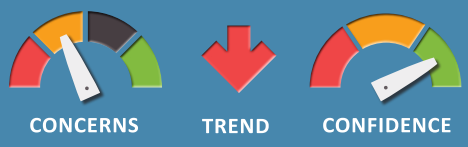
5. Condition of the Region
HEALTHY AND BIOLOGICALLY DIVERSE

5.1 Intertidal rock and sediments



Colours are explained in the key at the beginning of the document

KEY SUPPORTING EVIDENCE

SNH commissioned report 347 www.snh.org.uk/pdfs/publications/commissioned_reports/347.pdf

Scotlands Marine Atlas www.gov.scot/Resource/Doc/345830/0115114.pdf

MPA surveys www.snh.gov.uk/protecting-scotlands-nature/protected-areas/national-designations/marine-protected-areas-(mpa)/mpa-survey-research-reports/

Scotland's Marine Atlas Clyde score: 'Some concerns and deteriorating'. Regional assessment is consistent with this.

Figure 5.1 Intertidal zone at Hunterston



© CMPP

Figure 5.2 Saltmarsh at Bowling, Inner Clyde



© CMPP

Introduction

Intertidal rock includes habitats of bedrock, boulders and cobbles that lie between Mean High Water Springs and Mean Low Water Springs. Species in these habitats are affected by numerous physical variables including wave exposure, salinity, temperature and tides. On many rocky shores there is a distinct vertical zonation pattern brought about by a small number of dominant species inhabiting broad bands on the surface depending on their tolerance to the length of time they are exposed to the air at low tide and competition for space.

Intertidal sediments are mobile shingle and gravel, sand and mud or combinations of these, as well as saltmarsh soils. They support species that are tolerant of exposure to air and to variable temperature and salinity. The most notable areas for sediment are the mudflats and pockets of saltmarsh in the Clyde estuary, the heads of the lochs and the sandflats on the Ayrshire coast. The last of these have cultural and economic importance being frequented by many tourist visitors, in particular, during the summer months.

SENSITIVITY TO ACTIVITIES/PRESSURES[193]

Species found on rocky shores are likely to face increased pressures due to climate change with increasing sea temperatures and rainfall patterns. These pressures may be further exacerbated by the introduction of non-native species.[194]

Mudflats and sandflats are sensitive to physical disturbance, changes in wave regimes, sea-level rise and pollution. Development pressure can be significant in various parts of the Clyde, in particular in the Clyde estuary, but also on the Ayrshire coast. Beach litter levels remain high and have been increasing in almost all areas[195] and can be particularly problematic on the northern shore of the Clyde estuary in West Dunbartonshire where a combination of litter from recreational use, along with litter brought by wind and tide, leads to accumulations.[196] Sandflats can also be sensitive to any beach grooming. Sandflats are sensitive to fisheries and various damaging recreational activities although there is no direct evidence of this in the CMR.

193. Baxter *et al.*, 2011
194. Baxter *et al.*, 2011
195. UK National Ecosystem Assessment, 2011
196. Dyson, 2011

Table 5.1 Priority Marine Features found on intertidal sediments in the Clyde Marine Region and their sensitivity to activities/pressures

For further details on specific pressures in the region, see the Productive section

PMF	COMPONENT BIOTOPES/SPECIES	SENSITIVITY TO ACTIVITIES/PRESSURES[200]
Intertidal mudflats	Littoral mud	Physical disturbance, changes in wave regimes, sea-level rise and pollution.
Sea loch egg wrack beds	*Ascophyllum nodosum* ecad *mackayi* beds	Coastal development and any potential seaweed harvesting that may occur in future as this industry develops.
Seagrass beds	*Zostera noltii* beds in littoral muddy sand	Suction dredging and bait digging as well as a range of coastal developments.
Blue mussel beds	*Mytilus edulis* beds on littoral sediments	Physical damage, in particular demersal fishing, bait-digging, anchoring, coastal developments, chemical pollution and harvesting.
	Mytilus edulis and *Fabricia sabella* in littoral mixed sediment	
Native oyster	*Ostrea edulis* individuals and beds on shallow sublittoral muddy sediment	Over-fishing, pollution, disease and non-native species.

There are no PMFs currently mapped on intertidal rock in the CMR.

The main concern for intertidal rock and sediments in the Clyde Marine Region (CMR) is the introduction and increase in non-native species, in particular wireweed (*Sargassum muticum*).[197] Wireweed is a distinctive large olive-brown seaweed, often over 1m long which can dominate in rock pools, altering the habitat. It was first recorded in Scotland in Loch Ryan in 2004 and has since spread northwards throughout the Firth of Clyde and beyond. In 2010 Scottish Natural Heritage (SNH) commissioned research on the spread of wireweed on the west coast of Scotland. The report concluded that *'much of the eastern Firth of Clyde is colonised by established populations of* S. muticum*, with less dense colonisation in the west Firth of Clyde.* S. muticum *favoured bedrock and boulder substrates but dense populations were also recorded attached to small pebbles buried in sandy sediments, as well as on man-made coastal structures such as slipways and piers'. The species was recorded both in rock pools and subtidally*.[198]

The non-native common cord-grass (*Spartina anglica*) is also present in the CMR. It colonises the lower zones of estuarine salt marshes and intertidal mudflats, excluding native flora and fauna such as the dwarf eelgrass (*Zostera noltii*) and can lead to a loss of habitat for feeding and roosting, seriously affecting populations of migratory wildfowl and waders. It may compete with areas used for commercial oyster and mussel farming.[199] For further information on these and other non-native species see Chapter 5.10 – Marine Non-Native species.

Intertidal mudflats are found in sheltered areas within upper reaches of estuaries and sea lochs. They are a widespread feature of the CMR and not indicated on map 13.

Sea loch egg wrack beds are a detached form of eggwrack that only occur in very sheltered conditions, such as the upper reaches of sea lochs. They are known to exist at only one location in the CMR, at Tarbert.

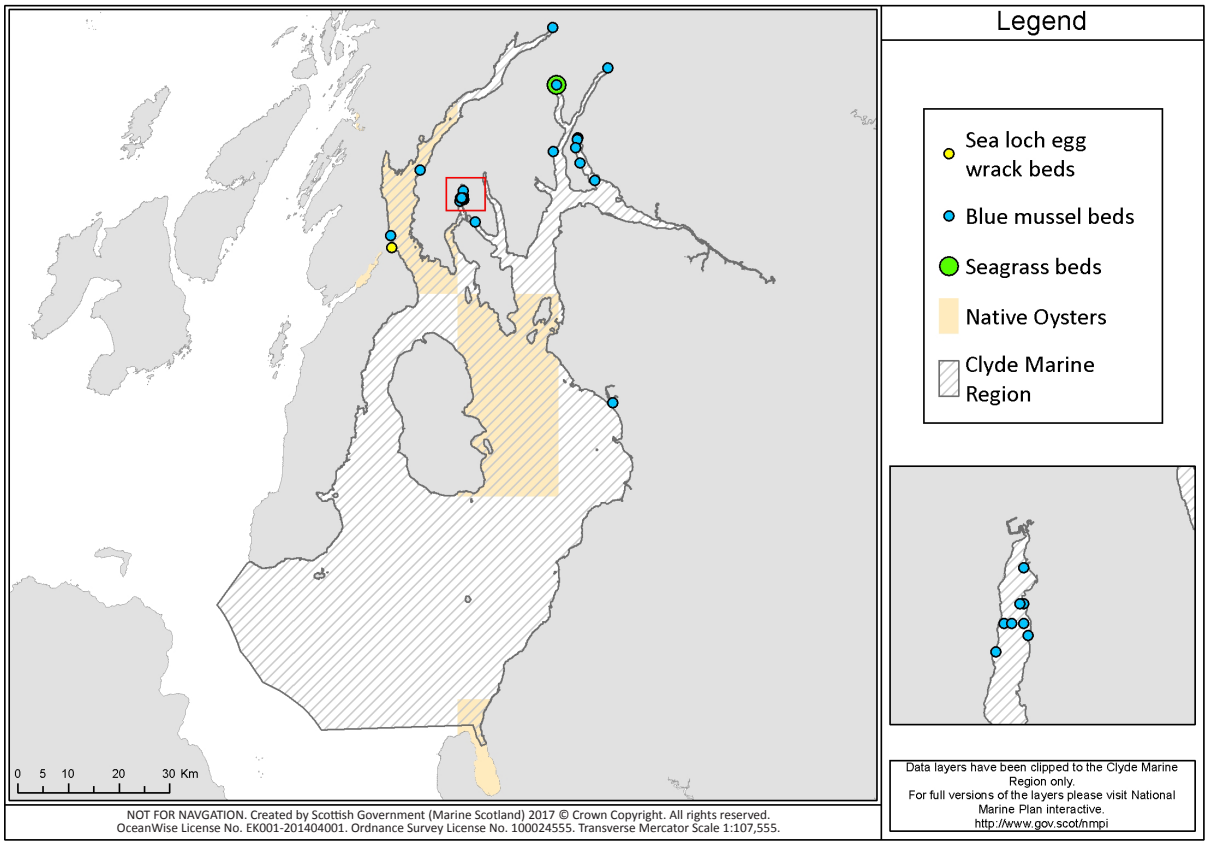
Figure 5.3 Blue Mussels



© CLAIRE PESCOD

197. Baxter *et al.*, 2011
198. Trendall *et al.*, 2010
199. Great Britain Non-native Species Secretariat, a
200. Baxter *et al.*, 2011

Map 13. Priority Marine Features found on intertidal rock and sediments in the Clyde Marine Region (note that these PMFs are likely to be more widely distributed than indicated on this map)



Intertidal seagrass beds have been documented at the head of Loch Goil, although the Upper Loch Fyne and Loch Goil MPA does not include this as a feature. They are also known to exist on the SSSI at Southannan Sands near Hunterston[201] although this is not currently indicated on NMPi. There have been significant declines in recent years in the UK and seagrass populations are currently considered as degraded.[202] However, the IUCN Red List of Threatened Species lists it as being of 'Least concern' at a global level.[203]

Blue mussels (figure 5.3 on previous page) can form dense beds or reefs in more sheltered firths and bays in the intertidal area. This PMF occurs in the sheltered lochs in the north of the CMR, but are not included as a feature within any MPAs.

Native oysters (figure 5.4) are typically found attached to rocks or other shells on mudflats in estuaries. They form beds that stabilise the underlying sediments and provide a hard substrate for other species. They were once widespread in Scotland and three records exist in the CMR (see Map 13 above).

For more information and a full list of Scotland's Priority Marine Features, visit www.snh.gov.uk/protecting-scotlands-nature/priority-marine-features/.

Figure 5.4 Native Oyster



© DAVID DONNAN, SNH

201. Scottish Natural Heritage, b
202. Baxter *et al.*, 2011
203. International Union for the Conservation of Nature

ECOSYSTEM SERVICES[204]		
SERVICE TYPE	**BENEFITS PROVIDED**	**COMMENTARY**
Provisioning	Food (incl. habitat provision for juvenile and spawning life stages)	Saltmarsh, seagrass beds and mudflats provide nursery grounds for fish species. Beds of cockles are found in several sandflats of the CMR, including the Isle of Bute, and the Ayrshire coast, but there are no commercial operations. Native oysters were once abundant and widespread in Scottish waters, but are now scarce.[205] Blue mussels and native oyster are not wild fisheries, but mussels and Pacific oysters are grown by the aquaculture sector of the CMR.
	Pharmaceuticals, fertiliser, biofuels	Seaweeds found on rocky shores, can be used for food, pharmaceuticals and in a range of other products. There is limited seaweed harvesting in the CMR.
Regulating	Sea defence	Loss of saltmarsh may reduce the provision of important natural sea defence services. Mudflats also provide a natural sea defence by absorbing wave energy and are an important sink for organic material.[206] Coastal sand dunes can protect the land behind them from wind and waves. Saltmarsh and mudflats are sensitive to sea-level rise (see Chapter 3.2 Climate change – Sea-level rise and coastal flooding).
	Clean and Safe waters	Loss of saltmarsh may reduce water purification services, i.e. breaking down waste and detoxifying water.
	Climate regulation (carbon capture and storage)	Saltmarsh is a carbon sink; sequestration rates are high, but the net benefit is small due to the low total area of these habitats in the CMR.
Cultural	Tourism and nature watching	Tourism, recreation and education are all provided by sandy beaches, saltmarsh and rock pools. The presence of marine litter or effects of eutrophication in the CMR may impact on the provision of these ecosystem services.
	Education and science	Intertidal rock and sediments provide an important education opportunity as an area accessible by students e.g. at FSC Millport.
Supporting services underpin the provision of other services		Seagrass provides substrate stabilisation by rhizomes, input of organic matter and habitat formation.[207] Mussel and oyster beds provide species habitat. Mudflats provide foraging areas for waterbirds. Rocky shores provide important resting and foraging places for many animals such as harbour and grey seals, otters and various wading birds, including oystercatchers, curlews and turnstones. Rocks provide hard substrate for seaweed and other organisms to attach to.

204. Marine Climate Change Impacts Partnership, 2015a
205. Mason and Fraser, 1986
206. Baxter *et al.*, 2011
207. Lancaster, 2014

5.2 Subtidal rock

Subtidal rock



Biogenic reefs only



Colours are explained in the key at the beginning of the document

KEY SUPPORTING EVIDENCE

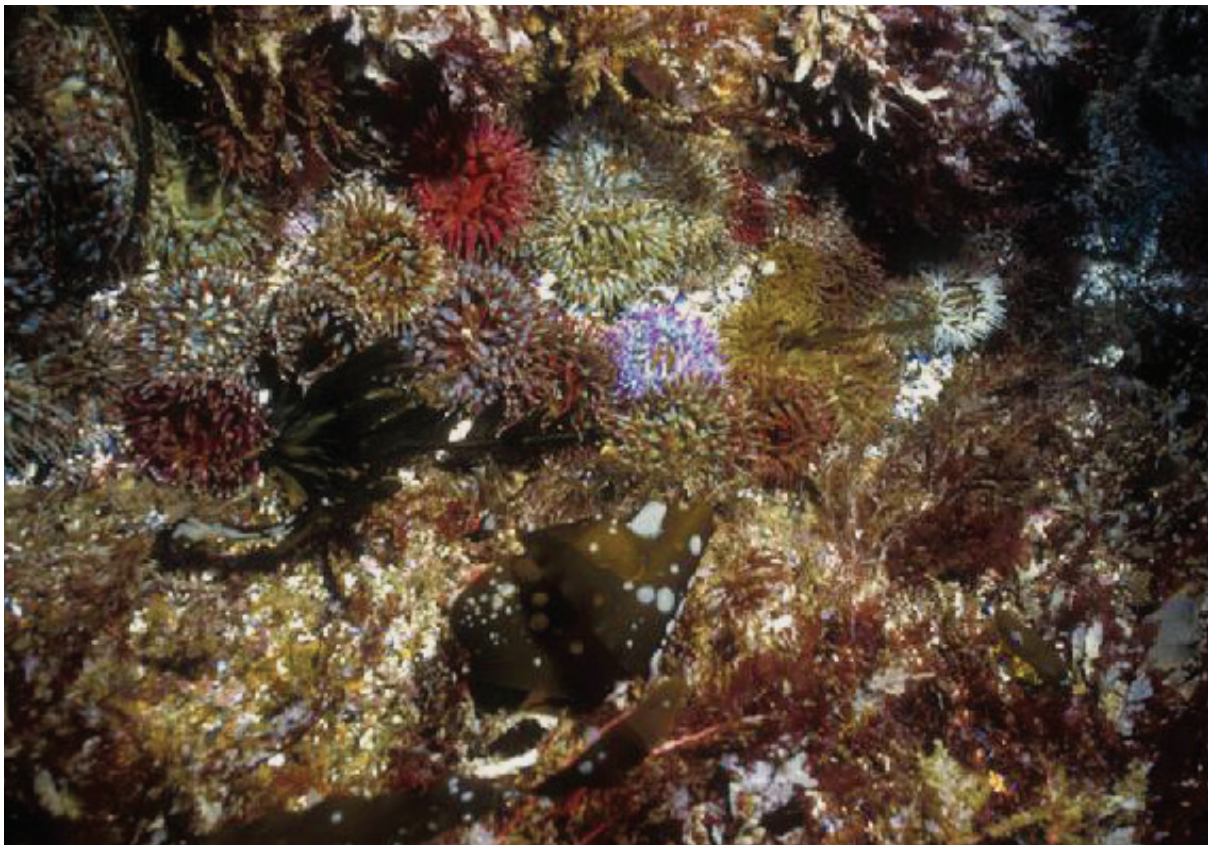
Scotland's Marine Atlas
www.gov.scot/Resource/Doc/345830/0115114.pdf

MPA surveys
www.snh.gov.uk/protecting-scotlands-nature/protected-areas/national-designations/marine-protected-areas-(mpa)/mpa-survey-research-reports/

Scotland's Marine Atlas Clyde score: 'Few or no concerns and stable'. Regional assessment is consistent with this except for biogenic reefs which have declined in extent in the CMR.

Introduction

Subtidal rock comprises bedrock, boulders and cobbles and occurs below the low water mark. Light plays an important role in the types of species found, with seaweeds inhabiting those areas with plenty of light nearer the surface and animals such as sponges and soft corals inhabiting deeper areas. Subtidal communities can also be influenced by wave and tidal action and salinity. There are limited areas of subtidal rock within the Clyde Marine Region (CMR) and these occur to the south of Arran, along the Ayrshire coastline and subtidal extensions of rocky shorelines or cliffs. This chapter also includes biogenic reefs where 'rocky' habitat is created by living organisms such as molluscs (see table 5.2).



Subtidal rock community, showing seaweeds and anemones © SUE HISCOCK

Table 5.2 Priority Marine Features found on subtidal rock in the Clyde Marine Region and their sensitivity to activities/pressures

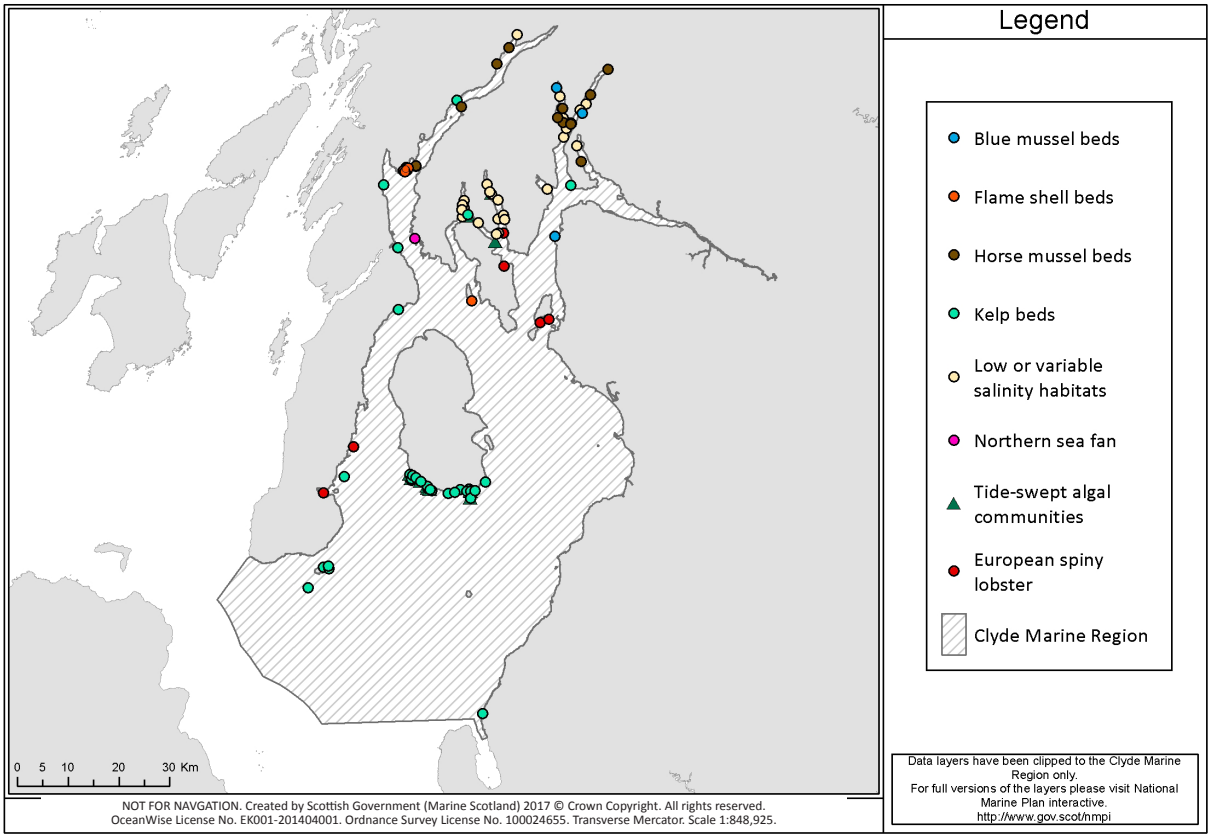
For further details on specific pressures in the region, see the Productive section

PMF	COMPONENT BIOTOPES/SPECIES	SENSITIVITY TO ACTIVITIES/PRESSURES[208]
Northern sea fan and sponge communities	*Caryophyllia smithii* and *Swiftia pallida* on circalittoral rock	Physical damage from bottom fishing gear and siltation from fish farms. Increasing temperature (climate change) as sea fans are at the southern limit of their distribution in the CMR.
Pink sea fingers	*Alcyonium hibernicum*	Climate change and pollution
European spiny lobster	*Palinurus elephas*	Overfishing, although this species is not targeted in the CMR.
Kelp beds	*Laminaria hyperborea* on tide-swept, infralittoral rock	Any future seaweed harvesting.
	Laminaria hyperborea on tide-swept infralittoral mixed substrata	
	Laminaria hyperborea and foliose red seaweeds on moderately exposed infralittoral rock	
Tide-swept algal communities	Kelp and seaweed communities in tide-swept sheltered conditions	Seaweed harvesting, scallop dredging and any activity or development that reduces water flow.
Low or variable salinity habitats	Kelp in variable or reduced salinity	Saline lagoons are threatened by destruction of the habitat or change due to altering the water flow and salinity regime which could be due, for example, to coastal development, land claim, water abstraction. Sea level rise, storm events and pollution.
	Submerged fucoids, green or red seaweeds (low salinity infralittoral rock)	
BIOGENIC REEFS		
Blue mussel beds	*Mytilus edulis* beds on sublittoral sediment	Anchoring, demersal fishing operations, coastal developments and pollution.
Horse mussel beds	*Modiolus modiolus* beds with hydroids and red seaweeds on tide swept circalittoral	Physical damage to the seabed which may severely damage or even destroy beds.
	Modiolus modiolus beds with fine hydroids and large solitary ascidians	
	Modiolus modiolus beds with *Chlamys varia*, sponges, hydroids and bryozoans on slightly tide-swept very sheltered circalittoral mixed substrata	
Flame shell beds	*Limaria hians* beds in tide-swept sublittoral muddy mixed sediment	Physical damage to the seabed from mobile fishing gear, dredging and boats anchoring as well as coastal developments resulting in changes in water flow patterns.

208. Baxter *et al.*, 2011

Map 14. Priority Marine Features found on subtidal rock in the Clyde Marine Region

(note that these PMFs are likely to be more widespread than indicated on this map)



Pink sea fingers are found on shaded vertical rock surfaces and almost 50% of global records are from Scotland's west coast. Pink sea fingers have been recorded in 2006 by a Seasearch dive off Sanda Islands, although the record is currently being validated and does not appear on NMPi.[209]

The **European spiny lobster** is usually found at depths of between 5 and 70m but can go much deeper. It is now considered to be scarce in Scotland.

Three kelp bed biotopes of *Laminaria hyperborea* are found around the CMR but in particular to the south of Arran and around the Sanda islands.

Kelp and seaweed communities in tide-swept sheltered conditions are mainly found in sea lochs and are known to occur off the northern tip of the Isle of Bute.

Within the CMR there are records of **'Kelp in variable or reduced salinity'** at the heads of most of the Lochs; this feature tends to be found on very wave sheltered bedrock and boulders. 'Submerged fucoids and seaweeds on low salinity intralittoral rock' are characterised by dense seaweeds. This is a feature unique to Scotland and has been recorded at the head of Loch Shira.

Blue mussel beds are found on shallow mixed sediments. The bed stabilises the underlying sediment, providing a hard substrate for a diverse community of plants and animals. There are a small number of known sites in the Inner Firth and lochs of the CMR.

Horse mussels can form dense raised beds over sediments and thereby alter the habitat by providing a hard substrate and refuge for other species. Three different biotopes occur in the sheltered lochs of the CMR and is a feature of the Upper Loch Fyne and Loch Goil MPA.

Flame shell beds are formed where byssus threads of the flame shell intertwine with seaweed, maerl, shells and stones to provide a surface to which other species can attach. Large beds once existed in the Firth of Clyde, including at Skelmorlie Bank, Ayrshire, Stravanan Bay, Isle of Bute and Tan Buoy, Great Cumbrae.[210] Only one remaining extensive bed is now known to exist in Loch Fyne and its location has been confirmed during MPA survey work. It is a feature of the Upper Loch Fyne and Loch Goil MPA – see Chapter 5.9 Protected areas.

209. Seasearch, 2006
210. Hall-Spencer and Moore, 2000

Flame shell beds have declined considerably in the Clyde.[211] The beds are prone to damage from anthropogenic impacts and are especially susceptible to demersal fishing; recent evidence suggests they may take more than 100 years to re-establish following a single dredging event;[212] nests can be removed from the seabed and individuals are then consumed by fish, crabs and other scavengers. There is also evidence to suggest that historic use of TBT as an antifouling agent on salmon nets in the aquaculture industry may also have contributed to the decline of flameshell beds, due to a reduction in spat settlement.[213]

For more information and the full list of Scotland's Priority Marine Features, visit www.snh.gov.uk/protecting-scotlands-nature/priority-marine-features/

ECOSYSTEM SERVICES[214]		
SERVICE TYPE	**BENEFITS PROVIDED**	**COMMENTARY**
Provisioning	Food (incl. habitat provision for juvenile and spawning life stages)	Spiny lobsters are not currently targeted in the CMR but can provide a source of food. Subtidal rock supports the common lobster and crab species which are important to fisheries. There is concern over the decline in biogenic reefs in the CMR and the resultant lack in suitable habitat for certain species, especially nursery habitat. The lack of this type of complex substrate may hamper the recovery of fish stocks.
	Pharmaceuticals, fertiliser, biofuels	Seaweed can be cultivated/ harvested for food, chemicals, food additives and even health products.[215] Seaweed is not currently commercially cultivated in the CMR but is harvested on a small scale in some areas.
Regulating	Coastal protection Carbon storage	Biogenic reefs and seaweeds can capture and store carbon, and can provide coastal protection.
Cultural	Marine recreation	Interesting and attractive features such as rocky reefs and cliffs,[216] pink sea fingers and flame shell beds, can attract recreational divers.
Supporting services underpin the provision of other services		Biogenic reefs, such as horse mussel and flame shell beds along with rocky reefs, provide a hard substrate which other species can attach to or more complex substrate used for shelter and feeding.

211. Baxter *et al*., 2011
212. Tyler-Walters *et al*., 2016
213. Minchin *et al*., 1987
214. Marine Climate Change Impacts Partnership, 2015a
215. UK National Ecosystem Assessment, 2011
216. Clyde Diving

5.3 Shallow and shelf subtidal sediments



Colours are explained in the key at the beginning of the document

KEY SUPPORTING EVIDENCE

Scotland's Marine Atlas
www.gov.scot/Resource/Doc/345830/0115113.pdf

MPA surveys www.snh.gov.uk/protecting-scotlands-nature/protected-areas/national-designations/marine-protected-areas-(mpa)/mpa-survey-research-reports/

Clyde Ecosystem Review www.clydemarineplan.scot/wp-content/uploads/2016/06/Clyde-Ecosystem-Review.pdf

Tuck *et al.*, Kaiser *et al.* and Coggan *et al.*

Scotland's Marine Atlas Clyde score: 'Many concerns and stable'. Regional assessment is consistent with this.

Introduction

Subtidal sediments include shingle, gravel, sand and mud. Shallow subtidal sediments extend from the mean low water mark to around 70m; shelf sediments are those found from 70-200m depth. They cover the majority of the seabed in the Clyde Marine Region (CMR). For more information on substrates including a seabed sediments map, see the Chapter 3.3 Seabed and coastal geology and sediments.



Subtidal sediments © BEN JAMES, SNH

Table 5.3. Priority Marine Features found on shallow and shelf subtidal sediments in the Clyde Marine Region and their sensitivity to activities/pressures

For further details on specific pressures in the region, see the Productive section

PMF	COMPONENT BIOTOPES/SPECIES	SENSITIVITY TO ACTIVITIES/PRESSURES[217]
Northern feather star	*Leptometra celtica*	Dredging and demersal fishing
Fan mussel	*Atrina pectinata*	Scallop dredging and other mobile fishing gear.
Heart cockle	*Glossus humanus*	Dredging and demersal fishing activities
Ocean quahog	*Arctica islandica*	Mechanical damage particularly from bottom fishing gear.
Kelp and seaweed communities on sublittoral sediment	Kelp and seaweed communities on sublittoral sediment	Physical loss or removal
Burrowed mud	Seapens and burrowing megafauna in circalittoral fine mud	Fish farms (smothering, nutrient enrichment and chemical pollution), trawling for *Nephrops*.
	Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud	Bottom trawling and creeling, chemical pollution from fish farms.
	Tall seapen *Funiculina quadrangularis*	Mobile fishing gear and, to a lesser degree, creels.
	Fireworks anemone *Pachycerianthus multiplicatus*	Mobile fishing gear particularly trawling for *Nephrops* and, to a lesser degree, creels.
	Mud burrowing amphipod *Maera Loveni*	Unknown
Maerl beds		Physical disturbance and smothering due to scallop dredging, bottom trawling, aquaculture and extraction as a fertiliser.
Maerl or coarse shell gravel with burrowing sea cucumbers	*Neopentadactyla mixta* in circalittoral shell gravel or coarse sand	Scallop dredging or maerl extraction.
Inshore deep mud with burrowing heart urchins	*Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud	Benthic trawling for *Nephrops*.
Seagrass beds	*Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand	Anchors, nutrient enrichment and increasing turbidity that reduces available light.
	Ruppia maritima in reduced salinity infralittoral muddy sand	
Shallow tide-swept coarse sands with burrowing bivalves	*Moerella* spp. with venerid bivalves in infralittoral gravelly sand.	Can be targeted for scallop dredging – the slow growing bivalves are sensitive to overfishing and physical disturbance.
Low or variable salinity habitats	Sublittoral mud in low or reduced salinity (lagoons)	Saline lagoons are threatened by destruction of the habitat or change due to altering the water flow and salinity regime which could be due for example to coastal development, land claim, water abstraction. Sea level rise, storm events and pollution.

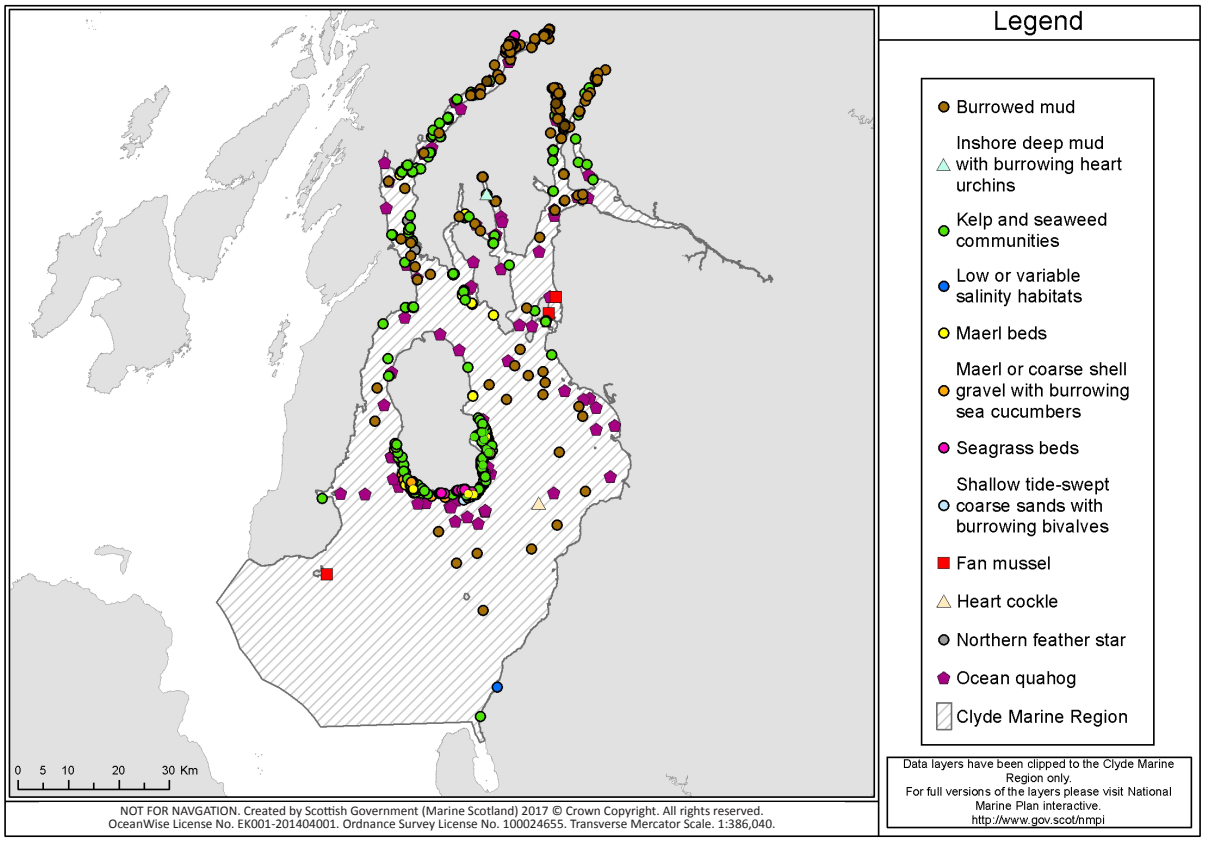
217. Baxter *et al.*, 2011

Many of the PMFs for subtidal sediments in the CMR (see table 5.3) are sensitive to physical damage, smothering or pollution from a range of activities including fishing activities such as demersal trawling and dredging and impacts from fish farms.[218]

In the past 50 years a commercially important fishery for burrowing *Nephrops* has developed in areas of the Clyde containing mud and muddy sediments. *Nephrops* are targeted by small demersal trawlers. Several studies from various parts of the world consider the impacts of trawling on habitats. It is generally recognised that trawling reduces the structural complexity of the seabed, by smoothing out mounds and filling in troughs,[219] although this type of structural change can also be caused by natural events. One study showed visible marks from trawling remaining for only 52 hours,[220] whilst trials in the deep-water mud of the Gare Loch suggested that after 16 months of trawling activity trawl marks were only faintly visible (although community effects extended beyond the life of the study) and this study concluded that scouring marks are likely to last longer in deep water and in sheltered areas with fine sediments.[221] The persistence of marks depends on their original depth, the sediment type, the current, wave action and biological activity.[222] Trawling also alters the benthic community but these changes can be difficult to predict. In the Clyde, studies have shown that different locations become more similar and that overall habitat and species diversity is reduced.[223] Some changes may be temporary but where the seabed is frequently disturbed, a new stable state may be reached.[224]

Scallops are the most important commercial mollusc species in the Clyde and again over the last 50 years, a dredge fishery has been active throughout the area, where there are sand or gravel sediments.[225] Dredging can change the granulometric properties of gravel,[226] can damage vulnerable soft animals such as sea sponges[227] and can negatively impact animals in previously stable mud, coarse gravel or biogenic habitats.[228] It can also break up maerl and cover adjacent beds with plumes of sediment.[229] Experiments conducted at two sites in

Map 15. Priority Marine Features found on shallow and shelf subtidal sediments in the Clyde Marine Region



218. Baxter *et al*., 2011
219. Coggan *et al*., 2001
220. Fonteyne 2000
221. Tuck *et al*., 1998
222 Tuck *et al*., 1998; Fonteyne, 2000; Smith *et al*., 2000; Humborstad *et al*., 2004
223. Coggan *et al*., 2001
224. Kaiser *et al*., 2000
225. McIntyre *et al*., 2012
226. Hauton *et al*., 2003
227. Boulcott and Howell, 2011
228. Collie *et al*., 2000
229. Hauton *et al*., 2002

the Clyde show that a single sweep with a Newhaven scallop trawl can kill up to 70% of living maerl in the dredge path with no signs of regrowth after 4 years.[230] ICES concluded that there is significant evidence to implicate the role of fishing activities, particularly dredging, in the widespread decline in maerl.[231] The potential for maerl recovery is extremely low, although studies do show a positive correlation between reduction or removal of fishing pressure and improvements in maerl growth.[232] The most important factor in hampering the recovery of maerl is the extremely slow rate of growth. Along with this, low reproduction capability and small populations reduce the recruitment, dispersal and settlement capability[233] of both the maerl and species which this habitat supports, including scallops and gadoids.

The **northern feather star** is normally a deep water species but western Scotland is unique in having shallow water examples in depths of around 20m in sea lochs. They are known to occur in Loch Fyne in the CMR.

The **fan mussel** is one of Britain's largest molluscs and is found partly embedded in the sediment. They are considered nationally scarce within the UK and are known to occur in the CMR around Cumbrae and the Sanda Islands.

The **heart cockle** is found in undisturbed muds, usually below 50m and it is thought to be under-recorded as there is currently only one record in the CMR, off South Ayrshire.

The **ocean quahog** is a mollusc that is thought to live for over 400 years. It is found in sandy and muddy sediments all around Scotland and throughout the CMR. Ocean quahog aggregations are a feature of the South Arran MPA and the Upper Loch Fyne and Loch Goil MPA – see Chapter 5.9 Protected areas – and are also found in areas outside of MPAs.

Kelp and seaweed communities on sublittoral sediment greatly increase the primary productivity of an area and create a more diverse habitat. The dominant species are sugar kelp (*Saccharina latissima*), bootlace weed (*Chorda filum*) and various red and brown seaweeds. The turfs of seaweed may support a diverse range of animals including burrowing polychaete worms, bivalve molluscs, and scavengers including hermit crabs and fish. This is a feature of the South Arran MPA, and is also found around the CMR.

Burrowed mud is a dominant feature of the CMR and is home to a number of burrowing species, including the commercially important *Nephrops*. Amongst the PMF species are seapens including the Tall sea pen, Fireworks anemone, a burrowing amphipod (*Maera Loveni*) and spoon worm (*Maxmuelleria lankasteri*). These are protected features in the South Arran MPA and the Upper Loch Fyne and Loch Goil MPA. It is also found in areas outside of these MPAs.

The **deep inshore muddy basins** of some sea lochs support a community dominated by the heart urchin (*Brissopsis lyrifera*) and the brittlestar (*Amphiura chiajei*). There is currently only one record in the CMR of this PMF at the head of Loch Striven.

Maerl beds are found throughout the west coast of Scotland and are of particular interest and concern in the CMR. Maerl is a calcareous red seaweed which forms an important biogenic habitat. Maerl is extremely slow growing and some beds may be over 1000 years old. They create a complex, open structure that supports many other species. Over five hundred faunal species and 150 microalgal species are recorded as living on or in maerl beds; additionally maerl is an important feeding ground for juvenile Atlantic cod and provides nursery areas for bivalves such as scallops.[234] Maerl is a protected feature of the South Arran MPA. In the CMR it is also found around the Isle of Bute.

Eelgrass (*Zostera marina*/*angustifolia*) and *Ruppia maritima* form seagrass beds in the sheltered areas throughout the west coast of Scotland with *Ruppia marina* favouring more brackish conditions. Seagrass beds provide shelter or substratum for a wide range of species, such as wrasse or goby species.[235] These beds occur in a small number of places on the CMR and they are a protected feature of the South Arran MPA, but also occur in other areas around the CMR.

Shallow tide-swept sands with burrowing bivalves particularly tellin bivalves, surf clams, polychaete worms, tanaids and sand hoppers have been found off the south coast of Arran and this is a feature of the MPA.

Saline lagoons are shallow coastal water bodies with varying salinity and contain specialised species that can tolerate the wide range of environmental conditions that can occur in these areas. **'Sublittoral mud in low or reduced salinity'** is a lagoon with short-lived species such as blow lugworms and mud shrimps. This PMF is present at Ballantrae.

For more information and the full list of Scotland's Priority Marine Features, visit www.snh.gov.uk/protecting-scotlands-nature/priority-marine-features/.

230. Hall-Spencer and Moore, 2000
231. International Council for the Exploration of the Sea, 2005
232. Howarth *et al*., 2013
233. Mazik *et al*., 2015
234. The Marine Life Information Network, 2007
235. The Marine Life Information Network, 2016

ECOSYSTEM SERVICES[236]		
SERVICE TYPE	**BENEFITS PROVIDED**	**COMMENTARY**
Provisioning	Food (incl. habitat provision for juvenile and spawning life stages)	Spiny lobsters are not currently targeted in the CMR but can provide a source of food. Subtidal rock supports the common lobster and crab species which are important to fisheries. There is concern over the decline in biogenic reefs in the CMR and the resultant lack in suitable habitat for certain species, especially nursery habitat. The lack of this type of complex substrate may hamper the recovery of fish stocks.
	Pharmaceuticals, fertiliser, biofuels	Seaweed can be cultivated/ harvested for food, chemicals, food additives and even health products. Seaweed is not currently commercially cultivated in the CMR but is harvested on a small scale in some areas.
Regulating	Coastal protection Carbon storage	Biogenic reefs and seaweeds can capture and store carbon, and can provide coastal protection.
Cultural	Marine recreation	Interesting and attractive features such as rocky reefs and cliffs, pink sea fingers and flame shell beds, can attract recreational divers.
Supporting services underpin the provision of other services		Biogenic reefs, such as horse mussel and flame shell beds along with rocky reefs, provide a hard substrate which other species can attach to or more complex substrate used for shelter and feeding.

236. Marine Climate Change Impacts Partnership, 2015a

5.4 Marine fish (demersal and pelagic) and shellfish



Colours are explained in the key at the beginning of the document

KEY SUPPORTING EVIDENCE

Some fish species are identified as overexploited or in decline or are lacking in sufficient data to make an assessment.
Shellfish stocks are largely over exploited or lacking in data apart from *Nephrops* stocks which are considered abundant.

Marine Scotland Science – Clyde Ecosystem Review www.clydemarineplan.scot/wp-content/uploads/2016/06/Clyde-Ecosystem-Review.pdf and other reports.

ICES www.ices.dk/community/advisory-process/Pages/Latest-Advice.aspx

Scotland's Marine Atlas Clyde score: commercial fish and shellfish 'many concerns with No Area Assessment'. Regional assessment is consistent with this.

Introduction

Pelagic species are those that move throughout the water column such as mackerel (*Scomber scombrus*) and herring (*Clupea harengus*), while demersal species such as cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) spend most of their lives in close proximity to the seabed.

The condition of the pelagic and demersal fish stocks in the Clyde is a complex and potentially contentious area. Views regarding populations of pelagic and demersal species range from the 'ecological meltdown' and 'endpoint of fishing' of Thurstan and Roberts (2010) to the functioning but 'altered ecosystem' as shown by Heath and Speirs (2012). There is more certainty with regards some shellfish stocks; *Nephrops* (*Nephrops norvegicus*) in particular are better understood and appear to be more productive in recent years.[237] In terms of demersal and pelagic species the composition has undeniably been altered and large individuals are now rare, despite a recovery in biomass of some species which was observed following the end of a targeted fishery for demersal finfish.

Other marine fish such as wrasse (*Labridae*), gobies (*Gobiidae*) and blennies (*Blennioidei*) should also be considered but data are significantly lacking in the Clyde and so this Assessment will focus on commercial demersal and pelagic species. The benefits of a full stock assessment of target and non-target species are being discussed by the Clyde 2020 group.

Many peer reviewed scientific papers about the changes in the Clyde Marine Region (CMR) ecosystem have been published, and widely discussed. Under the European Fisheries Fund (EFF) Inshore Fisheries Management projects produced in 2015, work package 4 includes a summary of available published biological and environmental data relevant to inshore fisheries management for the CMR.[238, 239, 240, 241]

There is a lack of data on the number of vessels under 10m trawling in the CMR and on the number of creels placed annually. It is apparent, however, that a greater volume of catch is landed by the trawl fishery than by the creel fishery (See Chapter 6.2 Productive – Sea fisheries) and that spatial and temporal conflicts potentially remain between the two approaches.

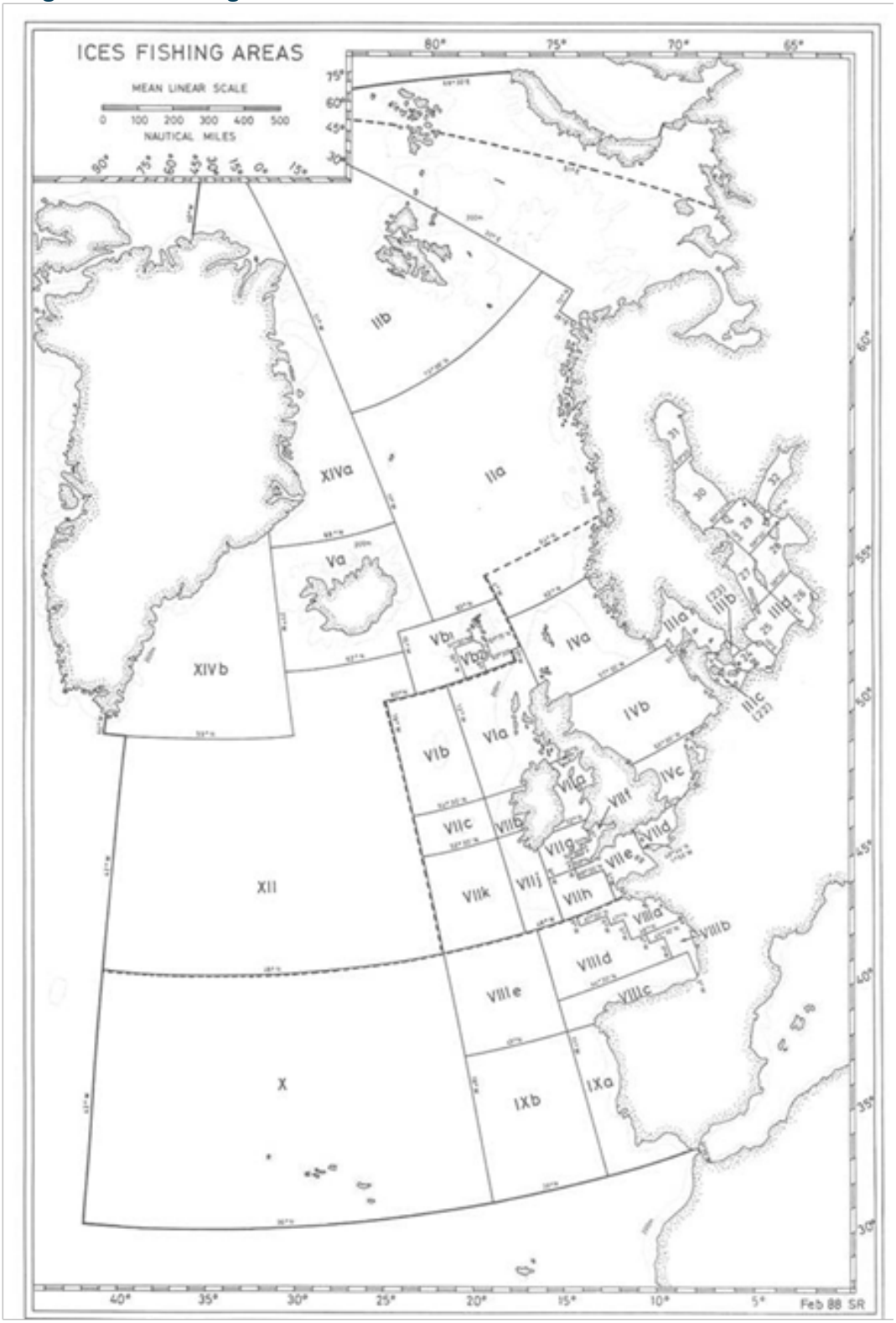
Whilst creel fishing is not as low impact as hand dived collection of target species, studies have shown that towed demersal fishing gear physically interacts with the seabed and water column (see Chapter 5.3 Shallow and shelf subtidal sediments).[242]

Stock assessment

Assessment of the state of commercially relevant stocks in the area is performed at a much larger scale than the Clyde; this is referred to as the VIa region. The International Council for the Exploration of the Sea (ICES), a meeting point for more than 4000 fisheries scientists from the 20 North Atlantic countries, makes the assessment within the VIa region (see figure 5.5). This area of sea is 236,928km^2 and includes the CMR, along with much of the West Coast of Scotland. A detailed assessment of the CMR itself is not currently available although ICES recently (2016) undertook a review of the Celtic Seas Region (the Malin shelf; the Celtic Sea and west of Ireland; the Irish Sea) and concluded that the five most important pressures in the Celtic Seas ecoregion are selective extraction of species, abrasion, smothering, substrate loss, and nutrient and organic enrichment.[243] A number of ICES statistical areas (the smaller accounting units which make up the ICES regions) do cover the CMR, including areas 39E4, 39E5, 40E5, 41E5, 41E4 and 40E4, and their advice (below) covers these units.

237. International Council for the Exploration of the Seas 2017e
238. Fox *et al.*, 2015
239. Thurstan and Roberts, 2010
240. Heath and Speirs, 2011
241. Hunter *et al.*, 2015
242. Ivanovic, 2015
243. Bailey and Barreto, 2015

Fig. 5.5 ICES Fishing Areas



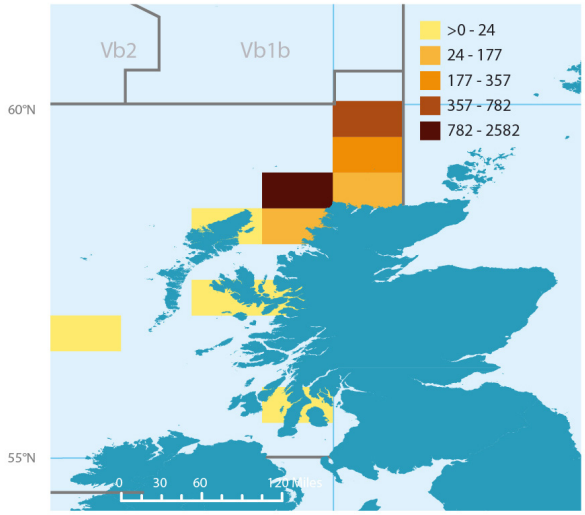
The ICES West of Scotland assessment of fin fish stocks includes information about spawning stock biomass (SSB), recruitment (the number of young fish entering the system) and the rate of mortality from fishing (F). A summary of their assessment is below.[244] No accurate stock assessment is currently available for species including, lobster (*Nephropidae*), or King scallop (*Pecten maximus*) in the Clyde Marine Region however Marine Scotland now state that they have sufficient evidence to undertake an assessment for brown crab (*Cancer pagurus*).[245]

244. Bailey and Barreto, 2015
245. Mesquita, 2017

West Coast of Scotland (ICES area VIa)[247]

- ICES now assess haddock on the basis of a Northern Shelf stock (North Sea, Skagerrak and West of Scotland).In 2017 ICES advised that Haddock stocks were fished at Maximum Sustainable Yield (MSY) (i.e. fished too heavily compared to fishing that produces maximum sustainable yield) although the spawning stock biomass was mostly above the ICES trigger level (Btrigger) since 2002.Recruitment of juvenile haddock is characterized by occasional large year classes but is currently low.[246]
- Cod stock remains in a very poor condition and ICES 2017 advice is "zero catches in each of the years 2018 and 2019."Cod was subject to the cod recovery plan for some time, although, there has been little response and stock biomass remains too low to be fished sustainably.[247]
- West coast herring, which is subject to a Long Term Management Plan,[248] is now subject to advice from ICES which concludes that there should be zero catch due to fishing mortality and the low level of the spawning stock biomass.

Fig 5.6 2015 Distribution of landings into Scotland by UK Vessels (tonnes) of herring *(Clupea harengus)*



Source: Marine Scotland Science Fish and Shellfish Stocks 2017 Edition

Table 5.4 Status of ICES target species of relevance to the Clyde Marine Region

SPECIES	SEA AREA	STATUS
Anglerfish *Lophius piscatorius*	Territorial waters and offshore	High risk species taking many years to reach maturity. North sea stock in decline, ICES continues to recommend a reduction in fishing effort and catch. West coast stock stable.
Atlantic herring	Territorial waters and offshore	An important food fish for many other species, ICES have set a Long Term Management Plan for west coast stocks.
Atlantic mackerel	Territorial waters and offshore	Western mackerel stocks considered of regional and possibly global importance. North Sea stock still to fully recover from decline in 1960s. Mackerel are one of the most widely distributed stocks on the West of Scotland. The fish migrate throughout the year and can be found from the Iberian Peninsula to the west of Norway and beyond. In 2010 the stock was considered to be in 'good' condition by ICES, but as the SSB is back-calculated based on egg production, there is some caution about the assessment. A long-term management plan for mackerel which includes fishing above FMSY has improved the biomass.
Cod	Territorial waters and offshore	Stocks severely declined. ICES consider stocks in the North Sea, western Scotland and Irish Sea below safe biological limits. Listed as vulnerable on IUCN Red List.
Ling *Molva molva*	Territorial waters and offshore	Scotland has a large proportion of the British population; numbers are maintaining a stable low level.
Norway pout *Trisopterus esmarkii*	Territorial waters and offshore	Recruitment is variable but fluctuations in North Sea stocks probably natural rather than due to fishing pressure.
Saithe	Territorial waters and offshore	Stocks recovering and thought to be fished sustainably.
Sandeel *Ammodytes* spp	Territorial waters and offshore	Stocks are in decline. Sandeels are an important source of food for many species including many species of seabird and cetaceans.
Whiting	Territorial waters and offshore	Stocks have been stable or declining for last 10 years, and North Sea distribution contracted.

246. International Council for the Exploration of the Sea,2017b
247. International council for the Exploration of the Sea, 2017a
248. Council Regulation (EC) No 1300/2008 of 18 December 2008 establishing a multi-annual plan for the stock of herring distributed to the west of Scotland and the fisheries exploiting that stock.

They state that the spawning stock biomass has been decreasing since 2004 and that 2016 was a record low year for F_{MSY}.[249]

- West coast whiting (*Merlangius merlangus*) SSB has been increasing since 2006 but remains very low compared to historical estimates ICES advises zero catch in each of the years 2017 and 2018.[250]
- Fishing mortality for North-east Atlantic Mackerel is below management trigger points and SSB is maintained at long term high levels. Incoming year classes appear to be around or above recent averages.[261]
- With regards to other demersal and pelagic species, there is quota for a range of species in the Vla region including for Saithe (*Pollachius virens*). There is no directed fishery for any other demersal or pelagic fish in the CMR.

Table 5.4 (left) summarises the species targeted within the ICES areas relevant to the CMR. Although these species are not subject to a targeted fishery within the CMR, their status in the wider area should be noted with regards to their likely role in the CMR ecosystem.

Historical context

The earliest records of herring as a commercial catch in Scotland date back to the early 12th Century. In 1674 up to 20,000 barrels of salted herring left the Clyde destined for France and by the late 1800s the catch per unit effort (CPUE[252]) for herring had increased while the CPUE for white fish had dropped. Salmon fishing records date back to the 12th century but overfishing, combined with significant pollution saw no salmon entering the Clyde system by 1900. However, this situation has since improved markedly and salmon have once again been recorded spawning in the Black Cart and Kelvin catchments.[253, 254, 255]

In the late 18th and 19th Centuries, fishing for herring, cod, haddock and turbot (*Scophthalmus maximus*) was common in the area. The herring fishery, in particular, continued to be significant due to the productive waters which attracted spawning shoals. The importance of the Clyde herring fishery to the Scottish fishing industry increased throughout the 1860s and 70s. To protect a crucial spawning ground located at Ballantrae Bank, the area was closed to fishing between January and May in 1860. This was repealed in 1867 and fishing restarted as before in 1868. By the early to mid-20th Century declines were observed in herring numbers.

In 1889, steam trawling was banned in the Firth of Clyde. However, in 1962, a byelaw was introduced allowing trawling except within 3 nautical miles (NM) of the low water mark. Further declines in demersal fish stocks resulted in a repeal of the 3 mile limit and trawling was opened up to this part of the Clyde in 1984. Landings in whiting, cod, saithe and flounder (*Platichthys flesus*) have all decreased through to the start of the 21st Century.

In 2014 the South Arran Marine Conservation Order[256] came into effect, prohibiting all types of fishing activities, both commercial and recreational and any removals from the seabed within areas of the South Arran MPA where maerl was known to be present.[257] Previously, in 2008 the Inshore Fisheries (Prohibition of Fishing)(Lamlash Bay) (Scotland) Order took effect, supported at the time by both Clyde fisheries interests and conservationists which established the Lamlash Bay No-Take Zone; This is now encompassed within the South Arran MPA.[258]

Clyde 2020

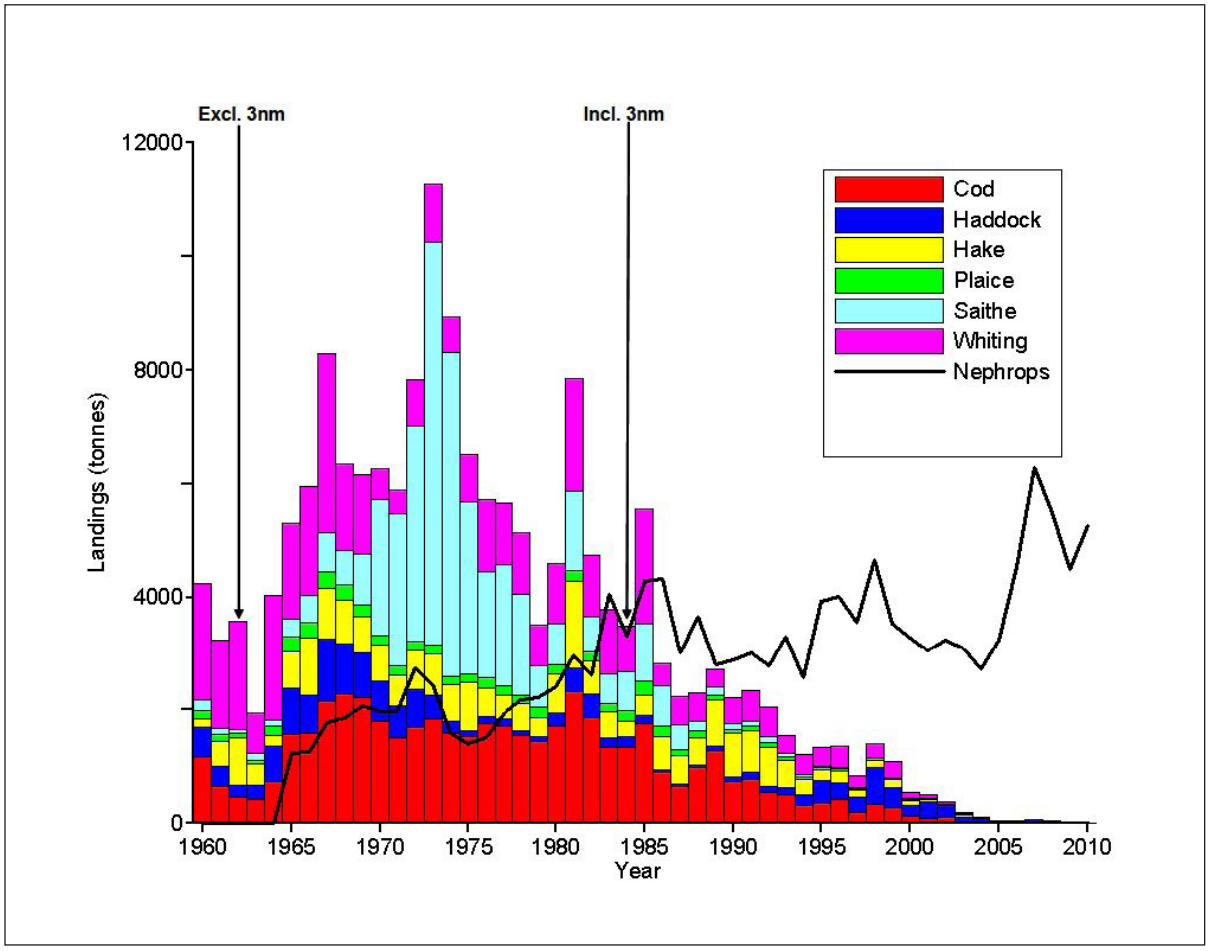
In 2014, the Clyde 2020 project held a summit where the latest Scottish Government (Marine Scotland Science) scientific evidence for demersal finfish populations in the Clyde was presented. This showed that the biomass in the Clyde is now greater (almost double) that of the 1930s and 1940s, however 90% of it is below minimum landing size and 72% of it is whiting. This indicates that the CMR demersal finfish biomass has recovered from very high exploitation rates in 1970s and 1980s (figure 5.7) and the area is still productive but it is in a new regime of small fish dominated by whiting.

Figure 5.8 also shows that there are some positive signs of change in the Clyde Sea demersal fish populations. The species evenness index is increasing; in the period 1995-2004 just four fish species made up 95% of the biomass of Clyde demersal fish, whereas in 2005-2009 this had increased to eight. In the earlier period 87% of the biomass was whiting, while in the later period this had decreased to 72%. The results also show a significant increase in overall biomass since 1990. As stated in the Clyde Ecosystem Review *'all of these indicators of improving conditions in the Clyde should be strong arguments supporting the prospect of a restored Clyde'*.[259]

In a comparison of stakeholder engagement systems, Clyde 2020 scored highly for dialogue and interaction with fishermen and the fishing sector.[260]

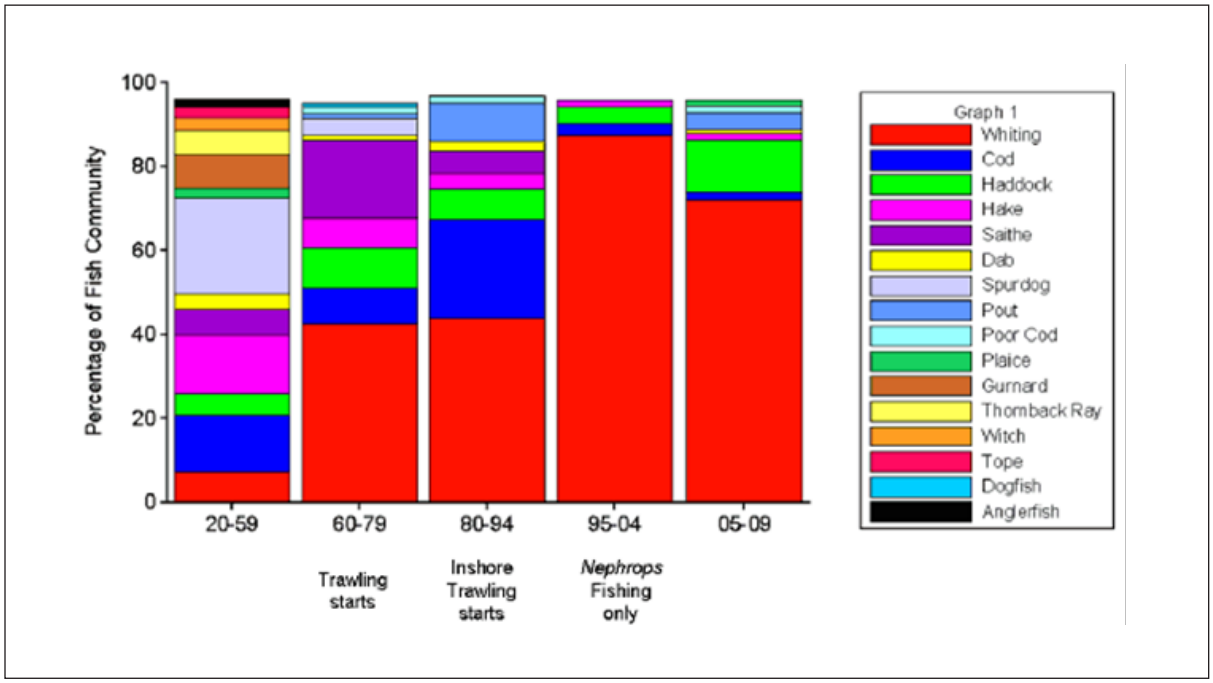
249. International Council for the Exploration of the Sea 2017c
250. International Council for the Exploration of the Sea , 2016
251. International Council for the Exploration of the Sea,2017d
252. Catch-Per-Unit-Effort (also called catch rate) is an index for fisheries monitoring. Declines in CPUE may mean that the fish population cannot support the level of harvesting. Increases in CPUE may mean that a fish stock is recovering and more fishing effort can be applied. CPUE can therefore be used as an index of stock abundance, where some relationship is assumed between that index and the stock size.
253. Wood, 1960
254. Buckland, 1871
255. Mackay and Doughty, 1986
256. Scottish Statutory Instruments, 2014 No 260
257. The Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 2014
258. The Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 2008
259. McIntyre *et al.*, 2012
260. Little *et al.*, 2015

Figure 5.7 Summary of landings (not stock) in tonnes of six demersal fish species in the Clyde Sea (ICES 39E4, 39E5, 40E4, 40E5). (Years when the Clyde opened to trawling, excluding 3nm from the coast and including 3nm are highlighted. Landings of *Nephrops* are shown as a black line.)



Source: Clyde Ecosystem Review

Figure 5.8 The species in the Clyde that make up 95% of the biomass of Clyde demersal fish (Figures along the X axis represent years)



Source: Clyde Ecosystem Review

Demersal species growth rates

In 2015 Hunter published results of research looking at trends in growth of five demersal species; cod, haddock, whiting, Norway pout and saithe. The conclusion was that large changes in growth (length/age ratios) of fish in the Clyde have been brought about independently of environmental influences. Due to the long-term nature of the declines in length, and regional differences in growth trends and the fisheries, the results suggest that the changes may have been largely due to over fishing with size selective nets. The declines in length were particularly severe in Clyde haddock and whiting and are suggestive of a long-term selective pressure favouring small sizes.[261]

Investigation of reports of semi-pelagic white fish in the Clyde Marine Region

In 2012 the Clyde Fisherman's Association (CFA) held a presentation at the Scottish Parliament, which documented changes in Clyde fisheries in more detail, and made many additional points concerning the findings of McIntyre *et al*. (2012).

One of the principal suggestions was that cod (and other white fish) in the CMR is no longer a demersal fish, but a semi-pelagic one. Hence it was also suggested that the standard demersal trawl surveys used by Marine Scotland Science (MSS) in the CMR, and which provided the data for the Heath and Speirs (2011) analysis, do not generate a correct picture of the abundance or distribution of cod (figure 5.9), or white fish in general, including whiting, in the CMR.

In response to extensive consultation with the Clyde fishing industry, MSS undertook a trial survey to investigate these reports of semi-pelagic white fish in the CMR. This was carried out in February 2014 and the results were published in 2016 showing that, on average, long-duration semi-pelagic fishing within the deep basins of the CMR catch white fish at a lower rate (i.e. numbers of fish caught per hour fishing) than standard demersal fishing in the same areas. However, such semi-pelagic fishing catches large fish at higher rates than in demersal fishing. It must be remembered that the results presented here are from an investigative survey and not a statistically designed survey.[262] In order to provide a more representative picture of the whitefish community of the CMR, a more comprehensive survey including semi-pelagic and bottom trawl sampling across the CMR and throughout the year is underway with the third research trial undertaken in 2017, results should be published shortly.

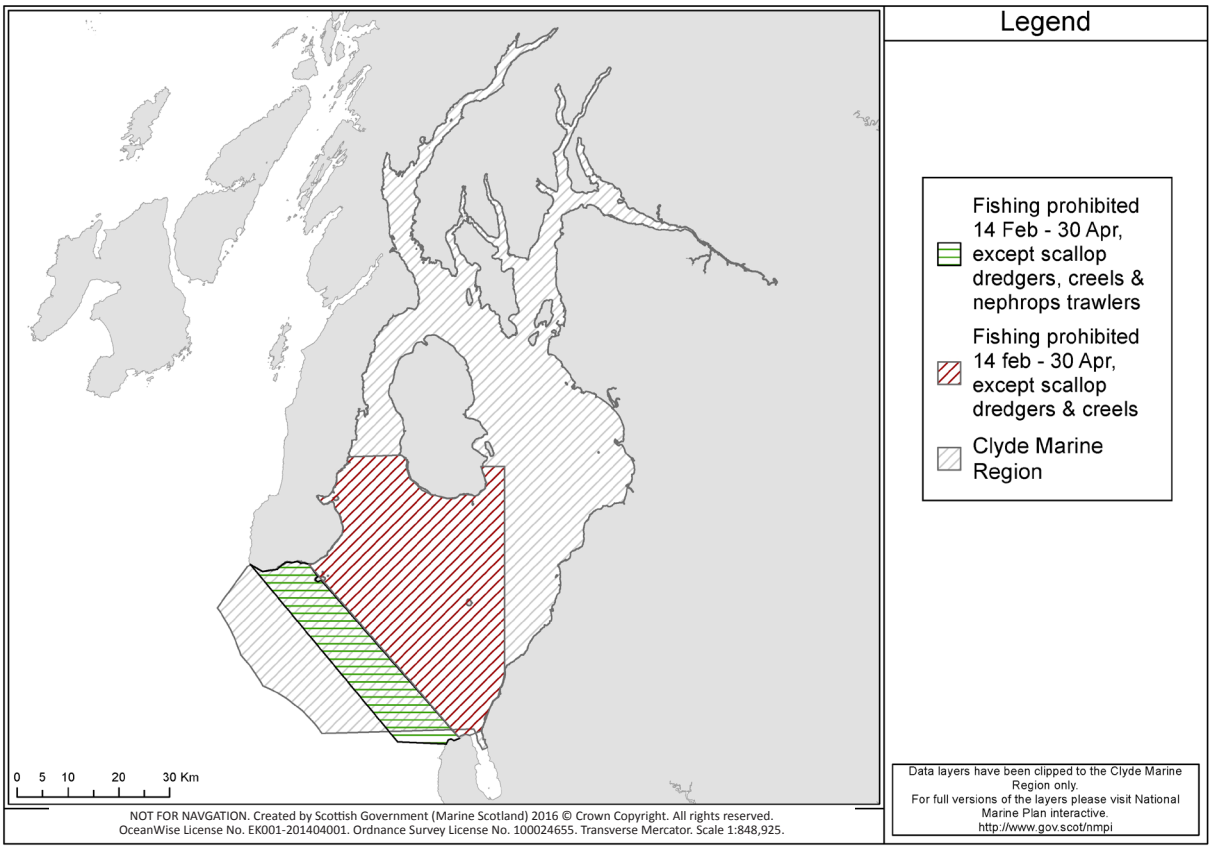
Figure 5.9 Juvenile Cod



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261. Hunter *et al*., 2015
262. Turrell *et al*., 2016

Map 16. Clyde Cod box



Connectivity of the Clyde Marine Region demersal and pelagic fish populations with other regions

Much work has been done to try to establish the distinctiveness of CMR fish populations – from genetics to otolith microchemistry. In herring this has drawn limited conclusions; the body of opinion is that fish sampled from the Clyde had otolith[263] chemistry consistent with fish originating from the Western Irish Sea.[264] Whilst demersal species research, focusing on cod, saithe and haddock, seems to conclude that the CMR fish are a largely separate, discrete residential stock with limited mixing with stock from outside the region.[265] This will be of particular relevance as the Clyde 2020 steering group considers options to improve the white fish stock status of the CMR.

Spawning grounds

The Ballantrae Bank, near the mouth of Loch Ryan, is accepted as being an important spawning ground for herring in particular[266] and further into the CMR, off the South end of Arran a further smaller herring spawning ground[267] has been identified and suggested as new protected areas, including during discussions regarding the network of MPAs in the Clyde.[268] Protective measures for spawning herring include a ban on herring fishing from 1st January to the 30th April,[269] a ban on all active fishing from 1st February to 1st April on the Ballantrae Bank spawning grounds,[270] and a ban on herring fishing between midnight on Saturday morning to midnight Sunday night.[271]

The 'Cod Box' area (shown in Map 16) is designated as an important area for cod, haddock and hake spawning. In order to protect spawning cod, no fishing is allowed in this area between 14th February and 30th April. In 2015 research published concluded that there was no evidence of local recovery in terms of abundance, biomass, or reduced mortality more than a decade after establishing the closure. Mortality may have

263. An otolith is a bony structure found in the middle ear of fish.
264. Geffen *et al.*, 2011
265. Galley *et al.*, 2006
266. Ewart, 1984
267. Parrish *et al.*, 1959
268. Marine Scotland, 2013b
269. Council Regulation (EC) No. 850/98 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms.
270. The Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 2004
271. The Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 2004

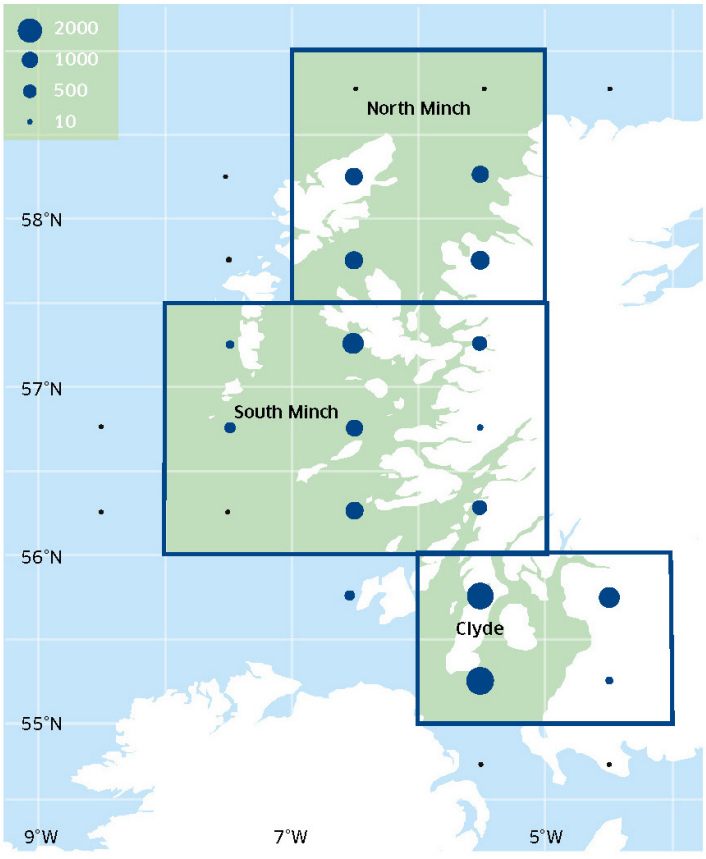
remained high because young cod are still caught as bycatch in the *Nephrops* fishery in the area (although by-catch of cod has reduced due to changes in mesh size and other measures[272]) and the predation rate may have increased due to an expanding whiting population.[273]

It has been more difficult to be precise about the areas most heavily used for spawning by other demersal species and so no specific areas are designated for this purpose.[274]

Shellfish

The development of the shellfish fishery was delayed in the Clyde by the Herring Fishery (Scotland) Act 1889, which prohibited otter and beam trawling until 1962 when otter trawling for *Nephrops* was permitted in the summer only. Shellfish, such as *Nephrops* (figure 5.10), king scallops, queen scallops (*Aequipecten opercularis*), lobster and edible or brown and velvet crab (*Necora puber*) are now the most important resource to the inshore fleet of the region. The majority of the inshore trawling fleet is dependent on *Nephrops* which are now landed all year.

Figure 5.11 Distribution of Scottish west coast *Nephrops* landings (tonnes) in 2015 (UK vessels into Scotland)



Source: Marine Scotland Science Fish and Shellfish Stocks 2017 Edition

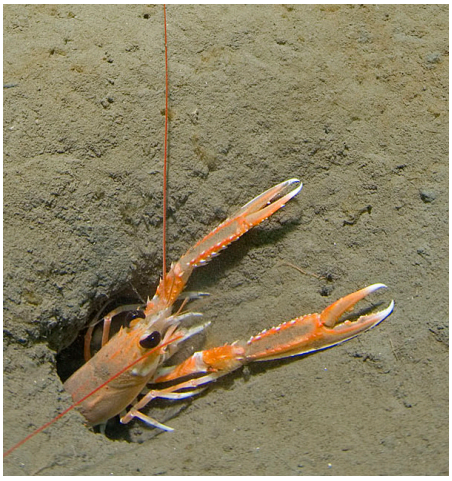
Nephrops

Owing to its burrowing behaviour, the distribution of *Nephrops* is restricted to areas of a particular sediment type; mud, sandy mud and muddy sand. In the CMR, burrow densities are higher in the south and the average size of *Nephrops* is smaller. This is particularly evident from the differences in discard composition between the north and the south of the CMR. Catches from the south have a higher proportion of small *Nephrops*, resulting in large proportions of undersized *Nephrops* and *Nephrops* heads. Trawls in the south also generate larger quantities of roundfish discards (35%), including the important commercial species whiting, cod and haddock.[275]

Survey assessments of the CMR *Nephrops* stock are carried out annually by an underwater TV survey (UWTV) which determines *Nephrops* burrow density on the seabed. The information gathered provides an index of stock abundance which is independent of the fishery and together provides information on the status and predicted stock level.

ICES describe the state of the *Nephrops* stock in the CMR as above the MSY trigger point and, with the recent high catches by trawlers, it is perceived to be a viable fishery although assessment still relies on an area covering the whole of the CMR and the Sound of Jura. In 2015, ICES altered its advice from a precautionary approach to one based on discard rates and survivability.[276] It should be noted that there is a predator/prey relationship between finfish and shellfish; it is possible that the change in fish species diversity in the CMR resulted in reduced pressure from predator species and may have led to a boost to the *Nephrops* population in the Clyde.

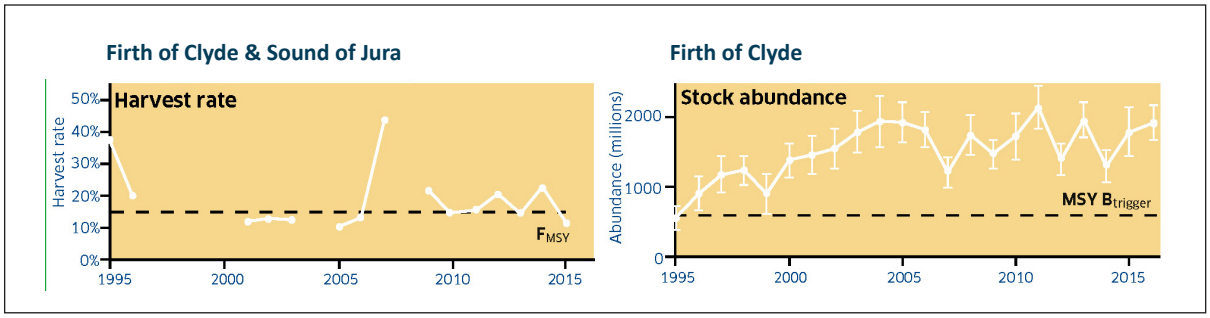
Figure 5.10 *Nephrops* emerging from its burrow



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272 . Stratoudakis *et al*., 2001
273. Clarke *et al*., 2015
274. Hislop, 1986
275. Bergmann, 2002
276. International council for the Exploration for the Sea, 2015a

Figure 5.12 Under Water TV surveys for *Nephrops* in the Firth of Clyde and Sound of Jura



Source: Marine Scotland Science Fish and Shellfish Stocks 2017 Edition

Nephrops Stocks

The latest ICES *Nephrops* stock assessment for the Clyde was released in May 2017and concluded that the CMR stock remained above **MSY $B_{trigger}$** and was being harvested above the proposed **F_{MSY} proxy**. On the basis of this assessment, ICES have recommended that the following CMR limits are set: Landings 6,185 tonnes, Catch 6,747 tonnes, an increase on their advice from the previous year of 6,206 and 6,568 respectively.

NB: MSY (Maximum Sustainable Yield) is, theoretically, the largest yield (catch) that can be taken from a specific fish stock over an indefinite period under constant environmental conditions. It is measured in tonnes. ***'B'*** refers to Biomass (so the MSY in this context is measured in total tonnes of *Nephrops* biomass regardless of age or sex). MSY ***trigger*** is the MSY point which triggers a cautious response in terms of management. ***F_{MSY}*** is the maximum rate of fish mortality (the proportion of fish removed by fishing) in this case a proxy is being used.

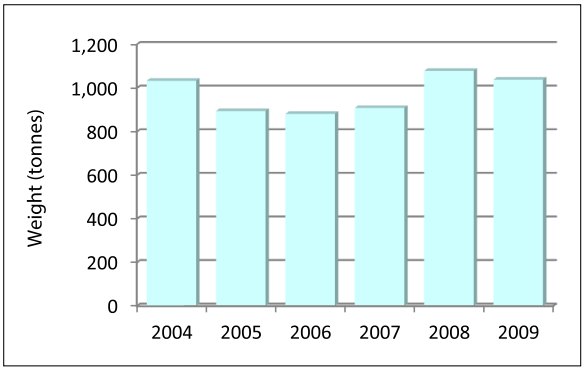
Scallops

The most important commercial molluscan species in the CMR are the king scallop and the related but smaller queen scallop. Landings from the Clyde king scallop stock unit have fluctuated markedly, declining to under 20 tonnes in 1990 and increasing since then to over 700 tonnes in 2012. Research does suggest that the size structure is heavily truncated in the CMR[277] however there is not enough data for reliable stock assessment (ICES, 2013, 2015).

Both species occur wherever the sea bed consists of sand, fine gravel or sandy gravel. The distribution of suitable sediments results in the species being found in a narrow strip of sea bed on each side of the CMR and around Arran in depths no greater than 40m. Anecdotally fishermen report changes in stock density in a variety of time scales and cycles which have yet to be fully investigated and understood.

In September 2003, The Prohibition of Fishing for Scallops (Scotland) Order 2003 was implemented. This put in place new measures for scallop conservation that limited the number of dredges a scallop vessel can tow to a maximum of eight per side for Scottish Inshore waters. Currently the Clyde 2020 group are discussing evidence from other models of management including the successful model in the Isle of Man.[278]

Figure 5.13 King Scallop landings (dredge) Clyde Inshore Fisheries Group Area 2004–2009 (tonnes)



Source: Clyde Inshore Fisheries Group, Fisheries Management Plan (2011)

Currently, there is no catch limit on UK scallop fisheries. They are mostly managed through minimum sizes, restriction on dredge numbers and seasonal closures in some areas. MSS conducts assessments of king scallop stocks around Scotland on a regional basis. In some areas, including the Clyde, insufficient data from sampling of landings means that analytical stock assessments have not been undertaken. There are also issues associated with apportioning catches, which are reported by statistical rectangle to the Clyde management area.

Scallop stocks are highly susceptible to overfishing, due to their limited mobility and confinement to a particular type of sea bed. Discussions are on-going within the Clyde 2020 group and the WCRIFG Clyde Sub-Group about the best way to undertake a king scallop stock assessment in the CMR.

277. Howarth *et al*, 2015
278. Howarth *et al*, 2014

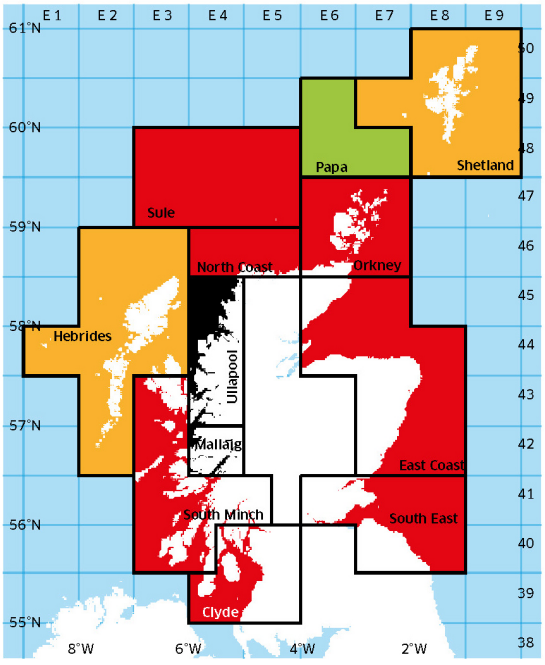
Other Shellfish

In the Clyde, there are creel fisheries for crabs, lobsters and shrimp some of which are on a part-time basis; these fisheries are regulated by minimum landing size only. Marine Scotland is currently consulting on minimum and maximum landing sizes for crab and lobster around the Scottish coast. Length Cohort Analysis (LCA) compares animals of the same length and is the method used for assessing crab stocks. Whilst data about brown and velvet crabs and lobsters in the Clyde could be improved, the ICES advice is updated annually and recommends a reduction in fishing mortality across all relevant species. see maps below for landings summaries for Scotland as a whole Gathering mussels has gone out of favour and now only a few are taken, mainly in the lochs. Beds of cockles are found in several parts of the Clyde, including the Isle of Bute, the Ayrshire coast and at Stranraer. Around the Arran coast and in other parts of the CMR electrofishing for razor fish is known to occur but remains illegal at time of writing.

Edible or brown Crab

Assessments based on LCA, done by ICES for their 2017 advice, show that brown crab are fished above F_{MSY} in the period 2013-2015 and that a reduction in fishing effort would give positive results in terms of yield and biomass in the longer term.

Brown Crab Assessment 2013–2015



Source: MSS Fish and Shellfish Stocks, 2017 Edition.

- Fishing mortality around or below F_{msy}
- Fishing mortality above F_{msy} for either males or females
- Fishing mortality above F_{msy} for both males or females

Figure 5.15 Brown crab stocks, relationship between F and F_{MSY} proxy

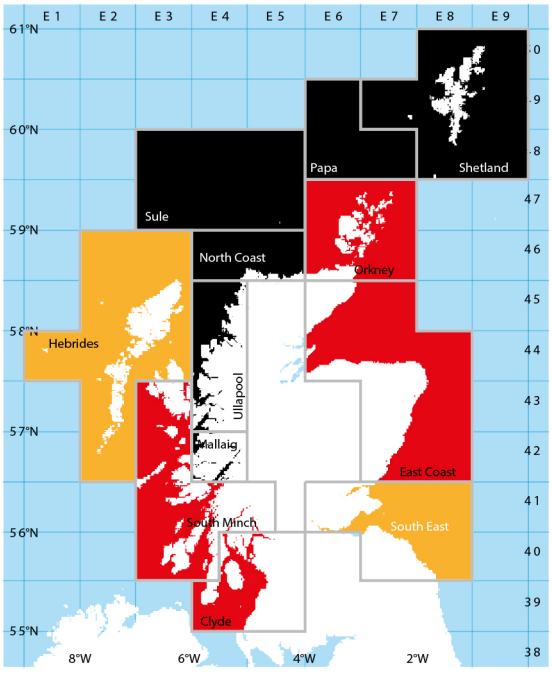
		F (Fishing Mortality)			
		2006-2008	2009 - 2012	2013- 2015	
Clyde	Males	✗	?	✗	Unknown
	Females	✗	?	✗	Unknown

See key on page 98. Source: MSS Fish and Shellfish Stocks, 2017 Edition.

Velvet Crab

Overall, assessments for the period 2013-2015 in areas with sufficient sampling data (including the Clyde) showed that most velvet crab assessment units in Scotland were being fished close to or above the F_{MSY} proxy. In some assessment units, a higher yield and biomass per recruit in the long term could potentially be obtained by reducing the level of fishing mortality (effort).

Velvet Crab Assessment 2013–2015



Source: MSS Fish and Shellfish Stocks, 2017 Edition.

- Fishing mortality around or below F_{msy}
- Fishing mortality above F_{msy} for either males or females
- Fishing mortality above F_{msy} for both males or females
- Not assessed for the period 2013–2015

Figure 5.16 Velvet Crab, relationship between F and F_{MSY} proxy

		F (Fishing Mortality)			
		2006-2008	2009-2012	2013 - 2015	
Clyde	Males	✗	✗	✗	Above F_{MSY}
	Females	✗	✗	✗	Above F_{MSY}

See key on page 98. Source: MSS Fish and Shellfish Stocks, 2017 Edition.

Lobster

Overall, assessments for the period 2009-2012 show that most lobster assessment units in Scotland, including the Clyde, were fished close to or above the F_{MSY} proxy. A higher yield and biomass per recruit in the long term could potentially be obtained by reducing the level of fishing mortality (effort).

Figure 5.17 Lobster, relationship between F and F_{MSY} proxy

		F (Fishing Mortality)		
		2006-2008	2009 - 2012	2009 - 2012
Clyde	Males	✗	✗	✗ Above F_{MSY}
	Females	✗	✗	✗ Above F_{MSY}

See key below. Sources: MSS Fish and Shellfish Stocks, 2017 Edition.

Figure 5.14 Key to Shellfish Stock Tables

		No overfishing	Overfishing	Unknown exploitation status
		✓	✗	↗ → ↘ ?
Decreasing stock trend	↘ or ✗	Reduce catch at rate of stock decrease.	Reduce catch at rate greater than the rate of stock decrease.	Reduce catch at rate greater than the rate of stock decrease.
Stable stock trend	→	Do not allow catches to increase.	Reduce catch.	Reduce catch.
Increasing stock trend	↗ or ✓	Increase catch at rate of stock increase.	Do not allow catches to increase.	Do not allow catches to increase.
No trend information	?	Do not allow catches to increase.	Reduce catch.	Reduce catch.

Source: MSS Fish and Shellfish Stocks, 2017 Edition

ECOSYSTEM SERVICES		
SERVICE TYPE	**BENEFITS PROVIDED**	**COMMENTARY**
Provisioning	Food (fish and shellfish)	The Clyde is responsible for a significant percentage of the *Nephrops* catch for Scotland. There are smaller fisheries for other species such as scallops, crab and lobster (see Chapter 6.2 Sea fisheries). There are currently no commercially exploitable white fish stocks.
Regulating	Biological regulation	Different trophic levels are exploited by different species and at different stages within the lifetime of any one species; juvenile fish will consume planktonic stages of other fish whilst adults may graze on seaweeds or predate on crustaceans.
Cultural	Cultural heritage	Fish and fishing are an important part of the Clyde's cultural heritage. Many of the small towns around the Clyde have been, or still are, reliant on fishing as a core economic activity. The Clyde Fishermen's Association estimates the added value from the fishing sector to be in the region of £40m per annum (see Chapter 6.2). Many of the fishing harbours and surrounding areas in these towns are important parts of the cultural landscape and are supported by aspects of some local and regional development plans.
	Recreation	The Clyde was once recognised as a world class recreational fishing ground and supported not only significant numbers of angling businesses, but also encouraged mass participation by local people, although this activity has significantly declined over recent years due to a reduction in the numbers of large fish.
Supporting services underpin the provision of other services		Fish populations play a significant role in supporting the whole structure of the Clyde ecosystem; for example, the nutrients they process, excrete and generate from their decaying bodies form the basis of some of the muddy substrate food webs. Fish populations have a role to play in regulating nutrient, sediment and carbon cycles.

5.5 Sharks, skates and rays

Basking shark in the UK



All other elasmobranchs



Colours are explained in the key at the beginning of the document

KEY SUPPORTING EVIDENCE

Scotland's Marine Atlas www.gov.scot/Resource/Doc/345830/0115138.pdf

SNH commissioned reports 339 www.snh.org.uk/pdfs/publications/commissioned_reports/339.pdf and 908 www.snh.gov.uk/publications-data-and-research/publications/search-the-catalogue/publication-detail/?id=2403)

ICES Working group on Elasmobranchs report www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2015/WGEF/wgef_2015.pdf

OSPAR Commission Background commission on Basking Shark www.ospar.org/documents?v=7189

IUCN Red List www.iucnredlist.org/

Scotland's Marine Atlas Clyde score: 'many concerns and deteriorating'. Regional assessment consistent with this, except for basking shark where more recent data suggest an improving trend in Scottish waters.

Introduction

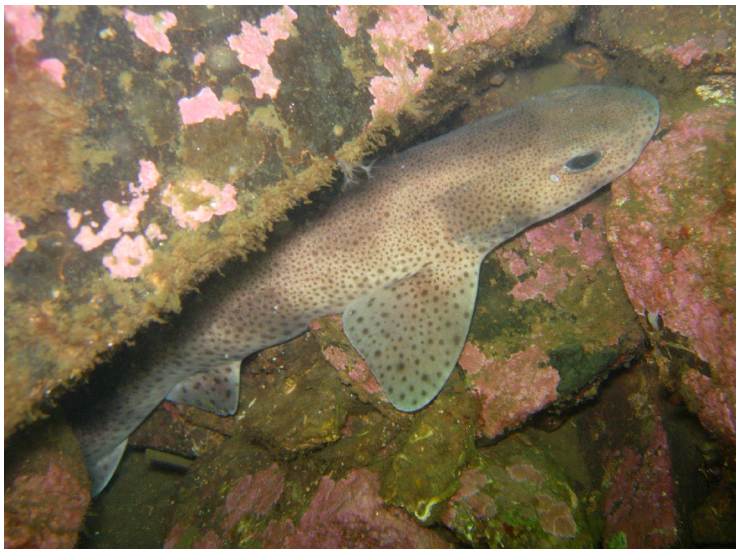
Sharks, skates and rays are a group of fish known as elasmobranchs. They are characterised by features including: a skeletal structure made out of cartilage instead of bone, five to seven pairs of gill clefts, and no swim bladder. Scotland has over 30 species of sharks, skates and rays recorded in its waters, 25 of which are found in coastal waters. Of these, eight in total are classified as Priority Marine Features (PMFs) and of these, six have been recorded within the Clyde Marine Region (CMR). Scotland's Marine Atlas provides more detail on the coastal species of skates, rays and sharks not listed as PMFs.[279]

Conservation status

All species of elasmobranchs found in Europe are on the OSPAR list of Threatened and Declining Species[280] due to their removal as target and non-target species by fisheries activity. They are also vulnerable to climate change impacts,[281] habitat disturbance and ship strikes or collision, particularly basking sharks (*Cetorhinus maximus*), as they spend time at the water surface[282] and lesser understood impacts such as the effect of electromagnetic frequencies.[283] Populations of elasmobranchs can take a long time to recover as they are typically slow growing and late to reach maturity, resulting in low fecundity.[284] Table 5.8 over page highlights the six PMFs known to be present in the CMR, any available information on their population trend, IUCN status and the main pressures which affect them. Of these six, all are migratory except the common skate which is considered to be possibly migratory.[285] Many species are subject to being caught as bycatch by several types of gear, including trawl nets.[286] Basking sharks are listed on Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) and are protected against intentional or reckless disturbance or harassment.

Catch per unit effort (CPUE) data from fisheries is available for the CMR for basking sharks (based on historic fisheries data) (0.05hr^{-1}) and for spurdog (*Squalus acanthias*) (0.67-503hr^{-1}).[287, 288] This may provide some indication of relative abundance, but should be considered with caution. For spurdog in particular, CPUE may be a misleading indicator of abundance. As the aggregating habitat of mature (often pregnant) females can result in enhanced vulnerability to capture and high CPUE figures even in depleted stocks.

Figure 5.18 Dogfish, a species of shark



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279. Baxter *et al*., 2011
280. OSPAR Commission, 2009a
281. Whitnich and Balanger, 2014
282. Baxter *et al*., 2011
283. Normandeau *et al*, 2011
284. Fecundity is the reproductive rate of an organism or a population

Table 5.8 Elasmobranch PMFs found in the Clyde Marine Region, their status and sensitivity to activities/pressures

(For further details on specific pressures in the region, see the Productive section)

SPECIES	IUCN STATUS[289]	POPULATION TREND[290]	SENSITIVITY TO ACTIVITIES/ PRESSURES[291. 292]
Basking shark (*Cetorhinus maximus*)	Endangered (for both the Northeast Atlantic and North Pacific subpopulations)	Declined by 50-90% in Scottish waters based on historic fisheries data. More recent sightings data suggest an overall long-term increasing trend, with a small but significant increase in the sightings of larger individuals.[293]	Ship strikes, potential disturbance and bycatch.
Spurdog (*Lamna nasus*)	Critically Endangered (Northeast Atlantic subpopulation)	Declining	Overfishing[294] and bycatch.
Porbeagle shark (*Lamna nasus*)	Critically endangered (Northeast Atlantic population)	Declining	Targeted fishery and is highly susceptible to overfishing.
Common skate (*Dipturus batis*)	Critically endangered (Northeast Atlantic subpopulation)	Declining	Bycatch
Blue Shark (*Prionace glauca*)	Near threatened	Unknown, but appears to be declining	Bycatch and targeted fishery
Sandy ray (*Leucoraja circularis*)	Endangered	Declining	Bycatch

Populations in the Clyde

There is very little stock information for elasmobranchs in the Celtic seas region (which includes the CMR);[295] however, biomass estimates based on research survey data have been made.[296] These are not stock assessments but do reflect trends and relative abundance of different species. These show that in the Clyde sea from 1920–1959, 13 taxa accounted for 95% of the average biomass, with spurdog accounting for greater than 20% (table 5.9). Additionally, species considered non-commercial by the study (such as spurdog) showed a strongly declining trend in biomass density over the period 1920–2004, with a slight recovery in 2005–2009. The study concludes that size structure of species has changed dramatically over time, with a deficiency in large (> 40cm) individuals after the period of peak harvesting rates in the 1980s and that it did not recover during the period of low harvesting rates after the late 1990s. Table 5.10 sets out the percentage biomass of species cumulatively accounting for 95% of demersal fish of greater than 40cm.

Table 5.9 Species cumulatively accounting for 95% of total demersal biomass averages over periods of years

SPECIES COMMON NAME	1920-1959	1960-1979
	% BIOMASS	
Spurdog	22.71	4.04
Thornback ray	5.91	
Tope	2.75	
Dogfish		0.99

285. Fowler, 2014
286. Food and Agriculture Organisation of the United Nations
287. CPUE is based on research surveys and data from fisheries before the 0 TAC was set in 2015.
288. Baxter *et al.*, 2011
289. International Union for the Conservation of Nature
290. Baxter *et al.*, 2011
291. Baxter *et al.*, 2011
292. International Council for the Exploration of the Sea, 2015b
293. OSPAR commission, 2015
294. Pre 2015 introduction of zero Total Allowable Catch in 2015 by the European Commission
295. International Council for the Exploration of the Sea, 2015b
296. Heath and Speirs, 2011

Table 5.10 Species cumulatively accounting for 95% of biomass of demersal fish > 40cm averaged over periods of years[297]

SPECIES COMMON NAME	1920-1959	1960-1979	1995-2004	2005-2009
	% BIOMASS			
Spurdog	32.44	13.69		5.81
Thornback ray	9.97	2.39		
Tope	3.94	2.90		
Dogfish			5.27	17.58
Cuckoo ray			6.01	
Spotted Ray			4.65	8.52
Nurse hound				19.58

Many species of elasmobranch have been exploited through commercial fisheries until relatively recently in Scotland, and this has been the main pressure on stocks. Prior to the landings ban in 2011, spurdog represented a sporadic, but valuable bycatch to the *Nephrops* (*Nephrops norvegicus*) trawl fishery.[298, 299] Numbers now caught as bycatch are considered to be small and this has been further reduced by the fishing industry implementing technical measures, such as modified nets, to reduce numbers of those caught. Despite this, they are a highly vulnerable species due to several life history characteristics; they tend to aggregate by age and sex, hence large groups are often caught at once; they reach sexual maturity between 9–11 years with low fecundity; they gestate their young for up to 24 months and live for up to 50–75 years.[300] In the years to come, as the Discard ban[301] is progressively applied, spurdog bycatch may present an additional challenge to the *Nephrops* fishery; as a species that has no quota, but is caught as bycatch, it may cause a vessel to stop fishing even if they still have quota for other species.

The International Council for the Exploration of the Sea (ICES) advises applying the precautionary approach and that a suite of measures, specific to species and fishery, be developed to manage the harvesting of commercial species or to achieve recovery of depleted species with zero total allowable catch, such as basking shark and spurdog.[302]

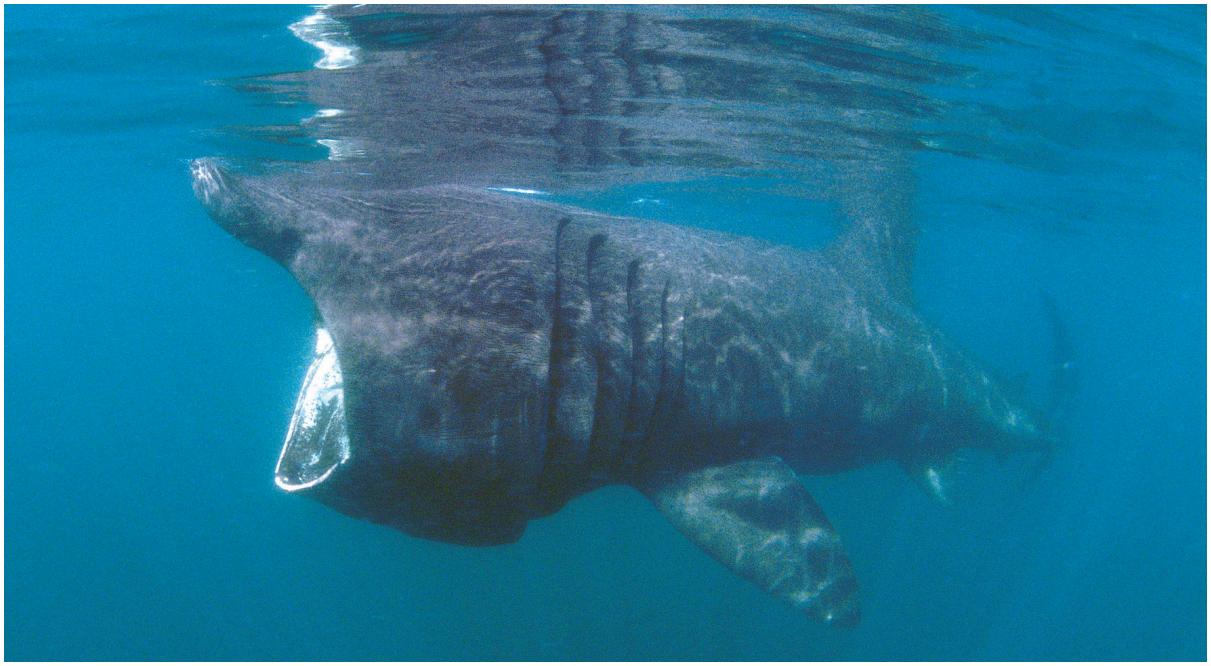
The Scottish Sea Angling Conservation Network (SSACN) created the Scottish Shark Tagging Programme (SSTP) to facilitate data collection on growth rates, maturation size and population ecology of sharks, skates and rays. Tagging is carried out in Scottish waters, including the CMR, by anglers. Both SSACN and the SSTP work in partnership with SNH, Marine Scotland and academic institutions to undertake further research on these animals in Scotland.[303]

Basking sharks in the Clyde Marine Region

Basking sharks (figure 5.19) are plankton feeding pelagic sharks that can grow up to 12m in length, making them the largest fish in UK waters and the second largest in the world.[304] These animals are highly migratory and can be seen in Scottish coastal waters from May to September. There is a strong relationship between the distribution of basking sharks and high levels of plankton; especially around areas with seasonally persistent tidal fronts (such as the CMR, Western Scotland and the central Irish Sea) where there is high plankton abundance.[305] Numbers of basking sharks sightings and planktonic copepod abundance have shown downward trends and were positively correlated.[306] A 2009 study based on sightings data identified The Sea of Hebrides as an important hotspot and area of high abundance for basking sharks and shows evidence of seasonal residence to coastal regions. Within the CMR, basking sharks were most commonly seen around north Arran, the Kyles of Bute and the mouth of Loch Fyne.[307]

297. Under descriptor 3 (commercial fish) of the Marine Strategy Framework Directive a target indicator of achievement of Good Environmental Status is over 30 % of finfish greater than 40cm in length.
298. Milligan *et al*., 2013
299. Fox, C., 2015
300. Milligan *et al*., 2013
301. Commission Delegated Regulation (EU) 2015/2440 of 22 October 2015 establishing a discard plan for certain demersal fisheries in the North Sea and in Union waters of ICES Division IIa
302. International Council for the Exploration of the Sea, 2015a
303. Scottish Sea Angling Conservation Network
304. OSPAR commission, 2009a
305. Lancaster *et al*., 2014
306. OSPAR commission, 2015
307. Speedie *et al*., 2009

Figure 5.19 Basking shark



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Surveys carried out annually between 2002-2006 determined that the CMR had a below average Shark per Unit Effort value, compared to other areas of Western Scotland.[308] This is in contrast with historic records, which show the area supported a successful commercial basking shark fishery; so much so, that one of the most successful hunters of the twentieth century built his original factory on the Kintyre peninsula. This fishery began sometime around the Second World War until the 1960's when the animals were targeted for their liver oil products. Demand then declined due to increased supplies of mineral oil and began again in 1983-1995. This was due to a resurgence in industrial sales of liver oil and human consumption of fins and flesh).[309]

ECOSYSTEM SERVICES[310]		
SERVICE TYPE	**BENEFITS PROVIDED**	**COMMENTARY**
Cultural	Recreational opportunities and sense of place	All forms of wildlife-watching tourism in Scotland have been estimated to generate £63 m and support 1,704 jobs. Basking sharks are an important part of this; they have a role as a charismatic species which stimulates people's interest in the marine environment. People take part in various activities linked to their presence, such as diving and boat trips. The history of the basking shark fishery forms an important part in the heritage of the region.
	Knowledge systems	As fish populations in the Clyde have changed in structure over the years, and fishing for historically popular target species has declined, recreational angling groups have become involved in shark, skate and ray tagging programmes facilitating the continuation of their hobby in the local area and also contributing to our knowledge of elasmobranchs.[311]
Supporting services underpin the provision of other services		Sharks, skates and rays play an important role in regulating food webs as top predators. Spurdog for example, feed on a wide range of both bottom dwelling fish and fish which can be found mid-water. The historic abundances reported of elasmobranchs, particularly of spurdog, suggest that the ecosystem has changed from being able to support such numbers of a high-level predator and the role of these animals in ecosystem functioning have also become depleted or absent in this time. Different species of skates and rays may separate themselves within the same ecosystem by their different foraging behaviour (they are very selective and have different preferences) and patterns of activity; this allows a high diversity of species to share difference niches.[312] Rays in shallow waters feed by disturbing seabed sediment, creating a 'feeding pit' to uncover prey. This behaviour results in the immediate clearing of infaunal invertebrates followed by accumulation of organic material, resulting in food availability and nutrient cycling. Basking shark feed on primary food resources and can be considered to be health indicators for the marine environment and primary production. Having healthy and diverse populations of sharks, skates and rays enables supporting services which drive the provision of other services.

308. Speedie *et al*., 2009
309. Kunzelik, 1988
310. UK National Ecosystem Assessment, 2011
311. Scottish Sea Angling Conservation Network
312. Pierce, 2005

5.6 Whales, dolphins and porpoises



Colours are explained in the key at the beginning of the document

KEY SUPPORTING EVIDENCE

Scotland's Marine Atlas
www.gov.scot/Publications/2011/03/16182005/93

IUCN Red List www.iucnredlist.org/

Clyde Marine Mammal Project
www.clydemarinemammalproject.org/

Scotland's Marine Atlas score: 'Some concerns and stable'. Regional assessment consistent with this.

Introduction

There have been 23 species of cetacean (the order of mammals which includes whales, dolphins and porpoises) recorded in Scottish waters in recent years.[313] Only two of these, the harbour porpoise (*Phocoena phocoena*) and minke whale (*Balaenoptera acutorostrata*), are regularly spotted in the Clyde Marine Region (CMR). Other species are more occasional visitors. Bottlenose dolphins (*Tursiops truncatus*) and a humpback whale (*Megaptera novaeangliae*) were spotted in the Clyde in 2015 and 2016 by the Hebridean Whale and Dolphin Trust (HWDT) community sightings network[314] and these species have also been recorded here in the 1990s and 2000s.[315] Other species that have infrequent sightings or strandings records in the CMR are northern bottlenose whale (*Hyperoodon ampullatus*), Risso's dolphin (*Grampus griseus*), killer whale or orca (*Orcinus orca*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), pygmy sperm whale (*Kogia breviceps*), Sowerby's beaked whale (*Mesoplodon bidens*) and striped dolphin (*Stenella coeruleoalba*).[316, 317]

Coastal waters around headlands and islands, narrow channels and fronts are important feeding areas for cetaceans. The front that occurs around the Clyde Sea Sill is considered to be a key attraction for cetaceans visiting the CMR from spring to autumn, due to the mixing of waters and the upwelling of nutrients along with associated food webs. The islands and narrow channels of the inner and outer Firth provide suitable feeding areas for resident harbour porpoise, the most abundant of cetacean species on the west coast of Scotland and in the CMR. A report by Whale and Dolphin Conservation highlighted that *'a very high density estimate of 1.071 animals/km^2 was reported for the Inner Hebrides, an area frequently reported to host concentrations of harbour porpoises* (Embling *et al.*, 2010; Marubini *et al.*, 2009; Evans and Wang, 2002; Pollock *et al.*, 2000) *and a high density of porpoises was also recorded for the Firth of Clyde, 0.823 animals/km^2. There are much less data available for the Firth of Clyde compared to the Inner Hebrides, but this high density estimate suggests it may also be an area of importance for harbour porpoises. High densities of harbour porpoises during the summer, the time of year when these animals breed and produce young, suggest these waters may be important for these behaviours'.*[318] For further background information on cetaceans in Scotland see this SNH publication www.snh.org.uk/pdfs/publications/naturallyscottish/whales.pdf.[319]

Conservation status

Populations of cetaceans are not managed at the scale of the CMR as they are so wide ranging.[320] All cetacean species are European Protected Species listed on Annex IV of the EC Habitats Directive defined as 'in need of strict protection' and bottlenose dolphin and harbour porpoise are also listed on Annex II 'whose conservation requires the designation of Special Areas of Conservation' (SACs). There are no SACs for these species in the CMR. The Habitats Directive also requires the UK to 'maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest' and 'establish a system to monitor the incidental capture and killing of the animal species listed in Annex IVa. In the light of the information gathered, Member states shall take further research of conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned.' In Scottish inshore waters, the Conservation (Natural Habitats) Regulations 1994 (as amended in Scotland) implement the species protection requirements of the Habitats Directive.

The precise population status of cetaceans occurring in the CMR is unknown as data are mainly restricted to sightings rather than effort-related surveys which can give information on absolute abundance. In addition, these species are highly mobile and at a global level their population range is far greater than the Clyde region. The Clyde Marine Mammal Project has recently been established to

313. Baxter *et al.*, 2011
314. Hebridean Whale and Dolphin Trust
315. Ross *et al.*, 2009
316. Clyde Marine Mammal Project
317. Scottish Marine Animals Stranding Scheme
318. Dolman *et al.*, 2013
319. Gillham and Baxter, 2009
320. For management units see this report http://jncc.defra.gov.uk/pdf/Report_547_webv2.pdf

improve our knowledge of cetaceans in the Clyde. Other sources of data include Seawatch Foundation and the Hebridean Whale and Dolphin trust (HWDT). The overall conservation status for those cetaceans that are Priority Marine Features (PMFs) in Scotland is presented in table 5.11. Population estimates undertaken at a wider scale have led the International Union for the Conservation of Nature (IUCN) to categorise these species as 'Least Concern' at a global level.[321]

For further information about marine mammals in the Clyde, visit the Clyde Marine Mammal Project website at www.clydemarinemammalproject.org/ or the HWDT at www.whaledolphintrust.co.uk/. When observing marine mammals always follow the Scottish Marine Wildlife Watching Code.[324]

Table 5.11 Cetacean PMFs occurring in the CMR and their status and sensitivity to activities/pressures

further details on specific pressures in the region, see the Productive section

SPECIES	IUCN STATUS[322]	STATUS (SCOTLAND)[323]	SENSITIVITY TO ACTIVITIES/ PRESSURES
Harbour porpoise	Least Concern	Favourable	Collision – the CMR is a very busy shipping area, particularly around the Inner Firth which may be used in particular by harbour porpoise. Noise disturbance from shipping and military activities are of particular relevance in the CMR Entanglement is a threat in particular to minke whales. Underwater noise from coastal developments, such as the construction of harbours, sea defences and other infrastructure, can cause disturbance to cetaceans. Piling operations, in particular, produce high levels of underwater noise. Wildlife watching operations, and marine recreational activities, have the potential to cause disturbance to cetaceans if carried out inappropriate ways. Relevant codes of best practice such as the Scottish Marine Wildlife Watching Code should always be followed to reduce the impacts. Pollution – although most contaminants are now in decline, they are still at high levels in some parts of the CMR (see Chapter 4.2 Hazardous substances). Management and mitigation measures for dealing with these pressures are in place through marine licensing, SEA, EIA, Habitats Directive (EPS).
Minke whale	Least Concern	Favourable	
Bottlenose dolphin	Least Concern	Favourable	
Short-beaked common dolphin (*Delphinus delphis)*	Least Concern	Favourable	

ECOSYSTEM SERVICES[325]		
SERVICE TYPE	BENEFITS PROVIDED	COMMENTARY
Cultural	Tourism	They are increasingly becoming a tourist attraction and the total gross income generated (directly and indirectly) by cetacean-related tourism in rural parts of the west of Scotland has been estimated in one paper at £7.8 m in the year 2000, with 242,000 tourists taking part.[326] A more recent report estimates that the West Coast and Islands, Loch Lomond & Trossachs is the second most important region for wildlife visitors (after Highlands & Islands), with 23% of trips and nights, and £65 m of wildlife visitor expenditure.[327] Note that this includes terrestrial wildlife. Generally there is evidence that the marine wildlife watching industry is growing.
	Spiritual and cultural well-being	Cetaceans have traditionally been part of Scottish marine heritage.
Supporting services underpin the provision of other services		Cetaceans generally play an important role as predators within the food web. Dolphins and porpoises have teeth and feed mainly on fish. Baleen whales, such as the minke whale, feed on small fish and krill by taking large volumes of water into their mouths and sieving the food out using baleen plates. Cetacean carcasses provide a source of food for many other marine species. The full role of cetaceans within the ecosystem is still not completely understood.

321. International Union for the Conservation of Nature
322. International Union for the Conservation of Nature
323. Baxter *et al.*, 2011
324. Scottish Marine Wildlife Watching Code, 2017
325. UK National Ecosystem Assessment, 2011
326. Parsons *et al.*, 2003
327. The Scottish Government, 2010b

5.7 Seals



Colours are explained in the key at the beginning of the document

KEY SUPPORTING EVIDENCE

Scotland's Marine Atlas
www.gov.scot/Publications/2011/03/16182005/93

SNH Commissioned report No. 361 www.snh.org.uk/pdfs/publications/commissioned_reports/361.pdf and publication of South West count

IUCN Red List www.iucnredlist.org/

Scotland's Marine Atlas score: 'Some concerns and stable'. Regional assessment includes more recent data showing an improvement in numbers in the CMR.

Introduction

The Atlantic grey seal (*Halichoerus grypus*) and the harbour (common) seal (*Phoca vitulina*) are found throughout Scotland's waters and are both present in the Clyde Marine Region (CMR), although in lower numbers than elsewhere. They are both known as 'true seals' and are highly adapted to life in water, with the ability to dive deeper and remain underwater longer than eared seals, sea lions and walrus found in other parts of the world. They do, however, need to return to land at 'haul-out' sites to rest, moult and breed. Seals eat fish; dive records show that both species forage for fish on or close to the seabed.[328] For further background information on seals see the SNH Commissioned Report No. 361.[329]

The harbour seal is the more common of the two species in the CMR and can be found in particular at Sanda Island, at certain points on the Mull of Kintyre coastline, in the south of Arran, around the Isle of Bute and in Loch Fyne.[330] The grey seal is found in lower numbers, again at Sanda Island and the south of Arran, but also at Lady Isle off Troon on the Ayrshire coast.[331] Some of these areas have been designated as haul-out sites (see map 17). The total population estimate in Scotland in 2009 for grey seals was 105,072 and for harbour seals was 20,427.[332] The latest count for harbour seals in the CMR was 1,167 in 2015, up from 811 in 2007. This is in contrast to the general decline seen on the east coast of Scotland (>90% since 2000) and Orkney (>70% decline since 2000).[333] Grey seals were counted at 304 in 2015, up from 272 in 2007.[334]



Seal © PETER SANDGROUND

Conservation status

The EC Habitats Directive includes grey and harbour seals on Annex II *'whose conservation requires the designation of Special Areas of Conservation'* (SACs). Whilst there are SACs for seals in other parts of Scotland, there are none in the CMR. Additionally, in response to declines in harbour seal numbers, the Marine (Scotland) Act 2010 has introduced Seal Conservation Areas in parts of Scotland; there are no conservation areas for harbour seals in the CMR.

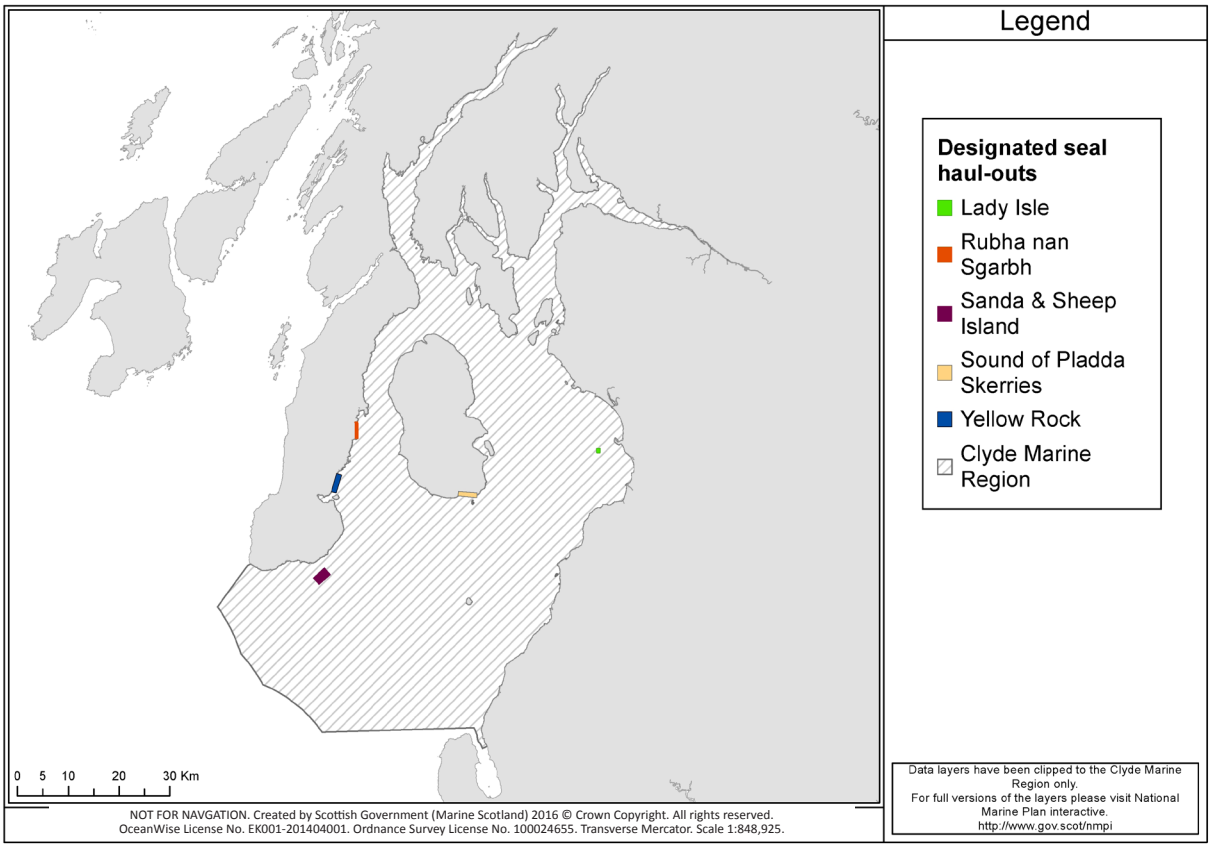
The Marine (Scotland) Act 2010 makes it an offence to shoot seals in Scotland, and since 2011 it has been an offence to kill, injure or take a seal at any time of year except to alleviate suffering or where a licence has been issued to do so. Licences may be issued for limited seal management if strict legal tests are met where it is necessary to avoid damage to fisheries or fish farms. For the purposes of considering licence applications to shoot seals, the coast has been divided into seven seal management areas: the CMR is in the South-West Scotland area. The number of seals licensed to be shot in any seal management area is determined on an annual basis, based on the most recent data on seal population size and the underlying trend in their numbers. For 2016, of the 43 licences granted across Scotland, four were issued in the South-West Scotland area, two for protection of health and welfare and two for prevention of serious damage. This equates to the potential loss of 15 grey seals and 17 common seals.[335] It should be noted that, in general, the number of seals shot is well below the potential loss figures.

The Protection of Seals (Designated Sea Haul-out Sites) (Scotland) Order 2014 introduced additional protection for seals at 194 designated haul-out sites, some of which are in the CMR (see map 17). It is an offence to intentionally or recklessly harass seals at these sites.

Both species are of 'least concern' on the IUCN Red List due to their large and either stable or increasing population at a global level. However, for the harbour seal, monitoring should be at a finer scale as some populations are small and declining.[336]

328. Duck, 2007
329. Duck, 2010
330. Duck, 2010
331. Duck, 2010
332. Baxter et al., 2011
333. NERC Special Committee on Seals, 2016
334. Duck and Morris, 2016
335. Marine Scotland 2016b
336. International Union for the Conservation of Nature

Map 17. Seal Haul-Out sites in the Clyde Marine Region



Pressures

There are a range of pressures that may generally affect seals, but the extent and magnitude of most have not been quantified and there have been no studies in the CMR. Potential pressures include exposure to hazardous substances, entanglement in marine litter, bycatch, a reduction in prey distribution and biomass due to habitat damage and climate change, collision with ships, shooting of seals under licence, the use of acoustic deterrent devices and disturbance from recreational activities at haul-out sites.

For further information about sightings of seals in the CMR, visit the Clyde Marine Mammal Project website at www.clydemarinemammalproject.org/. When observing marine mammals, always follow the Scottish Marine Wildlife Watching Code.[337]

ECOSYSTEM SERVICES[338]		
SERVICE TYPE	**BENEFITS PROVIDED**	**COMMENTARY**
Cultural	Tourism	They are increasingly becoming a tourist attraction as they are curious and easy to observe. Viewing seals on Arran is a popular tourist activity. A recent report estimates that the West Coast and Islands, Loch Lomond & Trossachs is the second most important region for wildlife visitors (after Highlands & Islands), with 23% of trips and nights, and £65m of wildlife visitor expenditure.[339] Note that this includes terrestrial wildlife. Generally there is evidence that the marine wildlife watching industry is growing.
	Spiritual and cultural well-being	Seals have traditionally been part of Scottish marine heritage and an inspiration to folklore and mythology.
Supporting services underpin the provision of other services		Seals are top predators and feed on fish, squid and crustaceans. They play an important role in maintaining an ecological balance. There has been much debate over the relationship between commercial fish stocks and seal numbers. Whilst over-fishing has depleted some commercial fish stocks and pollution has contributed to the decline in salmon in the Clyde, there is a question over whether increases in seal populations hinder the recovery of these other stocks. Science from other regions generally concludes that seals take less fish than predatory fish, humans, seabirds and probably cetaceans. However, it is also proposed that 'rogue' seals may predate heavily on salmon at fish farms and at the mouths of rivers.[340]

337. Scottish Marine Wildlife Watching Code, 2017
338. UK National Ecosystem Assessment, 2011
339. The Scottish Government, 2010b
340. Butler, 2011

5.8 Seabirds and waterbirds

Seabirds



Waterbirds



Colours are explained in the key at the beginning of the document

KEY SUPPORTING EVIDENCE

Scotland's Marine Atlas
gateway.snh.gov.uk/sitelink/index.jsp

Scotland's Marine Atlas
www.gov.scot/Publications/2011/03/16182005/93

Seabird Monitoring Programme jncc.defra.gov.uk/page-1550

Wetlands Bird Survey counts
www.bto.org/volunteer-surveys/webs

Birds of Conservation Concern
www.bto.org/science/monitoring/psob

Scotland's Marine Atlas score: seabirds 'Few or no concerns and improving', waterbirds 'some concerns and stable'. Regional assessment includes more detailed and more recent count trends showing declines in several species.

Seabirds

Introduction

Seabirds are bird species which have adapted to forage at sea, but are reliant on land to breed. They can be divided into those species which feed at the water's surface, such as terns and kittiwakes and those which are adapted to dive to much deeper depths and sometimes also swim to catch their prey, such as puffins and black guillemots.[341] Seabirds are considered a good indicator of the health of the marine environment for several reasons. They are at the top of the food chain and so any changes in lower trophic levels or in the physic-chemical environment are likely to manifest themselves within seabird populations. In addition, they have been monitored in the UK for over 20 years through consistent programmes which have produced reliable data.[342]

Twenty-one of the 24 species of seabird found in Scotland have bred or breed in the Clyde Marine Region (CMR).[343] Although the Clyde does not support a significant share of Scotland's seabirds (due to the low-lying coastline and the general ease of access of the coast to the surrounding human population), large populations are found in various sites around the Clyde, most notably the internationally important gannet (*Morus bassanus*) colony on Ailsa Craig. Other sites favoured by seabirds include the Ayrshire cliffs, Sanda island group, Horse Isle, Lady Isle, Little Cumbrae, Pladda, Holy Isle and Inchmarnock where gannet, black-legged kittiwake (*Rissa tridactyla*), Arctic tern (*Sterna paradisaea*) and sandwich tern (*Thalasseus sandvicensis*), lesser black-backed gull (*Larus fuscus*), herring gull (*Larus argentatus*), great black-backed gull (*Larus marinus*), black guillemot (*Cepphus grylle*), shag (*Phalacrocorax aristotelis*), cormorant (*P. carbo*), common guillemot (*Uria aalge*), razorbill (*Alca torda*), northern fulmar (*Fulmarus glacialis*) and Atlantic puffin (*Fratercula arctica*) are all found.[344]

Within Scotland, nine of the commonest seabirds have shown sustained declines over the past 20 years. These are: European shag, Arctic skua, herring gull, great black-backed gull, black-legged kittiwake, sandwich tern, common tern and common guillemot.[345] Across the whole of the UK seabird abundances have been declining since the early 1990s, with the lowest level recorded in 2004.[346]

Seabird populations in the Clyde Marine Region – Designated areas and the pressures affecting populations

Ailsa Craig

Ailsa Craig is home to one of the largest northern gannet colonies in the world, with over 33,000 pairs, and has been designated a Site of Special Scientific Interest (SSSI) under UK law for this reason. It is also designated a Special Protection Area (SPA) under EU law due to the gannet population and also on account of 1,800 breeding pairs of lesser black-backed gulls, which represents 1.5% of the Western European/Mediterranean/Western African population.[347, 348]

341. Monaghan and Zonfrillo, 1986
342. Parsons *et al*., 2008
343. Monaghan and Zonfrillo, 1986
344. Monaghan and Zonfrillo, 1986
345. Foster and Marrs, 2012
346. Baxter et al., 2011
347. Joint Nature Conservation Committee, 2001
348. European Council Directive 2009/79/409 on the Conservation of Wild Birds CITATION FOR SPECIAL PROTECTION AREA (SPA) AILSA CRAIG

Table 5.12. Seabird Monitoring Programme (SMP) colony count data for Ailsa Craig from 1995-2015[352]

		SPECIES									
		PUFFIN	FULMAR	GGB GULL	LBB GULL	HERRING GULL	GUILLEMOT	RAZORBILL	KITTIWAKE	SHAG	GANNET
POP. TREND		↑	↓	↓	↔	↓	NO TREND	↓	↓	NO TREND	↔
YEAR	1995	20									32,456
	1999										35,825
	2001		197	85	400	1,450	9,415	1,471	1,675	28	
	2004										27,130
	2005	84	50	50		500	9,000			100	
	2006	130									
	2008	120							200		
	2009			80		450	11,668	1,030	428	96	
	2010	61			183	131				72	
	2011	79	96								
	2012	37	106			82				49	
	2013		39	25	151	129	7,832	680	489		
	2014	149	58	10	172	60	4,681	769	228		33,226
	2015	183	49	11	166	129	5,404	446	299	66	

During the breeding season, the site regularly supports 65,000 individual seabirds, including guillemot, kittiwake, herring gull, lesser black-backed gull and gannets.[349] Ailsa Craig is managed by the Royal Society for the Protection of Birds (RSPB) who conduct annual surveys of the site. These data contribute to the Seabird Monitoring Programme (SMP). These results are reported in table 5.12 above, and show approximate population trends based on SMP counts on the island.

Numbers of seabirds, especially gannets, have shown a population increase since the eradication of rats in 1991.[350] A decline in numbers of gannets was seen in 2004 and this is thought to be due to a decline in breeding density throughout the colony. The next count in 2014 shows numbers had increased to levels similar to pre-2004 counts. The 2004 gannet count of adults on site represented 14.9% of gannets in Scotland and 10.4% in the UK and Ireland at that time.[351] The count information in the table shows declines for great black-backed gull, herring gull, razorbill and kittiwake. A similar trend is also reflected through site condition monitoring for the Ailsa Craig SPA.

Scottish Natural Heritage (SNH) assessments of the site have found the condition under the SSSI designation to be 'favourable maintained', meaning the population and distribution of the gannet population and the seabird assemblage including razorbills, guillemot, kittiwake and herring gull within the site have been maintained and where possible, the condition of the site has been enhanced for key seabird colonies.[353]

The conservation objectives for Ailsa Craig SPA are:

> To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
>
> To ensure for the qualifying species that the following are maintained in the long term:
> - Population of the species as a viable component of the site
> - Distribution of the species within site
> - Distribution and extent of habitats supporting the species
> - Structure, function and supporting processes of habitats supporting the species
> - No significant disturbance of the species

Qualifying species include gannets, guillemots, herring gull, kittiwakes, lesser black-backed gulls and the seabird assemblage. The site has been assessed under the SPA as 'favourable maintained' for breeding gannets, guillemots and the breeding seabird assemblage and 'unfavourable declining'[354]

349. Joint Nature Conservation Committee, 2001 342. Zonfrillo, 2001
350. Zonfrillo, 2001
351. Wanless *et al.*, 2015
352. Joint Nature Conservation Committee, 2016b
353. Scottish Natural Heritage, 2016d
354. One or more of the attribute targets have not been met and recovery is unlikely under the present management activity on the site

for breeding lesser black-backed gull, kittiwake and herring gull. The reason given for this is partly due to national declines in these species and may result in part from reduction in food availability.[355]
The reasons for some local declines may be complex and not related to wider changes; for example, reduced breeding space may well have been the cause of decline due to increased vegetation growth, which is now controlled. This may be an issue on Ailsa Craig, since the eradication of the rats has led to growth of vegetation and reduced breeding space.

The Joint Nature Conservation Committee (JNCC) provides guidance for monitoring designated sites such as SSSIs and SPAs. For more information on what targets are used to measure whether conservation objectives are being met for each feature on a site, see JNCC's Common Standards Monitoring Guidance for Birds.[356]

Sanda Islands

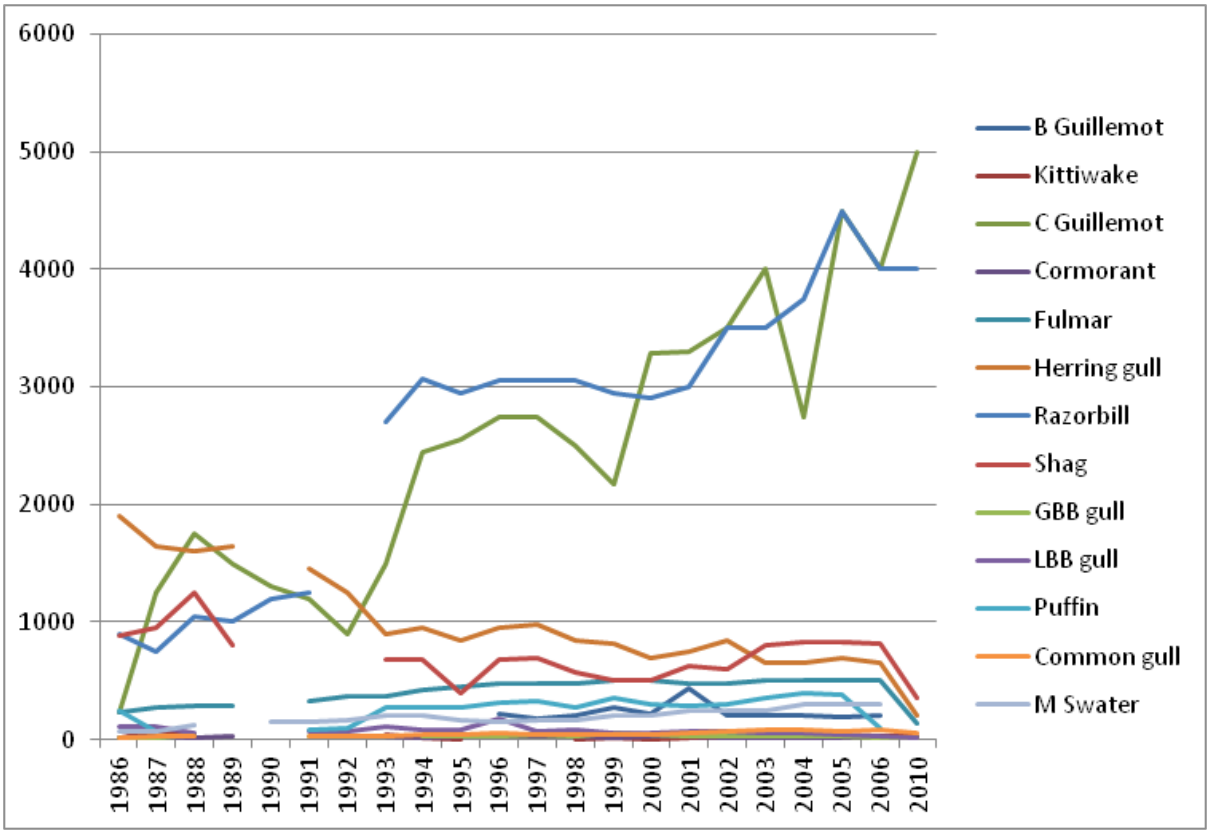
The Sanda Islands, located off the Mull of Kintyre are designated a SSSI (and are included within the boundary of the Clyde Sea Sill MPA) for breeding seabirds including, black guillemots, cormorants, fulmar, great black-backed gull, guillemot, kittiwake, Manx shearwater, puffin, razorbill, shag and storm petrel.[357] The location of the islands makes it an important outlying location and migration stop-over point for many seabirds, and is the biggest shag colony in the Clyde seabird population with internationally important numbers of this species and of razorbills.[358] The islands are also home to the most southerly established breeding colony of Manx shearwater and storm petrel in Scotland. Furthermore, the islands support a population of around 30 breeding pairs of cormorants.[359]

The assessment of seabird features at this site has found the breeding populations of black guillemot, cormorant, fulmar, guillemot, kittiwake, Manx shearwater, storm petrel and razorbill to be 'favourable maintained' while great black-backed gull were classified as 'favourable recovered'. Populations of puffin and shags were classified as 'unfavourable declining'.

Pressures identified on the island for the birds included suspected mink predation on black guillemots and climate change for razorbills, cormorants and fulmars. The national decline in seabirds could also be a contributing factor to seabird declines on this site.[360]

Figure 5.20 shows population changes from 1986-2010 on Sanda Island. The data shows declines in shag, herring gull, puffin and fulmar numbers and an increase in black and common guillemot and storm petrel (not shown in the graph, but 55 were counted in 1986 and 200 in both 1999 and 2006).

Figure 5.20. Populations of seabirds based on colony counts on Sanda Island 1986–2010[361]



355. Scottish Natural Heritage, 2016e
356. Joint Nature Conservation Committee, 2004
357. Scottish Natural Heritage, 2016a
358. Scottish Natural Heritage, 2011
359. Scottish Natural Heritage, 2011
360. Scottish Natural Heritage, 2016a
361. Joint Nature Conservation Committee, a



Oyster Catchers © PETER SANDGROUND

Clyde Sea Sill

Designated in 2015, the Clyde Sea Sill Marine Protected Area encompasses the Sanda islands, and among other marine features is designated for black guillemots (see Chapter 5.9 Protected areas for more information on the non-seabird features of this site). Study of these seabirds suggests that approximately 95% of foraging occurs within 2km of nesting sites,[362] and so the marine area near them is important and the MPA boundary is assumed to accommodate this. Although black guillemots are protected under the SSSI designation of the Sanda Islands, SSSI's are limited geographically to mean low spring water tides, and so foraging areas cannot be protected through the existing SSSI mechanism.

Black guillemots are the only bird species included in MPA Priority Marine Features (PMFs); this is because they do not fall under the protection of the European Commission Birds Directive as they are not considered migratory and over 80% of the population can be found in Scotland. Over 37,000 (around 88% of UK population) individuals were recorded in Scotland and over 1% of these are resident on Sanda and Sheep Island.[363]

A count made of the Sanda Islands population in 2013 shows a decline from 406 to 349 individuals from the previous survey carried out in 2001 for Seabird 2000. This is thought to be as a result of the 2013 survey being carried outside of the ideal count period when bird were still likely to have been in pre-breeding flocks.[364] A further decline has been seen from 2013 to 2014 when only 232 birds were counted, a 32% decrease. This decline may be down to day-to-day variability in black guillemot numbers in the pre-breeding period. It may also be as result of mink predation, which has been suspected on Sanda.[365]

Other important sites and activities within the Clyde Marine Region

Horse Isle is located 1km off the Ayrshire coast near Ardrossan. The island is an important site for high numbers of cormorants and lesser black-backed gulls. The gull population has increased here over the last 20-30 years after a cull of these species was stopped. The island is owned by Peel Holdings, but is managed as a nature reserve by the RSPB.[366] Pladda, Lady Isle, Little Cumbrae, the Ayrshire cliffs and Inchmarnock are also important sites for seabirds located around the CMR.[367]

Various dedicated local interest or specialist birding groups (both for sea and waterbirds) are active in the CMR, and these have contributed to our local knowledge of the life and habits of seabirds and waterbirds around the Clyde. Such groups include: the Buteshire, Arran and Glasgow Natural History Societies, Sanda birding group, Argyll Bird Club, the Scottish Ornithology Club, the Clyde ringing group and other British Trust for Ornithology (BTO) volunteers. Both Buteshire and Glasgow Natural History Societies produce their own publications, while the Arran Natural History Society produces the Arran bird atlas. The RSPB also has a number of local members groups around the CMR.

The Clyde ringing group operates over the region of the former Strathclyde Regional Council (an area wider than the CMR) and meets regularly to ring birds, an important activity which generates information on survival, productivity and movements of birds. The BTO reports ringing data on its website, by species and year for the wider Clyde area and the Clyde islands. In 2014, over 286 seabirds were ringed in the Clyde and 152 in the Clyde Islands. More information on this can be found on the BTO website.[368] The gull ringing project, led by University of Glasgow researchers, also colour rings gulls in the Clyde. This enables animals to be individually identified without having to be re-caught.[369]

362. Scottish Natural Heritage, 2014a
363. Scottish Natural Heritage, 2014a
364. Swann, 2013
365. Swann, 2014
366. Royal Society for the Protection of Birds
367. Monaghan and Zonfrillo, 1986
368. British Trust for Ornithologists, a
369. Arran Birding

Figure 5.21. Comparison of SMP population change data, percentage change in abundance in Scotland, classification under the Birds of Conservation Concern review and condition of seabird features at designated sites in the CMR

SPECIES	POPULATION CHANGE (%)[373]			% change in abundance in Scotland (1986-2011)[374]	BoCC 4	SITE CONDITION		
	1969-70 to 1985-88	1985-88 to 1998-2002	2000-2013			AILSA CRAIG SSSI	AILSA CRAIG SPA	SANDA ISLAND SSSI
Arctic tern	+50	-31	+6	-72				
Atlantic puffin	+15	+19	n/a		A			UD
Black guillemot	n/a	+3***	n/a	<+1*				FM
Black-headed gull	+5	0	+26	-53				
Black-legged Kittiwake	+24	-25	-47	-66	A	FM~	UD	FM
Common guillemot	+77	+31	+9	-24		FM~	FM	FM
Common tern	+9	-9	-17	-43				
European shag	+21	-27	-41	-47	A			UD
European storm-petrel	n/a	n/a	n/a					FM
Great black-backed gull	-7	-4	-24					FR
Great cormorant	+9	+10	-20					FM
Herring gull	-48	-13	-30	-58		FM~	UD	
Lesser black-backed gull	+29	+40	-48				UD	
Manx shearwater	n/a	n/a	n/a					FM
Northern fulmar	+77	-3	-13	-7				FM
Northern gannet	+39	+39**	n/a			FM	FM	
Razorbill	+16	+21	+13			FM~		FM
Sandwich tern	+33	-15	-7	-48				

** Change between censuses in 1984-5 and 2004-5
*** Change between censuses in 1982-91 and 1998-2002
* Not included in Operation Seafarer, the Seabird Colony Register or Seabird 2000
BoCC4 legend: The traffic light system used indicates the level of concern for each species, red being the highest level and green the lowest.
Where an 'A' is shown in the box, this means this bird was previously included in the Amber list, and the level of concern for the species has increased.
~ Part of breeding seabird assemblage, not assessed as an individual species
FM - Favourable maintained
FR - Favourable recovered
UD - Unfavourable declining

Clyde seabirds in context with UK and global population trends

Figure 5.21 above compares national trends from the SMP data, change in Scottish abundance trends (only calculated for 11 species),[370] the Birds of Conservation Concern fourth (BoCC4) review[371] and the site condition of seabird features of designated sites within the CMR.[372] The population changes shown in the data from the SMP illustrate that numbers of shag, kittiwake, herring gull, great black-backed gull, sandwich tern, common tern and arctic tern have decreased. While the Clyde data show a decreasing trend for puffin on Sanda, Kittiwake under the Ailsa Craig SPA, shag on Sanda, Herring gull on Ailsa Craig SPA and, to a lesser extent, lesser black-backed gulls on the Ailsa Craig SPA.

370. Foster and Marrs, 2012
371. BoCC is a review of the status of birds in the UK, Channel Islands and the Isle of Man; this review has seen three species (shag, puffin and kittiwake) move onto the red list from amber status (shown with an 'A' in the table), accompanying herring gulls and roseate terns under this status. The great cormorant is classified as green. The remaining 15 species are classified as amber and were also classified as amber under the third BoCC review.
372. The Seabird Monitoring Programme (SMP) has been routinely monitoring seabird colonies around Britain and Ireland since 1986; and some of its findings are reported here to provide context and further understanding of trends in seabird populations in the Clyde. Individual site count data from the SMP can be viewed on the Joint Nature Conservation Committees website, who coordinate this programme - http://jncc.defra.gov.uk/page-1550 (Accessed April 2016)
373. Joint Nature Conservation Committee, 2014
374. Foster and Marrs, 2012

Waterbirds

Introduction

Birds that live on or around water include: geese, swans, ducks (*Anseriformes*), waders, rails, grebes (*Charadriiformes*) and herons (*Ciconiiformes*) and are collectively known as waterbirds. Some waterbirds prefer freshwater habitats, while others prefer marine environments, or can move between these different aquatic environments.

The Inner Clyde estuary has been identified as an important site for wintering waterbirds and supports nationally important populations of: redshank (*Tringa tetanus*), oystercatcher (*Haematopus ostralegus*), goldeneye (*Bucephala clangula*), red breasted merganser (*Mergus serrator*), eider (*Somateria mollissima*), cormorant and red-throated diver (*Gavia stellate*). This has led to this site being designated as an SSSI, for its assemblage of wintering waterbirds and its habitat features, and a Special Protection Area (SPA) and a Ramsar site for wintering redshanks. However, waterbirds are found throughout the CMR coastline, at lochs and some inland water bodies.

For clarification, shags are covered above in the seabirds section and only count data for cormorants at the Inner Clyde estuary are included in this section as they are listed as a feature of the Inner Clyde estuary SSSI; other details on cormorant numbers in the CMR are provided above in the seabirds section.

Gathering data in the Clyde Marine Region – Wetlands Bird survey

The Wetlands Bird survey (WeBS)[375] is the principal scheme for monitoring the UK's non-breeding wintering waterbird populations. It provides a valuable indicator of their status and the health of wetlands around the UK. It also highlights particular sites of interest for waterbirds within the CMR.

There are core counts which take place monthly at wetlands during winter. In addition there are also occasional supplementary WeBS low tide counts which aim to identify key feeding areas. The coverage of counts and sites is dependent on the availability and location of volunteer groups who carry out the counts. The count data summarised here is a snapshot and does not take into account connectivity of sites and movement of birds between sites or from sites outwith the CMR. Further investigation needs to be made into this and other factors which may provide insight into changes in count numbers.

There are 16 sites in the CMR where counts take place, aside from the Inner Clyde estuary, including:



Grey Heron © PETER SANDGROUND

Bute, Black Cart water, Culzean pond, Dalmuir park pond, Forth and Clyde canal (Mayhill locks to Great Western Road and Clydebank to Bowling), Girvan Harbour, Girvan to Turnberry, Glen moss, Greenan Loch, Hogganfield Loch, Holy Loch, Hunterston to Fairlie, Kelvingrove Park, Knightswood park and Loch Long. Inland sites have been included as they may be important for connectivity to marine sites. Full details of these counts, going back across all years they have been carried out (the table opposite only looks at count data over 5 years) can be found on the WeBS Numbers and Trends reporting page- http://app.bto.org/webs-reporting/.[376]

Other known sites of importance for waterbirds in the CMR that do not appear in the WeBS counts and on which we have little data include Burnt Islands and Horse Island, which have two of the biggest colonies of eiders on the west coast. Eiders are also common around Inchmarnock, near Bute.

Wetlands Bird Survey count data in the Clyde Marine Region

Sites with the highest diversity of species counted are: Inner Clyde estuary (54 species), Black Cart Water (27 species), Holy loch (25 species), Girvan to Turnberry (25 species) Hogganfield Loch (24 species), and Greenan Loch (19 species). Sites with the highest average of birds counted over five years, which may be an indicator of their importance to the CMR are: Inner Clyde estuary (27,039), Bute (3,215), Black Cart Water (1,975), Holy Loch (1,305) and Hogganfield Loch (1,088). The rest of the CMR sites recorded averages below 1,000 birds. The total number of species at all sites in the CMR from 2010-2015 is recorded in figure 5.13 over.

375. British Trust for Ornithology, b
376. British Trust for Ornithology, c

Table 5.13 WeBS count data for all species across all sites included in the CMR from 2010/11 – 2014/15[377]

SPECIES	YEAR OF COUNT				
	2010/11	2011/12	2012/13	2013/14	2014/15
Bar-headed Goose	1	0	0	0	0
Barnacle Goose	6	86	0	11	0
Bar-tailed Godwit	31	46	5	11	18
Bean Goose	0	3	0	0	0
Black-tailed Godwit	9	7	3	6	6
Black-throated Diver	16	28	15	25	24
Brent Goose	1	2	1	0	0
Brent Goose (Light-bellied)	1	2	1	0	0
Canada Goose	589	425	150	271	324
Common Sandpiper	19	15	26	27	14
Common Scoter	2	35	36	16	0
Coot	163	130	123	117	120
Curlew	208	181	175	189	180
Dunlin	1,014	1,037	1,025	695	895
Eider	3,277	2,218	2,620	3,095	2,538
Gadwall	58	28	16	34	24
Golden Plover	2	1	421	0	0
Goldeneye	358	312	255	304	245
Goosander	100	46	75	99	89
Great Crested Grebe	228	205	216	125	117
Great Northern Diver	2	8	5	14	18
Greenshank	1	0	2	2	1
Grey Heron	85	65	56	112	78
Grey Plover	0	2	0	0	4
Greylag Goose	10,130	4,223	3,287	2,365	2,961
Greylag Goose (domestic)	0	5	5	3	3
Jack Snipe	2	5	6	1	0
Knot	14	15	12	7	14
Lapwing	1,728	1,837	1,512	1,243	1,479
Little Grebe	70	46	44	24	46

SPECIES	YEAR OF COUNT				
	2010/11	2011/12	2012/13	2013/14	2014/15
Long-tailed Duck	2	1	1	3	1
Mallard	1,535	1,208	1,420	1,539	1,242
Moorhen	80	84	71	100	146
Mute Swan	393	380	380	461	479
Oystercatcher	5,895	5,197	5,220	5,173	5,130
Pink-footed Goose	33	60	25	41	250
Pintail	8	11	3	4	2
Pochard	87	45	50	43	48
Purple Sandpiper	3	0	0	1	0
Red-breasted Merganser	221	141	186	136	200
Redshank	1,512	1,319	1,214	1,424	1,490
Red-throated Diver[369]	198	159	257	244	54
Ringed Plover	213	213	171	156	165
Ruddy duck	3	2	1	0	1
Ruff	0	1	0	0	0
Sanderling	3	0	0	7	3
Scaup	8	10	11	13	8
Shelduck	308	208	207	262	226
Shoveler	12	10	1	3	0
Slavonian Grebe	84	70	64	97	15
Snipe	127	132	148	176	93
Spotted Redshank	0	0	2	0	0
Teal	1,779	1,038	1,282	1,083	1,214
Tufted Duck	574	343	483	255	227
Turnstone	183	150	182	168	95
Water Rail	3	2	10	3	4
Whimbrel	7	1	6	15	2
White-fronted Goose	230	193	165	190	160
Whooper Swan	154	104	93	68	81
Wigeon	1,414	1,256	1,275	1,138	1,608
Woodcock	1	1	1	0	1

Overall counts for the CMR appear to be showing declines in numbers counted for 28 of the 61 species recorded in the WeBS counts for these years; counts over more years and examining other factors which may be affecting numbers would need to be investigated further. Species appearing to show an especially large decrease in numbers counted, over the period of years shown include: Canada goose (*Branta Canadensis*), dunlin (*Calidris alpine*), gadwall (*Anas strepera*), great crested grebe (*Podiceps cristatus*), greylag goose (*Anser anser*), lapwing (*Vanellus vanellus*), mallard (*Anas platyrhynchos*) and oystercatcher. Six species appear to show an increase in numbers counted including black-throated diver, great northern diver, moorhen, mute swan, pink-footed goose and widgeon.

The SNH waterbird biodiversity indicator for Scotland, from 2014, notes that the overall trend for wintering waterbirds (ducks and swans, geese, waders, grebes and coot) has now dropped below

377. Supplementary counts were carried out 10/11, 11/12 and 13/14, but not 12/13.

the 1975 baseline, when counting began and none of the groups have sustained their peak levels. Duck and swan numbers have shown a small increase over the winters of 12/13 and 13/14. Three species – pochard (*Aythya farina*), scaup (*Aythya marila*), and eider are at an all-time low. Collectively, waders have shown the largest decline. Numbers of great crested grebe (*Podiceps cristatus*), cormorant and coot show an overall decrease and coot reached an all-time low in 2011/12. Looking at the results in table 5.13, the national trend for declines is similar to what is seen in the Clyde, particularly for eider, pochard and goldeneye. In the Inner Clyde estuary, there is a similar trend in declines for eider, goldeneye, cormorant, redshank, Slavonian grebe (*Podiceps auritus*) and oystercatcher.

Redshanks were thought to be no longer impacted by the adverse factors which caused the large decline of the 70's and 80's and began to improve after this period until around 1999/2000 when their numbers began to decline again.[378] This may be as a result of declining numbers across the UK and may not be related to local factors. The BTO annual report of the Wetlands Bird Survey showed a decline of 22% in the 10 year trend from 2003/04-2013/14, down from the 10 year period 02/03-12/13 which showed a decline of 26%, suggesting a tentative recovery.[379] However, numbers in the UK are still down about 30% from a peak in the 1990s. Data for Scotland alone show a similar trend, with declines of about 40% since the 1999/2000 peak.[380]

Looking at the status of species included in table 5.13 at a national scale, curlew and Slavonian grebe are classified as having red status in the fourth review of BoCC4; both were previously classified under the amber list. Redshank, eider, goldeneye, oystercatcher and greenshank are classified as under the amber list; with greenshank being downgraded from the green list under the previous report. The decline for redshank overall across the CMR appears small, however considering the Inner Clyde Estuary in isolation, there would appear to be a larger decline at this site. Red-breasted merganser, which was previously amber listed, has been classified as having green status. The BTO WeBS report for 2013/14 reports that UK trends for shelduck, curlew, dunlin, redshank and oystercatcher have shown a steady decline.[381]

The history of the eider in the CMR has been particularly well recorded. At the start of the twentieth century these birds were a rare sight, but populations rose over the next 20 years across all parts of the CMR. In 1996 a monitoring programme was established by a network of local birders to carry out annual counts. This group recorded a population of 20,000 in 1997, making the Clyde home to the largest population of eiders in the UK; one in every four eiders in the UK was from the CMR. By 2000 the birds began to decline substantially for unknown reasons to the numbers recorded in table 5.14 (non-breeding individuals, winter count). Declines were seen across the entire CMR and there is no evidence of the birds moving elsewhere, either within or outside the region. Additionally, there is no evidence of a massive mortality event.[382] It is not currently known what caused the decline in eider numbers but more recent information shows that eider numbers are stabilising.[383]

The Inner Clyde estuary

The Inner Clyde Estuary is an SSSI (a national designation), an SPA (a European designation) and a Ramsar site (an international designation). Their boundaries are coincident and include the intertidal zone from Clydebank in a 20km strip along shores of the river to Helensburgh on the north bank of the river and Greenock on the south shore and landwards to Mean High Water Springs. The site of the largest single number of birds in the CMR and a heavily industrialised estuary, it is of national importance for its populations of waterbirds and is the most northerly of the UK's west coast estuaries. The habitat consists mostly of tidal mudflat with some saltmarsh and a shoreline of unmanaged semi-natural coastal vegetation.[384]

Table 5.14 highlights the population numbers for species which are either of national or international importance or are an SSSI or SPA feature. Many species found at the site in large numbers are not reflected in this list such as: mute swan (*Cygnus olor*), greylag goose, Canada goose common shelduck (*Tadorna tadorna*), wigeon (*Mareca penelope*), teal (*Anas crecca*), mallard (*Anas platyrhynchos*), great crested grebe, lapwing, dunlin, common snipe (*Gallinago gallinago*) and turnstone (*Arenaria interpres*). These can be viewed at the WeBS Numbers and Trends reporting page for the Inner Clyde location.[385]

Population counts for 05/06-14/15 are presented in table 5.14 and show that numbers across this period for non-breeding eider, goldeneye, oystercatcher, redshank and Slavonian grebe are decreasing. Numbers of non-breeding red-throated divers and red-breasted merganser curlew and greenshank for this period appear to be fluctuating.

Please note that the WeBS survey site extends beyond the boundary of the Inner Clyde SPA and SSSI, and so the numbers reported in this table will be higher than those reported for site condition monitoring of these designated sites.

378. Harding, 2008
379. Frost et al., 2016
380. Scottish Natural Heritage, 2014b
381. Frost et al., 2016
382. Waltho, 2011
383. Firth of Clyde Eider News, 2015
384. Scottish Natural Heritage, 2016f
385. British Trust for Ornithology, c

Table 5.14 WeBS counts for the Inner Firth of Clyde site for waterbirds 05/06– 14/15[386]
N.B. the boundary of the BTO survey area is more extensive than the boundary of the SPA/SSSI.

SPECIES	YEAR OF COUNT									
	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	20012/13	2013/14	2014/15
Eider	8,055	9,590	3,960	3,262	2,932	3,019	1,952	2,277	2,281	1,972
Goldeneye	636	688	609	215	270	227	235	204	221	157
Red-breasted merganser	252	195	168	202	158	202	128	152	103	140
Red-throated diver	202	182	199	139	177	191	140	245	233	40
Slavonian grebe[394]	35	41	73	49	47	84	70	64	96	15
Oystercatcher	5,880	5,308	5,836	4,101	5,042	4,938	4,369	4,631	4,363	4,400
Curlew	1,417	2,017	1,673	1,716	1,845	1,443	1,644	1,563	1,511	1,560
Cormorant	740	875	389	555	327	326	202	359	350	395
Greenshank	13	13	17	10	8	16	13	15	18	21
Redshank	1,984	1,915	1,901	1,965	1,596	1,293	1,042	1,038	1,131	1,244

Blue – exceeds British national important threshold
Green – exceeds international importance threshold
Orange – Indicates that a supplementary visit under the WeBS Core Count Survey was undertaken.

Inner Clyde SSSI

The SSSI has been notified for the following features: cormorant (discussed in seabirds but details given here as a feature of this designation), eider, goldeneye, oystercatcher, red-breasted merganser, red-throated diver, redshank and for the saltmarsh habitat. The site also contains large areas of nationally scarce dwarf eelgrass (*Zostera noltei*) and other plants and invertebrates that support the species which winter here.[387]

The management objectives for the SSSI designation are:

- To maintain the extent and condition of saltmarsh habitat
- To maintain the extent and forage value of intertidal sand and mudflats
- To maintain or increase the populations of wintering wildfowl and waders.

At the last site assessment (carried out in 2014, apart from redshanks which was carried out in 2007) all the waterbird features of the site and the saltmarsh (assessment of saltmarsh carried out in 2011) were found to be 'favourable maintained'.[388]

Improvements in sewage treatment in the CMR have been linked to a decline in invertebrate abundance and this has been cited as a potential cause for scaup declines.[389, 390] As a result, scaup are no longer noted as a feature of the Inner Clyde SSSI.[391] Improvements in sewage treatments are also thought to have been the cause for redshank, dunlin and lapwing declines in the 1970's and 1980's.[392, 393]

Inner Clyde SPA

The SPA has been designated based on the internationally important wintering population of redshank. The conservation objectives of the SPA are:

- To avoid deterioration of the habitats of the qualifying species (redshank) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - population of the species as a viable component of the site
  - distribution of the species within site
  - distribution and extent of habitats supporting the species
  - structure, function and supporting processes of habitats supporting the species
  - no significant disturbance of the species[394]

386. British Trust for Ornithology, c
387. Slavonian grebe are not a feature of the Inner Clyde SPA but are counted as having internationally important numbers by the WeBS survey data as the BTO Inner Firth of Clyde survey area is much more extensive than the Inner Clyde SPA.
388. Scottish Natural Heritage, 2016f
389. Burton *et al*., 2001
390. Scottish Natural Heritage, 2016c
391. Scottish Natural Heritage, 2016c
392. Furness *et al*., 1986
393. Harding, 2008
394. Scottish Natural Heritage, 2016g

The site qualified as an SPA in 2002, with a winter peak mean of 2,107 redshanks; 1% of the east Atlantic flyway and 2% of the British population.[395] At the last SPA condition monitoring survey in 2007, the redshanks were assessed to be in 'favourable maintained' condition.[396] Although WeBS counts cover a larger area than the SPA boundary, they show a significant decline in redshanks in the area (also reflected in the UK and Scottish trends noted above) which might indicate there would be a decline in the features assessment in the next monitoring cycle.

Main pressures affecting waterbirds

The main pressures identified for waterbirds include: intermittent risk of disturbance from cockle gathering on Pillar bank and recreational activities, in particular dog walking, bait digging and wildfowling. These activities are considered to be carried out at low intensity across the entirety of the CMR but there is evidence of some localised impacts.

Anticipated long-term sea-level rise is likely to have significant effects on the extent and distribution of intertidal and saltmarsh habitat. Landward migration is impeded by man-made sea defences. This may be offset if saltmarsh can gain height through accumulation of sediment.[397]

For further information on this and managed realignment opportunities, see Chapter 3.2 Climate change – sea-level rise and coastal flooding.

ECOSYSTEM SERVICES[398]		
SERVICE TYPE	**BENEFITS PROVIDED**	**COMMENTARY**
Regulating	Biological control	As a top predator and their role in marine food webs, seabirds contribute to biological control as they feed on marine organisms.
	Waste breakdown and detoxification	Scavenging bird contribute to waste breakdown at low levels, enabling species lower down the food web to feed on organic products. Herring and lesser black-backed gulls in particular have an impact on removing organic matter.
Cultural	Tourism and nature watching and sense of place and associated health benefits	Bird watching is an important recreational activity around the CMR and contributes to our knowledge and enjoyment of the natural history of the region. Visiting well-known seabird sites contributes to people's sense of place and interaction with the marine environment.
	Research and knowledge systems	Long term studies and research of seabirds and waterbirds has contributed to our knowledge of the marine environment and the impacts which may be affecting it and the wider ecosystem.
Supporting services underpin the provision of other services		The diversity of seabirds and waterbirds found in the CMR feed at different trophic levels; some are top predators feeding on fish while others forage in the intertidal zone on invertebrates. All play an important role in ecosystem functioning and maintaining ecological balance. Seabirds are consumers of primary production and transport nutrients from pelagic waters to coastal breeding sites.
		Burrow nesting seabirds, such as puffins and Manx shearwater make a significant physical impact to habitat by improving soil fertility and structure. All seabird breeding sites and colonies are part of the seascape. Seabirds are considered to be an indicator of marine health and if populations are in decline, this could be an indicator of problems or changes in the wider ecosystem or with other ecosystem services.

395. Harding, 2008
396. Scottish Natural Heritage, 2016g
397. Scottish Natural Heritage, 2016f
398. Burdon *et al*., 2017

5.9 Protected areas – nature conservation

Seabirds



Others



Colours are explained in the key at the beginning of the document

KEY SUPPORTING EVIDENCE

SNH site condition monitoring
gateway.snh.gov.uk/sitelink/

NCMPA surveys
www.snh.gov.uk/protecting-scotlands-nature/protected-areas/national-designations/marine-protected-areas-(mpa)/mpa-survey-research-reports/

Scotland's Marine Atlas: score not included

Introduction

Over the past 30-40 years, various pieces of Scottish, UK and European legislation have been introduced in order to help protect locations which are recognised for their natural, ecological and/or cultural value. This can be for landscapes, plants and animals, rocks, fossils and landforms. Their protection and management help to ensure that they remain in good condition for all to enjoy, both now and for future generations.

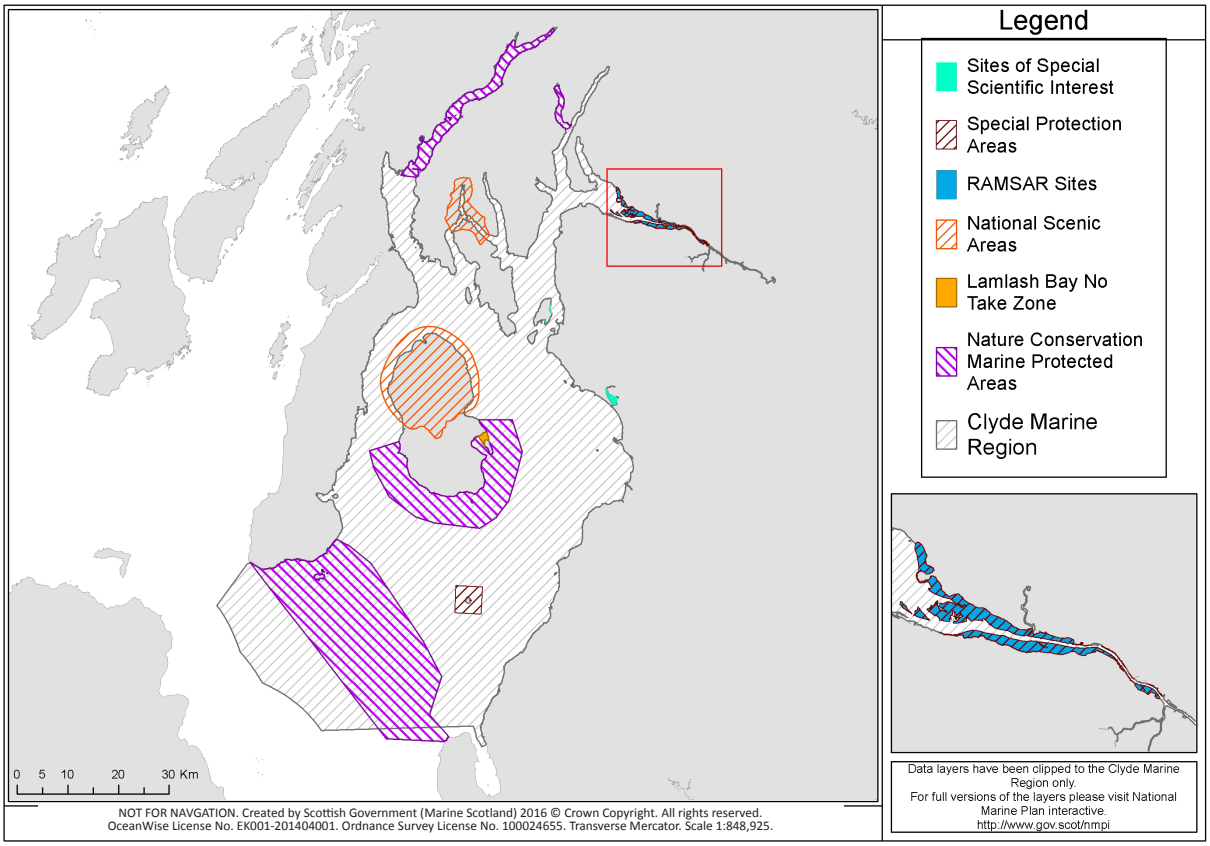
The Clyde's Marine Protected Area network includes Nature Conservation MPAs, Special Protection Areas (SPAs), Sites of Special Scientific Interest (SSSIs) and Ramsar sites. This network makes a significant contribution to the protection of Scotland's nationally important marine wildlife, habitats, geology and undersea landforms.

For a full list and further information about the features and condition of nature conservation protected areas around the Firth of Clyde see Appendix II.

The SSSI and Natura sites designated for habitats and species are generally in favourable condition with the exception of the following:

SITE	ISSUE AND COMMENTARY
Ailsa Craig SPA	Kittiwake (*Rissa tridactyla*), Lesser black-backed gull (*Larus fuscus*) and Herring gull (*L. argentatus*) form part of the SPA designation and are 'Unfavourable Declining'. Declines in the three gull species at least partly reflect national declines and may result in part from reductions in food availability.
Western Gailes SSSI	Long-term lack of grazing has resulted in some loss of habitat diversity in the sand dune habitats, and encroachment by non-native scrub. This has reduced the availability of habitat for sand dune insects. Strandline vegetation and insects that live on strandline vegetation and detritus have suffered losses due to unauthorised mechanical beach cleaning. Mechanical beach cleaning has now ceased.
Sanda Islands SSSI	Black guillemot (*Cepphus grille*), Puffin (*Fratercula arctica*), Shag (*Phalacrocorax aristotelis*), Great black-backed gull (*L. marinus*) and Kittiwake form part of the SSSI designation and are all showing a 25% or greater population decline. It is believed that this is not due to local issues but part of a wider UK seabird decline in some species.
Kames Bay, Cumbrae SSSI	Sandflats have no site condition assessment. Feature status under review.
Ballochmartin Bay, Cumbrae SSSI	Sandflats have no site condition assessment. Feature status under review.
Troon Golf Links and Foreshore SSSI	Long-term lack of grazing of sand dunes has resulted in some loss of habitat diversity and encroachment by native and non-native scrub. Scrub management by the golf course has restored some dune grassland and further measures are under discussion.
South Coast of Arran SSSI	Some decline in habitat condition has been attributed to localised under-grazing and bracken encroachment. Management measures have recently been agreed in some areas to control bracken and promote grazing. The shingle vegetation has suffered minor damage from small-scale shingle extraction and vehicle use.
Bogside Flats SSSI	Mudflat feature under review.

Map 18. Protected areas with a marine element in the Clyde Marine Region



Special Protection Areas (SPAs)

Inner Clyde SPA

The Inner Clyde estuary supports nationally important populations of several wading birds and has consequently been designated as a Site of Special Scientific Interest. The population of redshank (*Tringa tetanus*) is sufficiently large to be of international importance and the site has also been classified as a Special Protection Area (and Ramsar Site) (see Chapter 5.8 Seabirds and waterbirds for detailed information on waterbirds).

Ailsa Craig SPA

Numbers of gannets (*Morus bassanus*) on Ailsa Craig increased steadily in line with the national trend, from 13,000 Apparently Occupied Sites (AOS) in 1970 to 23,000 AOS in 1985 and 32,500 in 1995.[399] The aerial census in 2004 suggested that overall numbers of breeding gannets on Ailsa Craig had declined to 27,130 AOS.[400] However, this may be a result of the survey being completed too early in the season (see Chapter 5.8 for detailed information on seabirds).

Nature Conservation Marine Protected Areas (NCMPAs)

This type of protected area has been more recently established with designation orders in July 2014 under the Marine (Scotland) Act.

Clyde Sea Sill[401]

This site has been designated for Marine Geomorphology, Fronts, Black Guillemot and Circalittoral and offshore sand and coarse sediment communities. Fronts can concentrate nutrients and plankton, creating feeding hotspots for fish which in turn attract other higher marine predators. The sea bed at the sill is a dynamic environment; the sands and gravels on the sea floor are moved around, creating sandbank ridges or extensive sand ribbon and sand wave fields. Despite this highly mobile environment, there is a range of animals adapted to thrive here, taking advantage of the productive waters. Clam shells and polychaete worms (*Polychaeta*) live beneath the sediment, while fish (*Pisces*), starfish (*Asteroidea*), brittlestars (*Ophiuroidea*), sea mice (*Aphrodita aculeata*) and hermit crabs (*Paguroidae*) are found on the surface. In the north-west of the MPA a colony of breeding black guillemots relies on the rich feeding grounds around Sanda, Sheep Island and Glunimore Island.

399. Mitchell *et al.*, 2004
400. Wanless *et al.*, 2015
401. Scottish Natural Heritage, a

South Arran[402]

Designated for Burrowed mud, Maerl beds (*Corallinales*), Kelp (*Laminariales*) and seaweed communities on sublittoral sediment, Ocean quahog (*Arctica islandica*) aggregations, Seagrass (*Alismatales*) beds, Maerl or coarse shell gravel with burrowing sea cucumbers (*Aspidochireta*) and Shallow tide-swept coarse sands with burrowing bivalves:

The maerl beds support an array of other red and brown seaweeds as well as various sea anemones (*Zostera spp*.), starfish, juvenile fish and shellfish. Where the maerl is interspersed with coarse gravel, a variety of tube building worms (*Serpulidae*) are to be found, as well as sea cucumbers. Other areas of shallow tide-swept coarse sands are home to burrowing bivalves including tellins (*Tellinidae*) and surf clams (*Spisula solida*). A recent paper assessing juvenile cod distribution and growth suggested that protecting mixed gravel habitat could be beneficial to support the recruitment of juvenile cod.[403]
A narrow band of seagrass fringes the bottom of the shoreline along the south coast at Kildonan and Kilmory and a more substantial bed (believed to be the largest in the Clyde) is located in the shallow waters of Whiting Bay to the south-east of the island. Burrowed mud is widely distributed around the outer regions of the MPA and supports a range of animals including *Nephrops*, squat lobster (*Galatheidae*), crabs (*Brachyura*), worms (*Playtyhelminthes, Nematoda, Sipuncula, Echiura* and *Annelida*), ocean quahogs and the slender seapen (*Virgularia mirabilis*). There is also a record of flameshell (*Limaria hians*).[404]

Upper Loch Fyne and Loch Goil[405]

Designated for Ocean quahog aggregations, Burrowed mud, Flame shell (*Limaria hians*) beds, Horse mussel (*Modiolus modiolus*) beds, Sublittoral mud and specific mixed sediment communities:

The still waters of these sea lochs are the ideal environment for a range of muddy seabed habitats to develop. Loch Shira is home to fireworks anemones. At Castleton, there is a flame shell bed which benefits from the increased currents caused by the tide being forced around the headland at Otter Spit. Large aggregations of sea cucumbers are present in mixed muddy sediments on the sill at the entrance to the mouth of Loch Goil, alongside clumps of horse mussels and sea squirts. Ocean quahog can be found throughout the MPA along with slender seapens and tube dwelling sea anemones (*Ceriantharia*).

Management of Fishing Activity within Nature Conservation MPAs

Following lengthy consultation, fisheries management measures were established for some NCMPAs by March 2016. Different regimes exist in different parts of the NCMPA network in order to allow fishing activities to take place where possible, whilst conserving or recovering the features of the site. Map 19 (over) shows measures for the South Arran and Upper Loch Fyne and Loch Goil NCMPAs within the Clyde Marine Region. Management measures for the Clyde Sea Sill will be introduced at a future date. For more information see www.gov.scot/Topics/marine/marine-environment/mpanetwork/inshorempas.

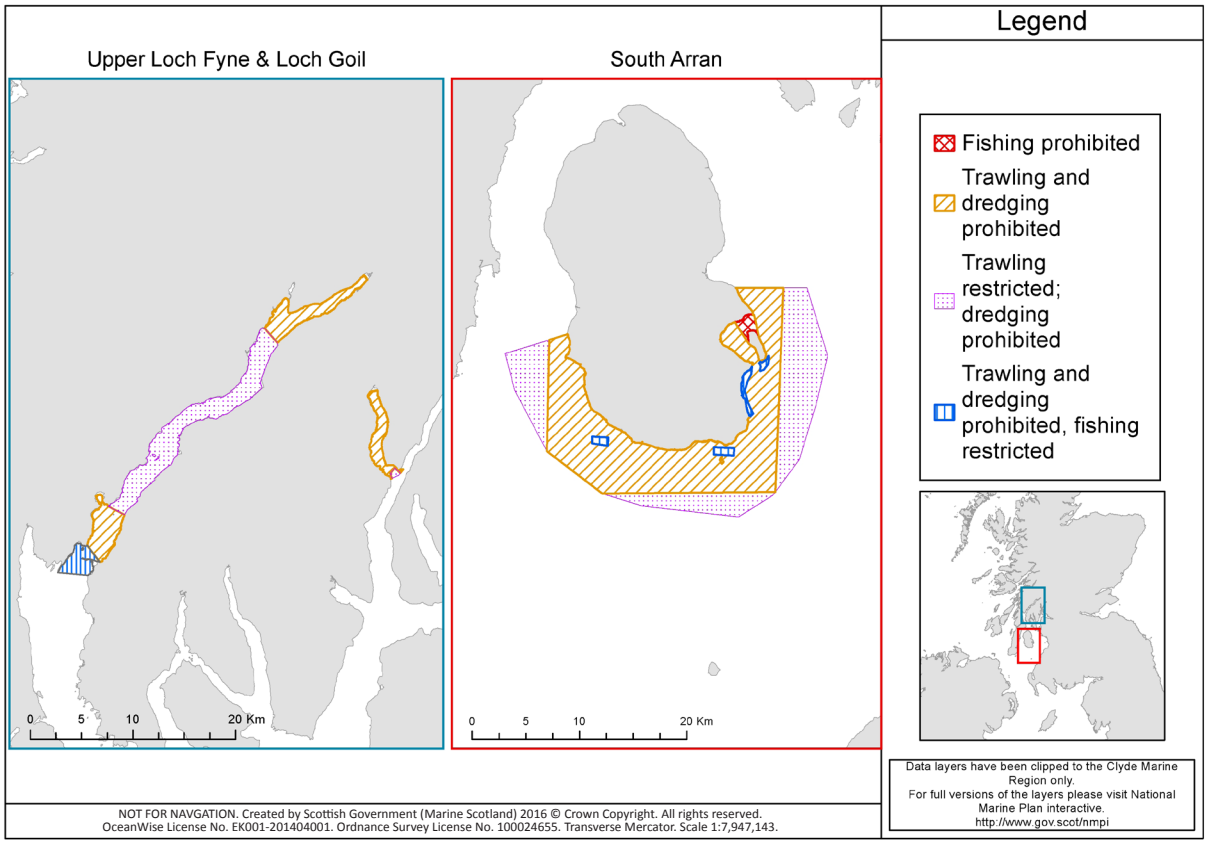
Lamlash Bay – No Take Zone

In September 2008, Scotland's first No Take Zone came into effect in part of Lamlash Bay, off the Isle of Arran. It is underpinned by fisheries statute as this was the only appropriate legislation available at the time.[406] Its establishment is a result of campaigning by the Community of Arran Seabed Trust (COAST) over many years, aiming to conserve and enhance the biodiversity of the Bay, and the subsequent work of a voluntary Working Group of the main interested parties: Clyde Fishermen's Association, COAST, SNH, Marine Scotland Science, Scottish Government and chaired by the Firth of Clyde Forum. Following lengthy discussions and broad agreement by all parties, the No Take Zone was established. It now lies within the larger South Arran Marine Protected Area and is now legally enforced as part of the South Arran Marine Conservation Order.

A number of surveys have been undertaken and are ongoing in order to assess how the No Take Zone is responding to protection. They show that the population dynamics of crustaceans have changed. Whilst the size and abundance of lobster has markedly increased over time, and the size, age and biomass of scallops have also increased,[407] the abundance of Brown Crab has decreased when compared to the area outside the No Take Zone. Fieldwork for a PhD thesis at York University has shown evidence from photo quadrats that species which attach to the seabed (such as maerl, seaweed, hydroids, bryozoans and sponges) are more abundant within the No Take Zone than the surrounding area.[408]

402. Scottish Natural Heritage, c
403. Elliott *et al*., 2016
404. National Biodiversity Network Atlas
405. Scottish Natural Heritage, d
406. The Inshore Fishing (Prohibition on Fishing) (Lamlash Bay) (Scotland) Order 2008
407. Howarth *et al*., 2011
408. Howarth, L., 2013

Map 19. Fisheries management measures South Arran and Upper Loch Fyne and Loch Goil



Ecosystem Services

Protected areas provide a wide range of ecosystem services as part of the natural environment. These have been highlighted under the relevant habitat and species chapters within this section of the Assessment. In addition, protected areas provide the cultural ecosystem services indicated below.

ECOSYSTEM SERVICES		
SERVICE TYPE	**BENEFITS PROVIDED**	**COMMENTARY**
Cultural	Tourism and recreation	Protected areas provide aesthetic, educational and spiritual benefits which can be enjoyed by visiting the site and through recreational activities.
	Wellbeing	There is a non-use value of particular relevance to protected sites whereby people value knowing that iconic species and habitats exist without necessarily using them and that they will be available to benefit future generations.[409]
	Research and knowledge systems	Studying the changes within Marine Protected Areas can increase our knowledge and understanding of the marine environment, the impact of human activities on it, and how best to protect our natural resources.
Supporting services underpin the provision of other services		Protected areas safeguard important habitats such as spawning and nursery grounds for various species of commercial value, such as *Nephrops*, scallops and gadoids. MPAs also have a role in supporting ecological connectivity and functioning within the CMR and across Scotland's seas.

409. Jobstvogt *et al*., 2014

5.10 Marine Non-Native species



Colours are explained in the key at the beginning of the document

KEY SUPPORTING EVIDENCE

SEPA Water Body data 2013, 2014 and 2015

Scotland's Marine Atlas score: 'Some concerns and stable'. Regional assessment includes water bodies at risk of deterioration and increase in number of species found.



Wireweed © CMPP

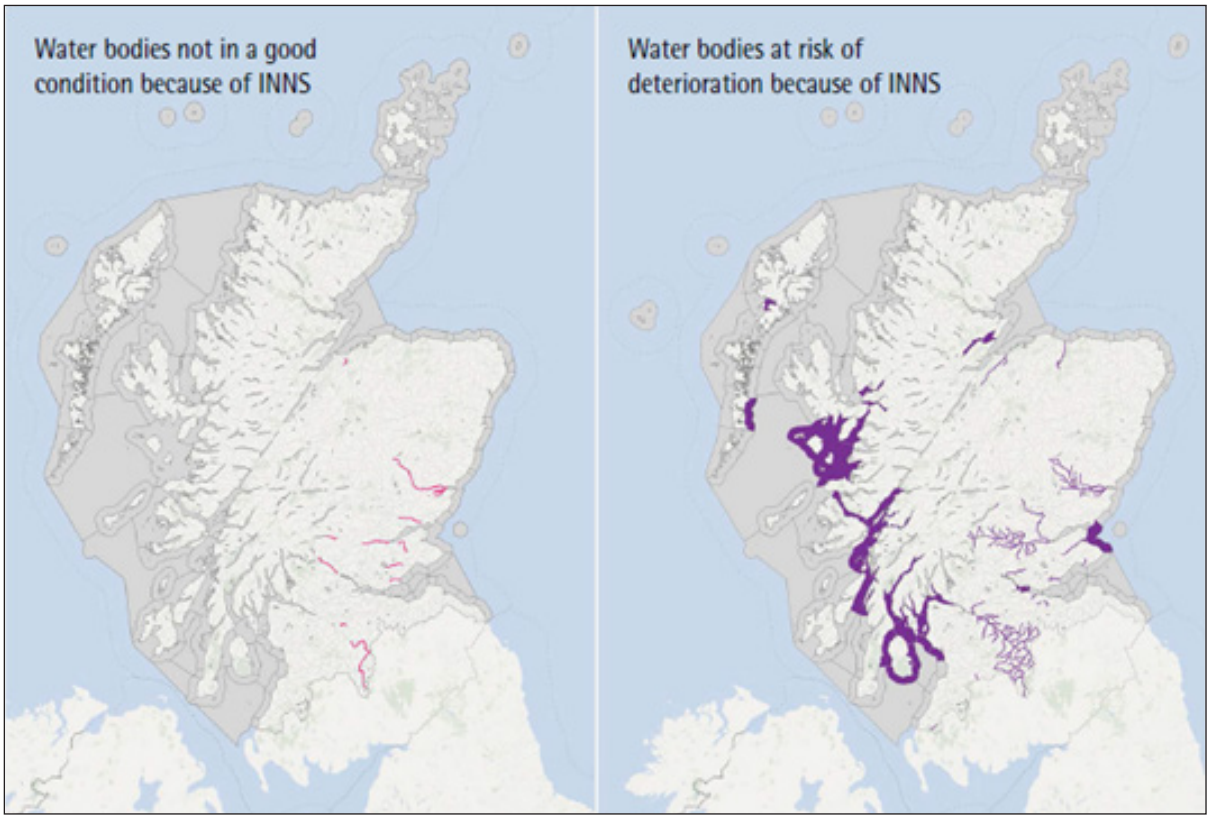
Introduction

Non-native species (NNS) are those that have been intentionally or unintentionally introduced outside their native range as a consequence of human activity. Once established, if these species then threaten biodiversity and/or cause economic damage they are referred to as 'invasive'. More than 90 marine NNS have been identified in British and Irish waters (including Republic of Ireland and Northern Ireland), of which 17 are now established in Scotland.[410, 411] Approximately 15% of NNS go on to become invasive (INNS). The classification of NNS as INNS is species and site specific.

Monitoring and status

The presence of a NNS can lead to the failure of a sea area to achieve Good Environmental Status (GEnvS) under Descriptor 2 of the EU Marine Strategy Framework Directive (MSFD). Under the Water Framework Directive (WFD) the presence of NNS can result in a water body not achieving Good Ecological Status (GEcS). In the River Basin Management Plan released by SEPA in 2015 18 water bodies around

Figure 5.22. Surface Water Bodies which are not in Good condition and Water bodies at risk from the spread of invasive non-native species



Source: SEPA, 2015

410. AquaNIS
411. Minchin *et al.*, 2013

Scotland were not achieving Good status because of NNS. None of the 18 areas are in the Clyde. However SEPA identify 150 areas which are at risk of failing due to NNS; 12 of which are in the Clyde Marine Region (CMR).[412]

The presence of NNS alone does not prevent a water body from achieving *Good* status. The NNS must have become established and be self-supporting before it is considered a high impact (i.e. invasive) species. For example a Chinese mitten crab (*Eriocheir sinensis*) shell was found in the inner CMR in 2015, this is a potentially highly invasive species, but has not resulted in the downgrading of the water body. The discovery of the shell was followed by a series of kick sample surveys which have, to date, not found an established population.

If NNS become invasive they can be very destructive to both the natural and manmade environment. In the correct conditions INNS can overwhelm, outcompete, consume or destroy indigenous wildlife. If a species becomes invasive this can be indicated by the development of a monoculture environment and changes to the local species profile. As they proliferate, depending on the characteristics of the species in question, they can also clog, smother, damage and disable machinery, water intakes other structures such as lock gates, pontoons, boat hulls and other under water structures.[413]

The estimated cost of INNS to the economy in Great Britain (GB) is £1.7bn a year, of which £245m is estimated to be attributable to Scotland. The annual cost to marine-based industries (e.g. shipping and aquaculture) in GB is estimated to be £39.9m (£7m for Scotland), although this is probably an underestimate, as there is little distinction made between native and NNS during pest control operations.[414]

NNS move via a number of pathways and vectors, including natural dispersal as well as on boat hulls and equipment and in ballast water or sediment. The aquaculture industry has tight biosecurity and animal health controls, which aim to limit the spread of NNS, however other industries are not so closely controlled. At present, there are significant risks from boat, equipment and stock movements. It should be noted that the problem of INNS is not just one of new species arriving in the UK but the UK also exports species which become INNS in other parts of the world.

NNS, once established, are very difficult to eradicate. They are also quick to exploit ecological niches which favour them if the ecosystem is degraded in any way. This is especially true in the marine environment where additional difficulties include identification, isolation of target species and control of spread.[415]

NNS – Policy and Legislation

In Scotland, amendments to Section 14 of the Wildlife and Countryside Act[416] and the accompanying Code of Practice on Non-Native Species[417] have significantly strengthened the law in relation to NNS. Two further offences have been added to the existing offence of releasing a non-native animal from captivity in the 1981 Act. The new offences are:

- allowing an animal to escape from captivity outwith its native range, and:
- causing an animal to be in a place outwith its native range.

The Scottish offences in relation to non-native plants and animals are 'strict liability offences' so knowledge, intention, recklessness or negligence do not have to be proved.

Two other significant Scottish legal drivers are:

- The Environmental Liability (Scotland) Regulations (SI 2009/226). These have established a civil law mechanism based upon the 'polluter pays' principle.[418]
- The Nature Conservation (Scotland) Act 200[419]

The MSFD and the WFD set a wider strategic and operational context for preventing the spread of NNS and their control. An EU Regulation on Invasive Alien Species has recently been published.[420, 421, 421]

In 2013, SEPA published a supplementary plan on managing invasive species in Scottish waters.[423] The plan describes the roles of organisations and partners involved in risk assessment, monitoring, classification, data collection, and prevention and control mechanisms.

Following the identified needs of marine industries, particularly marine tourism and recreation businesses, Scottish Natural Heritage published guidance in 2014 on how to construct a marine biosecurity plan for a site or operation based on the Code of Practice.[424] Marine Scotland are supportive of the biosecurity planning approach to risk management in the marine environment with regard to NNS and have also produced a Code of Conduct to accompany the revision of the WANE(S) Act. Marine Scotland leads on the enforcement of the WANE(S) Act, and as part of this work convenes the marine NNS working group which coordinates activity and shares information across relevant departments, organisations and agencies.

412. Scottish Environment Protection Agency, 2015b
413. Holt and Cordingley, 2011
414. Williams *et al.*, 2010
415. Cook *et al.*, 2016
416. Wildlife and Natural Environment (Scotland) Act, 2011
417. The Scottish Government, 2012a
418. The Environmental Liability (Scotland) Regulations, 2009
419. Nature Conservation (Scotland) Act, 2004
420. European Commission Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)
421. European Commission, 2016f
422. Council Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species.
423. Natural Scotland, 2013
424. Cook *et al.*, 2014

NNS in the Clyde Marine Region

The CMR is heavily used by commercial and recreational marine traffic and is an important focus for UK and international commercial shipping routes. Other recreational activities such as sea angling, scuba diving, sea kayaking, personal watercraft (also known as jet ski), wind and kite surfing are also growing in popularity. These activities increase the movement of boats and equipment in and out of the Clyde and therefore increase the possibility of introducing and spreading NNS. The GB non-native species secretariat, supported by The Green Blue, has an awareness raising campaign, 'Check Clean Dry' which targets this sector.

The CMR is also strategically placed as a hub for NNS with the Crinan and Forth and Clyde Canals offering short cut routes to new sites for infestation. However, it is also thought that the canals may offer some biosecurity protection as salt water species do not thrive in freshwater environments and may be killed by prolonged immersion in the canal system.

The CMR is now known to have 10 marine NNS and the arrival of other species already present in England, Wales and/or Ireland is likely. SEPA track and report on (via WFD water body status reports) a number of important INNS which are present in the Clyde, including leathery sea squirt (*Styela clava*), colonial tunicate/carpet sea squirt (*Didemnum vexillum*), Chinese mitten crab, wireweed (*Sargassum muticum*) and common cord-grass (*Spartina anglica*). Also present in the Clyde are a bryozoan (*Tricelleria inopinata*), a hydroid (*Cordylophora caspia*), the acorn barnacle (*Elminius modestus*), an orange sheath tunicate (*Botrylloides violaceus*), green sea fingers (*Codium fragile fragile*), Japanese skeleton shrimp (*Caprella mutica*) and orange tipped sea squirt (*Corella eumyota*).

The Firth of Clyde Forum produced a Biosecurity Plan for the Clyde area in 2011.[425] The Biosecurity Plan provides a platform for local action to address the issue of INNS. The Plan has a lifespan of five years and as part of an adaptive management cycle its outcomes and impacts will be monitored, reviewed and incorporated into the Clyde Regional Marine Plan. The outcomes to date include a series of workshop style training events, a range of publications for public and industry use and engagement with Marine Scotland's marine NNS working group. The Biosecurity Plan was also the starting point for the development of the Marine Biosecurity Planning Guidance, which was published in 2015 and has now been adopted by the statutory agencies across the UK.

Under the WFD 2013, SEPA included an assessment of NNS in water bodies for the first time. Eighteen water bodies within the CMR have recorded the presence of NNS (termed Alien Species in line with European documentation) as indicated in table 5.15 over.[426] It should be noted that where no NNS are recorded, but confidence levels are recorded as 'low', this should not be taken as confirmation of absence; this was demonstrated in the Inner Clyde Estuary where the recent discovery of Chinese mitten crab shell had been preceded by several years of 'low' confidence ratings. This is likely to be indicative of the capacity (both time and expertise) to undertake extensive surveys which are expensive and difficult to undertake effectively. The 2015 WFD classification results do not show any change of classification due to NNS when compared to 2014.

To date, the impact of NNS and INNS in the CMR has not been as catastrophic as once feared. For example, wireweed was once thought of as a high impact species of great concern due to its vigorous growth potential and fast spreading nature and its ability to clog machinery, including propellers. Now widespread in the Clyde, the impacts on biodiversity have not been as extreme as anticipated. In the Clyde ecosystem wireweed seems to have fulfilled some ecosystem services and not created areas of monoculture or negatively affected local species. By comparison, the carpet sea squirt, which is a more recent invader to the Clyde, and was first found in the Largs Channel in the CMR in 2010,[427] has been shown to have a negative impact on species diversity and abundance on the Georges Bank, northeast US and in the Netherlands and is of significant concern and the cause of several water bodies failing to achieve GEcS in those countries.[428, 429]

Wireweed remains a species of high interest to biologists and the agencies tracking marine NNS, as it is a useful indicator species, acting to highlight areas which are at risk from new and potentially invasive species.

It should be noted that, whilst not specifically marine, Japanese knotweed (*Fallopia japonica*) is spread by the sea along the Clyde coastline. In addition, American mink (*Neovison vison*) habitat is often alongside water bodies, including coasts, and this species has had a detrimental impact on some ground nesting birds and water voles (*Arvicola amphibius*).[430]

In the latest River Basin Management Plan, SEPA[431] states that it will undertake a number of strategies with regard to management of NNS:

'During the period 2015 to 2027, we will continue the approach developed over the period 2009 to 2015:

- *We will take a zero tolerance approach to actions that could result in introductions of invasive species.*

425. Mills, 2012b
426. Scottish environment Protection Agency, h
427. Beveridge *et al.*, 2011
428. Lengyel, 2009
429. Gittenberger, 2007
430. GB non-native species secretariat
431. Scottish Environment Protection Agency 2015a

- *Police Scotland will work with other public bodies to ensure legislation banning or restricting the possession, sale and release into the wild of invasive non-native species is rigorously enforced.*
- *Public bodies and non-government organisations will continue to work together to raise awareness of how invasive species can spread and the steps businesses and the public need to take to minimise risks using biosecurity measures.*
- *This will include developing further biosecurity plans, where appropriate.*
- *Public bodies, voluntary organisations and other institutions will work together to carry out and coordinate the monitoring needed to give us early warning of the first appearance of new invasive species, including encouraging help from businesses and the public.*
- *Where there are early warnings of the appearance of new species, we will take such rapid action as is feasible and proportionate to destroy or contain the species concerned before they can become established.*

Table 5.15. SEPA 2013/14 Water Body Classification data sheet information[432]

Surface water bodies are classified using a system of five quality classes – *High*, *Good*, *Moderate*, *Poor* and *Bad*
Note that results for 2015 are available and there is no change for NNS from the 2014 results.

WATER BODY TYPE	SUB BASIN	WATER BODY	Overall water body status /Status of NNS in that WB / Confidence Level regarding NNS status /INNS Species Identified (2013)	Overall status water body/Status of NNS/ Confidence Level (2014)
TRANSITIONAL	CLYDE	Ayr Estuary	Good / High / Low	Good / High / Low
		Ballantrae Lagoon North	High / High / Low	High / High / Low
		Ballantrae Lagoon South	High / High / Low	High / High / Low
		Clyde Estuary- Inner (incl. Cart)	Moderate / High / Low	Moderate / High / Low
		Clyde Estuary- Outer	Moderate / High / Low leathery sea squirt, colonial tunicate/carpet sea squirt	Moderate / High / Low
		Gare Loch	Good / High / Low leathery sea squirt, colonial tunicate/carpet sea squirt	Good / High / Low
		Girvan Estuary	Good / High / Low	Good / High / Low
		Garnock/Irvine Estuary	Good / High / Low	Good / High / Low
		Stinchar Estuary	Good / High / Low	Good / High / Low
COASTAL	CLYDE	Ayr Bay	Good / High / Low	Good / High / Low
		Ballantrae	Good / High / Low	Good / High / Low
		Culzean	Good / High / High	Good / High / High
		East Arran	Moderate / Good / Low leathery sea squirt, colonial tunicate/ carpet sea squirt	*Moderate / Good / High*
		Firth of Clyde inner- Dunoon and Wemyss Bay	Good / High / High leathery sea squirt, colonial tunicate/carpet sea squirt	*Good / High / High*
		Firth of Clyde inner- Cumbraes	Good / High / High leathery sea squirt, colonial tunicate/carpet sea squirt	*Good / High / High*
		Firth of Clyde Middle (offshore)	Moderate / High / Low	Moderate / High / Low
		Firth of Clyde Outer (offshore)	Good / High / Low	Good / High / Low
		Girvan	Good / High / Low	Good / High / Low
		Holy Loch	Good / High / Low	Good / High / Low
		Irvine Bay	Moderate / High / Low leathery sea squirt, colonial tunicate/carpet sea squirt	Moderate / High / Low
		Kyles of Bute	Good / High / Low leathery sea squirt, colonial tunicate/carpet sea squirt	Good / High / Low

432. Scottish Environment Protection Agency, F

WATER BODY TYPE	SUB BASIN	WATER BODY	Overall water body status /Status of NNS in that WB / Confidence Level regarding NNS status /INNS Species Identified (2013)	Overall status water body/Status of NNS/ Confidence Level (2014)
COASTAL	CLYDE	Largs Channel (Fairlie Roads)	Good / Good / High leathery sea squirt, colonial tunicate/carpet sea squirt	Good / Good / High
		Loch Goil	Moderate / High / Low	Moderate / High / Low
		Loch Striven	Good / High / Low leathery sea squirt, colonial tunicate/carpet sea squirt	Good / High / Low
		Rothesay	Good / High / Low leathery sea squirt, colonial tunicate/carpet sea squirt	Good / High / Low
		Seamill and Ardrossan	Moderate / Good / High common cord-grass, colonial tunicate/carpet sea squirt	Moderate / Good / High
		Sound of Bute	Moderate / High / High leathery sea squirt	Moderate / High / High
		South Arran	Good / High / Low leathery sea squirt	Good / High / Low
		Loch Long North	Moderate / High / Low	Moderate / High / Low
		Loch Long South	Moderate / High / Low	Moderate / High / Low
		Loch Riddon	Good / High / Low leathery sea squirt	Good / High / Low
	ARGYLL AND LOCHABER	Campbeltown Loch	Good / High / High	Good / High / High
		Kilbrannan Sound	Good / High / High leathery sea squirt, colonial tunicate/carpet sea squirt	Good / High / High
		Loch Fyne Middle	Good / High / High leathery sea squirt	Good / High / High
		Loch Fyne Outer	Good / High / High leathery sea squirt, colonial tunicate/carpet sea squirt	Good / High / High
		Loch Fyne Upper	Good / Good / High leathery sea squirt	Good / Good / High
		Mull of Kintyre-South East	Good / Good / High	Good / Good / High

- *We will work with government administrations across the UK to ensure action is taken to reduce the risk of introductions via ship ballast water, in line with protocols established by the International Maritime Organization.*
- *We will continue to support further research aimed at developing effective eradication methods.'*

UK and EU measures

The UK Government and the devolved administrations take the issue of marine NNS seriously and various task forces and working groups exist at a policy level. The Scottish Government hosts the Marine NNS working group, a group of experts who meet regularly to discuss action and policy with regard to marine NNS.

At a UK level, the Marine Pathways project was undertaken by statutory and non-statutory organisations within the UK and Ireland and contributed to the delivery of the Non-Indigenous species descriptor of the Marine Strategy Framework Directive (MSFD). The overall aim of the project is to protect marine biodiversity in the UK and Ireland by managing key pathways by which marine INNS are introduced and spread. Formal funding for the project ended in April 2015, although, the steering group remains in place and strategic work continues.[433]

The GB Secretariat for Non-Native Species is the co-ordinating body for action and policy on terrestrial, aquatic and marine NNS and the 2015 strategy builds on the work of the 2008 strategy and covers the whole of the UK.[434]

433. Great Britain non-native Species Secretariat, c
434. Great Britain Non-native Species Secretariat, a

ECOSYSTEM SERVICES[435]		
SERVICE TYPE	**BENEFITS PROVIDED**	**COMMENTARY**
Provisioning	Food (fish and shellfish	INNS may reduce an ecosystem's provisioning ability. Carpet sea squirt is present in the CMR and could impact aquaculture installations; however, there is no evidence of this currently.
Regulating	Clean and Safe waters	INNS may impinge on an ecosystem's ability to self-regulate.
Cultural	Tourism & Recreation Wellbeing	INNS can reduce the amenity value of an area and can have significant economic impact on the businesses affected.
Supporting services underpin the provision of other services		INNS reduce native species' ability to fulfil their role in the ecosystem. However it has been observed that some NNS have fulfilled some ecosystem roles in their new range. There is concern that wireweed may impact full ecosystem functioning on intertidal rock and sediments in the CMR, however, there is no evidence of this currently.

435. Marine Climate Change Impacts Partnership, 2015a