Light Otter Trawl on *Sabellaria spp.* Reef

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	Light Otter Trawl on *Sabellaria spp.* Reef
2. Risk Level	Purple (High risk)
3. Description of Feature	This feature is comprised of two different polychaetes: **Honeycomb Worm** (*Sabellaria alveolata*) and **Ross Worm** (*Sabellaria spinulosa*). (See Annex 1 for Biotope description). **1. Honeycomb worm *Sabellaria alveolata*** The Honeycomb worm habitat can be separated into two biotopes – • SS.SBR.PoR.SalvMx - *Sabellaria alveolata* on variable salinity sublittoral mixed sediment • LS.LBR.Sab.Salv - *Sabellaria alveolata* reefs on sand-abraded eulittoral rock *Sabellaria alveolata* is a frequently gregarious segmented worm that builds tubes from sand or shell fragments. Found intertidally (although occasionally subtidally) generally in exposed and moderately exposed areas. Tubes are often densely aggregated forming a honeycomb pattern, they may form large reefs up to several metres across and a metre deep. Open coast reefs are found on hard substrata on exposed and moderately exposed coasts, with moderate to considerable water movement where sand is available for tube building. Typically found on the bottom third of the shoreline but also in the shallow sub-tidal (Jackson, 2008).

	Cunningham *et al* (1984) reported that actively growing *Sabellaria* colonies are able to outcompete all other littoral species for space, and noted that young sheets of *Sabellaria alveolata* may reduce the diversity of shores by reducing the number of crevices available, but as the sheets get older and break up the range of habitats provided increases (UK Marine Centre). *Sabellaria alveolata* reefs undergo cycles of development and decay over a period of a few years. Although reefs may come and go - areas that are good for *Sabellaria alveolata* tend to remain so. *Sabellaria alveolata* appear to favour warmer winter temperatures and are often associated with cooling water discharges (Bamber & Irving, 1997) but growth is inhibited below 5°C (Jackson, 2008). Spawning occurs each July but recruitment levels vary considerably from year to year. Larvae spend between 6 weeks and 6 months as plankton in the water column. Most *Sabellaria alveolata* individuals have a lifespan of 3 to 5 years but there are records of them reaching 7 to 9 years old (Jackson, 2008). **2. Ross worm (*Sabellaria spinulosa)*** SS.SBR.PoR.SspiMx - *Sabellaria spinulosa* on stable circalittoral mixed sediment. The tube-building polychaete *Sabellaria spinulosa* are found at high abundances on mixed sediment. These species typically form agglomerations of tubes forming a low lying matrix of sand, gravel, mud and tubes on the seabed. High densities of *Sabellaria spinulosa* have been observed in a variety of forms. In some locations tubes do not stand particularly proud of the surface even though the worm is abundant. These have been described as crusts or sheets but this habitat would not normally be classified as biogenic reef. The simplest definition of *Sabellaria spinulosa* as ‘reef’ in the context of the Habitats Directive (Council Directive 92/43/EEC) is considered to be an area of *Sabellaria spinulosa* which is elevated from the seabed and has a

	large spatial extent (Gubbay, 2007). However, where *Sabellaria spinulosa* crusts occur on rock, this would also be considered as Annex I reef habitat but not the biogenic reef sub type. *Sabellaria spinulosa* will consolidate the sediment and allow other species not found in adjacent habitats to settle, leading to a diverse community of epifaunal and infauna species. The matrix of various tubes and other erect structures will trap sediment providing food for deposit feeders. The trapped sediment also means that the biotope will be composed of habitats similar to both sedimentary and hard substratum environments, thereby increasing the number of potential niches. The aggregation provides shelter and protection for small species in an otherwise exposed sedimentary landscape. The development of these reefs is assisted by the settlement behaviour of larval *Sabellaria* which are known to selectively settle in areas of suitable sediment and particularly on existing *Sabellaria* tubes (Tait & Dipper, 1998; Wilson, 1968, 1970a). *Sabellaria spinulosa* requires only a few key environmental factors for survival in UK waters. Most important seems to be a good supply of sand grains for tube building, put into suspension by strong water movement from either tidal currents or wave action (Jackson & Hiscock, 2008). *Sabellaria spinulosa* also appears to be very tolerant of polluted conditions (JNCC, 2016). It should be noted that the *Sabellaria spinulosa* reefs have a dynamic nature and can colonise, evolve and degrade rapidly.
4. Description of Gear	Otter/stern trawlers range in size from small, undecked boats, powered by outboard engines up to large vessels with up to 8,000HP engines (Galbraith *et al*, 2004). An otter trawl is a cone-shaped net that is towed over and remains in contact with the seabed. The net is usually towed from the stern of a vessel and comprises: a codend (which retains the catch), the body of the net, the mouth of the net with two lateral wings extending forward from the mouth of the net and connected to the boat via warps. The trawl mouth is kept open vertically by a headline with floats, it also has

	a ground rope (sweep/bridle) equipped with rubber discs, bobbins, spacers etc. to protect the trawl from damage. Tickler chains can be attached to the ground rope in certain fisheries to disturb the target species from the seabed into the net. The mouth of the net is kept open horizontally by two otter boards or ‘doors’. These can be made of wood or steel and can be shaped differently depending on the type of vessel, water depth and target species. The ‘flat’ or ‘v’ shapped doors are mainly used by inshore vessels. The weight of the doors vary depending on the size of the net and the power of the vessel. During fishing operations the doors and the ground rope/chain are in constant contact with the seabed as this helps to disturb the fish and send them upwards into the mouth of the net. The door size will vary depending on the power and size of the vessel and the net being used. The weight of the doors will depend on the material used in their construction e.g wooden doors are usually made from hardwood planks over an inch thick, these doors will be heavier than softwood construction but lighter than steel construction (SEAFISH). The area of seabed impacted by the doors will depend on the angle of the doors to the net. When a door is 4m long, the width of the track is about 2m with a door angle of 30 degrees. The track can be made narrower by reducing the angle of the door to the net or by altering the height/length ratio of the door (FAO). The penetration depth of otter trawl gear components range from 2-10cm in sand sediments and 2-35cm in muddier sediment (Eigaard *et al*, 2016). On very rough seabed special rock hopper gear can be used. The rockhopper gear is simply the heavy fibre ground rope furnished with rubber discs or rubber wheel rollers (bobbins) and spacers which roll over small obstructions or rough ground. Otter trawls generally cover a greater area of ground than beam trawls (MMO, 2014). The ground rope will have the most extensive contact

	with the seabed, with the length of the ground rope depending on the size of the gear. **Light otter trawls** normally have a ground rope around 10m (FAO) with nets approximatley 10 to 20m long. Light otter trawls generally comprise: netting of less than 4mm twine thickness with rockhoppers or discs less than 200mm diameter. Wire instead of a chain will be used for the ground rope and they will not use tickler chains (MMO, 2014). The doors will usually be between 0.5 and 1.5m in length.
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.	Light otter trawling will exert the same direct and indirect pressures on both *Sabellaria* reef species habitats and associated communities considered in the assessment below: **1.** Demersal mobile fishing gear reduces habitat complexity by: removing emergent epifauna, smoothing sedimentary bedforms, and removing taxa that produce structure (Auster & Langton, 1999). Demersal otter trawl gear has a direct physical effect on the seabed wherever the ground rope, chains and bobbins, sweeps, doors and any chaffing mats or parts of the net bag contact with the seabed. 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). Impact to the seabed sub-surface by otter trawling is likely to structurally damage and break-up *Sabellaria spinulosa* tube aggregations leading to the loss of reef within the footprint of direct impact. Studies have found significant evidence of trawl scars from unspecified fisheries through *Sabellaria spinulosa* reefs (Collins, 2003; Pearce *et al*, 2007) indicating that damage from fishing gear is a possibility (Hendrick *et al*, 2011). In the event of damage caused by otter trawling, recovery rates for *Sabellaria spinulosa* are likely to be determined by a range of factors such as degree of impact, season of impact, larval supply and local environmental factors including hydrodynamics (Gibb *et al*, 2014).

	Where reefs are damaged or removed, recovery can occur through larval recolonisation. Aspects of *Sabellaria spinulosa* reproduction have been studied (Wilson, 1970b; Pearce *et al*, 2007; Pearce *et al*, 2011a) indicating that individual *Sabellaria spinulosa* may reach sexual maturity rapidly, those inhabiting the intertidal area spawned within their first or second year (Pearce, 2008) and growth rate studies also suggest sexual maturity for subtidal populations could be reached within the first year (Pearce *et al*, 2007). The reproductive phase appears to be relatively long with *Sabellaria spinulosa* spending 6 - 8 weeks as planktonic larvae (Wilson, 1970b). Aside from induced spawning by disturbance, a number of studies have indicated that the major spawning event is in the spring. Plankton trawls during a survey by Pearce *et al* (2011b) revealed a high abundance of *Sabellaria spinulosa* larvae in February 2008 and smaller numbers in September and November 2009, suggesting that *Sabellaria spinulosa* are most likely to have a main spawning event at the beginning of the year but do also produce larvae throughout the subsequent months. Pearce *et al* (2011b) found that separating the adult *Sabellaria spinulosa* from tubes in the laboratory induced gamete release, suggesting this could represent a ‘significant evolutionary development whereby sabellariid polychaetes spawn in response to disturbance as a means of potentially securing the future population’. Abrasion at the surface of *Sabellaria spinulosa* reefs is likely to damage the tubes and result in sub-lethal and lethal damage to the worms. It is possible that patchier clumps of *Sabellaria spinulosa* on mixed sediment could be particularily sensitive to trawling activity (Last *et al*, 2012). In these circumstances it is suggested that *Sabellaria spinulosa* reefs are more fragile than *Sabellaria alveolata* and therefore surface abrasion may lead to greater damage and lower recovery rates than observed for *Sabellaria alveolata* (Gibb *et al*, 2014). Evidence relating to *Sabellaria alveolata* reefs (Vorberg, 2000; Cunningham *et al*, 1984) suggests that areas of limited damage on a reef could be repaired rapidly (within weeks) through the tube-building activities of adults.

	Vorberg (2000) used video cameras in the Waddon Sea, to study the effect of shrimp fisheries on *Sabellaria alveolata* reefs. Vorberg's experiments focused on large sections of *Sabellaria alveolata* reef probably attached to bedrock substrata. The imagery showed that the 3m beam trawl easily ran over a reef that rose to 30 to 40cm, although the beam was occasionally caught and misshaped on the higher sections of the reef. At low tide there were no signs of the reef being destroyed although the trawl had left impressions but all traces had disappeared four to five days later due to the rapid rebuilding of tubes by the worms. The daily growth rate of the worms during the restoration phase was significantly higher than undisturbed growth (undisturbed: 0.7mm, after removal of 2cm of surface: 4.4mm) and indicated that as long as the reef was not completely destroyed recovery could occur rapidly. These recovery rates are as a result of short-term effects following once-only disturbance. The impact of the groundrope or chains of the otter trawl would have a similar effect to the beam trawling gear. *Sabellaria alveolata* reefs will be particularly affected by continual trawling or disturbance leading to an impoverished community if the activity or disturbance is prolonged. It is likely that reefs of *Sabellaria spinulosa* can recover quickly from short term or intermediate levels of disturbance as found by Vorberg (2000) in the case of disturbance from shrimp fisheries. Recovery will be accelerated if some of the reef is left intact following disturbance as this will assist larval settlement of the species (JNCC[1]). In some areas, such as the Wadden Sea (Riesen & Reise, 1982) and Morecambe Bay (Holt *et al*, 1998), *Sabellaria* reefs thought to have been removed by trawling have disappeared and have not recovered. There is no overriding explanation of this but it is believed it may be due to a lack of larval supply or larval settlement, since larvae may preferentially settle on existing adult reefs or habitats with structure, (although direct settlement on sediments can occur) (Holt *et al*, 1998).

	Sabellaria reefs which exist in wave exposed areas and are subject to significant natural disturbances may undergo annual cycles of erosion and recolonisation (Holt *et al*, 1998). Surveys on the North Yorkshire and Northumberland coasts found that areas where *Sabellaria spinulosa* had been lost due to winter storms appeared to be recolonised up to the maximum observed 2.4cm thickness during the following summer (Holt *et al*, 1998). Recovery of thin encrusting reefs may therefore be relatively rapid. Cumulatively, otter trawling on an exposed or naturally disturbed *Sabellaria* reef feature could exacerbate the loss of reef and hinder recovery further or potentially inhibit recovery completely. *Sabellaria spinulosa* does not rely on light penetration for photosynthesis. It is also believed that visual perception is limited and that this species does not rely on sight to locate food or other resources. In a recent review of sensitivity of *Sabellaria spinulosa* reefs to anthropogenic disturbance Fariñas-Franco *et al* (2014) concluded that negative impacts on *Sabellaria spinulosa* due to a decrease in water clarity resulting from an increase in suspended solids (inorganic or organic) are unlikely. Sabellariid organisms live in dynamic sedimentary environments and some degree of sediment transport is essential for their tube-building. They are considered to have a low intolerance to burial from prolonged periods of increased levels of sedimentation (Holt*, et al*, 1998; Jackson & Hiscock, 2008; Last *et al*, 2011). **In conclusion**, direct contact by light otter trawls on both *Sabellaria alveolata* and *Sabellaria spinulosa* reefs is likely to cause damage. In singular events of limited damage, recovery can occur on both types of reef, sometimes rapidly. However, there is little evidence to suggest that recovery is guaranteed following significant damage and/or removal of the reef feature. The use of light otter trawls on *Sabelleria* reefs in areas of high natural disturbance could further hinder or inhibit recovery.

		Increased amounts of sediment in the water column caused by fishing gear passing nearby are not thought to negatively effect the *Sabellaria* reefs as they do not require light for photosynthesis and can withstand a level of sedimentation. **2**. Studies have compared an area of *Sabellaria spinulosa* with other macrofaunal communities in the Bristol Channel and found that the *Sabellaria* reef had a higher faunal diversity (more than 88 species) and higher annual production (dominated by suspension-feeders) than other benthic communities in the area (JNCC[1]). A wide range of species are associated with the *Sabellaria alveolata* reef biotopes. The reef and individual *Sabellaria alveolata* worms are not dependent on the associated species to create or modify the habitat, provide food or other resources (Tillin, 2015). The associated species occur in a range of other biotopes and are therefore not considered to characterise the sensitvity of this biotope. Trawling, as explained above, can cause physical damage to erect *Sabellaria* reef communities. The impact of the trawl can break the reefs into smaller bits which will no longer provide a habitat for the rich infauna and epifauna species associated with this biotope. After any impact by an otter trawl the recovery of the *Sabellaria* reef will be when the relevant functional components of the reef are present and the habitat is structurally and functionally as prior to the impact (Tillin & Gibb, 2015). **In conclusion**, direct contact by light otter trawls on both *Sabellaria alveolata* and *Sabellaria spinulosa* reefs is likely to cause damage to the typical species of the reefs. The lasting damage or recovery of the typical species of the reefs will depend on the intensity of the impacts to the reef feature.
6. MPAs where feature exists	**Cardigan Bay SAC**	Biogenic reefs of the honeycomb worm *Sabellaria alveolata* are found in the intertidal and very shallow subtidal environment, particularly in the northeast of the site from Newquay to Aberarth.

		There are possible *Sabellaria spinulosa* reefs at 6 locations within the SAC but these need further survey to confirm whether these areas are biogenic reef or *Sabellaria* crusts.
	Lleyn Peninsula and the Sarnau SAC	There is one definite record of *Sabellaria spinulosa* reef about 4km off the coast at Nefyn. There are possible *Sabellaria spinulosa* reefs off the North Llyn coast between Morfa Nefyn and Braich y Pwll and also off the south coast of Bardsey Island but these need further survey to confirm whether these areas are biogenic reef or *Sabellaria* crusts. There are *Sabellaria alveolata* reefs within the SAC, the reefs are located in the intertidal and very shallow subtidal between Pwllheli and Criccieth, between Mochras point and Harlech, between Fairbourne and Tonfannau and between Borth and Aberystwyth.
	Pembrokeshire Marine SAC	There are possible *Sabellaria spinulosa* reefs located offshore from Martin's Haven, near Stack Rocks and outer reaches of St Bride's Bay. However, these need further survey to confirm whether these areas are biogenic reef or *Sabellaria* crusts.
	Severn Estuary SAC	*Sabellaria* reef (*Sabellaria alveolata*) is found throughout the Severn Estuary SAC. There are records of *Sabellaria* reef (*Sabellaria alveolata*) in the south east of the SAC, at Goldcliff and in the northeast between Goldcliff and the Severn Crossing. Note that data for this species comes from an old dataset and this habitat is hard to survey. It is possible therefore that further records of this species occur in other locations within the SAC.

7. Conclusion

Light otter trawling can negatively impact on *Sabellaria alevolata* and *Sabellaria spinulosa* reefs through partial or total damage and/or removal of the reef structure through abrasion and ploughing. Recovery will be dependant on local factors such as season of impact, larval supply, environmental factors, condition of reef etc. Although there is a potential for rapid recovery of a partially damaged reef, and a much slower recovery for heavily impacted reefs, the conditions to support recovery are not guaranteed.

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)

SBR.PoR.SalvMx - *Sabellaria alveolata* on variable salinity sublittoral mixed sediment
Tide-swept sandy mixed sediments with cobbles and pebbles, in variable salinity or fully marine conditions, may be characterised by surface accumulations of the reef building polychaete *Sabellaria alveolata*. The presence of *Sabellaria* sp. has a strong influence on the associated infauna as the tubes bind the surface sediments together and provide increased stability. Such reefs may form large structures up to a metre in height although they are considerably less extensive than the intertidal reefs formed by this species (Salv). Other associated species may include the polychaete *Melinna cristata*, itself often as dense aggregations, mobile surface feeding polychaetes including *Typosyllis armillary* and *Eulalia tripunctata*. Other polychaetes may include *Mediomastus fragilis* and *Pygospio elegans* whilst amphipods such as *Harpinia pectinata* and *tubificid oligochaetes* may also be found.

LS.LBR.Sab.Salv - *Sabellaria alveolata* reefs on sand-abraded eulittoral rock
Exposed to moderately exposed bedrock and boulders in the eastern basin of the Irish Sea (and as far south as Cornwall) characterised by reefs of the polychaete *Sabellaria alveolata*. The sand based tubes formed by *S. alveolata* form large reef-like hummocks, which serve to stabilise the boulders and cobbles. Other species in this biotope include the barnacles *Semibalanus balanoides* and *Elminius modestus* and the limpet *Patella vulgata*, the winkle *Littorina littorea*, the mussel *Mytilus edulis* and the whelk *Nucella lapillus*. The anemone *Actinia equina* and the crab *Carcinus maenas* can be present in cracks and crevices on the reef. Low abundance of seaweeds tend to occur in areas of eroded reef. The seaweed diversity can be high and may include the foliose red seaweeds *Palmaria palmata, Mastocarpus stellatus, Osmundea pinnatifida*, *Chondrus crispus* and some filamentous species e.g. *Polysiphonia* spp. and *Ceramium* spp. Coralline crusts can occur in patches. Wracks such as *Fucus vesiculosus, Fucus serratus* and the brown seaweed *Cladostephus spongiosus* may occur along with the ephemeral green seaweeds *Enteromorpha intestinalis* and *Ulva lactuca*. On exposed surf beaches in the south-west *S. alveolata* forms a crust on the rocks, rather than the classic honeycomb reef form, and may be accompanied by the barnacle *Balanus perforatus* (typically common to abundant). On wave-exposed shores in Ireland, the wrack *Himanthalia elongata* can also occur.

SBR.PoR.SspiMx - *Sabellaria spinulosa* on stable circalittoral mixed sediment
The tube-building polychaete *Sabellaria spinulosa* at high abundances on mixed sediment. These species typically forms loose agglomerations of tubes forming a low lying matrix of sand, gravel, mud and tubes on the seabed. The infauna comprises typical sublittoral polychaete species such as *Protodorvillea kefersteini, Pholoe synophthalmica, Harmothoe* spp, *Scoloplos armiger, Mediomastus fragilis, Lanice conchilega* and cirratulids, together with the bivalve *Abra alba*, and tube building amphipods such as *Ampelisca* spp. The epifauna comprise a variety of bryozoans including *Flustra foliacea*, *Alcyonidium diaphanum* and *Cellepora pumicosa*, in addition to calcareous tubeworms, pycnogonids, hermit crabs and amphipods. The reefs formed by *Sabellaria* consolidate the sediment and allow the settlement of other species not found in adjacent habitats leading to a diverse community of epifaunal and infauna species. The development of such reefs is assisted by the settlement behaviour of larval *Sabellaria* which are known to selectively settle in areas of suitable sediment and particularly on existing *Sabellaria tubes* (Tait and Dipper, 1997; Wilson 1929).