Scallop (Queen) Dredge on Subtidal Mussel Bed on Rock

Introduction

The Assessing Welsh Fisheries Activities Project is a structured approach to determine the impacts from current and potential fishing activities, from licensed and registered commercial fishing vessels, on the features of Marine Protected Areas.

1. Gear and Feature	Scallop (Queen) Dredge on Subtidal Mussel Bed on Rock
2. Risk Level	Purple (High risk)
3. Description of Feature	Subtidal mussel bed on rock habitats are comprised of three relevant biotopes (see annex 1 for full biotope descriptions). **1. IR.LIR.IFaVS.MytRS** are shallow, tide swept, reduced salinity infralittoral rock with dense beds of *Mytilus edulis*. **2. CR.MCR.CMus.CMyt** typically occurs on the upper faces of tide-swept circalittoral bedrock, boulders and mixed substrata exposed to varying amounts of wave action. **3. CR.MCR.CMus.Mdis** (*Musculus discors*) beds with cushion and branching sponges on moderately tide-swept and exposed bedrock, boulders and cobbles. The biotope **IR.LIR.IFaVS.MytRS** occurs in shallow, often tide-swept, reduced salinity conditions,comprising dense beds of the mussel *Mytilus edulis* with the occasional barnacle *Balanus crenatus*. Mussels appear to provide the predominant substratum in this biotope. The mussel shells are colonized by epibiota - species that can survive reduced (but not necessarily 'low') salinity. Most species are suspension feeders and so do not interact but the predatory starfish *Asterias rubens* can be very common in this biotope and can have a major effect on survival of the mussels.

	The dominant species in the biotope can be present throughout the year except for filamentous brown and any other algae which most likely show seasonal change related to light levels. It is possible that some species in the biotope will be killed by low salinity during heavy rain in the winter. The mussels provide hard substratum for a range of algae and invertebrates to settle and interstices for polychaete worms and other mobile biota to live. If sediments are present amongst the mussels, infaunal burrowing species will be supported (Tillin & Mainwaring, 2015). The biotope **CR.MCR.CMus.CMyt** occurs in strong tides on a variety of substrata. Although a wide range of species are associated with *Mytilus edulis* reef or bed biotopes these characterizing species occur in a range of other biotopes and are therefore not considered to be obligate associates. Species richness is not particularly high, *Asterias* sp. are usually common, as are crabs such as *Cancer pagurus, Carcinus maenas* and *Necora puber*. Hydroids such as *Kirchenpaueria pinnata* and those characteristic of strong tides and a little scour are also often present such as *Sertularia argentea* and *Tubularia indivisa*. Ascidians such as *Molgula manhattensis* and *Polycarpa spp*. and *Flustra foliacea* may be present, particularly in silty conditions, although not often on the mussels themselves (Tyler-Walters, 2016a). The gaps between interconnected mussels form numerous interstices for a variety of organisms. In the intertidal *Mytilus* sp. beds the species richness and diversity increases with the age and size of the bed (Suchanek, 1985; Tsuchiya & Nishihira, 1985,1986; Seed & Suchanek, 1992). The mussel matrix may support sea cucumbers, anemones, boring clionid sponges, ascidians, crabs, nemerteans, errant polychaetes and flatworms (Suchanek, 1985; Tsuchiya & Nishihira, 1985,1986). Epifloral/faunal grazers, such as limpets, chitons and sea urchins (e.g. *Echinus esculentus*), may use the

	mussel bed as a refuge. Their grazing reduces epiflora/faunal fouling of *Mytilus edulis* shells, hence reducing the potential for dislodgement of the mussels due to strong water flow or storm surges (Suchanek, 1985). The biotope **CR.MCR.CMus.Mdis:** The mussel *Musculus discors* occurs in dense mats (around 60,000 individuals per m²) and occasionally completely coats all available surfaces. There is often a layer of pseudofaeces, forming a thick, silty matrix. A relatively diverse fauna of cushion and branching sponges is often present on rocky outcrops and other hard substratum that is free of mussels. An investigation into the infauna associated with *Musculus* beds found 88 infaunal species (Hopkinson, 2011). The majority of the UK records for this biotope are from the Lleyn Peninsula (JNCC).
4. Description of Gear	Queen scallops (*Aequipecten opercularis)* are predominantly targeted using towed fishing gear, either in the form of skid dredges (modified Newhaven dredges) or modified otter trawls. Queen scallops are more active swimmers than king scallops and do not recess into the seabed (Brand, 2006). Dredges and otter trawls take advantage of the natural propensity of queen scallops to swim up into the water column when disturbed, rather than relying on extraction of the scallops from the sediment as is the case for Newhaven dredges (Beukers-Stewart & Beukers-Stewart, 2009). A modified Newhaven dredge can be about 1.95m wide, often with a higher front opening. Instead of metal teeth it can have a rubber lip or sometimes the front part of the dredge consists of a metal grid mounted on four rubber rollers, two on each side of the grid. Alternatively, the tooth bar is replaced with a tickler chain. The modified dredge is normally fitted with skis or skids on either side designed to run along the top of the seabed. The dredge has a traditional metal belly bag with a mesh size of 60mm to retain the queen scallops (Humphey, 2009).

	Traditional toothed king scallop dredges are occassionally used to target queen scallops, these dredges are approximately 0.76m wide, with a chain mail belly bag and a 60mm mesh. Each dredge bar usually has 17 metal teeth of around 6cm in length on it (Hinz *et al*, 2009). The amount of dredges per side of the vessel can vary between 1 and 16 depending on the size and power of the vessel. The choice of skid dredges or otter trawls is largely governed by the nature of the substrate on different fishing grounds, with skid dredges being more effective in rough/coarse sediment areas and trawls in sandy/muddy areas (Vause *et al*, 2007).
5. Assessment of Impact Pathways: 1. Damage to a designated habitat feature (including through direct physical impact, pollution, changes in thermal regime, hydrodynamics, light etc.). 2. Damage to a designated habitat feature via removal of, or other detrimental impact on, typical species.	There are a lack of studies specifically investigating the impacts of scallop (queen) dredge gear on subtidal mussel bed on rock communities; therefore it is necessary to widen the research parameters to include other comparable bottom contacting mobile gear. **1**. Demersal mobile fishing gear reduces habitat complexity by: removing emergent epifauna, smoothing sedimentary bedforms, and removing taxa that produce structure (Auster & Langton, 1999). Ways in which gear affects the seabed can be classified as: scraping and ploughing; sediment resuspension; and physical destruction, removal, or scattering of non-target benthos (Jones, 1992). The Newhaven dredges and trawls employed in this fishery are also known to cause considerable damage and disturbance to benthic communities and associated nursery habitat (Eleftheriou & Robertson, 1992; Jennings *et al*, 2001; Kaiser *et al,* 2006). The action of the scallop (queen) dredge gear, like the impacts from king scallop dredges, will affect the mussel bed by coming into direct contact with the surface layers, causing lethal disturbance and destruction of the Mussel bed. Scallop (queen) dredge gear have penetration depths of 1-15cm in sand and 1-35cm in mud (Eigaard *et al*, 2016; Paschen *et al*, 2000).

	Impact to the seabed sub-surface by scallop (queen) dredge gear will structurally damage and break-up the mussel bed leading to the loss of reef within the footprint of direct impact. Trawl gear can crush, bury or expose marine flora or fauna and reduce structural diversity (Auster & Langton 1999). *Mytilus edulis* lives on the surface of the seabed held by byssus threads attached to either the substratum or to other mussels in the bed. Activities resulting in abrasion and disturbance can either directly affect the mussel by crushing them or indirectly affect them by the weakening or breaking of their byssus threads making them vulnerable to displacement (Denny, 1987). Once the beds are fragmented they are vunerable to being displaced where they are unlikely to survive (Dare, 1976). Disturbed or displaced mussels can also be affected by lower tolerances (24–28% lower) to toxic compounds and increased risk of predation, compared to bysally attached mussels (Rajagopal *et al*, 2005). The Scottish MPA Project Fisheries Management Guidance (JNCC, 2013) suggests that scallop dredges and other demersal towed gear are likely to result in the removal of a proportion of the bed along with its associated fauna and flora. Physical abrasion would probably physically remove some *Musculus discors* individuals from their substratum and break the shells of some individuals, depending on their size. Disturbance of the cohesive mat of individuals may strip away tracts of the biotope or create gaps or 'edges' that may allow peeling away of the *Musculus discors* mat by tidal streams or wave action. *Musculus discors* may be affected indirectly by physical disturbance that removes macroalgae to which they are attached. Mainwaring *et al*. (2014) reviewed the evidence for recovery of *Mytilus edulis* beds from disturbance and an earlier study by Seed & Suchanek (1992) reviewed studies on the recovery of ‘gaps’ in *Mytilus* spp. beds. It was concluded that beds occurring on less exposed sites took longer to recover after a disturbance event than

	beds found at more exposed sites. However, the slowest recovering sites are at the least risk of natural disturbance and often considered more 'stable' (Lewis, 1964) as they are less vulnerable to removal by wave action. Death or disturbance of underlying individuals may detach the mussel bed from the substratum, leaving the bed vulnerable to tidal scour and wave action (Seed & Suchanek, 1992). Blue mussels, *Mytilus edulis*, are sessile attached organisms that are unable to repair significant damage to individuals. Mussels do not reproduce asexually and therefore the only mechanism for recovery from significant impacts is larval recruitment to the bed or the area where previously a bed existed (Tyler-Walters, 2016a). The resilience and the ability to recover from human induced pressures is a combination of the environmental conditions of the site, the frequency (repeated disturbances versus a one off event) and the intensity of the disturbance. Recovery of impacted populations will always be mediated by random events and processes acting over different scales including, but not limited to, local habitat conditions, further impacts and processes such as larval-supply and recruitment between populations (Tillin & Mainwaring, 2015). Larval settlement and recruitment of many invertebrates are strongly influenced by substrate structure (Botero & Atema, 1982; Bourget *et al*, 1994; Jacobi & Langevin, 1996; Lemire & Bourget, 1996; Lapointe & Bourget, 1999; Linnane *et al*, 2000). Compared with a smooth substrate such as mud or sand, the roughness of solid elements also increases turbulence above the seabed, which in turn will increase the amount of organisms and non-living matter available to the benthic suspension feeders (Fréchette *et al*, 1989; Butman *et al*, 1994; Lenihan, 1999). Moreover, the solid elements serve as attachment sites and increase substrate heterogeneity and complexity, providing refuges for prey and predators (Revelas, 1982; Arnold, 1984; Orth *et al,* 1984; Sponaugle & Lawton, 1990; Lee & Kneib, 1994; Hedvall *et al*, 1998). The altered composition of the seabed induced by bottom contacting mobile gears thereby interferes with recruitment, growth and survival of the associated fauna.

	Recruitment within a population or between adjacent populations and recovery of *Musculus discors* is probably fairly rapid. Therefore, where some of the population is lost or its abundance reduced it is suggested that prior abundance may recover within up to two years. However, where the bed is significantly or severely damaged and recovery is dependant on recruitment from distant populations recruitment may take longer. If a population is removed recovery will depend on recruitment from nearby populations by drifting, followed by subsequent expansion of the population. Therefore, it is suggested that recovery after removal or significant damage to a population may take about up to 10 years (Tyler-Walters, 2016b). **In conclusion**, direct contact between scallop (queen) dredge gear and subtidal mussel beds could cause structural damage to the mussel beds through the ploughing and scraping of the beam which would result in the removal and loosening of mussel matrices. Those individuals which have been loosened are at a greater risk, in tidal influenced areas, of being removed by natural disturbances. Recovery is possible although dependant on local environmental factors. **2**. Dermersal trawls can cause direct mortality to non-target organisms through shoe, tickler chain or chain mat impact on the seabed (Bergman & van Santbrink, 2000). The use of dredges, beam trawls, otter trawls and the development of heavier and more powerful fishing gear has increased concern about the impact on benthic communities (Jennings & Kaiser, 1998; Hall, 1999). Erect epifaunal species are particularly vulnerable to physical disturbance. Veale *et al* (2000) reported that the abundance, biomass and production of epifaunal assemblages decreased with increasing fishing effort. Hydroids and bryozoans are likely to be uprooted or damaged by bottom trawling or dredging (Holt *et al*, 1995).

		In Limfjorden, Denmark, observations on commercial dredge tracks and field experiments with controlled dredging have demonstrated a significant short-term effect on the infauna. In particular, the polychaetes associated with mussel beds had a reduced density after dredging, and gastropods and bivalves were also reduced in number after dredging (Dolmer *et al,* 2002). *Mytilus edulis* beds are not dependent on associated species to create or modify habitat, provide food or other resources, although their loss would represent a loss of diversity. For attached organisms the sensitivity of the *Mytilus edulis* biotope would be of primary concern as removal of the reef would also lead to removal of the attached species. The associated epifaunal community of *Muculus discors* will probably develop within less than 5 years of removal although slow growing sponges may take many years to develop (Tyler-Walters, 2016b). **In conclusion**, scallop (queen) dredge gear on subtidal mussel beds can damage and/or remove flora and fauna, reducing biodiversity. Recovery, although possible is dependent on local environmental factors.
6. MPAs where feature exists	**Menai Strait & Conwy Bay SAC**	There are records of subtidal *Mytilus* Mussel Beds on rock within the Menai Strait between the Brittania Bridge and Menai Bridge
	Lleyn Peninsula and the Sarnau SAC	There are records of subtidal *Mytilus* Mussel Beds on rock along the North Llyn coast between Nefyn and Uwchmynydd and also off Cadlan and off Cilan head. Subtidal *Musculus discors* beds have been recorded off shore along the North Llyn coast from Trevor to Uwchmynydd.
	Cardigan Bay SAC	There are records of subtidal *Mytilus* Mussel Beds on rock westwards of Cardigan Island.

	Pembrokeshire Marine SAC	There are records of subtidal *Mytilus* Mussel Beds on rock between Strumble Head and Ynys Deullyn; within St Bride's Bay; around Skomer Island; between the 'Falls' rocks and Grasholm; around Skokholm Island and off St Govan's Head. Subtidal *Musculus discors* beds on rock have been recorded off shore near St Anne's Head and between 'Griffiths rocks' and 'Monkey rocks'.
	Carmarthen Bay & Estuaries SAC	There are records of subtidal *Mytilus* Mussel Beds on rock around Caldy Island; off Worms Head and between Worms Head and Port Eynon

7. Conclusion

The information presented above indicates that the action of fishing with scallop (queen) dredge gear directly on subtidal mussel bed on rock features is likely to be lethal by crushing or be indirectly damaging by weakening or breaking of the byssus threads, making them prone to becoming unattatched. While recovery is possible this is dependant on local environmental factors such as larval availability, tidal influence and the extent of the remaining bed. Recovery would also be less likely in periods of prolonged fishing. The damage or removal of a mussel bed would also result in the damage or removal of attached species.

8. References

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Annex 1
Biotope descriptions (version 15.03) (JNCC - http://jncc.defra.gov.uk/marine/biotopes/hierarchy.aspx?level=5)

IR.LIR.IFaVS.MytRS - *Mytilus edulis* beds on reduced salinity infralittoral rock
This biotope occur in shallow, often tide-swept, reduced salinity conditions. Dense beds of the mussel *Mytilus edulis* with the occasional barnacle *Balanus crenatus*. A wide variety of epifaunal colonisers on the mussel valves, including seaweeds, hydroids and bryozoans can be present. Predatory starfish *Asterias rubens* can be very common in this biotope. This biotope generally appears to lack large kelp plants, although transitional examples containing mussels and kelps plants may also occur. More information needed to validate this description.

CR.MCR.CMus.CMyt - *Mytilus edulis* beds with hydroids and ascidians on tide-swept exposed to moderately wave-exposed circalittoral rock
This biotope typically occurs on the upper faces of tide-swept circalittoral bedrock, boulders and mixed substrata exposed to varying amounts of wave action. The mussel *Mytilus edulis* forms dense beds, to the exclusion of other species. The starfish *Asterias rubens* is frequently recorded, and it predates heavily on the mussels. Occasionally, the anemone *Urticina felina* may be seen within crevices in the rock or on gravel patches. Crabs such as *Necora puber* and *Carcinus maenas* may be seen on the rock or mussels whilst fauna observed in crevices typically consists of the lobster *Homarus gammarus* and the crab *Cancer pagurus*. The anemone *Sargatia elegans* can be seen attached to bedrock and cobbles, whereas the barnacle *Balanus crenatus* may be seen attached to the mussels themselves.

CR.MCR.CMus.Mdis - *Musculus discors* beds on moderately exposed circalittoral rock
This biotope typically occurs on the upper faces of moderately exposed, moderately tide-swept bedrock, boulders and cobbles in slightly silty conditions. The mussel *Musculus discors* occurs in dense mats and occasionally completely coats all available surfaces. There is also often a layer of pseudofaeces, forming a thick, silty matrix. A relatively diverse fauna of cushion and branching sponges is often present on rocky outcrops and other hard substratum that is free of mussels. These include *Tethya aurantium*, *Scypha ciliata*, *Pachymatisma johnstonia*, *Dysidea fragilis*, *Cliona celata* and *Stelligera stuposa*. There may be isolated clumps of silt-tolerant bryozoans such as *Flustra foliacea* and *Bugula plumosa*. Various species may be observed on top of the mussels, including *Asterias rubens*, *Crossaster papposus* and the brittlestar *Ophiura albida*. Occasional *Alcyonium digitatum* and clumps of the hydroid *Nemertesia antennina* are found attached to rocky outcrops and boulders whilst the anemone *Urticina felina* may be seen in crevices in the rock or on gravely patches between boulders. Colonial ascidians such as *Clavelina lepadiformis* and didemnids may occasionally be present. A wide range of seaweeds may be present, including *Dictyota dichotoma*, *Plocamium cartliagineum*, *Dictyopteris membranacea*, *Cryptopleura ramosa* and *Heterosiphonia plumosa*. The crab *Cancer pagurus* may be observed in crevices.