

Biotope delineation using the Coastal and Marine Ecological Classification Standard (CMECS) for deep reefs (30-100 m) in the Hauraki Gulf, New Zealand

These biotope descriptions should be read in conjunction with the following report:

Bell, J.J. Broadribb, M. Novak, E., Wood, G., Pierotti, M. (2024) Benthic community analysis to support the development of the Coastal and Marine Ecological Classification Standard (CMECS) for Deep Reefs (30-100 m) in the Hauraki Gulf A report prepared for the Department of Conservation under contract NOF-BIO386



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Overview of approach

We began by using a multivariate analysis to assess any statistical differences in the biological communities at both the major benthic group level and at the species/OTU level at thirteen ROV drop sites in the Hauraki Gulf (Table 1). These analyses found statistically significant differences in community composition between all thirteen ROV drops, supporting the delineation of thirteen biotopes. However, a subsequent clustering analysis identified six larger groups; however, sites within these groups were only 50-60% similar in most cases, which we decided was not similar enough to support the delineation of only six biotopes. Based on further re-examination of the videos, the abundance data from the 13 videos, and the geofrom/substrate classifications (since biotopes are not defined on biotic communities alone), we defined twelve different biotopes, with only Drop 7 (South Alderman Islands) and Drop 19 (Burgess Island) being classified as the same biotope. Further information used to define the deep-water biotopes in the Hauraki Gulf region can be found in the accompanying report. An additional electronic appendix accompanies this report, providing video clips and more pictures of each biotope

Table 1. Metadata for the surveyed deep reef sites in the Hauraki Gulf. Note: More Remotely Operated Vehicle drops were made, but only 13 were analysed for abundance data.

Drop #	Date	Site	Latitude	Longitude	Depth (m)
1	4-Feb-24	Cape Colville	S 36° 27.020'	E 175° 23.205'	44
2	4-Feb-24	South Ohinau Island	S 36° 45.904'	E 175° 55.546'	54
3	5-Feb-24	South Aldermen Islands	S 37° 00.710'	E 176° 03.245'	53
6	5-Feb-24	South Aldermen Islands	S 37° 01.470'	E 176° 06.459'	89
7	5-Feb-24	South Aldermen Islands	S 36° 59.698'	E 176° 06.596'	65
13	6-Feb-24	Cradock Channel	S 36° 15.516'	E 175° 10.632'	36
15	6-Feb-24	Southwest Mokohinau Islands	S 35° 59.986'	E 175° 07.184'	48
17	6-Feb-24	South Mokohinau Islands	S 35° 57.298'	E 175° 08.955'	60
19	6-Feb-24	Burgess Island	S 35° 53.563'	E 175° 08.301'	85
21	6-Feb-24	Burgess Island	S 35° 54.796'	E 175° 07.261'	50
24	6-Feb-24	West Atihau Island	S 35° 54.100'	E 175° 06.123'	45
25	7-Feb-24	Southeast Channel Island	S 36° 25.320'	E 175° 20.324'	47
28	7-Feb-24	Southeast Channel Island	S 35° 26.519'	E 175° 18.569'	55

Modifiers

We created our own modifier for different mesophotic reef zones, which included both bedrock and boulder substrates (Table 2). We also created a modifier to include the dominant sponge morphologies (Table 3), since many sponges could not be identified reliably from the frame grabs. We also used one of the existing CMECS modifiers for rugosity (Table 4).

Table 2. The mesophotic reef modifier considered in our classification. Mesophotic zones were classified based on the presence of macroalgae, calcareous coralline algae (CCA), and depth.

Zone	Code	Characteristics
Mesophotic Transition Zone	MTZ	Characterised by the presence of more than 10% cover of macroalgae
Mesophotic Shallow Reef	MSR	Animal-dominated reef in less than 40 m with no algae or CCA
Mesophotic Mid-Depth Reef	MMR	Reef ranging in depth generally from around 40 to 60 m that has more than 10% CCA cover
Mesophotic Deep Reef	MDR	Reefs generally below 60 m that have no CCA cover and are completely animal-dominated

Table 3. Sponge morphology modifiers. This modifier was only used in the biotope description if the sponge morphology covered more than 5% of the substrate. Note that lowercase letters are used to describe this modifier in the biotope identifiers (Table 5).

Code	Characteristics
pa	Papillate
br	Branching
ma	Massive
en	Encrusting
gl	Globulose
mi	Mixed

Table 4. Seafloor Rugosity. A value of 1 represents a completely flat surface, while a value of >2 means for each horizontal metre along the reef, you are moving up and down more than 2 m.

Rugosity	Value	Characteristics
Very Low	1.0 to < 1.25	Flat > Sand Ripples
Low	1.25 to < 1.50	Sand Ripples > Megaripples
Moderate	1.50 to < 1.75	Low Relief Reef
High	1.75 to < 2.00	Complex Reef

Very High	≥ 2.00	Very Complex, Crevices, Boulder Field
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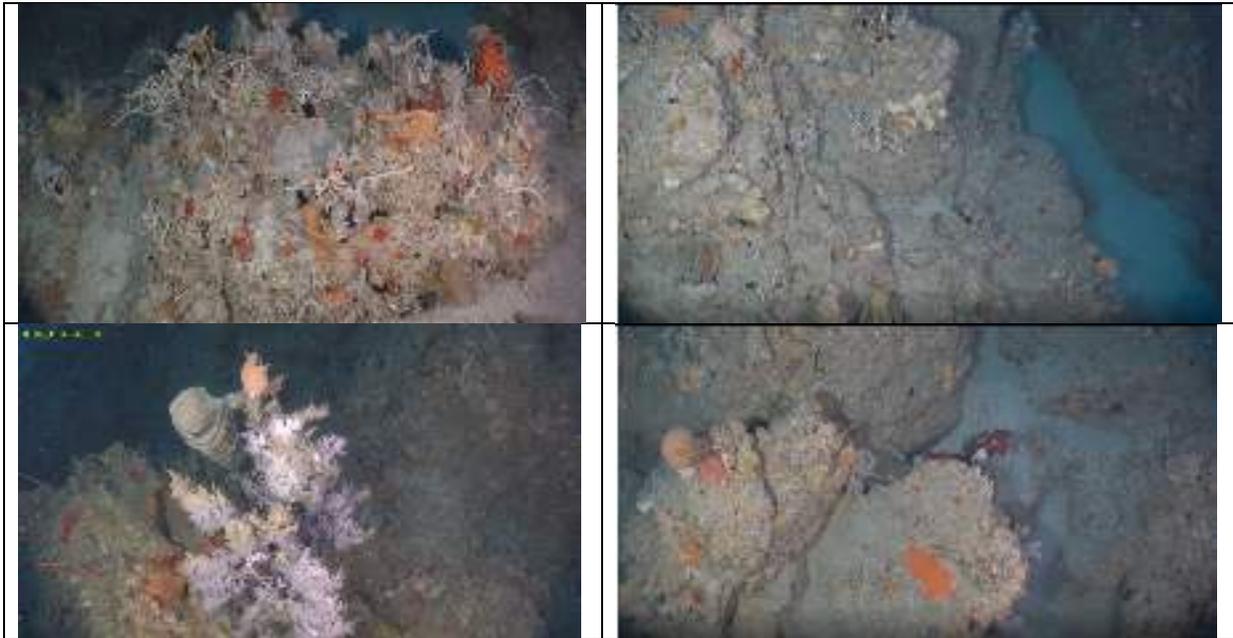
A hierarchical summary of the biotopes described in the Hauraki Gulf can be found in Table 5.

Table 5. Biotope classification hierarchy including, mesophotic reef modifier, primary substrate component, geoform, rugosity modifier, biotope identifier code and biotope name for deep reefs (30-100 m) in the Hauraki Gulf based on the Coastal and Marine Ecological Classification Standard (CMECS). Notes: Primary substrate only is given in the table. The biotope identifier is based on mesophotic reef modifier (MTZ = Mesophotic Transition Zone = MTZ, MSR = Mesophotic Shallow Reef (30-40 m), MMR = Mesophotic Mid-Depth Reef (40-60 m) or MDR = Mesophotic Deep Reef (>60 m), Primary substrate component (Bedrock = BE, Boulder = BO), Geoform (RO = Rock Outcrop or PL = Platform, note that boulder substrates have no geoform classification), dominant benthic organisms (Ma = Macroalgae, Bm = Biological Matrix, Sp = Sponge, Cca = Calcareous Coralline Algae), and the sponge morphology modifier (Papillate = pa, Branching = ba, Massive = ma, Encrusting = en, Globulose = gb and Mixed = mi). The ROV drop number refers to the metadata for the locations where the biotopes were described from, which can be found in Table 1.

Mesophotic Zone Modifier	Primary substrate component	Geoform	Rugosity modifier	Sponge morphology modifier	Biotope identifier	Biotope name
MTZ	BE	RO	Very high	en,ma	MTZ.BE.RO.Ma.Bm.Sp(en.ma)	Macroalgae, biological matrix and mixed sponges on rocky reef at the mesophotic transition zone (ROV Drop 24)
MTZ	BE	RO	Very high	ma	MTZ.BE.RO.Ma.Sp(ma).Bm	Macroalgae, sponges and biological matrix, on rocky reef at the mesophotic transition zone (ROV Drop 21)
MTZ	BO	N/A	High	ma	MTZ.BO.Bm.Sp(ma).Ma	Biological matrix, massive sponges and macroalgae on boulders at the mesophotic transition zone (ROV Drop 13)
MTZ	BO	N/A	High	en	MTZ.CO.Cca.Bm.Sp(en)	Crustose coralline algae, biological matrix and encrusting sponges on boulder reef at the mesophotic transition zone (ROV Drop 15)
MSR	BO	N/A	High	ma,br	MSR.BO.Sp(ma.br).Bm	Massive and branching sponge-dominated shallow mesophotic boulder reefs (ROV Drop 1)
MMR	BE	RO	Very high	mi	MMR.BE.RO.Sp(mi).Bm.Cca	Diverse sponge, invertebrate and Crustose Coralline Algae communities on mid-depth mesophotic rocky reef (ROV Drop 17)
MMR	BE	RO	Very high	mi	MMR.BE.RO.Cca.Bm.Sp(mi)	Crustose coralline algae, biological matrix and sponges on mid-depth mesophotic rocky reef (ROV Drop 3)
MMR	BE	PL	Moderate	en	MMR.BE.PL.Cca.Bm.Sp(en)	Crustose coralline algae, biological matrix and sponges on bedrock platforms on mid-depth mesophotic reefs (ROV Drop 2)

Mesophotic Zone Modifier	Primary substrate component	Geoform	Rugosity modifier	Sponge morphology modifier	Biotope identifier	Biotope name
MMR	BE	PL	Moderate	pa,gl,br	MMR.BE.PL.Sp(pa.gl.br)	Polymastid, massive and branching sponges on current-swept mid-depth mesophotic reef platforms (ROV Drop 25)
MMR	BO	N/A	High	ma	MMR.BO.Sp(ma)	<i>Stelletta conulosa</i> -dominated mid-depth mesophotic current-swept boulders (ROV Drop 28)
MDR	BE	RO	Very high	mi	MDR.BE.RO.Sp(mi).Bm	Diverse sponge and invertebrate assemblages on deep mesophotic rocky reef (ROV Drop 7 and 9)
MDR	BO	N/A	High	mi	MDR.BO.Bm.Sp(mi)	Diverse invertebrate communities on deep mesophotic boulder reefs (ROV Drop 6)

Biotope name: Diverse sponge and invertebrate assemblages on deep mesophotic rocky reefs (MDR.BE.RO.Sp(mi).Bm)



Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Rock Outcrop

Substrate Component:

Substrate Origin: Geologic Substrate

Substrate Class: Geologic Rock Substrate

Substrate Subclass: Bedrock

Modifier Rugosity: Very High

Modifier Mesophotic Zone: Deep Reef

Biotic Component

Biotic Setting: Benthic/Attached Biota

Biotic Class: Faunal Bed

Biotic Subclass: Attached Fauna

Biotic Group: Attached Sponges.

Biotic Community: Diverse sponge and invertebrate community

Modifier sponge morphology: Mixed

Description: This biotope is generally found at depths below 80 m on solid bedrock and is associated with low energy environments. The substrate is dominated by sponges and biological matrix (a mixture of small low profile, but branched bryozoans, hydroids, and ascidians, which form a dense biological mat) as well as larger bryozoans and hydroids. Sediment is trapped in the biological matrix in this biotope. Colonial ascidians are also common to this biotope. The biotope is also characterised by a high diversity of three-dimensional sponges including cup and plate shaped morphologies, particularly *Aciculites pulchra*. There is also the abundance of thin, upright rope-like sponges (species unidentified – but consistently seen in deeper water biotopes), which create considerable three-dimensional structure on the seafloor. These upright morphologies likely represent adaptations to the high sediment deposition environment. This deeper mesophotic biotope differs from the shallower mesophotic biotopes by the noticeable absence of the sponges *Ecionemia alata*, *Geodia regina*, and *Stelletta conulosa*.

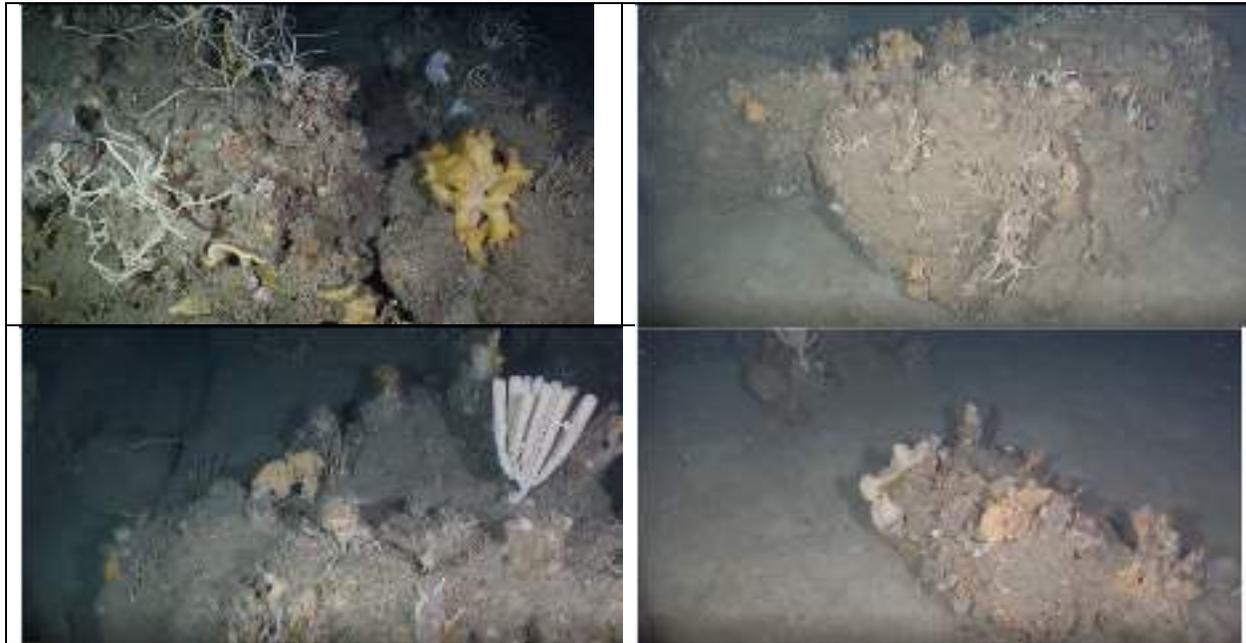
Physical Associations: This biotope is associated with deeper reef bedrock, although at the base of the reef there are gravel spurs creating rocky fingers into the surrounding substrate. The rock substrate is generally complex having very high rugosity. This biotope is associated with low current, but high-water clarity. This deep biotope is generally associated with offshore locations. This rocky biotope has high vertical relief, with the reef standing 10 m+ from the surrounding seafloor and has many steep, near vertical surfaces.

Biological Associations: This biotope has a very diverse benthic community with many unidentified species. One notable conspicuous species associated with this biotope is the black coral, *Antipathella* sp., and the rare giant tube sponge *Calyx imperialis*, which are only generally seen in low energy environments and associated with high relief bedrock. These species have not been considered as defining characters for this biotope as they can be strongly impacted by anchoring and bottom contact fishing and therefore their absence from a location could be the result of previous human impacts rather than environmental parameters. Also found occasionally are the branching sponges *Raspailia topsenti*, and *Iophon laevistylis*, which can be very large. Few mobile organisms have been reported from this biotope to date.

Range: The full range of this biotope is currently unknown, but it is known from the Hauraki Gulf. This biotope was described from East of Burgess Island and South of the Alderman Islands in the Hauraki Gulf between 65 and 85 m.

Related Biotopes: This biotope is closely related to MDR.BO.Bm.Sp, although the present biotope has higher vertical relief and is associated with bedrock rather than boulders. Black corals have not yet been associated with MDR.BO.Bm.Sp

Biotope name: Diverse invertebrate communities on deep mesophotic boulder reefs (MDR.BO.Bm.Sp(mi))



Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Boulder Field

Co-occurring Geoform: Sediment Wave Form

Substrate Component:

Primary Substrate Origin: Geologic Substrate

Primary Substrate Class: Geologic Unconsolidated Mineral Substrate

Primary Substrate Subclass: Coarse Unconsolidated Substrate

Primary Substrate Group: Gravel 2 mm – 4 m

Primary Substrate Subgroup: Boulder (40 – <50%)

Secondary Substrate Origin: Geologic Substrate

Secondary Substrate Class: Geologic Unconsolidated Mineral Substrate

Secondary Substrate Subclass: Coarse Unconsolidated Substrate

Secondary Substrate Group: Gravel mixes 2 mm – 4 m

Secondary Substrate Subgroup: Sandy Gravel (40 – <50%)

Modifier Rugosity: High

Modifier Mesophotic Zone: Deep Reef

Biotic Component

Biotic Setting: Benthic/Attached Biota

Biotic Class: Faunal Bed

Biotic Subclass: Attached Fauna

Biotic Group: Diverse colonisers

Biotic Community: Mixed encrusting invertebrate community dominated by biological matrix and diverse sponges

Modifier sponge morphology: Mixed

Description: This biotope is generally found at depths below 80 m and considered a low energy environment. The substrate is dominated by a mixture of low profile, but branched bryozoans and hydroids, which form a dense biological matrix (a mixture of small low profile, but branched bryozoans, hydroids, and ascidians, which form a dense biological mat). Lots of sediment is trapped in the biological matrix in this biotope. The biotope is also characterised by a number a high diversity of three-dimensional sponges including cup and shape morphologies, such as *Aciculites pulchra*. These upright morphologies likely represent adaptations to the high sediment deposition environment. This deeper mesophotic biotope differs from shallower mesophotic biotopes by the noticeable absence of the sponges *Ecionemia alata*, *Geodia regina*, and *Stelletta conulosa*. Instead, there are many rope-type sponges (currently unidentified).

Physical Associations: This biotope is associated with deeper reef large boulder structures generally surrounded by sandy gravel. The surface of the boulders is generally complex, and some boulders are very large, and greater than 4 m, and could potentially be considered bedrock. The boulders only rise several metres from the sandy gravel surrounding substrate. This biotope is associated with low current, but high-water clarity. This deep biotope is generally associated with offshore locations. The rugosity of this biotope is high.

Biological Associations: This biotope has a very diverse benthic community with many unidentified species. One notable conspicuous species associated with this biotope is the glass sponge *Symplectella rowi*, which is only generally seen in low energy environments. Also found are the sponges *Rowella lancifera* and *Iophon laevistylis*, which can be very large. Few mobile organisms have been reported from this biotope to date.

Range: The full range is currently unknown, but this biotope is known from the Hauraki Gulf. This biotope was described from South of the Aldermen Islands between 85 and 90 m.

Related Biotopes: The biotope is closely related to MDR.BE.Sp, although no black coral or *Calyx imperialis* have been found associated with the current biotope, although this could reflect different fishing pressure through time as both these species are susceptible to the impact of bottom contact fishing and anchoring.

Biotope name: Crustose coralline algae, biological matrix and sponges on bedrock platforms on mid-depth mesophotic reefs (MMR.BE.PL.Cca.Bm.Sp(en))



Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Rock Outcrop

Substrate Component:

Substrate Origin: Geologic Substrate

Substrate Class: Geologic Rock Substrate

Substrate Subclass: Bedrock
Modifier Rugosity: Moderate
Modifier Mesophotic Zone: Mid-depth Mesophotic Reef

Biotic Component

Biotic Setting: Benthic/Attached Biota
Biotic Class: Faunal Bed
Biotic Subclass: Attached Fauna
Biotic Group: Diverse colonisers
Biotic Community: CCA and mixed invertebrate community
Modifier sponge morphology: Encrusting

Description: This biotope typically occurs on large platform rocky reefs. This biotope occurs in areas of low turbidity and therefore high light penetration, hence the high abundance of CCA. This biotope is however, too deep to support macroalgae. Generally, this biotope is characterised by a very high abundance of CCA, which may cover 30-50% of the rocky substrate in some areas. Like many mesophotic ecosystems, biological matrix (a mixture of small low profile, but branched bryozoans, hydroids and ascidians, which form a dense biological mat) and larger hydroids and bryozoans are also abundant in this biotope. This biotope also supports many very thin encrusting sponge species, although most are currently unidentified, but likely comprise multiple species. This biotope is generally characterised by high abundance of low-profile forms, which are generally characteristic of high energy/current areas.

Physical Associations: This biotope is characterised by large areas of platform reef with small (< 2 m) caves and grooves 'cut' into the rock. Overall rugosity is moderate. These environments are generally further offshore (5-10 km+) and as a result have low turbidity and high light penetration. These biotopes also experience moderate tidally generated current flow, resulting in rock surfaces that have lower cover of sediment compared to deep reef mesophotic ecosystems.

Biological Associations: Although this biotope is characterised by very low-profile forms, there are rare three dimensional sponge species. Large schools of fish are often associated with this biotope including Pink Mau Mau (*Caprodon longimanus*), Butterfly Perch (*Caesioperca lepidoptera*) and the New Zealand (or two-spot) demoiselle (*Chromis dispilus*).

Range: The full range of this biotope is currently unknown, but it is known from the Hauraki Gulf. This biotope was described from South of Ohinau Island between 50 to 55 m.

Related Biotopes: This biotope shares some similarity to biotope MTZ.BO.Cca.Bm.Sp, although the current biotope has more larger massive sponges than found in MTZ.BO.Cca.Bm.Sp and has

no algae. The current biotope also has a bedrock substrate compared to boulders in MTZ.BO.Cca.Bm.Sp.

Biotope name:

Polymastid, massive and branching sponges on current-swept mid-depth mesophotic reef platforms (MMR.BE.PL.Sp.pa.gl.br)



Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Platform

Substrate Component:

Primary Substrate Origin: Geologic Substrate

Primary Substrate Class: Geologic Rock Substrate

Primary Substrate Subclass: Bedrock (90-100%)

Secondary Substrate Origin: Geologic Substrate
Secondary Substrate Class: Geologic Unconsolidated Mineral Substrate
Secondary Substrate Subclass: Coarse Unconsolidated Substrate
Secondary Substrate Group: Gravel mixes 2 mm – 4 m
Secondary Substrate Subgroup: Sandy Gravel (1 – <10%)
Modifier Rugosity: Moderate
Modifier Mesophotic Zone: Mid-depth Mesophotic Reef

Biotic Component

Biotic Setting: Benthic/Attached Biota
Biotic Class: Faunal Bed
Biotic Subclass: Attached Fauna
Biotic Group: Attached Sponges.
Biotic Community: Mixed branched and Polymastid-dominated sponge assemblage
Modifier sponge morphology: Papillate, Globulose, Branching

Description: This mid-depth mesophotic biotope is found between about 45 and 60 m and characterised by a diverse assemblage of conspicuous sponges. However, the platform bedrock is largely covered in a layer of coarse sediment, leading to the development of a community with mostly three-dimensional forms or adaptations to sedimented environments. Papillate and globular sponges are characteristic of this biotope including *Polymastia croceus* (yellow), *Polymastia hirsuta*, *Aaptos globosum*, and *Ciocalypta cf. penicillus*. The papillae of *Ciocalypta cf. penicillus* can be seen just above the surface of the sediment. The massive sponge, *Stelletta conulosa*, is occasionally seen in this biotope. There are also many branching sponges associated with this biotope, particularly *Raspailia topsenti*, *Pararhaphoxya sinclairi*, and *Iophon minor* (note species ID for these still need to be verified by future sample collection as they look very similar in ROV footage). Biological matrix (a mixture of small low profile, but branched bryozoans, hydroids, and ascidians, which form a dense biological mat) also features in this biotope, although their benthic cover is much lower than other mesophotic reefs at around 10%.

Physical Associations: This biotope is characterised by large areas of continuous platform bedrock that are covered in coarse sediment, which buries many of the organisms. This biotope experiences strong tidally driven current flow and low light penetration. Most of the areas of bedrock are flat with limited vertical relief and rugosity is moderate. Most rock surfaces that are available to be colonised are horizontally orientated.

Biological Associations: There are other sponge species that are encountered in this biotope although they are generally rarer including *Tethya* sp., *Geodia regina* and *Psammocinia hawere*. Protected cup corals, particularly *Monomyces rubrum*, are also encountered in this biotope, often

at densities of 5-10 corals m⁻². The erect bryozoan, *Steginoporella neozelanica*, is also associated with this biotope. Little is currently known about the mobile organisms associated with this biotope as few such organisms were seen during biotope classification.

Range: The full range of this biotope is currently unknown, but it is known from the Hauraki Gulf. This biotope was described from the Southeast of Channel Island at around 50 m.

Related Biotopes: This biotope is related to MMR.BE.SP.St, and occurs in a similar depth range in turbid waters. However, it is currently unknown what environmental factor accounts for the different biological communities found in these two biotopes.

Biotope name: Crustose coralline algae, biological matrix and sponges on mid-depth mesophotic rocky reef (MMR.BE.RO.Cca.Bm.Sp(mi))



Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Rock Outcrop

Substrate Component:

Substrate Origin: Geologic Substrate

Substrate Class: Geologic Rock Substrate

Substrate Subclass: Bedrock

Modifier Rugosity: Very High

Modifier Mesophotic Zone: Mid-depth Mesophotic Reef

Biotic Component

Biotic Setting: Benthic/Attached Biota

Biotic Class: Faunal Bed

Biotic Subclass: Attached Fauna

Biotic Group: Diverse colonisers

Biotic Community: CCA and mixed invertebrate community

Modifier sponge morphology: Mixed

Description: This biotope typically occurs on large continuous rocky reef, which generally has high rugosity and seafloor complexity. This biotope generally occurs in areas of low turbidity and therefore has high light penetration, hence the high abundance of CCA. However, this biotope does not generally support macroalgae. This ecosystem can be found from around 40 to 60 m. Generally, this biotope is characterised by a high abundance of CCA, which may cover 30-50% of the rocky substrate in some areas. Like many mesophotic ecosystems, biological matrix (a mixture of small low profile, but branched bryozoans, hydroids and ascidians, which form a dense biological mat) and larger hydroids and bryozoans are also abundant in this biotope. This biotope also supports many very thin encrusting sponge species, although most are currently unidentified, but likely comprise multiple species. Although the biotope is generally comprised of organisms with a low-profile morphology, there are also occasional three dimensional sponge species, particularly the massive sponge *Stellata conulosa*, the organ pipe sponge *Iophon laevistylis*, the cup-shaped sponge *Geodia regina* and the branched sponge *Iophon minor*.

Physical Associations: This biotope is characterised by continuous rocky reef with small (<-2 m) caves and lots of vertical and inclined surfaces. The biotope is characterised as having very high rugosity. These environments are generally further offshore (5-10km+) as they have low turbidity and high light penetration. These biotopes also experience moderate tidally generated current flow, resulting in rock surfaces that have a lower cover of sediment compared to other deeper mesophotic ecosystems.

Biological Associations: Large schools of fish are associated with this biotope including Pink Mau Mau (*Caprodon longimanus*), Butterfly Perch (*Caesioperca lepidoptera*) and the New Zealand (or two-spot) demoiselle (*Chromis dispilus*).

Range: The full range of this biotope is currently unknown, but it is known from the Hauraki Gulf. This biotope was described from South of the Aldermen Islands at approximately 50 to 55 m.

Related Biotopes: This biotope also shares some similarity to biotope MTZ.BO.Cca.Bm.Sp, although the current biotope has more massive and tubular sponges than found in MTZ.BO.Cca.Bm.Sp. The current biotope also has a bedrock substrate compared to boulders in the MTZ.BO.Cca.Bm.Sp biotope.

Biotope name: Diverse sponge, invertebrate and Crustose Coralline Algae communities on mid-depth mesophotic rocky reef (MMR.BE.RO.Sp(mi).Bm.Cca)



Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Rock Outcrop

Substrate Component:

Substrate Origin: Geologic Substrate

Substrate Class: Geologic Rock Substrate

Substrate Subclass: Bedrock
Modifier Rugosity: Very High
Modifier Mesophotic Zone: Mid-depth Mesophotic Reef

Biotic Component

Biotic Setting: Benthic/Attached Biota
Biotic Class: Faunal Bed
Biotic Subclass: Attached Fauna
Biotic Group: Attached Sponges.
Biotic Community: Sponge and invertebrate dominated community
Modifier sponge morphology: Mixed

Description: This biotope is characterised by very high coverage of sponges, biological matrix (a mixture of small low profile, but branched bryozoans, hydroids and ascidians, which form a dense biological mat) and larger bryozoans and hydroids. This is also one of the few mesophotic biotopes where there are abundant colonial ascidians. There is also still some CCA, occupying between 10-15% of the substrate due to relatively high light penetration associated with this more offshore biotope. The surface of the bedrock has very low sediment cover and competition for space is high. While sponge diversity is very high many of the low profile and encrusting species found are impossible to identify based on pictures alone and many may be new species. Nonetheless, this biotope is characterised by these abundant multicolour sponges. There are a few larger massive sponges compared to other mid-depth mesophotic reef biotopes, branching sponges can also be found including *Lophon minor*.

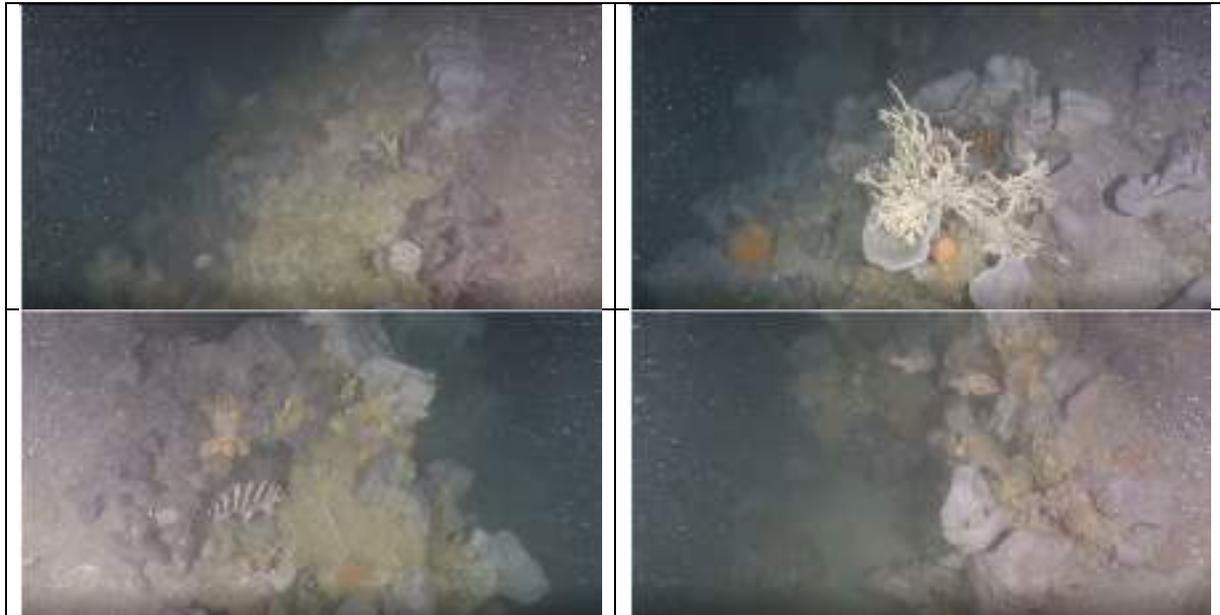
Physical Associations: This biotope is characterised by high vertical relief continuous bedrock, with several inclined and near vertical faces, with very high rugosity. The biotope is located in more offshore environments typically between around 55 to 70 m and likely experiences high current flow resulting in the generally low-profile organisms found. The light penetration in this biotope is very high because of being further offshore and away from coastally derived sediment.

Biological Associations: Although large, massive sponges are not typical in the characterisation of this biotope, *Suberites* sp. and *Stelletta conulosa* are occasionally found. Large schools of fish are often associated with these ecosystems including Pink Mau Mau (*Caprodon longimanus*) and Butterfly Perch (*Caesioperca lepidoptera*).

Range: The full range of this biotope is currently unknown, but it is known from the Hauraki Gulf. This biotope was described from the South of the Mokohinau Islands at around 60 m.

Related Biotopes: This biotope shares some similarity to MDR.BE.RO.Sp.Bm, except the current biotope has more low profile sponge species and no black coral.

Biotope name: *Stelletta conulosa*-dominated mid-depth mesophotic current-swept boulders (MMR.BO.Sp(ma))



Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Boulder Field

Substrate Component:

Primary Substrate Origin: Geologic Substrate

Primary Substrate Class: Geologic Unconsolidated Mineral Substrate

Primary Substrate Subclass: Coarse Unconsolidated Substrate

Primary Substrate Group: Gravel 2 mm – 4 m

Primary Substrate Subgroup: Boulder (60 – <70%)

Secondary Substrate Origin: Geologic Substrate

Secondary Substrate Class: Geologic Unconsolidated Mineral Substrate

Secondary Substrate Subclass: Coarse Unconsolidated Substrate

Secondary Substrate Group: Gravel mixes 2 mm – 4 m

Secondary Substrate Subgroup: Sandy Gravel (20 – <30%)

Modifier Rugosity: High

Modifier Mesophotic Zone: Mid-depth Mesophotic Reef

Biotic Component

Biotic Setting: Benthic/Attached Biota

Biotic Class: Faunal Bed

Biotic Subclass: Attached Fauna

Biotic Group: Attached Sponges

Biotic Community: *Stelletta conulosa*-dominated reef

Modifier sponge morphology: Massive

Description: This biotope is characterised by very large boulders (some larger than 4 m so could be considered bedrock) that have areas of coarse sediment between them, and benthic communities that are dominated by sponges, particularly *Stelletta conulosa*. Sponges are extremely abundant and can cover over 60% of the substrate. The sponges create lots of complexity to the seafloor and sponges are often more than 1 m across. This biotope is highly turbid and experiences fast water currents, which provides the food to support the suspension feeding community. Generally, these communities occur at mid-mesophotic reef depths, between 45 and 60 m in low light environments. There are few larger mobile species associated with this biotope compared to other mesophotic reefs at similar depths.

Physical Associations: This biotope is generally characterised by large boulders (>4 m in places) that have low vertical relief, so predominately flat rock, separated by small areas (10-15 m²) of gravel/coarse sediment. There is limited light penetration in this biotope and many of the sponges trap sediment on their surfaces. These are high energy areas that are tidally current swept, although coarse sediment is very common on surfaces not covered by sponges. The reefs have high overall rugosity.

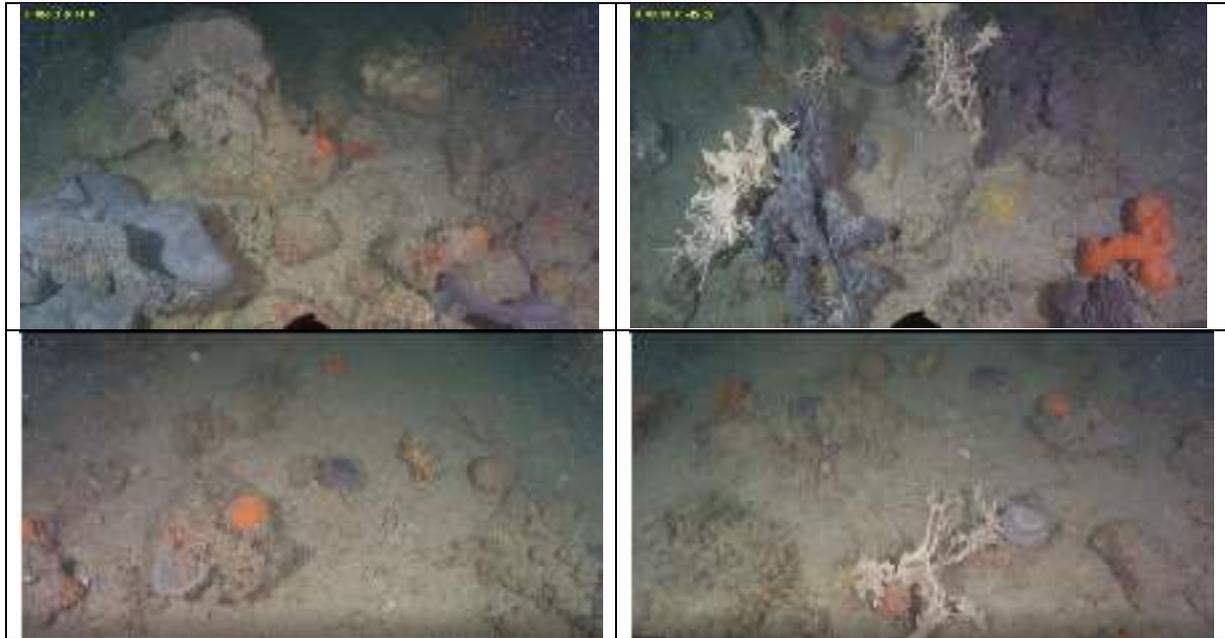
Biological Associations: The main feature of this biotope is the domination by sponges. While *Stelletta conulosa* is the dominant species, other massive/cup-shaped sponge species that are common include *Geodia regina* and *Psammocinia hawere*. It is also possible to find the branching sponge species, *Pararhaphoxya* sp. and the papillate sponge *Polymastia croceus*. associated with this biotope. There is also a white/cream plate sponge associated with this biotope (see pictures above), but this species needs to be examined to confirm its identity. Red pig fish (*Bodianus*

unimaculatus), which is typically a warm water species, Jock Stewart (*Helicolenus percoides*), and Red Moki (*Cheilodactylus spectabilis*) are commonly associated with this biotope.

Range: The full range of this biotope is currently unknown, but it is known from the Hauraki Gulf. This biotope was described from Southeast of Channel Island at 55 m.

Related Biotopes: This biotope is related to biotope MSR.BO.Sp.St, with this biotope having much larger boulders and stability and therefore more sponge cover.

Biotope name: Massive and branching sponge-dominated shallow mesophotic boulder reef (MSR.BO.Sp(mas.br).Bm)



Biotope: Sponge-dominated shallow mesophotic shallow boulder reef (MSR.BO.Sp.Bm)

Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Boulder Field

Substrate Component:

Primary Substrate Origin: Geologic Substrate

Primary Substrate Class: Geologic Unconsolidated Mineral Substrate

Primary Substrate Subclass: Coarse Unconsolidated Substrate

Primary Substrate Group: Gravel 2 mm – 4 m

Primary Substrate Subgroup: Boulder (50 – <60%)

Secondary Substrate Origin: Geologic Substrate

Secondary Substrate Class: Geologic Unconsolidated Mineral Substrate

Secondary Substrate Subclass: Coarse Unconsolidated Substrate

Secondary Substrate Group: Gravel mixes 2 mm – 4 m

Secondary Substrate Subgroup: Sandy Gravel (40 – <50%)

Modifier Rugosity: High

Modifier Mesophotic Zone: Mid-Depth Mesophotic Zone

Biotic Component

Biotic Setting: Benthic/Attached Biota

Biotic Class: Faunal Bed

Biotic Subclass: Attached Fauna

Biotic Group: Attached Sponges

Biotic Community: Mixed massive and branching sponge-dominated reef

Modifier sponge morphology: Massive and Branching

Description: This biotope is characterised by abundant massive and branching sponges on relatively shallow buried boulder fields. Although this biotope is found in relatively shallow water between 40 and 50 m there is no macroalgae or CCA present. The fistules of the sponge *Petromica* sp., can be seen protruding from the sediment between the boulders. This biotope experiences strong current, which provides food to support extensive sponge populations. The dominant species' in this biotope include and *Ecionemia alata* and *Stellata conulosa* although other branching and massive sponges are found. There is also a white/cream plate sponge associated with this biotope, but this species needs to be examined to confirm its identity. Biological matrix (a mixture of small low profile, but branched bryozoans, hydroids, and ascidians, which form a dense biological mat) also features heavily in this biotope and traps fine sediment particles on the seafloor.

Physical Associations: Boulders separated by coarse sediment are characteristic of this biotope, with boulders being generally less than several meters across and coarse sediment occurring between the boulders. This biotope is generally found close to the coastline (max 1-2 km, which is the source of sediment). Despite this biotope experiencing strong current flow, surfaces are covered in coarse sediment, and turbidity is generally moderate to high. This biotope has high rugosity.

Biological Associations: There are several other common sponges in this biotope, although specimens tend to be small and are only encountered occasionally, including *Geodia regina*, *Polymastia* sp., *Stelletta crater* and *Tethya* sp. Branching sponges are found in this biotope, particularly *Pararhaphoxya* sp. Protected cup corals, including *Monomyces rubrum*, are also encountered in this biotope, often at densities of 5-10 corals m⁻². Little is currently known about the mobile organisms associated with this biotope as few such organisms were seen during biotope classification.

Range: The full range of this biotope is currently unknown, but it is known from the Hauraki Gulf. This biotope was described from the Colville Channel at about 45 m.

Related Biotopes: This biotope is related to MMR.BE.Sp, although the current biotope generally has less sponge cover as the substrate is comprised of boulders separated by sand/gravel.

Biotope name: Macroalgae, biological matrix and mixed sponges on rocky reef at the mesophotic transition zone (MTZ.BE.RO.Ma.Bm.Sp(en.ma))



Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Rock Outcrop

Substrate Component:

Substrate Origin: Geologic Substrate
Substrate Class: Geologic Rock Substrate
Substrate Subclass: Bedrock
Modifier Rugosity: Very High
Modifier Mesophotic Zone: Mesophotic Transition Zone

Biotic Component

Biotic Setting: Benthic/Attached Biota
Biotic Class: Faunal Bed
Biotic Subclass: Attached Fauna
Biotic Group: Diverse Colonizers
Biotic Community: Macroalgal transition zone with diverse encrusting invertebrates
Modifier sponge morphology: Encrusting and Massive

Description: This biotope occurs between approximately 35 to 55 m and lies at the transition zone between shallower macroalgae-dominated communities and deeper animal-dominated reefs in the true mesophotic. Macroalgae remains the dominant feature of this biotope, occupying around 30% of the substrate, and there is also some CCA cover, although the macroalgae are generally small due to light limitation. Biological matrix (a mixture of small low profile, but branched bryozoans, hydroids, and ascidians, which form a dense biological mat) is the dominant seafloor group and sponges are also common. The biotope has a rich bryozoan community including *Steginoporella neozelanica*. This biotope is characterised by the massive sponges *Stelletta conulosa* and *Ecionemia alata* and the large branching sponge *Callyspongia ramosa*. This biotope is also characterised by the presence of the soft coral *Alcyonium* sp.

Physical Associations: This biotope is characterised by continuous bedrock with low turbidity and high light penetration supporting the existence of macroalgae at 50+ m. The bedrock surfaces of this biotope have little sediment accumulation characteristic of shallower current swept offshore ecosystems. The benthic community is generally dominated by low profile forms consistent with frequent impacts of heavy oceanic swell during storms. This biotope has very high rugosity.

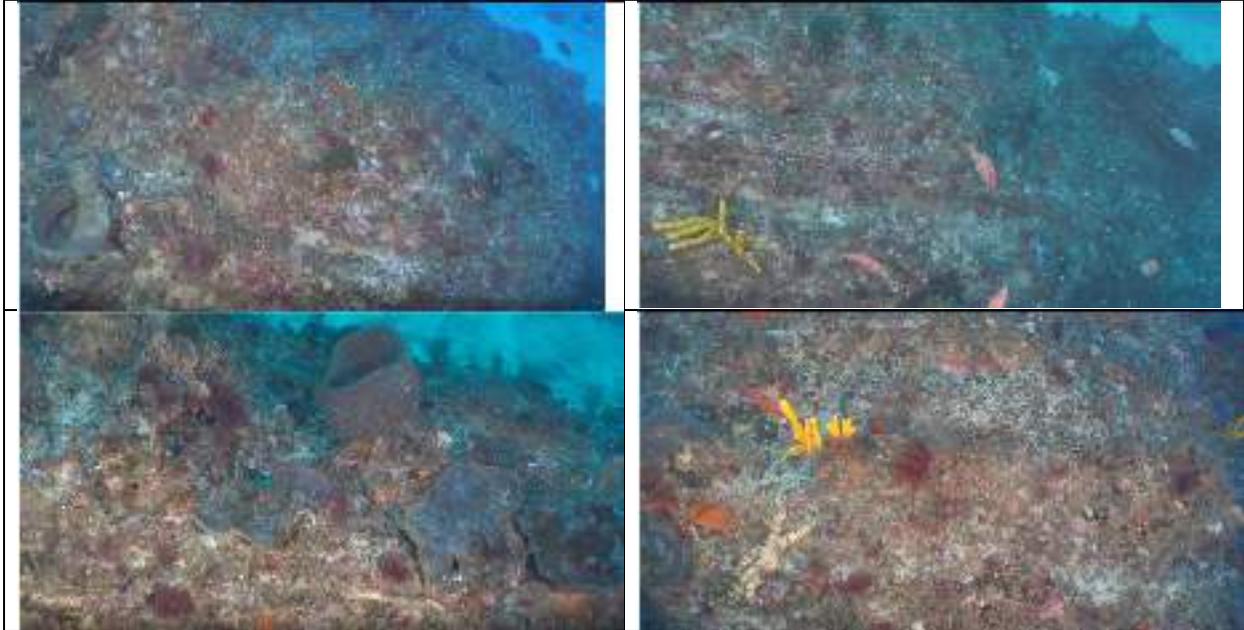
Biological Associations: There are also other sponge species that occur occasionally including *Stellata crater* and the branching sponges *Iophon minor* and *Raspailia topsenti*. Large fish populations are typically associated with this biotope including the New Zealand demoiselle (*Chromis dispilus*) and Butterfly perch (*Caesioperca lepidoptera*).

Range: The full range of this biotope is currently unknown, but it is known from the Hauraki Gulf. This biotope was described from West of Atihau Island at around 45 m.

Related Biotopes: This biotope is very closely related to MTZ.BE.RO.Ma.Sp.Bm, with the current biotope generally having a richer overall benthic community that is more dominated by

low profile and current resistant species. This biotope is also related to biotope MTZ.BO.Bm.Sp.Ma, although the current biotope is on bedrock compared to MTZ.BO.Bm.Sp.Ma being on boulder substrate.

Biotope name: Macroalgae, sponges and biological matrix, on rocky reef at the mesophotic transition zone (MTZ.BE.RO.Ma.Sp(ma).Bm)



Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Rock Outcrop

Substrate Component:

Substrate Origin: Geologic Substrate

Substrate Class: Geologic Rock Substrate

Substrate Subclass: Bedrock

Modifier Rugosity: High

Modifier Mesophotic Zone: Mesophotic Transition Zone

Biotic Component

Biotic Setting: Benthic/Attached Biota

Biotic Class: Faunal Bed

Biotic Subclass: Attached Fauna

Biotic Group: Diverse Colonizers

Biotic Community: Algal transition zone with encrusting invertebrates

Modifier sponge morphology: Massive

Description: This biotope occurs between at approximately 45-60 m and lies at the transition zone between shallower macroalgae communities and deeper animal-dominated reefs in the true mesophotic. Algae remains the dominant feature of this biotope, occupying around 25-35% of the substrate, and there is also some CCA cover, although the macroalgae are generally small due to light limitation. The dominant animal groups are sponges and biological matrix (a mixture of small low profile, but branched bryozoans, hydroids, and ascidians, which form a dense biological mat) and a rich bryozoan community including *Steginoporella neozelanica*. In particular, this biotope is characterised by massive sponges *Stelletta conulosa* and *Ecionemia alata*.

Physical Associations: This biotope is characterised by bedrock with low turbidity and very high light penetration supporting the existence of macroalgae at 50+ m. The biotope also has high rugosity. The bedrock surfaces of this biotope have little sediment accumulation characteristic of more offshore ecosystems. The benthic community is generally dominated by low profile organisms and likely experience frequent impacts of heavy oceanic swell during storms.

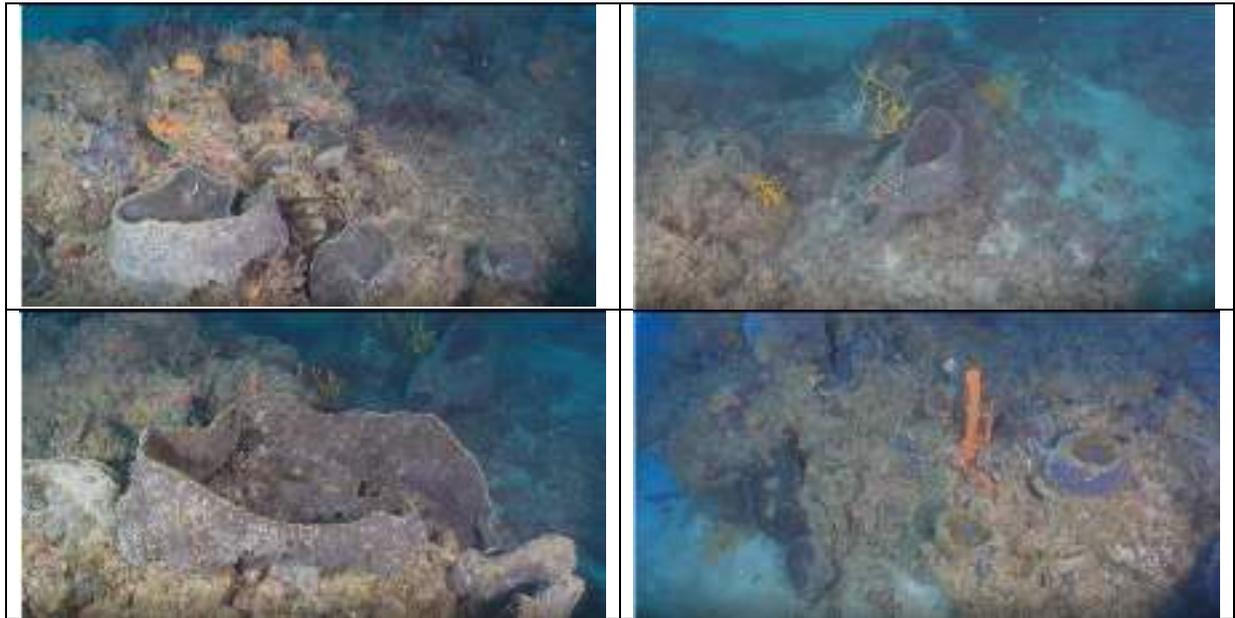
Biological Associations: There are also other sponge species that occur occasionally including *Stellata crater* and the branching species' *Iophon minor* and *Raspailia topsenti*. Large fish populations are typically associated with this biotope including the New Zealand demoiselle (*Chromis dispilus*) and Butterfly perch (*Caesioperca lepidoptera*). There are also several unknown starfish species associated with this biotope.

Range: The full range of this biotope is currently unknown, but it is known from the Hauraki Gulf. This biotope was described from East of Burgess Island at around 50 m.

Related Biotopes:

This biotope is related to biotope MTZ.BO.Bm.Sp.Ma, although the current biotope is on bedrock compared to MTZ.BO.Bm.Sp.Ma being on boulder substrate. These two biotopes share many similarities, although the current biotope has generally higher overall diversity.

Biotope name: Biological matrix, massive sponges and macroalgae on boulders at the mesophotic transition zone (MTZ.BO.Bm.Sp(ma).Ma)



Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Boulder Field

Substrate Component:

Primary Substrate Origin: Geologic Substrate
Primary Substrate Class: Geologic Unconsolidated Mineral Substrate
Primary Substrate Subclass: Coarse Unconsolidated Substrate
Primary Substrate Group: Gravel 2 mm – 4 m
Primary Substrate Subgroup: Boulder (50 – <60%)

Secondary Substrate Origin: Geologic Substrate
Secondary Substrate Class: Geologic Unconsolidated Mineral Substrate
Secondary Substrate Subclass: Coarse Unconsolidated Substrate
Secondary Substrate Group: Gravel mixes 2 mm – 4 m
Secondary Substrate Subgroup: Sandy Gravel (40 – <50%)
Modifier Rugosity: High
Modifier Mesophotic Zone: Mesophotic Transition Zone

Biotic Component

Biotic Setting: Benthic/Attached Biota
Biotic Class: Faunal Bed
Biotic Subclass: Attached Fauna
Biotic Group: Diverse colonisers
Biotic Community: *Ecionemia alata*, biological matrix and algae gardens
Modifier sponge morphology: Massive

Description: This biotope occurs between approximately 30-45 m at the transition zone between shallower macroalgae-dominated communities and deeper animal-dominated reefs in the true mesophotic. Animals are the dominant feature of this biotope, but there is still around 10% macroalgal cover, although the algae are generally small due to light limitation. The dominant groups are biological matrix (a mixture of small low profile, but branched bryozoans, hydroids, and ascidians, which form a dense biological mat) and sponges. In particular, this biotope is characterised by very high abundance of the massive grey sponge *Ecionemia alata*, occupying 15-20% of the available substrate. These reefs do often have an appearance of being covered in a fine layer of sediment, but this is caused by sediment trapping by *E. alata* and the biological matrix.

Physical Associations: This biotope is characterised by large boulders that are mostly buried and separated by coarse sediment. Vertical relief on these reefs is generally moderate to low and they are close to the sea floor. However, overall rugosity created by the boulders is high. This biotope is characterised by moderate tidal currents, with moderate levels of sediment accumulation and moderate turbidity, which limits the growth of macroalgae. The biological matrix and sponges trap sediment on their surfaces. Overall rugosity is high.

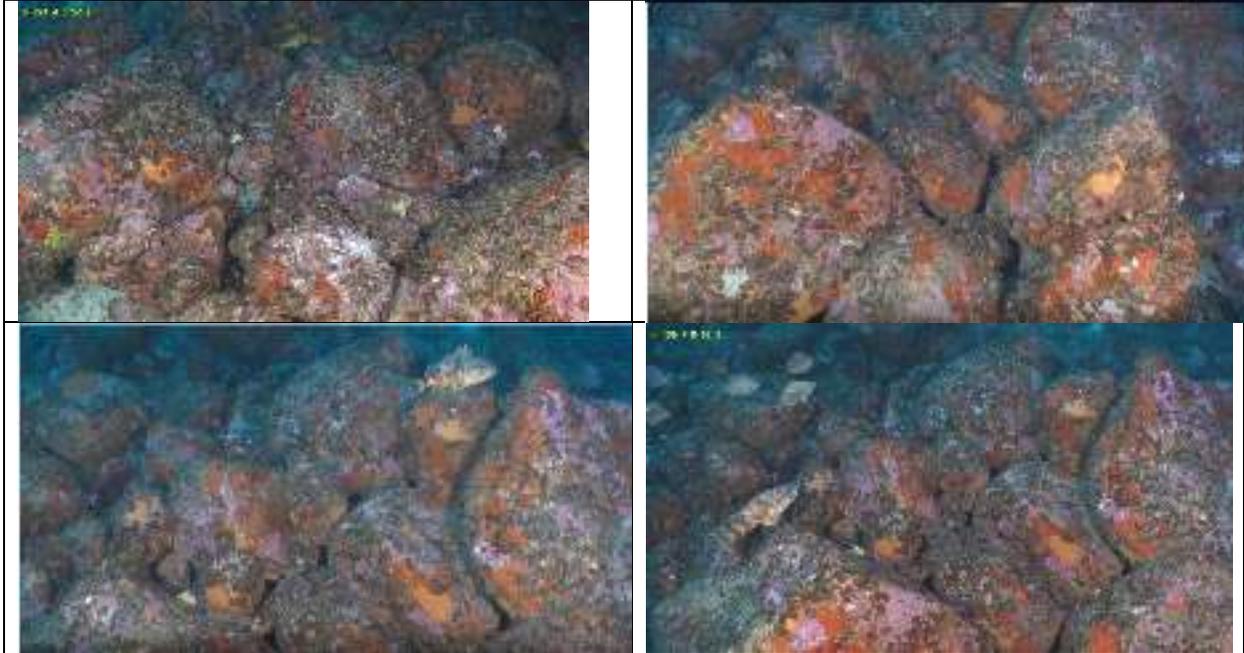
Biological Associations: Although this biotope is characterised by *Ecionemia alata*, other conspicuous sponge species encountered include the branching sponge *Iophon* sp and the cup

sponge *Geodia regina*. These biotopes are also home to many crinoids living between the sponges. Many recreationally and economically valuable species including snapper (*Pagrus auratus*), trevally (*Pseudocaranx dentex*), and kingfish (*Seriola lalandi*) are found associated with this biotope.

Range: The full range of this biotope is currently unknown, but it is known from the Hauraki Gulf. This biotope was described from Cradock Channel at 35 m.

Related Biotopes: While this biotope is related to others in the mesophotic transition zone (including MTZ.Cca.Bm.Sp), this transition zone is shallower. It shares some similarities with MTZ.BE.Ma.Sp.Bm, except that the current biotope substrate is boulders compared to the bedrock of MTZ.BE.Ma.Sp.Bm

Biotope name: Crustose coralline algae, biological matrix and encrusting sponges on boulder reef at the mesophotic transition zone (MTZ.BO.Cca.Bm.Sp(en))



Biogeographic Component:

Realm: Temperate Australasia

Province: Northern New Zealand

Ecoregion: Northeastern New Zealand

Aquatic Setting:

System: Marine

Subsystem: Marine Offshore

Tidal Zone: Marine Offshore Subtidal

Geoform Component:

Tectonic Setting: Active Continental Margin

Physiographic Setting: Continental/ Island Shelf

Geoform Origin: Geologic

Level 1 Geoform: Boulder Field

Substrate Component:

Primary Substrate Origin: Geologic Substrate

Primary Substrate Class: Geologic Unconsolidated Mineral Substrate

Primary Substrate Subclass: Coarse Unconsolidated Substrate

Primary Substrate Group: Gravel 2 mm – 4 m

Primary Substrate Subgroup: Boulder (80 – <90%)

Secondary Substrate Origin: Geologic Substrate

Secondary Substrate Class: Geologic Unconsolidated Mineral Substrate

Secondary Substrate Subclass: Coarse Unconsolidated Substrate

Secondary Substrate Group: Gravel mixes 2 mm – 4 m

Secondary Substrate Subgroup: Sandy Gravel (10 – <20%)

Modifier Rugosity: High

Modifier Mesophotic Zone: Mesophotic Transition Zone

Biotic Component

Biotic Setting: Benthic/Attached Biota

Biotic Class: Faunal Bed

Biotic Subclass: Attached Fauna

Biotic Group: Diverse Colonizers

Biotic Community: CCA, macroalgae and mixed invertebrate community

Modifier sponge morphology: Encrusting

Description: This biotope occurs at the transition zone between shallower macroalgal-dominated communities and deeper animal-dominated reefs and is particularly characterised by the high abundance of CCA, green, brown, and red algae (which are generally very small in size), biological matrix (a complex association between hydroids, filamentous algae, and bryozoans) and encrusting sponges. This biotope is typically found from around 30 m to 55 m. The benthic communities of this biotope have a very low profile, with few three-dimensional forms. The encrusting sponges of this biotope are generally very thin red and orange crusts, which cannot be easily identified from ROV images. The communities inhabiting this biotope are generally very homogeneous over large areas, being dominated by CCA.

Physical Associations: This biotope is comprised of overlaying boulders ranging in size from approximately 50 cm to several metres, with small (less than 1 m²) areas of sand/gravel between some of the boulders. The overlying nature of the boulders creates a complex three-dimensional structure on the sea floor. This biotope is characterised by very high light penetration and low turbidity and is generally found at distances greater than 10 km from the coast. The biotope is likely to be impacted by oceanic swell making it a high energy environment with low levels of settled sediment.

Biological Associations: The complex nature of the overlying boulders creates many small microhabitats, and many juvenile and late-stage larval fish are often associated with areas between

the boulders. Large adult fish populations are also typically associated with this biotope including the New Zealand demoiselle (*Chromis dispilus*), Butterfly perch (*Caesioperca lepidoptera*), Jock Stewart (*Helicolenus percoides*), and Scorpion fish.

Range: The full range of this biotope is currently unknown, but it is known from the Hauraki Gulf. This biotope was described from the southwest area of the Mokohinau Island at 50 m.

Related Biotopes: This biotope shares some similarity to biotope MTZ.BE.PL.Cca.Bm.Sp, although the current biotope lacks any of the larger massive sponges found in MTZ.BE.PL.Cca.Bm.Sp and has more macroalgae. The current biotope also has a boulder substrate compared to rock in MTZ.BE.PL.Cca.Bm.Sp.