintained under SMP2 policy across all epochs (i.e., protected from inundation). Eight coastal lagoons are considered vulnerable to SLR in at least one epoch; two are located in front of the existing line of defence or high ground, and six are fronted by defences subject to MR or NAI SMP2 policies in future epochs.

Under the Defences Maintained management scenario, 10 coastal lagoons are considered to be protected as they are located behind a defence. The remaining five coastal lagoons are considered vulnerable under this management scenario as they are either located in front of a defence or high ground, or are located behind a natural frontage.

Table 13. Coastal lagoons in Wales vulnerable to SLR.

| Coastal lagoon | Type of MPA lagoon located within (*lagoon designated as feature of MPA) | Area (ha) | Position | SMP2 – 2055 | SMP2 – 2105 | SMP2 – 2155 | Defences maintained |
|---|---|---|---|---|---|---|---|
| Aberthaw Lagoon | N/A | 1.44 | Behind defence | HTL – protected | HTL – protected | HTL – protected | Protected |
| Carew Castle Millpond | SAC*<br>SSSI* | 7.84 | In front of high ground | Vulnerable | Vulnerable | Vulnerable | Vulnerable |
| Cemlyn Bay Lagoon | SAC*<br>SSSI*<br>SPA* | 16.08 | Behind natural frontage | NAI – vulnerable | NAI – vulnerable | NAI – vulnerable | Vulnerable |
| Connah's Quay | SAC<br>SSSI<br>SPA<br>Ramsar | 2.93 | In front of defence | Vulnerable | Vulnerable | Vulnerable | Vulnerable |
| Goldcliff Lagoons | N/A | 10.43 | Behind defence | HTL – protected | HTL – protected | HTL – protected | Protected |
| Malltraeth Cob Pool | SAC<br>SSSI | 3.92 | Behind defence | HTL – protected | HTL – protected | HTL – protected | Protected |
| Morfa Aber Pools | N/A | 0.05 | Behind natural frontage ^ | NAI/MR – vulnerable | NAI/HTL – vulnerable | NAI/HTL – vulnerable | Vulnerable |
| Morfa Gwyllt Lagoon | SAC*<br>SSSI* | 0.33 | Behind defence and natural frontage | MR – vulnerable | MR – vulnerable | MR – vulnerable | Vulnerable |
| Morfa Madryn Pools | N/A | 1.84 | Behind defence | MR – vulnerable | HTL – vulnerable as defence line likely to be behind lagoon | HTL – vulnerable as defence line likely to be behind lagoon | Protected |
| Neyland Weir Pool | SAC*<br>SSSI* | 10.09 | Behind defence | HTL – protected | HTL – protected | HTL – protected | Protected |
| Pembroke Castle Pond | N/A | 3.48 | Behind defence | NAI – vulnerable | NAI – vulnerable | NAI – vulnerable | Protected |
| Penclacwydd North Pool | N/A | 1.67 | Behind defence | HTL – protected | HTL – protected | HTL – protected | Protected |
| Pickleridge Lagoon | SAC*<br>SSSI* | 6.46 | Behind defence | MR – vulnerable | MR – vulnerable | MR – vulnerable | Protected |

| Coastal lagoon | Type of MPA lagoon located within (*lagoon designated as feature of MPA) | Area (ha) | Position | SMP2 – 2055 | SMP2 – 2105 | SMP2 – 2155 | Defences maintained |
|---|---|---|---|---|---|---|---|
| Point of Ayr Colliery | SAC<br>SSSI<br>SPA<br>Ramsar | 1.61 | Behind defence | HTL – protected | HTL – protected | HTL – protected | Protected |
| Rhyl Marine Lake | N/A | 12.46 | Behind defence | HTL – protected | HTL – protected | HTL – protected | Protected |

**^** A small section of lagoon is also located in front of a natural frontage

### 3.2.8 SLR allowance comparison

This section of the report briefly considers the differences in results between the higher central allowance (70th percentile) and the upper end allowance (95th percentile) for SLR.

The pattern of habitat loss and gain is broadly similar between each of the SLR projections. However, for all Habitat Groups, the scale of losses is greater for the 95th percentile results, and the extent of any predicted habitat gains are reduced in comparison to the 70th percentile results. This is a result of the higher sea levels used in the 95th percentile projections which further encroaches on intertidal habitats and increases coastal and natural squeeze.

For example, under the SMP2 Policy scenario for the 95th percentile results, there is a loss of 23 ha predicted for saltmarsh across Wales in 2155 for total squeeze, as opposed to a gain of 1,565 ha for the 70th percentile results (Table 2).

Figure 4 provides a comparison of the 70th and 95th percentile projections for coastal squeeze induced habitat loss in Wales. In 2055, there is a 15% increase in loss under the 95th percentile results compared with the 70th percentile results. By 2155, this gap increases to nearly 50%.

The difference in habitat gains in Wales between the 70th and 95th percentile projections for total squeeze is shown in Figure 5. The differences in results between the SLR projections are less pronounced than for coastal squeeze, but for 2155, the 95th percentile projections predict habitat gains to be 14% less than the 70th percentile projections.

The analysis presented here shows that SLR projections have a large bearing on the outcome of the results. This has important implications when interpreting and using the data for future applications. The selection of SLR allowances should therefore be given careful consideration and decisions should be based on what the data outputs are being used for.

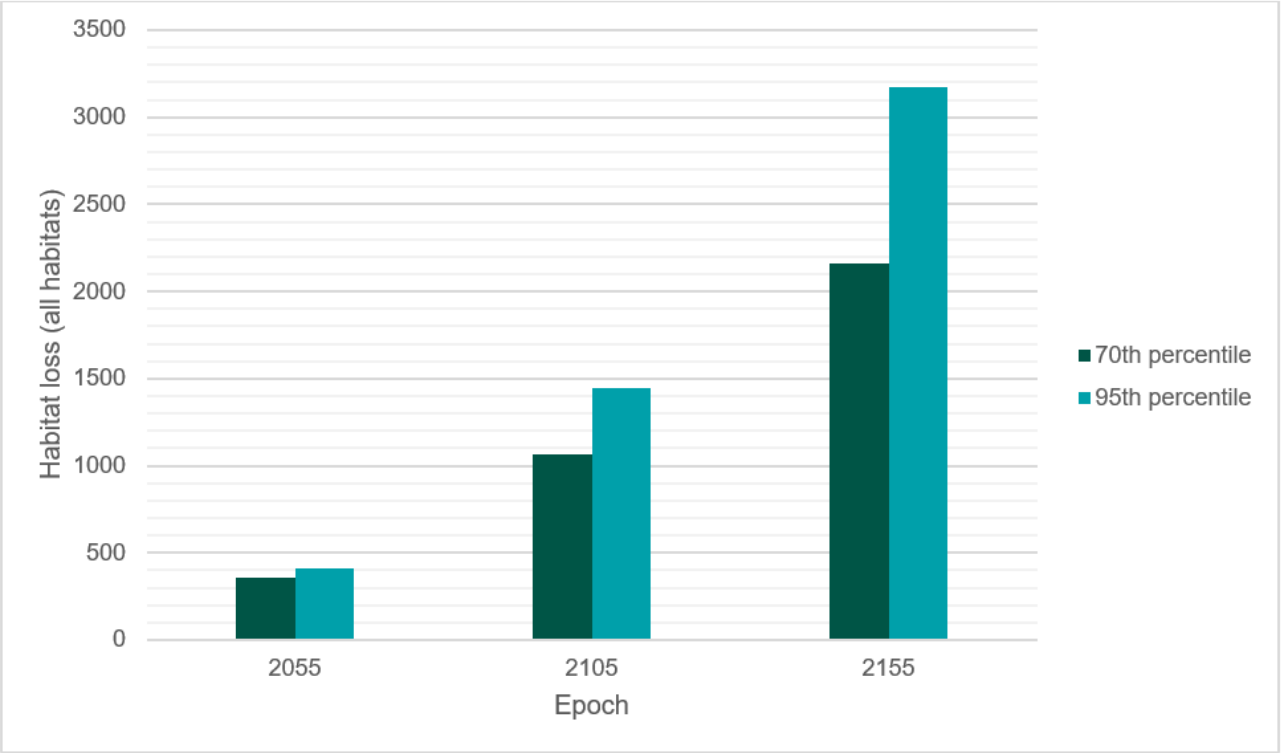


Figure 4 Total habitat loss (ha) across Wales due to coastal squeeze under the SMP policy management scenario.

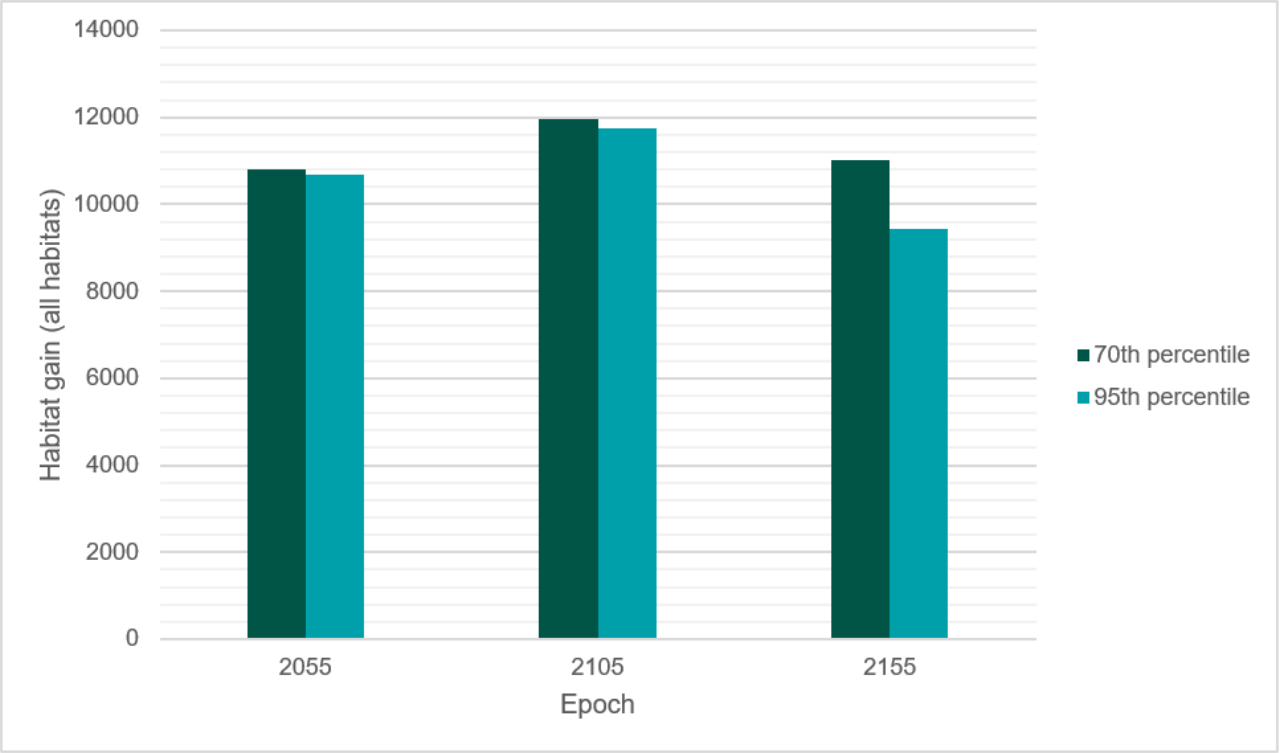


Figure 5. Total habitat gain (ha) across Wales for total (coastal and natural) squeeze under the SMP policy management scenario.

## 3.3 Coastal squeeze analysis – Special Areas of Conservation

This section of the report presents the results of coastal squeeze induced habitat loss and gain within Welsh marine SACs, as well as losses and gains associated with total squeeze (i.e., coastal and natural squeeze) for the 70th percentile SLR allowance. The results are presented separately for saltmarsh (Section 3.3.1), mudflat and sandflat (Section 3.3.2), and intertidal reef (Section 3.3.3). Other habitat types are not reported here as they are not directly aligned to specific designated habitat features of SACs. However, it is recognised that other habitat types included in the assessment may form part of a habitat feature within an SAC (e.g., Estuaries and Large Shallow Inlets and Bays – see Section 2.2). Results for these can be examined in the CSAT.

For each habitat, results are first presented for a scenario where the respective SMP2 Policy is implemented. The outputs of this analysis are then compared to two different management scenarios; one where all existing defences are removed (No Defences), and one where all existing defences are maintained (Defences Maintained) into the future. Section 3.3.4 provides a summary of the results for each SAC.

### 3.3.1 Saltmarsh

#### SMP2 Policy management scenario

Figure 6 shows predicted saltmarsh losses and gains for each epoch associated with coastal and total squeeze where the SMP2 Policy is implemented. Table 14 and Table 15 show detailed results for coastal squeeze and total squeeze respectively.

The largest absolute losses of saltmarsh caused by coastal squeeze occurs within the Dee Estuary SAC, totalling 336 ha by 2155, and large losses are also expected within the Carmarthen Bay and Estuaries SAC (158 ha by 2155), and the Severn Estuary SAC (143 ha by 2155). Carmarthen Bay and Estuaries SAC has the greatest present-day saltmarsh coverage (equivalent to all the other Welsh SACs combined), and the proportional loss by 2155 is circa 6% of the present-day habitat extent, due to a mix of HTL, NAI and MR policies. However, for the Dee Estuary SAC and Severn Estuary SAC, the proportional losses are much larger, circa 40%, as the coastline within these SACs is predominantly HTL.

When considering total squeeze, the Severn Estuary SAC and the Pembrokeshire Marine SAC suffer the greatest losses as a proportion of present-day saltmarsh extents. In the Severn Estuary, the scale of losses from coastal squeeze and total squeeze are similar (which again is due to the majority of loss being caused by the HTL policy). For total squeeze in the Severn Estuary SAC, a 39% reduction in saltmarsh is predicted by 2155. In the Pembrokeshire Marine SAC, total squeeze losses are greater than from coastal squeeze, which is a product of the large proportion of natural frontage within the SAC, and the small amount of Accommodation Space within the site that is available to support saltmarsh habitat. A 59% decrease in saltmarsh extent is predicted by 2155.

Large scale coastal squeeze losses (in absolute terms) within the Dee Estuary SAC are predicted to be offset by natural squeeze in the short term; a gain of 428 ha in saltmarsh, or a 54% increase, is predicted in the Dee Estuary in 2055 for total squeeze. This is

because some of the coastline is assigned an MR policy, resulting in an immediate gain in saltmarsh in the Accommodation Space in 2055 with limited loss in the Foreshore Area. However, by 2155 a loss of 220 ha (a 28% decrease) is predicted as sea levels continue to rise, and the Accommodation Space runs out.

Within the Carmarthen Bay and Estuaries SAC, 813 ha of saltmarsh is predicted to be gained by 2055 (29% increase). This reduces to 45 ha by 2155 (2% increase). Again, this is a result of NAI and MR policies assigned along most of this frontage in all epochs causing an immediate gain in saltmarsh in the Accommodation Space in 2055. However, the Accommodation Space is limited, and with increasing SLR the available room in the Accommodation Space is then only slightly greater than losses that occur in the Foreshore Area, so the overall net gain in saltmarsh becomes much smaller in 2155. Similar patterns of reducing gains are evident for the Anglesey Coast: Saltmarsh SAC.

In the Lleyn Peninsula and the Sarnau SAC, total squeeze results in large saltmarsh gains of 607 ha (51%), 1147 ha (97%), and 604 ha (51%) in 2055, 2105, and 2155, respectively. Gains of a similar scale (as a proportion of present-day extents) are predicted within the Kenfig SAC.

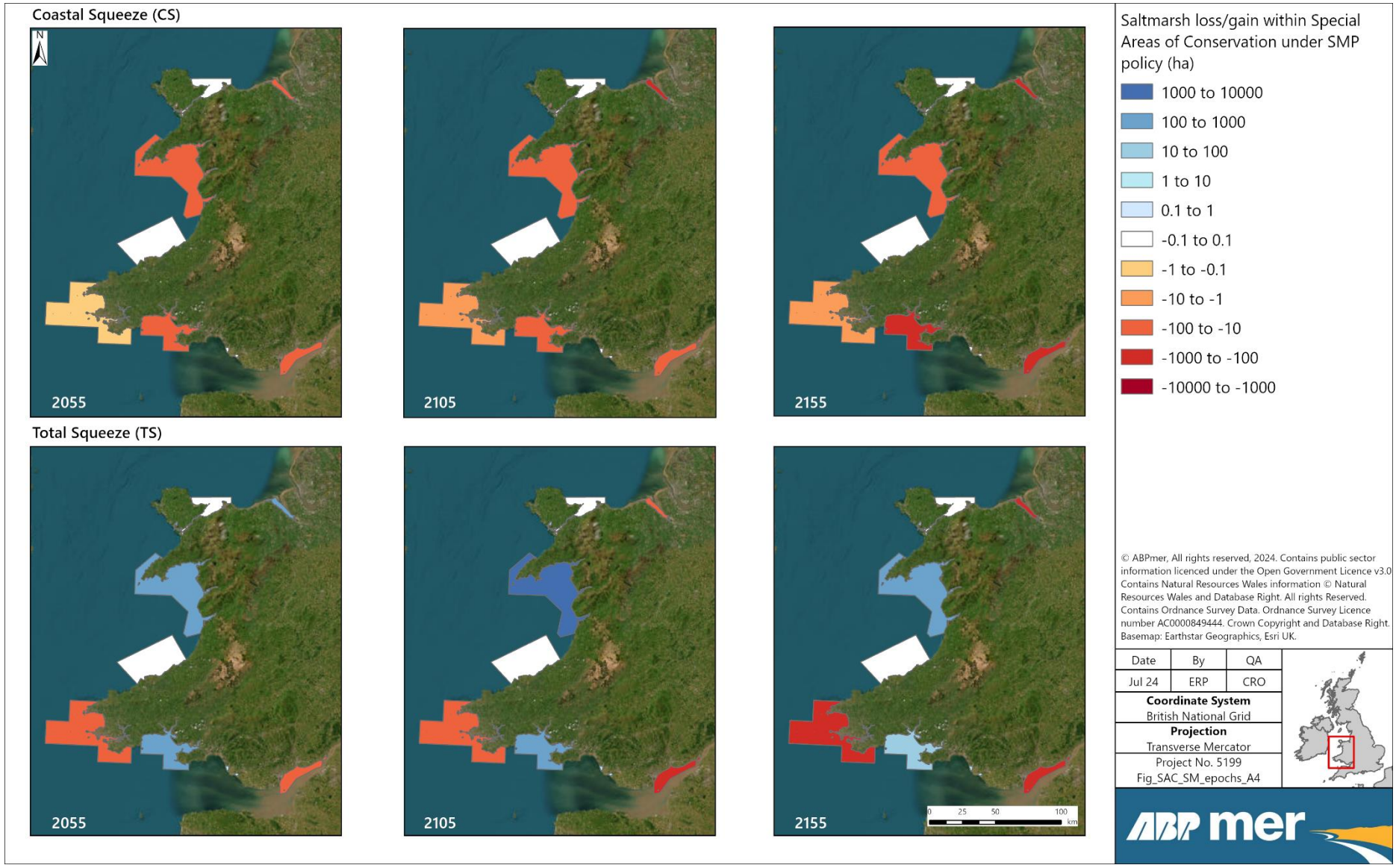


Figure 6. Coastal/total squeeze saltmarsh habitat loss/gain assuming SMP2 policy is implemented within SACs for 2055, 2105 and 2155 (70th percentile)

Table 14. Coastal squeeze saltmarsh habitat loss and gain within SACs – SMP2 Policy (70th percentile)

| SACs | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 227.89 | -0.69 | 0 | -1.49 | -1 | -1.98 | -1 |
| Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau | 1187.3 | -79.63 | -7 | -20.67 | -2 | -26.8 | -2 |
| Dee Estuary / Aber Dyfrdwy (Wales) | 785.94 | -27.64 | -4 | -264.75 | -34 | -335.58 | -43 |
| Glannau Mon: Cors heli / Anglesey Coast: Saltmarsh | 149.13 | -3.04 | -2 | -10.54 | -7 | -11.28 | -8 |
| Carmarthen Bay and Estuaries / Bae Caerfyrddin ac Aberoedd | 2765.32 | -28.31 | -1 | -93.53 | -3 | -158.48 | -6 |
| Kenfig / Cynffig | 8.78 | 0 | 0 | 0 | 0 | 0 | 0 |
| Severn Estuary (Wales) | 362.7 | -38.56 | -11 | -99.75 | -28 | -142.53 | -39 |

Table 15. Total (coastal and natural) squeeze saltmarsh habitat loss and gain within SACs – SMP2 Policy (70th percentile)

| SACs | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 227.89 | -14.15 | -6 | -95.35 | -42 | -133.64 | -59 |
| Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau | 1187.30 | 607.09 | 51 | 1146.65 | 97 | 603.77 | 51 |
| Dee Estuary / Aber Dyfrdwy (Wales) | 785.94 | 427.70 | 54 | -56.00 | -7 | -220.11 | -28 |
| Glannau Mon: Cors heli / Anglesey Coast: Saltmarsh | 149.13 | 204.89 | 137 | 53.16 | 36 | 19.84 | 13 |
| Carmarthen Bay and Estuaries / Bae Caerfyrddin ac Aberoedd | 2765.32 | 812.96 | 29 | 277.69 | 10 | 45.34 | 2 |
| Kenfig / Cynffig | 8.78 | 3.45 | 39 | 3.74 | 43 | 5.15 | 59 |
| Severn Estuary (Wales) | 362.70 | -38.71 | -11 | -100.22 | -28 | -143.26 | -39 |

## Comparison of non-defended and defended management scenarios

This section of the report provides a comparison between different management scenarios and the potential implications these may have on changes in saltmarsh extent within SACs in 2155.

Results for a No Defences scenario, where existing defences are removed from the analysis, are presented, as well as a scenario where existing defences are maintained into the future (Defences Maintained). These are compared against the scenario where the SMP2 Policy is implemented across Wales (which is presented in the preceding section).

Figure 7 shows predicted saltmarsh losses and gains in 2155 due to coastal and total squeeze with a No Defences scenario, an SMP2 Policy scenario, and a Defences Maintained scenario. Table 16 and Table 17 show detailed results for coastal squeeze and total squeeze respectively.

Under a No Defences scenario, there would be no coastal squeeze induced loss as any loss or gain would be attributed to natural squeeze. In a scenario where all defences are maintained, results suggest losses in saltmarsh would be higher than if the SMP2 policies were implemented. For example, saltmarsh loss in the Lleyn Peninsula and the Sarnau SAC increases from 27 ha or 2% (under the SMP2 Policy scenario) to 596 ha or 50% (Defences Maintained scenario). The coastline along the Severn Estuary predominantly has an SMP2 policy of HTL, and therefore coastal squeeze losses in the Severn Estuary SAC do not change between each scenario.

The Kenfig SAC is a special case as none of the coastline is defended and therefore coastal squeeze is not an issue under any scenario. It should also be noted that the present-day saltmarsh extent within the Kenfig SAC is situated within the Accommodation Space, since it lies up a very small creek that has not been resolved in the delineation of the coastline.

Total squeeze is anticipated to result in large gains in saltmarsh for SACs in Wales under a No Defences scenario. The largest gain is predicted in the Severn Estuary SAC where an increase of 4,570 ha (1,260%) is predicted. The exception to this is the Pembrokeshire Marine SAC, which is predicted to lose 115 ha (51%) of saltmarsh in 2055 reflecting the limited Accommodation Space to allow the rolling back of saltmarsh habitat before it reaches high ground.

The opposite occurs under a Defences Maintained scenario, where total squeeze results predict large losses in all SACs (between 18% and 55% decreases) except the Kenfig SAC. Here, large gains relative to the current extents are still predicted as there are no existing defences to maintain in this scenario.

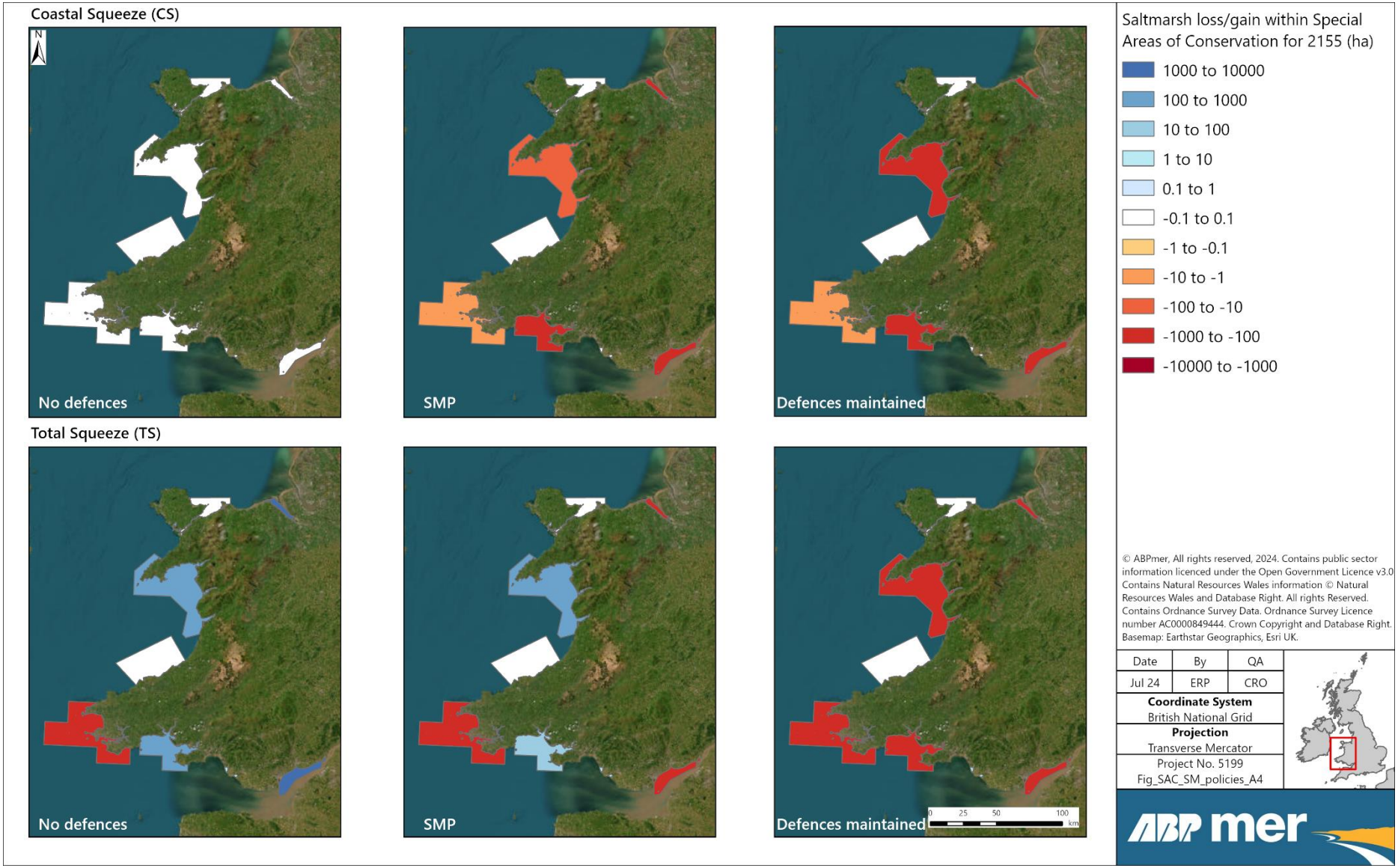


Figure 7. Coastal/total squeeze saltmarsh habitat loss/gain associated with different management scenarios (no defences, SMP2 policy, and defences maintained) within SACs for 2155 (70th percentile).

Table 16. Coastal squeeze saltmarsh habitat loss and gain associated with different management scenarios (no defences, SMP2 policy, and defences maintained) within SACs for 2155 (70th percentile)

| SACs | 2025 (present day) (ha) | No Defences (ha) | No Defences (% change) | SMP2 Policy (ha) | SMP2 Policy (% change) | Defences Maintained (ha) | Defences Maintained (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 227.89 | 0.00 | 0 | -1.98 | -1 | -4.50 | -2 |
| Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau | 1187.3 | 0.00 | 0 | -26.80 | -2 | -596.39 | -50 |
| Dee Estuary / Aber Dyfrdwy (Wales) | 785.94 | 0.00 | 0 | -335.58 | -43 | -440.72 | -56 |
| Glannau Mon: Cors heli / Anglesey Coast: Saltmarsh | 149.13 | 0.00 | 0 | -11.28 | -8 | -15.06 | -10 |
| Carmarthen Bay and Estuaries / Bae Caerfyrddin ac Aberoedd | 2765.32 | 0.00 | 0 | -158.48 | -6 | -262.62 | -9 |
| Kenfig / Cynffig | 8.78 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 |
| Severn Estuary (Wales) | 362.7 | 0.00 | 0 | -142.53 | -39 | -142.53 | -39 |

Table 17. Total (coastal and natural) squeeze saltmarsh habitat loss and gain associated with different management scenarios (no defences, SMP policy, and defences maintained) within SACs for 2155 (70th percentile)

| SACs | 2025 (present day) (ha) | No Defences (ha) | No Defences (% change) | SMP2 Policy (ha) | SMP2 Policy (% change) | Defences Maintained (ha) | Defences Maintained (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 227.89 | -115.13 | -51 | -133.64 | -59 | -148.64 | -65 |
| Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau | 1187.30 | 857.57 | 72 | 603.77 | 51 | -621.84 | -52 |
| Dee Estuary / Aber Dyfrdwy (Wales) | 785.94 | 1437.58 | 183 | -220.11 | -28 | -452.35 | -58 |
| Glannau Mon: Cors heli / Anglesey Coast: Saltmarsh | 149.13 | 239.05 | 160 | 19.84 | 13 | -32.55 | -22 |
| Carmarthen Bay and Estuaries / Bae Caerfyrddin ac Aberoedd | 2765.32 | 664.19 | 24 | 45.34 | 2 | -495.34 | -18 |
| Kenfig / Cynffig | 8.78 | 5.15 | 59 | 5.15 | 59 | 5.15 | 59 |
| Severn Estuary (Wales) | 362.70 | 4569.57 | 1260 | -143.26 | -39 | -143.26 | -39 |

## 3.3.2 Mudflat and sandflat

### SMP2 Policy management scenario

Figure 8 shows predicted mudflat and sandflat losses and gains for each epoch associated with coastal and total squeeze where the SMP2 Policy is implemented. Table 18 and Table 19 show detailed results for coastal squeeze and total squeeze respectively.

The largest loss of mudflat and sandflat caused by coastal squeeze is predicted to occur within the Severn Estuary SAC, totalling 479 ha by 2155 (proportional loss of circa 9%). Relatively large losses are also expected within the Carmarthen Bay SAC (93 ha by 2155, proportional loss of circa 1-2%), and the Lleyn Peninsula and the Sarnau SAC (30 ha by 2155, proportional loss of circa 1%). The higher absolute and proportional losses in the Severn Estuary SAC primarily results from the HTL SMP2 policy for the majority of coastline within this SAC.

In contrast, gains in mudflat and sandflat as a result of coastal squeeze are predicted within the Dee Estuary; 87 ha (a 2% increase) in 2105 decreasing to 32 ha (a 1% increase) in 2155. This is because the mudflat and sandflat is predicted to extend inshore and occupy areas previously occupied by saltmarsh in these SACs, and is therefore associated with a loss of saltmarsh that is unable to migrate inland where a defence is in place (see Table 14).

When considering total squeeze, gains in mudflat and sandflat are predicted in all but two SACs. The amount ranges from 5 ha (0% change) in 2155 in the Pembrokeshire Marine SAC, to 2,535 ha (93% increase) in 2155 in the Lleyn Peninsula and the Sarnau SAC. Total squeeze losses are only predicted in Menai Strait and Conwy Bay SAC (472 ha or 15% loss in 2155), which reflects a lack of Accommodation Space to support mudflat and sandflat, and the Severn Estuary SAC (484 ha or 9% loss in 2155) which is mostly attributed to coastal squeeze due to the HTL policy for this stretch of coast.

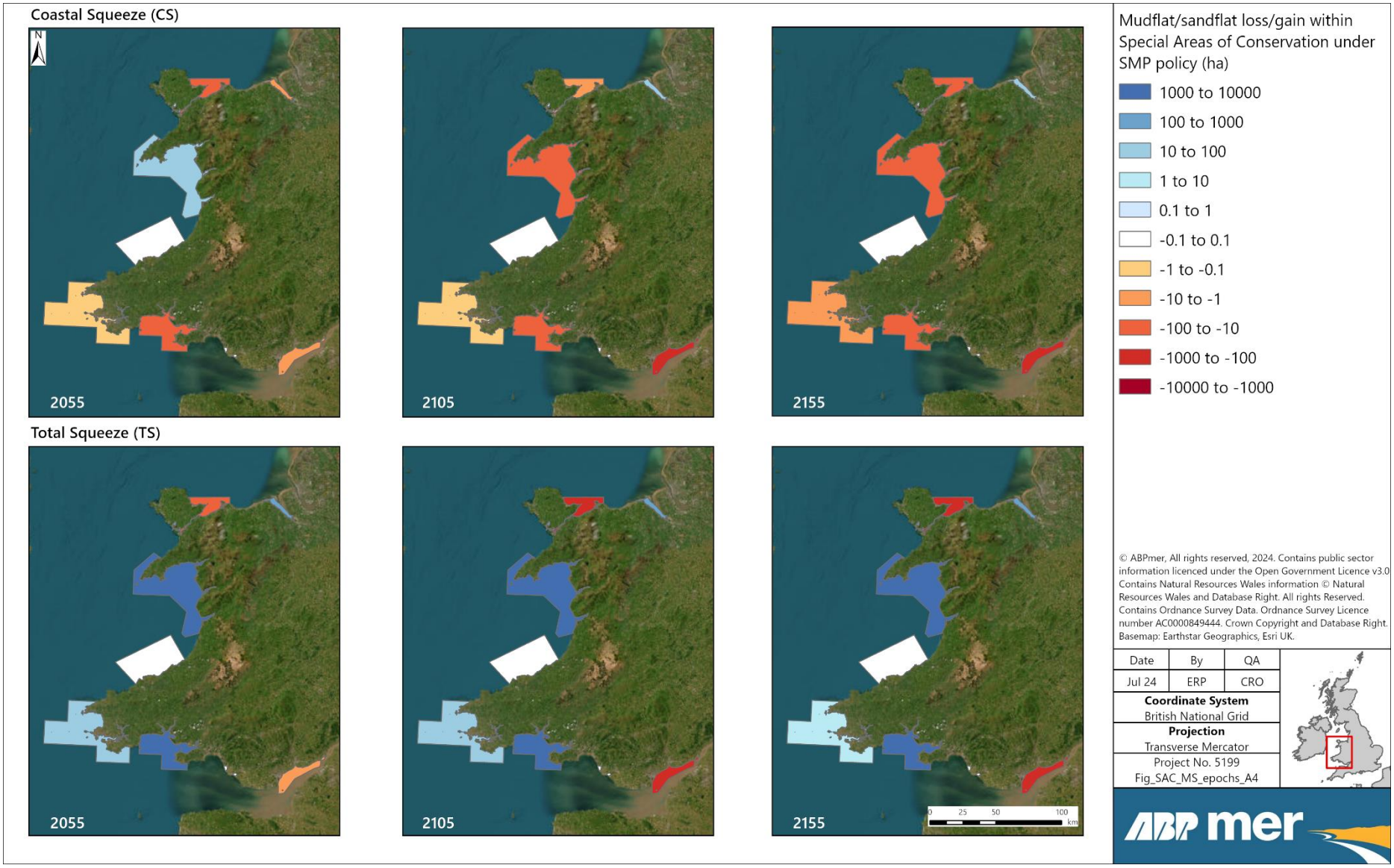


Figure 8. Coastal/total squeeze mudflat/sandflat habitat loss/gain assuming SMP2 policy is implemented within SACs for 2055, 2105 and 2155 (70th percentile)

Table 18. Coastal squeeze mudflat/sandflat habitat loss and gain within SACs – SMP2 policy (70th percentile)

| SACs | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 1136.25 | -0.37 | 0 | -0.67 | 0 | -2.38 | 0 |
| Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau | 2720.81 | 42.31 | 0 | -12.33 | 0 | -29.81 | -1 |
| Dee Estuary / Aber Dyfrdwy (Wales) | 4315.38 | -3.44 | 0 | 87.18 | 2 | 32.09 | 1 |
| Y Fenai a Bae Conwy / Menai Strait and Conwy Bay | 3142.86 | -11.09 | 0 | -6.41 | 0 | -11.93 | 0 |
| Glannau Mon: Cors heli / Anglesey Coast: Saltmarsh | 626.01 | 1.39 | 0 | 4.67 | 1 | 5.39 | 1 |
| Carmarthen Bay and Estuaries / Bae Caerfyrddin ac Aberoedd | 6300.62 | -38.19 | -1 | -57.24 | -1 | -93.12 | -1 |
| Severn Estuary (Wales) | 5483.23 | -3.46 | 0 | -166.52 | -3 | -478.80 | -9 |

Table 19. Total (coastal and natural) squeeze mudflat/sandflat habitat loss and gain within SACs – SMP2 policy (70th percentile)

| SACs | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 1136.25 | 56.64 | 5 | 44.63 | 4 | 4.83 | 0 |
| Pen Llyn a'r Sarnau / Lleyn Peninsula and the Sarnau | 2720.81 | 1086.07 | 40 | 1978.41 | 73 | 2535.13 | 93 |
| Dee Estuary / Aber Dyfrdwy (Wales) | 4315.38 | 231.91 | 5 | 526.89 | 12 | 506.83 | 12 |
| Y Fenai a Bae Conwy / Menai Strait and Conwy Bay | 3142.86 | -44.19 | -1 | -290.77 | -9 | -472.05 | -15 |
| Glannau Mon: Cors heli / Anglesey Coast: Saltmarsh | 626.01 | 174.41 | 28 | 375.89 | 60 | 413.47 | 66 |
| Carmarthen Bay and Estuaries / Bae Caerfyrddin ac Aberoedd | 6300.62 | 1162.74 | 18 | 1429.15 | 23 | 1386.65 | 22 |
| Severn Estuary (Wales) | 5483.23 | -3.95 | 0 | -169.65 | -3 | -483.93 | -9 |

## Comparison of non-defended and defended management scenarios

This section of the report provides a comparison between different management scenarios and the potential implications these may have on changes in mudflat and sandflat extent within SACs in 2155.

Results for a No Defence scenario, where existing defences are removed from the analysis, are presented, as well as a scenario where existing defences are maintained into the future (Defences Maintained). These are compared against the scenario where the SMP2 Policy is implemented across Wales (which is presented in the preceding section).

Figure 9 shows predicted mudflat and sandflat losses and gains in 2155 due to coastal and total squeeze with a No Defence scenario, an 'SMP2 policy' scenario, and a 'defences maintained' scenario. Table 20 and Table 21 show detailed results for coastal squeeze and total squeeze respectively.

Under a No Defences scenario, there would be no coastal squeeze induced loss as any loss or gain would be attributed to natural squeeze. In a scenario where all defences are maintained, losses in mudflat and sandflat are anticipated to be greater than if the respective SMP2 policies were implemented in the Pembrokeshire Marine SAC, Dee Estuary SAC, and Menai Strait and Conwy SAC. However, in the Lleyn Peninsula and the Sarnau SAC, there is an increase in mudflat and sandflat extent under the Defences Maintained scenario. This is also the case but to a lesser extent on the Anglesey Coast: Saltmarsh SAC and Carmarthen Bay and Estuaries SAC. The reason for this is the same as that which results in an increase of mudflat and sandflat in the national assessment (Section 3.2). For several frontages, there is a gain of mudflat and sandflat in front of an existing defence, with the habitat extending into space presently occupied by saltmarsh. This gain is classed as coastal squeeze under the Defences Maintained scenario, and classed as natural coastal squeeze under the SMP2 Policy scenario if the policy is not HTL. Thus, these gains are only associated with coastal squeeze when the defence is maintained. Coastal squeeze losses in the Severn Estuary SAC do not change between each scenario, as the SMP2 policy is predominantly HTL.

Total squeeze is anticipated to result in large gains in mudflat and sandflat for SACs in Wales under a No Defences scenario. The only exception to this is within the Menai Strait and Conwy Bay SAC. Here, a loss of largest absolute gains in mudflat and sandflat (greater than 2,000 ha) are predicted in the Severn Estuary SAC (37% increase), Lleyn Peninsula and the Sarnau SAC (133% increase), and Dee Estuary SAC (53%). A 257% increase in mudflat and sandflat is also predicted in the Anglesey Coast: Saltmarsh SAC.

Under a Defences Maintained scenario, gains in habitat are either reduced in comparison to the SMP2 Policy scenario, or losses of mudflat and sandflat are projected.

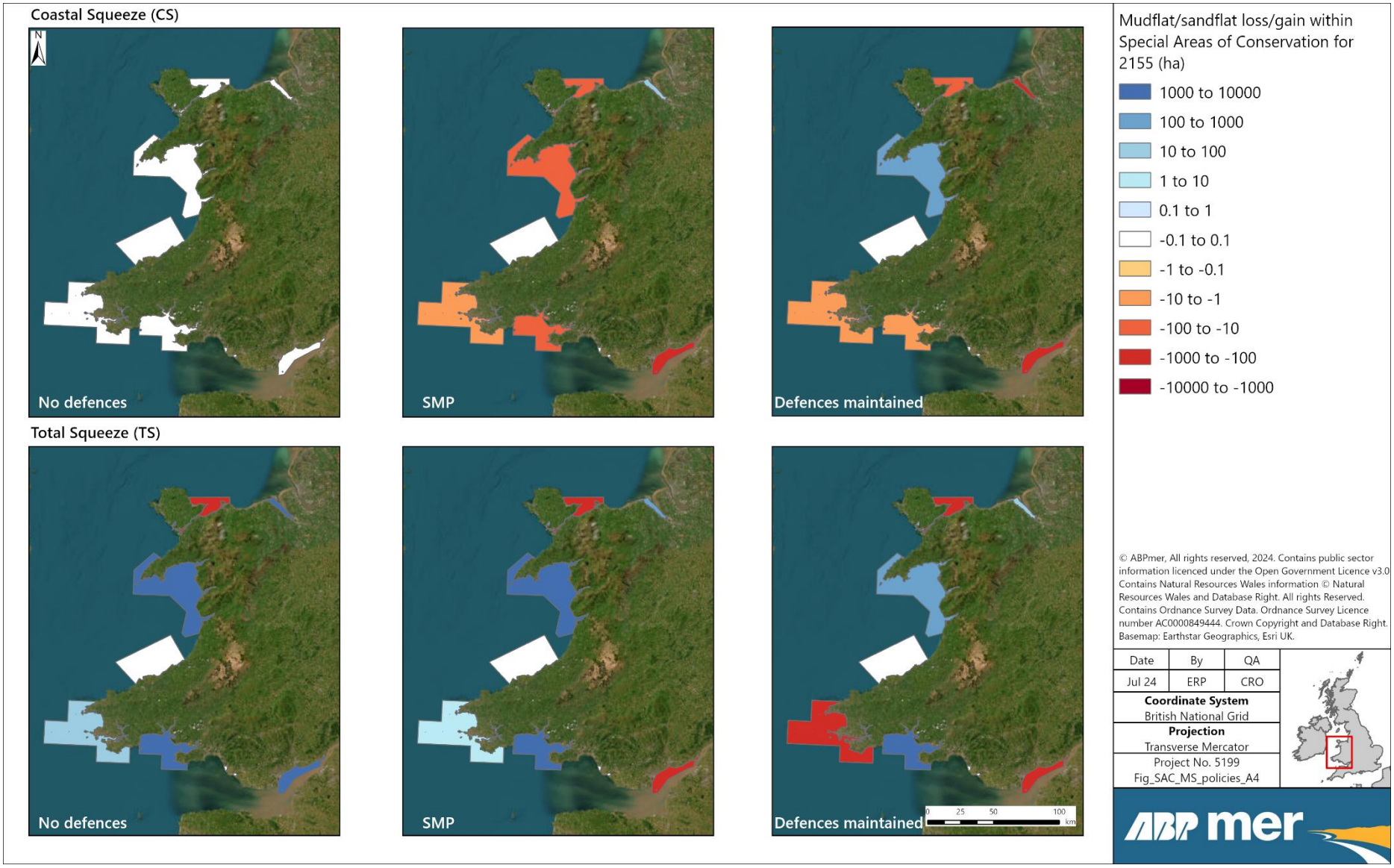


Figure 9. Coastal/total squeeze mudflat/sandflat habitat loss/gain associated with different management scenarios (no defences, SMP2 policy, and defences maintained) within SACs for 2155 (70th percentile).

Table 20. Coastal squeeze mudflat/sandflat habitat loss and gain associated with different management scenarios (no defences, SMP2 policy, and defences maintained) within SACs for 2155 (70th percentile).

| SACs | 2025 (present day) (ha) | No Defences (ha) | No Defences (% change) | SMP2 policy (ha) | SMP2 policy (% change) | Defences Maintained (ha) | Defences Maintained (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 1136.247281 | 0.00 | 0 | -2.38 | 0 | -8.10 | -1 |
| Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau | 2720.807058 | 0.00 | 0 | -29.81 | -1 | 347.12 | 13 |
| Dee Estuary / Aber Dyfrdwy (Wales) | 4315.379703 | 0.00 | 0 | 32.09 | 1 | -164.03 | -4 |
| Y Fenai a Bae Conwy / Menai Strait and Conwy Bay | 3142.858393 | 0.00 | 0 | -11.93 | 0 | -86.75 | -3 |
| Glannau Mon: Cors heli / Anglesey Coast: Saltmarsh | 626.0088322 | 0.00 | 0 | 5.39 | 1 | 1.98 | 0 |
| Carmarthen Bay and Estuaries / Bae Caerfyrddin ac Aberoedd | 6300.623337 | 0.00 | 0 | -93.12 | -1 | -6.68 | 0 |
| Severn Estuary (Wales) | 5483.225786 | 0.00 | 0 | -478.80 | -9 | -478.80 | -9 |

Table 21. Total (coastal and natural) squeeze mudflat/sandflat habitat loss and gain associated with different management scenarios (no defences, SMP2 policy, and defences maintained) within SACs for 2155 (70th percentile).

| SACs | 2025 (present day) (ha) | No Defences (ha) | No Defences (% change) | SMP2 Policy (ha) | SMP2 Policy (% change) | Defences Maintained (ha) | Defences Maintained (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 1136.25 | 14.71 | 1 | 4.83 | 0 | -106.07 | -9 |
| Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau | 2720.81 | 3621.14 | 133 | 2535.13 | 93 | 939.29 | 35 |
| Dee Estuary / Aber Dyfrdwy (Wales) | 4315.38 | 2305.09 | 53 | 506.83 | 12 | 59.55 | 1 |
| Y Fenai a Bae Conwy / Menai Strait and Conwy Bay | 3142.86 | -457.67 | -15 | -472.05 | -15 | -634.51 | -20 |
| Glannau Mon: Cors heli / Anglesey Coast: Saltmarsh | 626.01 | 1609.17 | 257 | 413.47 | 66 | 89.88 | 14 |
| Carmarthen Bay and Estuaries / Bae Caerfyrddin ac Aberoedd | 6300.62 | 1794.55 | 28 | 1386.65 | 22 | 1137.49 | 18 |
| Severn Estuary (Wales) | 5483.23 | 2049.14 | 37 | -483.93 | -9 | -483.93 | -9 |

### 3.3.3 Intertidal reef

As explained in Section 3.1.1, the assessment for intertidal reef assumes features lost due to coastal squeeze will not be replaced by subtidal reef features (i.e., the assessment is based on a hypsometric analysis applied to the whole intertidal reef layer). Furthermore, where gains in intertidal reef are predicted, no consideration is given to whether requisite substrates are present for reef habitat to form (e.g., rocky shores). These assumptions should be borne in mind when interpreting the results presented in this section.

#### SMP2 Policy management scenario

Figure 10 shows predicted intertidal reef losses and gains for each epoch associated with coastal and total squeeze where the SMP2 Policy is implemented. Table 22 and Table 23 show detailed results for coastal squeeze and total squeeze respectively.

Coastal squeeze losses of intertidal reef are predicted in all SACs except Cardigan Bay SAC where no loss is predicted. However, compared with saltmarsh or mudflat and sandflat, the scale of loss (both absolute and proportional loss) is modest (up to a 2% decrease) within most SACs. The exception to this is the Severn Estuary SAC which is predicted to suffer relatively large absolute and proportional losses of intertidal reef (106 ha in 2155, proportional loss of circa 17%). Again, the HTL policy within the Severn Estuary SAC is driving these losses.

When considering total squeeze, gains of 46 ha (21%) of intertidal reef are predicted in the Lleyn Peninsula and the Sarnau SAC by 2155. A gain of 29 ha (7%) is also predicted in the first epoch (2055) in the Menai Strait and Conwy Bay SAC, however, by 2155, a loss of 41 ha (10%) is predicted. Total squeeze losses of intertidal reef are also predicted in Cardigan Bay SAC (12 ha, or 50%, in 2155), Pembrokeshire Marine SAC (49 ha, or 14%, in 2155) and the Severn Estuary SAC (126 ha, or 20%, in 2155).

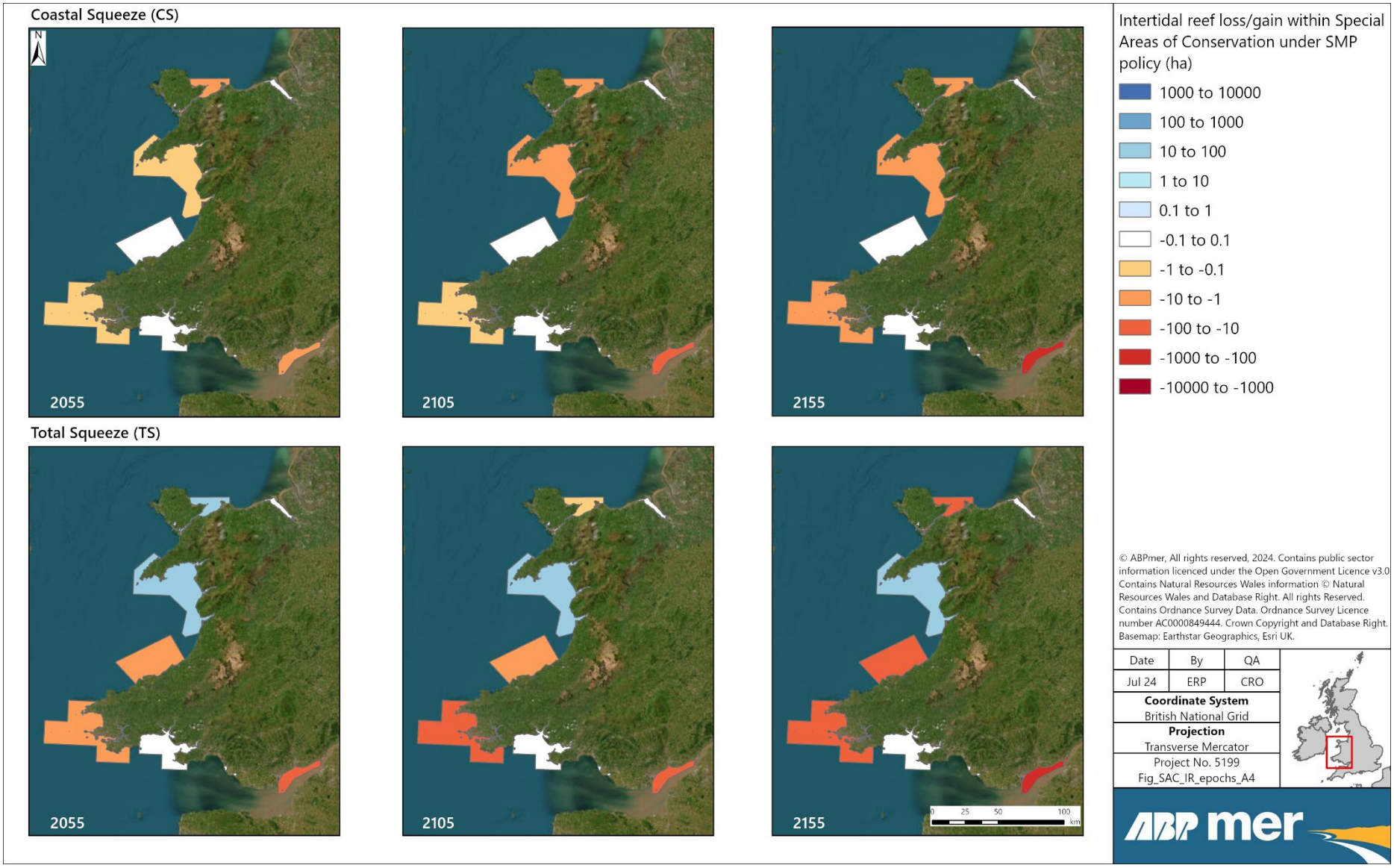


Figure 10. Coastal/total squeeze intertidal reef habitat loss/gain assuming SMP2 policy is implemented within SACs for 2055, 2105 and 2155 (70th percentile).

Table 22. Coastal squeeze intertidal reef habitat loss and gain within SACs – SMP2 policy (70th percentile)

| SACs | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 360.16 | -0.39 | 0 | -0.82 | 0 | -1.79 | 0 |
| Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau | 215.68 | -0.65 | 0 | -1.29 | -1 | -1.75 | -1 |
| Cardigan Bay / Bae Ceredigion | 24.69 | -0.03 | 0 | 0.00 | 0 | 0.00 | 0 |
| Y Fenai a Bae Conwy / Menai Strait and Conwy Bay | 400.7 | -3.90 | -1 | -4.91 | -1 | -7.35 | -2 |
| Severn Estuary (Wales) | 628.24 | -9.93 | -2 | -52.94 | -8 | -105.69 | -17 |

Table 23. Total (coastal and natural) squeeze intertidal reef habitat loss and gain within SACs – SMP2 policy (70th percentile)

| SACs | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 360.16 | -2.01 | -1 | -24.56 | -7 | -49.06 | -14 |
| Pen Llyn a'r Sarnau / Lleyn Peninsula and the Sarnau | 215.68 | 59.85 | 28 | 38.57 | 18 | 45.82 | 21 |
| Cardigan Bay / Bae Ceredigion | 24.69 | -4.76 | -19 | -7.86 | -32 | -12.31 | -50 |
| Y Fenai a Bae Conwy / Menai Strait and Conwy Bay | 400.7 | 29.33 | 7 | -0.61 | 0 | -40.55 | -10 |
| Severn Estuary (Wales) | 628.24 | -12.70 | -2 | -65.59 | -10 | -125.92 | -20 |

## Comparison of non-defended and defended management scenarios

This section of the report provides a comparison between different management scenarios and the potential implications these may have on changes in intertidal reef extent within SACs in 2155.

Results for a No Defence scenario, where existing defences are removed from the analysis, are presented, as well as a scenario where existing defences are maintained into the future (Defences Maintained). These are compared against the scenario where the SMP2 Policy is implemented across Wales (which is presented in the preceding section).

Figure 11 shows predicted intertidal reef losses and gains in 2155 due to coastal and total squeeze with a No Defences scenario, an SMP2 Policy scenario, and a Defences Maintained scenario. Table 24 and Table 25 show detailed results for coastal squeeze and total squeeze respectively.

Under a No Defences scenario, there would be no coastal squeeze induced loss as any loss or gain would be attributed to natural squeeze. In a scenario where all defences are maintained, results suggest coastal squeeze losses of intertidal reef would be slightly higher than if the SMP2 policies were implemented. For example, intertidal reef loss in the Menai Strait and Conwy Bay SAC increases from 7 ha or 2% loss (under the SMP2 Policy) to 39 ha or 10% loss (Defences Maintained). Coastal squeeze losses of intertidal reef in the Severn Estuary SAC do not change between each scenario, as the SMP2 policy is predominantly HTL.

Under a No Defences scenario, gains in intertidal reef associated with total squeeze are predicted within the Lleyn Peninsula and the Sarnau SAC and Severn Estuary SAC (totalling 338 ha or a 157% increase, and 133 ha or a 21% increase respectively by 2155). However, gains in the Lleyn Peninsula and the Sarnau SAC are reduced to 46 ha (21% increase) when the SMP2 Policy is applied, and to 3 ha (1% increase) under a Defences Maintained scenario. Losses of 126 ha (20%) are predicted in the Severn Estuary SAC under the SMP2 Policy scenario and Defences Maintained scenario.

Total squeeze losses are predicted in other SACs even under a No Defences scenario, though these are less than those attributed to the SMP2 Policy and the Defences Maintained scenarios.

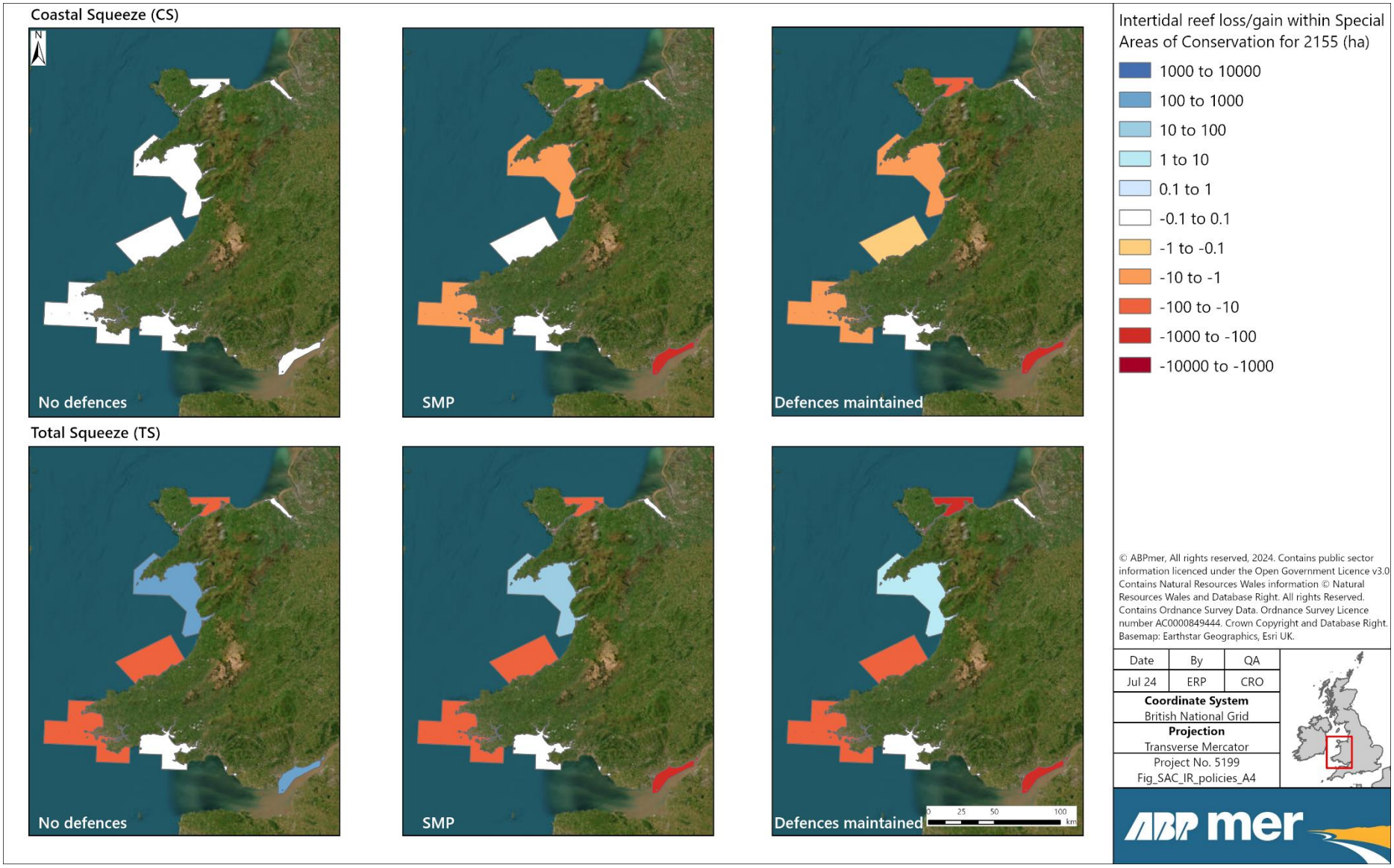


Figure 11. Coastal/total squeeze intertidal reef habitat loss/gain associated with different management scenarios (no defences, SMP2 policy, and defences maintained) within SACs for 2155 (70th percentile).

Table 24. Coastal squeeze intertidal reef habitat loss and gain associated with different management scenarios (no defences, SMP2 policy, and defences maintained) within SACs for 2155 (70th percentile)

| SACs | 2025 (present day) (ha) | No Defences (ha) | No Defences (% change) | SMP2 Policy (ha) | SMP2 Policy (% change) | Defences Maintained (ha) | Defences Maintained (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 360.16 | 0.00 | 0 | -1.79 | 0 | -2.78 | -1 |
| Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau | 215.68 | 0.00 | 0 | -1.75 | -1 | -4.69 | -2 |
| Cardigan Bay / Bae Ceredigion | 24.69 | 0.00 | 0 | 0.00 | 0 | -0.27 | -1 |
| Y Fenai a Bae Conwy / Menai Strait and Conwy Bay | 400.7 | 0.00 | 0 | -7.35 | -2 | -38.96 | -10 |
| Severn Estuary (Wales) | 628.24 | 0.00 | 0 | -105.69 | -17 | -105.69 | -17 |

Table 25. Total (coastal and natural) squeeze intertidal reef habitat loss and gain associated with different management scenarios (no defences, SMP2 policy, and defences maintained) within SACs for 2155 (70th percentile)

| SACs | 2025 (present day) (ha) | No Defences (ha) | No Defences (% change) | SMP2 Policy (ha) | SMP2 Policy (% change) | Defences Maintained (ha) | Defences Maintained (% change) |
|---|---|---|---|---|---|---|---|
| Pembrokeshire Marine / Sir Benfro Forol | 360.16 | -39.44 | -11 | -49.06 | -14 | -68.33 | -19 |
| Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau | 215.68 | 337.62 | 157 | 45.82 | 21 | 3.20 | 1 |
| Cardigan Bay / Bae Ceredigion | 24.69 | -12.31 | -50 | -12.31 | -50 | -12.59 | -51 |
| Y Fenai a Bae Conwy / Menai Strait and Conwy Bay | 400.7 | -26.74 | -7 | -40.55 | -10 | -108.37 | -27 |
| Severn Estuary (Wales) | 628.24 | 132.95 | 21 | -125.92 | -20 | -125.92 | -20 |

### 3.3.4 SAC summary

The **Severn Estuary SAC** is consistently predicted to suffer large losses of saltmarsh (circa. 39% by 2155), mudflat and sandflat (circa. 9% by 2155) and intertidal reef (circa. 20% by 2155) for both coastal squeeze and total squeeze under the SMP2 Policy scenario. This is because this stretch of coast in Wales is assigned an SMP2 policy of HTL. Under a management scenario where all existing defences were removed (noting that this is probably unlikely given the landward constraints within the Accommodation Space), these losses could be remedied, where large gains would be expected for all types of habitat.

The **Carmarthen Bay and Estuaries SAC** and the **Lleyn Peninsula and the Sarnau SAC** are also expected to lose saltmarsh (up to 9%) and mudflat and sandflat (1%) habitat under the SMP2 Policy scenario due to coastal squeeze by 2155. Gains in saltmarsh and mudflat and sandflat habitat are predicted when accounting for total squeeze, owing to prevalence of NAI and/or MR policies assigned along the coast within these sites. These gains are expected to increase if a No Defences management scenario was adopted. These results make the significant assumption that all of the Accommodation Space at the relevant elevation would be available for habitat to develop.

The **Dee Estuary SAC** and the **Anglesey Coast: Saltmarsh SAC** are predicted to lose a relatively large extent of saltmarsh under SMP2 Policy (43% and 8% respectively by 2155). These SACs are examples of where this habitat would, to an extent, be replaced by mudflat and sandflat which is expected to increase by around 1% by 2155 for coastal squeeze and 12% and 66% respectively for total squeeze.

The **Pembrokeshire Marine SAC**, **Cardigan Bay SAC,** and **Menai Strait and Conwy Bay SAC** are projected to lose relatively small amounts of habitat (<2% by 2155) due to coastal squeeze which is due to the fact much of the coastline is not defended by an anthropogenic structure and/or has an SMP2 policy of NAI or MR (and therefore not subjected to much coastal squeeze). More significant losses of habitat (i.e., >10% by 2155) are expected in these SACs when considering total squeeze, reflecting the limited Accommodation Space to allow the rolling back of habitat before it reaches high ground. The exception to this is mudflat and sandflat within the **Pembrokeshire Marine SAC** where small gains are anticipated as saltmarsh is replaced.

No coastal squeeze is attributed to the **Kenfig SAC** as the coastline is not defended and therefore coastal squeeze is not an issue under any scenario.

## 3.4 Sites of Special Scientific Interest

This section of the report presents an overview of the results of coastal squeeze induced habitat loss and gain, as well as losses and gains associated with total squeeze (i.e., coastal and natural squeeze), within marine SSSIs in Wales. The first set of results are based on the scenario where the respective SMP2 Policy is implemented across Wales and are presented for saltmarsh, mudflat and sandflat, and intertidal reef across each epoch (Figure 12, Table 26, and Table 27). Results are also presented for each management scenario (No Defences, SMP2 Policy, and No Defences) in 2155 (Table 28 and Table 29). Other permutations of data (e.g., outputs for specific SSSIs) can be interrogated using the CSAT.

The results are similar to the habitat losses and gains predicted within SACs. For saltmarsh within SSSIs, coastal squeeze induced losses of 3%, 8%, and 11% are predicted in 2055, 2105 and 2155 under the SMP2 Policy scenario respectively (Table 26). Large gains in saltmarsh across SSSIs are, however, predicted when accounting for total squeeze under the SMP2 Policy scenario (Table 27). In 2055, 43% of additional saltmarsh is predicted, though this declines to 10% additional saltmarsh by 2155 (compared to present-day extents) as the Accommodation Space runs out as sea levels rise.

With respect to management scenarios, the Defences Maintained scenario results in the largest amount of coastal squeeze induced loss, totalling a 25% decrease in saltmarsh by 2155 (Table 28). A similar result is predicted for total squeeze; however, gains in saltmarsh are predicted under a No Defence scenario (159% increase by 2155) and the SMP2 Policy scenario (10% increase by 2155) (Table 29).

A small increase (representing 0% change in current extents) is predicted in the extent of mudflat and sandflat habitat within SSSIs in 2055 (43 ha) and 2105 (33 ha) due to coastal squeeze, but a decline of 307 ha (1%) is predicted in 2155 (Table 26). Total squeeze is anticipated to result in large gains in mudflat and sandflat habitat in all epochs (Table 27). By 2155, an increase of 5,638 ha (23%) compared to present-day extents is predicted. This demonstrates the importance of implementing SMP2 policies and safeguarding areas where habitat may be able to migrate landwards as sea levels rise.

As is the case for the national results and for SACs, the Defences Maintained scenario results in less impact to mudflats and sandflats due to coastal squeeze (6 ha gain in extent in 2155, 0% change) than under the SMP2 Policy scenario (1% loss) (Table 28). This is because there are several frontages where there is a gain of mudflat and sandflat in front of an existing defence, with mudflat and sandflat extending into the area presently occupied by saltmarsh. Under the SMP2 Policy scenario, where these frontages have an MR or NAI policy, this habitat gain is attributed to natural squeeze instead of coastal squeeze. Therefore, these gains are not accounted for in the coastal squeeze results for the SMP2 Policy but are accounted for in the Defences Maintained scenario. For total squeeze, large gains in mudflat and sandflat are predicted for all management scenarios, with the largest gains predicted under the No Defences scenario (52% increase by 2155) (Table 29).

Small losses in intertidal reef are projected in each epoch due to coastal squeeze under the SMP2 Policy scenario, totalling 39 ha (2%) by 2155 (Table 26). Accounting for total squeeze under the same management scenario, gains of 167 ha (8%), 188 ha (9%) and 123 ha (6%) of intertidal reef are predicted in 2055, 2105 and 2155, respectively (Table 27).

The Defences Maintained management scenario represents that highest predicted loss of intertidal reef habitat due to coastal squeeze, totalling a 3% decrease in 2155 (Table 28). A 2% loss of intertidal reef is also predicted under the SMP2 Policy scenario by 2155. Conversely, for total squeeze, gains in habitat are projected under a No Defences management scenario (23% increase in 2155) and under the SMP2 Policy scenario (6% increase in 2155) (Table 29). A loss of 1% is still predicted for total squeeze under a Defences Maintained scenario for intertidal habitat.


Figure 12. Coastal/total squeeze loss/gain within Welsh SSSIs for different habitat types in 2155 (70th percentile) under the SMP Policy management scenario.

Table 26 Coastal squeeze loss and gain within Welsh SSSIs for habitat types across epochs under SMP2 Policy (70th percentile)

| Habitat type | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Saltmarsh | 6061.027 | -177.38 | -3 | -480.63 | -8 | -670.64 | -11 |
| Mudflat and sandflat | 24556.47 | 43.07 | 0 | 32.85 | 0 | -307.47 | -1 |
| Intertidal reef | 2120.282 | -0.28 | 0 | -6.81 | 0 | -38.68 | -2 |

Table 27 Total (coastal and natural) squeeze loss and gain within Welsh SSSIs for habitat types across epochs under SMP2 Policy (70th percentile)

| Habitat type | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Saltmarsh | 6061.03 | 2602.12 | 43 | 1803.48 | 30 | 612.31 | 10 |
| Mudflat and sandflat | 24556.47 | 3421.19 | 14 | 5323.69 | 22 | 5638.28 | 23 |
| Intertidal reef | 2120.282 | 166.84 | 8 | 187.72 | 9 | 122.80 | 6 |

Table 28. Coastal squeeze loss and gain within Welsh SSSIs for habitat types in 2155 under different management scenarios (70th percentile)

| Habitat type | 2025 (present day) (ha) | No Defences (ha) | No Defences (% change) | SMP2 Policy (ha) | SMP2 Policy (% change) | Defences Maintained (ha) | Defences Maintained (% change) |
|---|---|---|---|---|---|---|---|
| Saltmarsh | 6061.03 | 0.00 | 0 | -670.64 | -11 | -1488.56 | -25 |
| Mudflat and sandflat | 24556.47 | 0.00 | 0 | -307.47 | -1 | 6.00 | 0 |
| Intertidal reef | 2120.282 | 0.00 | 0 | -38.68 | -2 | -60.50 | -3 |

Table 29. Total (coastal and natural) squeeze loss and gain within Welsh SSSIs for habitat types in 2155 under different management scenarios (70th percentile)

| Habitat type | 2025 (present day) (ha) | No Defences (ha) | No Defences (% change) | SMP2 Policy (ha) | SMP2 Policy (% change) | Defences Maintained (ha) | Defences Maintained (% change) |
|---|---|---|---|---|---|---|---|
| Saltmarsh | 6061.03 | 9631.07 | 159 | 612.31 | 10 | -1717.55 | -28 |
| Mudflat and sandflat | 24556.47 | 12691.58 | 52 | 5638.28 | 23 | 3158.95 | 13 |
| Intertidal reef | 2120.282 | 495.69 | 23 | 122.80 | 6 | -24.23 | -1 |

### 3.4.1 Dyfi SSSI case study example

The outputs of the CSAT provide detailed results within specific MPAs. This can be achieved by interrogating the results for individual Assessment Units along the coast within an MPA, which serves to identify where loss or gain of different Habitat Groups is predicted to occur. Other information for that Assessment Unit will inform what is driving the loss or gain of habitat, such as the type of Assessment Unit (i.e., Defence, Natural, High Ground, Cliff), the SMP2 policy assigned to the Assessment Unit, and the amount and location of Accommodation Space. The latter point is particularly important in evaluating the feasibility or likelihood of any habitat gains becoming a reality (considering factors such as the presence of any built infrastructure and whether it is likely that this would be 'let go' to allow colonisation of marine habitats to take place).

To provide an example of the type of MPA-level information that can be derived from the assessment outputs, a case study for the Dyfi SSSI is presented in this section of the report. Figure 13 shows the location of the Dyfi SSSI, the Assessment Units, the Habitat Groups within the Foreshore Area, and the Accommodation Space.

Using saltmarsh as an example, Figure 14 and Table 30 show projected changes in saltmarsh habitat extent within the Dyfi SSSI due to coastal and total squeeze. This specific example focusses on projected changes under the SMP2 Policy scenario. Within Figure 14, the total losses and gains of saltmarsh within the SSSI are represented across the full SSSI extent using a colour scale. The losses and gains against each individual Assessment Unit that contribute to overall habitat change within the SSSI are also presented using the same colour scale to show the location of loss or gains along the coast.

Within the Dyfi SSSI, the largest losses due to coastal squeeze are predicted in 2055 (75 ha, 13%). This is driven by the fact that the majority of the coastline on the south bank of the estuary which lies in front of significant Accommodation Space is associated with a HTL SMP2 policy in this epoch (larger losses shown by darker red Assessment Unit lines in Figure 14). However, by 2105 and 2155, much of this coastline has been reassigned to an MR or NAI SMP2 policy. This removes any coastal squeeze induced loss within these Assessment Units (shown by white Assessment Unit lines in Figure 14). Across the SSSI as a whole, a loss of 7 ha (1%) is predicted by 2155.

As with the results presented above for all Welsh SSSIs, gains in saltmarsh are also expected within the Dyfi SSSI under the SMP2 Policy scenario when considering total squeeze as habitat is allowed to roll-back. Predicted habitat increases are more modest in 2055 (36 ha, 6%) but increase to 714 ha (128%) and 436 ha (78%) in 2105 and 2155, respectively. Again, this is attributed to the fact that the SMP2 policy switches from HTL to MR or NAI for key sections of the frontage that are backed by large Accommodation Space and saltmarsh is able to extend into that Accommodation Space. Increases in saltmarsh extent reduce by 2155 as natural squeeze begins to take effect and habitat is pushed against high ground bounding the Accommodation Space. This is associated with an increase in mudflat and sandflat (see CSAT).

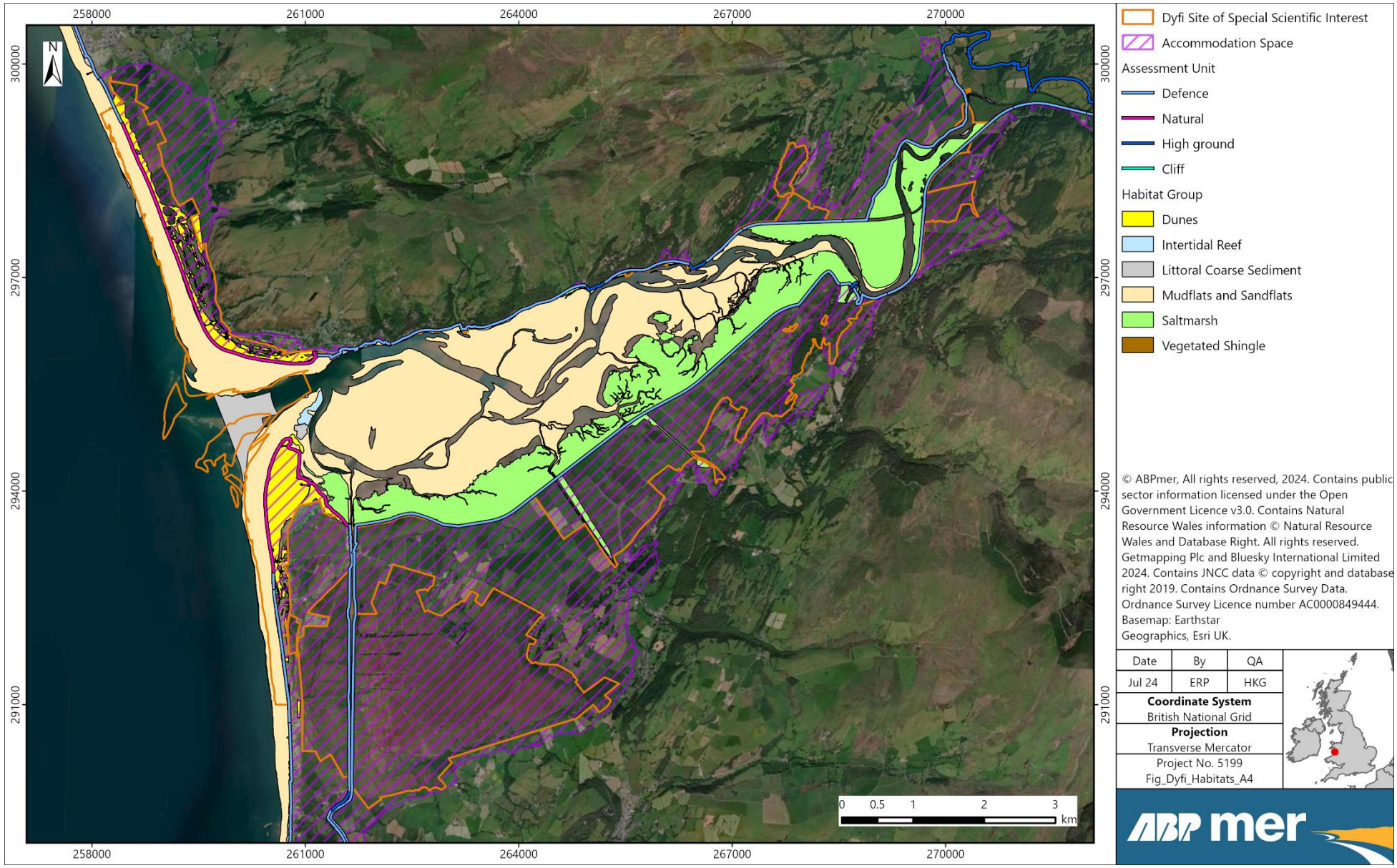


Figure 13. Dyfi SSSI Assessment Units, Habitat Groups within the Foreshore Area, and Accommodation Space

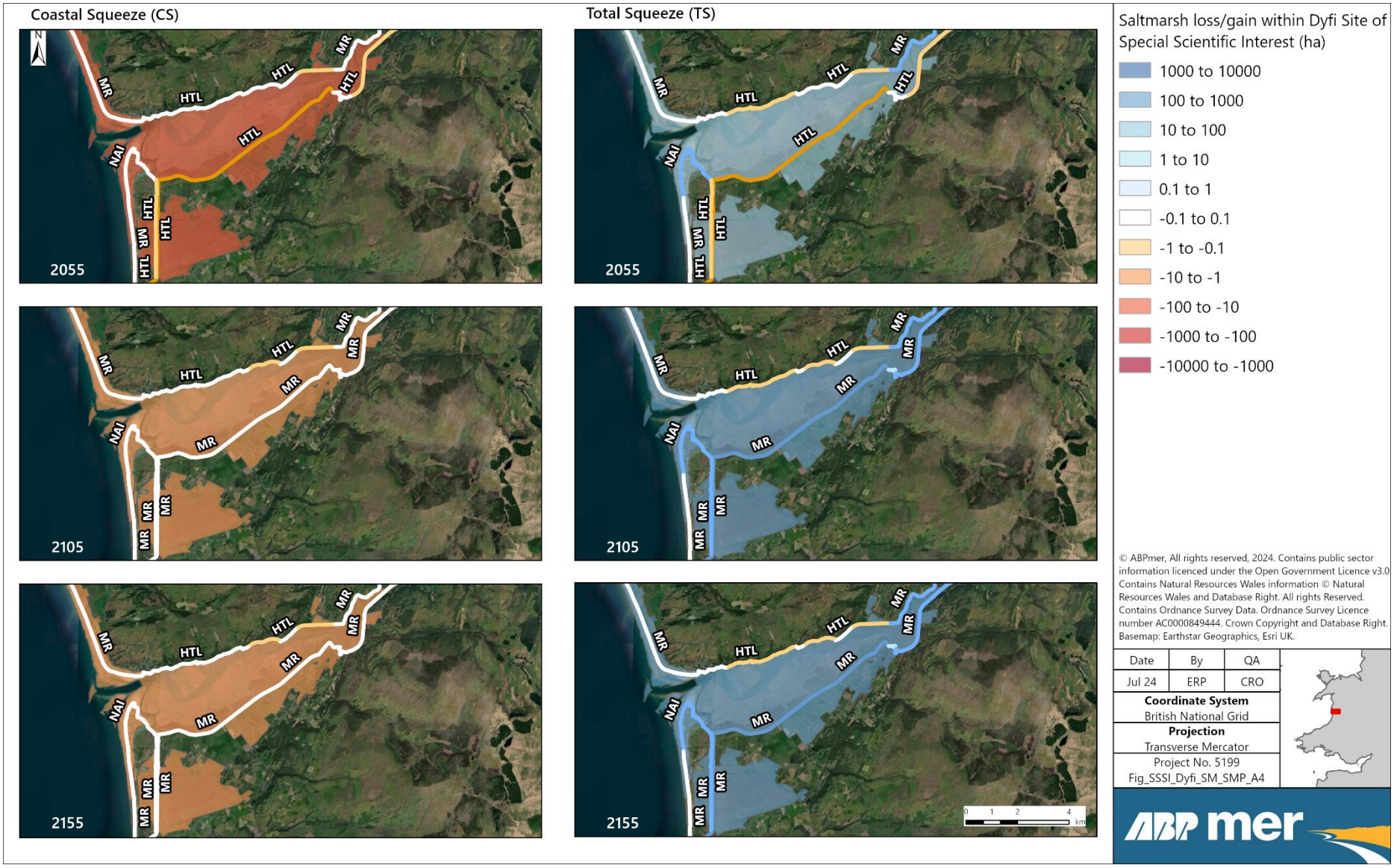


Figure 14. Saltmarsh loss and gain within the Dyfi SSSI across epochs and SMP2 policy (SSSI polygon represents overall loss/gain, Assessment Unit represents loss/gain along coast and identified SMP2 policy).

Table 30. Saltmarsh loss and gain within the Dyfi SSSI across epochs under the SMP policy management scenario

| Coastal/total squeeze | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Coastal squeeze | 558.92 | -74.66 | -13 | -5.27 | -1 | -7.02 | -1 |
| Total (coastal and natural) squeeze | 558.92 | 35.66 | 6 | 714.32 | 128 | 435.96 | 78 |

## 3.5 Special Protection Areas

This section of the report presents an overview of the results of coastal squeeze induced habitat loss and gain within marine SPAs in Wales, as well as losses and gains associated with total squeeze (i.e., coastal and natural squeeze) (Figure 15, Table 31 and Table 32). The results are based on the scenario where the respective SMP2 Policy is implemented across Wales and are presented for each Habitat Group and across each epoch. Other permutations of data (e.g., outputs under different management scenarios or for specific SPAs and Ramsar sites) can be interrogated using the CSAT.

It should be noted that whilst saltmarsh, mudflat and sandflat and intertidal reef habitats are presented here, littoral coarse sediment, vegetated shingle and dunes are also supporting habitats of SPAs and Ramsar sites in Wales. Information on the changes in extent of these habitats caused by coastal and natural squeeze can be found in the CSAT which is held by NRW as a project output.

Changes in habitat extent within SPAs follow the same pattern as presented above for other MPAs under the SMP2 Policy scenario. Losses are predicted for coastal squeeze in SPAs sites across all habitat types, and gains in habitat are predicted when considering total squeeze. However, by 2155, total squeeze losses in saltmarsh (2%) are predicted in SPAs in Wales.

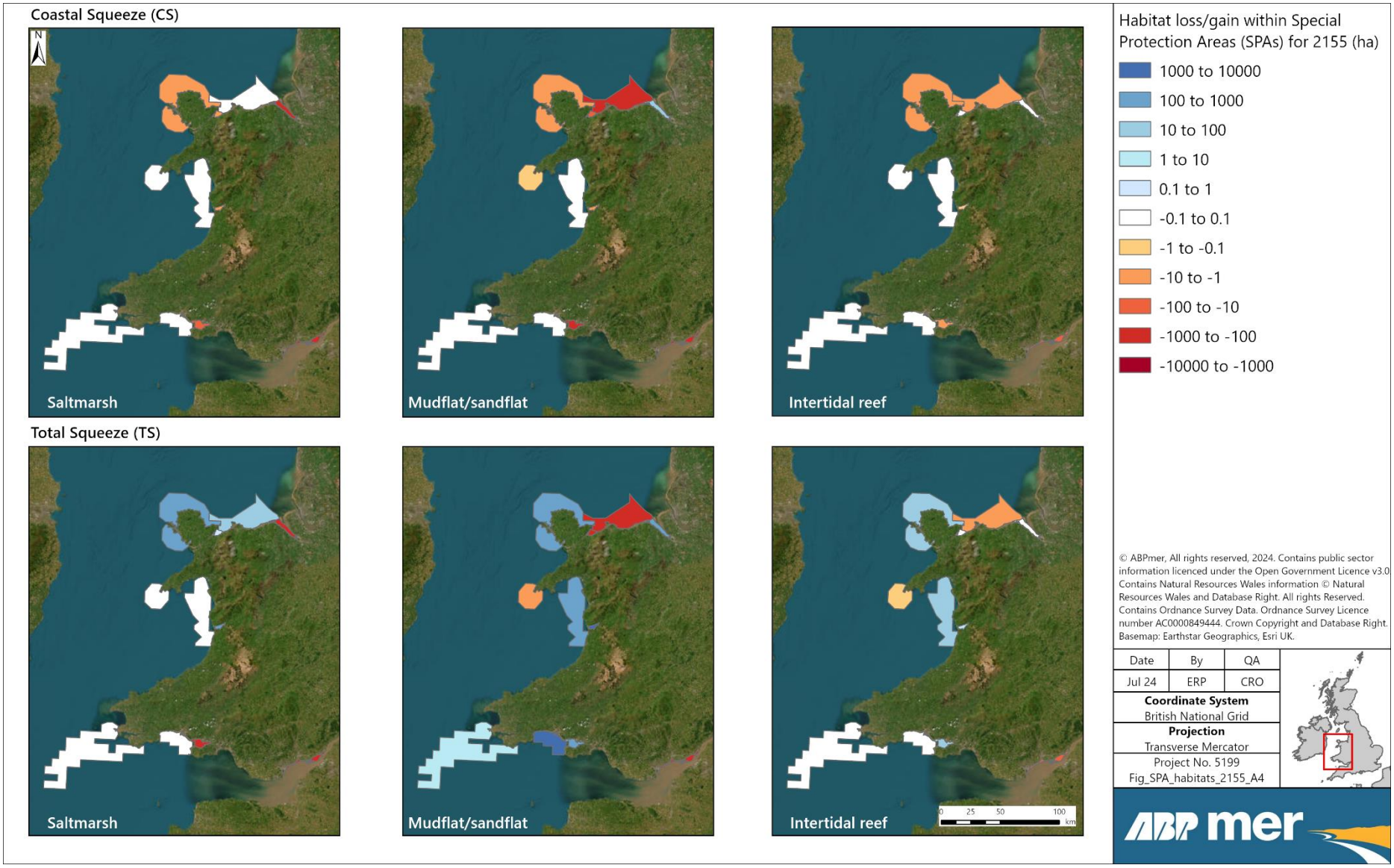


Figure 15. Coastal/total squeeze loss/gain associated with the SMP2 policy within Welsh SPAs for different habitat types in 2155 (70th percentile).

Table 31. Coastal squeeze loss and gain associated with the SMP2 policy within Welsh SPAs for different habitat types across epochs (70th percentile)

| Habitat type | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Saltmarsh | 3518.18 | -162.98 | -5 | -436.53 | -12 | -589.85 | -17 |
| Mudflat and sandflat | 17523.17 | 0.88 | 0 | -41.29 | 0 | -432.55 | -2 |
| Intertidal reef | 1178.62 | -3.14 | 0 | -10.39 | -1 | -40.36 | -3 |

Table 32. Total (coastal and natural) squeeze loss and gain associated with the SMP2 policy within Welsh SPAs for different habitat types across epochs (70th percentile)

| Habitat type | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Saltmarsh | 3518.18 | 1000.98 | 28 | 650.28 | 18 | -75.14 | -2 |
| Mudflat and sandflat | 17523.17 | 1977.45 | 11 | 3375.98 | 19 | 3339.11 | 19 |
| Intertidal reef | 1178.62 | 63.90 | 5 | 88.12 | 7 | 70.77 | 6 |

## 3.6 Ramsar sites

This section of the report presents an overview of the results of coastal squeeze induced habitat loss and gain within marine Ramsar sites in Wales, as well as losses and gains associated with total squeeze (i.e., coastal and natural squeeze) (Figure 16, Table 33 and Table 34). The results are based on the scenario where the respective SMP2 Policy is implemented across Wales and are presented for each Habitat Group and across each epoch. Other permutations of data (e.g., outputs under different management scenarios or for specific SPAs and Ramsar sites) can be interrogated using the CSAT.

It should be noted that whilst saltmarsh, mudflat and sandflat and intertidal reef habitats are presented here, littoral coarse sediment, vegetated shingle and dunes are also component habitats of Ramsar sites in Wales. Information on the changes in extent of these habitats caused by coastal and natural squeeze can be found in the CSAT which is held by NRW as a project output.

Changes in habitat extent within Ramsar sites follow the same pattern as presented above for other MPAs under the SMP2 Policy scenario. Losses are predicted for coastal squeeze in Ramsar sites across all habitat types, and gains in habitat are predicted when considering total squeeze. However, total squeeze losses in saltmarsh are predicted in Ramsar sites by 2105 (10%) and 2155 (25%).


Figure 16: Coastal/total squeeze loss/gain associated with the SMP2 policy within Welsh Ramsar sites for different habitat types in 2155 (70th percentile).

Table 33. Coastal squeeze loss and gain associated with the SMP2 policy within Welsh Ramsar sites for different habitat types across epochs (70th percentile).

| Habitat type | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Saltmarsh | 2864.27 | -86.43 | -3 | -421.81 | -15 | -572.40 | -20 |
| Mudflat and sandflat | 12013.71 | -9.10 | 0 | 28.99 | 0 | -280.63 | -2 |
| Intertidal reef | 730.76 | 2.51 | 0 | -0.92 | 0 | -27.80 | -4 |

Table 34. Total (coastal and natural) squeeze loss and gain associated with the SMP2 policy within Welsh Ramsar sites for different habitat types across epochs (70th percentile)

| Habitat type | 2025 (present day) (ha) | 2055 (ha) | 2055 (% change) | 2105 (ha) | 2105 (% change) | 2155 (ha) | 2155 (% change) |
|---|---|---|---|---|---|---|---|
| Saltmarsh | 2864.27 | 546.18 | 19 | -299.96 | -10 | -717.34 | -25 |
| Mudflat and sandflat | 12013.71 | 427.90 | 4 | 895.58 | 7 | 614.59 | 5 |
| Intertidal reef | 730.76 | 9.67 | 1 | 26.09 | 4 | -5.06 | -1 |

# 4 Summary and conclusions

This section provides a summary of the key findings of the coastal squeeze assessment associated with the likely scale of habitat loss occurring in future due to coastal squeeze in Wales. The findings are discussed separately in the context of Habitat Groups, management scenarios and SLR projections. Potential applications of the data, as well as recommendations for any potential application, are also discussed.

Overall, changes to habitat extent attributed to coastal squeeze and natural squeeze in Wales are delicately balanced and very case specific. Key governing factors include the type of frontage along the coast, management of the coast, the extent of Accommodation Space available for habitats to roll-back into, as well as the magnitude of sea level rise (and the SLR rise projection used in the assessment).

Habitat types are also very sensitive to the elevation and the profile of foreshore within the tidal frame. In some cases, losses in some habitats can be replaced by other intertidal habitats, where the foreshore is of the requisite profile within a changing tidal frame. However, this is not always the case, and data needs to be thoroughly investigated before drawing firm conclusions. It should also be recognised that this national scale study has a number of limitations when the data outputs are considered at a local scale, and the data should be interpreted in that context (see Section 3.1).

## 4.1 Habitat Groups

In terms of the risk of coastal squeeze to specific Habitat Groups/MPA features, **saltmarsh** is predicted to experience significant losses due to coastal squeeze. At a national level this is predicted to be up to 1,521 ha / 21% by 2155 under a 70th percentile SLR allowance and 1,770 ha / 25% under a 95th percentile SLR allowance. Within MPAs the figures are generally similar but the scale of loss is dependent on the specific MPA and factors such as management scenarios and availability of Accommodation Space.

**Mudflats and sandflats** are also predicted to experience losses due to coastal squeeze, though the relative scale of this loss is less than for saltmarsh habitats. For example, losses of up to 1,701 ha / 6% are predicted across Wales as a worst case within the assessment outputs. It is often the case that areas previously occupied by saltmarsh transition to mudflats and sandflats through time. This moderates the loss of mudflats and sandflats to some degree, and in some cases results in gains in habitat extent. This pattern of loss and gain can generally also be observed within MPAs. Therefore, mudflats and sandflats are considered less vulnerable to coastal squeeze.

**Intertidal reef** is predicted to decrease by as much as 10% due to coastal squeeze at a national scale. This is predominantly made up of losses in the Severn Estuary. In other locations around Wales where intertidal reef is common (e.g., Pembrokeshire and Cardigan Bay), losses of intertidal reef are less due to the fact much of the coastline is not defended by an anthropogenic structure (i.e., it is cliff) and/or has an SMP2 policy of NAI or MR (and therefore not subjected to coastal squeeze). However, an important limitation of the study is that no consideration is given to requisite substrate types for reef to form as this habitat migrates landward as sea levels rise (and therefore predicted changes may not be realised). This should be borne in mind when interpreting the results for intertidal reef.

Relatively large losses, up to 14% as a proportion of current habitat extents, are also predicted for **littoral coarse sediment** across Wales by 2155 (noting that results were only presented at a national level for this habitat type).

Whilst the scale of absolute losses of **dunes** and **vegetated shingle** associated with coastal squeeze is predicted to be small, losses are fairly large relative to current habitat extents; up to 20% and 40% by 2155, respectively. However, the methodology for the assessment of coastal squeeze impacts on **dunes** and **vegetated shingle** differ from other habitat types. It was assumed these habitats will roll-back until they meet high ground, but any potential increases in their extent within the Accommodation Space are not accounted for (i.e., the extent of dunes and vegetated shingle within the assessment is either maintained or lost). Therefore, direct comparisons with other habitat types are not appropriate.

The predicted timing of all habitat loss is very dependent on specific locations around Wales, but it is usually the case that losses increase (or gains decrease) towards 2155 as sea levels rise.

## 4.2 Management scenarios

Management of the coast has a large influence on the severity of coastal squeeze on different habitat types.

A No Defence scenario would prevent any coastal squeeze occurring at all as it does not fall within the definition of coastal squeeze (see Section 2.1). In fact, when accounting for total (coastal and natural) squeeze, significant gains in habitat are projected to occur for most habitat types under this management scenario, provided sufficient Accommodation Space is available for habitat to roll-back into. This therefore represents the best-case scenario for limiting the impacts of sea level rise on coastal habitats. However, opening up Accommodation Space to allow the landward migration of coastal habitats is likely unfeasible along much of the Welsh coastline.

The worst-case scenario for coastal squeeze impacts is a Defences Maintained scenario. In most cases, and as one would expect, this scenario results in the largest amount of habitat loss (or smallest amount of gain) for most habitat types due to coastal squeeze.

The middle ground in terms of the outcomes of each management scenario is where the SMP2 Policy is implemented. Whilst coastal squeeze losses for most habitat types and MPAs are still predicted, the extent of losses are more moderate compared with the Defences Maintained scenario. In some cases, and especially when accounting for total squeeze, gains in habitat are often predicted to occur where NAI or MR is implemented under SMP2. On this basis, it is important to ensure these policies are implemented to limit the extent of habitat loss. The consequences of not doing so are demonstrated by the results for the Defences Maintained scenario. Given the variation in SMP2 policy around the coast, and the fact that SMP2 policy changes for each epoch, the pattern of losses and gains in habitat are site specific.

Overall, if the SMP2 policies were implemented along the Welsh coastline, then coastal squeeze impacts have the potential to be relatively limited for most Habitat Groups. However, there are significant challenges in achieving this outcome. For instance, where MR policies are identified, implementing such schemes may be extremely difficult. Barriers to MR schemes include engineering constraints, high costs and funding availability, and issues associated with land-take, community infrastructure and the

consenting process. None of these issues have been taken into account in this study. In reality, where MR schemes are identified, a much more modest 'opening up' of the Accommodation Space is more likely. Therefore, this assessment may overestimate gains (or underestimate losses) in these locations.

Given the potential difficulties in implementing MR policies, opportunities for natural gain along the Welsh coast are very important to offset coastal squeeze losses. For example, there is potential for gains in habitat in the upper reaches of estuaries which have an NAI policy. These need to be safeguarded to realise the outcomes identified under the SMP2 Policy scenario.

## 4.3 SLR allowances

As discussed in this report, a key controlling factor in the extent of coastal squeeze induced habitat loss is the magnitude of sea level rise that will occur in the future. Climate change projections that are applied in the assessment will therefore significantly influence the results.

As described in Section 3.2.8, the rate and extent of habitat loss is very sensitive to the SLR rise projections used in the assessment. The 95th percentile SLR allowance could result in increased predicted losses from coastal squeeze by up to 50% by 2155, compared with that predicted using the 70th percentile allowance. It is therefore important to recognise the sensitivity of the results to SLR projections.

Welsh Government (2022) advises the use of the 70th percentile SLR allowance when assessing coastal risk management schemes, but also that sensitivity testing should be undertaken to allow for consideration of climate change uncertaintly. For coastal risk management schemes, Welsh Government (2022) suggests that sensitivity testing should be undertaken for the 95th percentile SLR allowances. The appropriateness of SLR projections should therefore be considered in the context of the aims/requirements of the analysis that is being undertaken.

## 4.4 Potential data applications

There is a vast quantity of data and detailed information available within the data outputs for this project. As such, there are many potential uses for the data. They may be helpful to inform strategic direction of coastal management across Wales, or they may have uses in informing management measures at a local or site level (though the limitations of using the data for this type of application should be taken into account).

A potential application for the data outputs is to help examine and form future plans for habitat creation in Wales. Using saltmarsh as an example, potential gains will typically be expected to occur behind present-day anthropogenic structures and Natural Ridges. Therefore, the potential for Accommodation Space to support saltmarsh habitat in the future is a key to understanding where habitat gains could be secured. Figure 17 shows areas around Wales where potential saltmarsh gain is predicted (based on values for total squeeze) in each Accommodation Space. Potential gains are presented for each management scenario (No Defence, SMP2 Policy and Defences Maintained).

The analysis shows that that under the SMP2 Policy scenario, for example, there are large potential gains to be had in the Dyfi Estuary, Carmarthen Bay, and on the north coast of Wales around the Dee Estuary. This analysis provides a very high level overview of where

potential areas may exist for saltmarsh development, so that coastal management considerations can be focused in these areas.

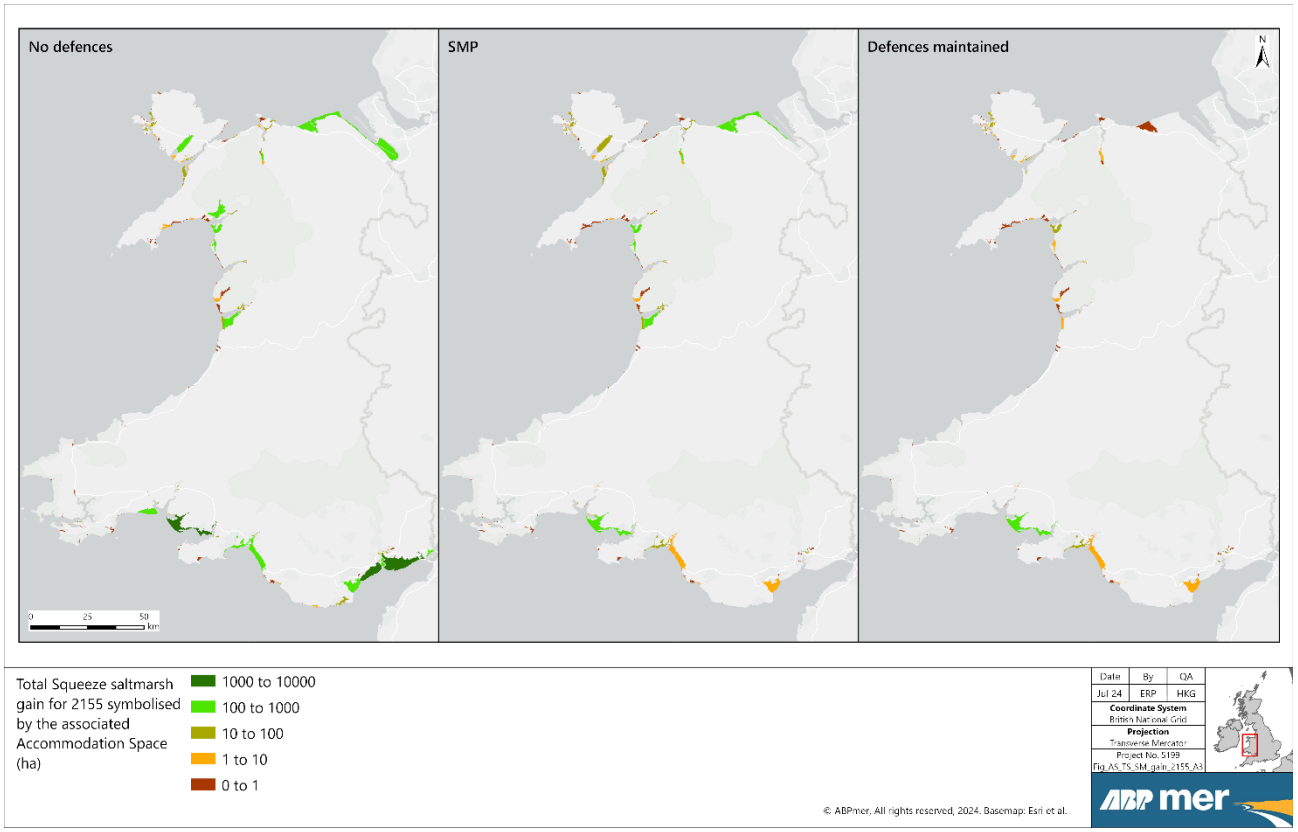


Figure 17. Potential saltmarsh gain based on availability of Accommodation Space.

## 4.5 Recommendations

The following recommendations should be considered when using the outputs of this coastal squeeze assessment for any potential future application:

- The applicability of the results at a local scale should take into account the limitations of the national scale assessment;
- The practical constraints in realising predicted habitat gains, and the viability of Accommodation Space to be used to support coastal habitats, should be recognised and be considered in coastal management decisions; and
- The SLR projections used to inform decision making should take into account the sensitivity of habitat loss predictions to sea level rise.

Overall, this project has improved the understanding of the location, timing and likely scale of habitat loss occurring in Welsh MPAs due to coastal squeeze. The data outputs of the project can be used to help inform the management measures that will be required to address the issue across Wales.

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# Appendices

# A Data interpretation

## A.1 Observations and nuances identified that help in the interpretation of the data

As identified, the derived model outputs are vast and complex, and results are not necessarily intuitive when they are initially examined. To help the user of the data to interpret the results several frequently encountered observations are summarised below:

- **Coastal squeeze associated with a frontage is smaller in later epochs:** This can occur where the frontage may be defended in the earlier epoch, but the defence is not maintained in a future epoch, and habitat may be able to roll-back into the Accommodation Space.
- **Reported habitat gain in response to coastal squeeze:** This is quite common, especially for mudflat and sandflat in estuaries. In these locations the seabed is typically quite steep adjacent to the low water tidal channel and much flatter within the higher tidal frames. Therefore, with SLR, there is only a small loss of habitat extent lower in the tidal frame, but a large gain in the higher tidal frame (typically as the mudflat and sandflat replaces existing saltmarsh). Hence, there can be a gain in some habitat types through coastal squeeze as it replaces another habitat type (see Figure A.1).
- **Reported gain in coastal squeeze (all habitats combined) when a defence is maintained:** Extending the case described in the previous bullet, if a defence is maintained, and there is ample Accommodation Space, the displaced saltmarsh would be attributed as coastal squeeze loss, and the gain in mudflat and sandflat would cancel out the loss in saltmarsh in the total figures for all habitats. However, if there is no, or limited, Accommodation Space, the saltmarsh loss would be attributed to natural squeeze. Thus, when coastal squeeze loss is summed for all Habitat Groups there is a net gain resulting from coastal squeeze. In either scenario, the loss of saltmarsh is significant, but this point explains why it is useful to look at the results separately for each Habitat Group and not just the total figures.
- **Coastal squeeze loss is greater under the SMP2 Policy scenario than Defences Maintained scenario for some habitat types:** Intuitively it could be expected that losses would be greater under a Defences Maintained scenario, than under SMP2 Policy scenario, as all defences will be maintained in the former. However, in some instances, where there is gain of mudflat and sandflat in front of an existing defence with an MR or NAI SMP2 policy, this habitat gain is attributed to natural squeeze instead of coastal squeeze. Therefore, these gains are not accounted for in the SMP2 Policy scenario coastal squeeze results, but are accounted for in the 'defences maintained' scenario for coastal squeeze. This exemplifies why it is important to consider the results for coastal squeeze in the context of the results for total squeeze (coastal squeeze + natural squeeze).
- **Habitat gains where there is a natural frontage with a HTL policy:** In a few locations a natural frontage is allocated a HTL policy in SMP2. Through discussion with NRW, a few of these frontages were modified and assigned as a defence because of further detail within the SMP2 around management intent. However, several natural frontages remain within the dataset with a HTL policy. In these instances, the frontage is treated as a natural frontage, irrespective of the management scenario, and therefore any losses/gains are assigned to be natural

squeeze and not coastal squeeze. It is also assumed that any associated Accommodation Space would be utilised as SLR occurs.

- **Calculated coastal squeeze and natural squeeze where a large Accommodation Space, extends across multiple Assessment Units:** Where this occurs the available Accommodation Space is pro-rated based on the relative length of the Assessment Unit associated with it. The loss and gain of habitat and its classification as either coastal squeeze or natural squeeze can be affected by this simplification. For example, if there is a large habitat loss in front of a small frontage, the available Accommodation Space to this frontage may be restricted by the simplified pro-rating rule. In this case the loss in the Foreshore Area could possibly be assigned to natural squeeze instead of coastal squeeze. At a national scale, the implications of this simplification in approach are expected to be minimal, but it should be considered when data is examined locally.
- **Use of 'no defences' management scenario:** Under the 'no defences' management scenarios, all the Accommodation Space becomes available, and there is no coastal squeeze. The results from this management scenario should help to identify locations with potential for natural gain and opportunities for restoration.

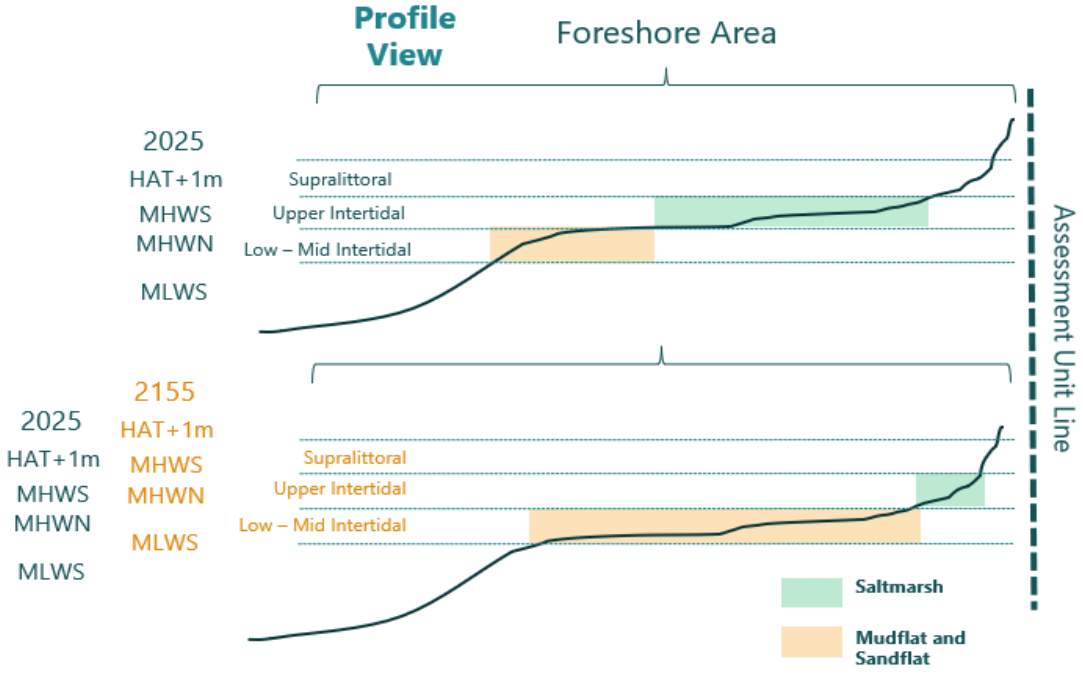


Figure A.1.Schematic showing mechanism of habitat gain as it replaces another habitat type

## A.2 Specific cases that require additional explanation

When developing and schematising the coastline in order to undertake the national scale assessment of coastal squeeze and natural squeeze, two particular frontages required specific attention, which affected the results within these areas and how these results should be interpreted. These two sites are:

- Cymyran Strait, and
- Cleddau Estuary (Milford Haven Waterway)

The particular details related to these two sites are noted below.

## A.2.1 Cymyran Strait

The Cymyran Strait lies between Anglesey main island and Holy Island. The northern extent of the strait is tidally restricted by two bridges (Figure A.2) and the northern of these bridges (hosting the A5 and A55 North Wales Expressway) is also assigned a policy unit in SMP2 (policy unit 17.18). Therefore, the frontages on either side of the northern Cymyran Strait are subjected to two SMP2 policy units, that have different policies. Furthermore, both affect the extent to which Accommodation Space could be inundated as Policy Unit 17.18, aligned along the northern bridge (together with the southern bridge), significantly restricts the tidal range in the northern Cymyran Strait.

For the present national scale assessment, Policy Unit 17.18 is ignored and the tidal range in the northern part of the Strait is assumed to be that which would occur if the bridges were not present. Within the assessment, this will typically result in larger loss/gains being estimated, compared to the case with the bridges remaining in place.

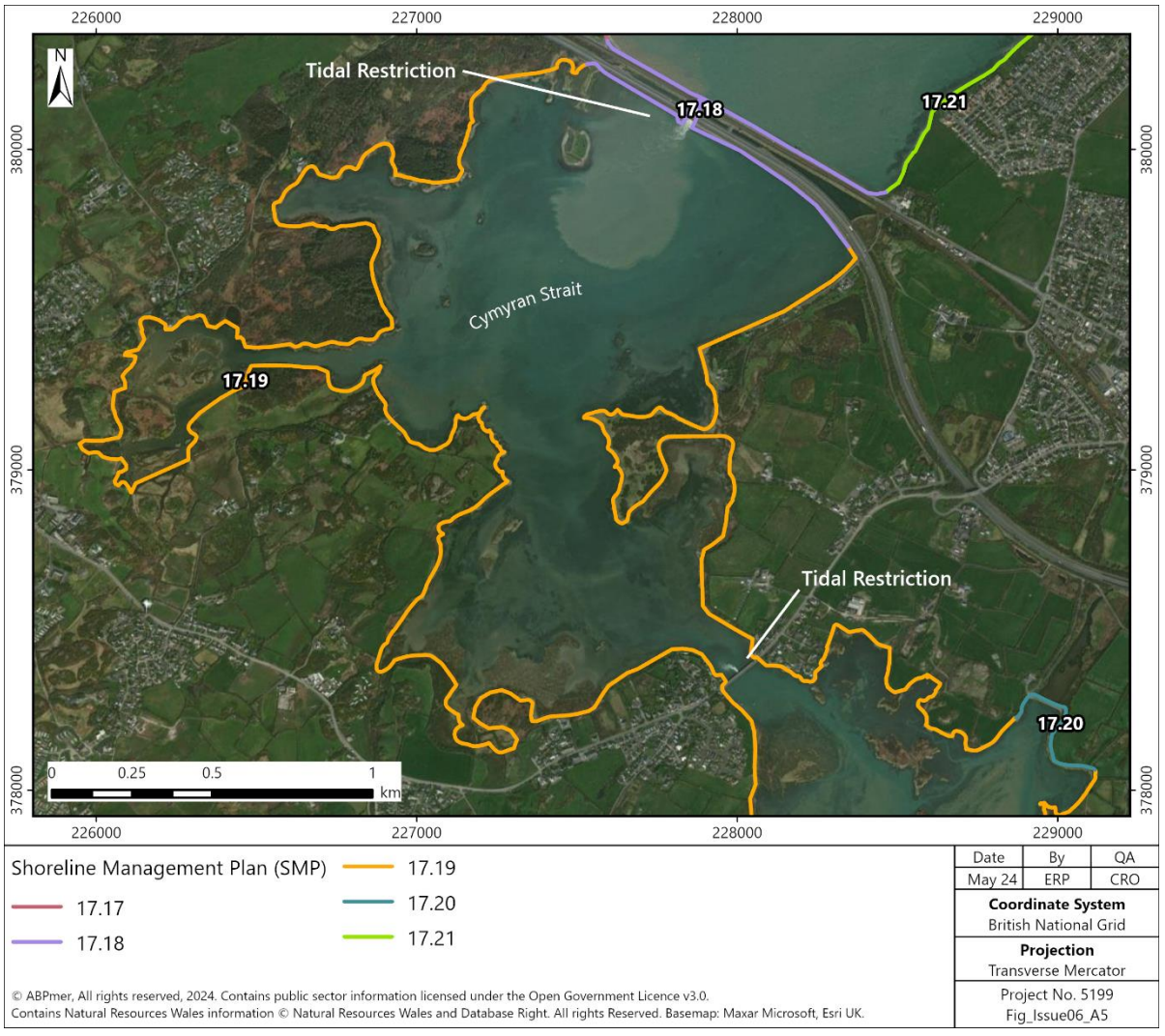


Figure A.2.SMP2 Policy Units for the Cymyran Strait

## A.2.2 Cleddau Estuary (Milford Haven Waterway)

Within the Cleddau Estuary, SMP2 has only defined Policy Units up to the Cleddau Bridge (A477 crossing), therefore stopping significantly short of the estuary limits (Figure A.3). In this case, new Assessment Units are defined from the end of the SMP2 policy unit (at the Cleddau Bridge), up to the tidal limit in 2155. These Assessment Units are either defined as 'defence', 'natural', or 'high ground', following the standard rules, but the SMP2 Policy Unit assigned to each is 'no policy'. Along these frontages defences are assigned a HTL policy across all epochs and 'natural' and 'high ground' frontages are assigned a NAI policy across all epochs.

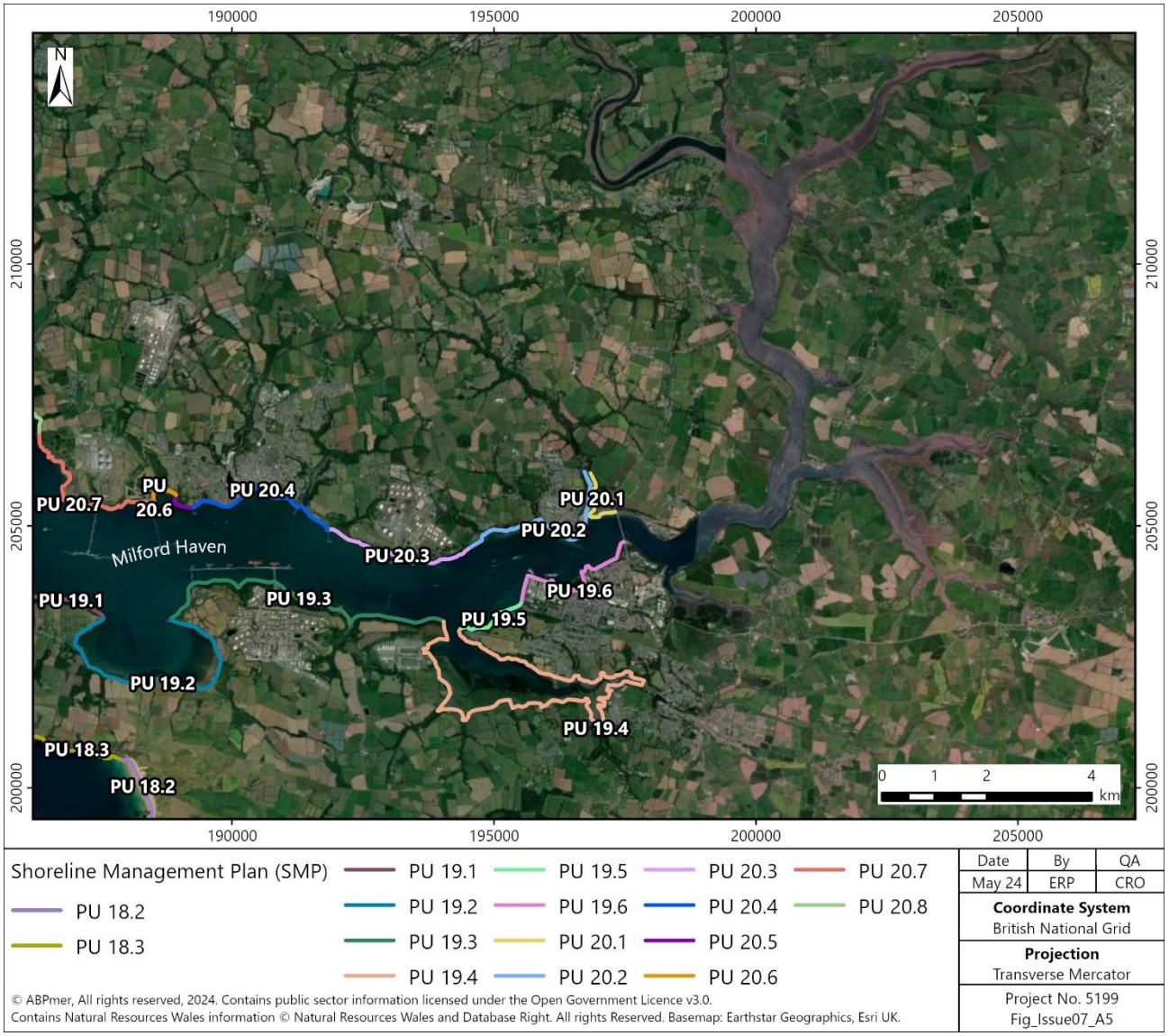


Figure A.3.SMP2 Policy Units for the Cleddau Estuary

# B Coastal lagoon assessment

It should be noted that for some coastal lagoons, the Accommodation Space is extensive. Therefore, the full extent of the Accommodation Space may not be shown on all figures in this appendix.

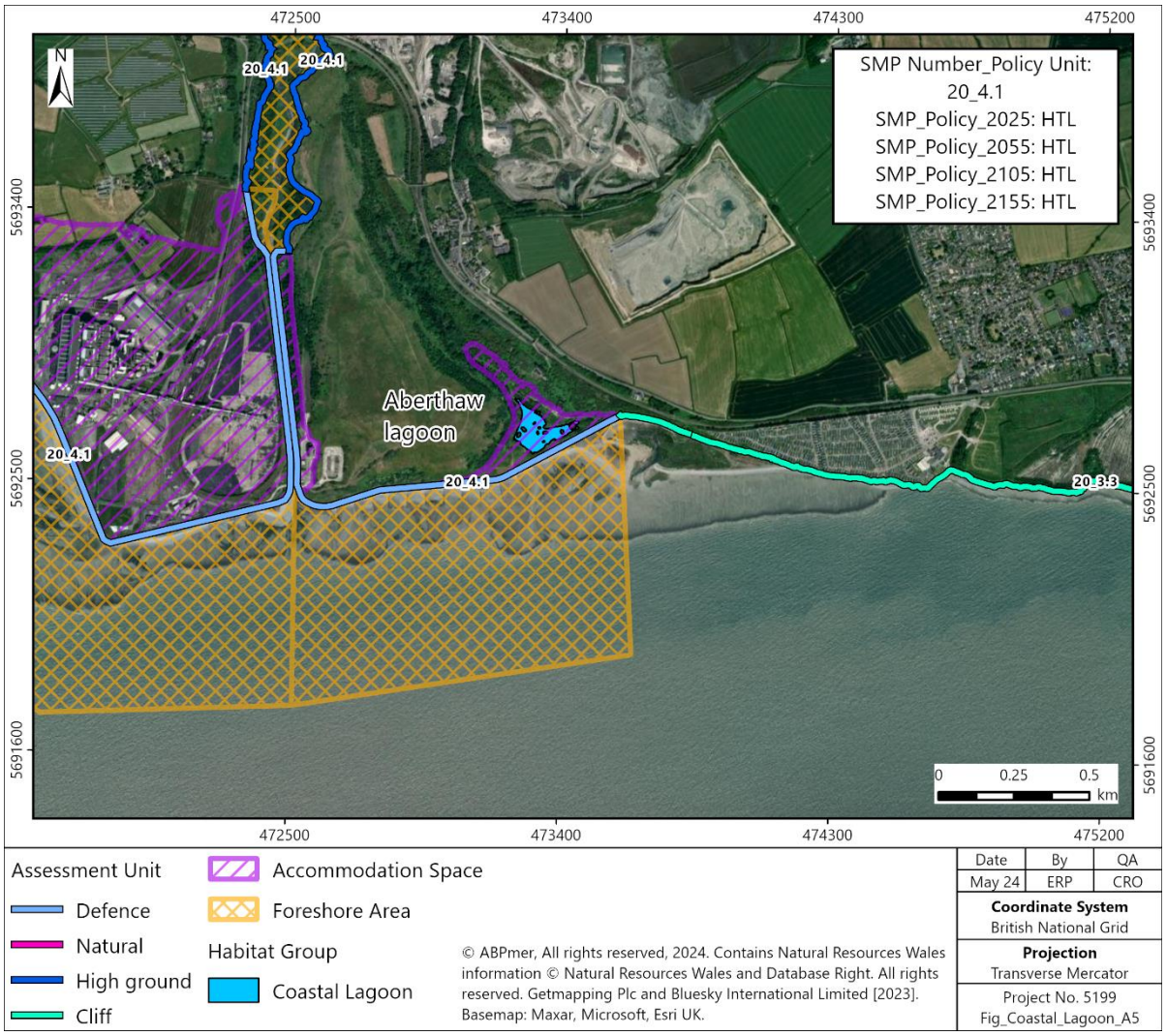


Figure B.1 Aberthaw Lagoon

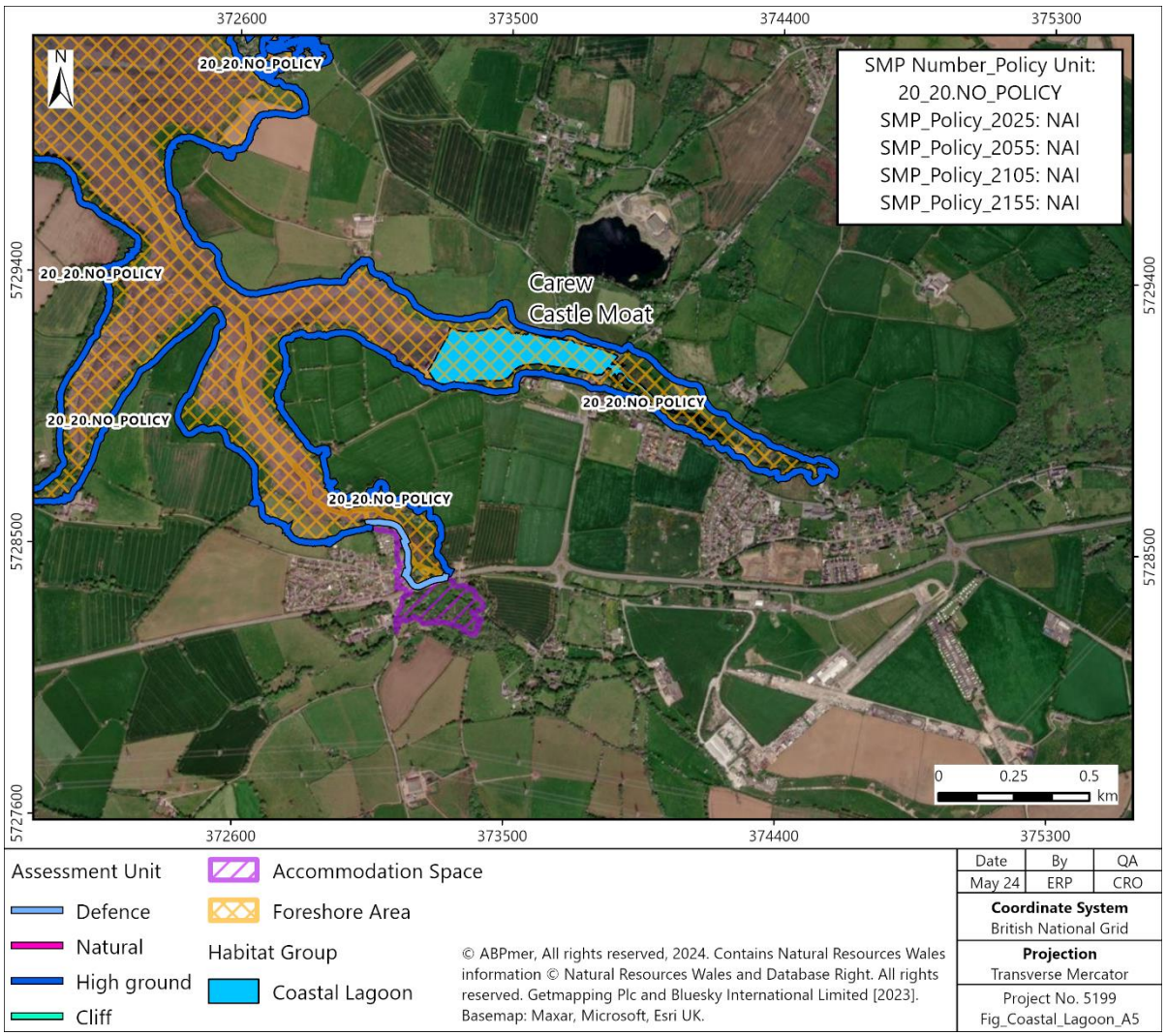


Figure B.2 Carew Castle Millpond

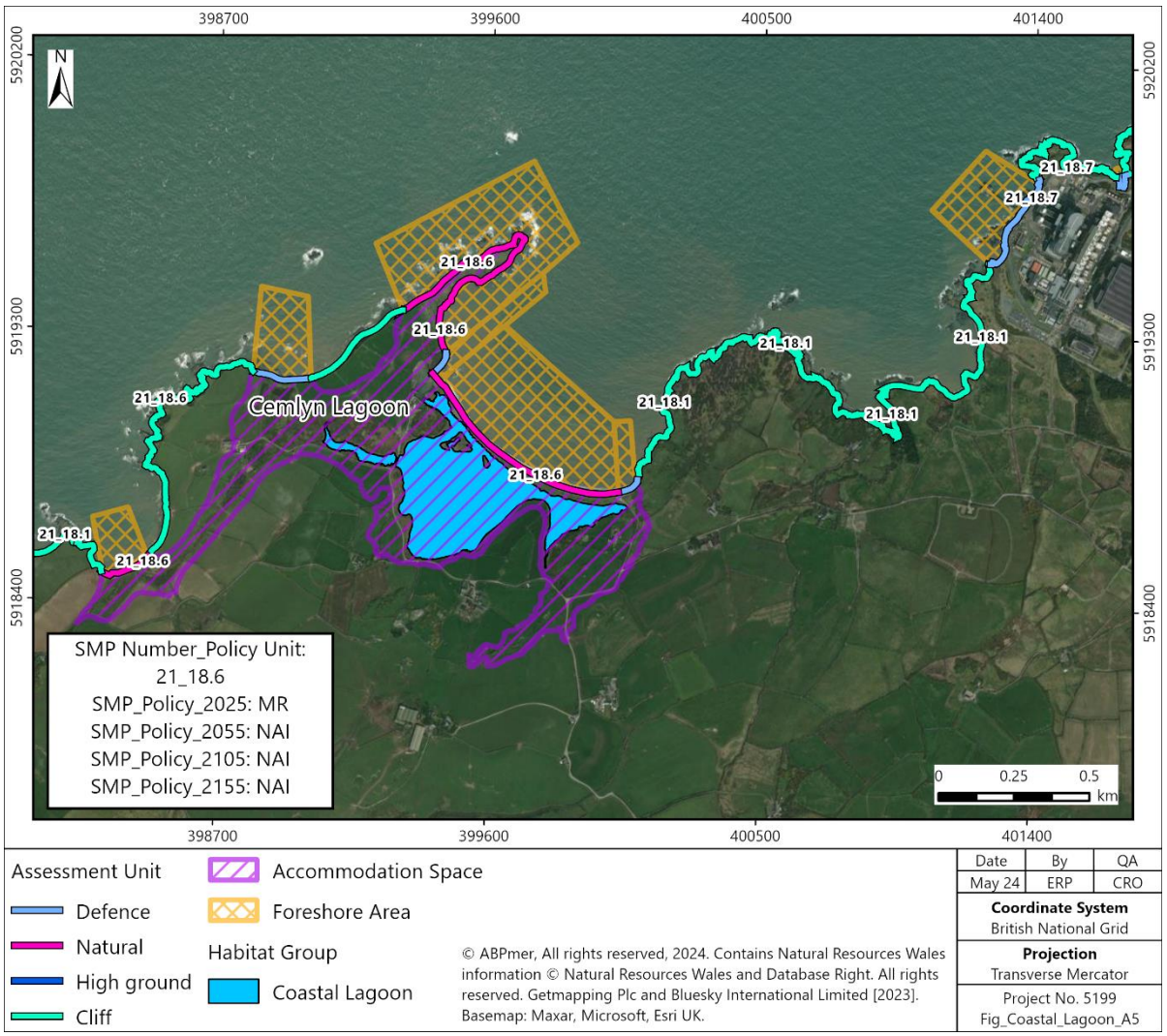


Figure B.3 Cemlyn Bay Lagoon

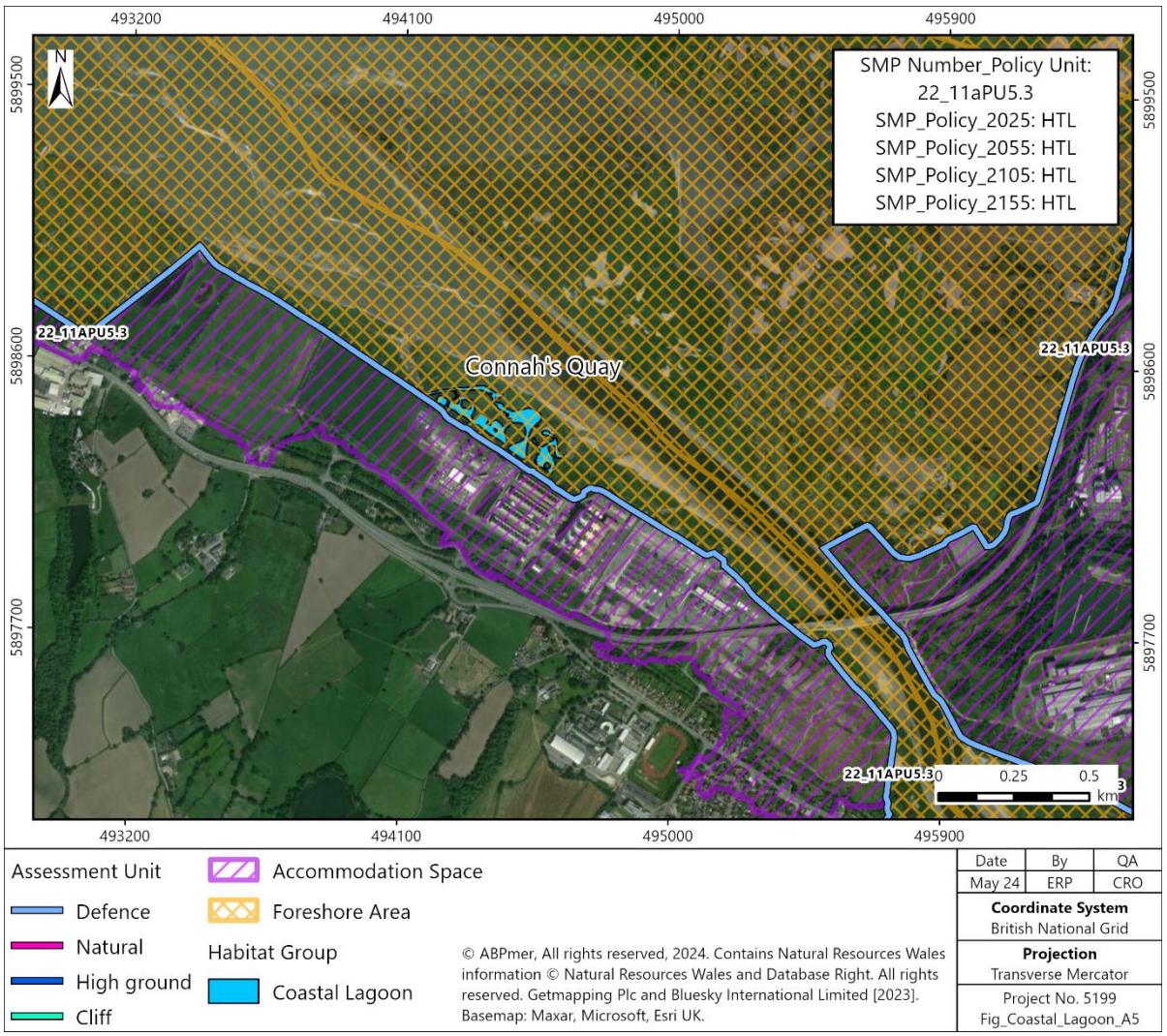


Figure B.4 Connah's Quay

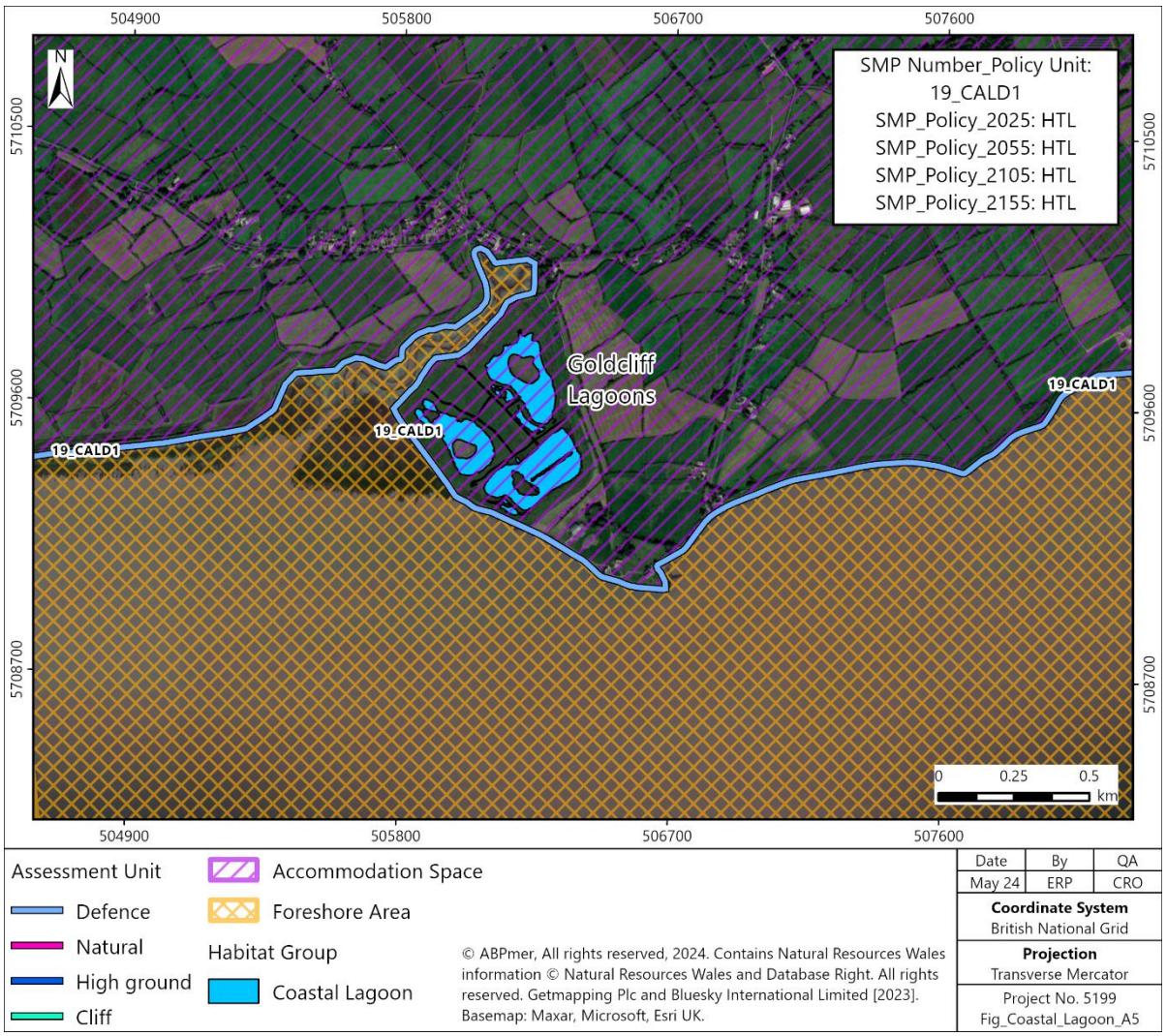


Figure B.5 Goldcliff Lagoons

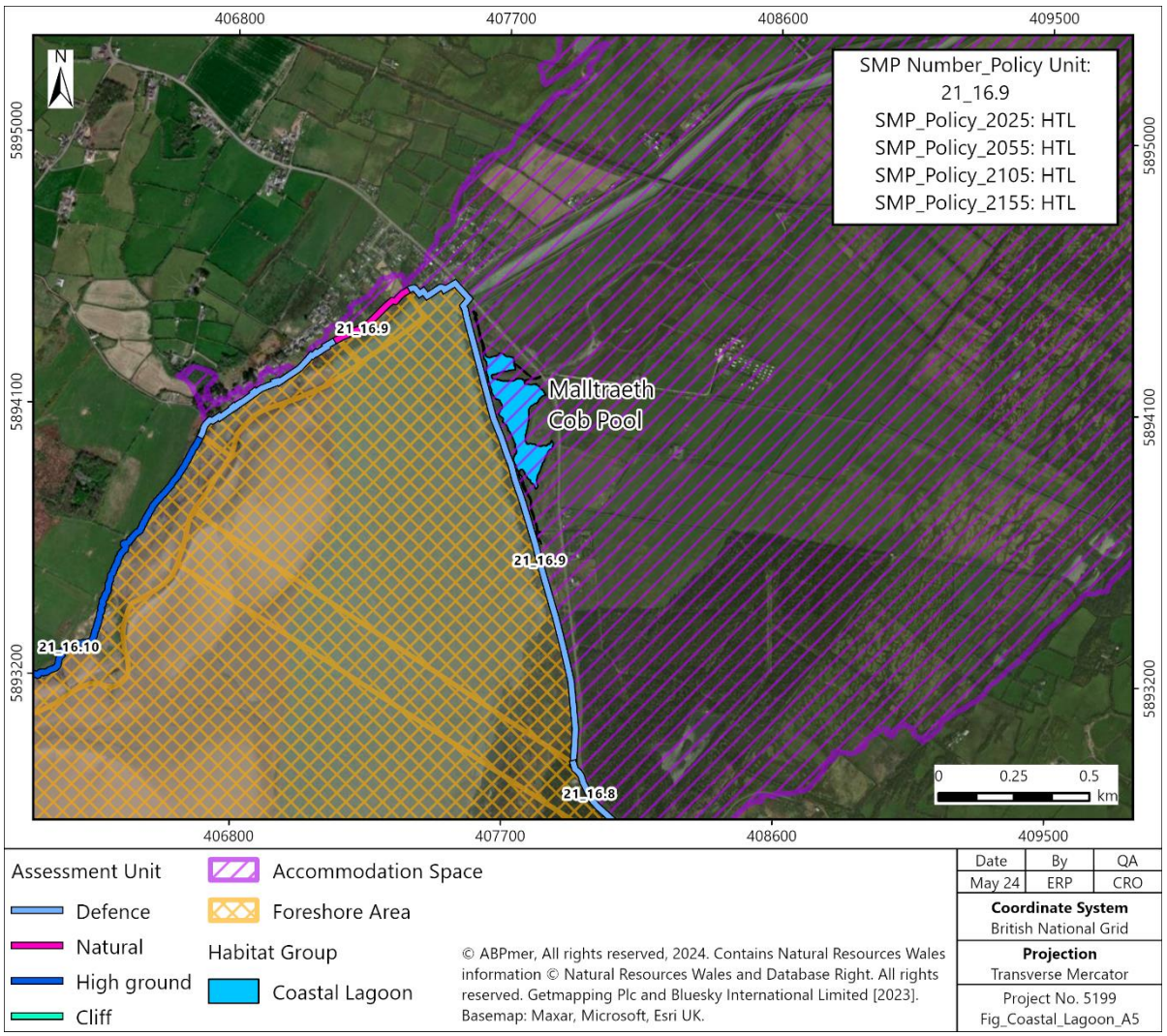


Figure B.6 Malltraeth Cob Pool

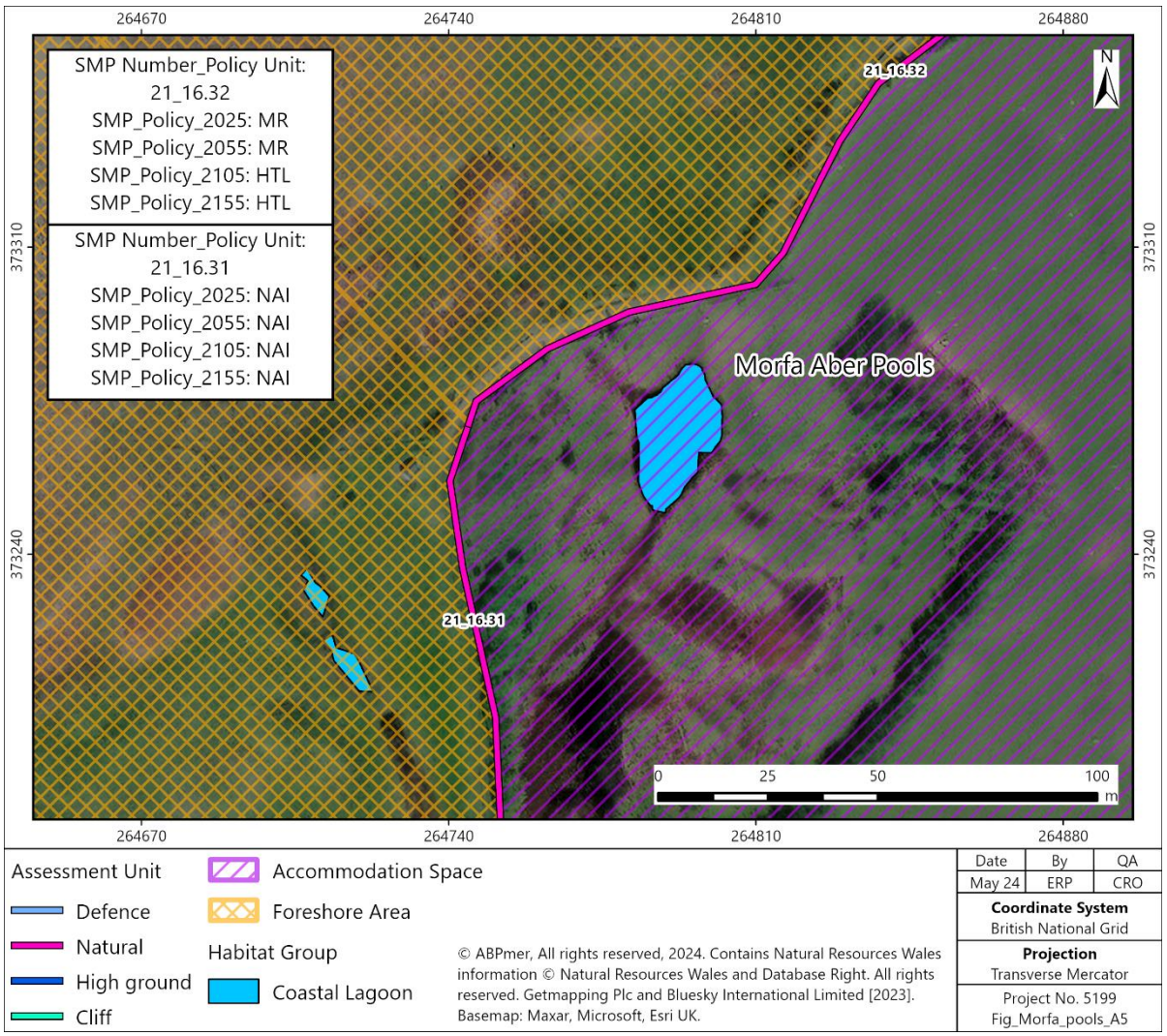


Figure B.7 Morfa Aber Pools

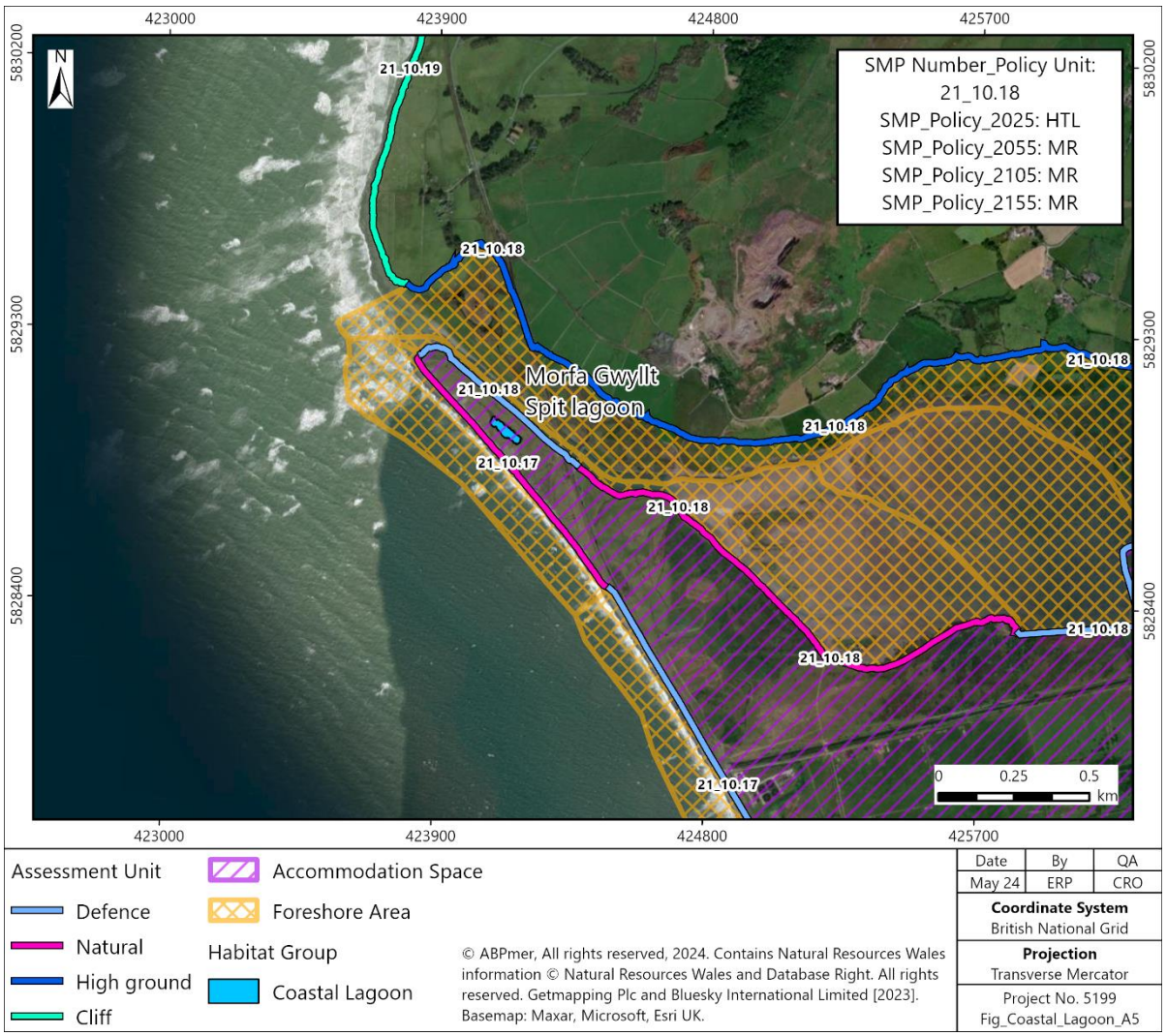


Figure B.8 Morfa Gwyllt Lagoon

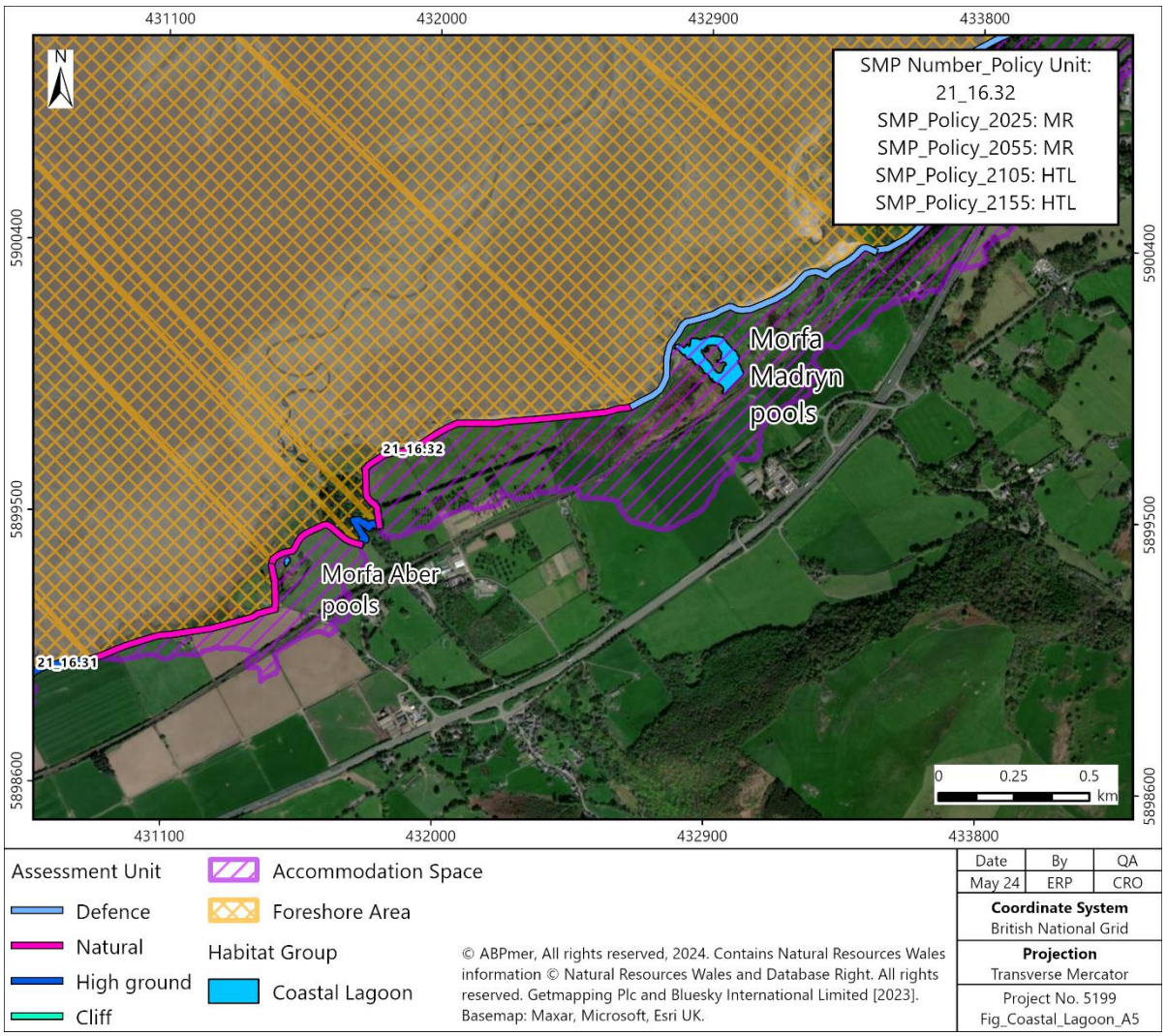


Figure B.9 Morfa Madryn Pools

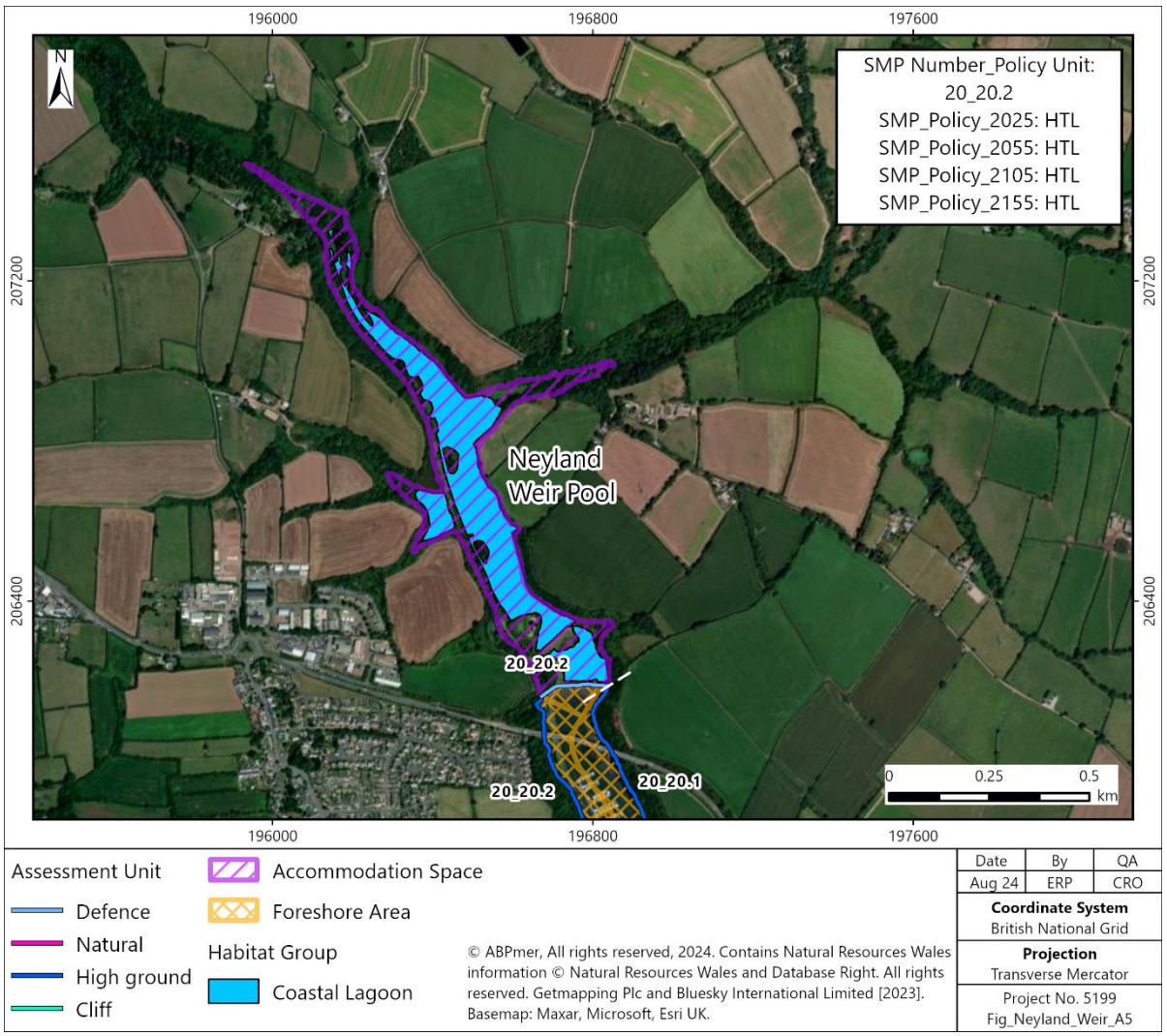


Figure B.10 Neyland Weir Pool

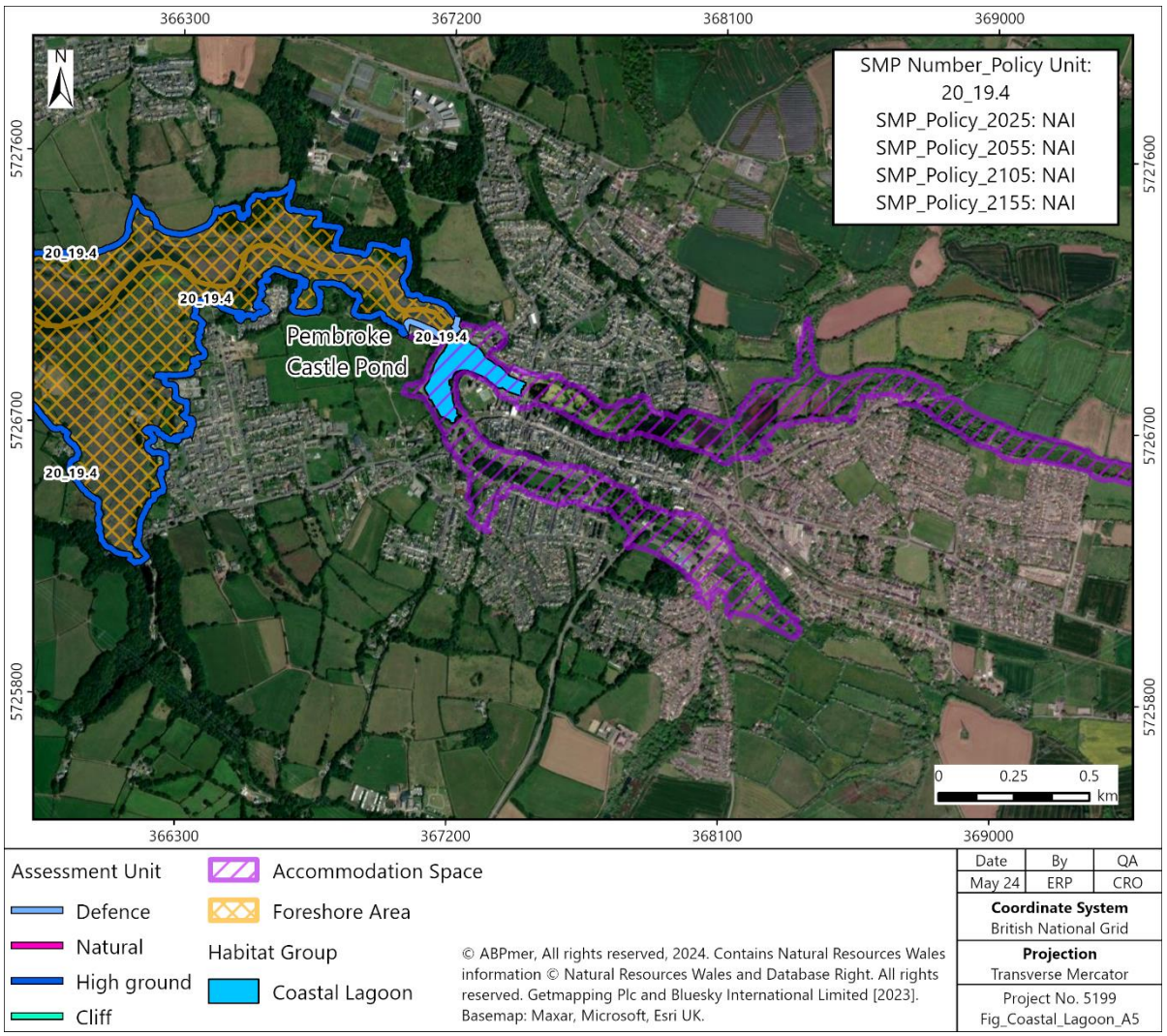


Figure B.11 Pembroke Castle Pond

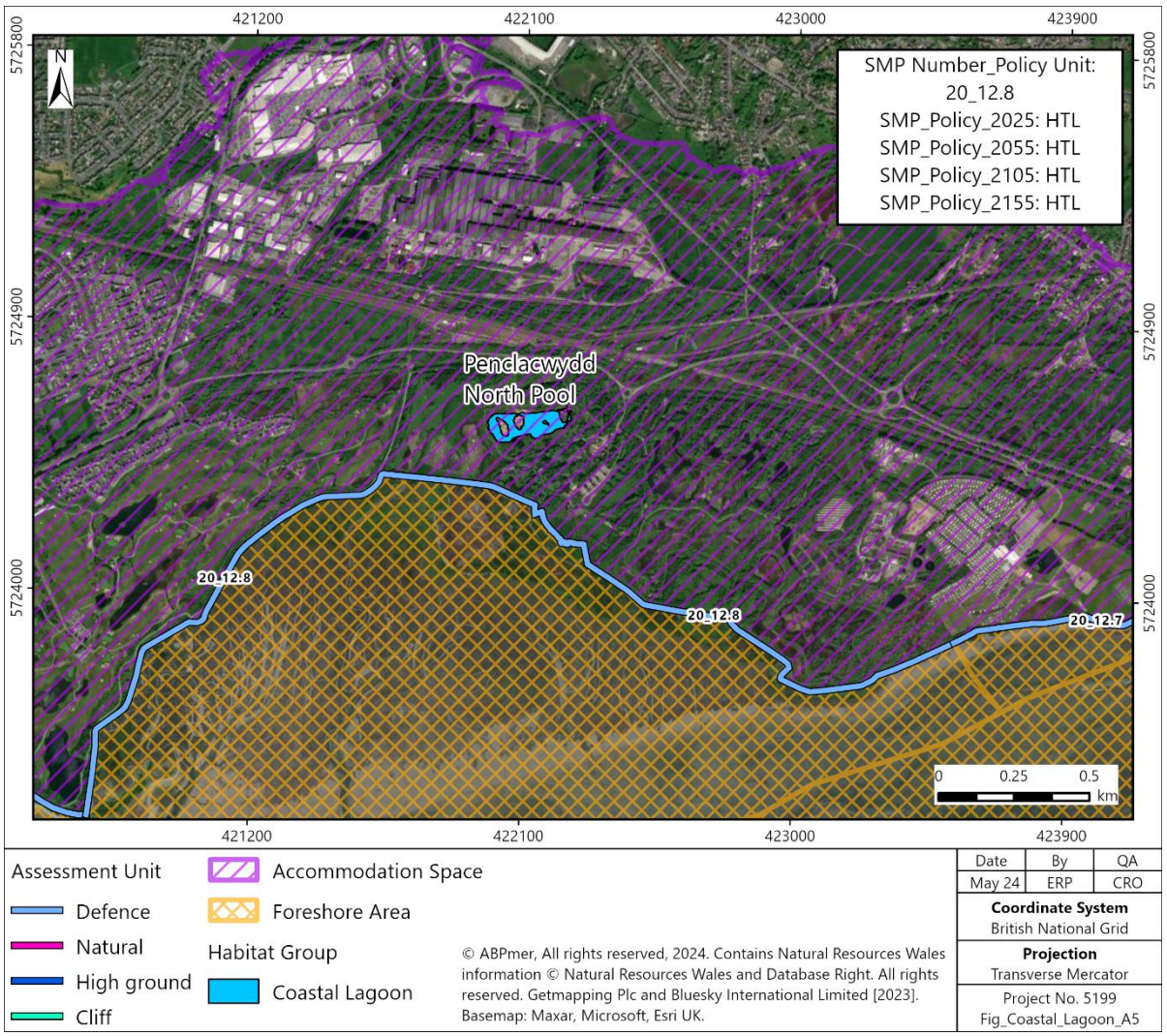


Figure B.12 Penclacwydd North Pool

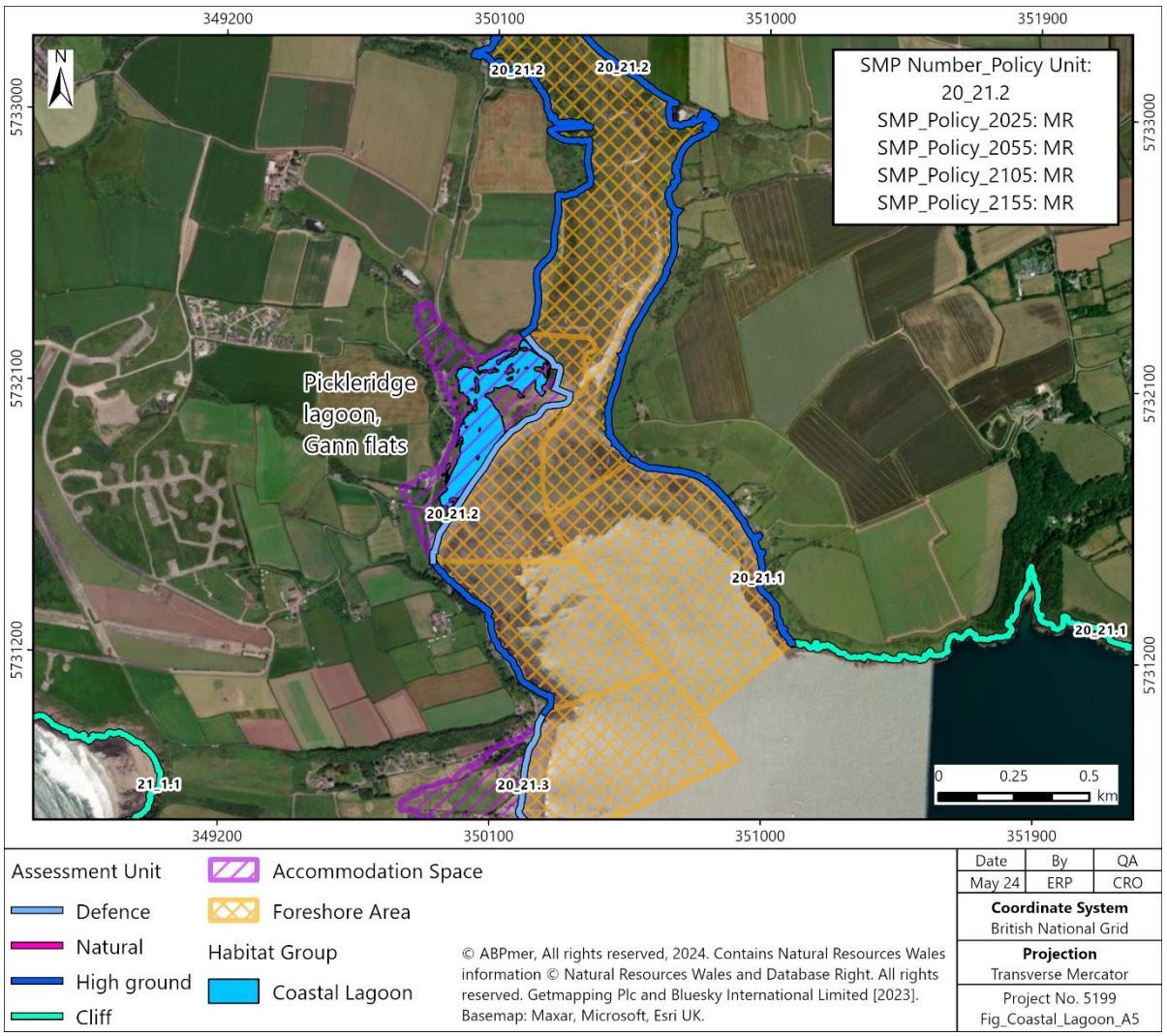


Figure B.13 Pickleridge Lagoon

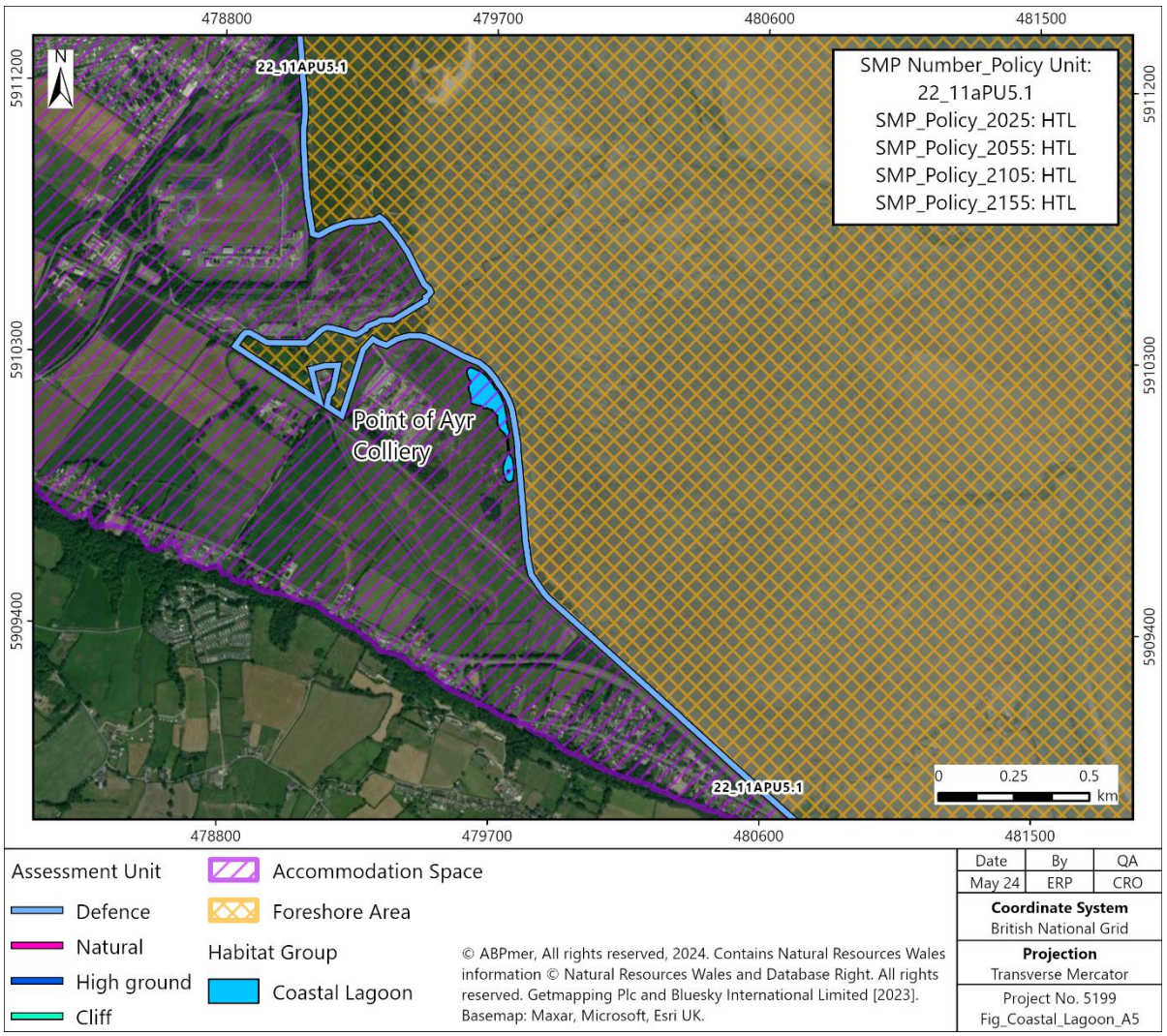


Figure B.14 Point of Ayr Colliery

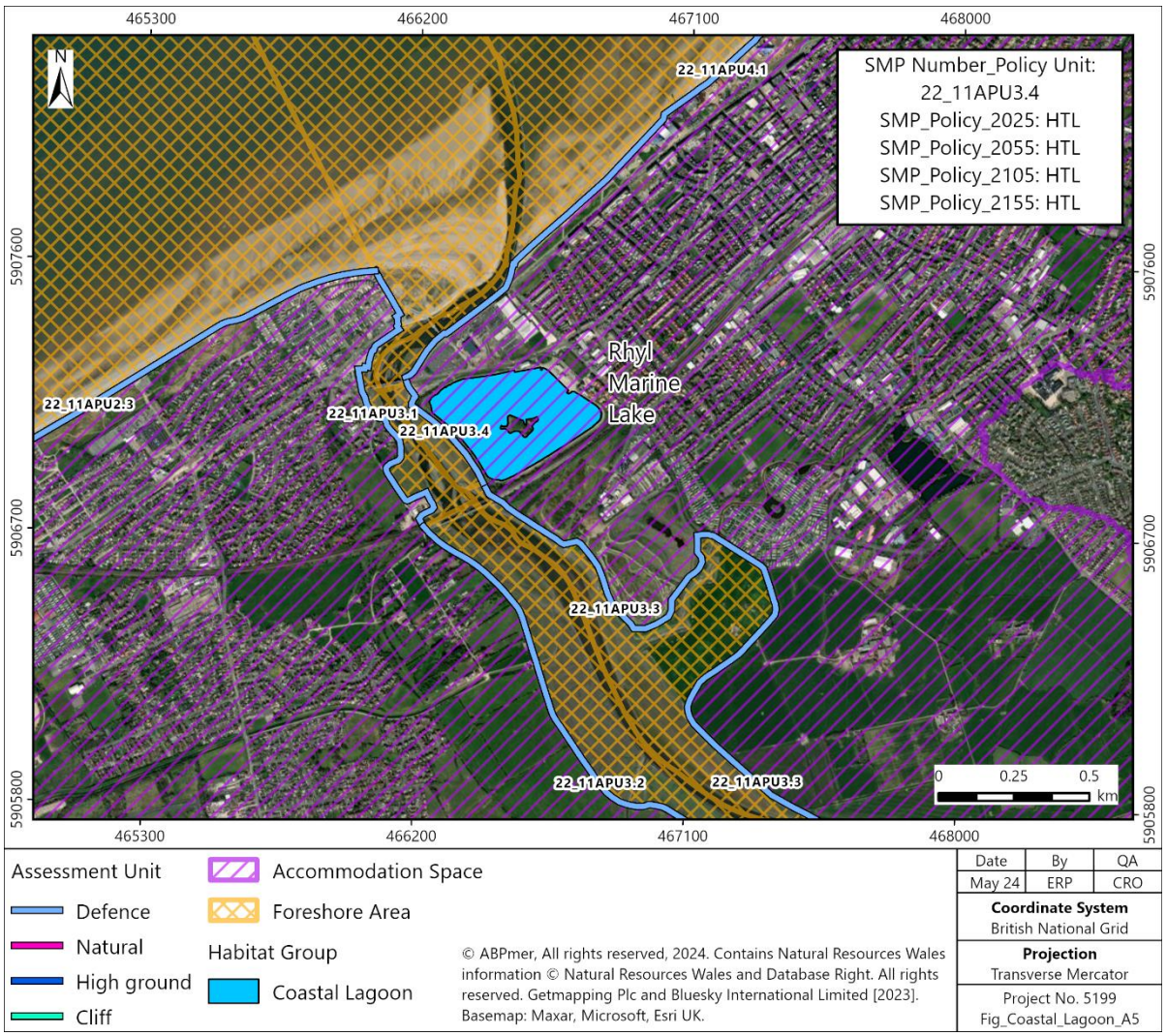


Figure B.15 Rhyl Marine Lake

# Data Archive Appendix

Data outputs associated with this project are archived in NRW's corporate geospatial drive on server–based storage at Natural Resources Wales.

The data archive contains:

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

[B] A series of GIS layers

[C] Associated data outputs on Microsoft Excel

Metadata for this project is publicly accessible through Natural Resources Wales' Data Discovery Service https://metadata.naturalresources.wales/geonetwork/srv (English version) and https://metadata.cyfoethnaturiol.cymru/geonetwork/cym/ (Welsh Version). The metadata is held as record no **NRW_DS161284**



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