Considerations for developing criteria to assess
the compatibility of fisheries and fishing with climate mitigation and resilience goals

Developed by the Climate Bonds Initiative with input from the Marine Technical Working Group
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Executive Summary

The Climate Bonds Initiative (CBI) has sought to develop screening criteria for green bond investments in aquaculture and capture fishing in the marine environment. With the help of a Marine Technical Working Group (TWG), the work explored key climate and environmental issues in the sector. The TWG wrestled with identifying usable, ambitious and scientifically grounded criteria to screen for appropriate climate mitigation and climate adaptation and resilience performance in the sector. As a result, work has been halted because the GHG impact of capture fishing is still relatively poorly understood, and subsequently there are few indications of what constitutes best practice in the sector in respect of GHG emissions from which to set appropriate screening criteria. This paper summarises the work undertaken and findings to date in order that: (1) Either when sufficient data and understanding is available on GHG thresholds or benchmarks in fishing operations or when bond market demand increases for criteria, the lessons learned through this work can provide a foundation for the future development of screening criteria for the sector; and: (2) Existing certification schemes and other initiatives in the fisheries sector build on this work to incorporate climate aspects into their own standards. Overall, CBI recommends a concerted push to better understand the climate impacts of fisheries and fishing operations and where key mitigation opportunities lie. CBI recognises that the fishery sector faces unique and complex sustainability challenges which interact with such climate impacts. Such work thus needs to include academia, public policy institutions and industry.

Introduction

Climate Bonds Initiative (CBI) established a Marine Technical Working Group (TWG) with the purpose of developing criteria for Climate Bonds Certification of marine renewable energy, coastal ecosystem restoration and conservation and fisheries related bonds. Development of criteria for fisheries was progressed once the marine renewable energy criteria were published.

The intention was to address all levels of fisheries – both aquaculture (specifically mariculture) and capture fisheries, as well as the range of stakeholders that traditionally define a fishery. However, in reality the scope of discussions focussed principally on emissions mitigation for fishing operations (i.e. fishing vessels and activities). Discussions did not explicitly extend to fisheries as a whole, which encompass a wide range of stakeholders, inputs and associated complexities. For this reason (and added to the fact that fuel use of fishing vessels is the largest source of GHG in capture fisheries), we refer to this work as the Low Carbon Fishing Criteria (and hereafter the Fishing Criteria). For brief discussion on the issues of addressing with fisheries as a whole, see the 'Unresolved Issues' section at the end of the document.

This paper acts as a summary of the work that has been done on the development of Fishing Criteria. It begins by summarising the scope of and process for the development of criteria under the Climate Bonds Standard, and then discusses how the Fishing Criteria would fit into the Climate Bonds Standard and briefly summarises the relationship

between fishing and climate change. It outlines how far discussions progressed and highlights challenges to address and possible pathways to support the development of Fishing Criteria for the Climate Bonds Certification scheme in the future.

Fishing and the Climate Bonds Standard

The Climate Bonds Standard applies sector-specific criteria to assess whether bonds are eligible for Climate Bonds Certification. These sector-specific criteria screen the bonds use-of-proceeds to ensure that: (1) the emission performance of projects and assets is in line with requirements to limit warming to well below 2C; and (2) the projects and assets are climate resilient themselves and contribute to the climate resilience of the system in which they operate.

Sector criteria are generally developed by a Technical Working Group (TWG) convened by CBI with advisory input from an Industry Working Group (IWG). For marine related activities, including fishing, a Marine TWG was established and its members are shown in Table 1 below. Some IWG members with expertise in fishing were confirmed, but a formal fishing IWG was not established.

Table 1: Technical Working Group members

Member	Affiliation
Christine Negra	Versant Vision
Andrea Copping	Pacific Northwest National Laboratory
Andrew Buglass	Buglass Energy Advisory
Bill Karp	Affiliate Professor, University of Washington School of Aquatic and Fishery Sciences
Brian Soden	Coastal Risk Consulting
Carmen Lacambra	Global Climate Adaptation Partnership
Michael Adams	Ocean Assets
Louise Heaps	WWF
Lucy Holmes	WWF
Max Carcas	Caelulum
Michael Phillips	CGIAR
Roberta Anderson	Global GAP
Stuart Whitten	CSIRO
Charlie Colgan	Middlebury Institute of International Studies at Monterey
Robert Lefebure	ISEAL

Thanks goes also to Rob Parker, of Dalhousie University, who kindly provided expert insight and advice outside of the TWG, most specifically regarding his own academic work on Fuel Use Intensity (FUI) and low carbon fisheries.

The TWG covered a variety of topics in their discussions including the scope of the Fishing Criteria. This included identifying the most material contributions to climate change from this sector, how to set thresholds that indicate a fishing activity or operator is low GHG emissions and what credentials a climate resilient fishing activity or operator has. Over the course of these discussions it has become apparent that fisheries, fishing and their contribution to climate change is an emerging area of research. The sustainability of fisheries has been researched

in quite some detail, particularly when it comes to fish stock status, but data and research about whether a fishery or fishing operator is low GHG emissions or not is still nascent.

For this reason, and because there is comparatively low existing demand for the Fishing Criteria in the green bond market at this time, this summary of discussions is being published as an interim thought piece to the market and thereafter a starting tool for any recommencement of criteria development in the future. Development of the full criteria may be resumed when:

- Information and data are sufficiently available and geographically representative as to provide reliable and robust GHG thresholds in the sector;
- Criteria development for fishing is a priority to provide guidance to the market.

The TWG approached criteria development with both mariculture (the rearing of aquatic animals or the cultivation of aquatic plants for food in marine water environments) and capture fisheries and fishing operations as part of scope. The TWG considered the possibility that the distinctions between mariculture and capture fisheries could be significant enough to necessitate separate criteria and technical expertise. This is because mariculture has specific system boundaries, inputs and emissions largely differing from capture fisheries and fishing operations. Notably, GHG emissions associated with mariculture activities come from a more diverse set of inputs such as the feedstock, fertiliser and other inputs. However, the consensus amongst the TWG was to first aim for broad requirements and definitions that would cover both sub-sectors.

With that said, the main focus of this paper is on marine capture fishing (the harvesting of naturally occurring living resources in marine environments) as the challenges encountered in accessing reliable and robust data to assess these operations is the reason for halting the development of the Fishing Criteria.

Note: CBI has also advised on criteria for agriculture in China developed by ADBC and CECEP, which contains stipulations on pollution prevention and fisheries resources and ecological conservation[1].

Fishing and climate change

Food production accounts for approximately 25% of global GHG emissions.[2] Typically, marine fisheries are excluded from global GHG assessments but recent work estimates that, in 2011, fisheries generated at least 179 million tonnes of CO_2e GHG emissions, or 4% of emissions associated with global food production.[3] The largest contributor of GHG emissions from capture fisheries is fuel use of the fishing vessels[4]. Refrigeration, waste and transport (particularly when by air) can also be significant contributors depending on how the processing of catch and supply chain is managed.

Data that can be used to analyse the GHG emissions of capture fishing are beginning to emerge and hopefully will become globally representative in the near future. Potential data sources identified during the TWG process are discussed in the later section on setting mitigation thresholds for fishing operations. However, for context, Figures 1, 2 and 3 below present the emissions associated with producing different types of animal-based protein. This provides a basis for what might be viewed as relatively below average/ low emission animal-based protein production and has informed one of the methods for establishing a threshold for 'low emissions' capture fishing, as discussed in greater detail later in the document.

[1] This document is currently under expert review and will be shared here upon publication.
[2] The forgotten 10%: climate mitigation in agricultural supply chains, CDP (2015), accessible at: https://6fefcbb86e61af1b2fc4-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/reports/documents/000/000/829/original/climate-mitigation-in-agricultural-supply-chains.pdf?1471970747. Data referenced is from IPCC, 2014: Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the IPCC
[3] Fuel use and greenhouse gas emissions of world fisheries, Parker, R., Blanchard, J., Gardner, C., Green, B., Hartmann, K., Tyedmers, P. and Watson, R. (2018).
[4] Also from Parker et al. (2018), this study provides an excellent general overview of many of the issues discussed in this paper.

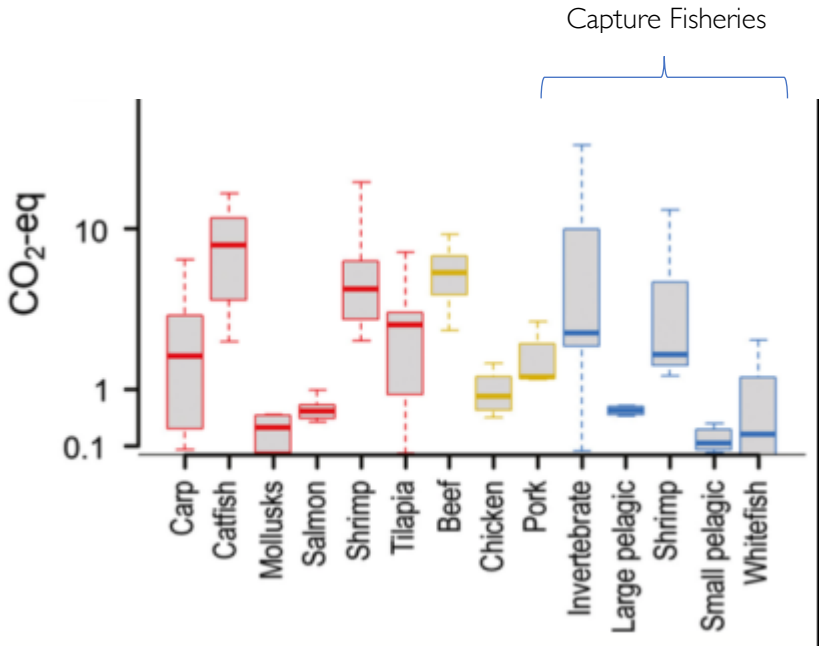

Figure 1: GHG emissions in CO2e of production of different types of animal-based protein Source: Hilborn et al (2018). Units are CO2-eq per 40g protein

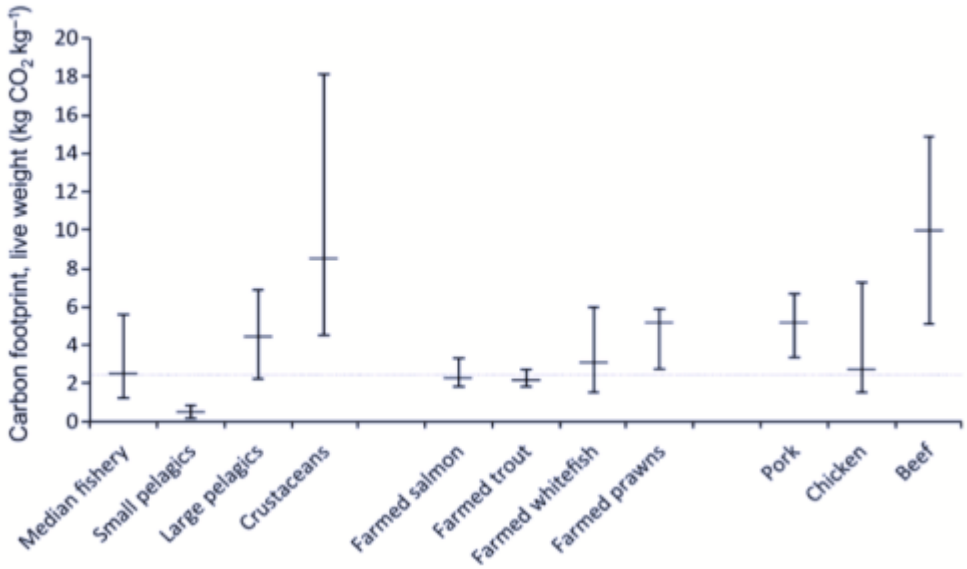

Figure 2: Median expected greenhouse gas emissions of different forms of fisheries, aquaculture, pork and chicken, showing median and range of results. Presented in Parker and Tyedmers (2015). Sources of data for aquaculture and agriculture: Sonesson et al. (2010), Pelletier et al. (2009), Ayer and Tyedmers (2009), Boissy et al. (2011), Aubin et al. (2009), Baruthio et al. (2008), Cao et al. (2011), Papatryphon et al. (2004), Sun (2009), Nijdam et al. (2012).

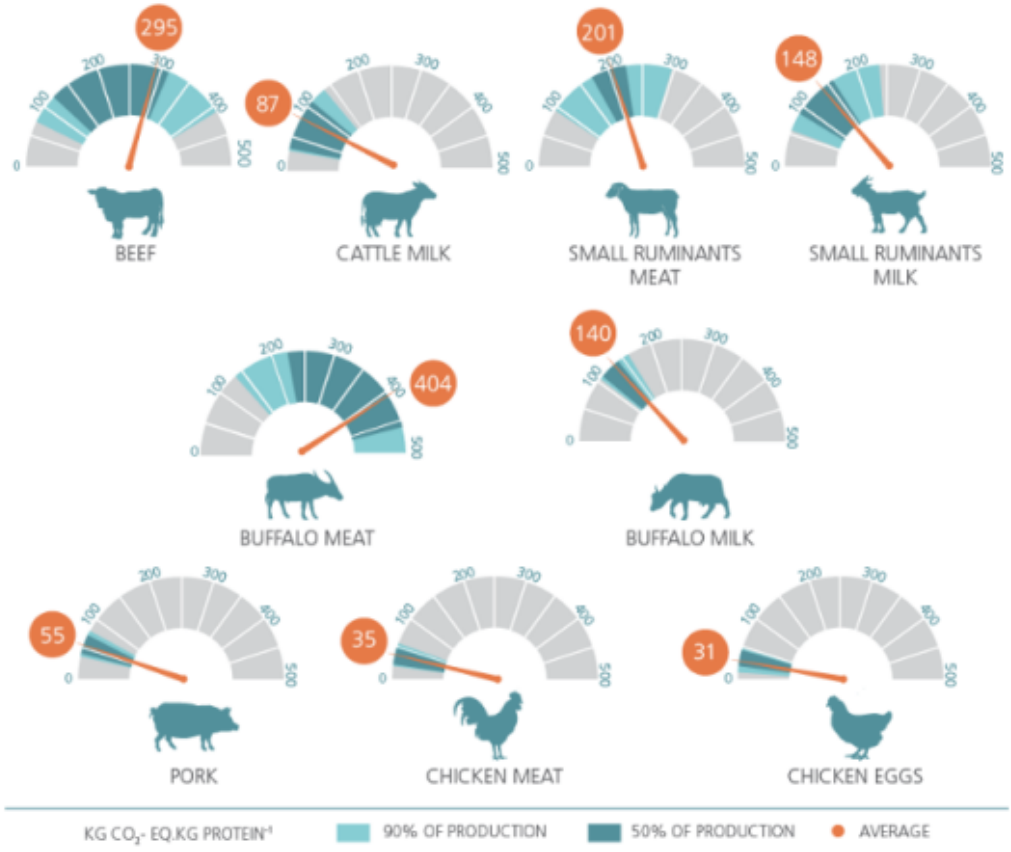

Figure 3: Global emissions intensity by commodity. All commodities expressed in per protein basis. Source: FAO. 2017. Global Livestock Environmental Assessment Model (GLEAM) [online]. Rome. [Cited 18 May 2017]. www.fao.org/gleam/en/

Fishing and the bond market

Fishing related assets and projects have not typically appeared as use of proceeds in the green bond market. However, towards the end of 2018 the Republic of Seychelles issued the first sovereign blue bond to support sustainable marine and fisheries projects[5] and others are starting to investigate how they can bring these types of projects and use of proceeds into green bonds. Moreover, in early 2020, Norwegian salmon fishing farming corporate Mowi ASA ("Mowi"), the world's largest salmon producer, issued a green bond to finance primarily its sustainable aquaculture activities, and to a lesser degree its water and wastewater management activities[6].

These are believed to be the first examples of bonds being issued to finance sustainable fish production and could signal early signs of movement towards green bond financing in the sector.

Looking ahead to future potential bond issuances in the sector, the TWG determined that criteria should be developed to screen the types of assets and projects described in Table 2.

[5] https://www.worldbank.org/en/news/press-release/2018/10/29/seychelles-launches-worlds-first-sovereign-blue-bond
[6] A useful analysis by FAIRR of the MOWI green bond can be found here: https://www.fairr.org/article/mowis-green-bond/#:~:text=Bond%20Analysis-,Summary,Coller%20FAIRR%20Protein%20Producer%20Index.

Table 2: Assets and projects in scope

Category	Example eligible assets and projects
Offshore operations	Vessels for catching and processing catch
	Equipment on vessels – for catching, for processing, for storage
	Measures designed to improve fish stock sustainability
Onshore operations	Fish processing facilities
	Fish storage facilities (including refrigeration facilities)
	Vessel manufacturing facilities
Supporting infrastructure	Monitoring and reporting systems

Options for mitigation criteria

The TWG focussed on setting criteria for fishing operators (or 'fishers') rather than fishery management at a broader level. More specifically, this focus on the emissions of fishing operators (i.e. vessels) centred around fuel use intensity (FUI). This essentially concerns the fuel used to propel a vessel in order to catch a certain amount of fish. As such, the subsequent options for mitigation criteria that were discussed by the TWG do not explicitly address all possible emissions that might be associated with a fishery.

FUI was discussed as a potential proxy for emissions, assuming emissions of 3.3 kg CO_2-eq GHG per litre of fuel used[7]. However, it is recognised that between 10 and 40% of fishery emissions come from non-fuel sources such as refrigerant loss. In other words, fuel use can account for as little as 60% of emissions from capture fishing. Whether or not such a level of materiality would be acceptable in criteria was not discussed by the TWG, nor whether requirements on refrigerant loss could account for this.

Improved fish stocks as a result of good management can result in shorter trips needed by vessels to locate and fish the stocks, leading to a lower fuel use and hence GHG emissions[8]. Acknowledging therefore that improvements in the sector generally come at fishery level, rather than individual fishing operator level, this could create a mismatch between operators that will issue the bond and those that can effectively alter the GHG emissions associated with fishing operation.

Even focussing just on emissions associated directly with fish harvesting, the TWG noted that there are also other activities in the seafood production process that might need to be considered as part of developing sector criteria such as use of refrigerators, processing on board a vessel, and transport. Table 3 summarises these activities and their implications for determining criteria.

Any fishing criteria will require fishing operator and vessel emissions to be directly addressed, but this is not to say that fisheries management and other aspects of fisheries are out of scope for such criteria. However, the TWG did not explicitly discuss whether or not the following options could extend to cover mitigation requirements for

[7] Average fuel density was assumed to be 0.9 kg/L with average carbon content of 860g/kg. Total direct emissions from burning fuel were calculated to be 2.8 kg CO_2-eq/kg GHGs based on chemical content of marine fuels and using IPCC 2013 characterization factors. Upstream emissions associated with mining, refining, and distributing diesel fuel were extracted from the ecoinvent 3.0 life cycle inventory database, resulting in a total rate of 3.3 kg CO_2-eq GHG emissions per litre of fuel.

[8] According to MSC: https://www.msc.org/uk/what-we-are-doing/oceans-at-risk/climate-change-and-fishing

these other issues. Therefore, the remainder of this document considers more specifically setting criteria for fishing vessels. Assessment criteria would nonetheless have likely been partially derived from these options.

Table 3: Aspects of fish production and implications for criteria development

Issue	Consideration
Processing	Vessels that have processing facilities on board will have higher fuel usage than those that don't. There is therefore a need to ensure that thresholds for vessels adjust/take this into account, so that the criteria are comparing like to like. Further, Criteria need to include a broad, inclusive definition for mitigation in processing that can account for all types of processing, including at-sea and onshore processing, while distinguishing these emissions from capture activities or aquaculture.
Refrigerators – Use of HFCs.	Although Kigali Amendment for the phase-down of HFCs under the Montreal Protocol enters into force in 2019, different countries have different phase-down schedules. An option is to not issue Certification if any of the HFCs listed in 'Annex F: controlled substances' of the Montreal Protocol are being used. Annex F lists the HFC controlled substances and their global warming potential.
Waste	There is a need to consider whether/how the criteria need to address bycatch and wastage of catch. For example, MSC has requirements around minimising bycatch.
Transport of product	Although transport of fish is not seen as a significant GHG contribution overall, there are cases in which fish are flown either to be processed or to their final destination. There is a need to consider whether the Criteria will exclude fish being transported by air.

Focussing on setting GHG criteria for fishing vessels

To establish appropriate GHG criteria for fishing vessels it is necessary to understand what would represent 'low GHG emissions fishing'. This seemingly has not been a priority issue in the fishing industry and research and data are thus limited. After considerable research and gathering input from the TWG, several options (including different options for data usage) were developed for setting mitigation requirements for fishing vessels. To reflect properly the TWG discussions surrounding each option, pros and cons are listed for each option.

Option 1. Distinct emissions thresholds according to different types of fish species groups fished/gear types used, based on FUI data
Option 2. One single emissions threshold across all fish types fished based on FUI data to be applied to all types of fish species groups/ gear types
Option 3. One single emissions threshold based on FUI across all fish types fished measured against low GHG protein production across meat and fish
Option 4. One single emissions threshold based on FUI with a set % emissions improvement compared to BAU (Business As Usual)
Option 5. Good management as a proxy for low emissions

Option 1: Distinct species/gear-specific emissions thresholds based on FUI

Several thresholds would be developed based on groups of fish species (e.g. small pelagics, other finfish, crustaceans, etc.). To comply, an issuer would select the relevant threshold depending on the species of fish being caught and then demonstrate compliance with this threshold.

The thresholds could be set in either litres of fuel per tonne of catch (L/t) or CO_2 equivalent per tonne of catch (CO_2/t). If the issuers L/t or CO_2/t falls below the threshold relevant to the species that they are fishing, this would indicate compliance with the mitigation component. To work out their CO_2/t or L/t an issuer must know their fuel use (in volume) and their tonnage of fish caught.

Vessels catching fish species across multiple groups and which hence have multiple emissions thresholds that could apply to them should scale the threshold based on relative catch. For example, if the threshold for finfish was 500L/t and the threshold for crustaceans was 1000L/t, then a boat with 50% finfish and 50% crustaceans would have their threshold set at 750 L/t.

TWG discussions also addressed how to characterise capture fisheries (for the purposes of setting emissions thresholds) based on species, species group, or gear type. Gear type was considered an important metric alongside species group, as catches are frequently difficult to characterise based solely off species group, vessels often bringing in a wide variety of species due to the type of gear used to catch fish (e.g. longlines; purse seine). The TWG considered which of these metrics had a greater effect on a vessel's emissions, acknowledging that the complex interconnections between them makes separation of the two's effects difficult. However, the purpose of this exercise was principally to explore the option of differentiated thresholds based off sub-groups, versus options which would have one overarching threshold. As such, for simplicity, this option hereafter refers only to species groups rather than gear type. Nonetheless, the TWG acknowledged that the issue of interlinkages between species group and gear type was an important one, which would need properly addressing if this option was ultimately selected.

TWG discussions identified the Fisheries & Energy Use Database (FEUD)[9] as the most viable potential source of the necessary FUI data from which to determine these thresholds. More information on this database and other potential data sources identified is given in Box 1.

Some suggestions from TWG members advocated exploring the use of definitions somehow aligned with those of the Marine Stewardship Council's (MSC)[10]. This would leverage the considerable research they have carried out on characterising fishery activities. For example, MSC define the full scope of what is being assessed (i.e. the target stock combined with gear type and other information) as the Unit of Assessment. Definitions such as these can capture a more representative suite of information for evaluating a fishery's management practices.

The Pros:

This option gives flexibility to the different categories of fish species caught, meaning each category would be incentivised to improve rather than excluding whole species groups that are inherently more emissions-intensive. Since the Climate Bonds Standard generally aims to be technology-neutral in its criteria, in this case that could extend to species groups so as not to give unfair treatment to certain operators or geographical locations.

The Cons:

While there is data available in the datasets mentioned in Box 1, it was decided that the data coverage in terms of global catch is not comprehensive enough currently to be able to set globally applicable and robust thresholds for what constitutes low emissions fishing. The pool of data available is growing, however, so it is hoped that eventually there will be enough data to set thresholds.

Broadly speaking, it is not fully understood what proportion of the global catch the data used to set these thresholds represents. This makes it difficult to judge whether it is representative enough to be used to set emissions thresholds.

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[9] Compiled by Robert Parker & Peter Tyedmers, the Fisheries & Energy Use Database (FEUD) has data on the fuel use intensity (FUI) for different global fisheries. FUI can be used as a proxy for carbon emissions.

[10] Definitions can be found here: https://www.msc.org/docs/default-source/default-document-library/for-business/program-documents/chain-of-custody-supporting-documents/msc-msci_vocabulary_v1-2.pdf?sfvrsn=cef284dd_14

There are no other compiled datasets on global fisheries emissions that have published information on FUI or GHG emissions of fisheries. However, there are some good data sources for individual countries and regions. For example, Peter Tyedmers has an overview paper for North Atlantic, Rob Parker has one for Australia, Schau et al. 2009 for Norway, Thrane 2004 for Denmark, Boopendranath et al for India and Port et al for Brazil[11]. The data from these studies are in FEUD and help to inform these estimates, but ultimately still represent a potentially small sample size.

This lack of validity and representativeness increases when added to the fact that each threshold based off a species group will then be comprised of a smaller subset of these data.

Box 1: Potential data sources for setting emissions thresholds

The Fisheries and Energy Use Database (FEUD)

The database was compiled in a 2014 study by Robert Parker and Peter Tyedmers. It encompasses all available published and unpublished fuel use data for fisheries targeting all species, employing all gears and fishing in all regions of the world available at that time. This includes records going back to 1990 and would provide an analysis of the relative energy performance of fisheries.

The main aim of FEUD is to collect and synthesise primary and secondary records of Fuel Use Intensity (FUI) of fishing vessels or fleets. Database records include, where available, fleet and vessel characteristics, target species, locale of fishing, primary and secondary gears employed, effort and FUI. FEUD currently includes roughly 1800 fisheries records, ranging from individual vessel audits to fishery-wide assessments to national or global fleet statistics.

Other analyses of interest

Other analyses that are of relevance to this discussion includes work presented in Olmer et al. (2017)[1] which used data from Global Fishing Watch, IHS, and AIS satellite data to calculate the GHG emissions from commercial fishing vessels. This was against a context of emissions from global shipping and does not distinguish emissions according to species caught or gear type, for example. As such it was not considered appropriate for setting thresholds in this process. See also Parker et al. (2018) for global fisheries emissions data, which uses FEUD data to expand analysis of emissions trends within the fisheries sector.[1]

A more recent analysis by Greer et al., 2019[1] used the Sea Around Us global catch and effort databases[1] to calculate total CO_2 emissions of the industrial fishing sector. They have provided estimates of FUI and emission intensity of fishing activities in different parts of the world, though a paper by Ziegler et al. (2019)[1] questioned the reliability of the analysis.

Outside of these examples provided, there are few other sources that provide representative coverage of global fisheries fuel consumption and FUI. Since 2018 the shipping industry has benefited from the introduction of two mandatory regulations for the collection of vessel fuel consumption, the EU Data Collection System (DCS) – which covers the EU – and the IMO Monitoring, Reporting and Verification – which covers international shipping. However, no such standards exist for the fishing industry. Any policy developments of this nature would represent a significant step in understanding best practice in terms of fishing vessel FUI and will be followed in such an instance.

Option 2: One single emissions threshold based on FUI

Set one overarching emissions threshold that applies to all fishing activities regardless of gear or fish species, as above, utilising the FEUD database to set that threshold.

[11] See the Appendix for a list of these studies.

The Pros:

From an emissions standpoint, setting one single threshold sends a clear signal that anything below that threshold is considered aligned with a low GHG trajectory and anything above that threshold is considered not aligned with a low GHG trajectory. From a data standpoint, setting one threshold means all the data identified as usable for setting GHG thresholds (described later in the document) can be used in determining what this threshold should be, hence meaning there is the greatest possible number of observations included in its determination. Lastly, it is simple to understand and communicate to the market.

The Cons:

If we certified best performers across all species with one threshold, we would create a situation where the fishing of pelagic fish is generally compliant, while the fishing of more GHG intensive species, such as crustaceans, are not compliant. There would be little or no incentive for those fishing either pelagics or crustaceans to improve emissions performance because the threshold would either be easily achievable or completely unachievable. From a market perspective, different fish might not be substitutes for each other in the market (for example, crabs vs sardines) and so it would not make sense to make them aim for the same threshold.

Option 3: One single emissions threshold based on low carbon animal-based protein production

Set one overarching emissions threshold that applies to all fishing activities regardless of gear or fish species, but in this case the threshold is set in the context of the relative emissions from fish production compared to animal production (e.g. pork, beef and chicken). That way the threshold can be set to reflect levels of GHG emissions per unit of protein. Box 2 describes potential datasets that could be used to inform such a threshold.

The Pros:

In terms of practicalities, this option would provide an easily understandable, overarching idea of low emission protein production against the context of feeding a growing population within planetary boundaries. Equally, it would automatically recognise fish as a typically less GHG intensive source of protein. In this way it could set a precedent for consistent criteria across other sector criteria that deal with food production, for example agriculture and especially livestock production.

With this in mind, this option may allow for a sizeable number of fishing operations to meet this threshold, thus increasing the Criteria applicability (see Figure 2 for a visual comparison of various fish and livestock carbon footprints).

The Cons:

The drawbacks of this option are similar to those of option 2. Having one threshold based on low emission protein (which may be even higher than for option 2 due to the addition of livestock emissions data) would provide no incentive for many fishing operators (or livestock producers) to improve their practices as they would be either automatically compliant or too far off meeting the threshold for improvements to help (for example those fishing for crustaceans). And again, different fish species may not be directly interchangeable substitutes for other protein sources in the market (for example, pork vs tuna). In fact, this would be even more relevant to this option as fish protein often comprises the only source of protein or income in certain geographies that could be unsuited to livestock production.

The issue of data reliability is still pertinent here, though there is a considerable number of studies for the carbon footprint of animal protein and those shown in Figure 3 provide adequate estimates, albeit not for fish protein.

Lastly, but importantly, the Criteria under development for livestock production are not based on an emissions threshold per unit of production, so would be out of step with such an approach.

Box 2: Potential data sources for setting emissions thresholds per protein units

The Food and Agriculture Organisation of the United Nations' (FAO) Global Livestock Environmental Assessment Model (GLEAM)

GLEAM is a Geographic Information System (GIS) framework that simulates the biophysical processes and activities along livestock supply chains under a lifecycle assessment approach. It is designed to analyse multiple environmental dimensions, such as feed use, greenhouse gas emissions, land use and land degradation, nutrient and water use and interaction with biodiversity. It has systematic, global coverage of six livestock species and their edible products: meat and milk from cattle, buffalo, sheep and goats; meat from pigs and meat and eggs from chicken (as shown in Figure 3 above). It could be used to understand a value for low carbon animal-based protein, but it currently does not have any estimates for fish-based protein. While the FAO may be less active in the research of fisheries fuel use, the dataset nonetheless provides a useful comparison with other types of animal protein.

Other analyses of interest

A further dataset highlighted by the TWG was the one compiled by Ray Hilborn et al.[1] It contains 148 assessments of animal source food production for livestock, aquaculture and capture fisheries that measured four metrics of environmental impact (energy use, greenhouse-gas emissions, release of nutrients and acidifying compound) and standardised these by CO_2 equivalent per units of protein production.

Option 4: One upper limit emission threshold and % improvement in carbon emissions

The next option would be to require production to fall below an upper limit FUI threshold and also achieve a % improvement in FUI. This approach would exclude certifying extremely high emissions fishing operations, while still creating an incentive to improve across all species groups.

The Pros:

This option would appropriately exclude the highest emitting fishing operations that are not aligned with a low emissions economy, while being inclusive for operations that are higher emitting but have the capacity to improve their practices. At the same time, operations that are already low carbon enough will still have an incentive to improve.

As with option 3, this upper limit threshold gives a clear indication as to what high emission fishing looks like and thus a minimum benchmark which fishing operations should improve past.

The Cons:

Deciding the level to set the percentage improvement part of this option was problematic. From the TWG discussions, it seems that while individual fishing operators may be able to improve their FUI to an extent, it's difficult for them to achieve big fuel savings as that is more dictated by the condition and stocks of the fish they are harvesting. Further work would be needed in understanding the extent to which any fishing operator could make improvements. Equally, there is the question of whether the same percentage improvement would be required of the best performing fishing operators. If already extremely low emitting, it might be unfair to require substantial further improvements and improvements in such operations may be extremely difficult to achieve.

The same issue goes for setting the upper limit emission threshold – in other words, what is the lowest level of performance of a fishing operation that can be accepted before the percentage improvement is taken into account. Failure to do so in a scientifically robust manner could result in the unfair exclusion of certain operations.

Option 5: Rely on a management argument for mitigation component

Option 5 provides an alternative to a threshold approach by using good management practices as a proxy for low emissions. This is based on an assumption that well-managed fisheries are likely to result in improved fish stocks or improved knowledge of fish stocks, which are subsequently easier to locate and catch and therefore result in lower fuel usage by vessels.

The TWG decided that good management practices would be determined by whether or not a fishery is certified by a best practice certification body. CBI explored the Marine Stewardship Council (MSC) and the Global Sustainable Seafood Initiative (GSSI) as the principal options. At the time of criteria development being halted, MSC certification was being discussed as a requirement for anyone seeking certification under the Fishing Criteria.

From the perspective of a fishing operator or vessel, this might mean seeking certification from MSC (for example) as such, with the fishery to be certified being defined simply as the vessel within a larger fishery. Being certified would thus meet the mitigation requirement for that fishing operator or vessel. This flexibility in defining a fishery for the purposes of MSC certification may also mean that this option could be flexible for fisheries in general, not just fishing operators as has been discussed thus far. However, the costs of certifying under MSC was identified as a potentially significant barrier to this, especially in the case of an individual vessel.

The Pros:

Good management practice in the form of best practice certification can circumvent the issues of lack of data seen in the other options listed. These certification schemes leverage expert stakeholder and industry knowledge and often draw on criteria and metrics far more established in the fisheries industry such as by-catch and ecological limits. As such, these schemes can be widely applicable within the industry and theoretically cover a wide range of operators.

An overarching principle across all CBI sector criteria stipulates that, where possible, best practice certification schemes are leveraged to support issuers in meeting criteria (for the reasons given above), making this option consistent with this principle.

One particular benefit this option brings as opposed to the previous options is that of wider sustainability benefits. Despite not dealing directly with emissions reductions in fisheries, MSC and GSSI incorporate significant requirements on ensuring a fishery operates in an ecologically sustainable manner. As Climate Bonds Standard sector criteria contain a component for adaptation and resilience (A&R) as well as one for climate mitigation, fisheries managed to be ecologically sensitive (and subsequently be best practice certified) are likely to have management processes in place that would enable A&R to be adopted relatively easily. Secondly, MSC incorporates an improvement aspect into its certification requirements which means all fisheries are encouraged to improve.

The Cons:

When exploring the options of using best practice certification schemes as good management proxies, it is crucial that they themselves adequately cover important issues that the TWG identify. Both MSC and GSSI had certain issues associated with their requirements that could make them problematic in their use. For example, MSC has come under criticism for potential unreliability in the way certification is awarded by third-party verifiers.

A significant concern raised with this option is that better management may not in fact be a reliable indicator of lower GHG emissions. A vessel may operate in a more sustainable manner yet use greater amounts of fuel in their operations. The TWG did mention studies that link better management to lower emissions, but ultimately this is an assumption made in the absence of more reliable emissions data.

Lastly, there was the question of what would happen if a bond certified under the Climate Bonds Standard loses certification from either MSC or GSSI. In this situation, certification would likely be revoked as is seen in the Forestry Criteria of the Climate Bonds Standard, where similar best practice schemes are leveraged.

Summary of options

With pros and cons captured for each potential mitigation requirement, there was then a need to determine what characteristics would be key for maximising the effectiveness of the mitigation option ultimately chosen.

Table 4 below illustrates the key pros identified across all the options. These can act as indicators to demonstrate which option(s) might be the most suitable for setting as mitigation requirements in the Fishing Criteria.

Table 4. Performance of the mitigation requirement options perform against key indicators.

Indicator	Option 1	Option 2	Option 3	Option 4	Option 5
Recognise good performers	✓	✓	✓	✓	✓
Encourage improved performance	✓	✗	✗	✓	✓
Clear signal to market of low carbon credentials	✗	✗	✓	✓	✗
Doesn't exclude entire species	✓	✗	✗	✓	✓
Based on an adequately robust dataset	✗	✗	✗	✗	✗
'Science based'	✓	✓	✓	✓	✗
Leverage established industry research	✗	✗	✗	✗	✓
Wider sustainability benefits	✗	✗	✗	✗	✓
Globally applicable threshold	✓	✓	✓	✓	✓
Realistic and practical for use	✓	✓	✓	?	✓

As can be clearly seen from Table 4, none of the options discussed by the TWG meet all the indicators that would improve its effectiveness as a mitigation requirement. This presented considerable barriers to the TWG accepting any option as a viable option moving forward, which contributed to the criteria development process being halted.

It was highly likely that MSC certification would have been set as one of the requirements for demonstration of the mitigation requirements being met, as Table 4 shows Option 5 meeting the most indicators. However, this was not enough to take MSC certification forward as the only requirement for meeting the mitigation component of the criteria.

Exceptions to the above

The TWG discussed whether certain assets or projects might be automatically deemed to be low emissions, without needing to meet any mitigation criteria (though would still have to meet adaptation and resilience requirements). For example:

- Electric, hydrogen fuel cell and other zero direct emission vessels
- Fleet management technology
- Possibly some necessary and dedicated supporting infrastructure

Taking the example of land transport, clear industry and policy trends exist which point towards vehicle electrification. Such trends are less obvious for fishing assets and activities. TWG members noted that some new vessel construction activities are also taking place which aim for increased FUI and lower emissions. In 2015, the world´s first commercial electric-hybrid fishing vessel, Selfa Elmax 1099, or "Karoline", was delivered by Selfa Arctic to operator Øra AS. In 2019, Selfa started working on their second commercial, hybrid-electric fishing vessel. However, the substantial gap between construction of the two vessels illustrates to a degree the relative lack of development in terms of vessel design and propulsion design (there are few other examples globally of electric-hybrid vessels, let alone pure electric ones).

Therefore, at this time it is unlikely that many large-scale commercial fishing vessels are likely to automatically be acceptable as sufficiently low-emissions vessels and would need to be subject to an assessment of their performance against some GHG related criteria.

Developing adaptation and resilience requirements for fisheries

There is considerable work that has been done already on resilience of fish stocks and marine ecosystems, both in terms of climate resilience and resilience in general, and therefore this is a concept that is better understood than mitigation.

As mentioned previously, there was a growing consensus among the TWG that MSC certification would be included as a requirement for fisheries and fishing operators to be eligible. As MSC have extensive requirements for fisheries to be managed in an ecologically sensitive manner, being certified by MSC may automatically meet some of the A&R requirements that would likely be part of the Fishing Criteria. It may also have the co-benefit of promoting low-emissions fish production though this is as yet unclear as discussed previously. Linked closely to this was the idea of Fishery Improvement Plans (FIPs) being included as an alternative requirement for demonstrating a fishery is sustainable generally, but it was unclear in discussions whether they could act as genuine indicators of a sustainable and low emissions fishery. MSC carries out evaluative work on FIPs but further work could be done to ensure they result in sustainable fisheries management, particularly from an emissions standpoint.

Work to develop the adaptation and resilience component of the criteria did not progress because of the amount of work needed in defining the parameters for the mitigation component. Any future development of adaptation and resilience requirements would be developed in line with underlying Climate Resilience Principles as seen in other Climate Bonds Standard criteria. These principles were developed by an Adaptation and Resilience Expert Group (AREG), convened by CBI.

Unresolved issues

Definitions and fisheries applicability

As has already been mentioned extensively in the document, the complexities of fisheries management and emissions arising from them meant that criteria development focussed principally on setting requirements on fishing operators and vessels, rather than 'fisheries' as a whole.

It is recognised that this presents issues of communication with the term fisheries being widely accepted as the standard term for this area of work. However, for the purposes of criteria development this would mean the options for mitigation requirements must be applicable to all aspects of fisheries. As such, the TWG did not directly address this issue, and thus any development of Fishing (and potentially Fisheries) Criteria would need to explore this issue further. As previously mentioned, MSC takes a flexible approach to defining a 'fishery', but as this does not set explicit emissions reduction requirements, it is unclear how this could influence development of CBI criteria.

Processing of catch

The TWG discussed the issue of accounting for processing within mitigation requirements, and the subsequent complexities behind this. Processing of catch is not fully understood in the context of emissions from fisheries, and thus makes setting criteria to reflect this difficult. Processing can take place both onboard a vessel and onshore, potentially using highly varying levels of fuel and therefore leading to differing levels of emissions. Any fishing or fisheries criteria will need to properly incorporate these sources of emissions into any thresholds that are set for fishing operations.

Conclusions

Work undertaken as part of the Fishing Criteria has already identified possible pathways for setting quantitative requirements for the mitigation component of the criteria in respect of fishing vessels. These may also be applicable at the fishery level, though the TWG did not explicitly address this issue. However, the data coverage in terms of global catch is not comprehensive enough currently to be able to set globally applicable and robust thresholds for what constitutes low emissions fishing, and current market trends do not show demand for criteria for fishing related bonds. That said, the pool of data available is growing, so it is hoped that eventually there will be enough data to set thresholds. Development of the criteria may be resumed when more data have become available to support a more robust analysis.

Appendix: Where to look for further guidance

Other organisations and initiatives are taking forward work that is relevant to assessing the fishing sector. Some of these are listed below.

- Marine Stewardship Council (MSC)
- Aquaculture Stewardship Council (ASC) – for aquaculture
- Seafood Stewardship Index
- Global Sustainable Seafood Initiative
- Fish tracker
- KRAV
- Fisheries Improvement Projects (FIPs)
- The Seas, Oceans and Public Health in Europe project (SOPHIE)

It is not clear whether relevant international organisations such as FAO, IMO and intergovernmental fishery organisations (ICCAT, IATTC, etc.) are planning to set standards on (or monitor) emission performance of the fishing industry. This will also influence the quality and amount of data that can support development of sector criteria.

The following list is of relevant reading, literature and studies that may be of use in future work in this area, or simply for added information or context:

- Aubin, J., Papatryphon, E., van der Werf H. M. G. and Chatzifotis, S., 2009. Assessment of the environmental impact of carnivorous finfish production systems using life cycle assessment, *Journal of Cleaner Production*, vol. 17, pp. 354 - 361.
- Boopendranath, M.R. and Hameed, M.S., 2013. Gross energy requirement in fishing operations.
- National Marine Fisheries Service (NMFS), also known as NOAA Fisheries have general information
- on aquaculture
- Parker, R.W., Hartmann, K., Green, B.S., Gardner, C. and Watson, R.A., 2015. Environmental and economic dimensions of fuel use in Australian fisheries. Journal of Cleaner Production, 87, pp.78-86.
- Parker, R.W., Blanchard, J.L., Gardner, C., Green, B.S., Hartmann, K., Tyedmers, P.H. and Watson, R.A., 2018. Fuel use and greenhouse gas emissions of world fisheries. *Nature Climate Change*, 8(4), pp.333-337.
- Port, D., Perez, J.A.A. and de Menezes, J.T., 2014. RETRACTED: Energy direct inputs and greenhouse gas emissions of the main industrial trawl fishery of Brazil.
- Salmon farming industry handbook by MOWI ASA
- Schau, E.M., Ellingsen, H., Endal, A. and Aanondsen, S.A., 2009. Energy consumption in the Norwegian fisheries. Journal of Cleaner Production, 17(3), pp.325-334.
- Seafish guide to aquaculture
- Singh, K., 2012. Innovation for a High-Energy Planet - Implementing Climate Pragmatism Framing Document Two, *Consortium for Science, Policy & Outcomes*, Temple, Arizona.
- Thrane, M., 2004. Energy consumption in the Danish fishery: identification of key factors. Journal of Industrial Ecology, 8(1-2), pp.223-239.
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- UN FAO, "The State of World Fisheries and Aquaculture; Opportunities and challenges," Rome, 2014.