Scallop (Queen) Dredge on Submarine Structures Made by Leaking Gases

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 Submarine Structures Made by Leaking Gases
2. Risk Level	Purple (High risk)
3. Description of Feature	Submarine structures made by leaking gases consist of sandstone slabs, pavements, and pillars up to 4m high, formed by aggregation of sediment by carbonate cement resulting from microbial oxidation of gas emissions, mainly methane. The formations are interspersed with gas vents that intermittently release gas. The methane most likely originates from the microbial decomposition of fossil plant materials (EC, 2007). There are two types of submarine structures. The first type of submarine structures are known as "bubbling reefs". These formations support a zonation of diverse benthic communities consisting of algae and/or invertebrate specialists of hard marine substrates different to that of the surrounding habitat. A variety of sublittoral topographic features are included in this habitat such as: overhangs, vertical pillars and stratified leaf-like structures with numerous caves. Animals seeking shelter in the numerous caves further enhance the biodiversity (EC, 2007). Fauna found in "Bubbling reefs" consist of a large diversity of invertebrates from the phyla Porifera, Anthozoa, Polychaeta, Gastropoda, Decapoda and Echinodermata as well as a number of fish species. The polychaete *Polycirrus norwegicus* and the bivalve

	Kellia suborbicularis are typically associated with the habitat and rare elsewhere in the region (EC, 2007). Flora found in photic zone “Bubbling reefs” may consist of marine macroalgae such as Laminariales, other foliose and filamentous brown and red algae (EC, 2007). The second type are carbonate structures within “pockmarks” formed by leaking gases. Pockmarks are depressions in soft sediment seabed areas, they can be up to 45m deep and a few hundred meters wide. Methane gas escapes the seabed leaving a circular depression. It is suspected that pockmarks form by sudden “catastrophic” gas or porewater eruption and that they periodically have short outbursts followed by long periods of quiescence or micro seepage (Hovland *et al*, 2005). Pockmarks comprise benthic communities of invertebrate specialists, some preferring hard marine substrata which differs from the communities comprising the surrounding (usually) muddy habitat. Invertebrate specialists of hard substrate include Hydrozoa, Anthozoa, Ophiuroidea and Gastropoda. The diversity of the infauna community in the muddy slope surrounding the “pockmark” may be high (EC, 2007). One species has been recognised as endemic to pockmarks, the beard worm *Siboglinum poseidoni*. The worm lives in the surrounding soft sediment, not on the carbonate structures (Seffel, 2010). In the soft sediment surrounding the pockmark Nematodae, Polychaeta and Crustacea are also present (EC, 2007). No flora is usually found in “Pockmarks” (EC, 2007). There are thought to be several submarine structures (“bubbling reefs”) in Welsh waters, the main one is called Holden’s reef, it is described as: nodular boulders and consolidated carbonate-bound sand forming a low-lying reef surrounded by a sand plain. Filamentous and foliose red and brown algae covered the upward-facing surfaces with patches of the sea squirt *Molgula manhattensis,* bryozoans,

	hydroids, sponges, the soft coral *Alcyonium digitatum* and barnacles also present. Rock-boring fauna were apparent in most of the hard substrata including piddocks *Hiatella arctica* and the sponge *Cliona celata*. The rugged nature of the reef provides many holes and crevices for mobile crustacea, fish and echinoderms (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.	The three types of queen scallop fishing gear described above are all bottom contacting gear and as such impose a similar effect upon the seabed. The assessment below incorporates all three gears and will be referred to collectively as scallop (queen) dredge gear. Any differences in gear interactions will also be described below. There is a lack of studies specifically investigating the impacts of queen scallop fishing gear impacts on submarine structures; therefore it is necessary to widen the reseach parameters to include other comparable bottom contacting mobile gear. **1.** Fishing equipment like bottom trawling nets are known to tear off pieces of the carbonate structures, thus destroying or damaging the habitat (Seffel, 2010). 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 Submarine structure by coming into direct contact with the feature, causing lethal disturbance and destruction of the Submarine structure. 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). JNCC[1] (2008) report on the Scanner pockmark site states that ‘Bottom trawling could have modified the structure of the pockmark, causing burial of some of the submarine structures, as well as breaking and displacement of carbonate pieces and some fishing nets were observed caught on the structures. However, the feature appears to be largely undamaged. Bottom trawl gears effect the environment in both direct and indirect ways. Direct effects include scraping and ploughing of the substrate, sediment resuspension and destruction of benthos. Indirect effects

	include post-fishing mortality and long-term trawl-induced changes to the benthos (Jones, 1992). Little is understood about the recoverability or growth rates of the submarine structures caused by leaking gases. Crocker *et al* (2005), however, do make a correlation between the seepage rates and migration pathways of leaking gases and growth, although no rate is mentioned. In their report, “Gas-Related Seabed Structures in the Western Irish Sea”, they discuss echosounder profiles of the 30 mound structures identified; some of which are made by actively seeping gas, although the exact mode of formation of the mounds was unclear. They conclude that simple cementation of the sands by Methan-derived Authigenic Carbonate (MDAC) doesn’t explain how they grow to become features with vertical relief of some 5-10m above the seabed. Following direct contact that causes damage, recoverability is not measurable or predictable. Gears such as beam trawls and scallop dredges, are designed specifically to disturb surface sediments to increase the catch rate of the target species (Kaiser *et al*, 1996). The carbonate structures created in the seabed are dependant on erosion of the surrounding sediments to become exposed. High sedimentation rates may counteract the erosion and cover the structures (Seffel, 2010). Trawling and dredging can re-suspend large amounts of sediments (Pilskaln *et al*, 1998) and this sediment could settle on the carbonate structure. In areas of low tidal influence, the sediment disturbed by bottom contacting gears may settle and smother low-lying carbonate structures. In areas of high tidal influence, sedimentation may be removed on the following tide. **In conclusion**, direct contact between scallop (queen) dredge gear and submarine structures made by leaking gases could cause

	structural damage through the ploughing and scraping of the rigid mouths of dredges and doors of trawls and the tearing and fragmenting of the trailing nets. The increase in sediment disturbance from the interaction of the bottom contacting gear with the seabed, in areas of low tidal influence, could cause a settling of sediment, covering the structure which could slow the rate of recovery. **2.** Fishing equipment like bottom trawling nets are known to tear off pieces of the carbonate structures, thus destroying or damaging the habitat (Seffel, 2010). The direct effects of scallop (queen) dredge on a submarine structure could include the loss of erect and sessile epifauna, smoothing of sedimentary bedforms and removal of taxa that produce structure. Trawl gear can crush, bury or expose marine flora or fauna and reduce structural diversity (Auster & Langton, 1999). The structural complexity of a carbonate reef structure is thought to provide spaces for animals like crustacea and fish to inhabit. Physical damage to the reef would lead to a loss of structural complexity and therefore a consequent loss in fauna might be expected. Collie *et al* (2000) undertook an analysis of published research into fishing activity impacts on the seabed, based on 39 research projects undertaken previously. They found an average of 46% decrease in total number of species individuals within study sites that were disturbed with bottom towed gear. Eutrophication changes the light reaching the structures and decreases the cover (and biomass) of macroalgae. Eutrophication also increases the amount of plankton production, increasing the amount of sedimentation, which also is a threat. High sedimentation rates may create an anoxic environment near the seafloor, making it hard for most flora and fauna to survive (Seffel, 2010). **In conclusion**, scallop (queen) dredge gear on submarine structures can damage and/or remove flora and fauna, reducing structural taxa. The increase in sedimentation by bottom contacting gears can create an anoxic environment, making it hard for flora and fauna to survive.

6. MPAs where features exist	**Pen Llyn A'r Sarnau SAC**	There is only one area of carbonate reef in Welsh territorial waters. This comprises several Bubbling reefs and it is found within this SAC within 2Nm of the coast between Barmouth and Dyffryn Ardudwy. The sediments surrounding Holden's Reef are medium to coarse sands and unlikely to cause an anoxic environment if increased sedimentation occurs.

7. Conclusion

The information presented above indicates that the action of fishing with scallop (queen) dredge gear directly on submarine structures made by leaking gases could cause damage to the structure and associated species through ploughing and scraping. An increase in sedimentation and eutrophication through seabed disturbance by the gear could influence gas seepage rates and cause smothering of structure, flora and fauna in an area of low tidal influence. Little is understood about growth rates of these structures, therefore recoverability is unknown.

8. References

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