REPORT
North Sea Fisheries and Climate Change Webinar

Meeting: North Sea Fisheries and Climate Change Webinar
Parties: NSAC members
Date: 7 December 2022
Time: 10:00 CET
Location: Zoom
Chair: Alexandre Philippe
Rapporteur: Sara Mynott

Table of Contents

1. Introduction: overview of Climate Change Focus Group objectives & EU policies

Alexandra Philippe, the Chair of the NSAC Climate Change Focus Group opened the webinar and thanked all attendees for participating alongside the important fishing negotiation meetings taking place the same week. She thanked presenters for joining and noted that a broad range of speakers will be contributing to the discussion. She then provided an overview of the session, highlighting that the aim was to gather information on the intersection between change and North Sea fisheries, and produce advice for the Commission on this basis.

To introduce the session, Philippe provided background to the NSAC and the NSAC Climate Change Focus Group (FG). She highlighted the NSAC's role in providing advice to the Commission and shared that the FG was developed in 2022. Philippe outlined that the Climate Change FG aimed to work on all issues relating to climate change that fall within the NSAC's remit, including blue food, decarbonisation and the impacts of climate change on the fishing sector. She noted that the group first focussed on decarbonisation, in response to the call for advice on alternative energy sources for fishing and aquaculture. Now, though, the FG aims to issue more comprehensive advice covering a wider range of issues related to climate change.

Phillipe shared that the changing climate is increasingly discussed in European and international fora, and that the ocean-climate nexus was discussed in COP26 and is expected in the Convention on Biodiversity (CBD) negotiations that were also taking place. Phillipe noted the Green Deal will have impacts on the marine environment and on fisheries resources – including the biodiversity strategy and the natural restoration law that sits under this. She noted that further legislation is anticipated to be published early in the new year. Phillipe shared that there are also many questions regarding energy resilience, the energy transition and blue food.

Introducing the agenda, Philippe noted that there were some changes as the European Commission were not able to present at this time. She thanked presenters again for their participation and initiated the webinar by introducing the first panel, to consist of Mark Dickey-Collas of the International Council for Exploration of the Seas (ICES), Grégory Beaugrand of Lille University, and Michael Andersen of Danish Fishers Producer Organisation (DFPO).

2. Climate change impact on fisheries in the North Sea

2.1 Effects of climate change on fish stock migration in the North Sea and implications for management – Mark Dickey-Collas, ICES

Dickey-Collas opened his presentation by stating the importance of the social-ecological system in the context of fisheries, and emphasised that the whole system, inclusive of all social and ecological elements, is being impacted by climate change. Dickey-Collas provided a brief overview of these impacts, noting that the ecological parts of the system are being affected by climate change drivers, with wide-ranging impacts across different temporal and spatial scales. He also noted that the social parts of the system are being affected by climate change – from governance and management through to culture, economics, and technology.

Dickey-Collas highlighted that there are three different approaches to climate change available: (1) carbon mitigation to reduce the likelihood and/or severity of the effects of climate change; (2) the adaptation of processes or behaviours to reduce impact of climate change, and (3) both mitigation and adaptation, combined.

Dickey-Collas shared that the main ways that fish stocks are impacted are through changes in productivity, distribution, or both. He noted that productivity can become very high as well as very low under the impacts of climate change. Dickey-Collas emphasised that changes in stock distribution (range), have huge governance consequences, given that stocks may move between Exclusive Economic Zones and management regions. He highlighted that the impacts of climate change are occurring over different temporal and spatial scales, and that flexibility in management doesn't yet exist at these same scales.

Presenting on work from ICES, Dickey-Collas showed that boreal (northerly, colder water) species were being replaced by Lusitanian (southerly, warmer water) species. He highlighted a map that revealed that Lusitanian species were becoming more dominant in both the southern and northern North Sea and the Skagerrak and Kattegat, with only the central North Sea retaining the boreal mix of species, drawing on results published by Baudron et al. (2020).

Dickey-Collas then provided a number of examples, drawing on EU projects, such as CERES and CLIMFISH, that highlight the impacts of climate change on fish stocks. He noted the following findings from one model: (1) there will be little change to horse mackerel and sprat abundance; (2) cod, mackerel, flatfish and gadoids will experience substantial declines in abundance; (3) the abundance of anchovy sardine and red mullet will also decline and (4) there will be pronounced declines in herring abundance. However, he cautioned that the assumptions of this particular CERES model should be questioned, so the findings presented should be taken with caution.

Dickey-Collas highlighted that low-likelihood, high-impact events (such as the sudden disappearance of a stock or large-scale impacts as a result of a prolonged heatwave) haven't occurred yet in the North Sea. He noted that while this was positive, the absence of extreme events can push climate change further down the policy agenda.

Also drawing on the work of the CERES project, Dickey-Collas illustrated the impacts of climate change on coastal communities. He highlighted that impacts on fish stocks have repercussions for fishing communities, and that there are particularly vulnerable communities in the North Sea, as highlighted in research by Payne et al. (2021). Dickey-Collas noted the importance of considering how climate change impacts the risks of achieving Ecosystem-Based Fisheries Management (EBFM), particularly in the context of the following three objectives:

1. **The ability to achieve**, which encompasses processes, governance, institutional drivers and external drivers.
2. **Ecological wellbeing**, inclusive of species, ecosystems and habitats.
3. **Human wellbeing**, inclusive of social, economic and cultural factors, like safety, secure livelihoods, food and nutrition, security, health, and equity.

Dickey-Collas highlighted that measures to mitigate carbon, such as the development of wind farms for renewable energy, are impacting fishers. He also highlighted that these measures

are affecting scientists – who are being excluded from wind farm development sites. He noted that this impacts the veracity of the long-term datasets that are used in fisheries science.

Dickey-Collas stated that resilient fisheries are a common goal for many stakeholders. To achieve this, he shared that that in addition to healthy stocks and limited environmental impacts, there is a need for on flexible governance and management, drawing on work by Mason et al. (2021). He focused on the need for well-developed participatory mechanisms that are flexible and inclusive. He noted that a report on this topic, produced by the workshop 'WKCLIMAD', was forthcoming. The workshop explored actionable strategies and approaches that could support advice for fisheries management. Dickey-Collas highlighted that it is important assess the risks (the magnitude and likelihood of change) and see how that impacts all parts of the sector, from fisheries and fisheries governance structures to the supply chain and the market. He shared that climate mitigation and adaptation measures impact the risk profile and should also be considered.

On management, Dickey Collas noted that, when considering the management of a fishery in a social-ecological context, it is important to evaluate the risks and measures across ecological, social, economic and governance components. He highlighted the need for precaution, particularly when there is a lot of uncertainty/it is not possible to evaluate the situation. Dickey-Collas stated that governance structures in Europe are less responsive to change than other systems and that this presents a challenge in the context of climate change. He queried whether current governance systems are sufficiently flexible before summarising core messages for the audience.

Dickey-Collas summarised in four key points: (1) change as a result of the changing climate is happening and will continue to happen; (2) the risk to communities varies regionally; (3) governance and management is currently rigid, but a flexible approach would better tackle challenges presented by climate change, and (4) that any reform must cross jurisdictions and account for impacts in the wider system.

2.2 The influence of fishing and climate on North Sea cod stocks: a view from FishClim (Beaugrand G, Balembois A, Kléparski L, Kirby RR) – Grégory Beaugrand, Laboratory of Oceanography and Geosciences, Lille University

Beaugrand thanked the NSAC for the opportunity to present. He began by highlighting that there is substantial evidence for fishing and climate change having both strong and widespread impacts on species, before moving to discuss the outcomes of modelling work on this topic. Beaugrand noted that it is difficult to separate the impact of climate and fishing on fish stocks and – as a result – fisheries have not been included in most climate models. He then provided an overview of FishClim, a model that aims to address this through incorporation of both climate and fisheries. The model, which aims to be straightforward to use and widely applicable, predicts changes in species populations and distribution patterns over time.

Beaugrand presented a map showing maximum spawning stock biomass (SSB), determined only by the environment without taking into account the influence of fishing, which showed that maximum SSB is higher with increases in latitude. He then showed results of climate and fishing together, noting that fishing always has a negative impact on SSB. He shared that 55%

of the variation in SSB between 1960 and 2018 can be attributed to the impacts of fishing, while climate can explain the remaining 45% of SSB variation.

Beaugrand then presented a key paper that considered the issue from the perspective of management, showing how SSB varies spatially with climate and fisheries considerations.
A plot showed that in climate-induced poor environmental conditions, fishing has a limited additional impact on the stock because climate impacts have already reduced SSB to a low level, while in healthy environmental conditions, fisheries can deplete stocks rapidly if poorly managed. He used this to identify a range of scenarios over which: (a) a favourable climate means that fisheries management is possible and encouraged; (b) fishers should be warned of poor stock condition and vulnerabilities to fishing intensity; and (c) where there is a critical situation in which the stock is depleted and unsuitable for fishing due to poor environmental conditions.

Beaugrand showed how adjusting fisheries management to the climate regime can help enable the exploitation of stocks for longer – for two decades or further still. The difference in pooled catch over these years can be as much as 30% or even more at the peripheries of the North Sea.

He concluded with the following points:

1. A principal UN Sustainable Development Goal involves sustainable management of fish stocks.
2. There is a need to urgently and explicitly consider the impacts of rapid climate change in the context of fisheries management. Incorporating climate considerations within fisheries management will allow stocks to be exploited for longer and optimise pooled catch.
3. There is a need to recognise that some stocks will disappear under climate change, regardless of fishing effort. It is possible to anticipate stock disappearance and the establishment of new stocks.
4. The FishClim model can be applied to many stocks for which there is sufficient data.

2.3 Sector observations concerning fish migration and management: opportunities for industry-science collaboration – Michael Andersen, DFPO, Chair of Landing Obligation Focus Group

Michael Andersen thanked Philippe. He noted that fishing affects the climate through both emissions and resuspension of sediment, while the climate affects fishing through changing fish distribution and growth, runoff into marine waters, and ocean acidification. Andersen said that while climate should be accounted for in fisheries management, currently it is not.

He pointed out that associated carbon emissions per kilo of protein of landed seafood is lower than most animal proteins, meaning fishing's climate impact is 'something we can work with' in terms of ensuring future food security while keeping carbon emissions to a minimum.

On this topic, Andersen said that the Common Fisheries Policy (CFP) has made fisheries less efficient over decades through closures, a preference for small-scale fisheries, and technical regulations. He highlighted that all of these changes lead to greater fuel consumption. On resuspension of sediment through trawling, he noted that this releases carbon dioxide to the sea and to the atmosphere, but this process is poorly understood and disputed among

scientists. He reiterated that every food production method has a carbon footprint, and that the footprint generated by fisheries is relatively low.

Andersen drew reference to changes in species distribution, including the northward movement of cod and halibut. While some species of fish are moving out of areas of fishing and management interest, new species - such as bass, squid, mullet, and anchovy - are moving in. He noted this is a slow process, and that many of these species may have existed there for some time, but the population is slowly increasing as species move poleward. He added that the fishing industry is 'fond of' relative stability as a method for quota distribution, given it enables fishers to hold fishing rights for traditional fishing grounds, but the future appropriateness of this method will need to be considered in light of range shifts.

Andersen highlighted that the climate affects stock size, with cod being a notable example. A new reference point was introduced for cod in 2021, a possible 'new normal' trend for cod. Fishers, on the other hand, query whether management ambitions are unrealistic. From fishers' perspectives, they are being 'hit on both sides' by climate change, through inefficient fisheries that require more fuel expenditure, and inefficient management measures with demands that are difficult to deliver. He said that to have true EBFM, there needs to be an openness to new or more flexible approaches, such as industry input into scientific advice.

Philippe thanked Andersen for his presentation, noting the links to other presentations shared. She highlighted the importance of trade-offs, the dependency of fuels and the impact of CO_2 emissions, which were discussed in more detail later in the session. She noted the need to consider relative stability and the challenges around this approach, and that this could align with the assessment of the CFP.

2.4 Discussion on the impacts of climate change on fisheries in the North Sea

One attendee asked whether it is correct that the effects of climate change are primarily on small animals, such as plankton, and target species for fisheries follow their food northward in response to these changes. Andersen responded that it is a matter of cause and effect, as changes in small animal distributions will affect animals further up the food chain. Dickey-Collas noted that this is not the only mechanism, citing the example of anchovy, which die in the winter if they have not grown to a sufficient size, or if the winter is too cold; likewise, cold winters kill sole too. This illustrates there are direct impacts on target species. Beaugrand stated that the effects of climate change are very complex, with impacts occurring across the whole ecosystem and involving many interactions between species. He added that there are also direct effects on target species through effects on metabolism as well as the food web.

An attendee asked whether a maximum sustainable yield (MSY) approach to quota setting is appropriate under climate change, and what was known about anticipated biological changes. Mark Dickey-Collas said that there is insufficient information to understand the impacts of following MSY under climate change in the North Sea and was unaware of any work taking place in this specific region, although he knew of equivalent work being undertaken in the Celtic Sea. Beaugrand said there is a need to assess MSY year on year in response to climate change, as well as to adapt fisheries management accordingly. Regarding biological knowledge, he said there is a plankton index that reveals that larval cod survival is highly correlated with planktonic changes in the North Sea.

An attendee asked whether FishClim is applicable to all stocks including those that are highly migratory, and whether FishClim could be used to integrate climate models and fish stock evolution models. Beaugrand confirmed that he believed it could in the future, depending on the level of acceptance from the scientific community. He shared that a PhD position, using FishClim to analyse cod stocks in the north Atlantic, is beginning. He believed FishClim could be used for any stock with sufficient biological and ecological data available. Beaugrand highlighted that FishClim also incorporates environmental variables such as temperature and bathymetry, and future versions of the model could incorporate additional variables.

A question was asked about whether an increased rollout of MPAs could reduce the effects of climate change on fish stocks, by providing areas of reduced stress to increase the ability of marine organisms to adapt. Andersen replied that the effect on the fishery will depend on where the MPAs are situated. If they are placed in areas for good fishing, then the displacement effect will have a negative impact through the usage of more fuel in less efficient areas. He said he could not speculate whether MPAs would allow species to adapt, but that the fisheries industry sees current MPAs as having a net negative effect on climate change due to displacement and introduction of inefficiencies.

Philippe thanked attendees for their questions and noted that there would not be time to answer all of them in the session. She highlighted that climate change and climate impacts need to be accounted for in fisheries management frameworks.

3. Fisheries role in climate change: North Sea perspective

3.1 Good fisheries management is good carbon management - Rebecca Hubbard, Our Fish

Hubbard noted that her expertise is not in the North Sea, but the issue is being examined broadly and there would be lessons to share from this broad context. She noted the need for everyone to do everything possible to avert the climate crisis. Hubbard stated that the most important action is to reduce CO_2 emissions and that EBFM is an important part of the suite of actions needed.

She gave context on the ocean as a 'life giver' in producing approximately 50% of global oxygen, absorbing 93% of global heat, and storing 30% of the world's sequestered carbon. She referred to fish as the 'lifeblood' and noted that diverse populations (types, ages, structures, etc.) are essential.

Hubbard presented a graphic illustrating the biological pump – the system that moves energy and carbon through the ocean system. She noted it was a new and exciting part of scientific research and that knowledge on how the system works is rapidly growing, including the role of fish. Fish contribute to 16% of the total ocean carbon flux. Hubbard highlighted that fishing's impacts on ocean carbon are not just through impacts on the seabed, but also through extraction of fish from that system. She stated that fish are carbon engineers, helping to move carbon up and down the water column and that the carbon pumping capacity of whales alone has been valued at around 1 trillion dollars in terms of ecosystem services offered.

Hubbard said that fishing is identified by the Intergovernmental Science-Policy Platform on Biodiversity and ecosystem services (IPBES) as the most significant impact of any human

activity on ocean biodiversity, which in turn impacts fishers' catches and related socioeconomics, the biological pump, and the ocean's capacity to mitigate climate change. From 1950 to 2014, a 2020 study has calculated that fishing has extracted an estimated 318.4 million metric tons of large fish, resulting in the direct emission of around 165 million tons of carbon from fuel combustion, plus 37.5 million tons of carbon through fish consumption and processing. Hubbard shared that the quantity of extracted blue carbon is estimated at around 40 million tons, and around 22 million tons of carbon that would otherwise have been sequestered. She noted that current annual extraction of all fish is around 80 million tons worldwide and this has almost halved the biogeochemical capacity of fish over the last century.

Hubbard noted that the scale of carbon release through bottom trawling was an area in need of investigation, though it is known that it involves the resuspension of large amounts of sediment. Whether or not this carbon returns to the atmosphere, even its entry into the water column will have a negative impact (such as via ocean acidification). Hubbard highlighted that the top layer of sediment has been identified as a globally significant carbon store. She said the northeast Atlantic was an area of intense fishing and high carbon richness; more work is needed to understand carbon fluxes and stores, but the quantities involved are large and should be managed. The EU fishing fleet is estimated to produce 7 million tonnes of carbon dioxide annually.

A 2022 paper from Cheung et al., currently in press, highlights the impact of climate on the capacity to restore biomass. Hubbard said there is a range in the possible extremity of impact on fisheries, but impact is high even in low-emissions scenarios; even a best-case scenario, with 1.5 °C of warming and conservation-focused fisheries management, will still see stock biomass at around two-thirds of pre-industrial level.

Hubbard summarised why 'good fisheries management is good carbon management' in that it: (1) protects/increases fishes' status as carbon engineers, and builds resilience; (2) protects food webs and the biological pump; (3) avoids habitat disturbance and destruction (including carbon-rich habitats); (4) decreases CO_2 emissions, and (5) increases CO_2 sequestration.

Hubbard proposed five approaches for modifying fisheries management within the existing framework. These included: (1) setting fishing limits below MSY or precautionary advice and rebuild fish populations to B_{MSY}; (2) assessing and managing the climate and ecosystem impacts of fishing to protect food webs, habitats, carbon stores, and ecosystem functioning; (3) implementing Article 17 to incentivise transitions to low-impact, low-carbon fishing; (4) recognising fisheries management as carbon management, including in nations' Nationally Determined Contributions (NDCs), and (5) ending the subsidisation of fuel tax.

3.2 Constraints and trade-offs in the climate impact of fisheries - Giovanni Codotto, Aalborg University

Codotto noted that the project he was presenting on was in its early stages, and that further work would take place over the next three years. The focus of the project presented was on life cycle assessment (LCA), in particular the demand for sustainable food products from consumers, to include seafood. He explained that LCA accounts for all material and energy inputs into a product throughout its life cycle. Codotto shared that LCAs are challenging, given

they require large volumes of data, and need to account for uncertainty and variability. He added that LCA models can be designed specific to the relevant supply chain.

Codotto said that while global volumes landed from marine capture fisheries have plateaued, consumption of fish per capita has increased. Model outcomes indicate that this increasing demand can be better met through aquaculture. While current LCA approaches take a retrospective approach – tracing back the impact of a product – he shared that this project will take a prospective approach, to predict the impacts of increasing demand for a product. Codotto also noted challenges around this, such as difficulties in establishing clear cause-and-effect relationships, the inclusion of subjective judgements, and questions around substitution (e.g. aquaculture for wild fish).

The first objective of the project is to develop methods that accurately assess the climate impacts of fisheries, taking into account constraints in supply, as well as calculating projected impacts of increasing demand for specific seafood products. Codottto shared that the project will focus on sustainable practices and labelling, highlighting that indicators of climate impacts are often not used in labelling schemes. He said the project aims to assess whether sustainable fishing and climate considerations are in conflict or aligned.

The second objective of the project is to assess climate vs marine environment labelling. This will involve analysis of sustainable practices and eco-labels' requirements and to what degree they incorporate climate considerations. Codotto noted that the project will also identify the trade-offs between sustainable fisheries practices and reduction of carbon emissions.

Codotto shared that the expected outcomes of the project are to: (1) produce an evidence-based LCA model; (2) identify climate-friendly fishing practices, gears, and labels; (3) contribute to the green transition of fisheries to inform current fisheries policies, practice, and labelling, and (4) advise consumption in the direction of climate change mitigation.

Codotto concluded by saying that the team aimed to better understand carbon dynamics involved to inform future policies and advice, to include approaches to influence and enable consumer behaviour towards buying more sustainable products.

Philippe thanked Codotto for his presentation. Given time constraints, questions and answers would be given in writing. She noted that insight into evidence-based modifications that reduce the climate impact of fishing practices is much appreciated.

Philippe introduced Kenn Skau Fischer of the DFPO.

3.3 Sector efforts in ensuring compatibility of fisheries production with conservation objectives - Kenn Skau Fischer, DFPO and NSAC

Skau Fischer began with the core message that the contribution of fisheries to climate change is limited, but the climate has a significant impact on fisheries, echoing points made earlier in the webinar. He added that a greening of the fisheries sector will be necessary for its 'licence to operate' but time is needed for this transition.

Skau Fischer drew on the example of the Danish fishing industry, which has over 800 vessels fishing in the waters around Denmark and in the north Atlantic. He provided further context,

sharing that while many vessels are under 20 years old, many are older, and the average age of skippers is over 50. Skau Fischer stated that fisheries are highly regulated and restricted, and are subject to increasing spatial squeeze. He added that these restrictions are not just for environmental protection, but also are in place owing to other marine activities, such as offshore wind, pipelines, or military activities.

The Danish government has introduced a 'green tax' that will come into effect in 2025, which will impact many sectors including fishing. He noted that its aim is to reduce greenhouse gas emissions by 70%, which is more ambitious than the EU's overall target. Since 1992, the Danish fishing industry has reduced its CO_2 emissions by 62%, and currently accounts for 0.4% of Denmark's total CO_2 emissions. Skau Fischer underscored that the tax's impact on total emissions of the fishing fleet would be limited, but that it would impact people significantly, making a third of the fleet unprofitable and impacting small and medium-sized vessels and businesses the most.

Skau Fischer said that it will be cheaper for many fishers to pay the green tax than to pay for more climate-friendly solutions, because, at present, such solutions don't exist for the fishing sector or are in development. Skau Fischer shared that 350 million Danish Krone (47 million EUR) will be returned to the sector to fund projects that facilitate the green transition.

Skau Fischer also listed a range of approaches detailed in the NSAC advice on decarbonisation. He said there was a challenge in the coming years to find ways to reduce fuel consumption, with current options not being sufficient to facilitate a rapid transition.

Philippe thanked Skau Fischer for his presentation. She noted the contrasting points raised by the panel and said that the broad array of regulatory measures imposed can lead to a lack of clarity over ultimate goals and benefits. She highlighted that the trade-offs in approaches – in particular reducing fuel consumption versus paying tax – were of particular interest.

3.4 Discussion

An attendee asked how sedimentation and resuspension affects primary production, and noted that other industries such as offshore wind also affect these processes. Hubbard referenced a paper by Bradshaw et al. which investigates how trawling impacts sedimentation and has knock-on effects on biochemistry. The study estimated that 500 tonnes of sediment per km are displaced by a 36m-wide trawl track. Hubbard noted that this changes the water chemistry, through release of ammonia, nitrates, and so on. She said that there is also damage to the ecosystem, and she noted potential conflicts with the MSFD and Good Environmental Status goals. Hubbard added that the impacts of bottom towed gear include damage to the seabed, shifts towards a greater abundance of smaller and faster-growing species, fewer larger and longer-lived species, and increases in scavenger species. Skau Fischer queried whether this study related to the North Sea. Hubbard answered that the values would vary with location but that ecological impacts remain widespread. Andersen added that sediment spread is extremely dependent on particle size and currents, so there is a need to consider these results in a context that is location specific.

An attendee asked about the prospective approach used in the LCA study, and how future energy developments can be integrated into new practices – for instance, possible replacement of old vessels with more energy-efficient practices. On the first question, Codotto

answered that assessment of fishing practices needs a large quantity for data, especially for consumption; this is possible for current practices but not for future technologies, which will require the modelling of future scenarios including other sectors such as aquaculture.

Another attendee asked whether the LCA study will consider land-based substitution for protein and micronutrients. Codotto affirmed that some substitutions will likely be included, given consumers are likely to turn towards land-based protein sources if there are constraints on supply of marine capture fisheries.

4. Reconciling sovereign food supply with nature conservation

Philippe introduced the final panel for the day, noting that the trade-off between sovereign food supply and nature conservation, and how this feeds into management measures under consideration by the Commission. She noted that the advice produced by the Climate Change Focus Group will consider the role of blue food as a low-carbon source of animal protein as it can have an important role in a number of Sustainable Development Goals, if efficient and sustainable fisheries management can be secured.

4.1 Resilience of the EU common fisheries policy towards climate change and fuel efficiency (CINEA study) - Francois Bastardie, DTU Aqua

Bastardie introduced his presentation on a set of published studies that have been used in a report delivered to the Commission. He described the challenge of fishing as a variable and uncertain occupation, and the interest of fishing businesses in securing a more stable and improved income. Additionally, climate change affects marine ecosystems and fish stock populations, which in turn can lead to unsatisfactory outcomes with fisheries management if it does not account for these changes. He said that a precautionary approach is needed to address this issue; in the North Sea, this would involve fishing in the lower range of MSY.

Bastardie noted the need to recognise ‘decarbonisation win-wins’, where fishing less could mean earning more - for instance, lower fishing effort or larger mesh sizes use less fuel. Through respecting sensitive species and habitats through an ecosystem approach, radical tipping points can be avoided. He said that it is time to phase out less effective fishing techniques and focus on the co-benefits of more effective techniques. Bastardie highlighted that there is also the need to limit the suspected impacts of fishing on blue carbon habitats, such as trawling disturbing marine sediments. He added that, overall, co-benefits to the fisheries economy include saving on operating costs, higher prices for larger fish, and support for biodiversity.

The project aimed to identify win-win fishing strategies that spend less fuel but obtain the same quota, to build resilience to climate change. Models involving simulated ‘shocks’ looked across management, economic, and environmental impacts, and associated resilience. Bastardie provided an overview of plausible scenarios and the number of factors to be considered within them, inclusive of environmental effects, future climate, and socio-economic context.

This led to ten core lessons, of which Bastardie described three:

1. Healthy and well-assessed stocks are resilient to short-term stress, as seen in the recovery of North Sea cod. This leads to the recommendation of following low MSY and regular revision of biological reference points.

2. Many technologies exist to reduce fuel use in fisheries, but they are not yet implemented. This includes retrofitting vessels, changing gears, and switching fishing strategies to reduce fuel consumption. For instance, the trawl fisheries of the North Sea switched strategies in response to the 2008 fuel crisis through actions such as reducing contact between the trawl and seafloor, which brings co-benefits of reducing fuel use and limiting negative impacts to the seabed. He recommended that actions such as these are taken.
3. Management should anticipate and respond to changes with adaptive, flexible approach. Bastardie recommended that key allocations should be revised to align fishing opportunities with shifting stocks and stock assemblages.

Bastardie concluded with a suggested road map for the EU for climate-aware fisheries. He noted that there is a need to think ahead in terms of meeting strong policy commitments to reduce energy usage, while aiming to make energy costs more affordable and for the sector to be carbon neutral by 2050.

Bastardie underscored that uptake of energy-efficient solutions by the fishing industry has been low to date. Addressing this involves improving knowledge transfer and implementation, removing regulatory barriers, reducing costs for transition, and finding solutions for inertia. He stated that there is a need to change mindsets to encourage uptake of solutions, which includes giving incentives, training for new practices or technologies, and avoiding fuel tax subsidies. Bastardie added that there should be caution around the 'rebound' effect, which could see vessels spending more time at sea if they have implemented fuel-saving methods. He noted that there is a need to overall reduce fishing effort.

Additionally, Bastardie shared that consumers and retailers should be given 'scores' for fisheries, depending on sustainability criteria that are inclusive of the carbon footprint. Related to this, he indicated that there is a need for increased knowledge on fuel use now and in the future, through fuel-monitoring tools onboard vessels and associated monitoring programmes.

4.2 NSAC Advice on decarbonisation of fishing fleet - Alexandra Philippe, NSAC

Philippe presented the NSAC advice on decarbonisation of the fishing fleet, which had been submitted to the Commission and North Sea Member States on 19 October 2022. This represented the first piece of advice from the Climate Change FG. She noted the aim was to respond to the Commission's request for stakeholder feedback on the energy transition and that the call for evidence closed on 5 December 2022.

The objectives were as follows: (1) to understand the EU framework on energy transition and the related initiatives with a focus on blue sectors; (2) provide a state-of-play update on research, knowledge, and ongoing projects relating to the decarbonisation of the maritime sectors, particularly the fishery sector; (3) tackle the issues of alternatives to fossil fuels and energy efficiency for the fisheries sector, and (4) provide information on the different funding possibilities for the fisheries sector to transition.

Philippe invited attendees to look at the advice on the NSAC website and noted the range of data sources used to form the advice. She drew attention to a number of challenges in her slides and spoke to some key themes, in particular that technologies are costly and not yet adapted to fisheries, and that funding for adaptation is limited. She noted that some options

also have other negative impacts, such as the toxic effects to fish when using ammonia as a fuel.

Philippe identified the following opportunities related to decarbonisation of the fishing fleet: (1) reducing dependency on fossil fuels; (2) reducing operating costs of vessels; (3) investing in energy efficiency, so facilitating scaling up of new technologies, and (4) reducing carbon footprints of fishing products, to help reach climate objectives.

Lastly, Philippe showed the recommendations outlined in the advice and focused on the need for stakeholder buy-in, not only informing them of opportunities but also consulting them in the development of technologies and approaches. Philippe underscored the need for realistic objectives and making funding available to support industry members. She stated that guidelines would be valuable to inform such a transition. She invited participants to read the advice and thanked them for their participation in the webinar.

Philippe then handed to Guus Pastoor of AIPCE to share his concluding remarks.

4.3 Discussion

All further questions were answered in writing following the event. The anonymised questions, and responses to them, are provided below:

'Do you take into account in your calculations the potential of fish to replace red meat for human consumption if you propose measures that lead in the end to less landings?'

Response from Francois Bastardie: Yes, studies show that land-based animal proteins (chicken, lamb, beef) are (much) more fuel intense than fishing products (for most of them). It does not mean there is no gain and only loss of opportunities at increasing gear mesh sizes (fisheries for small pelagics put aside), and that expanding the mesh sizes will decrease landings mechanically as, on the contrary, the (demersal) fish stocks' productivity will improve. As a general rule, we know (see STECF 21-07 report) that improving gear selectivity is beneficial for most stocks when larger, more fecund fish are left in the sea for enough time to let them grow and mature and for making bigger catches soon later. Hence, some fishers might experience lower catch rates from using more selective gears but will gain alongside stock recovery no long after (of course, the problem is to ensure they will be the ones benefiting from this effect). As a win-win, towing larger mesh gears also consume less fuel in absolute just by reducing the hydrodynamical drag effect (the net itself explains most of the fuel consumed towing a gear as the water resistance is proportional to the number of meshes per metre squared).

'Should we anticipate the disappearance of cod in the southern North Sea (and Channel / Celtic Sea) or can we still manage it to recovery?'

Response from Michael Andersen: I do not think that it is realistic to recover cod in the Southern areas with the present climatic (as well as other environmental) factors prevailing. This will hopefully also be realised at the upcoming benchmark an Northern Shelf cod in ICES in February. Let us see – hope to see you there!

Response from Gregory Beaugrand: I think we should indeed expect the disappearance of cod from the southern part of the North Sea (and especially in the Channel and Celtic Sea). However, if we implement the climatic regime into fish management, we can delay stock disappearance and optimise pooled catch. Cod management in these regions (and especially in the Channel and Celtic Sea) is limited because the stock is low and the maximum SSB (with no fishing) is also very weak due to warming. We should keep in mind that the exact timing of cod disappearance will depend upon the intensity of warming and fishing.

'You mentioned the need to include climate considerations into management plans, but what we see happening is countries fighting for shares and access year after year, instead of focusing on such long-term management plans. Stocks like mackerel or North Sea herring are examples of this. It seems we are losing precious time. What is your view of this?'

Response from Michael Andersen: I have heard about the attempts to establish record on certain stocks from some countries through questionable activities. I find this understandable although perhaps not very civil. I do not know what you mean by losing precious time. My remarks on inclusion of climate in management plans and scientific assessments does not(necessarily) have any effects on quota sharing. I am just trying to say that if our only ambition is to meet conditions that are not possible with the present environmental conditions, then we will be permanently in a crisis which perhaps is speculative more than real. If climate prevents cod from recovering to historic levels, then this needs to be incorporated in the management plans.

'How much of the total catches are used for other purposes than direct human consumption e.g. as feed to fish farms?'

Response from Giovanni Codotto: If we consider on the marine fish capture (in 2018), globally the amount landed was 84.4 million tonnes and the amount used for industrial uses was 22.2 million tonnes so around 26%. (Source FAO, 2020, page 3). I am not sure if it is in the same source as I cannot find it again but use of industrial fish for feed should be around 80% I think.

'Is there any knowledge on the extent of the contribution of fisheries displacement due to MPAs to climate change (in increase of CO_2 emissions)?'

Response from Rebecca Hubbard: From the literature that I have read about increasing fish populations and decreasing overfishing (which is what a large amount of literature says highly protected MPAs do for many fish populations), MPAs could actually decrease CO_2 emissions as a result of there being more fish and fishers having a lower CPUE.

'An angling observation. We used to have huge commercial but also recreational cod fisheries in the North Sea. Now for anglers, seabass is much more important. We also see a strong increase of squid in the North Sea but to my best information anglers can't fish for those as this requires multiple hooks that are currently prohibited. This also ties into the need expressed earlier to reassess fisheries management.'

Response from the Commission: This reassessment of fisheries management (measures) takes place already within the Common Fisheries Policy framework regarding recreational fisheries and commercial fisheries. The Commission is aware and concerned that recreational

fisheries can have an impact on the state of some stocks. This is the case, for example, for Baltic cod, European sea bass or European eel, where, in some instances recreational catches are more important than the commercial ones. The Commission is monitoring the situation closely and proposes measures for recreational fisheries on a case-by-case basis, as was the case for recreational catches of sea bass and European eel (Council Regulation (EU) 2021/92 of 28 January 2021 fixing for 2021 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters). This has also been done with the fishing opportunities of 2023 to which an agreement was reached last week with the co-legislators.

In order for the Commission to (re)assess the impact of recreational fishing on specific stocks and to set appropriate measures, we rely heavily on reliable and uniform data collection. The obligation to provide data on recreational fisheries for some stocks is within the Data Collection Framework – and the financial support of the European Maritime Fisheries and Aquaculture fund makes recreational fishers eligible for support insofar as their projects help achieve the funds' objectives.

5. Concluding remarks by NSAC Chair – Guus Pastoor, AIPCE

Pastoor concluded the webinar by highlighting the key points shared in each panel. He stated that the global demand for seafood is increasing, and this puts pressure on the system, including the North Sea. Pastoor highlighted that there is a need to regulate actions in order to address and respond to the challenges of climate change. He added that this will not be easy.

Reflecting on the presentations, he noted that we are all in a period of change and that there is a need to increase precaution. He highlighted that climate change needs to be included in fisheries models, and there is a need for a precautionary approach.

Pastor noted that the CFP has directed fisheries to less efficient approaches, which does not align with the need to be more fuel efficient. He added that time is needed to adjust and transform the sector. He noted that the advice by the NSAC Climate Change Focus Group was a useful resource and encouraged attendees to make use of it.

Continuing his reflection on the presentations shared, he highlighted that fisheries are important in nature, with this in mind, good fisheries management is good carbon management. He emphasised that the impacts of climate change on fisheries are significant, despite the relatively limited contribution of fisheries to the problem.

On management, Pastoor highlighted that a 'one-size-fits-all approach' would not be appropriate and underscored the need for tailored solutions. He stated that both science and stakeholder input are needed, together, to craft policies that are fit for purpose. He also noted that there was also a need to revisit the concept of relative stability.

Pastoor emphasised that everyone is looking for win-wins: to fish in a clever way, by shifting approaches and techniques, and shifting our mindset. He concluded by thanking all for their contributions, particularly Talevska and Philippe for their role in organising the workshop.