



Marine
Management
Organisation

Marine Non- Licensable Activity Impacts Evidence: Reef (DRAFT)

September 2026



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Marine Non-Licensable Activity Impacts Evidence: Reef (DRAFT)

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Executive Summary

This document collates and analyses the best available evidence on the impacts of marine Non-Licensable Activities (mNLA) on marine protected area (MPA) features and will inform site level assessments of the impact of mNLA on MPAs as part of the Marine Management Organisation's (MMO's) work to manage MPAs. mNLA have the potential to impact reef, therefore management of these activities may be required within an MPA. For each MPA, a site level assessment considering the site conservation objectives, spatial and temporal activity levels and exposure to natural disturbance will be completed to determine whether management will be required.

Available evidence indicates that hovercraft activities are unlikely to occur over, or impact reef. Wildlife watching activities will also not create any additional impacts to reef that are not already produced by motorised watercraft. The operation of non-motorised watercraft will not significantly impact reef due to the nature of the activity. All mNLA, with the exception of hovercraft and wildlife watching at sea (commercial) will have an adverse impact on subtidal chalk or littoral chalk communities as even single events can result in the loss of this irreplaceable habitat. Anchoring, diving and snorkelling, motorised watercraft, motorised personal watercraft (MPW) and sailing will impact reef, but the level of impact will depend on the biological and physical characteristics of each reef type, the activity intensity and the site specifics.

1 Introduction

The Marine Management Organisation (MMO) is the principal regulator for England's seas, including leading the assessment and management of marine Non-Licensable Activities (mNLA) for marine protected areas (MPAs) inshore of 12 nautical miles (nm).

This document forms part of MMO's work to achieve the government's aim of identifying and implementing appropriate management measures where required for all inshore MPAs in English waters by the end of 2030. It is one of a suite of documents which focus on the interaction of designated features with mNLA, and it will support the delivery of site level assessments.

The potential for pressures resulting from mNLA and their impacts on designated features within MPAs have been assessed by gathering and analysing the available evidence for activity-feature interactions.

This document describes the pressures resulting from mNLA which may impact reef which are designated features of MPAs.

The Marine Non-Licensable Activity Impacts Evidence: Summary¹ provides further background information, including details of documents produced and the features and activities included within the scope of the mNLA programme of works.

1.1 Key definitions

A separate glossary in Marine Non-Licensable Activity Impacts Evidence: Methodology¹ includes the important terms used in this document. Wherever possible these are taken from [Natural England's Glossary of terms used within conservation advice packages \(CAP\)](#)².

The following terms are particularly important when reading this document:

Designated Feature ("feature") - a species, habitat, geological or geomorphological entity for which an MPA is identified and managed.

Sensitivity – the sensitivity of a feature (species or habitat) is a measure that is dependent on the ability of the feature (species or habitat) to resist change and its ability (time taken) to recover from change (**Figure 1**).

¹ Marine Non-Licensable Activity Impacts Evidence documents are available: <https://www.gov.uk/government/calls-for-evidence/marine-non-licensable-activities> (last accessed 30 September 2026)

² Natural England MPA Conservation Advice - Glossary of Terms: designatedsites.naturalengland.org.uk/pdfs/MPA_CAGlossary_March2019.pdf (Last accessed 24 April 2026)

Pressure - the mechanisms through which an activity has an effect on a feature.

Impact - the consequence of a pressure/pressures (such as habitat degradation) where a change occurs that is different to that expected under natural conditions.



Figure 1: The approach to determine sensitivity from pressures for each feature and activity interaction.

1.2 Structure of this document

Section 2 lists the MPA features considered and references the evidence sources used in this document.

Section 3 describes the types of mNLA considered in this document.

Sections 4 to 8 describe the available evidence of the pressures resulting from the mNLA and impacts on the designated features. Where a feature is potentially sensitive to mNLA (based on its resistance to the pressure and ability to recover) the interaction is considered. Each section lists the pressures to which the features may be sensitive, using Natural England's CAPs and MMO judgement. It also lists those pressures which have not been assessed or where insufficient evidence has been found to assess sensitivity. Each section also details available evidence about the designated feature, its ability to resist and recover from change, and its resultant sensitivity.

Section 9 summarises the conclusions of the assessed pressure feature interactions within this review.

Annex 1 describes how feature-pressure interactions have been identified; and provides a table of all the potential pressure-feature interactions and the sensitivity assessment for each.

2 Overview of reef features

This section describes the different features which are considered in this document under the broad terminology of reef or reef features.

Reefs are an Annex I habitat listed in European Union (EU) Council Directive 92/43/EEC³. Several marine conservation zone (MCZ) features including circalittoral, infralittoral and intertidal rock, subtidal chalk, and biogenic reef (such as mussel beds and *Sabellaria* reef) correspond to the Annex I reef classification. The Joint Nature Conservation Committee (JNCC) classifies reef into one (or more) of the following three subtypes: biogenic reef, bedrock reef and stony reef. Bedrock reef and stony reef are together categorised as rocky reef (JNCC, 2026a).

Table 1 and Table 2 provide links to more detailed descriptions of habitats and species which fall under the biogenic and rocky reef feature classifications. These tables as well as the descriptions below draw on information taken from the Marine Life Information Network (MarLIN, 2026). Annex 1 summarises the pressures resulting from mNLA and the sensitivities of the features described in this document to those pressures. These sensitivities were derived using advice from Natural England, Natural England's CAPs for sites designated for reef features and review of the available scientific literature.

To understand and assess the ecological impact of mNLA on designated reef features, these features have been grouped into functional groups reflecting their sensitivity, resilience, recovery and spatial distribution. The designated features "Annex 1 Reef" or "Reef" can be made up of a variety of other reef types, referred to as sub-features or supporting features, and are assessed using the sensitivity of those features to relevant pressures. Epifaunal reef species have been included when they are a designated feature.

³ For more information: eur-lex.europa.eu/eli/dir/1992/43/oj/eng

Table 1: Biogenic reef feature descriptions which are included within this document.

Feature name	Feature description
Blue mussel (<i>Mytilus edulis</i>) beds	Blue mussel beds ⁴
Honeycomb worm (<i>Sabellaria alveolata</i>) reefs	Honeycomb worm (<i>S. alveolata</i>) ⁵
Native oyster (<i>Ostrea edulis</i>) beds	O. edulis beds on shallow sublittoral muddy mixed sediment ⁶
Ross worm (<i>Sabellaria spinulosa</i>) reefs	Ross worm (<i>S. spinulosa</i>) ⁷

Table 2: Rocky reef feature descriptions which are included within this document. Intertidal and subtidal stony reef do not have supporting feature description webpages but are described in section 2.3.

Feature name	Feature description
High energy circalittoral rock	High energy circalittoral rock ⁸
High energy infralittoral rock	High energy infralittoral rock ⁹
High energy intertidal rock	High energy littoral rock ¹⁰
Intertidal under-boulder communities	Intertidal under-boulder communities ¹¹
Littoral chalk communities	Intertidal chalk ¹²
Low energy circalittoral rock	Low energy circalittoral rock ¹³

⁴ Blue mussel beds www.marlin.ac.uk/habitats/habitat/4/blue_mussel_beds_intertidal (Last accessed 04 September 2026).

⁵ Honeycomb worm www.marlin.ac.uk/species/detail/1129 (Last accessed 04 September 2026).

⁶ *Ostrea edulis* www.marlin.ac.uk/habitats/detail/69 (Last accessed 04 September 2026).

⁷ Ross Worm www.marlin.ac.uk/species/detail/1133 (Last accessed 04 September 2026).

⁸ High energy circalittoral rock mhc.jncc.gov.uk/biotopes/JNCCMNCR00002118 (Last accessed 04 September 2026).

⁹ High energy infralittoral rock mhc.jncc.gov.uk/biotopes/jnccmncr00001955 (Last accessed 04 September 2026).

¹⁰ High energy intertidal rock mhc.jncc.gov.uk/biotopes/jnccmncr00000780 (Last accessed 04 September 2026).

¹¹ Intertidal under-boulder communities data.jncc.gov.uk/data/18af713e-3401-485d-b40e-e920f99ef195/UKBAP-BAPHabitats-20-IntertidalUboulderComms.pdf (Last accessed 04 September 2026).

¹² Littoral chalk communities data.jncc.gov.uk/data/18af713e-3401-485d-b40e-e920f99ef195/UKBAP-BAPHabitats-21-IntertidalChalk.pdf (Last accessed 04 September 2026).

¹³ Low energy circalittoral rock mhc.jncc.gov.uk/biotopes/jnccmncr00002120 (Last accessed 04 September 2026)

Feature name	Feature description
Low energy infralittoral rock	Low energy infralittoral rock ¹⁴
Low energy intertidal rock	Low energy littoral rock ¹⁵
Moderate energy circalittoral rock	Moderate energy circalittoral rock ¹⁶
Moderate energy infralittoral rock (includes moderate energy infralittoral rock and thin mixed sediments)	Moderate energy infralittoral rock ¹⁷
Moderate energy intertidal rock	Moderate energy littoral rock ¹⁸
Peacock's tail seaweed (<i>Padina pavonica</i>)	Peacock's tail ¹⁹
Pink sea-fan (<i>Eunicella verrucosa</i>)	Pink sea-fan ²⁰
Sea fan anemone (<i>Amphianthus dohrnii</i>)	Sea fan anemone ²¹
Subtidal chalk	Subtidal chalk ²²
Subtidal stony reef	N/A
Intertidal stony reef	N/A

2.1 Features which have been scoped out

The following designated reef features are not included within this document:

- Geological or geomorphological designated features - such as estuarine rock habitats - are out of scope for this document as mNLA are considered incapable of significantly impacting these features. The sub-features will be included in site level assessments.

¹⁴ Low energy infralittoral rock mhc.jncc.gov.uk/biotopes/jnccmncr00001954 (Last accessed 09 September 2026)

¹⁵ Low energy intertidal rock mhc.jncc.gov.uk/biotopes/jnccmncr00000495 (Last accessed 04 September 2026)

¹⁶ Moderate energy circalittoral rock mhc.jncc.gov.uk/biotopes/JNCCMNCR00001510 (Last accessed 04 September 2026)

¹⁷ Moderate energy infralittoral rock mhc.jncc.gov.uk/biotopes/jnccmncr00000009 (Last accessed 04 September 2026)

¹⁸ Moderate energy intertidal rock mhc.jncc.gov.uk/biotopes/jnccmncr00000737 (Last accessed 04 September 2026)

¹⁹ Peacock's tail seaweed www.marlin.ac.uk/species/detail/1423 (Last accessed 04 September 2026)

²⁰ Pink sea-fan www.marlin.ac.uk/species/detail/1121 (Last accessed 04 September 2026)

²¹ Sea fan anemone www.marlin.ac.uk/species/detail/1120 (Last accessed 04 September 2026).

²² Subtidal chalk data.jncc.gov.uk/data/0a9b6b43-4827-44a4-ab06-0f94d5ad6b93/UKBAP-BAPHabitats-53-SubtidalChalk.pdf (Last accessed 04 September 2026)

- Features such as stalked jellyfish and maerl were considered more suited to the Marine Non-Licensable Activity Impacts Evidence: Seagrass beds, maerl beds, seahorses and stalked jellyfish (draft)¹ due to the ecology and sensitivities of these features.
- Fragile sponge and anthozoan communities are a designated feature which only occur within one MPA, therefore the literature review and evidence of these features will be included in site level assessments and not considered further in this review.

2.2 Biogenic reef

This document considers the following biogenic reefs: blue mussel beds; native oyster beds; and *Sabellaria* reef. These reefs are formed by blue mussels (*Mytilus edulis*), native oysters (*Ostrea edulis*), Ross worm (*Sabellaria spinulosa*) and Honeycomb worm (*Sabellaria alveolata*), respectively.

2.2.1 *Sabellaria* reef

Sabellaria reef is a Habitat of Principal Importance, identified through the UK Biodiversity Action Plan (UKBAP) (Defra and Natural England, 2022) which was published by the Secretary of State following their duties under the Natural Environment and Rural Communities (NERC) Act 2006, Section 41²³.

Sabellaria reef is also listed under the Oslo and Paris (OSPAR) Convention as a threatened habitat. There are two species of *Sabellaria* in the UK which can form biogenic reef: Ross worm (*S. spinulosa*) and Honeycomb worm (*S. alveolata*).

S. alveolata are sedentary polychaetes which build tubes from sand and shells. A hard substrate is required for them to attach, but they also need sand or small shell particles to build their tubes. They are gregarious and prefer to settle on adult tubes. Aggregations of *S. alveolata* form biogenic reef⁵.

S. spinulosa do not form reef in most parts of their geographical range, but are solitary or in small groups encrusting pebbles, shells, kelp holdfasts and bedrock (Maddock, 2008). In areas where they may form reefs, there are dense aggregations of the small, tube-building polychaete worm. *S. spinulosa* can act to stabilise cobble, pebble and gravel habitats, providing a consolidated habitat for epibenthic species. They are solid (albeit fragile) structures at least several centimetres thick, raised above the surrounding seabed.

Sabellaria reef habitats of greatest nature conservation significance are those which occur on predominantly sediment or mixed sediment areas, such as those designated within English MPAs (for example, Inner Dowsing, Race Bank and North Ridge Special Area of Conservation (SAC)). These enable establishment of a range

²³ For more information: www.legislation.gov.uk/ukpga/2006/16/section/41

of epibenthic species, their associated fauna and a specialised “crevice” infauna, which would not otherwise be found in the area (Maddock, 2008).

Sabellaria reef is ephemeral, but core reef areas can persist for many years. As such, they provide a biogenic habitat that allows many other associated species to become established.

S. alveolata is typically found on the lower intertidal zone but can extend into the subtidal zone⁵. In contrast, *S. spinulosa* is more commonly in the subtidal zone but can be on the lower intertidal zone⁷.

2.2.2 Blue mussel beds

Blue mussel beds are a Habitat of Principal Importance and are listed by the OSPAR Convention as a threatened habitat. A blue mussel bed is a dense aggregate of blue mussels (living or dead), which are held together by byssus threads. These mussel beds form a reef habitat which can support infaunal and epifaunal species (Mainwaring, Tillin and Tyler-Walters, 2014). Blue mussel beds can form on rocky habitats as well as sedimentary habitats. These beds stabilise the sedimentary substratum and provide hard substratum in an otherwise sedimentary habitat. Blue mussel beds can form in the intertidal and subtidal area and prefer to settle on adults of the same species⁴.

2.2.3 Native oyster beds

Native oyster beds are a dense aggregation of native oysters (living or dead), which can occur on shallow sublittoral muddy fine sand, sandy mud mixed sediments⁶, and intertidal mixed and sandy sediments (OSPAR Commission, 2026).

Native oysters prefer to settle on hard substrate, particularly on adults of the same species (Marine Biological Association, 2026b), where they use a process called cementation to settle, this involves their left valve being permanently attached to the substratum using a naturally produced adhesive (MacDonald, Freer and Cusack, 2010). Native oyster beds provide hard substratum in an otherwise sedimentary habitat which can support epifauna⁶.

2.3 Rocky reef

In contrast to biogenic reefs, rocky reefs consist of plant and animal communities that develop on bedrock, stable boulders, and cobbles. They can be extremely variable, with communities varying with rock type, topography, and hydrodynamic conditions (Connor et al., 2022).

For this literature review the following categories of rocky reef will be assessed:

- intertidal (littoral) rocky reef;
- infralittoral rocky reef;
- circalittoral rocky reef;
- chalk reef;

- stony reef; and
- intertidal under-boulder communities.

A description of each rocky reef category is provided in this section. **Table 3** summarises the physical and biological differences between intertidal rocky reef, infralittoral rocky reef and circalittoral rocky reef categories. While chalk reef and stony reef can fall within the intertidal, infralittoral or circalittoral reef categories they have not been included in **Table 3** and are assessed separately in **section 2.3.4** and **2.3.5** due to their specific characteristics.

Table 3: Comparison table of the characterising features of rocky reef categories.

Category	Location	Approximate depth range (metres. m)	Light availability	Dominant life
Intertidal (littoral)	Intertidal area between high and low tide marks	Tidal range to 0m	High (exposed to air at times)	Seaweed, barnacles, limpets, crabs
Infralittoral	Subtidal, below low tide, well-lit	0 to 30m (varies depending on turbidity which affects light availability)	High (supports photosynthesis)	Kelp, algae
Circalittoral	Deeper subtidal, below algal growth limit	30 to 200m (varies depending on turbidity which affects light availability)	Low (too dim for plants)	Sponges, bryozoan, corals, tunicates, filter feeders

2.3.1 Intertidal rocky reef

Intertidal rocky reef includes habitats of bedrock, boulders and cobbles which occur in the intertidal zone. Physical variables affect rocky shore communities, including salinity, temperature, wave exposure, and the diurnal emersion and immersion of the shore (European Environment Agency, 2019a).

Four features of intertidal rocky reef are considered in this review, these include high energy intertidal rock, moderate energy intertidal rock, low energy intertidal rock and intertidal under-boulder communities. High energy refers to those rocky reef habitats subject to a high degree of wave exposure¹⁰, in contrast low energy intertidal rocky reefs are present in sheltered bays or inlets¹⁵.

The degree of wave exposure affects the communities that form on the rocky reef. JNCC describes high energy intertidal rock as being primarily dominated by mussels and barnacles¹⁰, in contrast low energy intertidal rock is primarily dominated by fucoid seaweeds. Moderate energy intertidal rock is a mosaic of mussels, barnacles and fucoid species¹⁸.

Intertidal under-boulder communities are areas of boulders (greater than 256mm in diameter); they form microhabitats which can occur on bedrock, mixed rock, sediment or mud. They require a sufficient gap between the benthos and the boulder to support communities. These areas which are rich in biodiversity are a UK BAP habitat. Intertidal under-boulder communities are dominated by encrusting fauna including sea squirts, coralline algae, sponges and barnacles. They also provide shelter for fish eggs, dog whelks, sea slugs and crustaceans¹¹.

2.3.2 Infralittoral rocky reef

Infralittoral rocky reef, made up of bedrock, boulder and cobble habitats, occurs in the subtidal zone from 0m to approximately 30m and is typically dominated by seaweed and kelp communities (Connor et al., 2022).

Three features of infralittoral rocky reef are considered in this review: high energy infralittoral rock, moderate energy infralittoral rock and low energy infralittoral rock. The key difference between the three features is the interaction between the rocks and waves and tides. High energy infralittoral rock has high wave exposure and powerful tidal streams. Moderate energy infralittoral rock is subject to moderate levels of wave exposure and moderate tidal flow (up to three kilonewtons (kN)¹⁷.

Low energy infralittoral rock is sheltered from wave or tidal influence, leading to accumulation of silt and organic matter; less light is therefore likely to reach the rock feature¹⁴. Conversely, greater exposure to tidal influence results in high energy infralittoral rock having low sedimentation levels and higher levels of light penetration⁹. The most common kelp species present on high energy infralittoral rock is *Laminaria hyperborea*, while, low energy infralittoral rock more commonly supports *L. saccharina* (Connor et al., 2022). Moderate energy infralittoral rock typically supports a mixture of *L. digitata*, *L. hyperborea* and foliose red seaweeds (JNCC, 2026b).

2.3.3 Circalittoral rocky reef

Circalittoral rock occurs in the subtidal zone from approximately 30m to 200m and is dominated by animal communities (European Environment Agency, 2019b).

The circalittoral zone is defined by the amount of light reaching the seabed, which means its depth can vary depending on environmental conditions. For example, in turbid waters, sediment in the water column can reduce light penetration, causing the zone to begin just below the water's surface. The composition of fauna is also highly variable and is influenced not only by light availability but also by factors such as wave exposure, tidal strength, salinity, turbidity, scouring, and rock topography. As a

result, the circalittoral zone often supports a high diversity of species, in contrast to inshore and infralittoral habitats, which are typically dominated by one or a few species (European Environment Agency, 2019b).

Three features of circalittoral rocky reef are included in this review: high energy circalittoral rock, moderate energy circalittoral rock and low energy circalittoral rock. High energy circalittoral rock is exposed to strong or very strong tidal streams⁸ whereas moderate energy circalittoral rock is only exposed to moderate or weak tidal streams¹⁷. Low energy circalittoral rock is exposed to weak and very weak tidal streams and are in sheltered environments with low wave exposure¹⁴.

The high tidal stream of high energy circalittoral rock results in the dominating species being filter feeders such as *Belanus crenatus* and *Tubularia indivisa*, as well as *Phakellia ventilabrum* and *Axinellid* sponges. Moderate energy circalittoral rock with weaker wave strength is able to hold more diverse species including faunal turfs, fragile sponges, cup corals, and delicate anthozoans (Connor et al., 2022). Low energy circalittoral rock is dominated by red algae, ascidians and brachiopods¹³.

2.3.4 Chalk reef

Chalk reef, a UKBAP Habitat of Principal Importance, is a type of sedimentary rock which in the marine environment can form rocky reef. Chalk reef is irreplaceable as any damage to the physical structure is permanent, this is because chalk is composed of skeletons of calcareous nanoplankton deposited millions of years ago and therefore takes millions of years to form (Moffat, Richardson and Roberts, 2020).

Two chalk reef features are considered in this review: subtidal chalk and littoral chalk communities. Littoral chalk is found along the shoreline and has periods of being wet and dry depending on tidal movements. This also causes periodic changes in temperature. The varying wave action creates differences in formation of chalk due to erosion¹². Subtidal chalk is found further offshore and is always submerged under water. This then means moisture levels are consistent and the water becomes cloudy. Subtidal chalk is comprised of exposed chalk beds in the subtidal region, while littoral chalk communities are comprised of exposed chalk beds in the intertidal region. Chalk habitats are of significance because of the reef habitat the exposed chalk bed provides, and the associated communities that are attracted by the rocky substrate²⁴. Intertidal chalk and subtidal chalk are both designated as Habitats of Principal Importance in England.

²⁴ Natural England Conservation Advice Package: Cromer Shoal Chalk Beds MCZ designatedsites.naturalengland.org.uk/conservationadvice.aspx?SiteCode=UKMCZ0031&SiteName=&countyCode=&responsiblePerson=&unitId=&SeaArea=&IFCAArea=&HasCA=1&NumMarineSeasonality=0&SiteNameDisplay=Cromer%20Shoal%20Chalk%20Beds%20MCZ (Last accessed 23 March 2026)

Intertidal chalk communities contain species that are rare or scarce in Britain including algal communities, such as *Apistonema carterae* and *Chrysotila* spp, although species richness can be low (OSPAR Commission, 2009).

2.3.5 Stony reef

Subtidal stony reef is characterised by a section of the seabed over 25m² with 10% or more substratum composed of pebbles or boulders (greater than 64mm across in diameter), which rises from the seafloor and is dominated by epifaunal species (**Table 4**). These epifaunal species can vary depending on location, but can include assemblages of *holothurians*, brittlestars, sponges (encrusting, lamellate, lobose and stylasterid), as well as caryophyllid and stylasterid lace corals, the pencil urchin (*Cidaris cidaris*) and stands of *Madrepora oculata* (JNCC, 2026a).

There are two features considered in this review: intertidal stony reef and subtidal stony reef. Intertidal stony reef is found in the region between high and low tide. They therefore have variable and cyclical moisture levels and air exposure. Subtidal stony reef is permanently submerged and therefore has consistent moisture levels and air exposure (Irving, 2009).

2.3.6 Intertidal under-boulder communities

Intertidal under-boulder communities are biological communities that are found under boulders (stones greater than 256mm in diameter), fissures, crevices and spaces between adjacent boulders. Boulders in the intertidal zone create microhabitats that increase biodiversity. Boulders can change wave exposure, current strength and trap organic matter. This habitat can occur on bedrock, mixed rock, sediment or mud.

Under-boulder communities are dominated by encrusting fauna, including byozoans, sponges (porifera), sea squirts (ascidians), barnacles, chitons and tube forming polychaetes. In addition, they are important shelter for other species including crustaceans, worms, brittlestars, juvenile fish, dog whelks and sea slugs¹¹.

2.3.7 Epifaunal reef species

There are three designated MCZ species found on reef habitats, including peacock's tail seaweed (*Padina pavonica*), pink sea-fan (*Eunicella verrucosa*) and sea fan anemone (*Amphianthus dohrnii*). Sensitivity of these features to anthropogenic pressures are often similar to the habitat in which they are found, however where species-specific differences exist, these have been included.

In England, peacock's tail seaweed (*P. pavonica*) is calcified brown algae found intertidally on rocky shores in all energy regimes. Peacock's tail seaweed is found in pools of rocky shores and are often near clay, silt or sandy sediments. It consists of a thin and leafy frond structure¹⁹.

Pink sea-fan (*E. verrucosa*) is an erect colonial gorgonian coral that varies from white to deep pink in colour. They attach to rocky reefs and can create aggregations that act as biogenic reefs providing essential nursery, feeding, and

sheltering grounds for various marine species²⁰. Pink sea-fan are among the most strictly protected marine species in the UK due to their extreme fragility and slow growth rate (roughly 1cm per year). They are protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended)²⁵. Pink sea-fan prefer circalittoral depth ranges (30m to 200m).

In England, the sea fan anemone (*A. dohrnii*) is a nationally rare species, primarily found in the South West, where it lives attached to its host the pink sea-fan (Readman, 2026). The sea fan anemone is only found at sublittoral depths (0m to 200m). Its presence is closely tied to the protection of its host, the pink sea-fan, therefore, this feature will be considered along with pink sea-fan throughout the rest of this document.

²⁵ For more information: www.legislation.gov.uk/ukpga/1981/69

Table 4: The main characterising features of a stony reef (Irving, 2009). In 2020, JNCC published further guidance on how this table should be interpreted (Golding, Albrecht and McBreen, 2020).

Characteristic	Not a stony reef	“Resemblance” to being a stony reef		
		Low	Medium	High
Composition (percentage of cobbles/boulders touching each other)	Less than 10%	10 to 40% matrix supported	40% to 95%	More than 95%
Notes: diameter of cobbles / boulders being greater than 64mm. Percentage cover relates to a minimum area of 25 meters squared (m ²). This composition also includes “patchiness”.				
Elevation	Flat seabed	Less than 64mm	64mm to 5m	More than 5m
Notes: minimum height (64mm) relates to a minimum size of constituent cobbles. This characteristic could also include “distinctness” from the surrounding seabed.				
Extent	Less than 25m ²	More than 25m ²		
Biota	Dominated by infaunal species	Dominated by epifaunal species		More than 80% of species present composed of epifaunal species

3 mNLA detail of activities

Within MMO remit there are eight types of mNLA which are listed and defined below.

1. Anchoring
2. Diving and snorkelling
3. Hovercraft
4. Motorised personal watercraft
5. Motorised watercraft
6. Non-motorised watercraft
7. Sailing
8. Wildlife watching from the sea (commercial)

There may be additional activities or categories of activities which are identified at a site level which would be considered and included in a site assessment.

3.1 Anchoring

This activity involves the dropping of an anchor by any vessel (with or without an engine) to secure the vessel to the seabed temporarily, in order to prevent it drifting with the wind or current (Griffiths et al., 2017). Anchors are generally heavy metal objects designed to dig into, or hook, onto the seabed. To create hold, the anchor is dropped and a length of chain is laid out on the seabed (Griffiths et al., 2017). The anchor is “set” (fixed in position) as some pulling force is exerted on the chain (Griffiths et al., 2017). As the vessel drifts, the dragging anchor carves furrows into the seabed or scrapes on the surface of firm seabed, or the anchor may move sideways along the benthos (Griffiths et al., 2017). In addition, vessels at anchor in the intertidal area will impact the seabed when the hull or keel rests on the seabed as the tide goes out, also known as beaching.

Anchoring will impact reef features as the activity is intended to interact with the seabed to secure the vessel, however anchoring is generally avoided on reefs or rocky seabeds because anchors may fail to hold securely and or risk getting permanently snagged.

3.2 Diving and snorkelling

Diving and snorkelling refer to swimming, either underwater or on the surface, using self contained underwater breathing apparatus (scuba) or snorkelling equipment. This activity excludes the extraction of any sea fisheries resources during the activity (such as spearfishing).

As divers or snorkelers will generally be positioned above the seabed, interaction between diving or snorkelling activity and the reef features covered in this review will be limited. However, there is potential for divers to make contact with the seabed during participation if they are removing litter (for example discarded fishing gear) by hand.

Some pressures associated with diving and snorkelling have potential to impact these features, including abrasion or disturbance of the seabed. Divers and snorkelers may kick epifaunal species, this can result in dislodgement or damage to fragile species such as pink sea-fan. Also, divers and snorkelers entering the water directly from land often enter at safe access points, allowing for potential impacts from trampling. Trampling in marine and coastal environments refers to the direct physical disturbance of intertidal or shallow subtidal habitats caused by the contact pressure of feet, equipment, or small craft during human access or movement.

3.3 Hovercraft

A hovercraft, also known as an air-cushion vehicle, is a craft capable of travelling over land, water, mud or ice and other surfaces. Hovercraft are primarily used in sheltered environments, typically with large expanses of flat, intertidal areas such as mudflats or sandflats (Natural England, 2017a).

Hovercraft activity may impact reef features in the intertidal area via abrasion and disturbance. However, rocky and biogenic reef habitats are rarely flat and hovercraft cannot navigate abrupt obstacles such as rocks if higher than the lift of the hovercraft (typically less than 30cm for small recreational hovercraft) (The Center for Land Use Interpretation, 2008). Additionally, hovercraft users are likely to avoid rock and reef outcrops where possible as the rough and sharp surfaces of these features can damage the skirt of the hovercraft (The Center for Land Use Interpretation, 2008). For these reasons, MMO considers the likely occurrence of hovercraft activity over reef features as very low. Hovercraft activity has been scoped out of this assessment as a result.

3.4 Motorised personal watercraft

A motorised personal watercraft (MPW) is a recreational watercraft that the rider rides or stands on. Some models have an inboard engine driving a pump jet that has a screw-shaped impeller to create thrust for propulsion and steering. These craft are often referred to by the brand names such as Jet Ski. The MPW category includes e-foils, "jet ski" and electric powered vessels. This can also include hydroflying. A hydroflyer is a water sports device that allows a person to "fly" above the water, propelled by the force of water jets. It connects to a MPW, like a jet ski, via a long hose, and the rider controls the thrust and direction by shifting their weight. The high pressure water jets propel the person on the hydroflyer above the water and below.

MPW can result in abrasion to reef features for example from water jets. No other interaction is expected as participants will be positioned above the water.

3.5 Motorised watercraft

The use of motorised vessels, including motorboats (powerboats), sailing vessels and yachts in marine and estuarine waters. The motorised watercraft category includes water sports that involve being towed behind a motorised vessel, such as

wakeboarding, waterskiing, parascending and parasailing as well as the impact of vessels carrying participants for other mNLA such as diving and snorkelling.

Motorised watercraft can result in abrasion to reef features for example from vessel wakes. No other interaction is expected as participants will be positioned above the water.

3.6 Non-motorised watercraft

Non-motorised watercraft covers a wide variety of paddle- or wind- propelled sports. This includes canoeing (all types), kayaking (all types), kitesurfing, kite boarding, kite foiling, windsurfing, wingsurfing, wingfoiling, winging, kite winging, dinghies, stand-up foil boarding and stand-up paddleboarding (SUP).

Interaction between non-motorised watercraft activity and reef features will be limited as the participants are positioned above the water. Non-motorised watercraft can create wakes during operation, however due to the scale of the wakes this will not be a significant interaction.

However, there may be abrasion to features if the activity is launched from the shore, through trampling²⁶ over the intertidal area. While more accessible routes that do not require walking over reef are more likely to be chosen in order to avoid damage to equipment, launching and trampling over reef can still occur. This is more likely to occur on stony reef or biogenic reef on sandy substrate. In addition, while non-motorised watercraft are often carried over the shore there can be instances of equipment or craft being dragged over the shore.

3.7 Sailing

This category includes sailing boats without a motor as well as sailing vessels with motors that remain unused while under sail. Sailing boats include dinghies, day boats or other small keelboats which may be taken out of the water at end of use.

Sailing can result in abrasion to reef features, for example from vessel wakes. No other interaction is expected as participants will be positioned above the water.

3.8 Wildlife watching from the sea (commercial)

This category covers wildlife watching from any commercial organised trip at sea from any vessel. This includes organised trips and excursions and refers to paid-for activities undertaken for the purpose of observing, photographing, or experiencing marine and coastal wildlife in its natural environment. These activities are typically

²⁶ Trampling impacts are included in this review to provide a complete assessment of recreational pressures on MPA features; however, management of trampling typically falls to landowners, site managers, or Local Planning Authority and is therefore outside the scope of MMO management measures.

delivered by a commercial operator using a motorised or non-motorised vessel and may target species such as cetaceans, seabirds, seals, basking sharks or other marine fauna. These trips can often access remote locations such as offshore islands or remote cliffs where birds and seals seek sanctuary from disturbance. Repeated wildlife-watching tours may impact seals and seabirds through disturbance, particularly when vessels approach too closely, visit colonies frequently, or operate during sensitive periods such as breeding, pupping, moulting or overwintering.

There is no pathway of impact between reef features and wildlife watching from the sea (commercial), there will be no interaction between wildlife watching from the sea and reef features. Any potential interaction between motorised or non-motorised watercraft are reviewed in **sections 6** and **7**, therefore wildlife watching from the sea (commercial) has been scoped out of this assessment.

4 Anchoring

This section brings together and analyses the available evidence on the impacts of anchoring on reef features; this includes recreational and commercial anchoring.

Natural England's Advice on Operations (AoO) was used to identify potential pressures from anchoring and to inform the understanding of feature sensitivity to the pressure. Where a sensitivity assessment has not been undertaken or the evidence base is insufficient to assess sensitivity, the activity-pressure-feature combination has been included to capture all possible evidence that may impact the features. Marine Non-Licensable Activity Impacts Evidence: Methodology¹ details the process of how MMO judgement refined pressures for assessment.

High risk pressures associated with this activity with the potential to impact reef features are:

- abrasion/disturbance of the substrate on the surface of the seabed;
- penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion;
- physical change (to another seabed type) – dependent on feature (**Table A1. 2 to Table A1. 3**); and
- physical change (to another sediment type) – dependent on feature (**Table A1. 2 to Table A1. 3**).

These high risk pressures have been included in this review as they have been determined to be pressures commonly induced by anchoring at a level that has the potential to cause significant impacts on reef features. This is because a single anchoring event is likely to result in these pressures at a damaging level, regardless of any site specific factors.

High risk pressures associated with this activity have been identified using Natural England's CAP (**Annex 1**) and MMO judgement.

The following pressures were identified as low risk and are therefore not included in this document:

- hydrocarbon and polycyclic aromatic hydrocarbon (PAH) contamination;
- introduction of light;
- introduction or spread of invasive non-indigenous species (INIS);
- organic enrichment;
- synthetic compound contamination (including pesticides, antifoulants, pharmaceuticals); and
- transition elements and organo-metal (such as Tributyltin (TBT) contamination.

Low risk pressures associated with this activity have been identified using Natural England's CAP (**Annex 1**) and MMO judgement. These low risk pressures have not

been included in this review as these pressures generally do not occur at a level of concern, as a result of anchoring. Should site specific factors increase the risk of these pressures, these will be considered in an individual site assessment.

4.1 Reef features scoped out of the anchoring assessment

The deployment, dragging and recovery of anchors and associated chains can have direct impacts on reef features via abrasion. The impact of an individual anchoring event depends on the type and size of vessel or anchor deployed and specific conditions such as duration, level of swing, deployment events such as difficulties with setting or retrieval of anchor and whether the boat dragged the anchor (Griffiths et al., 2017). In addition, the penetration of the anchor into the substrate will depend on the habitat type (Griffiths et al., 2017).

Griffiths et al. (2017) suggest that anchoring almost exclusively occurs in low energy marine environments for both recreational and commercial vessels and is generally limited to shallow waters for recreational vessels (less than 30m) and deeper sheltered areas for commercial vessels. This is due to the increased risks associated with “deep water” anchoring (depth in excess of 40 to 45m), such as losing the anchor and cable and causing damage to the windlass (winch). Impact from anchoring activity therefore depends on the degree to which habitats overlap with anchorages. Deeper habitats or those that occur in areas of high currents and wave exposure, such as high energy circalittoral reef, are less likely to be exposed to anchoring (Griffiths et al., 2017).

High energy circalittoral rocky and high energy infralittoral rocky reef environments are generally considered too dynamic to allow anchoring (Griffiths et al., 2017), therefore high energy circalittoral rock and high energy infralittoral rock features have been screened out from further assessment.

Intertidal rocky reef habitats are considered unsuitable for anchoring due to potential damage to boats when the tide is out (Griffiths et al., 2017), and have therefore been scoped out from further assessment; this includes high energy intertidal rock, moderate energy intertidal rock, and low energy intertidal rock.

4.2 Summary of the effects of anchoring on biogenic reefs

Anchoring usually occurs in low energy marine environments and shallow waters for recreational vessels therefore biogenic reef exposure is dependent upon the overlap of the reef types with common anchorages (Griffiths et al., 2017). The frequency and intensity of anchoring will vary, depending on the popularity of the anchorage and availability of anchorage space within the region (Griffiths et al., 2017). Therefore, depending on the location of biogenic reefs, some will be exposed to greater anchoring pressure than others. The impacts of site specific anchoring will be assessed during the mNLA MPA site assessments.

Anchoring can result in direct physical damage to biogenic reefs, through abrasion, penetration and disturbance. This can result in individual mortality, injury and displacement of the reef building organisms and damage to the biogenic structures (Gibb et al., 2014; Mainwaring, Tillin and Tyler-Walters, 2014). The direct impact zone of an anchor (and its chain) can result in increased habitat fragmentation and erosion, affecting biogenic habitat resilience (Griffiths et al., 2017). In addition, vessels that anchor on the intertidal area will further impact biogenic reefs in this area as the hull/keel of the boat will rest on the substrate when the tide is out, resulting in further abrasion.

An example of this is anchoring on *S. spinulosa* reefs. Abrasion from an anchor can result in the worm tubes being damaged, which in some cases can cause mortality of the worms (Gibb et al., 2014). The hydrodynamics of the environment can then further exacerbate the impacts, for example wave action can enlarge the damaged areas of the reef (Cunningham et al., 1984). Over time this can result in habitat fragmentation and potentially reef disappearance (Gibb et al., 2014).

The resistance and resilience (ability to recover) of biogenic reefs to abrasion, disturbance and penetration is dependent on the species characteristics, the intensity and frequency of the anchoring activity as well as the physical environment.

Fragile species such as *S. spinulosa* are more vulnerable to impacts of abrasion and disturbance (Maddock, 2008). In addition, species protruding from the seabed and those not protected by hard shells will be more vulnerable to damage (Griffiths et al., 2017). *Sabellaria* reef is therefore more likely to be susceptible to damage compared to oyster or mussel beds. There can also be species-specific differences, for example *S. spinulosa* reefs are thought to be more sensitive to abrasion than *S. alveolata* due to differences in reef structure, with *S. alveolata* forming dense honeycomb structured reefs with tightly packed tubes and *S. spinulosa* forming lower relief aggregations which are more regularly found on less stable sediments (Gibb et al., 2014). Abrasion can also suspend fine particles and organic matter which can be removed by tidal currents, and over time, this can change the sediment type (Herbert et al., 2009). This can make a habitat less suitable for the formation and the continued presence of biogenic reef. This can vary by biotope, for example only blue mussel beds on intertidal mixed substrate are known to have a high sensitivity to the physical change (to another sediment type) compared to other mussel biotopes²⁷.

Individual mussels are unable to repair themselves after significant damage, therefore recovery of a damaged mussel bed will be dependent upon larval recruitment (Mainwaring, Tillin and Tyler-Walters, 2014). Larval settlement may be

²⁷ Natural England Conservation Advice Package - The Wash and North Norfolk Coast SAC:
designatedsites.naturalengland.org.uk/conservationadvice.aspx?SiteCode=UK0017075 (Last accessed 19 September 2026)

impacted where large scale removal of established beds has occurred as mussel larvae prefer to settle on adult mussels (Marine Biological Association, 2026a). There are some instances where mussels can reattach when dislodged but this is dependent on the currents and suitability of the substrate (Banke et al., 2024). Overall, mussel populations are considered to have a strong ability to recover from environmental disturbance if there is a good annual recruitment, although recruitment is often sporadic as larval mortality can be as high as 90% if there are poor environmental conditions (Mainwaring, Tillin and Tyler-Walters, 2014). It takes one to two years for mussels to reach reproductive age (Marine Biological Association, 2026a). Recovery rates of individual blue mussel beds have been reported from anywhere between two years and several decades (Mainwaring, Tillin and Tyler-Walters, 2014).

Native oysters have a slow growth rate and sporadic recruitment success; they require a hard substrate to settle on and larvae prefer to settle where other oysters are present (Preston et al., 2020). The native oyster starts life as male and after spawning becomes a female. They take three years to reach reproductive age (Marine Biological Association, 2026b). Native oysters are considered to have a slow recovery rate and if the whole native oyster bed is lost this can prevent recovery in that area (Marine Biological Association, 2026b).

Evidence has shown that damaged parts of *Sabellaria* reef can be rebuilt in time (Vorberg, 2000). Depending on the extent and nature of the damage, this could be as quickly as within a few days, suggesting high recovery of the species (Salomidi et al., 2012). Recovery rates will also vary depending on factors such as season of impact, larval supply, recruitment, and local environmental factors (Gibb et al., 2014). A study by Gibb et al. (2014) extrapolated recovery data from post beam trawl studies of *S. alveolata* and applied these findings to *S. spinulosa*. The study predicted that recovery through reef repair and larval recolonisation could occur within two to ten years, provided that sufficient proportions of the reef structure and individual worms survive. However, the authors acknowledged limitations associated with extrapolating results between species. Despite these uncertainties, their sensitivity assessment concluded that *S. spinulosa* reefs are likely to experience both sub-lethal and lethal damage from abrasion pressures such as anchoring. Consequently, *S. spinulosa* was assessed as having low resistance and medium resilience to this pressure (Gibb et al., 2014).

MMO concludes that anchoring on biogenic reef is likely to result in a significant risk of hindering achievement of the conservation objectives of the MPA at any level of activity. This is because the impacts of abrasion/disturbance of the substrate on the surface of the seabed, penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion, physical change (to another seabed type) and physical change (to another sediment type) caused by this activity even at low

levels are likely to present a significant risk of hindering achievement of the site's conservation objectives.

4.3 Summary of the effects of anchoring on epifaunal reef species

Anchoring can physically damage epifaunal reef species. Pink sea-fan is a cold-water coral that provides habitats for sessile species including the sea fan anemone. Pink sea-fan is a slow growing species which is susceptible to physical impact and loss of suitable substratum (Pikesley et al., 2016), therefore it is vulnerable to mechanical damage such as anchoring (Coz et al., 2012). Griffiths et al. (2017) states the recovery of pink sea-fan from abrasion and disturbance is slow and resilience is assessed as medium.

Pink sea-fan is assessed as having medium sensitivity to abrasion pressures²⁰, reflecting a susceptibility to damage from abrasion together with an ability to recover over time where disturbance events are infrequent. It is important to recognise, however, that the pressure benchmarks used in the MARLIN sensitivity assessment for abrasion are based on a single disturbance event and fishing activity (potting) is used as a proxy. Alone, these assessments do not provide an appropriate reflection of a feature's vulnerability to repeated physical disturbance; therefore, the resistance (the ability to withstand impact from a single disturbance event) and resilience (the ability to recover from a single disturbance event) scores should also be considered. Given that anchoring can result in direct abrasion of reef features through anchor contact and chain sweep, the resistance component is considered particularly relevant. Pink sea-fan has low resistance and medium resilience to abrasion pressures, suggesting that recovery from a single disturbance event may take between two and ten years. While anchoring is generally avoided on rocky reef habitats, repeated anchoring where it does occur may result in cumulative disturbance, particularly where the frequency of disturbance does not allow sufficient time for recovery between events. Therefore, pink sea-fan is considered vulnerable to anchoring impacts and consequently the sea fan anemone is also vulnerable as anchoring can damage or destroy its host the pink sea-fan.

The only protected epifaunal reef species occurring in the intertidal area in English MPAs is the Peacock's tail seaweed, which is found in pools on rocky shores consisting of soft substrata and occasionally in the shallow infralittoral (Tillin, Bolam and Hiddink, 2010). Peacock's tail seaweed receives no shelter from abrasion due to its occurrence on the surface of rocky habitats¹⁹. While anchoring is not expected on intertidal rocky habitat, peacock's tail at the fringes of the reef could be impacted by single anchoring events. Tillin et al. (2010) assessed the pressure penetration and/or disturbance of the substrate below the surface of the seabed (of between 25mm and 30cm depth), which is considered applicable to assess sensitivity to the setting and locking of the anchor to gain purchase in the seabed. Peacock's tail was assessed as having low resistance (25 to 75% loss of species or habitat), low resilience (full recovery in 10 to 25 years) and high sensitivity to penetration and/or disturbance of

the substrate. No further evidence was cited in support of the assessment, which was based on expert judgement at a workshop (Tillin, Bolam and Hiddink, 2010).

MMO concludes that anchoring on epifaunal reef species (pink sea-fan, sea fan anemone and peacock's tail) is likely to result in a significant risk of hindering achievement of the conservation objectives of the MPA at any level of activity. This is because the impacts of abrasion/disturbance of the substrate on the surface of the seabed, penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion and physical change (to another seabed type) caused by this activity even at low levels are likely to present a significant risk of hindering achievement of the site's conservation objectives.

4.4 Summary of the effects of anchoring on chalk reef (intertidal and subtidal)

Chalk reef can occur in the intertidal and subtidal (infralittoral and circalittoral) zones. Damage to marine chalk is irreversible as these habitats are unique, cannot be easily recreated and are therefore considered irreplaceable (Tillin et al., 2022). If the physical structure of the chalk is altered it will not recover, unlike many of the habitats in English waters which can recover through natural processes given time and protection. The scarcity of marine chalk habitats combined with the high potential for permanent loss of habitats warrants precautionary management across the marine chalk network to prevent permanent losses from anthropogenic induced pressures (Moffat, Richardson and Roberts, 2020). Flat bedrock (pavement chalk) forms flat plains that do not outcrop above the seabed. In contrast the subtidal chalk feature is more structurally complex with increased rugosity (surface roughness) and therefore is susceptible to anthropogenic impacts as a result of its rugosity and crumbly composition when compared to harder pavement chalk or chalk cobble, pebble and boulder habitats (Benson et al., 2024). Damage to the rugose marine chalk is irreversible (Tillin et al., 2022).

Tibbitt et al. (2020) found that areas of elevated rugged chalk showed numerous occurrences of low, medium and severe damage from anchoring in comparison to the chalk/flint cobble plain site where no damage was observed, indicating that the primary concern of anchoring impacts relates to the rugged chalk elements of the subtidal chalk feature.

Anchoring may cause physical change (to another sediment type) through permanent irreversible damage to the chalk feature. Anchoring can damage chalk through direct anchor strike (when the anchor is deployed) and when the anchor moves across the substrate, as a result of water movement (Tibbitt et al., 2020).

Anchor strike directly impacts the structural complexity of the feature as it can remove protruding chalk pieces from the structure (Tibbitt et al., 2020), this reduces potential settlement opportunities for burrowing and epifauna/flora species (Benson et al., 2024). In addition, exposed edges of clean chalk are then more susceptible to

abrasion from natural processes when compared to rounded edges (Tibbitt et al., 2020).

Where anchor strike has removed chalk pieces (rubble) from the main structure, this changes the physical composition of the surrounding sediment and chalk pavement increasing the potential for permanent change in these habitats to being pebble/cobble/boulder dominated communities (Benson et al., 2024). The addition of rubble to sediment habitats can directly smother and/or remove biotopes linked to these habitats, whilst the introduction of scour as a result of the rubble can further reduce community assemblage (Natural England, 2020).

Abrasion and grating of the feature may generate fine sediments that can be transported and deposited on adjacent habitats and therefore cause the composition of interspersed sediment habitats and affect the community assemblages they support to be altered (Benson et al., 2024). In some cases, this could result in the loss of rare habitat elements from the marine chalk network. Natural erosion processes are, however, likely to be ongoing within this habitat type (Griffiths et al., 2017).

As there is limited direct evidence on the impact of recreational or commercial anchoring on chalk, best available evidence has been reviewed from studies undertaken for pot fishing activities (Natural England, 2020; Benson et al., 2024). Although these studies do not address anchoring from mNLA directly, impacts from anchoring are assumed to be similar in nature. This is because anchors and pots are both heavy objects deposited on the seabed with an associated rope or chain and pots have associated anchors to secure them to the seabed.

When considering damage to chalk features attributed to human activity, Tibbitt et al. (2020) identified, primarily from pot fishing activity, that damage to features occurs when pots strike the substrate during deployment and when pots move across the substrate due to storms and tides. This would also be true for anchoring from recreational boats and will be considered as part of this assessment. Tibbitt et al. (2020) also identified that the use of ropes specifically associated with potting activity exerted pressure on the features. This is likely to be similar to anchor chain impacts, although anchor chain impacts are expected to be on a greater scale as they are made of metal which is heavier than rope.

To understand the types of impact that may be associated with potting on the subtidal chalk feature, Tibbitt et al. (2020) conducted a damage assessment as part of their "Human impacts on Cromer Shoal Chalk Beds MPA: Chalk complexity and population dynamics of commercial crustaceans (2020)" study. In this study, the authors characterised the type of impact that could be observed on the subtidal chalk feature as a result of pots and their associated anchors, and the severity of each impact. Severity was categorised as the degree of disturbance to the chalk bed or how much chalk is removed by the impact, defined as: low (surface layer of chalk removed), medium (structure broken but not removed) and high (structure is broken

and removed). The study identified 11 types of distinct impact categories and proposed theoretical causes based on expert judgement. The evidence suggests that the most likely human cause for seven of the 11 impact types observed were due to anchoring and/ or pots. These impacts included strike, drag, lift, abrasion and grating resulting in angular rubble and unlevel shear, and ranged from low to high severity, with six impacts resulting in irreversible damage to the physical structure of the subtidal chalk feature. The study showed that anthropogenic damage tended to be more focused on certain points of the feature, rather than evenly across the feature on the chalk sites. Areas of elevated rugged chalk showed numerous occurrences of low, medium and severe damage from anchoring in comparison to the chalk/ flint cobble plain (pavement chalk) site, where no damage was observed (Natural England, 2020).

Chalk pavement and pebble/cobble or pebble/cobble/boulders chalk habitats are unlikely to be affected by penetration pressures based on the character of the substrate, however attached epifauna/epiflora have the potential to be removed via abrasion from anchoring and associated chains of recreational vessels. It is possible that commercial anchoring, due to the size of the ships, may result in greater impact and penetration of chalk pavement. Larger commercial vessels can have anchors exceeding weights of 20 tonnes (t) with anchor chains up to hundreds of metres in length (Davis et al., 2025) which would have a large abrasion footprint.

Impacts to rugged subtidal chalk are likely to occur as a result of abrasion and/or penetration of the substrate based on the results of the damage assessment described above and the structural complexity of the feature (Benson et al., 2024).

MMO concludes that anchoring on chalk reef is likely to result in a significant risk of hindering achievement of the conservation objectives of the MPA at any level of activity. This is because the impacts of abrasion/disturbance of the substrate on the surface of the seabed, penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion, and physical change (to another sediment type) caused by this activity even at low levels are likely to present a significant risk of hindering achievement of the site's conservation objectives.

4.5 Summary of the effects of anchoring on stony reef (intertidal and subtidal) and intertidal under-boulder communities.

Stony reef is characterised by a section of the seabed (which is over 25m²) having 10% or more substratum composed of pebbles or boulders (greater than 64mm across), which rises from the surrounding seabed and is primarily covered by epifaunal species (greater than 80% of species cover) (**Table 4**) (Irving, 2009). In contrast under-boulder communities are composed of boulders which are over 256mm in diameter, and include the associated crevices, fissures and gaps between the boulders¹¹.

The cobble/boulder composition of stony reef and intertidal under-boulder communities are less susceptible to subsurface damage (Griffiths et al., 2017). However, anchoring has the potential to displace the cobbles and boulders, resulting in increased disturbance in the area (New England Fishery Management Council, 2011).

The epifaunal component of stony reef and intertidal under-boulder communities is more susceptible to the impacts of anchoring as epifauna can be directly damaged by the anchor and chain. Epifaunal species include, but are not limited to seaweeds, sponges, corals (such as pink sea-fan), barnacles, sea anemones, and mussels. Specific epifaunal species such as mussels, oysters and pink sea-fan have been assessed in the biogenic review or the epifaunal reef species (**section 4.2 and 4.3**).

The ability of different epifauna species to resist pressures associated with anchoring and recover from damage is dependent upon their biological characteristics. For example, sponges and sea anemones are likely to be more susceptible to damage than hard shelled species such as barnacles and mussels, while epifauna may also be susceptible to being tangled and snagged by anchors and their associated ropes and chains (Griffiths et al., 2017). Therefore, anchoring has the potential to alter species composition and the structure of intertidal under-boulder communities and stony reefs. Both intertidal under-boulder communities and stony reef are therefore susceptible to abrasion and disturbance as a result of anchoring. In severe cases, the removal of epifaunal species may result in the habitat no longer meeting the definition of stony reef.

MMO concludes that anchoring on stony reef and intertidal under-boulder communities is likely to result in a significant risk of hindering achievement of the conservation objectives of the MPA at any level of activity. This is because the impacts of abrasion/disturbance of the substrate on the surface of the seabed, penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion and physical change (to another seabed type) caused by this activity even at low levels are likely to present a significant risk of hindering achievement of the site's conservation objectives.

4.6 Summary of the effects of anchoring on circalittoral rocky reef

In this section, only moderate energy and low energy circalittoral rocky reef features will be assessed as high energy circalittoral rocky reef environments are generally considered too dynamic to allow anchoring (Griffiths et al., 2017). This is due to the risk of damage to vessels in the high wave energy environment against the rocky substrate.

These broadscale habitats contain a range of biotopes characterised by animal dominated communities including ascidians, bryozoans, *Sabellaria* reef and mussel beds, and is typically a mosaic of species. The impacts of pressures associated with anchoring on the biotopes “Circalittoral *Sabellaria* reef” and “Mussel beds on

circalittoral rock” found within this broadscale habitat have been assessed separately (**section 4.2**).

The resistance to sub-surface damage and the recovery rates of epifauna which characterise low energy and moderate energy circalittoral rocky reef habitats will be variable depending on species present, due to life history characteristics, larval longevity, dispersal potential, recruitment, and growth rates (Griffiths et al., 2017).

Some organisms found in these habitats may have strong regenerative abilities, such as certain species of sponges and anemones which can readily repair damage to the body (Griffiths et al., 2017). While the ability to resist damage and recover varies between species, sponges are known to be highly resilient to physical damage and have been shown to survive severe damage and regenerate to function fully (Wulff, 2006; Griffiths et al., 2017). Species of anemone can regenerate lost tentacles within days and internally brood young, which will settle close by when released (Griffiths et al., 2017). Other organisms rely on spawning events to recolonise so recovery will vary depending on maturity and recruitment rates. The longevity of species will also be critical to recovery rates, with short-lived fauna (for example, with lifespans of one to three years) potentially recovering from damage in six months to three years, whereas long-lived fauna (for example, with lifespans greater than 10 years) may take over eight years to recover from damage (Hiddink et al., 2019).

Anchoring activities can abrade the substrate of moderate energy circalittoral rocky reef, leading to the exposure, damage and removal of the attached and associated epifauna potentially leading to mortality. Pressures from anchoring activities may result in a change to seabed type, community abundance, biomass or diversity, as well as damage or loss of biotopes (Griffiths et al., 2017).

The constituent of biotopes comprising moderate energy circalittoral rocky reef are assessed by Tillin et al. (2010) as ranging from medium to high sensitivity to penetration and/or disturbance of the substrate below the surface of the seabed, which is a pressure considered applicable during the setting and locking of the anchor in the seabed (Tillin, Bolam and Hiddink, 2010; Griffiths et al., 2017).

Moderate energy circalittoral rock was assessed as ranging from “low” to “high” sensitivity to surface abrasion, while low energy circalittoral rock was assessed as having a medium sensitivity. Surface abrasion is a pressure considered applicable when the anchor chain (rode) moves across the substrata (Tillin, Bolam and Hiddink, 2010; Griffiths et al., 2017).

It should be noted that circalittoral rocky reef habitats are highly variable, therefore some species and biotopes within the broadscale habitat may be more sensitive than others. As such, individual site level assessments will be completed to determine site specific biotopes and their sensitivities.

Biotopes with characterising species with an epifaunal position, erect growth form and relatively soft, unprotected body, such as dahlia anemone (*Urticina felina*), cored chimney sponge (*Ciocalypa penicillus*) and sea chervil (*Alcyonium diaphanum*) are likely to be less resistant to these pressures than other more robust species within the broadscale habitat (Griffiths et al., 2017).

Species characterising more sediment scoured biotopes within the broadscale habitat are likely to withstand some levels of abrasion due to the scouring by mobile sands and gravel being an important structuring factor of the biotope (Griffiths et al., 2017; Connor et al., 2022). Under these conditions, rocky reef habitats have been shown to develop communities consisting of fast growing species (Griffiths et al., 2017). Disturbance of epifauna attached to mobile substrate (for example cobbles, boulders) rather than stable bedrock may cause surfaces to be displaced and turned over, preventing feeding and leading to smothering (Griffiths et al., 2017).

Anchoring has the potential to cause physical change (to another seabed type) to circalittoral rocky reef type through abrasion and penetration to the seabed, leading to the permanent loss of one seabed type and replacement with a different seabed type. A change in seabed type may lead to the loss of biotopes and characterising species within the broadscale habitat.

Key characterising species that require a stable, hard substrate for attachment and/or benefit from the shelter provided by the various crevices of a specific biotope (Connor et al., 2022) will be highly sensitive to a change in seabed type. A change to a more mobile gravel or sand substratum in an area of high-water flow as a result of abrasion and/or penetration would significantly alter the character of the biotope and have a negative impact on the species present, potentially increasing the species vulnerability to dislodgement, scour and smothering (Widdows et al., 2004). A significant change in the character of the biotope may lead to the development of a biological assemblage more suited to, and typical of, the changed conditions, and the loss of the previous biotope (Stamp et al., 2023). Resistance to this pressure is therefore assessed as “none”, and as the pressure is permanent, resilience is “very low”, so overall sensitivity to physical change (to another seabed type) is likely high (Tillin, Bolam and Hiddink, 2010). A change in substrate is more likely to occur in areas where there is a high intensity of anchoring, such as known anchorages.

The impact of pressures on low and moderate energy circalittoral rocky reef will depend on anchor type, size, weight and frequency of anchoring event. Impacts are also likely to be variable due to the wide variety of structures and communities present (Connor et al., 2022).

MMO concludes that anchoring on low energy and moderate energy circalittoral rock may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed,

penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion and physical change (to another seabed type) caused by this activity. A site level assessment will determine whether the activity is hindering the achievement of MPA conservation objectives.

4.7 Summary of the effects of anchoring on infralittoral rocky reef

In this section, only low energy and moderate energy infralittoral rocky reef features will be assessed as high energy infralittoral rocky reef environments are generally considered too dynamic to allow anchoring (Griffiths et al., 2017). This is due to the risk of damage to vessels in the high wave energy environment against the rocky substrate.

Low and moderate energy infralittoral rocky reef occurs in wave and tide sheltered conditions and comprises a range of kelp dominated biotopes (Griffiths et al., 2017; JNCC, 2026c). Low energy infralittoral rock seaweeds are typically silt-tolerant and include a high proportion of delicate filamentous types¹⁴. Pressures caused by anchoring activity by any vessels on low energy infralittoral rocky reefs and moderate energy infralittoral rocky reefs are listed in (**Annex 1**).

Studies have shown that biotopes within the low energy infralittoral rocky reef broadscale habitat, such as kelp habitats, are relatively resistant to direct disturbance and removal with recovery occurring within one to six years for *L. hyperborea* dominated habitats (Griffiths et al., 2017). However, recovery time was shown to be impacted by recurrent disturbance (Griffiths et al., 2017). Additional factors such as competition and grazing pressure may also limit recovery by impacting recruitment and reducing diversity and abundance of associated biotope community following disturbance (Stamp, 2015; Griffiths et al., 2017).

The life history of species will also determine recovery rates, with some kelp species (*Saccharina latissimi*) reaching maturity within 15 to 20 months and releasing vast numbers of zoospores over a large dispersal range between autumn and winter (Griffiths et al., 2017). Recruitment following disturbance is likely to be influenced by the proximity of mature kelp beds (producing viable zoospores) to the disturbed area, due to the exponential decrease in density and rate of successful fertilisation with increasing distance from the parental source (Fredriksen et al., 1995; Griffiths et al., 2017).

Abrasion from anchoring has the potential to damage benthic habitats and species. Disturbance to the substratum can cause damage by exposing, removing or damaging characterising flora such as algae and kelp. These impacts can result in a change to community abundance, biomass or diversity, and potentially damage to, or loss of biotopes (Griffiths et al., 2017).

The low energy infralittoral rock broadscale habitat was assessed by Tillin, Bolam and Hiddink (2010) as having medium sensitivity to penetration and/or disturbance of the substrate below the surface of the seabed, while moderate energy infralittoral

rock was assessed as having medium to high sensitivity to penetration and/or disturbance of the substrate below the surface of the seabed. Penetration and/or disturbance of the substrate below the seabed is a pressure considered applicable during the setting and locking of the anchor in the seabed (Tillin, Bolam and Hiddink, 2010; Griffiths et al., 2017). Low energy infralittoral rock and moderate energy infralittoral rock were assessed as medium sensitivity to surface abrasion, which is a pressure considered applicable when the anchor chain (rope) moves across the substrata (Tillin, Bolam and Hiddink, 2010; Griffiths et al., 2017).

Stamp (2015) assessed the sensitivity of one of the representative biotopes of the broadscale habitat (mixed kelp with foliose red seaweeds, sponges and ascidians on sheltered tide swept infralittoral rock, considered more likely to be used for safe anchorages) to penetration and disturbance. Resistance was assessed as “none”, resilience as “high” and overall sensitivity as medium, in agreement with the assessment by (Tillin, Bolam and Hiddink, 2010).

Anchoring has the potential to cause physical change (to another seabed) of low energy infralittoral rocky reef and moderate energy infralittoral rock through abrasion and penetration, resulting in the permanent loss of one seabed habitat type with the replacement of a different seabed type (Griffiths et al., 2017). A change in seabed type is likely only to occur in an anchorage area with a high intensity of anchoring events. A change in seabed type from rock substrata to sedimentary substrata would render the habitat unsuitable because kelp species require a stable substratum on which to settle (Birkett, Maggs and Dring, 1998; Stamp et al., 2025). If pressures from anchoring activity resulted in a fundamental change in habitat type, changing the character of the biotope, kelp species would be unable to tolerate the unsuitable conditions and the biotope would be lost. For this reason, resistance to the pressure “physical change (to another seabed type)” has been assessed as “none”, and as the pressure is permanent, resilience is “very low” so overall sensitivity to physical change (to another seabed type) is likely high (Tillin, Bolam and Hiddink, 2010). The impact of pressures on infralittoral rocky reef will depend on anchor type, size, weight and frequency of anchoring event.

MMO concludes that anchoring on low energy infralittoral rock and moderate energy infralittoral rock may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed, penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion and physical change (to another seabed type) caused by this activity. A site level assessment will determine whether the activity is hindering the achievement of MPA conservation objectives.

5 Diving and snorkelling

This section brings together and analyses the available evidence on the impacts of diving and snorkelling on reef features.

Natural England's AoO was used to identify potential pressures from diving and snorkelling and to inform understanding of feature sensitivity to those pressures. Where a sensitivity assessment has not been undertaken or the evidence base is insufficient to assess sensitivity, the activity-pressure-feature combination has been included to capture all possible evidence that may impact the features. Marine Non-Licensable Activity Impacts Evidence: Methodology¹ details the process of how MMO judgement refined pressures for assessment.

High risk pressures associated with this activity with the potential to impact reef features are:

- abrasion/disturbance of the substrate on the surface of the seabed; and
- penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion (only applicable to subtidal habitats and species when divers are removing litter).

These high risk pressures have been included in this review as they have been determined to be pressures commonly induced by diving and snorkelling at a level that has the potential to cause significant impacts on reef features. This is because a single diving or snorkelling event is likely to result in these pressures at a damaging level, regardless of any site specific factors.

High risk pressures associated with this activity have been identified using Natural England's CAP (**Annex 1**) and MMO judgement. The following pressures were identified as low risk and are therefore not included in this document:

- introduction of light; and
- introduction or spread of INIS.

Low risk pressures associated with this activity have been identified using Natural England's CAP (**Annex 1**) and MMO judgement. These low risk pressures have not been included in this review as these pressures generally do not occur at a level of concern, as a result of diving and snorkelling activity. Should site specific factors increase the risk of these pressures, these would be considered in an individual site level assessment. Pressures associated with participation of vessels will be considered in the relevant activity sections.

5.1 Reef features scoped out of the diving and snorkelling assessment

Diving and snorkelling can result in accidental reef damage in the subtidal areas, particularly to fragile epifauna such as pink sea-fan. This is beyond the scope of the

mNLA literature review as impacts of the mNLA activity are being assessed when the activity is carried out correctly and responsibly.

MMO acknowledges that divers may remove reef material by hand (typically epifaunal reef species), this activity is exempt from requiring a marine licence, therefore it is a potential mNLA. Following a review, MMO considers that removal of peacock's tail seaweed (the only subtidal epifauna feature in scope) by hand is unlikely and therefore this has been scoped out of this literature review. If evidence of removal of peacock's tail seaweed is found at a site level this will be assessed during the site level assessment. The removal of pink sea-fan and the associated sea fan anemone by hand (including when its attached to marine litter) has been scoped out from this literature review as removal of these species by hand is an offence and requires a marine wildlife licence (MMO, 2021).

5.2 Summary of the effects of litter removal by diving and snorkelling on subtidal rocky reefs

There is no pathway to impact to subtidal habitats during normal diving and snorkelling operations, as recreational users will not contact the subtidal benthic habitats. The subtidal rocky reefs in scope are: circalittoral rock (high energy, moderate energy and low energy), infralittoral rock (high energy, moderate energy and low energy), subtidal stony reef and subtidal chalk.

However, some divers and snorkellers may, in the course of a dive, remove litter by hand from the seabed, therefore in these instances there is a pathway to impact as a result of abrasion or disturbance of the seabed or removal of attached subtidal epifauna. The impacts of diving and snorkelling on chalk in the subtidal zone have been assessed in **section 5.6**.

Studies on the use of marine litter for ecological enhancement has shown that most species that colonise marine litter are sessile and habitat forming (Danovaro et al., 2026). Marine litter can remain on the seafloor for many years and provide a habitat for these benthic communities by providing a substrate to settle (Danovaro et al., 2026). The removal of this litter will result in the disturbance, abrasion, penetration these reef communities. The impact of abrasion, penetration and disturbance on the subtidal benthic habitats will depend on the scale of the object and the degree to which it has been colonised.

MMO concludes that the removal of litter during diving or snorkelling on subtidal rocky reefs (circalittoral rock (high energy, moderate energy and low energy), Infralittoral rock (high energy, moderate energy and low energy), subtidal stony reef and subtidal chalk)) may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed and penetration and/or disturbance of the substratum

below the surface of the seabed (including abrasion) caused by this activity. A site level assessment will determine whether the activity is hindering the achievement of MPA conservation objectives.

5.3 Summary of the effects of diving and snorkelling on intertidal rocky reefs and stony reef

Divers and snorkelers will not impact intertidal rocky reef and stony reef when submerged in the water. However, divers and snorkelers can trample intertidal rocky reefs and intertidal stony reefs when accessing the marine environment.

Intertidal rocky reefs in this section cover four features: high energy intertidal rock, moderate energy intertidal rock, low energy intertidal rock and intertidal under-boulder communities. Divers and snorkelers may trample intertidal rocky reef and intertidal stony reef as they enter the marine environment. Trampling can result in abrasion to the intertidal rocky reef and intertidal stony reef. It is acknowledged that divers/snorkelers will aim to enter the water course at existing access points such as slipways, or from a vessel, but there is potential for reef features to be subjected to abrasion caused by trampling, depending on the access location.

Rocky reefs and stony reefs are characterised by being formed from rock attributes and are therefore less vulnerable to damage than biogenic reefs, which can have a more fragile structure (for example, *S. spinulosa*) (Griffiths et al., 2017). However, the species that the rocky reef support (the epifauna and epiflora) can be susceptible to damage from trampling and this can result in a shift in community composition (Brosnan and Crumrine, 1994). A study by Brosnan and Crumrine (1994) found that the rocky shore became more dominated by low profile algae and fewer mussels when trampled. However, it has been suggested that a small period of trampling²⁶ can be similar to the effects of natural disturbance (Griffiths et al., 2017). Therefore, MMO considers only high intensities of trampling from divers or snorkelers will have a significant effect on intertidal rocky reefs and intertidal stony reef.

MMO conclude that diving and snorkelling on intertidal rocky reefs and stony reefs may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed caused by trampling during this activity. However, as trampling is not within MMO remit, these impacts will not be assessed or managed by MMO.

5.4 Summary of the effects of diving and snorkelling on intertidal epifauna

The only protected epifaunal reef species occurring in the intertidal area is the Peacock's tail seaweed. Divers and snorkelers may impact this seaweed through trampling, which results in abrasion and disturbance. Peacock's tail seaweed is not

sheltered from abrasion due to its occurrence on the surface of rocky habitats. No direct evidence was found to assess abrasion impacts on this species so evidence pertaining to similar species (brown algae) is used to infer potential impacts of abrasion.

Abrasion from trampling can remove the frond of brown algae and reduce the canopy cover (Schiel and Taylor, 1999). Experimental results and observations of trampled vs non trampled areas have shown that turf forming algal species are relatively resistant to this pressure and may increase in abundance where foliose and canopy forming species are removed (Brosnan and Crumrine, 1994). Brosnan and Crumrine (1994), for example, found that in experimentally trampled plots the cover of foliose and canopy forming species declined while turf forming algae were relatively resistant. Brosnan (1993) noted that algal turf species (*Endocladia muricata* and *Gelidium spp.*) increased by 38% in trampled plots as foliose algae declined, and algal turf dominated trampled areas. Exclusion of visitors, and hence reduced trampling, reduced relative algal turf abundance by 31%, while foliose algae increased in abundance. As it is a foliose seaweed, Peacock's tail seaweed is vulnerable to abrasion and disturbance and may decline following trampling events. This evidence suggests management measures such as exclusion zones may help increase foliose species, such as Peacock's tail seaweed.

MMO conclude that diving and snorkelling on Peacock's tail seaweed may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed caused by trampling during this activity. However, as trampling is not within MMO remit, these impacts will not be assessed or managed by MMO.

5.5 Summary of the effects of diving and snorkelling; including litter removal on biogenic reefs

The primary cause of abrasion and disturbance from divers and snorkelers is trampling on intertidal biogenic habitats. There is no pathway to impact to subtidal biogenic reefs during the normal diving and snorkelling operations, as recreational users will not contact the subtidal benthic habitats. However, some divers and snorkellers may in the course of a dive remove litter by hand from the seabed, therefore in these instances there is a pathway to impact as a result of abrasion or disturbance of the seabed, in addition this can result in penetration and/or disturbance of the substratum below the surface of the seabed.

There is limited evidence on the impact of removing litter from the seabed and its impact on the habitat, however Natural England and JNCC have raised concerns that the removal of marine litter from designated features may have unintended impacts to Annex I rocky reef, such as damaging rocky reef communities and epifauna (Natural England et al., 2023).

Studies on the use of marine litter for ecological enhancement has shown that most species that colonise marine litter are sessile and habitat forming (Danovaro et al., 2026). Marine litter can remain on the seafloor for many years and provide a habitat for these benthic communities by providing a substrate to settle (Danovaro et al., 2026). The removal of this litter will result in the disturbance and removal of these reef communities. The impact of abrasion on the subtidal benthic habitats will depend on the scale of the object and the degree to which it has been colonised.

Sabellaria reef can form on marine litter (Danovaro et al., 2026) and therefore the removal of this encrusted litter by divers can damage and destroy these fragile reef structures.

There are two species of *Sabellaria* in England which can form reef, *S. alveolata* and *S. spinulosa*. *S. alveolata* is typically found on the lower intertidal, whereas *S. spinulosa* is more commonly found in the subtidal zone. *S. alveolata* is therefore more likely to be trampled due to its location on the foreshore.

Single, and low intensity trampling events can reduce the percentage cover of *S. alveolata* reefs (Plicanti et al., 2016). Studies have shown that *S. alveolata* reefs are able to recover after disturbance (Cunningham et al., 1984; Plicanti et al., 2016). Cunningham et al. (1984) reported that minor damage (small cracks) were fully recovered in 23 days following the effect of trampling on intertidal *S. alveolata*. However, severe damage for example (cracks between tubes and removal of sections) only showed partial recovery after 23 days (Cunningham et al., 1984).

There is limited evidence on the impact of trampling on *S. spinulosa*, which is probably due to it being more commonly found in the subtidal area. Therefore *S. alveolata* is being used as a proxy for impacts to *S. spinulosa*.

Oyster beds and mussel beds can form on marine litter (Danovaro et al., 2026) and therefore the removal of this encrusted litter by divers can damage these reef structures.

There is limited literature on the impact of abrasion on oyster beds from diving and snorkelling. Olympia oysters (*O. lurida*) have been used as a proxy as it is within the same genus and has similar life history traits (for example, both species spawn, have a larval stage and settles on hard substrate (Seale, 2009)). A study focusing on Olympia oysters noted that oyster beds subject to higher levels of human activity experienced more rapid breakdown, however the study combined impacts from all recreational activities (Goodwin, 2023). MarLIN considers that oyster beds are highly sensitive to abrasion and have low resistance and resilience to the pressure (Marine Biological Association, 2026b).

For the purpose of this review mussel beds are considered a proxy for oyster beds, as both have hard shells and are gregarious. However it is noted that oysters do not use byssal threads to permanently attach to the substratum and instead use a process of cementation (MacDonald, Freer and Cusack, 2010).

The ability of a mussel bed to recover from disturbance is dependent on the scale of the initial disturbance, the season of disturbance, height of the mussel bed, angle of substratum, age of mussel bed and intensity of larval settlement (Seed and Suchanek, 1992). This is also considered applicable to oyster beds.

Trampling can result in mussel bed percentage cover decreasing (Mainwaring, Tillin and Tyler-Walters, 2014; Mendez, Livore and Bigatti, 2019). Smith and Murray (2005) observed that percentage cover loss was not due to the immediate effects of trampling on *Mytilus californianus* mussel beds but occurred after the trampling event, suggesting that trampling weakened byssal threads and made them more susceptible to wave disturbance (Denny, 1987; Smith and Murray, 2005). It has been observed that recruitment to the mussel bed (*M. californianus*) can cease while the area is subject to trampling and can take years to recover (Brosnan and Crumrine, 1994). This may be due to byssal thread attachment and shell strength increasing with mussel size, making them more resistant to trampling (Veiga et al., 2023). Veiga et al. (2023) studied *Mytilus galloprovincialis* mussel beds and identified that smaller mussels were more vulnerable to trampling effects.

Native mussels are considered to be able to recover quicker than other mussel species. This is due to their ability to colonise gaps in the mussel bed more successfully than other species such as *M. californianus* (Seed and Suchanek, 1992). Mendez, Livore and Bigatti (2019) studied the impact of varying intensity of trampling on scorched mussel beds (*Brachidontes* spp.) subject to varying degrees of wave action. Mussels at wave exposed sites were more resistant to the effects of trampling than mussels at more protected sites, with an overall smaller loss in percentage cover. This is thought to be due to the strength of the byssal threads (Mendez, Livore and Bigatti, 2019).

MMO concludes that the removal of litter during diving and snorkelling on biogenic reef may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed and penetration and/or disturbance of the substratum below the surface of the seabed (including abrasion) caused by this activity. A site level assessment will determine whether the activity is hindering the achievement of MPA conservation objectives.

MMO conclude that diving and snorkelling on biogenic reef may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed caused by trampling during this activity. However, as trampling is not within MMO remit, these impacts will not be assessed or managed by MMO.

5.6 Summary of the effects of diving and snorkelling on chalk communities

There is no pathway to impact to subtidal chalk during the normal diving and snorkelling operations, as recreational users will not contact the seabed. However, some divers and snorkellers may, in the course of a dive, remove litter by hand from the seabed, therefore in these instances there is a pathway to impact as a result of abrasion or disturbance of the seabed.

There is limited evidence on the impact of removing litter from the seabed on subtidal chalk. The impact of the abrasion, penetration or disturbance as a result of the removal of litter will vary depending on the scale of the object removed. However, as chalk is an irreplaceable habitat any abrasion, penetration or disturbance resulting in a loss of the chalk substrate will have a significant impact on the feature (Tillin et al., 2022).

Littoral chalk communities will be subject to abrasion and disturbance from divers or snorkelers trampling to access the sea, however impacts are not expected when diving and snorkelling is undertaken. Any abrasion and disturbance resulting in a loss of the chalk substrate will have a significant effect as chalk habitat is irreplaceable.

MMO concludes that the removal of litter during diving and snorkelling on subtidal chalk may result in a significant risk of hindering achievement of the conservation objectives of the MPA at any level of activity. This is because the impacts of abrasion/disturbance of the substrate on the surface of the seabed and penetration and/or disturbance of the substratum below the surface of the seabed (including abrasion) caused by this activity. A site level assessment will determine whether the activity is hindering the achievement of MPA conservation objectives.

MMO conclude that diving and snorkelling on subtidal chalk and littoral chalk communities may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed caused by trampling during this activity. However, as trampling is not within MMO remit, these impacts will not be assessed or managed by MMO.

6 Motorised personal watercraft and motorised watercraft

This section brings together and analyses the available evidence on the impacts of MPW and motorised watercraft activity on reef features.

Natural England's AoO was used to identify potential pressures from MPW and motorised watercraft and to inform the understanding of feature sensitivity to the pressure. Where a sensitivity assessment has not been undertaken or the evidence base is insufficient to assess sensitivity, the activity-pressure-feature combination has been included to capture all possible evidence that may impact the features. Marine Non-Licensable Activity Impacts Evidence: Methodology¹ details the process of how MMO judgement refined pressures for assessment.

High risk pressures associated with this activity with the potential to impact reef features are:

- abrasion/disturbance of the substrate on the surface of the seabed; and
- penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion.

These high risk pressures have been included in this review as they have been determined to be pressures commonly induced by motorised watercraft or MPW at a level that has the potential to cause significant impacts on reef features. This is because a single motorised watercraft or MPW is likely to result in these pressures at a damaging level, regardless of any site specific factors.

High risk pressures associated with this activity have been identified using Natural England's CAP (**Annex 1**) and MMO judgement. The following pressures were identified as low risk and are therefore not included in this document:

- hydrocarbon and PAH contamination;
- introduction of light;
- introduction or spread of INIS;
- synthetic compound contamination; and
- transition elements and organo-metal contamination.

Low risk pressures associated with this activity have been identified using Natural England CAP (**Annex 1**) and MMO judgement. These low risk pressures have not been included in this review as these pressures generally do not occur at a level of concern, as a result of motorised watercraft or MPW. Should site specific factors increase the risk of these pressures, these would be considered in an individual site level assessment.

6.1 Reef features scoped out of the motorised personal watercraft and motorised watercraft assessment.

Subtidal rocky reef features have been scoped out of this assessment as there is no pathway to impact during normal vessel operations as the motorised watercraft and

MPW will not contact the benthic habitat. Therefore, the following features have been scoped out: circalittoral rock (high energy, moderate energy and low energy), infralittoral rock (high energy, moderate energy and low energy), subtidal stony reef and subtidal chalk.

As participants will be positioned above the water, interaction between motorised watercraft/MPW and subtidal epifaunal reef species and subtidal biogenic habitats will be limited. Therefore, subtidal epifaunal species (pink sea-fan and sea fan anemone) and subtidal biogenic habitats have been scoped out of this assessment as there is no pathway to impact during normal motorised watercraft or MPW operations.

The exception is hydroflying, which can involve participants using high pressure water jets on their feet which push a water stream underwater. However, it is unlikely participants will be operating over a reef due to the health and safety risks. Therefore, this has also been scoped out.

6.2 Summary of the effects of motorised personal watercraft and motorised watercraft on intertidal rocky reef

Motorised watercraft and MPW can impact intertidal rocky reefs through abrasion, disturbance and penetration. These pressures are a result of, trampling, dragging of equipment or craft, propellor wash, vessel wake or water jets. For the purpose of this section intertidal rocky reef includes: high energy intertidal rock, moderate energy intertidal rock, low energy intertidal rock, littoral chalk communities, intertidal under-boulder communities and intertidal stony reef.

Propellor wash from motorised watercraft can result in abrasion and disturbance on rocky reef. The intensity of the impact will depend on the size, speed and direction of the propeller. Generally, a horizontally angled propeller will have a smaller effect on bottom sediments, due to energy dissipating. MPW can result in similar abrasion and disturbance impacts from the water jets (Saunders et al., 2000).

There is limited evidence on the impact of propellor wash, vessel wake and water jets on intertidal rocky reefs. Studies available are focused on soft sediments. Bilkovic et al. (2017) reviewed the impact of boat wake on shoreline erosion. They noted that in many cases the cumulative impact of boat wakes is less than waves. While wake energy is often less than wave energy, the height of boat wakes can substantially exceed the wave height. While waves are a source of low to moderate wave energy, large boat wakes are high energy events which can result in shoreline erosion (Bilkovic et al., 2017).

The impact of the boat wake on the reef habitat will depend on the biological communities and physical characteristics of the habitat (**section 2**). Littoral chalk communities will be susceptible to even occasional boat wakes as any erosion of the substrate is irreplaceable (Tillin et al., 2022). The cobble/boulder composition of reef is less susceptible to subsurface damage (Griffiths et al., 2017). However, water jets

and propeller wash has the potential to displace the cobbles and boulders, resulting in increased disturbance in the area (Natural England, 2017b).

Impacts of boat wakes on intertidal rocky reef (high, medium and low energy), intertidal under-boulder communities and stony reef will depend upon the frequency of activity in the area and the size of the vessel.

In addition, the launching of watercraft can result in abrasion, disturbance or penetration of the reef features. In general, most launching of watercraft will be from established slipways and areas of rocky reef are likely to be actively avoided as these can be sharp and cause damage to the watercraft. However, there will be some locations within MPAs where watercraft are more likely to be launched over rocky reef. For example, stony reef compromised of small cobbles may be selected over rockier shores and the launching of watercraft can displace the cobbles and boulders resulting in increased disturbance (Natural England, 2017b).

There is limited literature on the impact of launching motorised watercraft from the shore on intertidal rocky reef. It is considered that impacts of trampling intertidal rocky reef will be similar to the impacts of trampling covered in the diving and snorkelling assessment above (**section 5.3**). The use of vehicles and trailers will have a greater impact due to their size and weight. However it is unlikely that equipment (including trailers) will be dragged over, or participants will trample over, intertidal rocky reef, due to the damage this may cause to the person or equipment.

The impact of launching watercraft on the reef habitat will also depend on the biological communities and physical characteristics of the habitat (**section 2**). Littoral chalk communities will be susceptible to even single events as any erosion of the substrate is irreplaceable (Tillin et al., 2022). Stony reef is also one of the reef features more susceptible to impacts, as there is the potential for the habitat type to change if abrasion, penetration and/or disturbance results in epifaunal species being removed, so that the habitat no longer qualifies as stony reef. However, the sensitivity of the stony reef to pressures associated with launching MPW and motorised watercraft will depend upon the epifauna colonising the reef and their specific species characteristics. Epifauna can be directly damaged by the launching of watercraft. Epifaunal species include, but are not limited to seaweeds, sponges, corals (such as pink sea-fan), barnacles, sea anemones and mussels. The ability of different epifauna species to resist pressures associated with launching of watercraft, and to recover following disturbance, is dependent upon species-specific characteristics. For example, sponges and sea anemones will be more susceptible to damage than hard shelled species such as barnacles and mussels (Griffiths et al., 2017). Therefore, launching of watercraft have the potential to change species composition and, consequently, the structure of stony reefs.

MMO conclude that the launching and recovery of motorised watercraft and MPW on littoral chalk may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific

sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed, and penetration and/or disturbance of the substratum below the surface of the seabed (including abrasion) caused by trampling, launching and recovery during this activity. However, as trampling, launching and recovery is not within MMO remit, these impacts will not be assessed or managed by MMO.

MMO concludes that operating motorised watercraft and MPW over all intertidal rocky reef features may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed and penetration and/or disturbance of the substratum below the surface of the seabed (including abrasion), caused by this activity. A site level assessment will determine whether the activity is hindering the achievement of MPA conservation objectives.

6.3 Summary of the effects of motorised personal watercraft and motorised watercraft on intertidal biogenic reef

As participants will be positioned above the water, interaction between MPW and motorised watercraft and reef features will be limited. However, features may be subjected to abrasion, penetration and disturbance if the vessel is launched from the shore, through trampling or dragging of equipment (including trailers) or craft over the intertidal area, or as a result of propellor wash, water jets and vessel wakes.

There is limited literature on the impact of trampling and launching watercraft on intertidal biogenic reef. It is considered that trampling impacts are similar to the impacts of trampling covered in the diving and snorkelling assessment above (**section 5.5**). The use of vehicles and trailers will have a greater impact due to their size and weight, however it is unlikely that equipment (including trailers) will be dragged over, or participants will trample over, biogenic reef, in particular mussel and oyster beds, due to the damage this may cause to the person or equipment.

Propellor wash can result in abrasion and disturbance on biogenic reef. The intensity of the impact will depend on the size, speed and direction of the propeller. Generally, a horizontally angled propeller will have a smaller effect on bottom sediments, due to energy dissipating. MPW can result in similar abrasion and disturbance impacts from the water jets (Saunders et al., 2000).

There is limited evidence on the impact of propellor wash, vessel wake and jet thrusts on intertidal biogenic reefs. Studies available are focused on soft sediments. Bilkovic et al. (2017) reviewed the impact of boat wake on shoreline erosion. They noted that in many cases the cumulative impact of boat wakes is less than waves. While wake energy is often less than wave energy, the height of boat wakes can substantially exceed the wave height. While waves are a source of low to moderate

wave energy, large boat wakes are high energy events which can result in shoreline erosion (Bilkovic et al., 2017).

The impact of the boat wake, propellor wash and water jets on the reef habitat will depend on the biological communities and physical characteristics of the habitat (**section 2**). *Sabellaria* reef which is composed of delicate fragile tubes are more likely to be damaged than oyster beds and mussel beds which are made of hard shelled species (Griffiths et al., 2017). *Sabellaria* reefs subject to wave action can break up, or the wave action can mobilise soft sediments resulting in abrasion and mortality (Wilson, 1929). Similar impacts may be from boat wakes, propellor wash and waters jets but this will depend upon the frequency of activity in the area and the size of the vessel.

MMO concludes that operating motorised watercraft and MPW over intertidal biogenic reef is likely to result in a significant risk of hindering achievement of the conservation objectives of the MPA at any level of activity. This is because the impacts of abrasion/disturbance of the substrate on the surface of the seabed and penetration and/or disturbance of the substratum below the surface of the seabed (including abrasion), caused by this activity, even at low levels, are likely to present a significant risk of hindering achievement of the site's conservation objectives.

MMO conclude that the launching and recovery of motorised watercraft and MPW on intertidal biogenic reef may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed, and penetration and/or disturbance of the substratum below the surface of the seabed (including abrasion) caused by trampling, launching and recovery during this activity. However, as trampling, launching and recovery is not within MMO remit, these impacts will not be assessed or managed by MMO.

6.4 Summary of the effects of motorised personal watercraft and motorised watercraft on epifaunal reef species

As participants will be positioned above the water, interaction between motorised watercraft and MPW with epifaunal reef species will be limited. However, features may be subjected to abrasion, disturbance or penetration if the vessel is launched from the shore, through trampling or dragging of equipment (including trailers) or craft over the intertidal area, or as a result of propellor wash, water jets and vessel wakes. The only protected epifaunal reef species occurring in the intertidal area is the Peacock's tail seaweed which is present on rocky reef.

There is limited literature on the impact of launching motorised watercraft from the shore on Peacock's tail seaweed. It is considered that impacts of trampling on

Peacock's tail seaweed will be similar to the impacts of trampling covered in the diving and snorkelling assessment (**section 5.4**). The use of vehicles and trailers will have a greater impact due to their size and weight, however it is unlikely that equipment (including trailers) will be dragged over, or participants will trample over, Peacock's tail seaweed which colonises rocky reef, due to the damage this may cause to the person or equipment.

Propellor wash can also result in abrasion and disturbance to Peacock's tail seaweed. The intensity of the impact will depend on the size, speed and direction of the propeller. Generally, a horizontally angled propeller will have a smaller effect on bottom sediments, due to energy dissipating. MPW can result in similar impacts from the water jets (Saunders et al., 2000).

There is limited evidence on the impact of propellor wash, vessel wake and jet thrusts on Peacock's tail seaweed. Studies available are focused on soft sediments. Bilkovic et al. (2017) reviewed the impact of boat wake on shoreline erosion. They noted that in many cases the cumulative impact of boat wakes is less than waves. While wake energy is often less than wave energy, the height of boat wakes can substantially exceed the wave height. While waves are a source of low to moderate wave energy, large boat wakes are high energy events which can result in shoreline erosion (Bilkovic et al., 2017).

Impacts of boat wakes, propellor wash and water jets will also depend upon the frequency of activity in the area and the size of the vessel. Peacock's tail seaweed are known to lose fronds during storm events (Herbert et al., 2016), therefore short term increases in wave action and height can damage the seaweed. However, Peacock's tail seaweed is assessed as having a high resistance and high resilience to changes in wave exposure¹⁹. Therefore, it is not expected that vessel wakes, propellor wash and water jets will have a significant impact on the seaweed.

MMO concludes that operating motorised watercraft and MPW over epifaunal reef species may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed and penetration and/or disturbance of the substratum below the surface of the seabed (including abrasion), caused by this activity. A site level assessment will determine whether the activity is hindering the achievement of MPA conservation objectives.

MMO conclude that the launching and recovery of motorised watercraft and MPW on epifaunal reef species may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed, and penetration and/or disturbance of the substratum below the

surface of the seabed (including abrasion) caused by trampling, launching and recovery during this activity. However, as trampling, launching and recovery is not within MMO remit, these impacts will not be assessed or managed by MMO.

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7 Non-motorised watercraft

This section brings together and analyses the available evidence on the impacts of non-motorised watercraft activity on reef features.

Natural England's AoO was used to identify potential pressures from non-motorised watercraft and to inform the understanding of feature sensitivity to the pressure. Where a sensitivity assessment has not been undertaken or the evidence base is insufficient to assess sensitivity, the activity-pressure-feature combination has been included to capture all possible evidence that may impact the features. Marine Non-Licensable Activity Impacts Evidence: Methodology¹ details the process of how MMO judgement refined pressures for assessment.

High risk pressures associated with this activity with the potential to impact reef features are:

- abrasion/disturbance of the substrate on the surface of the seabed; and
- penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion (only for littoral chalk communities).

These high risk pressures have been included in this review as they have been determined to be pressures commonly induced by non-motorised watercraft at a level that has the potential to cause significant impacts on reef features. This is because a single non-motorised watercraft is likely to result in these pressures at a damaging level, regardless of any site specific factors.

High risk pressures associated with this activity have been identified using Natural England's CAP (**Annex 1**) and MMO judgement.

The following pressures were identified as low risk and are therefore not included in this document:

- introduction or spread of INIS.

Low risk pressures associated with this activity have been identified using Natural England's CAP (**Annex 1**) and MMO judgement. These low risk pressures have not been included in this review as these pressures generally do not occur at a level of concern, as a result of non-motorised watercraft. Should site specific factors increase the risk of these pressures, these would be considered in an individual site level assessment.

7.1 Reef features scoped out of the non-motorised watercraft assessment.

Subtidal reef features have been scoped out of this assessment as there is no pathway to impact during normal vessel operations as the non-motorised watercraft will not contact the benthic habitat. Therefore, the following features have been scoped out: circalittoral rock (high energy, moderate energy and low energy),

infralittoral rock (high energy, moderate energy and low energy), subtidal stony reef and subtidal chalk.

As participants will be positioned above the water, interaction between non-motorised watercraft and subtidal epifaunal reef species and subtidal biogenic habitats (mussels beds, native oyster and *Sabellaria* reef) will be limited. Therefore, subtidal epifaunal species (pink sea-fan and sea fan anemone) and biogenic habitats in the subtidal have been scoped out of this assessment as there is no pathway to impact during normal non-motorised watercraft operations.

7.2 Summary of the effects of non-motorised watercraft on intertidal rocky reef, intertidal biogenic reef and intertidal epifaunal features.

During the operation of non-motorised watercraft the interaction with reef features will be limited as the participants are positioned above the water and non-motorised watercraft create very small wakes. There is no evidence of the impact of non-motorised watercraft wakes on reef. The MMO considers impacts will be similar to motorised watercraft wakes, but on a much smaller scale. Therefore impacts from non-motorised watercraft wakes on reef features will not be significant. However, reef features may be subjected to abrasion if the vessel is launched from the shore, through dragging of equipment or craft over the intertidal area.

Littoral rocky reef impacts from the launching of non-motorised watercraft (including associated trampling) will be the same as those covered under the motorised watercraft section above, therefore no further assessment is required.

Impacts of trampling while participants are carrying equipment to the water line over the reef are considered in the diving and snorkelling (**section 5.2**) it is noted that these watercrafts are lighter and therefore these impacts will be less damaging compared to motorised watercraft, as the non-motorised watercraft can be carried across the shore.

Single launch events on rocky reef are not expected to have a significant impact, with the exception of littoral chalk communities which are the most vulnerable as it is an irreplaceable habitat which cannot recover. Therefore, only if repeated launches within the same area are occurring is a significant effect on the other intertidal rocky reef biotopes expected to occur.

It is considered that a high intensity of launching is required to have a significant effect on the following features: intertidal rock (high, moderate and low energy), intertidal stony reef, intertidal under-boulder communities, intertidal biogenic reefs (blue mussels, native oyster and *Sabellaria spp.*) and peacock's tail.

MMO conclude that the launching and recovery of non-motorised watercraft on littoral chalk may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities

and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed, and penetration and/or disturbance of the substratum below the surface of the seabed (including abrasion) caused by trampling, launching and recovery during this activity. However, as trampling, launching and recovery is not within MMO remit, these impacts will not be assessed or managed by MMO.

MMO conclude that the launching and recovery of non-motorised watercraft on intertidal rocky reef, intertidal biogenic reef and intertidal epifauna may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed, and penetration and/or disturbance of the substratum below the surface of the seabed (including abrasion) caused by trampling, launching and recovery during this activity. However, as trampling, launching and recovery is not within MMO remit, these impacts will not be assessed or managed by MMO.

8 Sailing

This section brings together and analyses the available evidence on the impacts of sailing activity on reef features.

Natural England's AoO was used to identify potential pressures from sailing and to inform the understanding of feature sensitivity to the pressure. Where a sensitivity assessment has not been undertaken or the evidence base is insufficient to assess sensitivity, the activity-pressure-feature combination has been included to capture all possible evidence that may impact the features. Marine Non-Licensable Activity Impacts Evidence: Methodology¹ details the process of how MMO judgement refined pressures for assessment.

High risk pressures associated with this activity with the potential to impact reef features are:

- abrasion/disturbance of the substrate on the surface of the seabed; and
- penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion.

These high risk pressures have been included in this review as they have been determined to be pressures commonly induced by sailing at a level that has the potential to cause significant impacts on reef features. This is because a single sailing event is likely to result in these pressures at a damaging level, regardless of any site specific factors.

High risk pressures associated with this activity have been identified using Natural England's CAP (**Annex 1**) and MMO judgement.

The following pressures were identified as low risk and are therefore not included in this document:

- introduction of light;
- introduction or spread of INIS;
- synthetic compound contamination; and
- transition elements and organo-metal contamination.

Low risk pressures associated with this activity have been identified using Natural England's CAP (**Annex 1**) and MMO judgement. These low risk pressures have not been included in this review as these pressures generally do not occur at a level of concern, as a result of sailing. Should site specific factors increase the risk of these pressures, these would be considered in an individual site level assessment.

8.1 Reef features scoped out of the sailing assessment.

Interaction between sailing activity and reef features will be limited as participants will be positioned at the surface of the water. During vessel operation the only pathways to impact will be from vessel wash, trampling and vessel launching.

Therefore, rocky reef, biogenic reef and epifaunal reef species in the subtidal (infralittoral and circalittoral) zone has been screened out for further assessment. This includes circalittoral rock (high energy, moderate energy and low energy), infralittoral rock (high energy, moderate energy and low energy), subtidal chalk, subtidal stony reef, subtidal biogenic reef (blue mussels, native oyster and *Sabellaria*), pink sea-fan and sea fan anemone.

8.2 Summary of effects of sailing on intertidal rocky reef, intertidal biogenic reef and intertidal epifauna

Sailing can impact intertidal reefs through abrasion, disturbance and penetration. These pressures are a result of the vessel wake. For the purpose of this section, intertidal reef includes: high energy intertidal rock, moderate energy intertidal rock, low energy intertidal rock, littoral chalk communities, intertidal under-boulder communities, intertidal stony reef and intertidal biogenic reef (*Sabellaria* reef, oyster beds and mussel beds).

Intertidal reefs subject to water emersion as a result of vessel wash can be susceptible to damage from abrasion/disturbance as a result of the wake energy eroding the rock substrate or damaging the epifauna. There is limited literature on the impacts of boat wakes on reef features as studies have been focused on sediment features.

Bilkovic et al. (2017) reviewed the impact of boat wake on shoreline erosion. They noted that in many cases the cumulative impact of boat wakes is less than waves. While wake energy is often less than waves, the height of boat wakes can substantially exceed waves. While waves are a source of low to moderate wave energy, large boat wakes are high energy events which can result in shoreline erosion (Bilkovic et al., 2017).

The impact of the boat wake on the intertidal reef habitat will depend on the biological communities and physical characteristics of the habitat (**section 2**). Littoral chalk communities will be susceptible to even occasional boat wakes as any erosion of the substrate is irreplaceable (Tillin et al., 2022). *Sabellaria* reef which is composed of delicate fragile tubes are more likely to be damaged than oyster beds and mussel beds which are made of hard shelled species (Griffiths et al., 2017). *Sabellaria* reefs subject to wave action can break up, or the wave action can mobilise soft sediments resulting in abrasion and mortality (Wilson, 1929). Similar impacts may be from boat wakes but this will depend upon the frequency of activity in the area and the size of the vessel.

Intertidal reef may also be subjected to abrasion if the activity is launched from the shore, through trampling, dragging of equipment (including trailers) or craft over the intertidal area. Intertidal rocky reef, intertidal biogenic reef and intertidal epifaunal (Peacock's tail seaweed) impacts from sailing vessels being launched will be the

same as those covered under Motorised personal watercraft and motorised watercraft (**section 6**); therefore, no further assessment is required.

MMO concludes that sailing over littoral chalk is likely to result in a significant risk of hindering achievement of the conservation objectives of the MPA at any level of activity. This is because the impacts of abrasion/disturbance of the substrate on the surface of the seabed caused by this activity, even at low levels, are likely to present a significant risk of hindering achievement of the site's conservation objectives.

MMO conclude that the launching and recovery of sail boats over littoral chalk may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed, and penetration and/or disturbance of the substratum below the surface of the seabed (including abrasion) caused by trampling, launching and recovery during this activity. However, as trampling, launching and recovery is not within MMO remit, these impacts will not be assessed or managed by MMO.

MMO concludes that sailing over intertidal rocky reef, intertidal biogenic reef and intertidal epifauna may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed caused by this activity. A site level assessment will determine whether the activity is hindering the achievement of MPA conservation objectives.

MMO conclude that the launching and recovery of sail boats over intertidal rocky reef, intertidal biogenic reef and intertidal epifauna may result in a significant risk of hindering achievement of the conservation objectives of the MPA, dependent on site specific sensitivities and the level of activity within a site. This is because of the impacts of abrasion/disturbance of the substrate on the surface of the seabed, and penetration and/or disturbance of the substratum below the surface of the seabed (including abrasion) caused by trampling, launching and recovery during this activity. However, as trampling, launching and recovery is not within MMO remit, these impacts will not be assessed or managed by MMO.

9 Conclusion

This document has reviewed and synthesised the available evidence on the impacts of mNLA and pressures on reef features designated within MPAs. The review considered evidence relating to anchoring, diving and snorkelling, MPW, motorised watercraft, non-motorised watercraft and sailing.

The evidence demonstrates that the pressures associated with mNLA differ between activities and reef types. The primary pressures identified include abrasion/disturbance of the substrate on the surface of the seabed and penetration and/or disturbance of the substratum below the surface of the seabed. The relevance and severity of these pressures vary according to both feature characteristics and activity type.

The evidence indicates that reef features differ substantially in their resistance and recovery potential. Biogenic reef features are generally characterised by lower resistance and longer recovery times than many rocky reef habitats, resulting in greater sensitivity to physical disturbance. Similarly, some reef features, such as chalk reef, may experience irreversible damage where the physical reef structure is altered or removed.

Evidence was strongest for the effects of anchoring on reef habitats. Anchoring has the potential to directly damage reef habitats resulting in abrasion, breakage, displacement or removal of reef forming species and structural habitat components. Evidence for other activities was generally more limited, although impacts may occur where activities result in direct physical interaction with reef features.

There remain important evidence gaps and uncertainties for some reef feature and activity combinations. In several cases, evidence was derived from related habitats, similar activities or evidence from features with comparable ecological characteristics. Where direct evidence was unavailable, assessment has been informed by feature sensitivity and professional judgement.

This review supports the assessment of activity-feature interactions at the site level and should be considered alongside information relating to conservation objectives, feature extent and condition, activity distribution and intensity, environmental context and the presence of existing pressures.

Overall, the evidence indicates that mNLA have the potential to impact reef features where activities result in direct physical interaction with sensitive habitats. The likelihood that these impacts may hinder the achievement of conservation objectives will depend on the sensitivity of the feature, its ability to recover, the scale of exposure and the specific circumstances within each MPA.

References

- Banke, T.L., Steinfurth, R.C., Lange, T., Canal-Vergés, P., Svane, N. and Flindt, M.R. (2024) 'Dislodgement and mortality challenges when restoring shallow mussel beds (*Mytilus edulis*) in a Danish estuary', *Restoration Ecology* [Preprint]. doi:10.1111/rec.14160.
- Benson, A., Aldis, C., Boblin, E., Clarke, J. and Sotheran, I. (2024) 'Cromer Shoal Chalk Beds MCZ 2022 Imagery Analysis - NECR526'. Available at: <https://publications.naturalengland.org.uk/publication/5457267886129152>.
- Bilkovic, D., Mitchell, M., Davis, J., Andrews, E., King, A., Mason, P., Herman, J., Tahvildari, N. and Davis, J. (2017) *Review of boat wake wave impacts on shoreline erosion and potential solutions for the Chesapeake Bay*, STAC Publication Number 17-002.
- Birkett, D., Maggs, C. and Dring, M. (1998) 'Maerl - An overview of dynamics and sensitivity characteristics for conservation management of marine SACs', V(August), pp. 1–117.
- Brosnan, D.M. and Crumrine, L.L. (1994) 'Effects of human trampling on marine rocky shore communities', *Journal of Experimental Marine Biology and Ecology* [Preprint]. doi:10.1016/0022-0981(94)90145-7.
- Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O. and Reker, J.B. (2022) 'The Marine Habitat Classification for Britain and Ireland Version 04.05 (2004)', in JNCC (ed.) *The Marine Habitat Classification for Britain and Ireland Version 22.04*. Available at: <https://mhc.jncc.gov.uk/resources#version0405>.
- Coz, R., Ouisse, V., Artero, C., Carpentier, A., Crave, A., Feunteun, E., Olivier, J.M., Perrin, B. and Ysnel, F. (2012) 'Development of a new standardised method for sustainable monitoring of the vulnerable pink sea fan *Eunicella verrucosa*', *Marine Biology*, 159(6), pp. 1375–1388. doi:10.1007/s00227-012-1908-7.
- Cunningham, P., Hawkins, S., Jones, H. and Burrows, M. (1984) *The geographical distribution of Sabellaria alveolata (L.) in England, Wales and Scotland, with investigations into the community structure of, and the effects of trampling on Sabellaria alveolata colonies*, CSD Report No. 535.
- Danovaro, R., Nepote, E., Gambi, C., Corinaldesi, C., Canese, S., Dell'Anno, A., Castellan, G., Foglini, F. and Greco, S. (2026) 'Marine litter as a tool to enhance ecological restoration', *Marine Pollution Bulletin*, 223, p. 119019. doi:10.1016/j.marpolbul.2025.119019.
- Davis, A.R., Broad, A., Steele, C., Woods, C., Przeslawski, R., Nicholas, W.A., Maher, W., Krikowa, F., Morris, B., Ingleton, T.C., O'Hea Miller, S. and Rees, M.J. (2025) 'Dragging the chain: anchor scour impacts from high-tonnage commercial vessels on a soft bottom macrobenthic assemblage', *Frontiers in Conservation Science*, 6(March), pp. 1–11. doi:10.3389/fcosc.2025.1487428.
- Defra and Natural England (2022) *Habitats and species of principal importance in England*. Available at: <https://www.gov.uk/government/publications/habitats-and-species-of-principal-importance-in-england> (Accessed: 14 September 2026).

Denny, M.W. (1987) 'Lift as a mechanism of patch initiation in mussel beds', *Journal of Experimental Marine Biology and Ecology* [Preprint]. doi:10.1016/0022-0981(87)90103-1.

European Environment Agency (2019a) *EUNIS habitat classification 2012 amended 2019 - A1 - Littoral rock and other hard substrata*. Available at: <https://eunis.eea.europa.eu/habitats/424> (Accessed: 16 March 2026).

European Environment Agency (2019b) *EUNIS habitat classification 2012 amended 2019 - A4 - Circalittoral rock and other hard substrata*. Available at: <https://eunis.eea.europa.eu/habitats/445> (Accessed: 16 March 2026).

Fredriksen, S., Sjøtun, K., Lein, T.E. and Rueness, J. (1995) 'Spore dispersal in laminaria hyperborea (laminariales, phaeophyceae)', *Sarsia* [Preprint]. doi:10.1080/00364827.1995.10413579.

Gibb, N., Tillin, H., Pearce, B. and Tyler-Walters, H. (2014) *Assessing the sensitivity of Sabellaria spinulosa to pressures associated with marine activities*, JNCC Report No. 504. doi:10.1016/j.cub.2012.06.040.

Golding, N., Albrecht, J. and McBreen, F. (2020) *Refining the criteria for defining areas with a 'low resemblance' to Annex I stony reef*, JNCC Report No. 656. Available at: <https://data.jncc.gov.uk/data/4b60f435-727b-4a91-aa85-9c0f99b2c596/JNCC-Report-656-FINAL-WEB.pdf%0A>.

Goodwin, V.M. (2023) *Interacting effects of recruitment, eelgrass (Zostera marina), and human activity on restored olympia oyster (ostrea lurida) beds and their provision of ecosystem services*. doi:10.5281/zenodo.10426465.

Griffiths, C.A., Langmead, O.A., Readman, J.A.J. and Tillin, H.M. (2017) *Anchoring and Mooring Impacts in English and Welsh Marine Protected Areas: Reviewing sensitivity, activity, risk and management. A report to Defra Impacts Evidence Group from the Marine Biological Association of the United Kingdom*. Plymouth. Available at: www.marlin.ac.uk/assets/pdf/14267_ME6003_MBA_Report.pdf.

Herbert, R.J.H., Crowe, T.P., Bray, S. and Shearer, M. (2009) 'Disturbance of intertidal soft sediment assemblages caused by swinging boat moorings', *Hydrobiologia* [Preprint]. doi:10.1007/s10750-008-9700-x.

Herbert, R.J.H., Ma, L., Marston, A., Farnham, W.F., Tittley, I. and Cornes, R.C. (2016) 'The calcareous brown alga Padina pavonica in southern Britain: population change and tenacity over 300 years', *Marine Biology* [Preprint]. doi:10.1007/s00227-015-2805-7.

Hiddink, J.G., Jennings, S., Sciberras, M., Bolam, S.G., Cambiè, G., McConnaughey, R.A., Mazor, T., Hilborn, R., Collie, J.S., Pitcher, C.R., Parma, A.M., Suuronen, P., Kaiser, M.J. and Rijnsdorp, A.D. (2019) 'Assessing bottom trawling impacts based on the longevity of benthic invertebrates', *Journal of Applied Ecology*, 56(5), pp. 1075–1084.

Irving, R. (2009) *The identification of the main characteristics of stony reef habitats under the Habitats Directive. Summary report of an inter-agency workshop 2008*, JNCC Report No. 4332.

JNCC (2026a) *1170 Reefs*. Available at: <https://sac.jncc.gov.uk/habitat/H1170/>

(Accessed: 16 March 2026).

JNCC (2026b) *Kelp and red seaweeds (moderate energy infralittoral rock)*, *Marine Habitat Classification*. Available at: <https://mhc.jncc.gov.uk/biotopes/jnccmncr00001532> (Accessed: 14 September 2026).

JNCC (2026c) *Kelp and red seaweeds (moderate energy infralittoral rock)*, *Marine Habitat Classification*.

MacDonald, J., Freer, A. and Cusack, M. (2010) 'Attachment of oysters to natural substrata by biologically induced marine carbonate cement', *Marine Biology* [Preprint]. doi:10.1007/s00227-010-1476-7.

Maddock, A. (Ed. . (2008) *UK biodiversity action plan priority habitat descriptions. Sabellaria spinulosa reefs*, *UK Biodiversity Action Plan; Priority Habitat Descriptions*.

Mainwaring, K., Tillin, H. and Tyler-Walters, H. (2014) *Assessing the sensitivity of blue mussels (Mytilus edulis) to pressures associated with human activities*, *Peterborough, Joint Nature Conservation Committee, JNCC Report No. 506*.

Marine Biological Association (2026a) *Common mussel (Mytilus edulis)*, *The Marine Life Information Network (MarLIN) Marine Biological Association of the United Kingdom*. Available at: <https://www.marlin.ac.uk/species/detail/1421> (Accessed: 16 March 2026).

Marine Biological Association (2026b) *Native oyster (Ostrea edulis)*, *The Marine Life Information Network (MarLIN) Marine Biological Association of the United Kingdom*. Available at: <https://www.marlin.ac.uk/species/detail/1146> (Accessed: 16 March 2026).

MarLIN (2026) *The Marine Life Information Network (MarLIN)*. Plymouth: Marine Biological Association of the United Kingdom. Available at: www.marlin.ac.uk.

Mendez, M.M., Livore, J.P. and Bigatti, G. (2019) 'Interaction of natural and anthropogenic stressors on rocky shores: Community resistance to trampling', *Marine Ecology Progress Series* [Preprint]. doi:10.3354/meps13144.

MMO (2021) *Understand and apply for marine wildlife licences and report an incident*. Available at: <https://www.gov.uk/guidance/understand-marine-wildlife-licences-and-report-an-incident> (Accessed: 14 September 2026).

Moffat, C., Richardson, H. and Roberts, G. (2020) *Natural England marine chalk characterisation project*. Natural England. Available at: <https://publications.naturalengland.org.uk/publication/5385776319954944>.

Natural England (2017a) 'Marine recreation evidence briefing: hovercraft - EIN031', (November 2017). Available at: <https://publications.naturalengland.org.uk/publication/4665520443359232>.

Natural England (2017b) 'Natural England Evidence Information Note EIN026 - Marine Recreation Evidence Briefing: Motorised Personal Watercraft', (November), pp. 1–17. Available at: <https://www.gov.uk/government/collections/conservation-advice-packages-for-marine-protected->.

Natural England (2020) *Natural England Research Report NERR024*. Available at:

publications.naturalengland.org.uk/file/61078%5Cnhttps://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CC8QFjAA&url=http://publications.naturalengland.org.uk/file/61078&ei=P-T3UK7GHuW_0QXThYHIAw&usg=AFQjCNHicCVE6miHkUxCLWeFCd3DIQtSqq&bvm=.

Natural England, Natural Resources Wales, Nature Scot, DAREA and JNCC (2023) *Statutory Nature Conservation Body joint advice on marine debris removal as compensation for impacts to benthic habitats from development*.

New England Fishery Management Council (2011) 'NEFMC Amendment 2 The Swept Area Impact Approach Appendix D', p. 257. Available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwj3-NWwlbaTAXWTWEEAHsn3GwlQFnoECBgQAQ&url=https%3A%2F%2Fd23h0vhs26o6d.cloudfront.net%2FAppendix_D_Swept_Area_Seabed_Impact_approach_171011_091330.pdf&usg=AOvVaw2PCmltS0G0wokdjHIU-RM.

OSPAR Commission (2009) *Background Document for Littoral chalk communities. Biodiversity Series*. Available at: <https://www.ospar.org/documents?v=7192>.

OSPAR Commission (2026) *Ostrea edulis Beds*. Available at: <https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats/habitats/ostrea-edulis-beds> (Accessed: 27 March 2026).

Pikesley, S.K., Godley, B.J., Latham, H., Richardson, P.B., Robson, L.M., Solandt, J.L., Trundle, C., Wood, C. and Witt, M.J. (2016) 'Pink sea fans (*Eunicella verrucosa*) as indicators of the spatial efficacy of Marine Protected Areas in southwest UK coastal waters', *Marine Policy* [Preprint]. doi:10.1016/j.marpol.2015.10.010.

Plicanti, A., Domínguez, R., Dubois, S.F. and Bertocci, I. (2016) 'Human impacts on biogenic habitats: Effects of experimental trampling on *Sabellaria alveolata* (Linnaeus, 1767) reefs', *Journal of Experimental Marine Biology and Ecology* [Preprint]. doi:10.1016/j.jembe.2016.02.001.

Preston, J., Gamble, C., Debney, A., Helmer, L., Hancock, B. and zu Ermgassen, P. (2020) *European Native Oyster Habitat Restoration Handbook*. Available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjmweWVkl2SAxWk3AIHHQKUKFwQFnoECA4QAQ&url=https%3A%2F%2Fnativeoysternetwork.org%2Fwp-content%2Fuploads%2Fsites%2F27%2F2020%2F11%2FZSL00150%2520Oyster%2520Handbook_WEB.pdf&usg=AOvVaw3.

Readman, D.H.T. & D.A.J. & J. (2026) *Sea fan anemone (Amphianthus dohrnii)*, *MarLIN - The Marine Life Information Network*. Available at: <https://www.marlin.ac.uk/species/detail/1120>.

Salomidi, M., Katsanevakis, S., Borja, A., Braeckman, U., Damalas, D., Galparsoro, I., Mifsud, R., Mirto, S., Pascual, M., Pipitone, C., Rabaut, M., Todorova, V., Vassilopoulou, V. and Vega Fernandez, T. (2012) 'Assessment of goods and services, vulnerability, and conservation status of European seabed biotopes: a stepping stone towards ecosystem-based marine spatial management', *Mediterranean Marine Science*, 13(1), pp. 49–88. doi:10.12681/mms.23.

Saunders, C., Selwyn, J., Richardson, S., May, V. and Heeps, C. (2000) 'A review of the effects of recreational interactions within UK European marine sites', (November).

Schiell, D.R. and Taylor, D.I. (1999) 'Effects of trampling on a rocky intertidal algal assemblage in southern New Zealand', *Journal of Experimental Marine Biology and Ecology* [Preprint]. doi:10.1016/S0022-0981(98)00170-1.

Seale (2009) 'Seasonal Settlement of Olympia Oyster Larvae, *Ostrea lurida* Carpenter 1864 and Its Relationship to Seawater Temperature in Two Southern California Estuaries', *Journal of Shellfish Research* 28(1):113-120 [Preprint].

Seed, R. and Suchanek, T.H. (1992) 'Population and community ecology of *Mytilus*. In: The mussel *Mytilus* – ecology, physiology, genetics and culture.', *Developments in Aquaculture and Fisheries Science* [Preprint].

Smith, J.R. and Murray, S.N. (2005) 'The effects of experimental bait collection and trampling on a *Mytilus californianus* mussel bed in southern California', *Marine Biology* [Preprint]. doi:10.1007/s00227-005-1619-4.

Stamp, T.E. (2015) *Laminaria saccharina* with *Phyllophora* spp. and filamentous green seaweeds on variable or reduced salinity infralittoral rock, *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*. Available at: https://www.marlin.ac.uk/habitats/detail/184/saccharina_latissima_with_phyllophora_spp_and_filamentous_green_seaweeds_on_variable_or_reduced_salinity_infralittoral_rock.

Stamp, T.E., Tyler-Walters, H., Burdett, E.G., Williams, E. and Lloyd, K.A. (2025) 'Laminaria hyperborea forest, foliose red seaweeds and a diverse fauna on tide-swept upper infralittoral rock', in Tyler-Walters, H. (ed.) *Marine Life Information Network: Biology and Sensitivity Key Information Review*. Plymouth.

Stamp, T.E., Williams, E., Lloyd, K.A. and Watson, A.J. (2023) 'Alcyonium digitatum with dense Tubularia indivisa and anemones on strongly tide-swept circalittoral rock', in Tyler-Walters, H. (ed.) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*. Plymouth. Available at: www.marlin.ac.uk/habitats/detail/1053.

The Center for Land Use Interpretation (2008) *Hovercraft: The Ultimate Vehicle of the Fringe*. Available at: <https://clui.org/newsletter/spring-2008/hovercraft-ultimate-vehicle-fringe> (Accessed: 23 February 2026).

Tibbitt, F., Love, J., Wright, J. and Chamberlain, J. (2020) *Human impacts on Cromer Shoal Chalk Beds MCZ: Chalk complexity and population dynamics of commercial crustaceans (NERR04412)*. Available at: <https://publications.naturalengland.org.uk/publication/4884193307000832>.

Tillin, H.M., Bolam, S. and Hiddink, J.G. (2010) *Assessing and developing the required biophysical datasets and data layers for Marine Protected Areas network planning and wider marine spatial planning purposes. Report No 21: North Sea productivity pilot study, Project Code: MB0102 Marine Biodiversity R&D Programme*.

Tillin, H.M., Tyler-Walters, H., Mieszkowska, N. and Hiscock, K. (2022) 'Defining Marine Irreplaceable Habitats: Literature Review', (NECR474), p. 151. Available at: <https://publications.naturalengland.org.uk/publication/6712103688470528>.

Veiga, P., Sampaio, L., Moreira, J. and Rubal, M. (2023) 'Short-term effects of trampling on intertidal *Mytilus galloprovincialis* beds', *Marine Pollution Bulletin* [Preprint]. doi:10.1016/j.marpolbul.2023.114800.

Vorberg, R. (2000) 'Effects of shrimp fisheries on reefs of *Sabellaria spinulosa* (Polychaeta)', *ICES Journal of Marine Science*, 57(5), pp. 1416–1420. doi:10.1006/jmsc.2000.0920.

Widdows, J., Blauw, A., Heip, C.H.R., Herman, P.M.J., Lucas, C.H., Middelburg, J.J., Schmidt, S., Brinsley, M.D., Twisk, F. and Verbeek, H. (2004) 'Role of physical and biological processes in sediment dynamics of a tidal flat in Westerschelde Estuary, SW Netherlands', *Marine Ecology Progress Series* [Preprint]. doi:10.3354/meps274041.

Wilson, D.P. (1929) 'The Larvae of the British Sabellarians', *Journal of the Marine Biological Association of the United Kingdom* [Preprint]. doi:10.1017/S0025315400029787.

Wulff, J.L. (2006) 'Resistance vs recovery: Morphological strategies of coral reef sponges', *Functional Ecology* [Preprint]. doi:10.1111/j.1365-2435.2006.01143.x.

Annex 1: mNLA pressures on sensitive features - reef

This annex summarises the pressures resulting from mNLA and their potential impact on reef features described in this document.

Natural England's CAPs provide generic information on pressures that may be exerted by all marine industries and their potential impact on designated features within the AoO section. Natural England's AoO is an evidence based product which can be used to guide MPA assessments, together with bespoke advice from JNCC and Natural England. This is explained further in [Natural England's conservation advice guidance](#)²⁸. The sensitivities of designated features to mNLA pressures were derived using a staged approach.

Stage 1

Natural England's CAPs, including Natural England's AoO have been used by MMO to determine the sensitivities of each feature to the potential pressures from mNLA, based on actual or representative sites to highlight subject areas for evidence gathering. This has been done by identifying the 98 MPAs that are in scope for this mNLA programme of works that contain reef features and reviewing the AoO available for each site. The information from the AoO was collated (**Table A1. 2** to **Table A1. 3**), with the highest sensitivity for each pressure-feature interaction being recorded (**Table A1.1**) for the sensitivity categories). Natural England also provided additional guidance about pressure/feature interactions that should be considered.

Stage 2

An evidence gathering activity was then carried out. Evidence gathering and analysis was focused on interactions that were deemed sensitive (**Table A1. 2** to **Table A1. 3**) and high risk, as these are likely to be the most relevant interactions to be considered at each site level assessment (**Table A1. 2** to **Table A1. 3**). Interactions where there is insufficient evidence (IE) are not considered further here, but these interactions will be considered in site level assessments. In addition, site specific sensitivities for each pressure-feature interaction will be used at the site level assessment stage.

All the pressures from the mNLA categories described in section 3 and the potential sensitivity of reef features are displayed in **Table A1. 2** to **Table A1. 3**. This table summarises all the interactions according to the key in **Table A1.1**. The pressures listed in **Table A1. 2** to **Table A1. 3** are defined in Natural England's AoOs. Where multiple sensitivities exist for features, the most precautionary sensitivity has been displayed. Site specific sensitivities will be used at the site level assessment stage.

²⁸ Natural England MPA Conservation Advice – Guidance:
www.designatedsites.naturalengland.org.uk/MarineGuidance.aspx#advice (Last accessed 16 September 2026)

Table A1.1: Interaction sensitivity key for mNLA and designated features.

Key	
S	Indicates the feature is sensitive.
IE	Indicates there is insufficient evidence to make sensitivity conclusions, or a sensitivity assessment has not been made for this feature to this pressure.
NA	Indicates that a sensitivity assessment has not been made for this interaction, this interaction should not, however, be precluded from consideration.
NS	Indicates feature is not sensitive to pressure.
NR	Indicates the pressure is not relevant for the activity. There is no interaction between the pressure and biotope/species and/or no association between the activity and the pressure.

Table A1. 2: Summary of the sensitivities of biogenic reef designated features to potential pressures from mNLA. Feature and impact interactions which have no pathway for interaction or are not assessed have been removed from this table.

Pressure Name	Blue mussel beds	Native oyster beds	Intertidal biogenic reef: mussel beds	Intertidal biogenic reef: Sabellaria spp.	Intertidal biogenic reefs	Ross worm reefs	Subtidal biogenic reefs: mussel beds	Subtidal biogenic reefs: Sabellaria spp.
Abrasion/disturbance of the substrate on the surface of the seabed	S	S	S	S	S	S	S	S
Hydrocarbon and polycyclic aromatic hydrocarbon contamination	S	S	S	NA	S	NA	S	NA
Introduction of light	IE	NS	IE	IE	IE		IE	
Introduction or spread of invasive non-indigenous species	S	S	S	S	S	S	S	S
Organic enrichment	NS	NS	NS	NS	NS	NS	NS	NS
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion	S	S	S	S	S	S	S	S
Physical change (to another seabed type)		S						
Physical change (to another sediment type)	S		S		S	S	S	S
Removal of target species	S	S	S		S		S	
Synthetic compound contamination	S	S	S	NA	S	NA	S	NA
Transition elements and organo-metal contamination	S	S	S	NA	S	NA	S	NA
Underwater noise changes							IE	

Table A1. 3: Summary of the sensitivities of rocky reef designated features to potential pressures from mNLA. Feature and impact interactions which have no pathway for interaction or are not assessed have been removed from this table.

Pressure name	High energy circalittoral rock	High energy infralittoral rock	High energy intertidal rock	Low energy infralittoral rock	Low energy intertidal rock	Moderate energy circalittoral rock	Moderate energy infralittoral rock	Moderate energy infralittoral rock and thin mixed sediment	Moderate energy intertidal rock	Peacock' s tail	Pink sea-fan	Sea fan anemone	Circalittoral rock	Infralittoral rock	Littoral chalk communities	Subtidal chalk	Subtidal stony reef	Intertidal rock	Intertidal stony reef	Intertidal under-boulder communities
Abrasion/disturbance of the substrate on the surface of the seabed	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Hydrocarbon and polycyclic aromatic hydrocarbon contamination	NA	NA		S	NA	S	NA	NA	NA	NA	NA	NA	S	S	NA	NA	S	NA	NA	NA
Introduction of light	NS	S		S	S	IE	S	S	S	NS			IE	S	S	S	S	S	S	S
Introduction or spread of invasive non-indigenous species	S	S		S	S	S	S	S	S	IE	S	S	S	S	S	S	S	S	S	S
Organic enrichment		S		S	S	S	S	S	S	NS	IE	NS	S	S	IE	NS	S	S	S	NS
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion	S		S	S	S	S	S		S				S	S	S	S	S	S	S	S
Physical change (to another seabed type)		S		S	S	S	S	S	S	S	S	S	S	S			S	S	S	S
Physical change (to another sediment type)																S				

Pressure name	High energy circalittoral rock	High energy infralittoral rock	High energy intertidal rock	Low energy infralittoral rock	Low energy intertidal rock	Moderate energy circalittoral rock	Moderate energy infralittoral rock	Moderate energy infralittoral rock and thin mixed sediment	Moderate energy intertidal rock	Peacock' s tail	Pink sea-fan	Sea fan anemone	Circalittoral rock	Infralittoral rock	Littoral chalk communities	Subtidal chalk	Subtidal stony reef	Intertidal rock	Intertidal stony reef	Intertidal under-boulder communities
Removal of target species	S	S		S		S	S	S					S	S		S	S			
Synthetic compound contamination	NA	NA		S	NA	S	NA	NA	NA	NA	NA	NA	S	S	NA	NA	S	NA	NA	NA
Transition elements and organo-metal contamination	NA	NA		S	NA	S	NA	NA	NA	NA	NA	NA	S	S	NA	NA	S	NA	NA	NA
Underwater noise changes	NS				IE	NS							NS				NS	IE	IE	