Rural Affairs, Islands and Natural Environment Committee

7th Meeting, 2022 (Session 6), Wednesday, 2 March

Subordinate legislation

1. This paper supports the Committee's initial consideration of the Sea Fish (Prohibition on Fishing) (Firth of Clyde) Order 2022 (SSI 2022/35).

Background

2. Since 2001, a specific area in the Firth of Clyde has been closed to fishing for 11 weeks each year, between 14th February and 30th April, to protect spawning cod. The closure is implemented by an SSI. The purpose of this closure is to protect cod from disturbance from fishing activity during spawning in order to promote stock recovery.

3. In previous years, the SSI provided exemptions for Nephrops (langoustine) trawlers, creels and scallop dredgers.

4. The Scottish Government laid the Sea Fish (Prohibited Methods of Fishing) (Firth of Clyde) Order 2021 (SSI 2021/467) on 10 December 2021. This SSI provided for the closure in 2022 and 2023, with the same exemptions in place as for previous years.

5. The Cabinet Secretary for Rural Affairs and Islands wrote to the Committee on 17 January 2022 to inform it that the 2021 Order was to be revoked and a further order would be laid in its place. The Cabinet Secretary wrote that—

   "upon further reflection, I believe that this approach is no longer appropriate. Despite the ongoing seasonal closure, the stock has shown little sign of recovery and as such the Scottish Government has removed the exemptions to maximise numbers."

6. The Scottish Government laid the Sea Fish (Prohibition on Fishing) (Firth of Clyde) Order 2022 (SSI 2022/5) on 13 January 2022. This SSI removed the exemptions for Nephrops (langoustine) trawlers, creels and scallop dredgers.

7. The Committee informally discussed the order at its meeting on 19 January and agreed to seek written comments and take oral evidence ahead of its consideration of the instrument. The call for views was opened on 19 January 2022.

8. The Cabinet Secretary for Rural Affairs and Islands wrote again to the Committee on 1 February 2022 to inform it that the 2022 order was to be revoked and a further order would be laid in its place. The Cabinet Secretary wrote that—

"following further discussions with scientists and stakeholders, we believe that it is necessary to make a further adjustment to the closure. In response to legitimate concerns raised by local fishermen, we have reviewed the available scientific evidence to reassure ourselves that this approach is the most appropriate and proportionate."

9. The Scottish Government laid the Sea Fish (Prohibition on Fishing) (Firth of Clyde) (No. 2) Order 2022 (SSI 2022/35) on 1 February 2022. In comparison with previous closures, the closure provided for by the No. 2 Order 2022 is smaller in size but removes all exemptions, meaning that fishing activity by any method would be prohibited during the ban.

10. The Committee informally discussed the order at its meeting on 19 January and agreed to extend its call for views and postpone its evidence taking.

The Sea Fish (Prohibition on Fishing) (Firth of Clyde) (No. 2) Order 2022 (SSI 2022/35)

11. SSI 2022.35 was laid on 1 February and the lead committee must report by 14 March 2022. The policy note for the instrument is provided at Annexe A.

12. The SSI came into effect on 12 February 2022, which breaches the 28-day rule between an SSI being laid and coming into force. The Cabinet Secretary wrote to the Presiding Officer to set out the reasons for the breach; this letter is provided at Annexe B.

Committee consideration

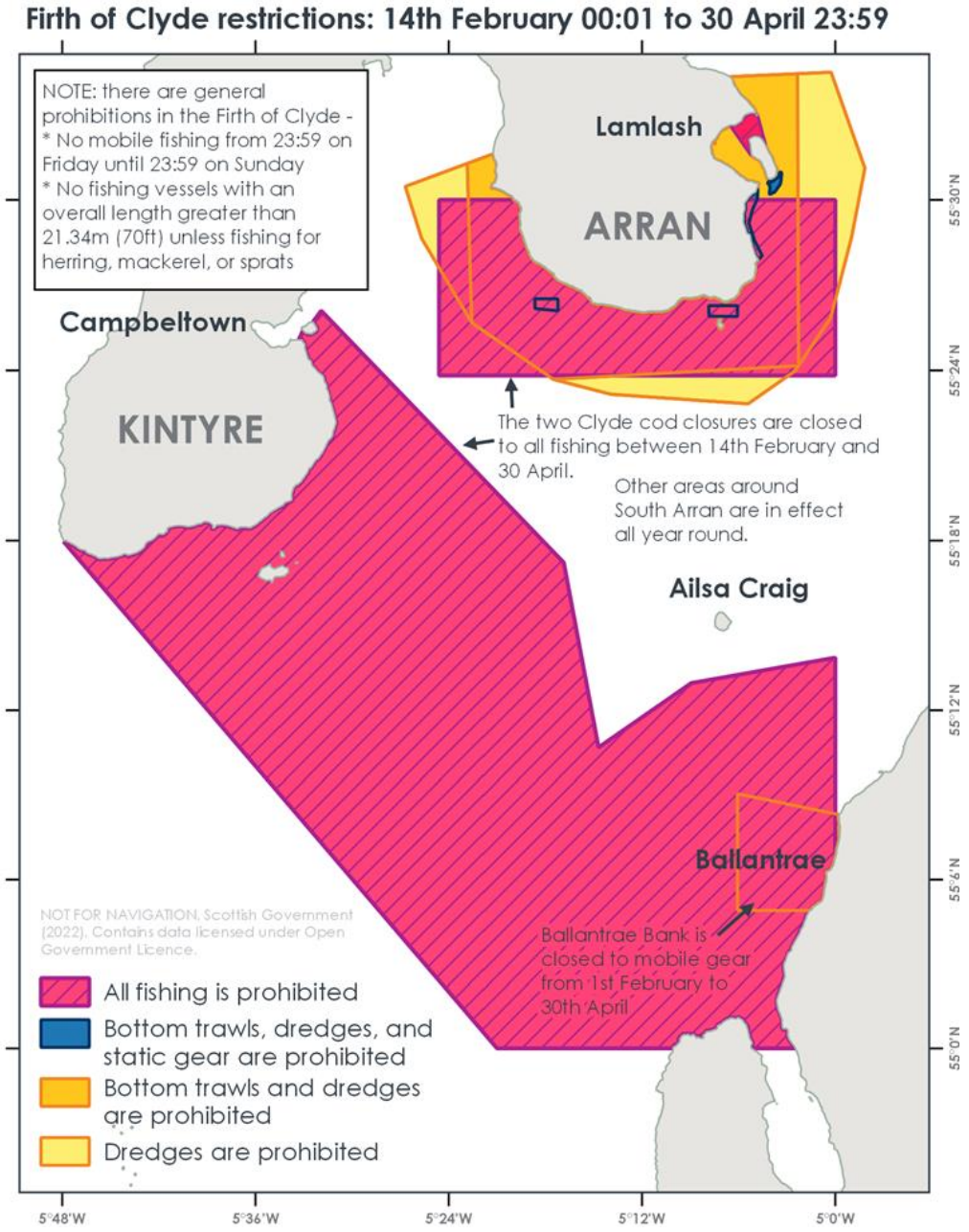
13. The Committee will take evidence from stakeholders at this meeting. At its meeting on 9 March, the Committee will take evidence from the Cabinet Secretary and will then formally consider the statutory instrument.

14. The call for views closed on 23 February and responses can be viewed here.

15. The response from the Marine Alliance or Science and Technology Scotland Fisheries Forum (MASTS FF), and the Clyde 2020 Research Advisory Group (C2020 RAG) provides an overview of current scientific knowledge on the status of Cod stocks in the Clyde and is provided at Annexe C.

16. Marine Scotland has produced some slides on the Clyde cod spawning closures 2022 and 2023 which set out the background to the SSI.

17. The following map shows the affected area and the fisheries management measures in place during the seasonal closure—



Source: Scottish Government

For action

18. **The Committee is invited to discuss the SSI with the three panels of witnesses.**

Rural Affairs, Islands and Natural Environment Committee clerks
February 2022

POLICY NOTE

The Sea Fish (Prohibition on Fishing) (Firth of Clyde) (No. 2) Order 2022

SSI 2022/35

1. This Order was made in exercise of the powers conferred by sections 5(1)(a), 15(3), 20(1), 22(2) and 22A of the Sea Fish (Conservation) Act 1967. The Order is subject to the negative procedure.

Purpose of the Instrument

2. To protect cod within two areas (detailed below) of the Firth of Clyde (a recognised spawning ground) from being fished or disturbed during the spawning period in 2022 and 2023. This is in response to the International Council for Exploration of the Sea (ICES) advice on the poor state of cod stocks in ICES area 6a (west of Scotland).

Policy objectives

3. The purpose of the Order is to protect cod stocks in the Firth of Clyde at a crucial time in their life cycle by prohibiting fishing effort during their spawning season. The Scottish Ministers make the Order in exercise of the powers conferred by sections 5(1)(a),15(3), 20(1), 22(2) and 22A of the Sea Fish (Conservation) Act 1967.

4. The Order prohibits fishing within two areas of the Firth of Clyde from 14 February until 30 April, in both 2022 and 2023. A prohibition on fishing covering a larger area in the Firth of Clyde has been in effect between 14 February and 30 April every year since 2001. In previous years, vessels fishing only with a scallop dredge, creels or a trawl used for fishing Norway lobsters were exempt from the prohibition on fishing.

5. The Order prohibits all fishing activity within two areas of the Firth of Clyde from 14 February until 30 April, in both 2022 and 2023.

Part 1 - North Area:

A	55° 30.000' N	005° 05.472' W
B	55° 30.000' N	005° 00.000' W
C	55° 23.820' N	005° 00.000' W
D	55° 23.820' N	005° 24.600' W
E	55° 30.000' N	005° 24.600' W
F	55° 30.000' N	005° 19.947' W

Part 2 – South Area:

A	55° 25.713' N	005° 32.426' W

B	55° 26.100' N	005° 31.920' W
C	55° 17.220' N	005° 16.860' W
D	55° 10.680' N	005° 14.700' W
E	55° 12.960' N	005° 08.940' W
F	55° 13.860' N	005° 00.000' W
G	55° 06.797' N	005° 00.000' W
H	55° 00.000' N	005° 02.496' W
I	55° 00.000' N	005° 05.170' W
J	55° 00.000' N	005° 10.120' W
K	55° 00.000' N	005° 21.000' W
L	55° 17.962' N	005° 47.914' W
M	55° 25.088' N	005° 33.303' W
N	55° 25.392' N	005° 33.065' W

6. In comparison with previous closures, the closure provided for by this Order is smaller in size. i.e. this is a more focused and targeted closure, with no exemptions, in order to increase the protection for spawning cod. The Order also revokes the Sea Fish (Prohibition on Fishing) (Firth of Clyde), Order 2022, the Sea Fish (Prohibited Methods of Fishing) (Firth of Clyde) Order 2021 and the Sea Fish (Prohibited Methods of Fishing) (Firth of Clyde) Order 2019.

7. The Order will apply to British fishing boats that fish in the relevant areas though, in effect, this means that the closure will apply to all fishing vessels and fishing activity as the areas fall within territorial waters.

Consultation

8. The Scottish Government consulted firstly with key stakeholders between 15 September and 13 October 2021 and then with the wider public between 20 October and 04 November 2021.

9. There were a total of 208 consultation responses, which have been published online where permission has been granted by the respondees. Almost all of the responses indicated that they were in favour of the closure continuing into 2022 and 2023. A high proportion of responses also called for some or all of the exemptions to be removed.

10. Provisions for such a closure have been implemented annually/biennially since 2001 and stakeholders have been consulted each time the closure has been renewed.

11. Prior to this Order being made, there was a further stakeholder meeting with key representatives from industry and environmental groups to discuss the shape, size and co-ordinates of the spawning cod fishing grounds. This gave participants a further opportunity to comment on the final closure areas.

Prohibition of all fishing activity within smaller areas

12. On 1 September 2021, the Scottish Government (SG) and the Scottish Green Party (SGP) published a shared policy programme, setting out areas of collaboration

over the current parliamentary term. The SG-SGP agreement is explicit in seeking to restore marine habitats in Scotland's inshore waters, with the aim of achieving good environmental status, recognising that those waters contain valuable blue carbon hot spots, nursery grounds for fish stocks and an array of rich marine wildlife and biodiversity. Furthermore, the SG-SGP agreement states it will provide additional environmental protection over and above the existing MPA network by establishing sites which will provide protection from all extractive, destructive or depositional activities, including all fisheries.

13. In addition, during the 2021 consultation, concerns were raised that the exemptions undermine the effectiveness of the closure. It would be contradictory to continue to implement exemptions in respect of gears that can catch cod whilst also causing environmental disturbance which will further impact on the success of the spawning cod. Any activity within the spawning grounds is understood to have an impact on the spawning cod, by making spawning more difficult.

14. Prohibition of all fishing activity will create consistency with fisheries management in other areas, namely the UK National North Sea Cod Avoidance Plan, which includes closure areas for all gear types (excluding pelagic), and the recent emergency Marine Protected Area (MPA) designation in certain areas of the Inner Sound, and related Marine Conservation Order, which includes prohibition on creeling in order to protect the critically endangered flapper skate nursery area.

15. The Scottish Government has therefore decided to implement a prohibition on all fishing activity for the closed areas in 2022 and 2023. The more targeted closure area allows vessels to continue fishing in some areas that were previously closed, without risking disturbance in areas where cod is more likely to be spawning. This closure will be subject to increased monitoring by Marine Scotland Compliance. We will continue to work closely with local stakeholders on the efficacy of this closure in achieving the stated policy objectives and will meet with representatives after the spawning season to discuss their experience of the closure.

Impact assessment

16. A Business and Regulatory Impact Assessment has been completed and is attached.

Financial effects

17. This Order has no bearing on quota, which remains unchanged, and the closure should not prevent skippers from catching their full quota over the duration of the year. At most, the proposed targeted closure may lead to a reduction in fish landings for its duration, and therefore may affect incomes on a temporary basis. The fishermen should not be financially disadvantaged overall. In addition, this closure should protect the stock so that in future years there is a benefit to all fishermen.

18. The Order will not give rise to further costs to the Scottish Government. Enforcement of this Order will be achieved by virtue of existing enforcement powers, implemented by Marine Scotland Compliance.

Letter from the Cabinet Secretary for Rural Affairs and Islands to the Presiding Officer, 1 February 2022

Since 2002, SSIs have provided for a closure in the Firth of Clyde to provide an area to protect cod during their spawning season (14 February – 30 April). Since its introduction, the closure has included exemptions to allow Nephrops trawlers, creels and scallop dredgers to continue to fish in the closure area, due to the low numbers of cod they catch.

The Sea Fish (Prohibited Methods of Fishing) (Firth of Clyde) Order 2021 was laid on 10 December 2021 with the exemptions in place for Nephrops trawlers, creels and scallop dredgers. The intention, at that time, was to review these exemptions in 2022.

However, upon reconsideration of the responses from the stakeholder consultation, the scientific evidence, the advantages of having a uniform approach with other sea fisheries management measures, and the precautionary principle we decided to revoke the Sea Fish (Prohibited Methods of Fishing) (Firth of Clyde) Order 2021 and replace it with the Sea Fish (Prohibition on Fishing) (Firth of Clyde) Order 2022 which provides for the same spawning closure areas but without any exemptions. The Sea Fish (Prohibition on Fishing) (Firth of Clyde) Order 2022 was laid on 13 January 2022.

Given the vulnerability of cod to any disturbance during the spawning season, we were of the view that the measures contained in this SSI would provide a higher chance of stock recovery and contribute to a more sustainable cod fishery in the West of Scotland in the medium-longer term. It would also create consistency with fisheries management in other respects, including the UK National North Sea Cod Avoidance Plan, which covers closure areas for all gear types (excluding pelagic), and the recent emergency Marine Protected Area (MPA) designation in the Inner Sound and the related Marine Conservation Order, which includes a prohibition on creeling in order to protect the critically endangered flapper skate nursery area. However, such an approach would clearly impact on fishers, even though the impact would be short term. Again, we reviewed the available scientific evidence to reassure ourselves that this approach was the most appropriate and proportionate. Following further discussions with scientists and stakeholders we believe that we can mitigate the impacts of the seasonal closure while maintaining the policy objective of protecting the spawning cod in the Firth of Clyde.

To that end, the Sea Fish (Prohibition On Fishing) (Firth Of Clyde) (No. 2) Order 2022 provides for reduced spawning closure areas without any exemptions. The provisions in this SSI take into account additional scientific and compliance-related data, particularly about the seabed and vessel activities, which means that we can be more precise in locating where the cod are spawning and identifying the habitats that could be used for spawning. This is a pragmatic and evidence-based solution to ensure that the spawning cod are protected whilst also mitigating the socio-economic impacts on our vulnerable coastal communities. Compared to the original closure with exemptions this provides for increased protection for spawning cod.

The Sea Fish (Prohibition on Fishing) (Firth Of Clyde) (No. 2) Order 2022, (SSI 2022/35) was made by the Scottish Ministers under sections 5(1)(a), 15(3), 20(1), 22(2) and 22A of the Sea Fish (Conservation) Act 1967 ("the 1967 Act") and laid before the Scottish Parliament today. The Sea Fish (Prohibition on Fishing) (Firth Of Clyde) (No. 2) Order 2022 comes into force on 12 February 2022.

Section 20(5) of the 1967 Act states that a statutory instrument containing an order made under section 5 of that Act shall be subject to the negative procedure.

Section 28(2) of the Interpretation and Legislative Reform (Scotland) Act 2010 sets out that a negative SSI must be laid before the Scottish Parliament at least 28 days before the instrument comes into force. On this occasion, this requirement has not been complied with and to meet the requirements of section 31(3) of that Act, this letter sets out the reasons why.

It is essential that the closure be in place when the spawning period begins on 14 February. To achieve this will mean that there is now insufficient time remaining to meet the 28-day requirement.

To ensure that the Sea Fish (Prohibited Methods of Fishing) (Firth Of Clyde) Order 2021 and the Sea Fish (Prohibition on Fishing) (Firth of Clyde) Order 2022 are revoked and, the Sea Fish (Prohibition on Fishing) (Firth of Clyde) (No. 2) Order 2022 is in place for the beginning of the spawining period, the Sea Fish (Prohibition on Fishing) (Firth of Clyde) (No. 2) Order 2022 must come into force on 12 February.

I appreciate that the process in this case has been far from ideal and that the revoking and replacing of the regulations takes up valuable parliamentary time and resource. This is not how I would have wanted this to happen. But it has been a complex issue to balance, and we will be looking to learn lessons from this. It is, however, important to remain flexible and responsive to new evidence, data and perspectives that emerge and to ensure that the approach we put in place to this closure achieves the right balance of objectives. We will continue to work closely with local stakeholders and their representatives this year to ensure that the closure continues to meet its intented policy purpose and will monitor its implementation.

I trust that this explanation will be sufficient to ensure Parliamentary support for this SSI to come into force on 12 February, i.e. in time for the spawning season. I and officials will of course be happy to continue to liaise with, provide evidence on and speak to the Sea Fish (Prohibition on Fishing) (Firth of Clyde) (No. 2) Order 2022 at the RAINE committee which had already been planned for the previous order. If your officials would like to discuss any matters arising from this order, government officials would also be happy to engage with them.

Response from the Marine Alliance or Science and Technology Scotland Fisheries Forum (MASTS FF), and the Clyde 2020 Research Advisory Group (C2020 RAG)

Response coordinator: Prof Michael Heath, University of Strathclyde, Department of Mathematics and Statistics (MASTS FF and C2020 RAG)

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Summary and Conclusions

- The limited evidence for the state of the Clyde cod stock indicates very low abundance, and there is no evidence of recovery. More formal information awaits the implementation of an analytical stock assessment (MSS/Univ Strathclyde).
- There is no evidence that after 20 years the existing cod box spawning closure has had any effect in promoting recovery of the stock.
- Any benefits arising from the extended justification for the cod box to include eliminating disturbance to mating behaviour are likely to be negligible and undetectable.
- The justification for excluding creels from the cod box is lacking.
- A possible reason for the in-effectiveness of the cod box is that it does not encompass sufficient of the spawning distribution of cod in the Clyde, although data on cod spawning sites is limited. There is no directed fishing on cod elsewhere in the Clyde from which to protect spawning aggregations. However, trawling and dredging activity in the complex topography of the inner Clyde and sea lochs could be interacting with local spawning aggregations.
- Discarded by-catch of cod in the Nephrops trawl fishery appears, on face value, to be a potentially significant factor that could be limiting recovery of the stock. Cod by-catch is a very small proportion of the Nephrops catch weight, but appears to be a potentially significant fraction of the cod stock biomass. Confirmation of this awaits results from the MSS/Univ Strathclyde stock assessment development.
- In addition, measures to protect and enhance inshore juvenile habitat for cod have the potential to enhance recruitment.

1. Background

Since 2001 a Scottish Statutory Instrument (SSI) has enabled a specific area of the Firth of Clyde to be closed to fishing for 11 weeks between 14th February and 30th April to protect spawning cod ("The 'cod box' closure). The purpose was to protect cod from capture during the period when they are aggregated for spawning and vulnerable to fishing gears.

In previous years, the SSI provided exemptions for Nephrops trawlers, creels and scallop dredgers since these gears were shown to catch very few, if any, mature cod.

The justification for the 2022 Order has been extended from simply preventing the capture of spawning cod, to also preventing their disturbance during mating and spawning. As a result, the exemption for Nephrops trawlers, creels and scallop dredgers has been removed.

The Scottish Government states that "despite the ongoing seasonal closure, the stock has shown little sign of recovery and as such the Scottish Government has removed the exemptions to maximise numbers."

On 24th January 2022, Marine Scotland proposed a change in the geographic limits of the 'cod box' to exclude muddy seabed types. It was suggested that cod do not undertake mating and spawning activity over muddy sediments, hence they could be excluded from the new SSI. Muddy seabed habitats are the primary areas for Nephrops trawling and creel fishing.

The change in justification and extent of the Clyde cod box closure SSI raises a number of issue, and demands an examination of its efficacy as a means to promote recovery of the Clyde cod stock.

2. What is the case for protect spawning aggregations of cod?

Fishermen have known for centuries that cod congregate every year in specific locations to mate and spawn. Extremely high densities of fish are found in these brief annual aggregations. This makes them highly vulnerable to capture by a range of fishing gears, including trawls, set nets and lines, during their spawning season. Fishermen may continue to maintain high catch rates in these aggregations even as the overall stock is shrinking, leading to false perceptions of the state of the stock. Prohibiting fishing during the spawning season when the fish are highly aggregated is therefore a means of mitigating over-exploitation, and offers some protection to the mature stock.

During the 1980s and 1990s there was an active light trawler fishery in the outer Firth of Clyde, which targeted historical aggregations of spawning cod on the Clyde Sill, between the Mull of Kintyre and Corsewall Point. As it became clear that the stock was declining, the "cod box closure" in 2001 was a sensible conservation measure.

3. Justification for the 2022 amended spawning closure, and the modification proposed by MS to exclude muddy seabed types.

Evidence for spawning behaviour of cod and the assertion that the passage of fishing gears may disturb their mating behaviour and prevent them spawning successfully is summarised at:

https://www.gov.scot/publications/cod-spawning-areas-research/

This summary is based in part on the work of González-Irusta and Wright (2016). The authors suggest that the passage of mobile fishing gears could reduce the egg production of cod by disturbing their behaviour, regardless of any actual capture.

No evidence is provided to suggest that deployment of creels is likely to disturb cod mating behaviour to any significant extent. Fish bycatch in Scottish lobster and crab creels is low, and lower still in Nephrops creels (Smith et al. 2010).

Maximising the egg production rate (eggs per tonne of stock) is intuitively a sound measure. The anticipation is that more eggs lead to greater subsequent recruitment of young-of-the-year fish to the stock, hence promoting stock recovery – though the report above stresses that this cannot be guaranteed.

The science behind the relationship between egg production and recruitment is clear - a doubling in egg production will on average lead to less than a doubling in recruitment. This is because a female cod lays up to 4 million eggs in a single spawning, and it takes only 2 of these to survive to the same age as the parents in order to maintain the stock. The vast majority are lost by predation and dispersal. Even small variations in these processes overwhelm variations in the number of eggs produced. Hence, while minimising the disturbance to mating cod seems a reasonable action in itself, it represents an inefficient measure for promoting stock recovery, with potentially a high social and economic impact on the fishing community.

Cod spawning areas are said to be identifiable by seabed sediment substrate type (preferentially coarse sand), with further requirements including high salinity, temperature in the range 5-7 °C, and low-to-moderate current flow. Hence, on face value the efforts by MS to adapt the cod box geography to exclude muddy areas, and hence limit the impact on Nephrops trawling, seems sensible. However, the evidence that cod spawning is concentrated over sand and gravel is based on a study in the North Sea (González-Irusta and Wright, 2016), and we cannot be sure that the same preference applies in the west of Scotland where the geography and sediment distribution is more complex..

4. Is the cod box likely to be an effective stock recovery measure in the long term?

4.1 Was the existing cod closure measure working?

There is no evidence that the Clyde spawning area protection established in 2001 has been effective. Collaborative work between the University of Glasgow and Marine Scotland Science (Clarke et al 2015), investigated trends in cod abundance over time in three cod sub-units on the Scottish west coast. Of these, only the Clyde sub-unit had been subjected to a spawning area protection.

If the Clyde spawning area protection had worked, we would have expected some change in the trend in cod biomass in the Clyde sub-unit, but not in the other two sub-units. No such effect was detected, leading us to conclude that the measure was not having the hoped-for effect. Speculation as to the reasons included that mortality and disturbance at other times or in other locations within the Clyde dominated any benefits from the spawning area protection.

4.2 What proportion of the Clyde cod stock spawns in the cod box?

The assumption underpinning the spawning protection measure is that the area enclosed by the cod box represents a significant fraction of the spawning area of Clyde cod. If not, the effectiveness is questionable.

There is little solid evidence for the distribution of cod spawning locations in the Clyde, but it is certainly not the case that spawning is confined to the cod box area. Much of the evidence originates from a PhD project (West, 1970). This study found that “in the Firth of Clyde cod roes have been taken in large quantities off the Heads of Ayr, south-west of Lady Isle, Girvan Bay, south of the Island of Arran (west of Pladda) and also from the Ailsa Craig fishing grounds.”

References within the above thesis also refer to cod eggs found in Loch Fyne in abundances indicative of spawning activity. Local fishers report cod spawning between St Catherine and Strachur in inner Loch Fyne, with larger cod present in the winter and juvenile cod in the summer. This area has been protected by a fishing closure due to MOD activity. Elsewhere in Loch Fyne, it is reported that areas of potentially suitable seabed habitat for cod spawning have been heavily disturbed by past trawling activity.

The only comprehensive spatial surveys of groundfish in the Clyde seem to have been carried out in November 1989 and December 1990 by the Marine Laboratory Aberdeen (now MSS). Data on the distributions of cod larger then 40cm (the mean length at maturity – Hunter et al. 2015) are shown in Figure 1. The survey timing precedes spawning by around 2-3 months, but probably give a rough idea of the general distribution of where mature cod might be spawning.

More recent surveying in the northern part of the Clyde in February 2014 by the Clyde Fishermen’s Association, University of St Andrews and MSS (Turrell et al.

2016), demonstrated the continuing existence of mature cod in Loch Fyne and to the northwest and northeast of Arran.

Despite the lack of recent survey data, it is clear that a high proportion of cod, perhaps the majority, do not spawn in the existing cod box, and are exposed to fishing disturbance especially in the northern Clyde (Figure 1).

It is also clear that any serious measure to protect cod spawning activity in the Clyde requires a concerted effort to establish where the remaining cod are to be found and where spawning activity is happening.

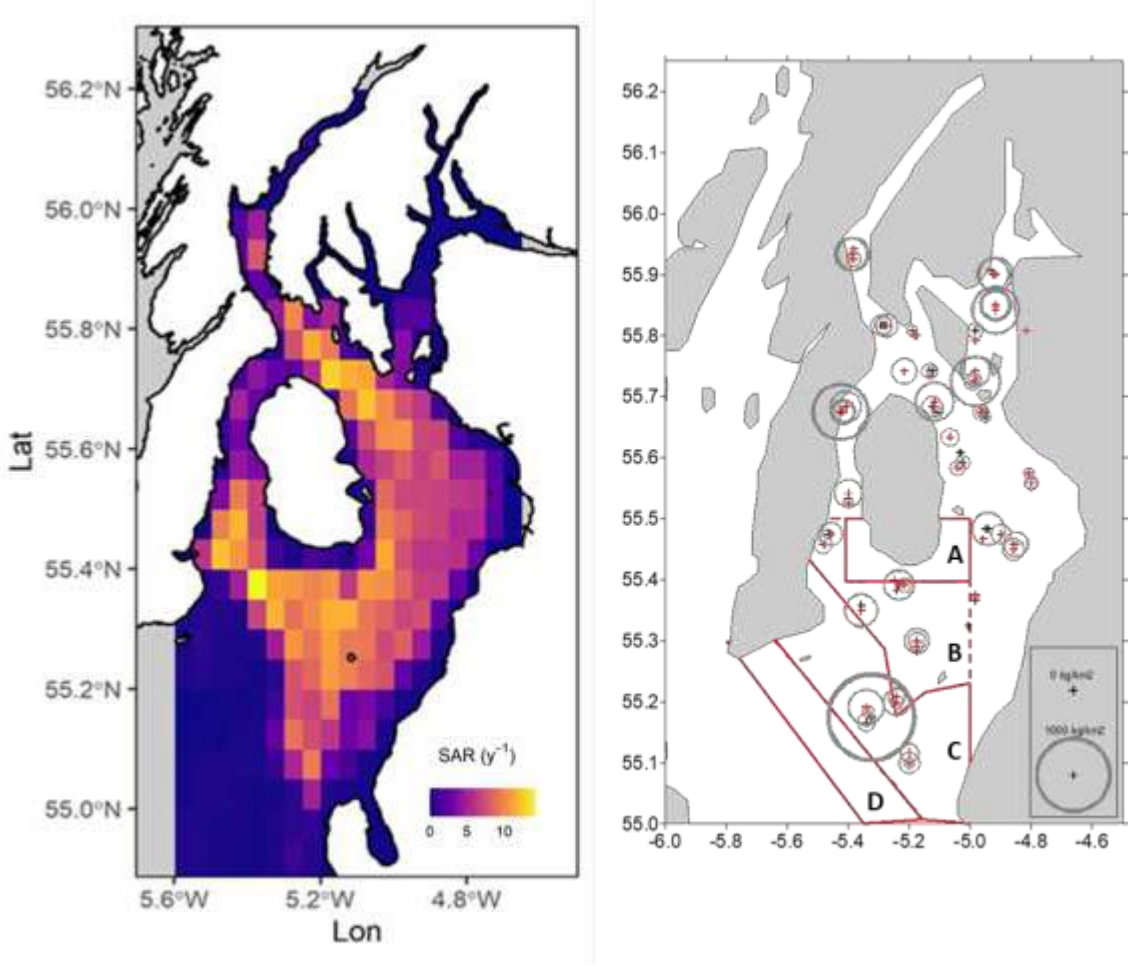

Figure 1. Left panel: Distribution of annual fishing intensity measured by the swept area ratio (SAR, proportion of seabed area swept per year by vessel greater than 12m - mainly Nephrops trawlers) calculated over a regular grid at a resolution of 0.05° x 0.05°, averaged for the years 2009 – 2016. Image from: Pace et al. 2021, based on data from ICES (2018). Right panel: Distributions of mature cod (larger than 40cm) in the Clyde during trawl surveys in November 1989 and December 1990 by the Marine Laboratory Aberdeen. Circles are scaled to the catch of cod per unit area swept by the gear (kg.km-2). Black crosses indicate the trawl sampling locations in 1989, red in 1990. Red boxes labelled A, B, C and D show configurations of the cod spawning closures. Under the original 2001 scheme, fishing except by scallop dredgers, creels and Nephrops trawlers was prohibited in area D, and all except scallop dredgers and creels in areas A, B and C combined. In the

initial version of the 2022 scheme, all fishing was prohibited in all areas. The Marine Scotland 24 January 2022 proposal allows any fishing in area B, which is identified as containing muddy sediments, while all fishing is prohibited in A, C and D. Survey data were included in the analysis of fish community length distributions reported by Heath and Speirs 2012.

4.3 What is the status of the Clyde cod stock?

There is no formal stock assessment for the Firth of Clyde cod stock. Until 2021, cod in the Clyde have been assessed as part of the wider west of Scotland cod stock. Any quotas for catching cod in the Clyde were subsumed into the wider west of Scotland quota, which limited the capacity to individually manage the Clyde cod stock.

In 2001 an ICES working group agreed to re-designate the cod stock units around the north of the UK, identifying the Clyde as a distinct unit. This represents an opportunity to develop a distinct management plan for cod in the Clyde. To this end, work is in progress at MSS and University of Strathclyde to develop a stock assessment model, but there is a severe lack of data.

The annual west of Scotland Bottom Trawl Survey carried out in March since 1985 has included a small number of hauls (maximum 4) each year in the four ICES statistical rectangles covering the Clyde. These data are shown in Figure 2. Unfortunately, the survey methodology was changed in 2011, so the time series is broken at that point. The absolute levels of the two series should not be compared. Nevertheless, just considering the period since 2011 there is no evidence of recovery, despite the deployment of the cod box measure, and a lack of any significant commercial landings from the fishery.

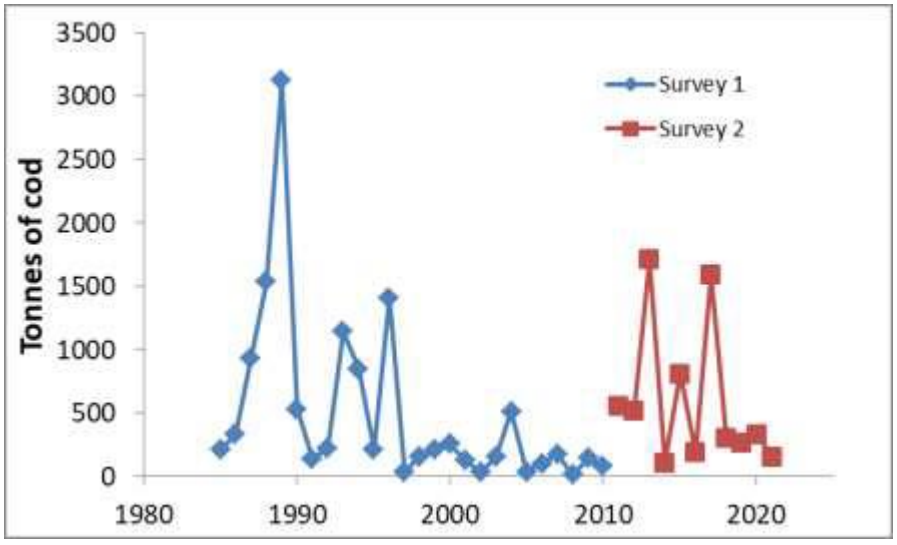

Figure 2. Raised swept-area estimates cod biomass estimated from the Marine Scotland west of Scotland Q1 survey hauls in the Clyde The numbers at length caught in each survey haul in the four ICES statistical rectangles covering the Firth of Clyde were converted to weight using standard weight-length relationships, then

to biomass per unit area swept by the wings of each trawl, and finally raised to the sea surface area of the four rectangles. This method produces an uncertain estimate of the tonnage of cod within the Clyde, since wing-spread describes the minimum capture width of the trawl track and other factors will affect the number caught (herding by the doors, vessel avoidance, and escapes above and below the trawl). The four statistical rectangles also cover more than the area of the Clyde which would contribute to a higher estimate than the true value. Survey data are openly available from the ICES website. The survey series is broken at 2011 due to a change in the survey design (duration of each haul, and locations of sample hauls).

4.4 Apart from spawning area protection, what other management measures could be deployed to facilitate recovery of the cod stock?

4.4.1 Cod by-catch in the Nephrops trawl fishery

There is currently no demersal trawl fishery targeting groundfish in the Clyde, and insignificant commercial landings of cod. However, there is a by-catch of cod in the Nephrops trawl fishery. Around 100 tonnes of juvenile cod are discarded per year in the Clyde (MSS data, average 2011-2017). This is a very small amount relative to the quantities of Nephrops caught (below 2%). But, it is not insignificant compared to the, albeit approximate, raised swept-area estimate cod biomass estimated from the west of Scotland Q1 survey hauls in the Clyde of around 250 tonnes (2018-2021) (see above). Hence, the implication is that the by-catch is potentially a significant source of fishing mortality on cod. We cannot yet answer the question of whether the Nephrops trawl by-catch of cod is limiting the recovery of the stock. But this will emerge in the coming 12 months from the MSS/Strathclyde stock assessment work

The spatial distribution of juvenile cod (smaller than 40cm) was concentrated in the northern half of the Clyde during the November/December 1989/1990 surveys, especially in the area northeast of Arran, where there is currently intense activity by Nephrops trawlers (Figure 3).

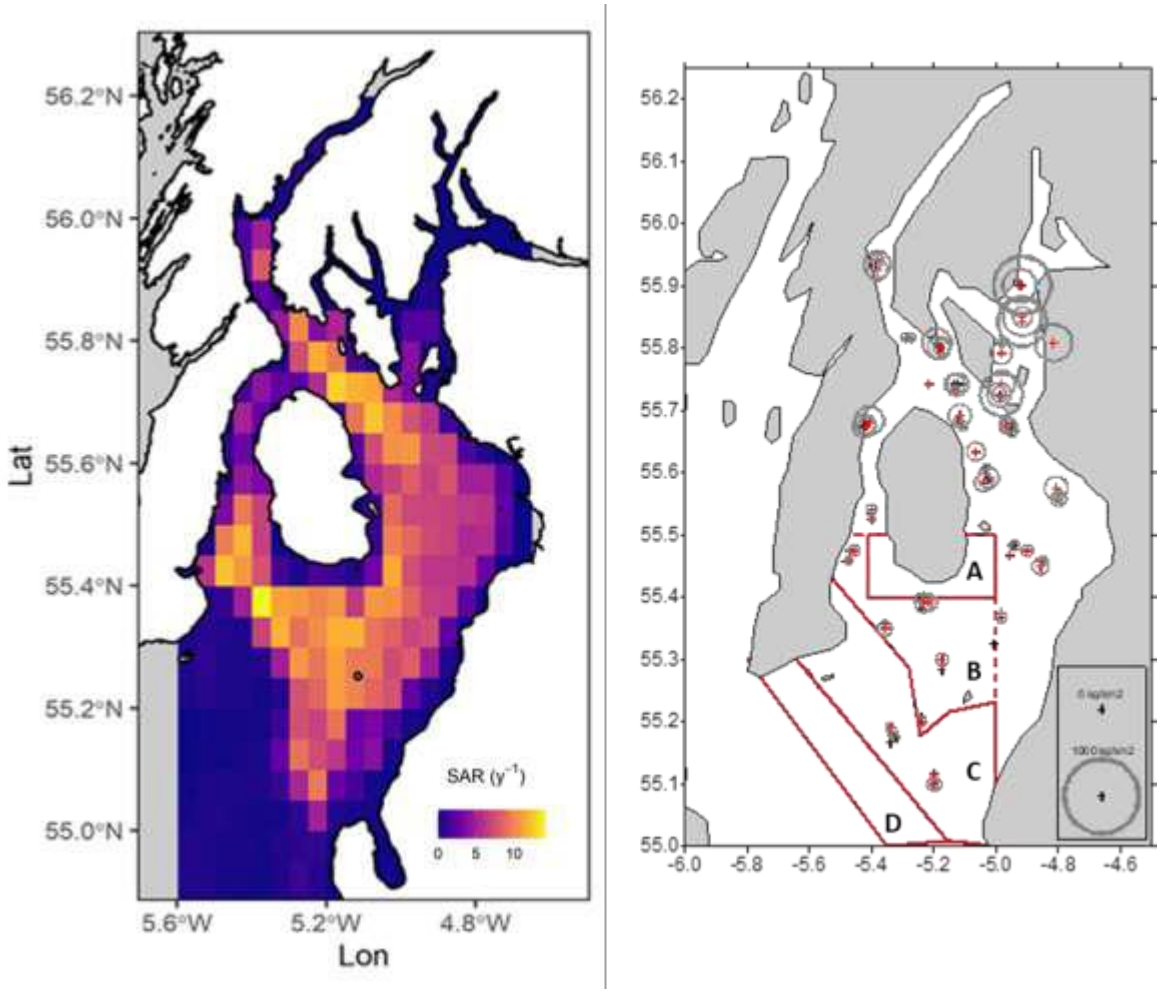

Figure 3. Left panel: Distribution of annual fishing intensity measured by the swept area ratio (SAR) as in Figure 1. Right panel: Distributions of juvenile cod (smaller than 40cm) in the Clyde during trawl surveys in November 1989 and December 1990 by the Marine laboratory Aberdeen. Circles are scaled to the catch of cod per unit area swept by the gear (kg.km-2). Other details as in Figure 1.

4.4.2 Inshore habitats as nursery areas for juvenile cod

We suspect that the cod box is likely to have a negligible effect on recruitment because variations in the survival of eggs and larvae have a much greater effect than variations in egg production - outlined above. Hence, it is worth considering if there are measures that could be taken to enhance juvenile survival. In fact, research by the University of Glasgow shows a clear association between inshore seagrass and complex rocky, gravelly seabed habitats sand the abundance and survival of juvenile cod (Elliott et al. 2018). The South Arran MPA and the Lamlash Bay no-take zone offer protection for these habitats from disturbance by fishing. However, we do not have a good overview of the full extent or locations of the key sites for juvenile cod in the Clyde.

5. Recommendations

- A coordinated effort is required to map the cod spawning distribution in the Clyde and nearby waters. Scotland could coordinate with efforts in Northern Ireland (AFBI Laboratory Belfast) to utilise commercial fishers' knowledge and echosounder data to gather data. This could be developed by partnerships between industry and scientists under current funding schemes. Echosounder data could also be gathered during any MSS surveys in the area (IBTS, Nephrops TV) to examine cod distribution at virtually no cost, as the device would merely need to be switched on and data recovered at the end of each trip. Processing could take place at MASTS HEIs via MSc or BSc projects.
- Implement the stock assessment model being developed at MSS and Univ Strathclyde. This will enable development of a management plan for cod in the Clyde and an assessment of the role, if any, of by-catch fishing mortality in the Nephrops trawl fishery in limiting stock recovery.
- Map inshore juvenile habitat in the Clyde, with a view to protecting or artificially enhancing these habitats to increase juvenile survival.

References

Clarke, J., Bailey, D.M. and Wright, P.J. (2015). Evaluating the effectiveness of a seasonal spawning area closure, ICES Journal of Marine Science, 72, 2627–2637, https://doi.org/10.1093/icesjms/fsv144

Elliott, S.A.M., Allan, B., Turrell, W.R., Heath, M.R. and Bailey, D.M. (2018). Survival of the fittest: explanations for gadoid imbalance in heavily fished seas. Aquatic Conservation 28, 1192-1199.

González-Irusta, J.M. and Wright, P.J. (2016). Spawning grounds of Atlantic cod (Gadus morhua) in the North Sea. ICES Journal of Marine Science, 73(2), 304– 315. doi:10.1093/icesjms/fsv180
Heath, M.R. and Speirs, D.C. (2012). Changes in species diversity and size composition in the Firth of Clyde demersal fish community, 1927-2009. Proceedings of the Royal Society B. 279, 543–552.

Hunter, A., Speirs, D.C. & Heath, M.R. 2015. Fishery-induced changes to age and length dependent maturation schedules of three demersal fish species in the Firth of Clyde. Fisheries Research, 170, 14-23.

CES. 2018. OSPAR request on the production of spatial data layers of fishing intensity/pressure. ICES Technical Service. sr.2018.14 https://doi.org/10.17895/ices.data.4686

Pace, M.C., Bailey, D.M., Donnan, D.W., Narayanaswamy, B.E., Smith, H.J., Speirs, D.C., Turrell, W.R. & Heath, M.R. (2021). Modelling seabed sediment physical properties and organic matter content in the Firth of Clyde. Earth Systems Science Data 13, 5847–5866, https://doi.org/10.5194/essd-13-5847-2021

Smith, P., Burrett, I., Bailey, D., Neat, F. Donnan, D, Dunlop, K., Thorburn, J., Milligan, R., Bastiman, S. and Dodds, J. (2010). Development and Evaluation of Methods for Surveying Fish Populations in Nearshore Waters. Scottish Industry Science Partnership Report : i-iv, 1 -50. https://core.ac.uk/download/pdf/215343247.pdf

Turrell, W.R., Gibson, P., McAllister, G. and Bailey, N. (2016). Investigation of Reports of Semi-Pelagic White Fish in the Clyde. Marine Scotland Science Report 01/16, 88pp.

West, W.Q.B. (1970). The spawning biology and fecundity of cod in Scottish waters. PhD Thesis. University of Aberdeen.
https://abdn.alma.exlibrisgroup.com/discovery/delivery/44ABE_INST:44ABE_VU1/12153399930005941