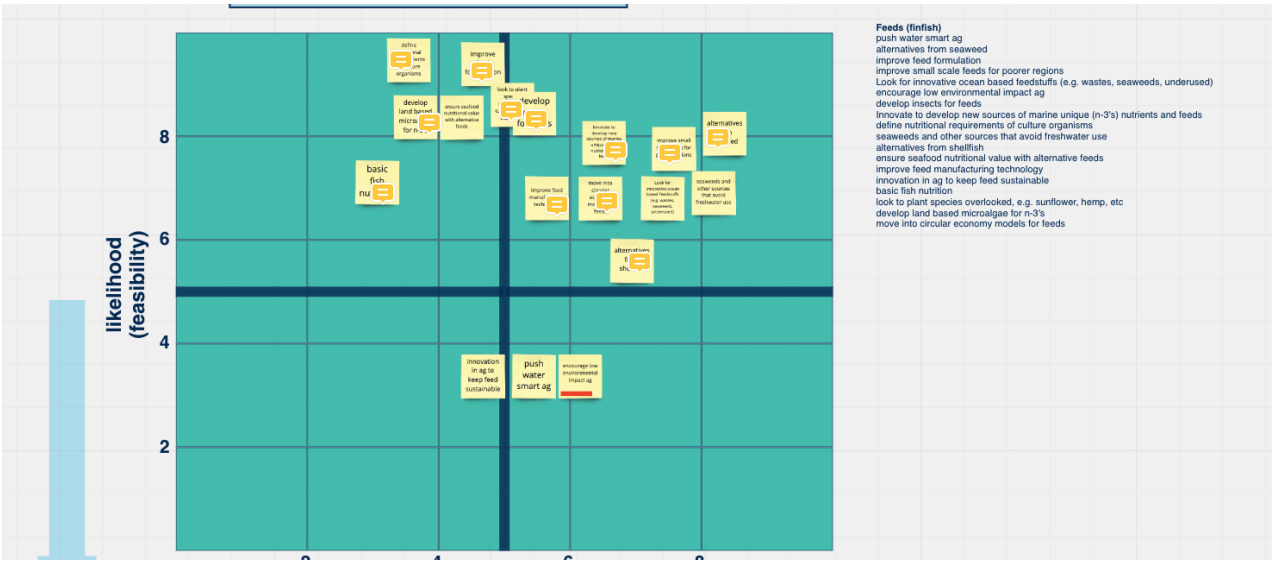
ICES International Council for the Exploration of the Sea

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 the AQUACULTURE Part 2 of the second Delphi Survey to rate the likelihood (feasibility) and magantude (effectiveness) of ADAPTATION measures to 1) add resliiancy to the climate threatened seafood industy 2) take advantage of new oppertunities presented by climate, or otherwise allow society and the ecosystem to prosper.** NOTE: This survey does not address ways to mitigate or remove carbon. - that is addressed in a seperate survey. 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 4 hours 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

Adaptation Measures

Adaptation Measures

Aquaculture and fisheries are captured on different forms. These measures were harvested from the MIRO board for the second day of the first WKCLIMAD workshop and ratings were added from the third day MIRO board. Note to equate our terms with those used by IPCC and the restoration literature think magnitude = effectiveness and likelihood = feasibility. In this survey we are asking you what you think the most likely (feasible) and effective (magnitude) management measures are to allow the fisheries and aquaculture industries and/or the underlying aquatic ecosystems to flourish in a high carbon dioxide world. NOTE: You do not need to agree with the ratings provided in the first columns below, they are just for your consideration. Using your expert judgement, please rate for each management measure the likelihood/feasibility (1 -none to 10 -extremely likely) that it can be applied and magnitude/effectiveness (from 1 - none to 10 -extreme) the measure would have, separately. Please also indicate the timeframe that each management measure is either likely to occur, or will have its maximum impact. Also indicate in the confidence column your confidence in your own rating. Further information on each impact can be found on the MIRO board linked above. There are pair sheets for likelihood and magnitude for each management measure. The timeframes are short (2021-2040), 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 then indicate very low confidence in your answer for those impacts (we may remove those rated very low 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.

Finfish Only: Issues dealing with Feed

For dealing with feeds: 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 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	Other Thoughts
Look for innovative ocean based feedstuffs (e.g. wastes, seaweeds, underused) 6.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop land based microalgae for n-3's 8.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
innovation in ag to keep feed sustainable 5.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
seaweeds and other sources that avoid freshwater use 6.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
alternatives from shellfish 5.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
ensure seafood nutritional value with alternative feeds 7.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
improve feed formulation 7.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Innovate to develop new sources of marine unique (n-3's) nutrients and feeds 7.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
encourage low environmental impact ag 4.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
define nutritional													

requirements of culture organisms 6.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
alternatives from seaweed 7.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
move into circular economy models for feeds 5.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
improve small scale feeds for poorer regions 6.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop insects for feeds 7.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
look to plant species overlooked, e.g. sunflower, hemp, etc 5.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
push water smart ag 5.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
basic fish nutrition 6.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
improve feed manufacuring technology 5.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

For issues dealing with Feeds: 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 adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. 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	Othe Thoug
encourage													

low environmental impact ag 3.3	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
Innovate to develop new sources of marine unique (n-3's) nutrients and feeds 5.8	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
innovation in ag to keep feed sustainable 5.3	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
push water smart ag 5.4	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
move into circular economy models for feeds 4.5	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
Look for innovative ocean based feedstuffs (e.g. wastes, seaweeds, underused) 5.6	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
develop insects for feeds 4.0	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
define nutritional requirements of culture organisms 4.4	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
alternatives from shellfish 5.3	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
ensure seafood nutritional value with alternative feeds 5.1	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
basic fish nutrition 3.8	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	

	1	2	3	4	5	6	7	8	9	10	Time Frame	Confidence	
look to plant species overlooked, e.g. sunflower, hemp, etc 4.9	○	○	○	○	○	○	○	○	○	○			
improve small scale feeds for poorer regions 6.0	○	○	○	○	○	○	○	○	○	○			
seaweeds and other sources that do not use freshwater 7.5	○	○	○	○	○	○	○	○	○	○			
develop land based microalgae for n-3's 4.5	○	○	○	○	○	○	○	○	○	○			
improve feed formulation 5.4	○	○	○	○	○	○	○	○	○	○			
alternatives from seaweed 7.5	○	○	○	○	○	○	○	○	○	○			
improve feed manufacuring technology 4.2	○	○	○	○	○	○	○	○	○	○			

Finfish and Shellfish: HABs

For issues dealing with HABs impacts on shellfish and finfish: 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 and ease of regulatory/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
HABs	○	○	○	○	○	○	○	○	○	○			

forecasting, early detection, real time monitoring 8.4													
Better background information on likelihood of HABs before farm location 4.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
improved husbandry methods 4.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
biotoxin monitoring 6.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
hatchery based seed 6.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
ability to protect local environment 7.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
threat predition models 6.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
genetic selection for resistant cultivars 7.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
crop insurance 4.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop seafood handling/safety measures 6.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
better nutrient x HABs understanding (timing and ratios) to develop management measures 6.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
depuration of products prior to sale 7.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Include climate													

projections to inform planning 5.7	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
monitoring strategies for disease impacting humans 6.6	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
move to unaffected areas 4.2	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
insure farms do not increase epiphytic HAB species 4.2	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
development of mitigation /husbandry measures by industry to negate HABs impacts 6.7	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	

For issues dealing with HABs impacts on shellfish and finfish: 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 adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. 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
development of mitigation /husbandry measures by industry to negate HABs impacts 6.0	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
Better background information on likelihood of HABs before farm location 5.2	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
genetic													

selection for resistant cultivars 7.6	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
insure farms do not increase epiphytic HAB species 3.2	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
biotoxin monitoring 8.7	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
threat predition models 8.0	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
crop insurance 6.6	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
improved husbandry methods 5.2	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
monitoring strategies for disease impacting humans 8.0	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
HABs forecasting, early detection, real time monitoring 8.3	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
move to unaffected areas 4.9	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
better nutrient x HABs understanding (timing and ratios) to develop management measures 7.2	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
Include climate projections to inform planning 6.5	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
hatchery based seed 7.0	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
develop seafood	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	

handling/safety measures 5.4	○	○	○	○	○	○	○	○	○	○			
ability to protect local environment 6.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
depuration of products prior to sale 6.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

Finfish and Shellfish: Oxygen and general water chemistry

For Oxygen and general water chemistry: 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 and ease of regulatory/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	T
move to areas with better water quality 2.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
improved upland management 5.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
better husbandry practices 4.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
spatial planning overlain with climatic data to develop 'future' map for suitable new locations 7.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
support transition to water column farming/IMTA 4.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
more sites/habitats available for stocking/rotation 5.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
	○	○	○	○	○	○	○	○	○	○			

reliable and monitoring activities in place/real time measurements 6.8												
better early warning/forecasting of low DO events (environmental forecasting) 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
look and solve upstream nutrient additions 5.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
use ecosystem approach to balance aquaculture in an area 6.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
species choice 5.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
Site sutability mapping in general that looks at all potential stressors in advance of licensing activity 6.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
bioenergetic models 5.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄
genetic improvement 7.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
develop aeration systems 4.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄
monitoring systems and methods 6.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄
decrease land based pollution 4.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄

For Oxygen and general water chemistry: 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 adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. Please indicate the time period that this mitigation measure would need to make a significant

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	T
support transition to water column farming/IMTA 4.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
improved upland management 5.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
better early warning/forecasting of low DO events (environmental forecasting) 7.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
move to areas with better water quality 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Site sutability mapping in general that looks at all potential stressors in advance of licensing activity 7.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
spatial planning overlain with climatic data to develop 'future' map for suitable new locations 7.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
decrease land based pollution 7.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
more sites/habitats available for stocking/rotation 6.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
better husbandry practices 5.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
genetic improvement 7.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
use ecosystem approach to balance aquaculture in an area 7.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

look and solve upstream nutrient additions 5.5	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
reliable and monitoring activities in place/real time measurements 6.8	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
bioenergetic models 3.3	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
species choice 6.6	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
monitoring systems and methods 6.2	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
develop aeration systems 6.9	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	

Shellfish and Seaweeds: Dealing with Ocean Acidification

Approaches to dealing with Ocean Acidification: 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 and ease of regulatory/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	C Tho
make seaweed products more cost effective 3.3	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
technology/ability to alter local pH other than co-culture with seaweeds 3.2	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
culture species that thrive in acidic conditions 7.6	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
improve	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	

predictions 5.5													
develop alternative culture methods other than hatcheries for vulnerable life stages 3.3													
culture more resiliant species 6.4													
better monitoring systems 5.3													
restore/protect sea grass beds 5.5													
genetic selection for resiliance 6.5													
relocated to areas where OA not such a problem 4.5													
hatcheries to by-pass vunerable stages 7.5													
Co-culture of shellfish and seaweeds 4.9													
develop adaptation strategies 5.0													

Dealing with Ocean Acidification: 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 adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. 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	C Tho

develop alternative culture methods other than hatcheries for vulnerable life stages 7.2												
relocated to areas where OA not such a problem 5.7												
better monitoring systems 7.0												
technology/ability to alter local pH other than co-culture with seaweeds 5.4												
develop adaptation strategies 5.0												
culture more resiliant species 7.8												
Co-culture of shellfish and seaweeds 7.5												
culture species that thrive in acidic conditions 8.2												
restore/protect sea grass beds 5.7												
improve predictions 7.7												
genetic selection for resiliance 8.0												
hatcheries to by-pass vunerable stages 7.7												
make seaweed products more cost effective 4.0												

Seaweeds and Shellfish: Nutrient and Plankton Availability

Approaches to dealing with nutrient or plankton availability: 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 and ease of regulatory/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	Th
Post harvest holding/finishing 6.0	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
model nutrient dynamics to determine balance for seaweeds/animals and wild 5.9	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
balance nutrients with IMTA 5.3	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
develop nutrient supplementation strategy 4.8	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
better reporting of good environmental status for habitats 7.2	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
better models and validation of nutrient/plankton flow 5.7	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
change growth and harvest timing 5.8	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	
better monitoring and early warning 5.2	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄	

technology to alter local conditions temporarily to make more favorable 1.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄
develop method to upwell nutrients when needed 4.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
optimize location 4.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
genetic selection for resiliance 7.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄
manage increasing agri run off 4.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
better understanding of plankton's role in nutrient and energy transfer 6.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
locate to avoid issues 3.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
monitor N in seaweed blades 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
integrated multi-trophic culture methods 4.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄
change consumer preference for size and other qualities 4.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
stricter environmental management targets 5.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
monitor plankton phenology 7.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄
improved knowledge of impacts during planning 4.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄

develop methods to balance nutrient ratio for beneficial plankton and not HABs 3.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
locate in high nutrient areas 3.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
ecosystem approach to put the right type of aquaculture in the right place to use/balance nutrients 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
model nutrients to balance for farms and wild-use an ecosystem approach 5.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

Dealing with nutrient or plankton availability 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 adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. 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	Th
develop methods to balance nutrient ratio for beneficial plankton and not HABs 4.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
balance nutrients with IMTA 5.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
monitor plankton phenology 4.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Post harvest holding/finishing 5.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop nutrient													

develop nutrient supplementation strategy 4.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
ecosystem approach to put the right type of aquaculture in the right place to use/balance nutrients 4.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄
integrated multi-trophic culture methods 5.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄
model nutrients to balance for farms and wild-use an ecosystem approach 6.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄
better models and validation of nutrient/plankton flow 6.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄
manage increasing agri run off 6.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄
genetic selection for resiliance 7.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
change consumer preference for size and other qualities 3.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
locate to avoid issues 7.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄
better reporting of good environmental status for habitats 5.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
better monitoring and early warning 6.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
improved knowledge of impacts during planning 5.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
technology to	○	○	○	○	○	○	○	○	○	○	⌄	⌄

technology to alter local conditions temporarily to make more favorable 3.7												
optimize location 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
monitor N in seaweed blades 2.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄
develop method to upwell nutrients when needed 4.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
stricter environmental management targets 4.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
better understanding of plankton's role in nutrient and energy transfer 5.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄
locate in high nutrient areas 3.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
model nutrient dynamics to determine balance for seaweeds/animals and wild 6.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄
change growth and harvest timing 5.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄

Any Species Group: Seafood Safety and Quality

Dealing with seafood safety and quality: 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 and ease of regulatory/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	T
Move farms away from the source of the hazard 4.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
better dialogue between farmers and processors to mitigate impacts from closures e.g. not requireing harvesting on specific dates 7.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop low cost depuration systems 5.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
need to develop monitoring programs to protect human health 7.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop added value products 8.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop post harvest storage so harvest can be timed to safe/high quality periods 6.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
better management actions/thresholds 4.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
improved forecasting to improve management 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
stock checks prior to harvest 8.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
public outreach/education 6.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

Dealing with seafood safety and quality: Please rate on a scale from 1 (no impact) to 10 (high impact), the MAGNITUDE/EFFECTIVENESS that each of the mitigation

10 (high impact), the MAGNITUDE/EFFECTIVENESS that each of the mitigation approaches listed in the first column could have on adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. 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	T
better management actions/thresholds 5.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
stock checks prior to harvest 5.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Move farms away from the source of the hazard 5.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
public outreach/education 3.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop low cost depuration systems 6.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop post harvest storage so harvest can be timed to safe/high quality periods 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop added value products 5.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
need to develop monitoring programs to protect human health 5.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
improved forecasting to improve management 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
better dialogue between farmers and processors to mitigate impacts from closures e.g. not requireing harvesting on	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

specific dates 5.4													

Any Species Group: Dealing with changes in growth and survival

Dealing with changes in growth or survival: 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 and ease of regulatory/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	Othe Thoug
Genetic selection for better performance 6.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
improve genetic risk x selection understanding 6.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop diversity in businesses 5.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
use of therapeautics (good and bad) to maintain good health 6.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
crop insurance programs 5.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
change species to something more approparate for new conditions - look south for species in north 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

new farming tech to move to locations with better environment for farming (offshore?) 7.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Develop Hatcheries 4.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
spatial planning to select optimal sites to max G and S 6.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Develop head start programs 5.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
proactive siting/planning to identify resilient farm sites 5.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
adopt and ecosystem approach to management including adaptive management 5.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

Dealing with changes in growth or survival: 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 adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. 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	O Tho
improve genetic risk x selection understanding 7.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

crop insurance programs 6.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
new farming tech to move to locations with better environment for farming (offshore?) 7.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
spatial planning to select optimal sites to max G and S 6.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Develop Hatcheries 5.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
change species to something more approparate for new conditions - look south for species in north 7.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
proactive siting/planning to identify resilient farm sites 6.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Develop head start programs 5.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
adopt and ecosystem approach to management including adaptive management 4.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop diversity in businesses 6.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Genetic selection for better performance	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

performance 6.7													
use of therapeautics (good and bad) to maintain good health 5.3	○	○	○	○	○	○	○	○	○	○			

Any Species Group: Dealing with changes in range of culture species

Dealing with changes in range of culture species: 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 and ease of regulatory/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	Othe Thoug
sterile cultured spp to avoid range expansion of feral pops 5.1	○	○	○	○	○	○	○	○	○	○			
spatial planning for change in species range 6.1	○	○	○	○	○	○	○	○	○	○			
choose new species 6.6	○	○	○	○	○	○	○	○	○	○			
reassess use of area for other species 6.5	○	○	○	○	○	○	○	○	○	○			
develop hatcheries 5.4	○	○	○	○	○	○	○	○	○	○			
target species development with adaptation in mind 5.3	○	○	○	○	○	○	○	○	○	○			

reduce other stressors to provide scope for CC stress; improve health management 4.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
reduce other stressors to provide scope for CC stress; improve nutrition 6.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Regular assessment of ecosystem approach to aquaculture management 6.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
create a historical record of activites lost to climate change 7.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
reduce other stressors to provide scope for CC stress; improve husbandry 5.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop genetic breeding programs if possible 7.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
determine heritability of culture species 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
proactive siting/planning to identify resilient farm sites 6.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
government support for	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

relocation of farms and time to make other adaptive changes 4.7													

Dealing with changes in range of culture species: 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 adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. 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	Othe Thoug
spatial planning for change in species range 6.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop hatcheries 5.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
government support for relocation of farms and time to make other adaptive changes 5.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop genetic breeding programs if possible 6.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
create a historical record of activites lost to climate change 3.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
determine heritability of culture species 2.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
proactive siting/planning to identify	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

resilient farm sites 6.1													
sterile cultured spp to avoid range expansion of feral pops 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
reduce other stressors to provide scope for CC stress; improve husbandry 7.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
reduce other stressors to provide scope for CC stress; improve health management 6.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
reduce other stressors to provide scope for CC stress; improve nutrition 6.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
reassess use of area for other species 5.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Regular assessment of ecosystem approach to aquaculture management 5.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
choose new species 4.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
target species development with adaptation in mind 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

Any Species Group: Dealing with changes predators, pathogens,

parasites and diseases

Dealing with changes in predators, pathogens, parasites and diseases: 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 and ease of regulatory/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	O Tho
move to land based farms 3.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
use of probiotics 7.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
faster growth so they can be harvested before they die 6.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
environmentally sound anti-foulants 5.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Insurance 5.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop monitoring protocols to catch early signs of disease 5.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
drug approval studies/better therapeutics & public education 7.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
identify and encourage adjacent wild species which benefit aquaculture 3.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
improved husbandry methods 6.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Advanced biosecurity 5.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

biosecurity 3.0												
Select resistant species 6.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄
develop a market for the grazers/preditors and harvest 2.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄
ensure seed from hatchery is pathogen free 7.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
deveolp new treatments 7.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
develop the field of "ocean epidemiology" to understand which pathogens will be significant and which will fade away 4.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄
increase number of aquatic Vets 4.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄
reduce other stressors to provide scope for CC stress; improve husbandry 7.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄
certification label from known entity, to ensure consumer confidence 6.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
increase research on pathogens of aquatic organisms (animal and plant) 5.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
threat forecasting for when diseases might be impactful 6.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄
reduce other stressors to	○	○	○	○	○	○	○	○	○	○	⌄	⌄

provide scope for CC stress; improve nutrition 6.9													
removal of non-native species 2.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Breed disease resistant species 8.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

Dealing with changes in predators, pathogens, parasites and diseases: 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 adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. 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	O Tho
move to land based farms 3.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
ensure seed from hatchery is pathogen free 6.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
increase number of aquatic Vets 3.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Select resistant species 5.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop a market for the grazers/preditors and harvest 2.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
environmentally sound anti-foulants 4.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
Advanced biosecurity 6.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
drug approval studies/better													

studies/better therapeutics & public education 6.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄
develop monitoring protocols to catch early signs of disease 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
removal of non-native species 5.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
reduce other stressors to provide scope for CC stress; improve husbandry 7.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
certification label from known entity, to ensure consumer confidence 5.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄
identify and encourage adjacent wild species which benefit aquaculture 4.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
Insurance 3.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
threat forecasting for when diseases might be impactful 6.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄
develop the field of "ocean epidemiology" to understand which pathogens will be significant and which will fade away 7.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
reduce other stressors to provide scope for CC stress; improve nutrition 7.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
	○	○	○	○	○	○	○	○	○	○		

increase research on pathogens of aquatic organisms (animal and plant) 5.3													
Breed disease resistant species 7.0	○	○	○	○	○	○	○	○	○	○			
deveolp new treatments 5.6	○	○	○	○	○	○	○	○	○	○			
use of probiotics 6.5	○	○	○	○	○	○	○	○	○	○			
improved husbandry methods 7.4	○	○	○	○	○	○	○	○	○	○			
faster growth so they can be harvested before they die 6.9	○	○	○	○	○	○	○	○	○	○			

Any Species Group: Dealing with Catastrophic Events

Dealing with Catastrophic Events: 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 and ease of regulatory/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
designs to mitigate other impacts 6.2	○	○	○	○	○	○	○	○	○	○		
insurance 8.0	○	○	○	○	○	○	○	○	○	○		
Geneticly select for ability to survival events 6.0	○	○	○	○	○	○	○	○	○	○		
ability to harvest early 4.6	○	○	○	○	○	○	○	○	○	○		

4.8												
event forecasting/prediction 7.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
use genetic risk models to choose low risk species when they escape 3.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
husbandry practices to ensure stock are not impacted 4.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄
required mitigation plans for events, structural requirements, a robust MSP needs to be in place 7.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
realistic scenarios and climte proof planning 7.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
harden shore-based infrastructure 3.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
design near shore farms to protect shoreline development 3.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄
design to collect energy for own use 2.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
co-locate with offshore wind farms or Marine energy farms to share risks 2.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄
sanctuaries/land based hatcheries for moving/holding fish in short term 4.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
choose robust species for ability to survival events 5.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
disaster relief support 5.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄
remote operation of												

	1	2	3	4	5	6	7	8	9	10		
farms (including feeding of fish and tending of crops) 3.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
timing of prouction to seasonal events 4.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄
make available systems and infrastructure for moving/storing gear 3.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄
move, harden or adapt production practices or timing 6.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
remote farm monitoring 3.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄
invest in ocean engineering/STEM 6.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
better gear 8.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄
develop low cost effective ways to make stock un reproductive for when they escape 4.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄

Dealing with Catastrophic Events: 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 adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. 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
move, harden or adapt production practices or timing 6.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
better gear 8.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
disaster relief support 5.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄

design near shore farms to protect shoreline development 4.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
event forecasting/prediction 7.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
husbandry practices to ensure stock are not impacted 5.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
Geneticly select for ability to survival events 6.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄
insurance 7.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
sanctuaries/land based hatcheries for moving/holding fish in short term 5.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄
co-locate with offshore wind farms or Marine energy farms to share risks 3.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄
make available systems and infrastructure for moving/storing gear 4.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄
designs to mitigate other impacts 7.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄
develop low cost effective ways to make stock un reproductive for when they escape 6.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄
realistic scenarios and climte proof planning 6.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄
remote operation of farms (including feeding of fish and tending of crops) 4.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄
harden shore-based	○	○	○	○	○	○	○	○	○	○	⌄	⌄

infrastructure 3.4												
remote farm monitoring 5.6												
invest in ocean engineering/STEM 5.1												
design to collect energy for own use 2.7												
use genetic risk models to choose low risk species when they escape 4.9												
ability to harvest early 6.0												
required mitigation plans for events, structural requirements, a robust MSP needs to be in place 7.5												
timing of prouction to seasonal events 3.7												
choose robust species for ability to survival events 5.4												

Any Species Group: Distribution of wild broodstock and natural spawn timing

Dealing with changesDistribution of wild broodstock and natural spawn timing: 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 and ease of regulatory/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	Other Thoughts

develop hatcheries to smooth out production over year 7.6													
genetic breeding programs to change spawn timing 4.9													
monitoring research on changing distribution and timing 7.3													
sterilization of cultured organisms 6.9													
use genetic risk models to choose low risk species 7.7													
focus on a few species that can have enough critical mass to support the science 6.8													
monitor phenology 6.8													

Dealing with changes in Distribution of wild broodstock and natural spawn timing: 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 adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. 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	Other Thoughts
monitor phenology 4.2	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
develop hatcheries to smooth out production over year 8.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
focus on a few species that can have enough critical mass to support the science 7.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
use genetic risk models to choose low risk species 5.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
genetic breeding programs to change spawn timing 6.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
monitoring research on changing distribution and timing 4.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
sterilization of cultured organisms 4.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

Any Species Group: Dealing with changes in Habitat suitability

Dealing with changes in Habitat suitability: 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 and ease of regulatory/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	C Th
Develop IMTA and all inclusive permits for species together 6.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
improve genetic ability for existing species to grow in old habitat 6.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
social and economic programs for losses in production areas 5.5	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
strong husbandry, cost-effective practices 5.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
spatial planning for long term suitability 6.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
aquaculture planned with an ecosystem approach can be designed to improve habitat for wild species of interest 6.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
exploratory cultures of new species (warm/introduced species) 4.8	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

	1	2	3	4	5	6	7	8	9	10	Time Frame	Confidence	C Th
industry conflict mitagation 5.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
land based aquaculture 2.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
spatial planning for easier permit processes with potential legal challenges 6.6	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
grow something else 6.4	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
need to develop species that are tolerant to wide rangigng conditns 5.0	○	○	○	○	○	○	○	○	○	○	⌄	⌄	

Dealing with changes in Habitat suitability: 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 adapting to climate change. In thinking about magnitude consider the resiliency the measure could add to the system and/or the amount of seafood the measure could provide. 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	C Th
industry conflict mitagation 2.9	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
spatial planning for easier permit processes with potential legal challenges 6.3	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
spatial planning for long term suitability 5.7	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
exploratory cultures of new species (warm/introduced species) 5.1	○	○	○	○	○	○	○	○	○	○	⌄	⌄	
need to develop species that are													

tolerant to wide rangigng conditns 6.4	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄
improve genetic ability for existing species to grow in old habitat 7.8	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄
aquaculture planned with an ecosystem approach can be designed to improve habitat for wild species of interest 6.2	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄
social and economic programs for losses in production areas 6.6	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄
land based aquaculture 3.0	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄
Develop IMTA and all inclusive permits for species together 4.9	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄
grow something else 6.0	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄
strong husbandry, cost-effective practices 5.9	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	⌄	⌄

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

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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.