

PRIORITY MARINE FEATURE (PMF) - FISHERIES MANAGEMENT REVIEW

Feature

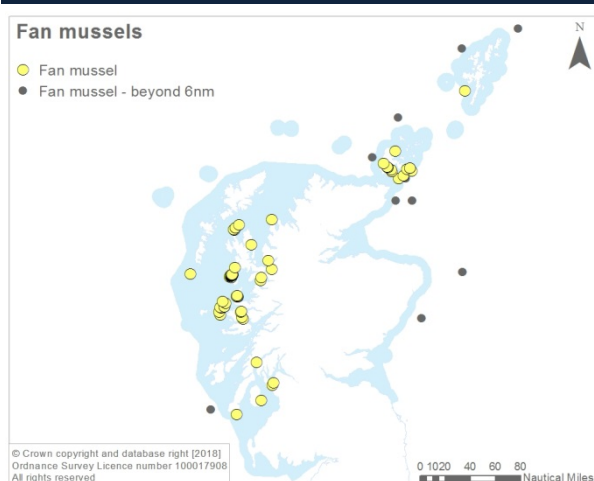
FAN MUSSEL AGGREGATIONS [*ATRINA FRAGILIS*]

Image



Image: Sue Scott

Map



Description

Characteristics - The fan mussel (*Atrina fragilis*) is one of Britain's largest molluscs, growing to 30-48 cm in length. The fragile shell is light yellow-brown to dark brown in colour, brittle and tapers to a point. Fan mussels live with their pointed end embedded in sediment, attached by many fine byssal threads. The posterior (broad) end protrudes from the surface of the sediment and may support growths of sea anemones, keel worms, hydroids, soft corals and sponges. They feed on plankton and suspended organic particles. Fan mussels are often solitary but also occur in clusters or aggregations. Assumed to be long-lived due to its large size, the fan mussel is believed to have a lifespan of between 7 and 32 years (Papoutsis & Galinou-Mitsoudi, 2010).

Definition - Fan mussel density in the Sound of Canna (the largest known aggregation in Scottish waters) varies from an estimated 1-4 per m² to widely scattered individuals. An aggregation is currently considered to exist where more than two fan mussels are present in a single survey sample (e.g. a single drop-down video camera run) or across multiple surveys / samples in a broad geographic area (1-2 km²). This is to accommodate variation in mussel density and ensure that potential aggregations are not overlooked. Additional sampling would be required to validate records where mussel numbers are low. This working definition may be revised subject to further analyses of new Scottish / UK records.

Environmental preferences - Fan mussels have been found embedded in lower intertidal and subtidal muds, sandy muds or gravels, at sites sheltered from water movement down to 400 m depth. The aggregation off Canna occurs between 100-275 m (Howson *et al.*, 2012).

Distribution

Scottish distribution - Most recent records are from Scotland in deep water on the west coast (Stirling *et al.*, 2016b). Fan mussels have also been found off Shetland (believed to be the northerly limit for the species) and around Orkney, with scattered records from the north-east coast (beyond 6 nm). The Sound of Canna in the Small Isles supports the densest known aggregation in UK waters. Recorded originally in 2009, follow-up survey work in 2010 and 2011 established the full extent of the fan mussels in this area (Moore & Roberts, 2011; Howson *et al.*, 2012; Moore, 2012; 2013).

Estimated known Scottish extent - The fan mussel aggregation in the Sound of Canna covers an area of ~3.9 km².

Wider distribution - Recorded off the north and west coasts of Ireland, the Irish Sea (Dublin Bay, Liverpool Bay and the Bristol Channel), the Scilly Isles, Channel Isles and along the south coast of England. *Atrina fragilis* distribution extends around the Iberian Peninsula down as far as the north-western African coast at Mauritania and throughout the Mediterranean (EOL, 2018; GBIF, 2018). The species has also been recorded around the Caribbean Islands and off Madeira (Nobre 1938-1940 cited in Šimunović *et al.*, 2001) with a record from the Pakistan coast in 2013 (Sultana & Jamil, 2013).

Status

Historical accounts describe the species as being 'sparingly and locally distributed' on all British coasts but 'gregarious', from low-water mark down to a depth of 150 m (Jeffreys, 1862). Individuals and sometimes aggregations were commonly caught in the nets of scallop and demersal fish trawlers and expedition ships in the 19th century (Solandt, 2003).

However, almost every reported record in the 20th century is based on sightings of individuals and these records are deemed newsworthy (e.g. MCS, 2011). The species is now considered one of the most endangered molluscs in Britain. The causes for the decline of the fan mussel in UK waters are reviewed by Solandt (2003) who presents a convincing case for the decline being linked to the industrialisation of benthic fishing over the last century. These observations are supported by the work of Hall-Spencer *et al.* (1999), Fryganiotis *et al.* (2013) and Stirling *et al.* (2016b).

Scottish fan mussels are therefore of national importance and are protected under Schedule 5 of the Wildlife and Countryside Act 1981 (killing & injuring; possession; & sale).

In the south-west of England, it is thought that the fan mussel has largely disappeared from inlets where it was once common. The main surviving UK populations appear to be from Cornwall and Devon with those in the Salcombe Estuary particularly well documented (Goodwin *et al.*, 2011). A cluster of ~20 fan mussels found by divers in comparatively shallow nearshore waters in Plymouth Sound in 2004 (BBC, 2004) has not been re-recorded in recent years (see - <http://www.seasearch.org.uk/achievements.html>).

Fisheries research cruises in the UK in the 1990s regularly observed fan mussels as bycatch (Solandt, 2003).

Sensitivity (including recovery)

[Key sources: [FEAST](#); [Fisheries Management Guidance](#)]

Fan mussels are vulnerable to over-exploitation due to their long life, slow growth, limited reproductive output and sporadic recruitment (Butler *et al.*, 1993). They are highly sensitive to physical changes at the sea bed (i.e. a change in substratum type, physical removal of substratum and abrasion), changes in siltation rates and removal of non-target species. These pressures arise from fishing (including hydraulic dredging, otter trawling and scallop dredging) and activities including infrastructure development and extraction of sand and gravel. They are also sensitive to smothering and changes in water flow and wave action (Mazik *et al.*, 2015; Tyler-Walters & Wilding, 2017). Fan mussels may also be vulnerable to future climate impacts, with changes in seawater temperature and chemistry (ocean acidification) potentially affecting larval dispersal and survival (Gazeau *et al.*, 2013; Gerber *et al.*, 2014).

Up to 30% of a fan mussel shell projects above the sediment surface making it vulnerable to towed bottom-contacting gear and, particularly to dredges. Trawling caused a >70% reduction in the fan mussel population in the Gulf of Venice (Adriatic), where 90% of the specimens caught by trawlers were lethally damaged (Hall-Spencer *et al.*, 1999; Solandt, 2003). Dredging for king scallop (*Pecten maximus*) off Glengad Head in Ireland after 1975 removed many live fan mussels and the population is thought to have been destroyed by subsequent fishing activity (Anon. 1999; Hiscock & Jones, 2003).

The presence of aggregations of fan mussels in the Sound of Canna (an area considered unfavourable for trawling due to the complex topography and presence of a spoil site) and also in Plymouth Sound (recorded near areas of heavy shipping traffic) suggest that these locations serve as possible refuges for fan mussels (Stirling, 2016).

Recovery of fan mussel populations is likely to be slow and sporadic (Fryganiotis *et al.*, 2013; Mazik *et al.*, 2015) and is dependent on removal of relevant pressures, the continued presence of suitable substrates and a source of larval recruits. Individuals can't rebury (Yonge, 1953) and growth rates of damaged shells have been reported as 1 cm yr⁻¹ (Yonge & Thomson, 1976). Fertilisation is dependent on proximity to other individuals and environmental factors influencing larval dispersal and survival. When populations become very sparse, as is the case in the UK, fertilization failure is likely to be significant (Butler *et al.*, 1993).

Connectivity

Between fan mussels - Fan mussel larvae are believed to have a pelagic larval duration (PLD) of up to 4 months (Stirling *et al.*, 2016a). Spawning peaks over the summer and winter with trickle spawning continuing throughout the year. Stirling (2016) modelled fan mussel larval transport on the west coast of Scotland, taking into account key aspects of the life-history, habitat suitability and fine scale hydrodynamics. The model outputs suggest that fan mussel larvae from the aggregation in the Sound of Canna have the potential to be transported over a wide geographical scale; as far north as Shetland during winter months and across to St Kilda in the west during the summer. The study concluded that with sufficient habitat protection in place, the Small Isles fan mussel population could re-colonise large areas of its former range in Scottish waters north of 57°N. However, due to the prevailing circulation patterns on the west coast (general larval transport from south to north), this source population could not, in isolation, underpin colonisation of all areas of suitable habitat. Areas of potentially suitable habitat are identified in Stirling *et al.* (2016b). Additional management to the south of the Sound of Canna could provide support to the population within the MPA network. Likewise, additional management of areas of suitable habitat to the north could support recolonisation from the population within the MPA.

With other PMFs - Fan mussels have been recorded within and adjacent to *horse mussel beds* within Scapa Flow (Marine Conservation Society, 2011) and off Copinsay in Orkney; and on the west coast, in the Sound of Canna (Moore & Roberts, 2011; Howson *et al.*, 2012). Fan mussels also have a known association with *seagrass beds*; formerly recorded from the Scilly Isles in SW England, they have not been recorded there since the seagrass beds were lost (Turk 1982; Turk & Seaward, 1997). This association can still be observed in the shallow subtidal and lower shore in the Salcombe Estuary (see [South Devon AONB](#) for details). Fan mussels have also been recorded from sublittoral sediments adjacent to bedrock, boulder and cobble habitats supporting the *northern sea fan and sponge communities* PMF. This relationship almost certainly only reflects the natural refuge function afforded to pockets of sediments within rough ground favoured by sea fans.

Ecosystem services

- | | |
|--|--|
| <ul style="list-style-type: none"> • Formation of habitat for other species (supporting biodiversity) • Larval/gamete supply (supporting connectivity) | <ul style="list-style-type: none"> • Socially valued places/seascapes • Ornamental materials (commercial & personal) • Watching/studying nature |
|--|--|

Existing Marine Protected Areas

Fan mussel aggregations are a protected feature of the Small Isles MPA.

Existing and proposed fisheries measures providing PMF protection

New fisheries management measures that will afford PMF protection in the Small Isles MPA will be consulted upon later in 2018 (see - <http://www.gov.scot/Topics/marine/marine-environment/mpanetwork/inshorempas/Management>).

Five records of individual fan mussels are afforded protection by virtue of fisheries measures associated with other designated features in a further 4 MPAs: Upper Loch Fyne and Loch Goil; South Arran; Lochs Duich, Long and Alsh; Loch Carron; and, Wester Ross.

The record from South Arran is from 1878 and the record from the outer reaches of Loch Ewe (Wester Ross MPA) is from sometime before 1985. Both records are presented in Woodward (1985). The three other records are more recent; a certain record from 2005 in Loch Duich and two inconclusive records (derived from underwater video footage), from Upper Loch Fyne in 2012 (Moore & Atkinson, 2012) and Loch Carron in 2017 (Moore *et al.*, 2018).

Examples of PMFs that have no or partial coverage by fisheries measures

Since 2000, fan mussels have been recorded from the following locations outside the Sound of Canna -

- South-east of Muck - an aggregation - multiple fan mussel records from a 2014 Marine Scotland Science (MSS) survey.
- East of Skye - a single fan mussel recorded as part of the 2014 MSS fan mussel modelling verification survey.
- Scapa Flow - a single fan mussel living in a horse mussel bed near the wreck of the SMS *Karlsruhe*. There are multiple records (at least 4 spanning 2011-2013) of the same mussel. There are also two additional fan mussel records from 1968 in different parts of Scapa Flow.

Older, scattered clusters of individual fan mussels in Scottish nearshore waters include -

- Around Skye - three records to the north of Skye; two records off Mallaig and a single record off the south-west coast.
- Coll - a cluster of records around the top and to the south-east of the island.
- Off Copinsay - a spread of fan mussel records (indicating widespread potentially suitable habitat) to the SE of Orkney.

Assessment against National Marine Plan General Policy 9:

Development and use of the marine environment must not result in significant impact on the national status of Priority Marine Features.

Fan mussel aggregations are functionally important, sensitive, slow to recover and if lost completely may not recover. They are considered one of the most threatened molluscs in UK waters. Therefore any activities that lead to the loss of fan mussels or fragment aggregations to the extent that function or provision of ecosystem services cannot be maintained should be considered a significant impact on national status.

Existing licensing and consenting processes will continue to consider the potential for significant impacts on the national status of development proposals on fan mussel aggregations. The following assessment relates to fishing using towed bottom-contacting gear only but is consistent with the approach taken for assessing proposed developments. Please refer to the *consultation overview* for further details.

In a fisheries context, there is currently only one area where there is sufficient information to recommend additional measures to protect an aggregation of fan mussels from pressures associated with towed bottom-contacting gears: **South-east of Muck**. The recommendation for fan mussel aggregations needs to be considered alongside the recommendations for the other 10 PMFs considered as part of this review. The area identified provides a starting point for discussions regarding future fisheries management. These discussions will be led by Marine Scotland.

A total of 44 fan mussels (and three observations of empty / broken shells) was recorded from five video transects completed to the South-east of Muck by Marine Scotland Science in 2014 (Stirling, 2016 - see map provided). The 2014 survey was undertaken to verify the conclusions of species distribution modelling presented in Stirling (2016b). The area of likely suitable habitat identified by that study in this area covers ~29 km². Further survey work is required to determine the distribution and density of fan mussels across the wider area.

The protection of fan mussels at the South-east of Muck area would supplement proposed measures in the nearby Small Isles MPA and provide a measure of replication in PMF management.

Knowledge gaps and other records

Knowledge gaps - Eight knowledge gap areas have been identified primarily on the basis of modelled habitat (i.e. records of fan mussels may not exist in these areas - except Scapa Flow): **NW Tiree; South of Islay; Off Clyde Sea Sill; South of Rum; East of Barra; Southern Inner Sound; Small Isles; and, Scapa Flow & Copinsay.**

An additional area of potential significance to the conservation of fan mussels was identified by Stirling (2016) to the **North of Rathlin Island**. This area is beyond Scottish waters but is shown on the map provided for reference.

If areas occupied by fan mussels can be identified and protected in SW Scotland they would serve as a source of larvae for areas of suitable habitat south of the Sound of Canna aggregation. To that end, the first three knowledge gap areas (**NW Tiree, South of Islay and Off Clyde Sea Sill**) mirror areas of suitable habitat identified by Stirling (2016b). Simplified areas have been adopted. Consideration should be given to implementing appropriate management measures should future survey work confirm the presence of fan mussel aggregations in any of these areas.

Four additional knowledge gap areas (**South of Rum, East of Barra, Small Isles and Southern Inner Sound**) were generated from the other 32 areas of suitable habitat identified on the west coast in Stirling (2016b). The South of Rum and East of Barra knowledge gap areas may also support suitable habitat for *cold-water coral reefs* (please refer to the paper for that PMF for further details).

In the absence of species distribution modelling away from the west coast, a single knowledge gap has been identified in Orkney based around historic records and the single confirmed, extant record in Scapa Flow (**Scapa Flow & Copinsay**).

Results of the studies presented in Stirling (2016) suggest that an area of suitable habitat to the **North of Rathlin Island** receives larvae from the Atlantic, displays high levels of self-recruitment during the summer (Stirling *et al.*, 2016a) whilst also potentially acting as a source of larvae to suitable areas to the north. Fan mussels have been recorded in the waters surrounding Rathlin Island and elsewhere on the north-coast of Northern Ireland (Godwin *et al.*, 2011) and as such, this is considered a particularly promising area in which to conduct future collaborative surveys. Opportunities for joint research should be explored through the 2018-2022 EU INTERREG VA-funded MarPAMM Project.

Other records - The implementation of targeted fisheries management measures in areas that still support aggregations of fan mussels would safeguard against advances in gear technology and changes in the economic landscape that may favour their exploration. However, to enable fan mussels to re-colonise the full range of suitable habitat, explicit protection of a proportion of sedimentary habitats characterised by less complex topographies should be considered (flatter areas more suitable for fishing) (Stirling, 2016).

Data confidence

The earliest records of fan mussels in Scottish waters were collated and presented in Woodward (1985). This account includes observations from 24 locations spanning 1764-1973. Most of the specimens were caught on assorted fishing gears and are imprecisely located. There have only been records from two areas in Orkney since 1970.

The clusters of records to the north of Skye, around the top of Coll and in the Sound of Mull are from fisheries research surveys undertaken in the 1990s. There are a small number of diver records including from Loch Duich and recent Seasearch observations in Scapa Flow. The fan mussel aggregation in the Sound of Canna was discovered in 2009 (identified by SEPA analysts on video footage collected as part of routine dredge disposal monitoring) and has been the subject of a number of follow-up studies. On the basis of the successful verification of the species distribution model developed by Stirling *et al.* (2016b), additional records of this species are anticipated. Fan mussel data from the NBN Atlas were used in this assessment.

References

- Anon. 1999. *UK Biodiversity Group Tranche 2 Action Plans - Volume V: Maritime species and habitats* (October 1999, Tranche 2, Vol V, p63).
<<http://webarchive.nationalarchives.gov.uk/20110303154116/http://www.ukbap.org.uk/UKPIans.aspx?ID=123>>
- BBC. 2004. *Rare giant shells found in Plymouth*. http://www.bbc.co.uk/devon/outdoors/nature/2004/giant_shells.shtml
- Butler, A.J., Vicente, N. & de Gaulejac, B. 1993. Ecology of the pteroid bivalves *Pinna bicolor* Gmelin and *Pinna nobilis* Linnaeus. *Marine Life*, **3**: 37-45.
- Encyclopedia of Life. 2018. *Atrina fragilis*. Accessed on 11/01/2018.
<<http://eol.org/pages/586410/maps>>
- Fryganiotis, K., Antoniadou, C. & Chintiroglou, C. 2013. Comparative distribution of the fan mussel *Atrina fragilis* (Bivalvia, Pinnidae) in protected and trawled areas of the north Aegean Sea (Thermaikos Gulf). *Mediterranean Marine Science*, **14**: 119-124.
- Gazeau, F., Parker, L.M., Comeau, S., Gattuso, J.P., O'Connor, W.A., Martin, S., Pörtner, H.O. & Ross, P.M. 2013. Impacts of ocean acidification on marine shelled molluscs. *Marine Biology*, **160**(8): 2207-2245. doi: 10.1007/s00227-013-2219-3.
<https://www.researchgate.net/publication/236597535_Impacts_of_ocean_acidification_on_marine_shelled_molluscs>
- Gerber, L.R., Mancha-Cisneros, M. Del Mar., O'Connor, M.I. & Selig, E.R. 2014. Climate change impacts on connectivity in the ocean: Implications for conservation. *Ecosphere*, **5**(3): 33. <http://gerberlab.faculty.asu.edu/wordpress/wp-content/uploads/2011/10/Gerber_et_al_2014_ESA.pdf>
- Global Biodiversity Information Facility. 2018. *Atrina fragilis*. Accessed on 11/01/2018.
<<https://www.gbif.org/species/2285345>>
- Goodwin, C., Picton, B., Breen, J., Edwards, H. & Nunn, J. 2011. Sublittoral Survey Northern Ireland (2006 - 2008). *Northern Ireland Environment Agency Research and Development Series No. 11/01*. DOI: 10.13140/RG.2.1.1169.3043.
- Hall-Spencer, J.M., Froggia, C., Atkinson, R.J.A. & Moore, P.G. 1999. The impact of Rapido trawling for scallops, *Pecten jacobaeus* (L.), on the benthos of the Gulf of Venice. *ICES Journal of Marine Science: Journal du Conseil*, **56**: 111-124. <<https://watermark.silverchair.com/56-1-111.pdf>>
- Hiscock, K. & Jones, H. 2003. *Testing criteria for assessing 'national importance' of marine species, biotopes (habitats) and landscapes*. Report to Joint Nature Conservation Committee from the Marine Life Information Network (MarLIN). Plymouth: Marine Biological Association of the UK. [JNCC Contract no. F90-01-681].
<http://jncc.defra.gov.uk/pdf/all_Marlin_dossiers.pdf>

Howson, C.M., Clark, L., Mercer, T.S. & James, B. 2012. Marine biological survey to establish the distribution and status of fan mussels *Atrina fragilis* and other Marine Protected Area (MPA) search features within the Sound of Canna, Inner Hebrides. *Scottish Natural Heritage Commissioned Report No. 438*. <<https://www.nature.scot/snh-commissioned-report-438-marine-biological-survey-establish-distribution-and-status-fan-mussels>>

Jeffreys, J.G. 1862. An Account of the Mollusca which now Inhabit the British Isles and the Surrounding Seas. *British Conchology*, 2(5): 465.
<<https://www.biodiversitylibrary.org/item/63267#page/118/mode/1up>>

Lancaster, J. (Ed.), McCallum, S., Lowe A.C., Taylor, E., Chapman A. & Pomfret, J. 2014. Development of detailed ecological guidance to support the application of the Scottish MPA selection guidelines in Scotland's seas. *Scottish Natural Heritage Commissioned Report No. 491*. Fan mussel aggregations - supplementary document.

Marine Conservation Society. 2011. *Seasearch divers discover giant rarity in the Orkney Isles*. News release. <<https://www.mcsuk.org/news/seasearch-divers-discover-giant-rarity-in-the-orkney-isles>>

Mazik, K., Strong, J., Little, S., Bhatia, N., Mander, L., Barnard, S. & Elliott, M. 2015. A review of the recovery potential and influencing factors of relevance to the management of habitats and species within Marine Protected Areas around Scotland. *Scottish Natural Heritage Commissioned Report No. 771*. <<https://www.nature.scot/snh-commissioned-report-771-review-recovery-potential-and-influencing-factors-relevance-management>>

Moore, C.G. 2012. An assessment of the conservation importance of benthic epifaunal species and habitats identified during a series of research cruises around NW Scotland and Shetland in 2011. *Scottish Natural Heritage Commissioned Report No. 507*.
<<https://www.nature.scot/snh-commissioned-report-507-assessment-conservation-importance-benthic-epifaunal-species-and>>

Moore, C.G. 2013. Biological analyses of underwater video from research cruises in Lochs Kishorn and Sunart, off the Mull of Kintyre and islands of Rum, Tiree and Islay, and in the Firth of Lorn and Sound of Mull approaches. *Scottish Natural Heritage Commissioned Report No. 574*. <<http://www.nls.uk/e-monographs/2013/574.pdf>>

Moore, C.G. & Roberts, J.M. 2011. An assessment of the conservation importance of species and habitats identified during a series of recent research cruises around Scotland. *Scottish Natural Heritage Commissioned Report No. 446*. <<https://www.nature.scot/snh-commissioned-report-446-assessment-conservation-importance-species-and-habitats-identified>>

Moore, C.G. & Atkinson, R.J.A. 2012. Biological analyses of underwater video from research cruises in the Clyde Sea, Loch Torridon and the Inner Sound, the North Minch, Loch Eriboll and off Orkney. *Scottish Natural Heritage Commissioned Report No. 536*.
<<https://www.nature.scot/snh-commissioned-report-536-biological-analyses-underwater-video-research-cruises-clyde-sea-loch>>

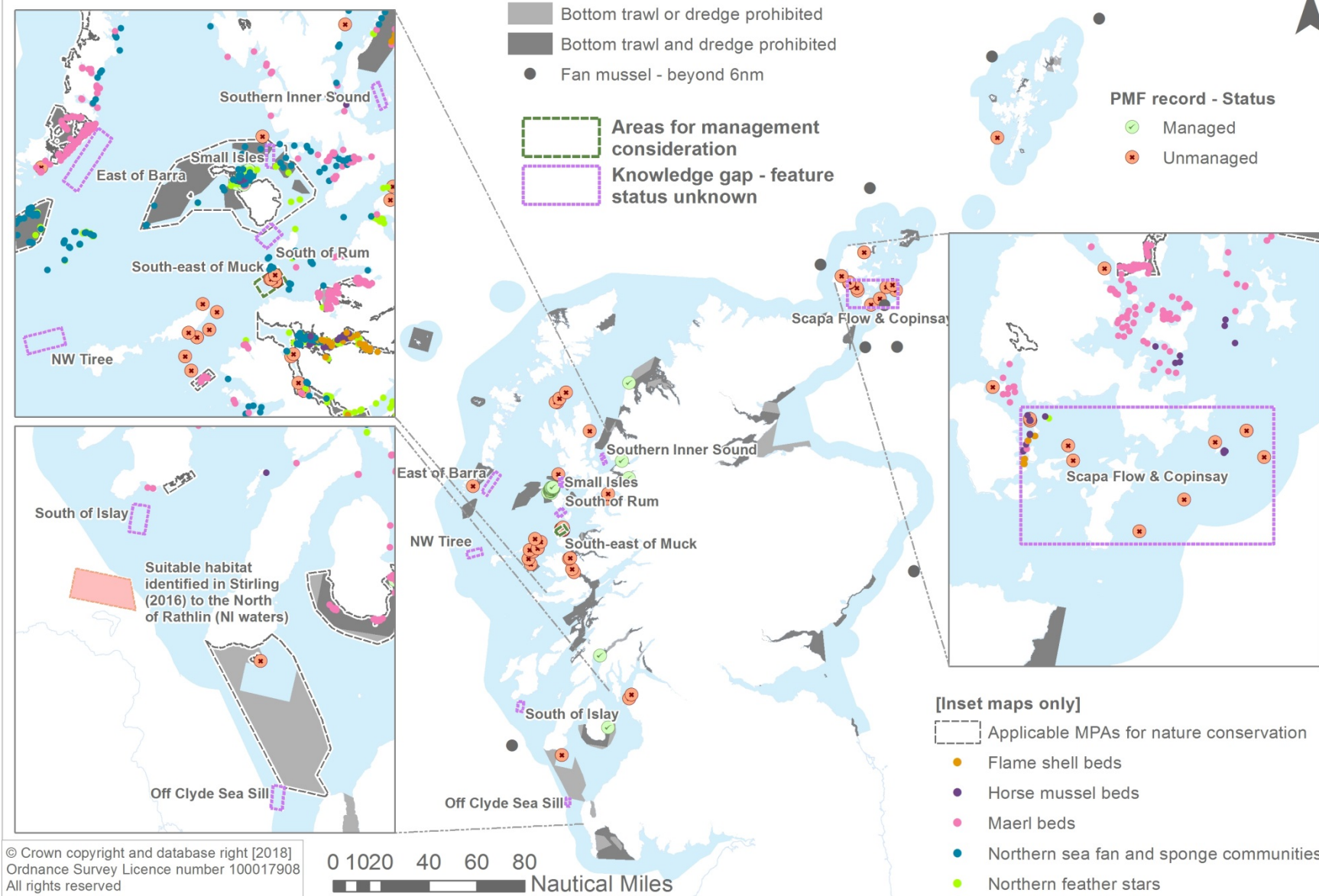
Moore, C.G., Harries, D.B., James, B., Cook, R.L., Saunders, G.R., Tulbure, K.W., Harbour, R.P. & Kamphausen, L. 2018. The distribution and condition of flame shell beds and other Priority Marine Features in Loch Carron Marine Protected Area and adjacent waters. *Scottish Natural Heritage Research Report No. 1038*. <<https://www.nature.scot/snh-research-report-1038>>

Nobre, A. 1938-1940. Fauna Malacológica de Portugal: 1 Moluscos marinhos e das Águas Salobras. *Annaes de Sciencias Naturaes* i-xiii. 1-806, 87 pls.

- Papoutsis, O. & Galinou-Mitsoudi, S. 2010. Preliminary results of population dynamics, age and growth of Atrina pectinata (Linnaeus, 1767) in Thermaikos gulf (Greece). *14th Panellenic Congress of Ichthyologists: Fisheries - Aquaculture, a multidimensional approach. Proceedings Panellenic Ichthyological Association, Athens (Greece), Piraeus, 6-9 May 2010.* May 2010, pp. 131-134.
- Šimunović, A., Piccinetti, C., Bartulović, M. & Grubelić, I. 2001. Distribution of Atrina fragilis (Pennant, 1777) (Pinnidae, Mollusca, Bivalvia) in the Adriatic Sea. *Acta Adriatica*, **42**(1): 49-59.
- Stirling, D. 2016. *Assessing the conservation benefit of Marine Protected Areas to vulnerable benthic species as illustrated by the fan-mussel, Atrina fragilis*. PhD Thesis. University of Aberdeen. <<http://ethos.bl.uk/OrderDetails.do?uin=uk.bl.ethos.725367>>
- Stirling D.A., Boulcott P., Bidault M., K. Gharbi, Scott B.E. & Wright P.J. 2016a. Identifying the larva of the fan-mussel, Atrina fragilis (Pennant 1777). *Journal of Molluscan Studies*, In Review.
- Stirling, D.A., Boulcott, P., Scott, B.E. & Wright, P.J. 2016b. Using verified species distribution models to inform the conservation of a rare marine species. *Diversity and Distributions*, **22**(7): 808-822.
- Solandt, J-L. 2003. The fan shell Atrina fragilis - A species of conservation concern. *British Wildlife*, **14**: 423-427.
<https://www.researchgate.net/publication/289793253_The_fan_shell_Atrina_fragilis_-_A_species_of_conservation_concern>
- Sultana, R. & Jamil, K. 2013. New record of Pinna fragilis from Pakistan coast. *Marine Biodiversity Records*, **6**. doi:10.1017/S1755267212000541.
- Turk, S.M. & Seaward, D.R. 1997. The marine fauna and flora of the Isles of Scilly - Mollusca. *Journal of Natural History*, **31**: 55-633.
- Turk, S.M. 1982. The silkworm of the sea, spinner of cloth of gold. *Conchologists Newsletter*, **83**: 39-42.
- Tyler-Walters, H. & Wilding, C.M. 2017. Atrina fragilis Fan mussel. In Tyler-Walters H. and Hiscock K. (eds) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 09-01-2018]. <<https://www.marlin.ac.uk/species/detail/1157>>
- Woodward, F.R. 1985. The Fan-mussel, Pinna fragilis Pennant in Scotland. *Glasgow Naturalist*, **21**: 63-69. <<https://www.biodiversitylibrary.org/item/225268#page/69/mode/1up>>
- Yonge, C.M. 1953. Form and Habit in Pinna carnea Gmelin. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, **237**: 335-374. DOI: 10.1098/rstb.1953.0006 <<http://rstb.royalsocietypublishing.org/content/237/648/335>>
- Yonge, C.M. & Thomson, T.E. 1976. *Living Marine Molluscs*. William Collins, London, 288pp.

Areas where fisheries management should be considered to avoid a significant impact on the national status of the PMF

Fan mussels



(bracketed values denote observations of empty / broken fan mussel shells)

