Marine Management Organisation

MMO Stage 3 Site Assessment: Markham's Triangle MPA (DRAFT)






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MMO Stage 3 Site Assessment: Markham's Triangle MPA DRAFT

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Executive summary

This assessment analyses the impact of anchored nets and lines, bottom towed gear and traps on the designated features subtidal sand, subtidal mud, subtidal mixed sediments, and subtidal coarse sediment in Markham's Triangle Marine Protected Area (MPA) to determine whether a significant risk of hindering the conservation objectives of the site can be excluded. The assessment sets out the evidence considered and analyses the quality of that evidence. The assessment finds that the ongoing use of bottom towed gear may result in a significant risk of hindering the achievement of the conservation objectives of the MPA. Management measures will therefore be implemented for bottom towed gear for Markham's Triangle MPA. **Section 6** contains further details of these measures.

1 Introduction

This assessment considers whether fishing activities are compatible with the conservation objectives of Markham's Triangle MPA.

This site is designated as a marine conservation zone (MCZ). This assessment uses the best available evidence to review site characteristics and fishing activity and determine if there is a significant risk of fishing activities hindering the conservation objectives of the site. If so, the Marine Management Organisation (MMO) will develop and introduce suitable management measures, such as MMO byelaws. If MMO byelaws are required, then these will be subject to public consultation and will require confirmation from the Secretary of State to come into effect.

2 Site information

2.1 Overview

The following Joint Nature Conservation Committee (JNCC) site information and Department for Environment Food and Rural Affairs (Defra) factsheet were used for background on site geography, designations, features, conservation objectives and general management approaches:

- JNCC Site Information – Markham's Triangle MCZ[1]
- Defra Factsheet – Markham's Triangle MCZ[2]

Markham's Triangle MPA is an offshore site located approximately 137 km from the Humberside coast in the Southern North Sea region. It is bordered to the east by a Dutch Special Area of Conservation known as Cleaver Bank. The site covers an area of 200 km^2 (**Figure 1**) and ranges from 25 m to 50 m in depth.

Markham's Triangle MPA was designated as a marine conservation zone (MCZ) in 2019 to protect a variety of broad-scale habitats. It is characterised by a range of benthic sedimentary habitats including subtidal sand, subtidal mud, subtidal coarse sediment, and subtidal mixed sediments. Subtidal coarse sediment occupies almost three quarters of the site, while subtidal sand and subtidal mixed sediments each occupy approximately an eighth of the total area. Subtidal mud occupies less than 1 % of the site, confined to deeper water.

The varied benthic habitats support a diverse range of species both in and on the sediment, allowing species to thrive, such as razor and Venus clams, bristle worms, urchins and crustacea. These habitats also host a range of commercially important flatfish species such as sole and plaice. The designated features and their general management approaches are set out below in **Table 1**.

The general management approaches for the features of Markham's Triangle MPA have been set based on a vulnerability assessment. The attributes driving these approaches are described in JNCC's supplementary advice on conservation objectives[1].

[1] Markham's Triangle Site Information Centre jncc.gov.uk/our-work/markhams-triangle-mpa/ (last accessed 23 October 2023)
[2] Markham's Triangle Defra factsheet assets.publishing.service.gov.uk/media/5f56589de90e07099624f03c/mcz-markhams-triangle-2019.pdf (last accessed 23 October 2023)

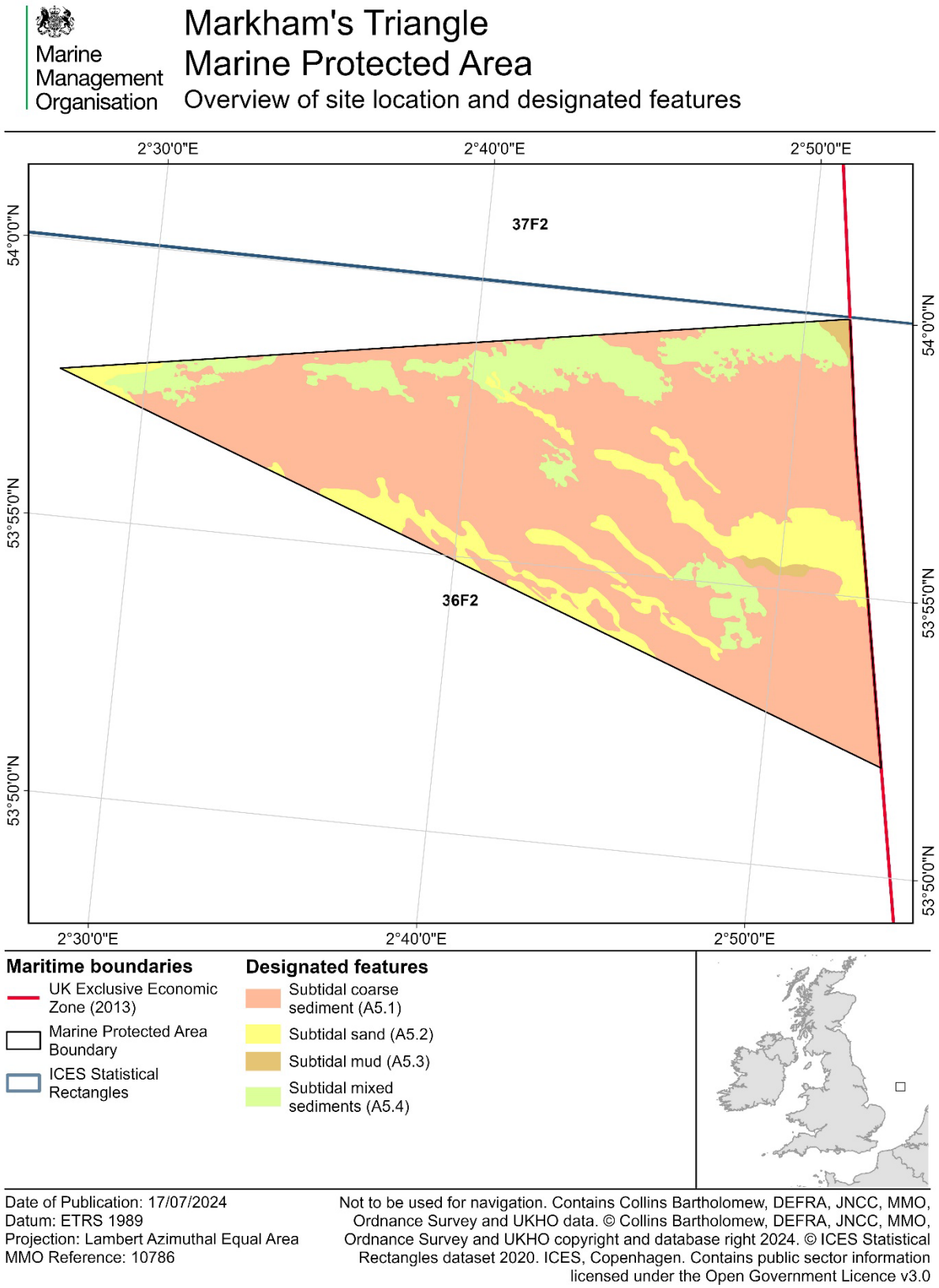

Figure 1: Site overview map.

Fishing, predominantly benthic trawling, and oil and gas industry activities within the site have resulted in all the designated features having general management approaches set to recover. JNCC advise that these activities should be managed to minimise the impact of the associated pressures on the attributes for the sites features.

Table 1: Designated features and general management approaches.

Designated feature	General management approach
Subtidal sand	Recover to favourable condition
Subtidal mud	
Subtidal coarse sediment	
Subtidal mixed sediments	

There is no feature condition assessment available for this site; in its absence a vulnerability assessment, which includes sensitivity and exposure information for features and activities in a site, is used as a proxy for condition. More information on this can be found in JNCC's supplementary advice on conservation objectives[1].

2.2 Scope of this assessment

The scope of this assessment covers fishing activities alone, and relevant activities in combination with fishing.

3 Part A - Identified pressures on the MPA

Part A of this assessment was carried out in a manner that is consistent with the 'capable of affecting (other than insignificantly)' test required by section 126 of the Marine and Coastal Access Act 2009[3]

Part A assesses the interactions between pressures from fishing gears and the designated features of this site, screening for interactions that require further consideration. Assessment of interactions not screened out in **Part A** will form **Part B** of the assessment. For each activity assessed in **Part A**, there are two possible outcomes for each identified pressure-feature interaction:

1. The pressure-feature interactions **are not** included for assessment in **Part B** and screened out:
    a. if the feature is not exposed to the pressure, and is not likely to be in the future;
    b. the pressure is not capable of affecting the feature, other than insignificantly; or
    c. if MMO has information that the activity or pressure is not occurring in the site and/or does not need to be considered further.

2. The pressure-feature interactions **are** included for assessment in **Part B**:
    a. if the feature is exposed to the pressure, or is likely to be in the future;
    b. the pressure is capable of affecting the feature, other than insignificantly;
    c. if it is not possible to determine whether the pressure is capable of affecting the feature, other than insignificantly; or
    d. if MMO has information that the activity or pressure is occurring in the site and/or does need to be considered further.

Consideration of a pressure on a protected feature in an MPA includes consideration of the pressure's exposure to, or effect on, any ecological or geomorphological process on which the conservation of the protected feature is wholly or in part dependent.

3.1 Activities taking place

Table 2 lists all commercial fishing gears included for assessment. All other gears have been screened out of further assessment as they do not take place and are not likely to take place in the future, as there are no vessel monitoring system (VMS) records present within the site linked to these gear codes, nor do they appear in landings data for International Council for the Exploration of the Sea (ICES) statistical rectangles that overlap the site.

[3] For more information see: www.legislation.gov.uk/ukpga/2009/23/section/126.

To determine fishing activity occurring within the site, the following evidence sources were used:

- VMS data;
- fisheries landings data (logbooks and sales records);
- ICES rectangle level fishing effort data in days (reference: MMO1264);
- swept area ratio (SAR) data.

For more information about the above evidence sources, please see the Stage 3 MPA Site Assessment Methodology document[4], which describes each type of fishing activity evidence and summarises the strengths and limitations of each source.

Table 2: **Fishing activities covered by this assessment present in VMS records (2016 to 2021) and landings data (2016 to 2020) for Markham's Triangle MPA.**

Gear type	Gear name	Gear code	Justification
Anchored nets and lines	Set gillnet (anchored)	GNS	Present in VMS records.
Bottom towed gear	Beam trawl	TBB	Present in VMS records and under 12 m landings data for ICES statistical rectangles that overlap the site.
	Bottom otter trawl	OTB	
	Scottish / fly seine	SSC	
	Towed dredge	DRB	
	Danish / anchor seine	SDN	Present in VMS records.
	Pair seine	SPR	
	Twin bottom otter trawl	OTT	
Midwater gear	Hand-operated pole-and-line	LHP	Present in under 12 m landings data for ICES statistical rectangles that overlap the site.
	Midwater otter trawl	OTM	Present in VMS records.
	Midwater pair trawl	PTM	
Traps	Pot/Creel	FPO	
Miscellaneous	Not known	NK	

[4] Stage 3 MPA Site Assessment Methodology: www.gov.uk/government/publications/stage-3-site-assessments) (last accessed 29 August 2024).

3.2 Pressures and activities screened out

This section identifies activities or pressures that are **occurring but do not need to be considered** for Markham's Triangle MPA.

The gear types and pressures screened out on this basis are listed below with justification:

- **Midwater gears:** although the use of midwater gears does occur within Markham's Triangle MPA, there is no feasible pathway for gears of this type to interact with benthic designated features under normal operation. These gears are not designed to operate on or near the seabed and are deployed entirely within the water column. Therefore, the use of midwater gear within Markham's Triangle MPA is not considered to be capable of affecting the designated features other than insignificantly and is not considered further within this assessment.
- **Unknown gear**: 'other gear' has been declared as having been used to land fish from this ICES statistical rectangle. The gear code used to report these landings does not provide any further information relating to the fishing method used. It is therefore not possible to assess the likelihood of this fishing method interacting with the seabed and it is not considered further within this assessment.

3.3 Pressures to be taken forward to Part B

The Stage 3 Fishing Gear MPA Impacts Evidence documents detail all pressures created by fishing activity on features of interest. The documents justify which pressures should be taken forward for consideration for each feature. This is documented in **Table A1.2** in the anchored nets and lines, bottom towed gear and traps Impacts Evidence documents:

- Stage 3 Fishing Gear MPA Impacts Evidence Anchored Nets and Lines[5];
- Stage 3 Fishing Gear MPA Impacts Evidence Bottom Towed Gear[6]; and
- Stage 3 Fishing Gear MPA Impacts Evidence Traps[7].

[5] Stage 3 Fishing Gear MPA Impacts Evidence Anchored Nets and Lines http://www.gov.uk/government/publications/stage-3-impacts-evidence (last accessed 29 August 2024).
[6] Stage 3 Fishing Gear MPA Impacts Evidence Bottom Towed Gear http://www.gov.uk/government/publications/stage-3-impacts-evidence (last accessed 29 August 2024).
[7] Stage 3 Fishing Gear MPA Impacts Evidence Traps http://www.gov.uk/government/publications/stage-3-impacts-evidence (last accessed 29 August 2024).

To determine whether a pressure should be taken forward for this particular site, **Table 3** uses the information from the Impacts Evidence documents, alongside site level information, including sensitivity assessments, risk profiling of pressures from conservation advice packages, and JNCC advice to assess the sensitivities of pressures on the designated features of the site.

Table 3 details the pressures for each gear type - anchored nets and lines (A), bottom towed gear (B) and traps (T) - to be assessed in **Part B**, taking into account the pressures screened out in **sections 3.1** and **3.2**.

Key	
	Dark blue highlighting indicates that the feature is sensitive to this pressure from the gear type in this site, and that the interaction should be taken forward for consideration.
	Light blue highlighting indicates that feature is sensitive to the pressure in general, but the gear type is unlikely to exert this pressure to an extent where impacts are of concern in the site.
	Grey highlighting indicates that there is insufficient evidence to make sensitivity conclusions, or that a sensitivity assessment has not been made for this feature to this pressure from the gear type.
	If there is no highlighting within a cell, this indicates that the pressure from the gear type is not relevant to the feature, or that the feature is not sensitive to the pressure.

Table 3: Summary of pressures on designated features of Markham's Triangle MPA to be taken forward to Part B.

Potential pressures	Designated features											
	Subtidal coarse sediment			Subtidal mixed sediments			Subtidal mud			Subtidal sand		
	A	B	T	A	B	T	A	B	T	A	B	T
Abrasion or disturbance of the substrate on the surface of the seabed												
Changes in suspended solids (water clarity)												
Deoxygenation												
Hydrocarbon and polycyclic aromatic hydrocarbon (PAH) contamination												
Introduction of light												
Introduction of microbial pathogens												
Introduction or spread of invasive non-indigenous species												
Litter												
Organic enrichment												
Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion												
Physical change (to another seabed type)												
Removal of non-target species												
Removal of target species												
Smothering and siltation rate changes												
Synthetic compound contamination												
Transition elements and organo-metal contamination												

4 Part B - Fishing activity assessment

Part B of this assessment was carried out in a manner that is consistent with the 'significant risk of hindering the achievement of the conservation objectives' test required by section 126 of the Marine and Coastal Access Act 2009[3].

Table 3 shows the fishing activities and pressures identified in Part A which have been included for assessment in Part B. The most relevant attributes of the designated features that could be compromised by fishing pressures were identified using the Markham's Triangle MPA conservation advice package and are shown in **Table 4**.

Table 4: Relevant favourable condition targets for identified pressures on all of the site's designated features.

Attribute	Target	Relevant pressures
Extent and distribution	An objective has not been set for this attribute	Relevant to: • abrasion or disturbance of the substrate on the surface of the seabed; • changes in suspended solids (water clarity); • penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion; • removal of non-target species; • removal of target species; and • smothering and siltation rate changes.
Structure and function	An objective has not been set for this attribute	
Supporting processes	An objective has not been set for this attribute	

4.1 Fisheries access and existing management

Non-UK vessels can operate within Markham's Triangle MPA, provided that they have a licence issued by the UK to do so. Nationalities which fished within the MPA from 2016 to 2021 include vessels from Belgium, Germany, Denmark, France, the Netherlands, Norway, and the UK. VMS records indicate that vessels from the Netherlands and France are most prevalent.

4.2 Fishing activity summary

Table A1.1 to **Table A1.8** in **Annex 1** display a detailed breakdown of fishing activity within Markham's Triangle MPA. The following analysis considers only fishing activities not screened out in Part A of this assessment; midwater gears are therefore not examined here. VMS record counts were available from 2016 to 2021 and landings data and SAR values were available from 2016 to 2020. When discussing weights from landings in this section, figures used are a total of weights

from UK and EU member states. The most prevalent gears operating within the site are demersal trawls and demersal seines.

4.2.1 Anchored nets and lines

There are currently no landings data to evidence any fishing using this gear type taking place within the site for over 12 m vessels or under 12 m vessels. VMS activity data highlighted 2 records in 2017 however with no landings data attached to these records it can be presumed that the vessel was in transit through the MPA.

4.2.2 Bottom towed gear

Demersal trawls accounted for 65 % of the total VMS records for over 12 m vessels in the site with an annual average of 385 VMS records, landing an apportioned total of approximately 156 tonnes (t) per year. This is just over 50 % of all landings from over 12 m vessels within the MPA. Demersal seines accounted for 30 % of the total VMS records for over 12 m vessels in the site with an annual average of 177 VMS records, landing an apportioned total of approximately 122 t per year.

VMS activity data allows us to see the location of fishing activity taking place by vessels over 12 m in length. Demersal trawling occurs across the entire site with slightly higher densities of activity happening in the northeast and northwest corners of the site where vessels have cut across into the MPA. Demersal seine activity occurs all over the site but is higher in the northern section of the site. Dredging took place sporadically within the northern half of the site in 2020 and 2021. There were 40 VMS records for dredging in 2020 landing 0.92 t and only one record in 2021. The were no VMS records for 2016 to 2019 for dredging from over 12 m vessels.

Fishing effort and landings data shows that dredging by UK under 12 m vessels only occurred in 2019 and 2021, taking place over an annual average of 0.05 fishing effort days and landing an annual average of 0.03 t. For vessels under 12 m in length, landings data have been used to determine activity in the absence of VMS records. These data are recorded at ICES rectangle level and have been attributed to Markham's Triangle MPA based on the 5.48 % of the ICES rectangle intersected by the MPA. Because of this, there are limitations on the accuracy of this data, as it is only possible to estimate how much activity is occurring in the MPA based on the average activity across the entire rectangle, rather than at specific locations within the site. If the dredging activity from 2019 and 2021 did not occur within the MPA, the landings values would be zero. Conversely, if the dredging activity occurred entirely within the MPA, the landings values would be 18 times higher.

SAR analysis indicates that demersal trawl and demersal seine activity occurred consistently in the site from 2016 to 2020. For trawls, mean surface SAR values for C-squares intersecting Markham's Triangle MPA ranged from 1.66 to 2.84 and mean subsurface values from 0.58 to 1.03. An SAR value of 1 means that each area C-square experiences a pass of fishing gear on average once a year. For demersal

seines, mean surface SAR values ranged from 0.86 to 2.03 and mean subsurface SAR values ranged from 0.04 to 0.09.

4.2.3 Traps

VMS activity data and landings data show that there is minimal use of traps within the site. Six VMS records were accounted for in 2020 landing 0.22 t across the southern tip of the site. There are no landings data for vessels under 12 m in length using traps.

4.3 Pressures by gear type

The Stage 3 Fishing Gear MPA Impacts Evidence documents for anchored nets and lines, bottom towed gear and traps collate and analyse the best available evidence on the impacts of different fishing gears on MPA features. This section summarises the analyses and conclusions of those documents, and considers these alongside site level information, including the nature and condition of the habitats and species present, the general management approaches for designated features, intensity of fishing activity taking place and exposure to natural disturbance.

As the designated features subtidal coarse sediment, subtidal mixed sediments, subtidal mud and subtidal sand have similar sensitivities to the pressures identified for different gear types, these features have been considered together. Where there are differences between the features or the potential impacts of different gears within each grouping, this has been highlighted.

In the context of MPA assessment, the pressures removal of target and non-target species refer to any damage, loss, or removal of species defined as a designated feature or integral to the integrity of a designated feature (for example key structural or influential species). This may occur through intentional or unintentional catch associated with the act of commercial fishing. Impacts from target and/or non-target removal pressures have been scoped out from this assessment in most cases, as the detail of key structural and influential species is yet to be fully defined and they are assessed more completely within the abrasion and penetration pressures. These pressures may require consideration as a result of any future evidence review, in conjunction with updated conservation advice from JNCC. However, for subtidal mud, JNCC recommended that removal of target species be considered as a result of the nearby targeted Nephrops fishery (Silver Pit), where such species can be caught by mobile gear.

Information about the biotopes in the site was provided by the Biotope Presence-Absence spreadsheet of JNCC Report No.647 (Tillin *et al.*, 2020), which listed European Nature Information System (EUNIS) biotopes that were present, likely to be present, or absent from each UK offshore bioregion based on survey data, environmental information, species records, literature and expert judgement. Biotopes were screened out if they were not located in the same region as

Markham's Triangle MPA (Southern North Sea), and if they were not found at the depth range for the site (25 to 50 m). Information about the depth range of each biotope was listed in the Biotope Database of JNCC Report No. 647 (Tillin *et al.*, 2020). **Table 5** shows the remaining biotopes that could be present within the site that have at least medium sensitivity to the relevant pressures from anchored nets and lines, bottom towed gear, and traps.

Table 5: Sediment biotopes with medium sensitivity to relevant pressures.

Broad-scale habitats	Biotopes	Sensitivity
Subtidal coarse sediment	*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel (H.M. Tillin, 2016a)	Sensitive to: • penetration.
Subtidal sand	*Echinocardium cordatum* and *Ensis* spp. in lower shore and shallow sublittoral slightly muddy fine sand (De-Bastos, Hill, Lloyd, *et al.*, 2023)	Sensitive to: • abrasion; and • penetration.
	Maldanid polychaetes and *Eudorellopsis deformis* in deep circalittoral sand or muddy sand (Ashley, 2016)	
	Owenia fusiformis and *Amphiura filiformis* in deep circalittoral sand or muddy sand (De-Bastos, 2023)	
Subtidal mixed sediments	*Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment (Perry and Watson, 2024)	Sensitive to: • abrasion; • penetration; and • smothering and siltation.
	Cerianthus lloydii with *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment (Perry and Watson, 2023)	
	Ophiothrix fragilis and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (De-Bastos, Hill, Garrard, *et al.*, 2023)	
	Flustra foliacea and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (Readman and Watson, 2024)	Sensitive to: • abrasion; and • penetration.
Subtidal mud	*Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud (De-Bastos and Budd, 2016)	Sensitive to: • abrasion; and • penetration.
	Levinsenia gracilis and *Heteromastus filifirmis* in offshore circalittoral mud and sandy mud (E. S. R. De-Bastos, 2016)	
	Paramphinome jeffreysii, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud (E. De-Bastos, 2016b)	
	Myrtea spinifera and polychaetes in offshore circalittoral sandy mud (E. De-Bastos, 2016a)	

4.3.1 Anchored nets and lines

The relevant pressures on the subtidal coarse sediment, subtidal mixed sediments, subtidal mud, and subtidal sand features of Markham's Triangle MPA from anchored nets and lines were identified in **Table 3** and are:

- abrasion or disturbance of the substrate on the surface of the seabed;
- removal of non-target species; and
- removal of target species.

Section 4.2 describes the fishing activity within Markham's Triangle and notes that vessels using anchored nets and lines were not in operation within the MPA between 2016 and 2021, however that may change in the future.

Impacts on sediment features relating to abrasion or disturbance of the substrate on the surface of the seabed occur primarily during setting and retrieval of nets and the associated ground lines and anchors, and their movement over the seabed during rough weather. **Section 9.4** of the anchored nets and lines Impacts Evidence documents[5] combines relevant research and finds that abrasion impacts from this gear type are unlikely to negatively impact the extent or distribution of any sediment feature or structure and function of the ecosystem in a significant manner. Subtidal sediment habitats are considered resilient to all but intense fishing activity using anchored nets and lines on species rich sediment habitats or those with long-lived bivalves. Abrasion impacts are greater on subtidal coarse sediment compared to subtidal sand as the coarser habitats often contain populations of epifauna which are slow growing and take longer to recover (Bolam *et al.*, 2017). Static gears are more likely to cause a negative impact on softer sediments such as subtidal mud and muddy sands (De-Bastos, 2023).

Table 5 identifies eleven sediment biotopes with medium sensitivity to the abrasion pressure. These are described fully in **section 4.3.2**. Of note to anchored nets and lines is one of the subtidal sand feature's biotopes, '*Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand', which is particularly sensitive to the abrasion pressure from all gears, including static gears, due to the fragility of the key species and the soft sediment where they occur (De-Bastos, 2023). Conversely, the subtidal sand biotope '*Maldanid* polychaetes and *Eudorellopsis deformis* in deep circalittoral sand or muddy sand' is relatively protected from surface disturbance by its burrowing life habit and is thought to have no sensitivity to surface abrasion from correctly deployed nets, weights and anchors (Ashley, 2016).

The evidence collated on the impacts of anchored nets and lines within the Impacts Evidence documents[5] suggests that they are unlikely to adversely affect the designated subtidal sediment features or any of the attributes laid out in **Table 4** due to their static nature, small footprint and no observed anchored nets and lines activity during the period considered.

Therefore, **MMO concludes that the ongoing use of anchored nets and lines at the levels described does not pose a significant risk of hindering the achievement of the conservation objectives of Markham's Triangle MPA.**

4.3.2 Bottom towed gear

The relevant pressures on the subtidal coarse sediment, subtidal mixed sediments, subtidal mud, and subtidal sand features of Markham's Triangle MPA from bottom towed gear were identified in **Table 3** and are:

- abrasion or disturbance of the substrate on the surface of the seabed*;
- changes in suspended solids (water clarity) $^{\Delta}$;
- penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion*;
- removal of non-target species;
- removal of target species; and
- smothering and siltation rate changes (light) $^{\Delta}$.

Pressures marked with matching superscript symbols ($^{\Delta}$ and *) have been consolidated due to the similar nature of their impacts on the sediment features.

Section 4.2 describes the fishing activity within the site and notes that demersal trawls were the most prevalent gear used within the site, followed by demersal seines, and these occurred throughout the entire site over all sediment features. SAR values also indicated that these gears sweep the entire site roughly once to twice a year. A small amount of dredging occurred sporadically within the northern part of the site in 2020 and 2021. The boundaries between sediment features are unlikely to be clearly defined and habitats will grade into each other across a transitional boundary. Therefore, dredging could have occurred over all sediment features.

As per section 8.4 of the bottom towed gear Impacts Evidence document[6], the abrasion and penetration pressures from this gear type can have both biological and physical impacts. These pressures are more likely to have physical impacts on subtidal mud than other sediment features because bottom towed gears are able to penetrate much deeper in mud habitats than in sandy habitats and because mud habitats have high physical stability. This can create furrows with much greater topographic relief than would naturally occur in mud habitats. Conversely, abrasion can also flatten the finer-scale topography of subtidal mud. These factors can combine to cause smooth topography interspersed with high relief features, which will take a long time to recover. Disturbance of subtidal mud sediments also leads to larger changes in biogeochemistry than in sandy habitats and impacts the nutrients in the sediment available for primary production.

Physical impacts on the remaining sediment features of the site are unlikely to significantly impact their large-scale topography. Of more concern are the impacts to

the biological structure of sediment habitats. Biological impacts that could occur include damage and mortality to flora and fauna on the seabed via surface and subsurface abrasion and penetration, as well as long term shifts in biological communities towards smaller, short-lived, opportunistic species that exhibit greater resilience to anthropogenic activity. Furthermore, the close contact interaction between the fishing gear and seabed can also alter the habitat structure and attract short-term scavengers.

Section 8.5.3 within the bottom towed gear Impacts Evidence document[6] investigates variations in sediment type and finds communities in subtidal coarse sediment and subtidal mixed sediments are sensitive to bottom towed gear activity because they generally contain large proportions of long-lived and sessile epifauna which are easily damaged or removed by the pass of bottom towed gears leading to reduced diversity, abundance and occurrence. There is limited information on the impacts of bottom towed gear on subtidal sand, but ‘clean’ sand and ‘well sorted’ sediments generally appear to have greater resilience to and recovery from, fishing disturbance. As the mud fraction of sand increases (for example muddy sand vs coarse sand) recovery times also increase, making muddy sediments more sensitive. Survey data collected in 2012 indicates that the site does not appear to have any well-sorted 'clean' sand and that all of the subtidal sand sediment samples were gravelly or muddy (Green and Cooper, 2014).

Of the seven possible subtidal coarse sediment biotopes that could be found within Markham’s Triangle, one has medium sensitivity to penetration and is shown in **Table 5**. This sensitivity is based on expert judgement and the known fragility of the tests of a characterising species, *Echinocyamus pusillus* (Tillin and Watson, 2023). There is no direct evidence for this sensitivity, however, or any direct evidence of mortality or damage to the characterising species, *Branchiostoma lanceolatum*.

The three subtidal sand biotopes listed in **Table 5** have medium sensitivity to the abrasion and penetration pressures. These biotopes are deemed sensitive because many of the characterising species live in burrows close to the sediment surface and can be damaged or destroyed by passing fishing gear that may collapse their burrows or directly damage their extended feeding appendages (Ashley, 2016; De-Bastos, 2023; De-Bastos, Hill, Lloyd, *et al.*, 2023). The subtidal sand biotope ‘*Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand’ is particularly sensitive to the abrasion pressure due to the fragility of the key species (De-Bastos, 2023). Larger bivalve species associated with the subtidal sand biotopes of the site are likely to be removed by bottom towed gears and have the potential to be targeted by commercial fishers (Tillin, 2022b, 2022a; Tillin and Rayment, 2022; Tillin and Budd, 2023; Tillin, Lloyd and Watson, 2023). Dredges are the most efficient method used to target the removal of bivalves.

The four subtidal mud biotopes with medium sensitivity to abrasion and penetration are listed in **Table 5**. Brittlestars within the characterising species of these biotopes

are easily damaged by bottom towed fishing gears but can tolerate considerable damage to their arms without suffering mortality due to their ability to regenerate (De-Bastos and Budd, 2016; E. De-Bastos, 2016b, 2016a; E. S. R. De-Bastos, 2016). Bivalves and urchins within these biotopes have higher mortality rates because they have fragile shells and are unable to regenerate in the same way. One subtidal mud biotope (*Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud (De-Bastos and Budd, 2016)) may even contain the sea-pen *Virgularia mirabilis,* which is sensitive to damage from bottom towed gear. The commercially important *Nephrops norvegicus* or Norweigan lobster are not a designated feature of the site, however they are potentially a key and influential species of the subtidal mud designated feature. From the fisheries landings data (**Table A1. 3**), expert opinion from MMO coastal officers and the Operations team there is a possible non-UK vessel Nephrops fishery known to occur in the 'Silver Pits' area, therefore it cannot be said with certainty that this activity is not occurring within the boundary of Markham's Triangle MPA. The continued removal of this target species and the impacts from abrasion, disturbance and penetration of the substrate below the surface of the seabed will result in the failure of the MPA to reach the favourable condition target.

The four subtidal mixed sediments biotopes listed in **Table 5** have medium sensitivity to abrasion and penetration pressures. Two of these biotopes contain burrowing anemones such as *Cerianthus lloydii*, that extend their tentacles into the water column to feed. Although there was no direct evidence on the sensitivity of *C. lloydii* to abrasion and penetration, it is thought that the anemone may be able to avoid these pressures to an extent by swiftly retracting into their tubes when required (Perry and Watson, 2023, 2024). However, they likely remain vulnerable when feeding close to the surface. There is evidence of the hydroids characteristic of these biotopes being entangled and removed by abrasion but this was on rock surfaces and damage was incremental with increasing frequency of trawls rather than the first pass causing the most damage (Perry and Watson, 2023, 2024).

When the subtidal mixed sediments biotope '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (Readman and Watson, 2024) is associated with a sediment instead of circalittoral rock, an infaunal sample is required to characterise it. This has not occurred for Markham's Triangle as there is no known record of this biotope within the site at the current time. It must be acknowledged however that lack of data does not equate to confirmed absence, and hence confidence in an absence of this biotope must be regarded as low. If it is present, abrasion and penetration could cause damage and mortality due to the erect and sessile nature of the characterising bryozoans and hydroids (Readman and Watson, 2024). However, it should be noted that natural abrasion from the scouring of sand and gravel is an important environmental condition to allow this biotope to persist (Readman and Watson, 2024) so the penetration pressure may be of most concern.

The remaining subtidal mixed sediments biotope in **Table 5** is '*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment' (De-Bastos, Hill, Garrard, *et al.*, 2023). As mentioned in other biotope descriptions, brittlestars are sensitive to damage from abrasion but have considerable ability to regenerate (De-Bastos, Hill, Garrard, *et al.*, 2023). However, penetration from bottom towed gear is likely to remove or displace the cobbles, pebbles or small boulders of this biotope meaning that the entire biotope could be lost or severely damaged (De-Bastos, Hill, Garrard, *et al.*, 2023). Increased footprint, magnitude and duration of the pressure will increase the impact on the biotope.

The subtidal mixed sediments feature occupies one eighth of the site and is the only feature with medium sensitivity to the smothering and siltation pressure. As discussed in section 8.4.2 of the bottom towed gear Impacts Evidence document[6], the contact of bottom towed gear on the seabed causes the top layers of sediment to mix with the water, particularly around and behind the gear. Small particles are then entrapped in the ambient water, creating a suspension of particles, a cloud in the water column which will then settle. The amount of suspended sediment will depend on a number of contributing factors such as turbulence, gear type, sediment type, sediment grain size and the degree of sediment compaction. Research into smothering and siltation is predominately in relation to subtidal sand and subtidal mud and found that trawling over these substrates generated the resuspension of fine sediments, creating a sediment plume which can be carried up to over 1 km away. Subtidal mixed sediments are a heterogeneous environment consisting of a variety of sediments; muddy gravelly sands and mosaics of cobbles and pebbles, often embedded in or lying upon sand, gravel or mud. It can therefore be assumed that some impacts may be similar to those described, and bottom towed gear will have the potential to cause changes in smothering and siltation rates, negatively impacting organisms within the sensitive biotopes and altering the biological structure of key and influential species.

Table 5 identifies three subtidal mixed sediments biotopes with medium sensitivity to the smothering and siltation pressure (De-Bastos, Hill, Garrard, *et al.*, 2023; Perry and Watson, 2023, 2024). Two of these biotopes contain the burrowing, tube dwelling anemone, *C. lloydii*, which extends its tentacles above the tube, into the water column, to feed. Despite its ability to actively burrow through sediment, it is thought that a smothering of 5 cm or more is likely to cause some mortality (Perry and Watson, 2024). Hydroids such as *Nemertesia* spp, exhibit rapid rates of recovery from disturbance through repair, asexual reproduction, and larval colonisation, however in general it appears hydroids are sensitive to smothering due to the damage it can cause to their fragile feeding appendages (Perry and Watson, 2023). Both biotopes rely on the ability of *C. lloydii* to recover, however a lack of information regarding resilience and resistance of *C. lloydii* has resulted in a medium sensitivity based on expert judgement. Still, confidence in this assessment is low due to an absence of direct evidence for the above-mentioned species.

The final subtidal mixed sediments biotope with medium sensitivity to the smothering and siltation pressure contains two species of brittlestar, *O. fragilis* and/or *O. nigra* (De-Bastos, Hill, Garrard, *et al.*, 2023). These particular species of brittlestar are suspension/filter feeding organisms, holding their fragile arms up to catch prey in the water column and are often found in dense beds. Material in suspension can impact the efficiency of filter and suspension feeding and respiration. Dense beds of these species do not occur in high levels of sedimentation as it can suffocate them. Markham's Triangle MPA is located in the open sea, it is exposed to wave action which encourages the dispersion of fine sediments potentially mitigating the severity of this pressure naturally occurring in this location.

Given that the SAR levels for the site indicate that it is being completely swept by trawls and seines once or twice per year, it is likely that the sedimentary features of Markham's Triangle MPA are experiencing regular exposure to the abrasion, penetration and smothering pressures. As many of the biotopes within the features of the site are sensitive to these pressures, this activity may hinder the achievement of the site's general management approach 'recover to favourable condition'. The first pass of a trawl has the largest and most damaging initial impact on biomass and production of sediments, causing high levels of mortality (Hiddink *et al.*, 2006). Subsequent passes have additional effects and repeated passes allow little time for species to recover. Bottom towed gear contacts a much larger area of the seabed than static gears meaning that they have an impact on a spatial scale much larger than anchored nets and lines or traps.

Therefore, **MMO concludes that the ongoing use of bottom towed gear poses a significant risk of hindering the achievement of the conservation objectives of the subtidal coarse sediment, subtidal sand, subtidal mixed sediments and subtidal mud features of Markham's Triangle MPA.**

4.3.3 Traps

The relevant pressures on the subtidal coarse sediment, subtidal mixed sediments, subtidal mud, and subtidal sand features of Markham's Triangle MPA from anchored nets and lines were identified in **Table 3** and are:

- abrasion or disturbance of the substrate on the surface of the seabed;
- removal of non-target species; and
- removal of target species.

Section 4.2 describes the fishing activity within the site and concludes that there was no use of traps within the site during the six -year period, except in 2020 when 0.22 t was landed by over 12 m vessels. However, this low activity level may change in the future.

As per section 9.4 of the traps Impacts Evidence document[7], abrasion impacts from static gear types, including traps, are unlikely to be a concern unless they occur

where particularly sensitive species are present or when fishing occurs at damaging levels of intensity. Impacts on these features relating to abrasion or disturbance of the substrate on the surface of the seabed occur primarily during the setting and retrieval of traps and their associated ropes, weights, and anchors, as well as by their movement over the seabed during rough weather.

Table 5 identifies all the relevant biotopes with medium sensitivity to the abrasion pressure that could possibly occur within the MPA. These are described fully in **section 4.3.2**. Of note to traps is the subtidal sand biotope '*Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand', which is particularly sensitive to the abrasion pressure from all gears, including static gears, due to the fragility of the key species and the soft sediment where they occur (De-Bastos, 2023). Conversely, the subtidal sand biotope '*Maldanid* polychaetes and *Eudorellopsis deformis* in deep circalittoral sand or muddy sand' is relatively protected from surface disturbance by its burrowing life habit and is thought to have no sensitivity to surface abrasion from correctly deployed nets, weights and anchors, (Ashley, 2016) which may also apply to correctly deployed traps.

The information and research within the traps Impacts Evidence documents[7] suggests that static gears have a relatively low impact on benthic communities (Roberts *et al.*, 2010) and traps are unlikely to be a concern to the designated sediment features of the site at the activity levels described.

Therefore, MMO concludes that the ongoing use of traps at the levels described does not pose a significant risk of hindering the achievement of the conservation objectives of Markham's Triangle MPA.

4.4 Part B conclusion

The assessment of anchored nets and lines, bottom towed gear and traps on subtidal sand, subtidal mud, subtidal mixed sediments, and subtidal coarse sediment features of Markham's Triangle MPA has concluded that the ongoing use of bottom towed gear may result in a significant risk of hindering the achievement of the conservation objectives of the MPA. Management measures will therefore be implemented for bottom towed gear for Markham's Triangle MPA. **Section 6** contains further details of these measures.

5 Part C - In-combination assessment

This section assesses the impacts of fishing activities in-combination with relevant activities taking place. This includes the following:

- fishing interactions assessed in Part B but which were not considered, alone, to pose a significant risk of hindering the achievement of the conservation objectives; and
- other activities: such as marine development infrastructure plans and projects that occur in the MPA.

ArcGIS software has been used to check relevant activities that occur within, or adjacent to, the assessed site where there could be a pathway for impact. To determine relevant activities to be included in this part of the assessment, a distance of 5 km was selected as suitable to capture any potential way in which the activity could impact the benthic features of the site in combination with effects of the fishing activities assessed. A 5 km buffer was therefore applied to the site boundary to identify relevant activities. This assessment considers the in-combination impacts of marine licensable activities that are ongoing or upcoming, and with the same medium to high-risk pressure impact pathways as permitted fishing activity. As the models were run using ArcGIS in August 2023, any licences that ended before this date were screened out of the assessment.

The North Sea Transition Authority (NSTA) is responsible for regulating the oil, gas and carbon storage industries, and as such these activities fall outside of MMO's marine licensing remit. Oil, gas and carbon storage industry activities are not currently considered in this draft assessment, as information on the potential pressures exerted by associated activities is currently under review. Following formal consultation, relevant oil, gas and carbon storage industry activities that could impact the site in-combination with the effects of assessed fishing activities will be included before finalising this assessment, alongside marine licence applications submitted after August 2023.

There may be historic submarine cables within this MPA, these cables are already in-situ and are unlikely to have any residual abrasion/removal pressure in-combination with the assessed fishing activity. Any abrasion/removal pressure from submarine cable operation and maintenance activity will be temporary with limited seabed impacts and is therefore unlikely to have significant in-combination effects with assessed fishing activity.

Bottom towed gear was identified in Part B as requiring management to avoid posing a significant risk of hindering the achievement of the site's conservation objectives. Anchored nets and lines and traps are the only remaining fishing activities that interact with the seabed that could occur within Markham's Triangle MPA. In-

combination effects of these fishing activities as well as these activities in-combination with other relevant activities will be assessed in this section.

In accordance with the methodology detailed above, ArcGIS identified one project for the Hornsea Offshore Wind Farm Project 3 (DCO/2016/00001)[8] proposing the construction of up to 231 offshore wind turbines to be located within a 696 km^2 area as well as associated cables and infrastructure. This is the third project to be developed within the former Hornsea Zone of the North Sea, with Hornsea 1 and Hornsea 2 wind farms already operational. The proposed area overlaps significantly with the western portion of Markham's Triangle MPA. The activities relating to this project may include offshore wind construction, operation and maintenance and power cable construction, operation and maintenance. As this project lies within the site boundaries there are possible in-combination effects with assessed fishing activity.

The Pressure Activities Database (PAD)[9] and **Table 3** were used to identify medium to high risk pressures exerted by fishing and non-fishing activities to identify those which require in-combination assessment (**Table 6**).

Table 6 summarises the pressures exerted by fishing and non-fishing activities and identifies those pressures exerted by all gears (Y: pressure exerted). Activity-pressure interactions are highlighted dark blue to indicate an in-combination effect. Only fishing activity with no proposed or current fisheries management in place are considered.

[8] National Infrastructure Project. Planning Inspectorate: www.national-infrastructure-consenting.planninginspectorate.gov.uk/project-search (Last accessed 16 July 2024)

[9] **J**NCC Pressures-Activities Database (PAD): hub.jncc.gov.uk/assets/97447f16-9f38-49ff-a3af-56d437fd1951 (last accessed 11 March 2024).

Table 6: Pressures exerted by fishing activities.

	Non-fishing activities		Fishing activities	
Potential pressures	**Offshore wind: construction; operation and maintenance**	**Power cable: construction; operation and maintenance**	**Anchored nets and lines**	**Traps**
Abrasion or disturbance of the substrate on the surface of the seabed	Y	Y	Y	Y
Removal of non-target species			Y	Y
Removal of target species			Y	Y

5.1 In-combination pressure sections

Fisheries vs fisheries in-combination pressures will be considered in this section. The pressures exerted by the non-fishing activity will also be considered in-combination with the anchored nets and lines and traps fishing pressures.

5.2 Fishing vs Fishing in-combination pressures

5.2.1 Abrasion and disturbance of the substrate on the surface of the seabed and removal of target and non-target species

As noted in **section 4.3** impacts from the removal of target and non-target species pressure is not being considered in detail in this assessment. In-combination impacts from the removal of target and non-target species pressures are more fully assessed under the pressure abrasion, as the detail of key structural and influential species is yet to be fully defined. Therefore, the removal pressures are not considered further in this in-combination assessment. The pressures may require further consideration as future evidence becomes available, in conjunction with updated conservation advice from JNCC and Natural England.

The combined impacts from anchored nets and lines and traps could potentially increase the risk of negative effects from the pressure abrasion and disturbance of the substrate on the surface of the seabed. However, traps alone have been assessed as having no significant risk of hindering the achievement of the conservation objectives of the MPA, and there are currently no landings data to evidence the use of anchored nets and lines within the site, therefore, MMO does not

consider the in-combination effect from these activities likely to cause a significant risk of hindering the achievement of the conservation objectives.

Therefore, MMO concludes that the combined pressures from anchored nets and lines and traps will not result in a significant risk of hindering the achievement of the conservation objectivise for Markham's Triangle MPA at the levels described.

5.3 Fishing vs non-fishing activities in-combination pressures

5.3.1 Abrasion and disturbance of the substrate on the surface of the seabed

The designated features of the Markham's Triangle MPA are sensitive to physical damage through surface abrasion and disturbance of the substrate from anchored nets and lines and traps during gear deployment, movement of the gear on the seabed due to tidal movements and storm activity, and as the gear is dragged along the seabed during retrieval.

Activities associated with the Hornsea Offshore Wind Farm Project 3 (DCO/2016/00001) which might cause abrasion or disturbance of the seabed relate to offshore wind construction, operation and maintenance, and power cable construction, operation and maintenance. This includes the construction of offshore infrastructure, likely to include up to 231 offshore wind turbines, foundations (for offshore turbines, platforms, substations and stations), scour protection, offshore accommodation platform(s), array cables linking the individual wind turbines to an offshore substation and a HVAC or HVDC transmission system. Installation of this infrastructure within the area of 696 km^2, through it's placement, associated scour protection and the use of jack up barges, will cause abrasion and disturbance of the seabed. In addition, the anchoring of installation vessels during windfarm and cable construction and maintenance may damage the seabed, from both deployment and locking of anchors and from the chain causing abrasion and scour. The use of jack up legs during maintenance cause depressions in the seabed, further contributing to abrasion and disturbance.

Specific activities relating to the construction, operation and maintenance of cables, which will result in abrasion and disturbance include cable installation, anchor placement and pre-sweep dredging. Possible installation methods include trenching, dredging, jetting, ploughing, mass flow excavation, vertical injection and rock cutting. It is expected that 830 km of array cable will be required with an estimated 12,450,000 m^2 of seabed disturbed through installation. It is estimated that around 10 % of these cables will require protection, with rock protection area estimated to be up to 581,000 m^2. In addition to the array cables, it may be necessary to install up to 225 km of offshore interconnector cables and associated protection, disturbing an area of seabed of 3,375,000 m^2. The footprint of the cable installation machinery

varies depending on the installation methods used but could range from 5 to 20 m wide. Lower-level impacts can result from anchor handling within the anchor corridor up to 1 km either side of the cable. Even cables laid on the surface can cause abrasion, particularly in areas where wave action is high; this may be of concern due to exposed, offshore location of the site. While the frequency of maintenance of these cables is low, uncovering and reburying will also cause damage to the seabed.

However, as Markham's Triangle was not a designated MCZ at the time of the DCO, the impacts of this offshore wind project have since been reviewed and the applicant has now committed to avoiding direct impacts on the features of the MPA. As such it has been agreed that no infrastructure will be placed within the boundaries of the MPA, though construction may still occur within the 5 km buffer zone.

As detailed in **section 5.2.1**, anchored nets and lines and traps at the activity levels described are not considered to be causing significant pressure through abrasion and disturbance. It is possible that activities linked to the Hornsea Wind Farm Project 3 (e.g. construction of offshore infrastructure), in-combination with anchored nets and lines and traps may increase the potential for this pressure to have negative cumulative effects on the designated features of the MPA. However, as previously stated, Markham's Triangle MPA is now being excluded from the construction of Hornsea Wind Farm Project 3 area, as such no infrastructure will be established within the boundary of the MPA. Consequently, the fishing and non-fishing activities will be spatially separated, therefore, no pathway exists for in-combination impacts from abrasion and disturbance of the substrate on the surface of the seabed between anchored nets and lines and traps and non-fishing activity.

Therefore, MMO concludes that the combined pressures from anchored nets and lines and traps and other relevant activities will not result a significant risk of hindering the achievement of the conservation objectives for the Markham's Triangle MPA.

5.4 Part C conclusion

MMO concludes that different fishing gear types in combination, and fishing in-combination with other relevant activities will not result in a significant risk of hindering the achievement of the conservation objectives for Markham's Triangle MPA.

Further management measures will not therefore be implemented for fishing activities currently occurring within the MPA.

6 Conclusion and proposed management

Part A of this assessment concluded that that anchored nets and lines, bottom towed gear and traps, alone, are likely to have a significant effect on the designated features of Markham's Triangle MPA.

Part B of this assessment concluded that ongoing use of bottom towed gear on the sediment features of Markham's Triangle MPA may hinder the achievement of the conservation objectives of the MPA as a result of the impacts of abrasion or disturbance, penetration and smothering, siltation rate and suspended solid changes.

Part C of this assessment conclude that at the activity levels described, use of anchored nets and lines and traps, in combination with each other and with other relevant activities, will not result in a significant risk of hindering the achievement of the conservation objectives of the MPA.

To ensure that fishing activities do not result in a significant risk of hindering the conservation objectives of the MPA, MMO will implement a byelaw to prohibit the use of bottom towed gear throughout Markham's Triangle MPA.

Figure 2 shows the proposed management area in line with the conclusions set out above.

The boundaries of the proposed management area include an appropriate buffer zone to prevent direct damaging physical interactions between fishing activities and the designated features to be protected. The rationale for determining buffer size can be found in in Annex 2 of the Stage 3 MPA Site Assessment Methodology[4] document.

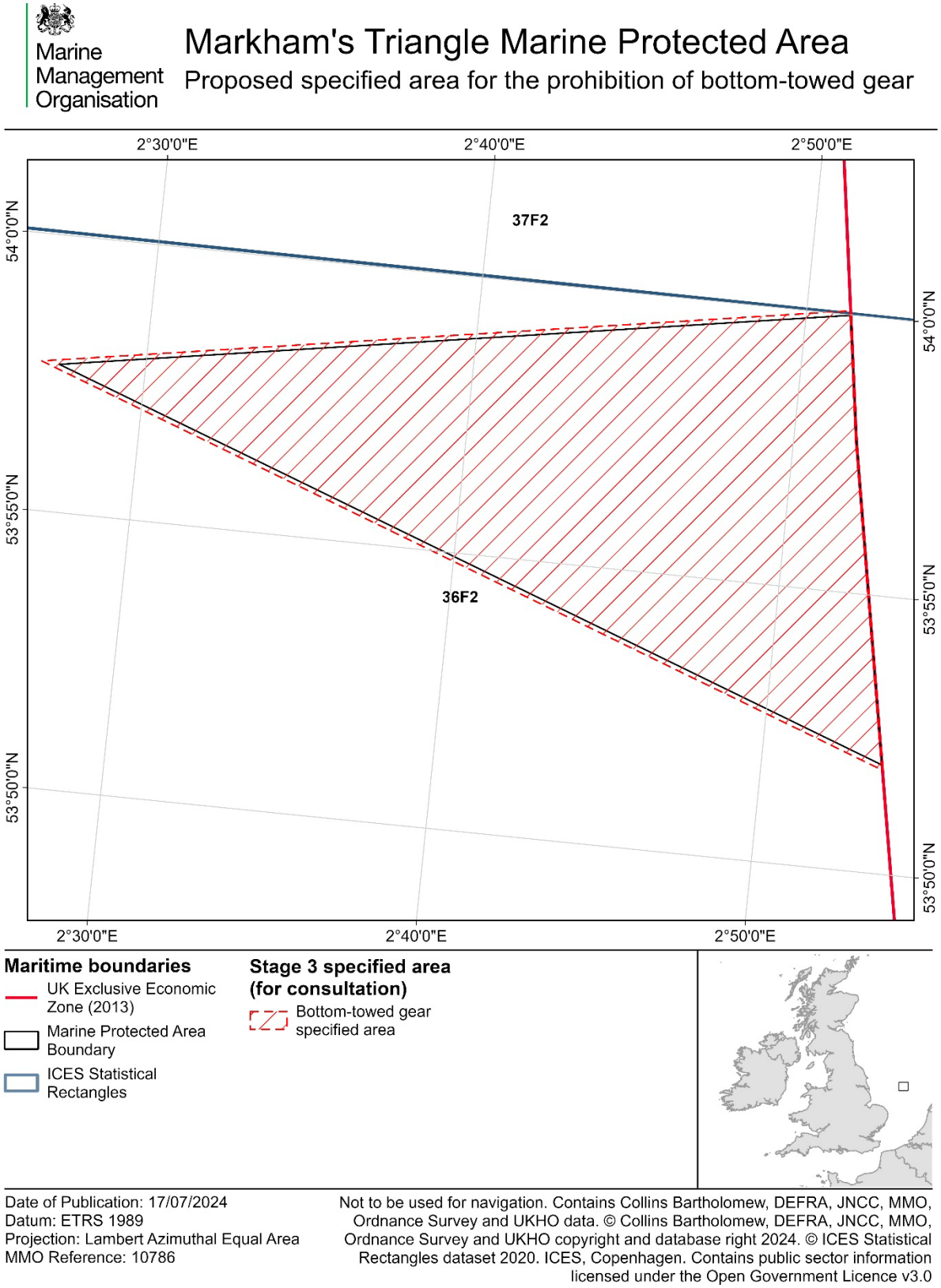

Figure 2: Map of proposed management.

7 Review of this assessment

MMO will review this assessment every five years, or earlier if significant new information is received. Such information could include:

- updated conservation advice;
- updated advice on the condition of the site's feature(s); and
- significant increase in activity levels

To coordinate the collection and analysis of information regarding activity levels, and to ensure that any required management is implemented in a timely manner, a monitoring and control plan will be implemented for this site. This plan will be developed in line with MMO's Monitoring and Control Plan framework.

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Annexes

Annex 1: Fishing activity data

Table A1.1: VMS record count per nation group (UK and EU Member State) and proportional activity (%), per gear, per gear group, per year (2016 to 2021), totals and annual average (2016 to 2021). All numbers are rounded to the nearest whole number.

			2016		2017		2018		2019		2020		2021		Total (2016 to 2021)		Annual average (2016 to 2021)
Gear group	Gear code	Nation group	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count
Anchored nets/lines	GNS	EU	0	0	2	100	0	0	0	0	0	0	0	0	2	100	0
	GNS Total		**0**	**0**	**2**	**100**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**100**	**0**
Anchored nets/lines total			**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
Demersal Seine	SDN	EU	110	100	155	100	99	100	167	100	143	99	34	94	708	99	118
	SDN	UK	0	0	0	0	0	0	0	0	2	1	2	6	4	1	1
	SDN Total		**110**	**88**	**155**	**84**	**99**	**94**	**167**	**90**	**145**	**67**	**36**	**15**	**712**	**67**	**119**
	SPR	EU	0	0	0	0	1	100	0	0	2	100	0	0	3	100	1
	SPR Total		**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**2**	**1**	**0**	**0**	**3**	**0**	**1**
	SSC	EU	15	100	28	93	5	100	18	100	70	100	197	93	333	95	56
	SSC	UK	0	0	2	7	0	0	0	0	0	0	14	7	16	5	3
	SSC Total		**15**	**12**	**30**	**16**	**5**	**5**	**18**	**10**	**70**	**32**	**211**	**85**	**349**	**33**	**58**
Demersal seine total			**125**	**23**	**185**	**46**	**105**	**17**	**185**	**24**	**217**	**34**	**247**	**46**	**1,064**	**30**	**177**
Demersal trawl	OTB	EU	103	100	89	100	181	100	378	100	240	100	253	100	1,244	100	207
	OTB Total		**103**	**24**	**89**	**42**	**181**	**36**	**378**	**69**	**240**	**69**	**253**	**91**	**1,244**	**54**	**207**

			2016		2017		2018		2019		2020		2021		Total (2016 to 2021)		Annual average (2016 to 2021)
Gear group	**Gear code**	**Nation group**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**
	OTT	EU	12	92	11	100	17	100	13	100	15	100	16	100	84	99	14
	OTT	UK	1	8	0	0	0	0	0	0	0	0	0	0	1	1	0
	OTT Total		**13**	**3**	**11**	**5**	**17**	**3**	**13**	**2**	**15**	**4**	**16**	**6**	**85**	**4**	**14**
	TBB	EU	303	98	112	100	233	78	112	73	95	100	10	100	865	88	144
	TBB	UK	6	2	0	0	66	22	41	27	0	0	0	0	113	12	19
	TBB Total		**309**	**73**	**112**	**53**	**299**	**60**	**153**	**28**	**95**	**27**	**10**	**4**	**978**	**42**	**163**
Demersal trawl Total			**425**	**77**	**212**	**52**	**497**	**80**	**544**	**70**	**350**	**55**	**279**	**52**	**2,307**	**65**	**385**
Dredge	DRB	UK	0	0	0	0	0	0	0	0	40	100	1	100	41	100	7
	DRB Total		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**40**	**100**	**1**	**100**	**41**	**100**	**7**
Dredge Total			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**40**	**6**	**1**	**0**	**41**	**1**	**7**
Midwater Trawl	OTM	EU	0	0	0	0	3	100	0	0	0	0	0	0	3	100	1
	OTM Total		**0**	**0**	**0**	**0**	**3**	**20**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**1**
	PTM	EU	0	0	0	0	12	100	43	100	18	100	10	100	83	100	14
	PTM Total		**0**	**0**	**0**	**0**	**12**	**80**	**43**	**100**	**18**	**100**	**10**	**100**	**83**	**97**	**14**
Midwater Trawl Total			**0**	**0**	**0**	**0**	**15**	**2**	**43**	**6**	**18**	**3**	**10**	**2**	**86**	**2**	**14**
Traps	FPO	UK	0	0	0	0	0	0	0	0	6	100	0	0	6	100	1
	FPO Total		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**100**	**0**	**0**	**6**	**100**	**1**
Traps Total			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**1**	**0**	**0**	**6**	**0**	**1**
Unknown	NK	EU	0	0	5	83	1	13	0	0	0	0	0	0	6	33	1
	NK	EFTA	4	100	1	17	7	88	0	0	0	0	0	0	12	67	2
	NK Total		**4**	**100**	**6**	**100**	**8**	**100**	**0**	**0**	**0**	**0**	**0**	**0**	**18**	**100**	**3**
Unknown Total			**4**	**1**	**6**	**1**	**8**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**18**	**1**	**3**

			2016		2017		2018		2019		2020		2021		Total (2016 to 2021)		Annual average (2016 to 2021)
Gear group	Gear code	Nation group	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count
Grand Total			554	1	405	1	625	1	772	1	631	1	537	1	3,524	1	587

Table A1.2: UK live weight landings tonnage (t) estimates by gear from vessels over 12 m in length in the MMO section of Markam's Triangle MPA (2016 to 2020).

Gear group	Gear code	2016	2017	2018	2019	2020	Total (2016 to 2020)	Average (2016 to 2020)
Demersal Seine	SDN	0	0	0	0	0.57	0.57	0.11
	SSC	0	4.09	0	0	0	4.09	0.82
Demersal Seine Total		**0**	**4.09**	**0**	**0**	**0.57**	**4.67**	**0.93**
Demersal trawl	OTB	0	0	0	0	0	0	0
	OTT	0.81	0	0	0	0	0.81	0.16
	TBB	6.74	0	50.96	27.29	0	84.98	17.00
Demersal trawl Total		**7.55**	**0**	**50.96**	**27.29**	**0**	**85.79**	**17.16**
Dredge	DRB	0	0	0	0	0.92	0.92	0.18
Dredge Total		**0**	**0**	**0**	**0**	**0.92**	**0.92**	**0.18**
Traps	FPO	0	0	0	0	0.22	0.22	0.04
Traps Total		**0**	**0**	**0**	**0**	**0.22**	**0.22**	**0.04**
Grand Total		**7.55**	**4.09**	**50.96**	**27.29**	**1.72**	**91.60**	**18.32**

Table A1. 3: EU27 live weight landings tonnage (t) estimates by gear from vessels over 12 m in length in the MMO section of Markam's Triangle MPA (2016 to 2020).

Gear group	Gear code	2016	2017	2018	2019	2020	Total (2016 to 2020)	Average (2016 to 2020)
Demersal Seine	SDN	10.92	38.73	12.86	2.59	6.20	71.30	14.26
	SSC	141.25	196.83	74.64	67.26	54.36	534.35	106.87
Demersal Seine Total		**152.17**	**235.57**	**87.50**	**69.85**	**60.56**	**605.65**	**121.13**
Demersal trawl	OTB	21.11	85.61	168.83	209.22	109.50	594.26	118.85
	OTT	0	0	0	0.11	0.26	0.37	0.07
	TBB	55.57	11.09	20.33	6.28	7.97	101.24	20.25
Demersal trawl Total		**76.68**	**96.71**	**189.15**	**215.61**	**117.73**	**695.88**	**139.18**
Midwater Trawl	OTM	0	0	154.10	0	0	154.10	30.82
Midwater Trawl Total		**0**	**0**	**154.10**	**0**	**0**	**154.10**	**30.82**
Grand Total		**228.86**	**332.27**	**430.75**	**285.46**	**178.29**	**1,455.62**	**291.12**

Table A1.4: Percentage of each ICES rectangle intersected by the MMO section of Markam's Triangle MPA.

ICES rectangle	Percentage overlap (%)
36F2	5.48

Table A1.5: **UK live weight landings tonnage (t) estimates by gear from vessels under 12 m in length for the MMO section of Markam's Triangle MPA (2016 to 2020).**

Gear group	Gear code	2016	2017	2018	2019	2020	Total (2016 to 2020)	Average (2016 to 2020)
Dredge	DRB	0	0	0	0.14	0	0.14	0.03
Dredge Total		**0**	**0**	**0**	**0.14**	**0**	**0.14**	**0.03**
Grand Total		**0**	**0**	**0**	**0.14**	**0**	**0.14**	**0.03**

Table A1.6: **EU27 live weight landings tonnage (t) estimates by gear from vessels under 12 m in length for the MMO section of Markam's Triangle MPA (2016 to 2020).**

Gear group	Gear code	2016	2017	2018	2019	2020	Total (2016 to 2020)	Average (2016 to 2020)
Demersal Seine	SSC	0	0	0	0	0.26	0.26	0.05
Demersal Seine Total		**0**	**0**	**0**	**0**	**0.26**	**0.26**	**0.05**
Demersal trawl	OTB	0	0	0	0	0.16	0.16	0.03
	TBB	0	0	0.09	0	0.46	0.55	0.11
Demersal trawl Total		**0**	**0**	**0.09**	**0**	**0.62**	**0.71**	**0.14**
Midwater Hook/Lines	LHP	0.01	0	0	0	0	0.01	0
Midwater Hook/Lines Total		**0.01**	**0**	**0**	**0**	**0**	**0.01**	**0**
Grand Total		**0.01**	**0**	**0.09**	**0**	**0.88**	**0.98**	**0.20**

Table A1.7: Mean annual surface and subsurface SAR values for C-squares intersecting the MMO section of Markam's Triangle MPA (2016 to 2020).

Gear group	SAR category	2016	2017	2018	2019	2020
Demersal seines	Surface	1.47	2.03	0.86	0.90	1.22
	Subsurface	0.07	0.09	0.04	0.04	0.05
Dredges	Surface	0	0	0	0	0.004
	Subsurface	0	0	0	0	0.004
Demersal trawls	Surface	2.15	1.66	2.52	2.84	1.94
	Subsurface	1.03	0.60	0.94	0.87	0.58
Bottom towed gear total	**Surface**	**3.62**	**3.69**	**3.38**	**3.74**	**3.16**
	Subsurface	**1.10**	**0.69**	**0.97**	**0.91**	**0.63**

Table A1.8: **Fishing effort (days) recorded by UK vessels under 12 m in length, separated by gear type for the area of Markam's Triangle MPA that intersects the MMO portion of ICES rectangles 36F2 (2016 to 2021). ICES rectangle level data has been apportioned to the MPA based on the percentage area of the ICES rectangle that intersects the MPA (Table A1.4).**

Gear group	Fishing effort (days at sea)							
	2016	2017	2018	2019	2020	2021	Total (2016 to 2021)	Annual average (2016 to 2021)
Dredge	0	0	0	0.16	0	0.11	0.27	0.05
Bottom towed gear total	**0**	**0**	**0**	**0.16**	**0**	**0.11**	**0.27**	**0.05**
Traps	0	0	0	0	<0.01	0	<0.01	<0.01
Static gear total	**0**	**0**	**0**	**0**	**<0.01**	**0**	**<0.01**	**<0.01**
MPA total	**0**	**0**	**0**	**0.16**	**<0.01**	**0.11**	**0.27**	**0.05**