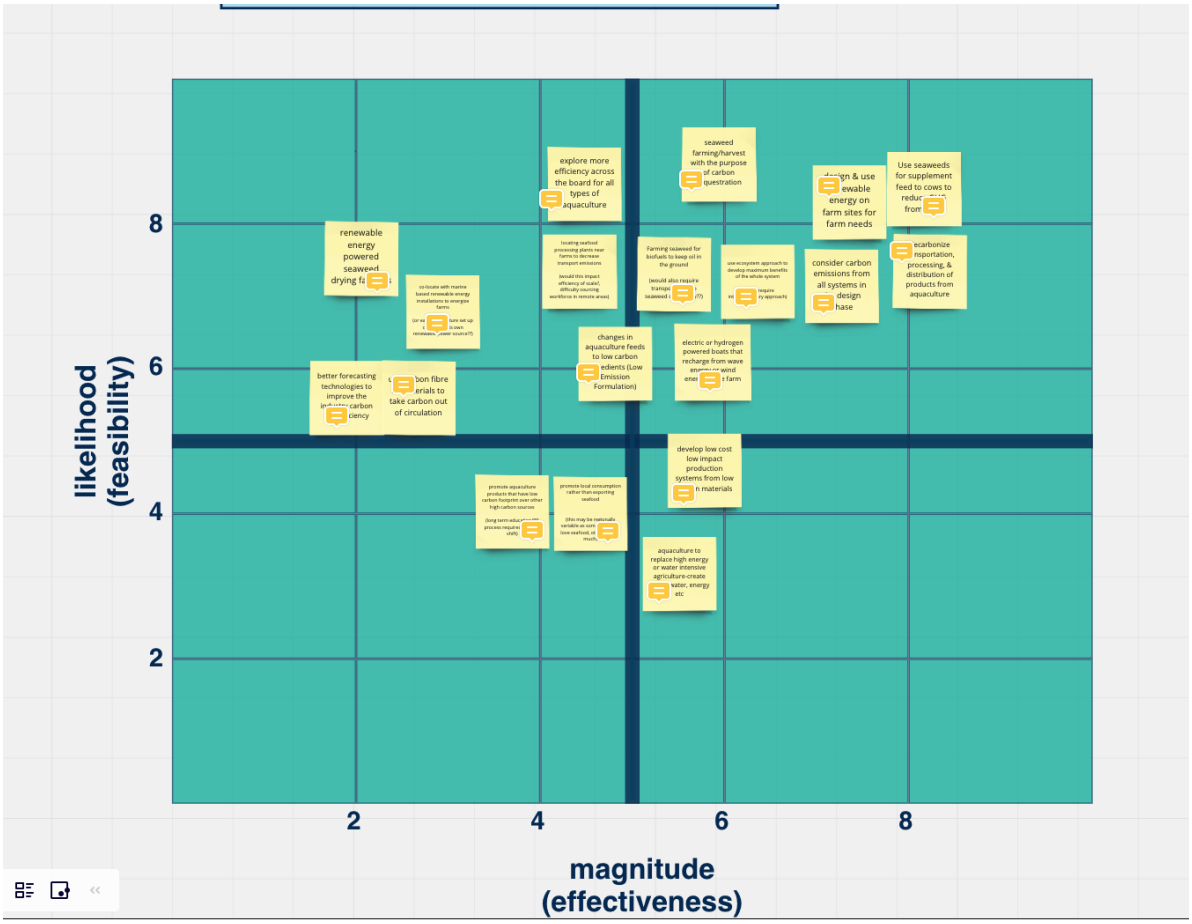
ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

You are receiving this survey as part of the ICES workshop on pathways to climate-aware advice (WKCLIMAD). This workshop is exploring how the short-, medium-, and long-term impacts of climate change on aquaculture, fisheries, and ecosystems can be accounted for in ICES advice. **This is Part 2 of the second Delphi Survey to rate the likelihood (= feasibility) and magantude (= effectiveness) of MITIGATION measures to either 1) remove carbon from the environment or 2) reduce the release of carbon to the environment by the fisheries and aquaculture industries.** NOTE: This survey does not address ways to adapt to a high carbon world. This topic was explored during the third day of the virtual workshop on October 18th, 2021. You may return to the MIRO board with the link provided.

You may recall your work looked something like this:



ICES has identified you or your organization, or you have nominated yourself as a stakeholder or knowledge holder in the fields of climate, fisheries, or aquaculture.

Information gathered via this questionnaire is subject to the ICES data privacy statement.

The information provided by you will be used to assist ICES to outline actionable strategies and approaches that can be taken to promote resiliency in fisheries, aquaculture, and ecosystems. This information will be published online and made available to the public. Data will be aggregated so you will not be identifiable; in the event direct quotes are used, these will be identified by an alias/pseudonym.

You may withdraw from the research at any time, without the need to explain, without penalty, and your personal data will be immediately deleted. Anonymized research data will be archived by ICES. All personal data will be deleted 5 years after the WKCLIMAD report is published.

By responding to this survey you acknowledge and consent to your personal data being used as described above.

We expect this survey to take 1 hour to complete. You may save the form and come back

We expect this survey to take 1 hour to complete. You may save the form and come back to it later using the SAVE button at the bottom. An email will be sent to you with a link that you can use to work on it later.

Email

example@example.com

Name

First Name

Last Name

Mitigation Measures

Aquaculture and fisheries are captured on the same form. These measures were harvested from the MIRO board for the second day of the first WKCLIMAD workshop and average ratings were obtained from discussions on the third days work. In this survey we are asking you what you think the most likely (feasible) and effective (magnitude) management measures are to remove or reduce inputs of carbon dioxide from/in the ocean-atmospheric pool. Note to equate our terms with those used by IPCC and the restoration literature think magnitude = effectiveness and likelihood = feasibility. You do not need to agree with the ratings developed during the discussion but they are provided in the first column for your consideration. Using your expert judgement, please rate for each management measure the likelihood/feasibility (1 -none to 10 -extremely likely) that the measure could be implemented and magnitude/effectiveness (from 1 - none to 10 -extreme) of the of that measure, separately. Please also indicate the timeframe that each management measure is either likely to occur, or when it will have maximum impact. Also indicate in the confidence column your confidence in your rating. Further information on each impact can be found in on the MIRO board linked above. There are two sheets for likelihood and two for magnitude; one set for aquaculture and one set for fisheries. The timeframes are short (2021-2040), medium (2041-2060) and long term (2061-2100). NOTE: you must rate all

medium (2041-2060) and long term (2061-2100). NOTE: you must rate all mitigation measures. If the measure is out of your area of expertise (for example an aquaculture expert rating the fisheries measures) then indicate very low confidence in your answer for those impacts (we may remove those rated very low confidence from the ranking). There is space for further comment at the end of the survey and at the end of each row. You may save the form and come back to it later using the SAVE button at the bottom. An email will be sent to you with a link that you can use to work on the rest later.

AQUACULTURE

The next two exercises relate to ways aquaculture can mitigate climate change

Aquaculture: Please rate on a scale from 1 (unlikely) to 10 (highly likely), the LIKELIHOOD/FEASIBILITY that each of the mitigation approaches listed in the first column could occur. In thinking about likelihood consider cost, state of technical advancement political will and ease of regulatory or social change. Please indicate the time period that this mitigation measure could take hold and indicate your confidence in the estimate. *

	1	2	3	4	5	6	7	8	9	10	Time Frame	Confidence	Oth Thou
better forecasting technologies to improve the industry carbon use effiency 5.5	○	○	○	○	○	○	○	○	○	○			
consider carbon emissions from all systems in the design phase (esp RAS) 5.9	○	○	○	○	○	○	○	○	○	○			
co-locate with marine based renewable energy installations to energize farms 5.8	○	○	○	○	○	○	○	○	○	○			
develop low cost low impact production	○	○	○	○	○	○	○	○	○	○			

production systems from low carbon materials 4.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
changes in aquaculture feeds to low carbon ingrediants (Low Emission Formulation) 6.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
decarbonize transportation, processing, and distribution of products from aquaculture 7.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
aquaculture to replace high energy or water intensive agriculture- create virtual water, energy and so on 4.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
locating seafood processing plants near farms to decrease transport emissions 6.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
explore more efficiency across the board for all types of aquaculture 6.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
promote local consumption rather than exporting seafood 5.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
electric or hydrogen powered boats that recharge from wave energy or wind energy at the farm 4.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

use carbon fiber in materials to take carbon out of circulation 5.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
renewable energy powered seaweed drying facilites 5.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Use seaweeds for supplement feed to cows to reduce GHG from cows 7.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
use ecosystem approach to develop maximum benefits of the whole system 6.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Farming seaweed for biofuels to keep oil in the ground 6.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
promote aquaculture products that have low carbon footprint over other high carbon sources (eg beef) 5.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
seaweed farming/harvest with the purpose of carbon sequestration 7.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
design and use renewable energy on farm sites for farm needs 7.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

Aquaculture: Please rate on a scale from 1 (no impact) to 10 (high impact), the MAGNITUDE/EFFECTIVENESS that each of the mitigation approaches listed in the first column could have on mitigating climate change. In thinking about magnitude consider the amount of carbon the measure could remove or keep out of the environment. Will the management measure really make a difference? Please indicate the time period that this mitigation measure would need to make a significant impact and indicate your confidence in the estimate. *

	1	2	3	4	5	6	7	8	9	10	Time Frame	Confidence	Oth Thou
Farming seaweed for biofuels to keep oil in the ground 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
promote local consumption rather than exporting seafood 5.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
locating seafood processing plants near farms to decrease transport emissions 4.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
renewable energy powered seaweed drying facilites 2.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
promote aquaculture products that have low carbon footprint over other high carbon sources (eg beef) 3.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop low cost low impact production systems from low carbon materials 4.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
	○	○	○	○	○	○	○	○	○	○			

Use seaweeds for supplement feed to cows to reduce GHG from cows 7.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
co-locate with marine based renewable energy installations to energize farms 3.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
consider carbon emissions from all systems in the design phase (esp RAS) 5.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
aquaculture to replace high energy or water intensive agriculture- create virtual water, energy and so on 5.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
design and use renewable energy on farm sites for farm needs 5.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
electric or hydrogen powered boats that recharge from wave energy or wind energy at the farm 4.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
use carbon fiber in materials to take carbon out of circulation 2.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
better forecasting technologies to improve the industry carbon use effiency 3.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

decarbonize transportation, processing, and distribution of products from aquaculture 6.8	○	○	○	○	○	○	○	○	○	○		
seaweed farming/harvest with the purpose of carbon sequestration 7.2	○	○	○	○	○	○	○	○	○	○		
use ecosystem approach to develop maximum benefits of the whole system 5.4	○	○	○	○	○	○	○	○	○	○		
explore more efficiency across the board for all types of aquaculture 4.8	○	○	○	○	○	○	○	○	○	○		
changes in aquaculture feeds to low carbon ingrediants (Low Emission Formulation) 4.8	○	○	○	○	○	○	○	○	○	○		

FISHERIES

The next two exercises relate to ways fisheries can mitigate climate change

Fisheries: Please rate on a scale from 1 (unlikely) to 10 (highly likely), the LIKELIHOOD/FEASIBILITY that each of the mitigation approaches listed in the first column could occur. In thinking about likelihood consider cost, state of technical advancement political will and ease of regulatory or social change. Please indicate the time period that this mitigation measure could take hold and indicate your confidence in the estimate. *

	1	2	3	4	5	6	7	8	9	10	Time Frame	Confidence	Oth Thou

regulate to avoid carbon emissions due to ineffective policies (e.g. poorly implemented discard bans) 6.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄
incentives to use more fuel efficient vessels 7.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄
shift to low emission fishing methods 5.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄
maintain higher fish stock biomass to increase efficiency of fishing 4.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
improve fishery management to make industry more efficient 5.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
offshore wind to reduce emissions 8.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
reduce global trade & shipping of fish/fish products 3.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
regulate of bottom impact gear wrt blue carbon-tradeoffs 5.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
carbon audits to evaluation shore based versus at sea processors 5.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
protect, restore or increase blue carbon nursery habitats 5.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄

link to aquaculture to increase income diversity & reduce carbon 4.9	○	○	○	○	○	○	○	○	○	○			
reduce fishing 4.4	○	○	○	○	○	○	○	○	○	○			
carbon taxing 6.7	○	○	○	○	○	○	○	○	○	○			
develop fixed place fishing with clean energy needs provided at fishing site 1.3	○	○	○	○	○	○	○	○	○	○			
place wind farms in no-fishing areas 8.0	○	○	○	○	○	○	○	○	○	○			
enhance nearshore/small scale fisheries 5.0	○	○	○	○	○	○	○	○	○	○			
develop electric, hydrogen power and/or wind powered fishing boats 5.3	○	○	○	○	○	○	○	○	○	○			

Fisheries: Please rate on a scale from 1 (no impact) to 10 (high impact), the MAGNITUDE/EFFECTIVENESS that each of the mitigation approaches listed in the first column could have on mitigating climate change. In thinking about magnitude consider the amount of carbon the measure could remove or keep out of the environment. Will the management measure really make a difference? Please indicate the time period that this mitigation measure would need to make a significant impact and indicate your confidence in the estimate. *

	1	2	3	4	5	6	7	8	9	10	Time Frame	Confidence	Oth Thou
protect, restore or increase blue	○	○	○	○	○	○	○	○	○	○			

carbon nursery habitats 6.9													
regulate of bottom impact gear wrt blue carbon-tradeoffs 4.6													
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develop electric, hydrogen power and/or wind powered fishing boats 6.1													
reduce global trade & shipping of fish/fish products 7.3													
reduce fishing 6.5													
incentives to use more fuel efficient vessels 6.5													
shift to low emission fishing methods 6.8													

methods 5.5												
regulate to avoid carbon emissions due to ineffective policies (e.g. poorly implemented discard bans) 5.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
place wind farms in no-fishing areas 6.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄
enhance nearshore/small scale fisheries 4.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
carbon audits to evaluation shore based versus at sea processors 4.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
improve fishery management to make industry more efficient 5.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
carbon taxing 6.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄

Please add any management actions to mitigate climate change we might have missed or make any comments below:

Type here...

You may save the form and come back to it later using the SAVE button at the bottom. An email will be sent to you with a link that you can use to work on the rest later.