Seafood Strategic Outlook

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Climate change risk adaptation in UK seafood:

Understanding and responding to a changing climate in the wild capture seafood industry

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This document combines data, opinions and conjecture and is a position paper at the time of press. It is important to bear in mind that evidence today might suggest trends that turn out to be very different in the longer term.

Introduction

This summary report is focussed on climate change adaptation for the UK wild capture seafood industry covering key sources of domestic and international production. It considers the major impacts across seafood supply chains arising from key climate change drivers and sets out major areas of adaptation action.

A changing climate, and adaptation, is a strategic challenge facing the industry. This reporting exercise, conducted between 2022 and 2023, is an important part of responding to that. Aiming to support the UK seafood industry to develop a managed adaptive approach to climate change, two objectives were set out:

i) provide a review of projected climate change impacts with implications for seafood, and

ii) identify relevant seafood industry adaptation responses (for industry bodies and others to consider and take forward).

Focussing on wild capture supply chains relevant to UK seafood, the exercise was a 'refresh' of a previous wild capture adaptation report conducted in 2014/15. It has been a collaborative initiative of Seafish, Cefas and Aberdeen University, drawing on research evidence - including Marine Climate Change Impacts Partnership (MCCIP) research, as well as industry experience - engaging around 30 seafood stakeholders.

Contents

1. UK seafood industry

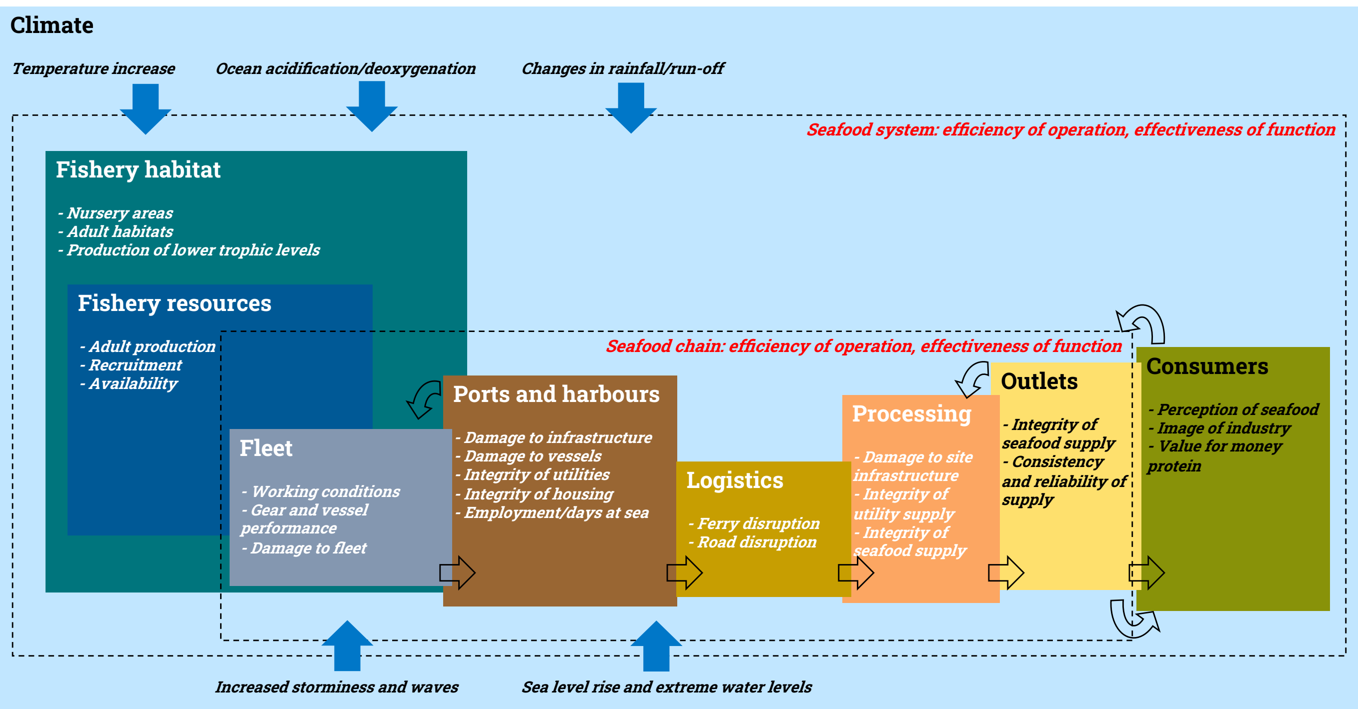
Seafood is part of the food system, centred on providing aquatic food from the marine environment to the consumer. Multiple supply chains, and stages within these chains, connect aquatic food resources with the protein needs of consumers. A changing climate, being a 'risk multiplier', has the potential to generate impacts across this system – threats as well as opportunities (figure 1.1).

The UK seafood system, being reliant on raw material from wild capture and aquaculture production, is diverse, complex, and dynamic. The seafood industry is considered here to operate as many sub-systems (regional, sectoral), of varying degrees of interdependence, nested within one overarching global system.

In the global context, from a UK perspective, there are at least two major seafood systems with distinct characteristics:

- A domestic system – defined as *a system reliant on domestically sourced material (material caught from North Atlantic stocks and landed in the UK, material farmed in the UK)*. Within the 'domestic system', the key UK actors are: producers (farmers/ vessels), agents and merchants in the UK handling material landed/farmed in the UK; seafood processors located in the UK; and the downstream supply chain in the UK of all the former including food service companies, retailers and exporters.
- An international system – defined as *a system reliant on internationally sourced material (material caught from stocks in the North Atlantic and elsewhere landed outside the UK, material farmed outside the UK)*. Within the 'international system', the key UK actors are agents and merchants in the UK importing fish and shellfish that is caught/landed/farmed and possibly processed outside of the UK; seafood processors of imported fish located in the UK; and the downstream supply chain in the UK of all the former including food service companies, retailers and re-exporters.

Figure 1.1 Climate change drivers and related impacts in the wild capture seafood system and chain



It is notable that from a UK perspective, seafood material is generally imported for UK consumption whilst material originating in the UK is largely exported for overseas consumption. The UK consumer maintains a robust preference for salmonids (farmed salmon), whitefish (wild caught cod, haddock and Alaska pollock), pelagics (wild caught tunas) and shellfish (wild caught cold water prawn and farmed warm water prawn). Meanwhile, volumes of UK wild caught seafood are dominated by mackerel and herring (pelagics), Nephrops (shellfish) and cod and haddock (whitefish) whilst UK aquaculture production is dominated by farmed salmon (salmonids) and cultivated bivalve molluscs - predominantly mussels and oyster species (shellfish).

The trade position is such that the UK imports a significant share of seafood (by volume) whilst exporting a large share of landed and farmed volumes. Important source regions for landed seafood imports are:

- North Atlantic and North Pacific for whitefish (cod, haddock and Alaska pollock)
- Equatorial regions – particularly the Indian and Western Central Pacific Oceans - for large pelagic fish (tunas)
- North Atlantic for shellfish (cold water prawn)

Important export destinations include continental Europe, the East and Far East and North America.

This exercise is concerned with wild capture seafood recognising there are some interdependencies with aquaculture (via input into feed ingredients). Being concerned with a natural resource, the wild capture industry is inherently uncertain. Perhaps unsurprisingly the industry, dealing with day-to-day realities, in highly uncertain conditions, does not tend to think far ahead (often a forward view is no more than one year ahead)

2. Perspectives on a changing climate and implications for seafood

The historical pathway for a changing climate is largely uncontested - the world is undoubtedly warming. However, future pathways - how warm the world will get - are by no means settled.

The scientific community outline several pathways where, depending on the emissions we generate, the world may be warmer than it was relative to 1850-1900. For example, we may see: a 'low emissions' world up to 1.8°C warmer, a 'medium emissions' world that is up to 4°C warmer, or a 'high emissions' world up to 6°C warmer.

The central message from the Intergovernmental Panel on Climate Change (IPCC) is that higher emissions, and temperatures, bring greater consequences. To ensure a world that is no warmer than 1.5°C above pre-industrial levels (enshrined in the Paris Agreement): the challenge is greater than previously described; action to date is insufficient; with deep rapid and sustained emissions cuts required. Within the scientific community, there is some criticism that this message has an undue focus on catastrophic futures that are implausible, that could be counterproductive and even harmful.

For UK civic society, broadly speaking, it is important to protect the environment and deal with climate change. Engagement in the climate agenda is moving in a positive direction. However, there are important caveats: intensity of environmental concern varies; there are questions on fairness and who bears the cost; and this agenda competes with other (sometimes more important) concerns. In the last 10 years, several parties - ranging from radical groups to trusted celebrities - have pursued prominent climate change narratives. Dominant narratives that disregard civic concerns could undermine efforts to adapt to a changing climate.

For UK Government, a changing climate has long been reflected in policymaking in national and international agreements. International commitments, becoming a signatory to the Paris Agreement for example, reflect national priorities including: the UK's Climate Change Act 2008; introducing binding commitments to mitigate emissions (net zero by 2050) and adapt to climate change; and, for seafood, the UK Fisheries Act 2020. The latter has a specific objective concerning climate change, such that: the adverse effect of fish and aquaculture activities on climate change is minimised; and fish and aquaculture activities adapt to climate change. This objective is to be operationalised across the UK through the Joint Fisheries Statement.

From a seafood industry perspective, climate change is a more important consideration today compared to the lower priority it was accorded a decade ago (during the previous review): this shift reflects the changing policy context rather than impacts experienced arising from a changing climate. Seafood businesses are used to managing risks and uncertainties; develop views conditioned by supply chain position; vary in their extent of foresight and planning; and range from reactive to proactive operators. A changing climate is highly uncertain, which makes it difficult for industry to invest and prepare for. In consequence, industry operators will tend to be more reactive, with responses delayed until impacts are much clearer. Seafood businesses recognise they'll be affected by a changing climate, in ways in which they're unlikely to gain, and have mixed views as to how far these changes can be anticipated. Seafood business concerns about a changing climate are nuanced and reflect their position in seafood supply chains. For example, catching sector concern for fishing opportunity and the changing ranges of fish species, ports alert to the increased frequency of severe meteorological impacts, and processors about the challenge to responsible sourcing.

2.1 Implications for the seafood industry

Five principal climate change drivers are relevant to seafood. These are:

- sea level rise;
- changes in storms and waves;
- air and water temperature change;
- ocean acidification; and
- changes in terrestrial rainfall.

The focus of this assessment is how these drivers might produce physical impacts, relating to capture fisheries and onshore, as well as non-physical impacts e.g. through behavioural response of stakeholders with direct, or indirect, influence on the seafood system.

The main physical impacts remain familiar to those identified in 2015. The implications for the domestic system relate to: changing catch potential; changes in prevalence of harmful algal blooms (HABs); and impacts on offshore and onshore operations and assets. The main implications for the international system are: alteration of ocean ecosystems with knock-on impacts on fisheries; changing catch potential; regional shifts in stock distribution; and increased severity of tropical storms and flooding.

However, there are additional impacts of emerging relevance now, but not identified in the initial review. These largely relate to non-physical impacts, are generated by stakeholder behaviours, and are relevant to both domestic and international stakeholders:

- market attitudes/demand for seafood, particularly around responsible sourcing;
- geopolitics and illegal, unreported and unregulated (IUU) fishing, particularly for international stakeholders; and
- the resilience of industry in the face of system wide shocks, such as EU exit and Covid-19.

3. Priority impacts and suggested adaptations

In the face of such potential impacts, some of which were identified in the previous 2015 review, helpful adaptations include action already underway, as well as additional action in the longer term. Earlier adaptations suggested in 2015, remain broadly relevant. Further action has been suggested, including additional actions to counter non-physical impacts arising from stakeholder behaviours.

Table 3.1 Key offshore and onshore threats and opportunities – domestic seafood

IMPACT	DRIVERS				
	Sea level rise, extreme water levels	Increased storminess and waves	Air or sea temperature change	Ocean acidification and de-oxygenation	Changes in rainfall/run-off
OFFSHORE					
WHITEFISH					
Fishery resources					
Changes to growth rate of target species			🔴🟢		
Changes to distribution of target species			🔴🟢		
Changes to year-class strength (including larval survival)			🔴🟢		
Alterations in species phenology			🔴		
Choke species (and landing obligations)			🔴		
Migration patterns of target species (timing and routes)			🔴🟢		
Offshore operations					
Physical working conditions for staff		🔴			
Damage to fleet		🔴			
Deployment / performance of beam trawl (flatfish, rays), bottom trawl (whitefish, flatfish), gillnets (whitefish), line capture (whitefish)		🔴			
PELAGIC					
Fishery resources					
Changes to growth rate of target species			🔴🟢		
Changes to distribution of target species			🔴🟢		
Changes to year-class strength (including larval survival)			🔴🟢		
Alterations in species phenology			🔴		
Migration patterns of target species (timing ands routes)			🔴		
Catchability (e.g. Mackerel / thermocline)		🔴	🔴		
Offshore operations					
Physical working conditions for staff		🔴			
Damage to fleet					
Deployment / performance of mid-water trawl, purse-seine, but particularly line capture		🔴			

IMPACT	DRIVERS				
	Sea level rise, extreme water levels	Increased storminess and waves	Air or sea temperature change	Ocean acidification and de-oxygenation	Changes in rainfall/run-off
SHELLFISH					
Fishery resources					
Changes to growth rate of target species			🔴🟢		
Changes to distribution of target species (inc squid)			🔴		
Changes to year-class strength (inc. spatfall)			🔴🟢		
Presence of non - natives / jellyfish			🔴🟢		
Migration patterns of target species (timing and routes)					
Presence of pollutants and contaminants					🔴
Presence of HABs		🔴	🔴		🔴
Presence of pests and disease					🔴
Offshore operations					
Physical working conditions for staff		🔴			
Damage to fleet		🔴			
Deployment / performance of trawls (prawns), dredging (molluscs), less so for pots (crustacea/ whelks)		🔴			
ONSHORE					
Ports and Harbours					
Disruption to marine users and damage to boats within ports/harbours		🔴			
Disruption to port operation and damage to site infrastructure/facilities	🔴	🔴	🔴		🔴
Integrity of electricity supply					🔴
Employment and fishing communities					
Integrity of housing and local amenities	🔴	🔴			
Days at sea (and stability of income for crew)		🔴			
Transportation					
Disruption to road network					
Disruption to ferry services (e.g. between scottish islands and from SW to the continent)					
Disruption to air freight					
Processing of catch					
Damage to site infrastructure/facilities	🔴	🔴			🔴
Integrity of electricity supply					🔴
Markets for seafood					
Changing attitude and demand for seafood products from customers and consumers			🔴		
MACRO CONDITIONS					
National economies, food security, supply chain resilience					
Impact on regional economies of changes in fisheries			🔴		

3.1 UK domestic wild capture seafood system

In a UK domestic sourcing context, two main climate drivers lead to priority impacts across whitefish, pelagic and shellfish fisheries: *air or sea temperature change and increased storminess and waves*. In shellfish fisheries an additional driver is *change in rainfall/run-off*. These give rise to impacts that represent both threats and opportunities (table 3.1).

For example, all fisheries may see changes in species growth rate and year-class strength. In whitefish and pelagic fisheries there may be changes to distribution of target species, as some traditional species move away and warmer water species move in. Shellfish fisheries may experience changes in the prevalence of non-natives / jellyfish. Onshore, these two drivers also lead to priority impacts but are compounded by *sea level rise and extreme water levels and changes in rainfall / run-off*. Several threats arise, particularly disrupted port operations, damage to processing facilities and the integrity of electricity and housing.

Over the last decade, independent stakeholder action has supported adaptation. Action has focussed on developing new, emerging fisheries; enhancing fisheries science and knowledge base; ensuring flexibility in fisheries management regimes and governance; building port resilience and improving port risk management; assessing the vulnerability of fleets; and keeping a 'watching brief' on a changing climate and industry response.

Further action, however, is needed to address ongoing and emerging impacts (table 3.2). In the immediate term suggested action centres on protecting port facilities and users, in the next five years action will be needed to improve fisheries science and quota management, adopt safer fishing practices and new roles (to support research and maintain a 'watching brief'), improve port risk management and contribute to local sea defences. Action is also needed beyond five years: investing in a strategic fisheries knowledge base; ensuring flexibility in fisheries governance and management; understanding fleet vulnerability; new practices for fishermen; investment in portside infrastructure and ensuring onshore capacity to handle changes in species and improve the market perception of seafood.

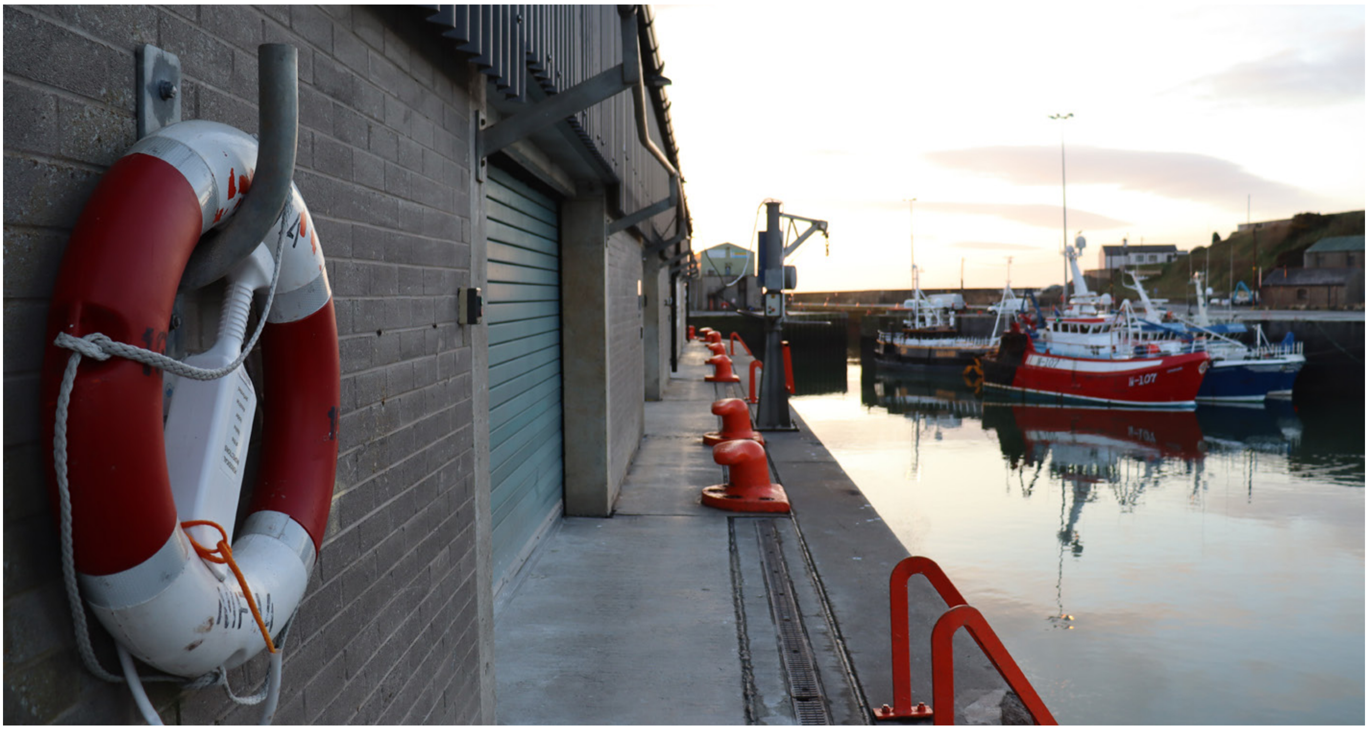


Table 3.2. Adaptation responses – domestic seafood system

Timeline		System	Adaptation response	Owner stakeholders	Resource		
					Low	Medium	High
Speed of response (inertia)	Immediate	Ports	Review port users' climate impacts on the inshore 'ecosystem' and fleet	**Govt, Seafish**	**L**		
			Build port resilience	**Industry, Govt**		**M**	
			Ensure berth allocations for vulnerable vessels	**Industry, Govt**		**M**	
			Address the disaggregated nature of local port users, tenants, power assets etc	**Industry, Govt (Dept of Transport)**		**M**	
			Manage the uncertainty of sea levels	**Industry, Met Office,** Govt, Seafish		**M**	
	Short term (<5 years)	Fishery	Enhance scientific data collection and advice	**Scientists,** Industry	L	**M**	H
			Improve science-industry collaboration and engaged research	**Scientists,** Industry	L	**M**	H
			Produce better science to support accreditation	**Industry,** Scientists	**L**	M	H
			Establish key 'climate' indicators, frequency of assessment, and response thresholds	**Govt,** Scientists	L	**M**	H
			Ensure quota transfer and flexibility (national level)	**Govt (& Devolved Administrations)**	L	**M**	H
		Offshore operations	Improve operational safety through vessel design	**Industry,** Scientists (FIS)	**L**	M	H
			Improve operational safety through safety at sea training and Personal Flotation Devices	**Seafish, Industry**	**L**	M	H
			Provide training and education modules for fishermen	**Industry,** Scientists, Seafish	**L**	M	H
			Provide bottom-up information feed, use of vessels at sea to detect oceanographic changes etc	**Industry,** Scientists, Govt	**L**	**M**	H
			Keep a 'watching brief' on climate change and potential responses	**Industry, Seafish,** Scientists	**L**	M	H
		Ports	Improve port risk management	**Industry, Govt**	**L**	**M**	
			Highlight ports' role in local towns' sea defences to ensure 'smart' public investment	**Industry**	**L**		
	Medium term (5-15 years)	Fishery	Develop a more robust strategic fisheries knowledge base	**Govt,** Industry, Scientists, Seafish	L	**M**	H
			Ensure quota swaps / transfers (international)	**Govt**	L	**M**	H
			Review domestic quota allocation	**Govt,** Industry, Scientists	L	M	**H**
			Review fisheries management to make it more flexible, including 'relative stability'	**Govt,** Industry, Scientists	L	M	**H**
		Offshore operations	Assess vulnerability of fishing fleet	**Seafish,** Industry, Scientists	L	**M**	H
			Review fishing seasons in response to disruptions	**Govt,** Industry, Scientists	L	M	**H**
			Provide funding for vessels looking to change gear to target emerging species	**Govt**	L	**M**	H
		Ports	Invest in portside infrastructure	**Govt,** Industry	L	M	**H**
		Processing	Ensure processors can cater for smaller/new species	**Industry,** Govt	L	M	**H**
		Market	Improve market perception, and highlight the importance, of seafood	**Seafish,** Industry, Govt	L	M	**H**

Case examples

Northeast Atlantic mackerel

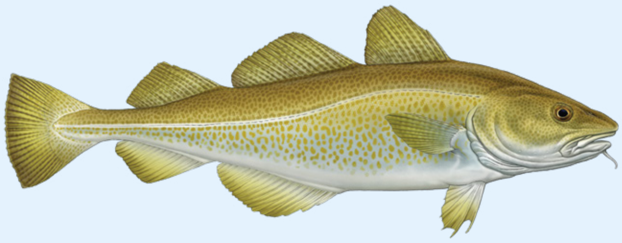
- **A 'straddling stock' - its range extends across several Exclusive Economic Zones (EEZs) and into international waters.**
- The UK fleet catches more mackerel than any other species, comprising **33% of the total UK catch in 2022 (197,003 tonnes).**
- During the period 2007-2016 the **distribution range increased three-fold** and the centre-of-gravity, shifted westward by 1,650 km and northwards by 400 km.
- Projections, under a medium emissions scenario, suggest 'habitat suitability' for mackerel may **increase in the UK EEZ by 2050**.
- Possible consequences: **disputes between catching nations** about quota allocation ('zonal attachment') as fish move across jurisdictions.

Atlantic bluefin tuna

- **Highly migratory,** with spawning site fidelity in the Mediterranean Sea.
- **Seas around the British Isles act as a feeding ground** between August and December.
- Jurisdiction and fishery management via **International Commission for the Conservation of Atlantic Tunas** (ICCAT).
- Tuna have now been reported as far north as Iceland and Greenland, possibly **shifting their distribution in response to the expansion of mackerel**.
- For 2023 the **UK was allocated 65 tonnes of bluefin tuna quota** by ICCAT, of which 39 tonnes were used to trial a new small-scale commercial fishery.
- Projections, under a medium emissions scenario, suggest that 'habitat suitability' for this high value fish will **increase in the UK EEZ**.
- Possible consequences: **fishing disputes between catching nations** as fish move across jurisdictions.

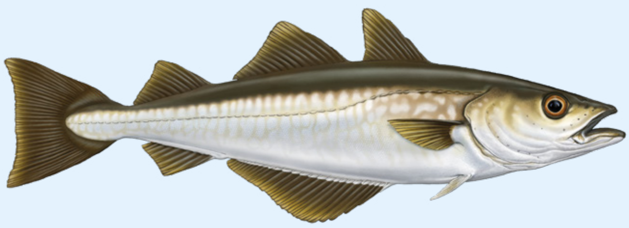
Cod and haddock from the Barents Sea fishery

- The **Barents Sea contains the largest cod stock** in the world.
- In 2020 the **UK imported 49,467 tonnes (liveweight) of cod and 26,843 tonnes (liveweight) of haddock** and caught 12,113 tonnes of cod and 320 tonnes of haddock.
- Under medium emissions scenario projections, NE Arctic cod and haddock are **expected to perform well with improved productivity, improved catches, and continued availability**.
- Fishing may damage vulnerable habitats as it pushes further north into new, less well understood terrain.
- Possible consequences: **fishing disputes between catching nations** as fish move across jurisdictions.

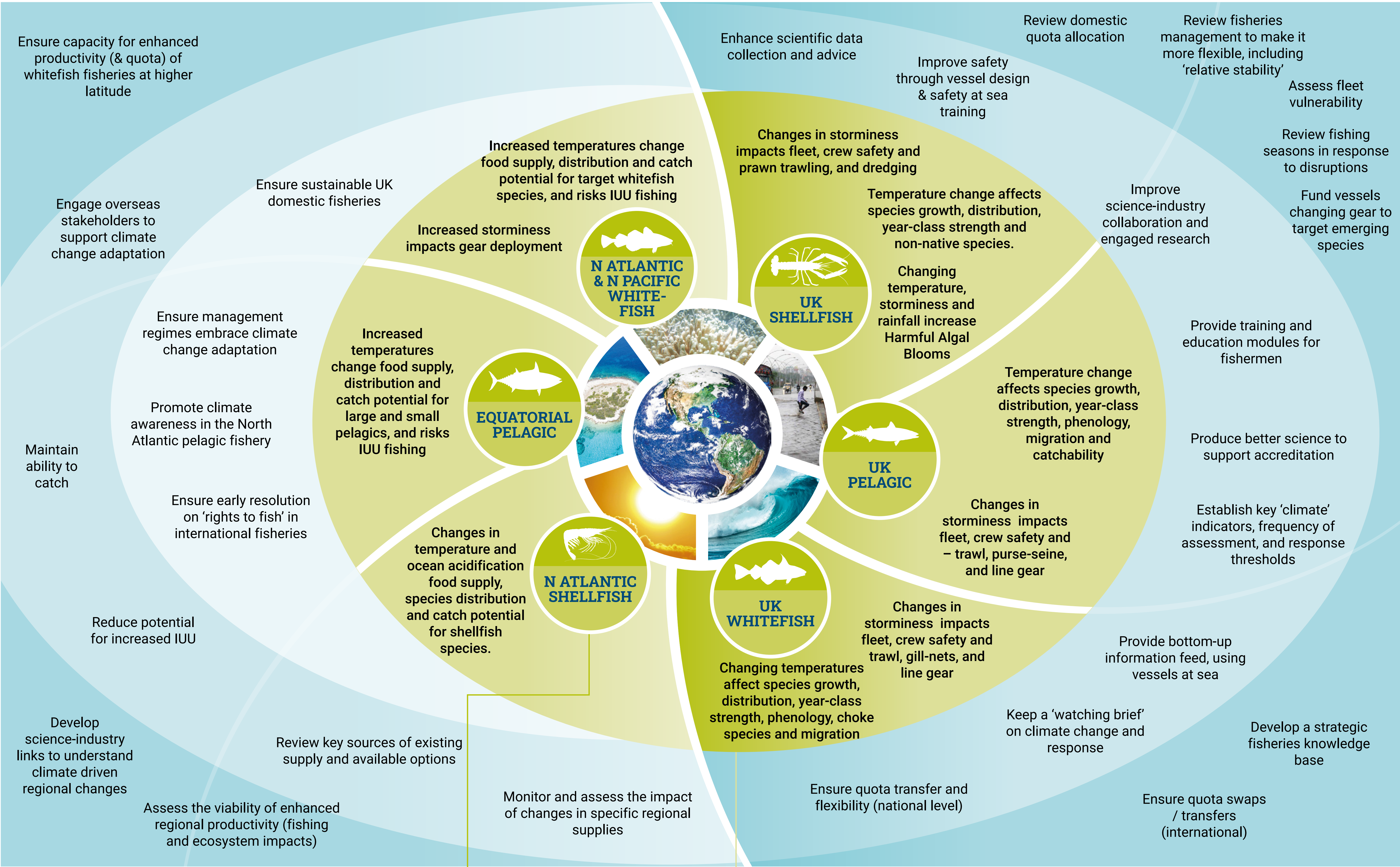


Alaska pollock from the Bering Sea fishery

- The **North Pacific contains the largest Alaska pollock stock** in the world.
- In 2020, the **UK imported 27,360 tonnes (liveweight) directly from USA**, for processing into several different consumer products, including fish fingers.
- Under high emissions scenario projections there is *"High confidence that centroids of biomass for some .. **species will shift northwards into northern Bering Sea** waters where commercial fishing is limited."*
- There are already indications of **marine heatwaves affecting the fish condition and quality** of Alaska pollock.
- Possible consequences: fish could **move across jurisdictions**, with potential for fishing disputes between catching nations.



Climate change and UK seafood:
example impacts and adaptation responses in key sources of wild capture production

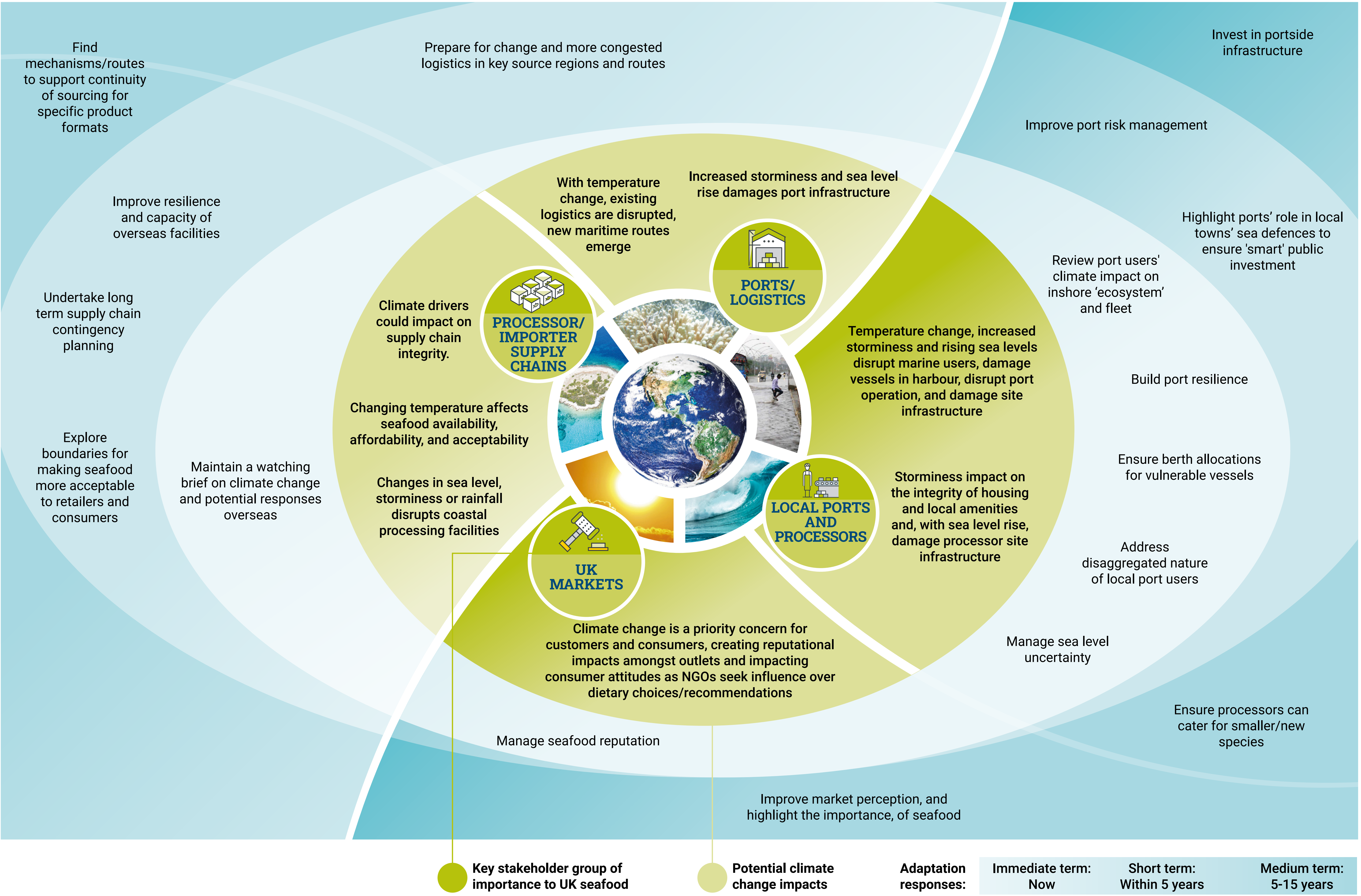


Key species group of importance to UK seafood

Potential climate change impacts

Adaptation responses: **Immediate term:** Now | **Short term:** Within 5 years | **Medium term:** 5-15 years

Climate change and UK seafood:
example impacts and adaptation responses in key onshore seafood operations



3.2 UK international wild capture seafood system

In a UK international sourcing context, *air or sea temperature change* is the main climate change driver leading to priority impacts offshore and onshore, with *increased storminess and waves* and *sea level rise and extreme water levels* as additional drivers behind onshore impacts (table 3.3).

In whitefish and pelagic fisheries changes in air or sea temperatures create both threats and opportunities in terms of changes of distribution of target species, and the potential for increased IUU practices as species move across jurisdictional boundaries. Logistics routes are also exposed with disruption to existing maritime routes and potential for new routes. Onshore, risks are compounded by potential changes in sea levels, water levels, rainfall and run-off, with potential for damage to port infrastructure and disruption to coastal processing facilities.

Over the last decade, independent stakeholder action has contributed to adaptation. Action has focussed on reviewing UK sources of seafood supply and understanding impacts in specific regions; improvements in fisheries governance; developing closer science-industry links, and greater stakeholder engagement to support adaptation, in key regions; keeping a 'watching brief' on a changing climate and industry response.

Further action, however, is needed to counter ongoing and emerging impacts (table 3.4). In the immediate term suggested action is to ensure management regimes can adapt and retain a focus on sustainability, keep a 'watching brief' on changes underway and manage seafood reputation. Within the next five years, there is a need to understand changes in key regional sources and the supply impact, maintain the ability to catch and avoid IUU incidence, prepare for change and more congested logistics in key source regions and routes, manage associated supply chain risks and improve product acceptability for customers. Beyond five years, action should focus on maintaining confidence in fisheries science, assessing the viability of fishing in specific regions, ensuring capacity to secure any enhanced whitefish productivity, and maintaining continuity of supplying product formats preferred by the market.

Additionally, for both domestic and international seafood systems, action is needed to address the impact of stakeholder behaviours (non-physical climate impacts). Of direct relevance is the potential for changes in market attitudes/demand for seafood. This relates primarily to preferences of seafood buyers (processors and outlets) and consumers. However, the behaviours of policymakers, civic society, and the scientific community are also relevant (given the potential/appetite for sensationalist headlines in the media). Suggested action is directed towards defending industry reputation and maintaining/enhancing market perceptions of seafood.

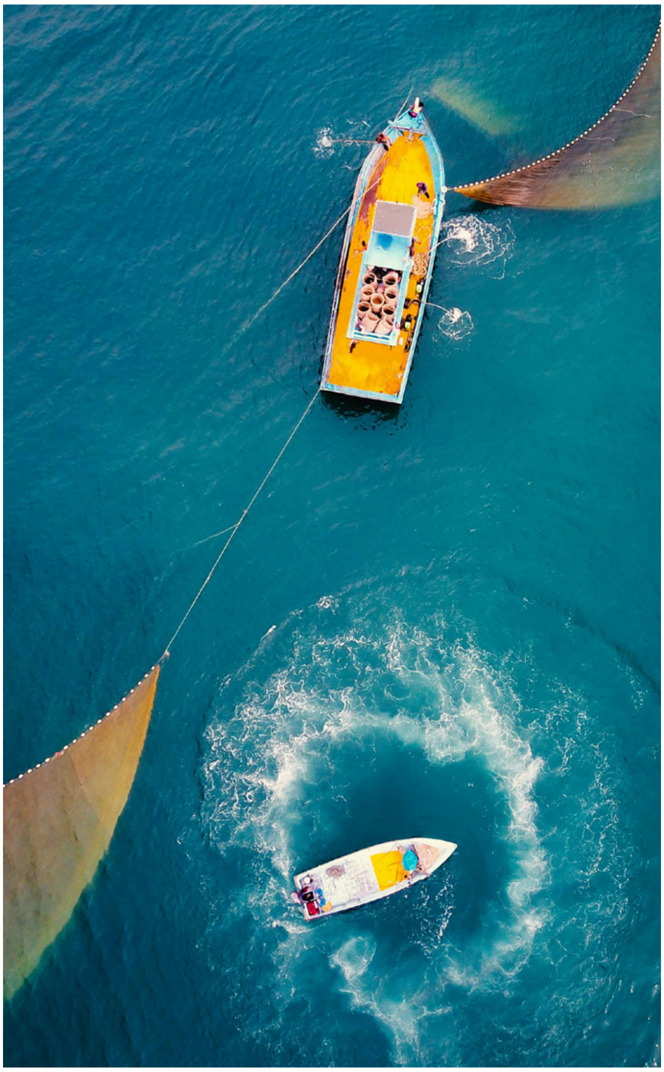


Table 3.3. Key offshore and onshore threats (red) and opportunities (green) – international seafood

IMPACT	DRIVERS				
	Sea level rise, extreme water levels	Increased storminess and waves	Air or sea temperature change	Ocean acidification and de-oxygenation	Changes in rainfall/run-off
OFFSHORE					
CAPTURE FISHERIES (global/general)					
Fishery resources					
Changes in food supply, species distribution, and fisheries productivity			🔴🟢		
Loss of fisheries production at lower latitudes			🔴		
Enhanced fisheries production at high latitudes			🟢		
Offshore operations					
Impact on international fisheries governance & access rights			🔴		
Increase in illegal, unreported, and unregulated (IUU) fishing			🔴		
WHITEFISH					
Fishery resources					
Changes in food supply, species distribution, and catch potential of target species (general):			🔴🟢		
Atlantic Arctic ocean			🔴🟢		
North Atlantic ocean			🟢		
North Pacific ocean (Bering Sea and Gulf of Alaska)			🔴🟢		
Impact on seafood quality			🔴🟢	🔴	
Offshore operations					
Impact on deployment/performance of gear					
North Atlantic ocean		🔴			
PELAGIC					
Fishery resources					
Changes in food supply, species distribution, and catch potential of target species (general):			🔴		
- Large pelagic fisheries			🔴		
Western Central Pacific ocean (tunas)					
- Small pelagic fisheries					
Pacific ocean (anchoveta and sardine)			🔴		
Offshore operations					
Increase in illegal, unreported, and unregulated (IUU) fishing					
Pacific ocean					
SHELLFISH					
Fishery resources					
Changes in food supply, species distribution, and catch potential of target species (general)					
Impact on stocks of harmful algal blooms					
Offshore operations					
Impact on deployment/performance of gear					

IMPACT	DRIVERS				
	Sea level rise, extreme water levels	Increased storminess and waves	Air or sea temperature change	Ocean acidification and de-oxygenation	Changes in rainfall/run-off
ONSHORE					
Ports and Harbours					
Damage to site infrastructure	🔴	🔴			🔴
Transportation					
Impact on maritime transport (disruption to existing logistics, new routes opening with Arctic ice loss)	🔴🟢	🔴🟢	🔴🟢		
Processing of catch					
Disruption or damage to coastal processing facilities	🔴	🔴			🔴
Demand for 'at sea' processing and freezing (as stocks shift to more distant grounds / supply chain cooling)					
Shifts in seafood availability, affordability and acceptability			🔴		
Employment and fishing communities					
Impact on fishing communities:					
- Integrity of local business and domestic facilities					
- Changes in catch potential and value of landed catch					
Markets for seafood					
Changing attitude and demand for seafood products from customers and consumers			🔴		
MACRO CONDITIONS					
National economies, food security, supply chain resilience					
Impact on national economies of changes in fisheries			🔴	🔴	
Impact on food security of changes in fisheries			🔴	🔴	
Impact on supply chain integrity	🔴	🔴	🔴	🔴	🔴

Table 3.4. Adaptation responses – international seafood system

Timeline		System	Adaptation response	Owner stakeholders	Resource		
					Low	**Medium**	**High**
Speed of response (inertia)	Immediate (Now)	Fishery	Ensure management regimes embrace the concept of climate change adaptation	**Industry, Scientists,** Govt	L	**M**	H
Speed of response (inertia)	Immediate (Now)	Fishery	Promote an awareness of climate change in the North Atlantic pelagic fishery	**Industry, Scientists, Govt**	L	**M**	H
Speed of response (inertia)	Immediate (Now)	Fishery	Ensure early resolution on 'rights to fish' in international fisheries management regimes	**Industry,** Scientists, Govt (UK+)	L	**M**	H
Speed of response (inertia)	Immediate (Now)	Fishery	Ensure sustainable UK domestic fisheries	**Govt,** Industry, Scientists, Seafish	L	**M**	H
Speed of response (inertia)	Immediate (Now)	Processing	Maintain a watching brief on climate change and potential responses overseas	**Seafish,** Industry, Scientists, Govt	L	**M**	H
Speed of response (inertia)	Immediate (Now)	Market	Manage seafood reputation	**Govt,** Industry, Scientists, Seafish	L	M	**H**
Speed of response (inertia)	Short term (<5 years)	Fishery	Review key sources of existing supply and available options	**Industry, Scientists,** Govt	L	**M**	H
Speed of response (inertia)	Short term (<5 years)	Fishery	Monitor and assess the impact of changes in specific regional supplies	**Seafish**, Industry, Scientists, Govt	**L**	M	H
Speed of response (inertia)	Short term (<5 years)	Offshore operations	Engage with overseas stakeholders to support climate change adaptation	**Industry,** Scientists, Govt, Seafish	L	**M**	H
Speed of response (inertia)	Short term (<5 years)	Offshore operations	Maintain ability to catch	**Industry,** Scientists	L	**M**	H
Speed of response (inertia)	Short term (<5 years)	Offshore operations	Reduce the potential for increased incidence of illegal, unreported, unregulated (IUU) fishing	**Industry, Govt,** Scientists	L	M	**H**
Speed of response (inertia)	Short term (<5 years)	Ports / logistics	Prepare for change and more congested logistics in key source regions and routes	**Govt (UK+),** Industry, Scientists	L	**M**	H
Speed of response (inertia)	Short term (<5 years)	Processing	Improve resilience and capacity of overseas facilities	**Industry,** Scientists, Govt	L	**M**	H
Speed of response (inertia)	Short term (<5 years)	Processing	Undertake long term supply chain contingency planning.	**Industry (e.g. ASMI, NSC etc)**	L	M	H
Speed of response (inertia)	Short term (<5 years)	Processing	Explore boundaries for making seafood more acceptable to retailers and consumers	**Industry (retail),** Seafish	L	M	H
Speed of response (inertia)	Medium term (5-15 years)	Fishery	Develop much closer science-industry links to understand climate driven regional changes	**Industry, Scientists,** Govt	L	**M**	H
Speed of response (inertia)	Medium term (5-15 years)	Fishery	Assess the viability of enhanced regional productivity (fishing and ecosystem impacts)	**Scientists,** Industry, Govt	L	M	**H**
Speed of response (inertia)	Medium term (5-15 years)	Offshore operations	Ensure capacity for enhanced productivity (& quota) of whitefish fisheries at higher latitude	**Industry,** Scientists	L	M	H
Speed of response (inertia)	Medium term (5-15 years)	Processing	Find mechanisms/routes to support continuity of sourcing for specific product formats	**Industry**	L	M	H

4. Response and next steps

This exercise has highlighted differences in how the domestic and international industry will be affected by a changing climate. The experience of the Covid-19 pandemic also revealed differing impacts across these domains, but also interdependencies and cascading impacts. To this extent there are useful similarities to be drawn in anticipating climate related shocks to the seafood system.

4.1 Vulnerability and response

Industry vulnerability, the ability to respond to anticipated changes, varies across the seafood system. This is influenced to a large degree by the extent of regulation, but also the wider seafood market - insofar as it determines what can be sold and the ability of sectors to serve market needs.

For UK domestic industry, regulatory arrangements that allow a flexible and agile management regime would support much faster response, and at a much bigger scale, in the face of the changes anticipated. Beyond regulatory conditions, those better placed to respond may be those in pelagic and whitefish - particularly larger operators, in concentrated sectors and mainland hubs. These stakeholders may have higher adaptive capacity and lower vulnerability, than those in diffuse sectors - like shellfish - with smaller operators across disparate locations.

For international stakeholders, operators better able to respond to climate related impacts appear to be those in pelagic and shellfish - and to a lesser extent whitefish, vessels in the offshore fleet, those with a mainland location with large operators and processing. Those that appear less able to respond – and consequently more vulnerable - are inshore vessels, those with an island location, and smaller operators.

4.2 Recommended pathway for adaptation

Barriers to climate change adaptation should be recognised. Climate change is an emergent challenge, our understanding of which continues to evolve, influencing a dynamic, unpredictable, industry. Although now a much higher priority than in 2015, climate change is one of many challenges facing the seafood industry and competes with other priorities – some which may represent more immediate existential threats for businesses. Finally, successful adaptation is subject to a wide range of interdependencies and cascading impacts.

The range of interdependencies and potential cascading impacts should be noted. These include those within seafood supply chains; between domestic and international wild capture seafood; and between wild capture seafood and other sectors. The latter include utilities (particularly electricity provision and offshore wind), logistics and transport sectors, other food sectors (agricultural production but also food outlet behaviour) and the public sector.

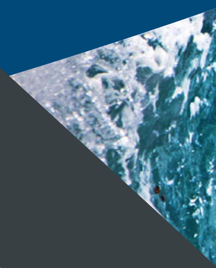
As climate change impacts and adaptation responses may be non-linear, advancing adaptation actions in wild capture seafood may benefit from a 'framework' rather than a 'grand plan' for adaptation. This would see:

- Adaptation responses brought into existing corporate planning processes of each stakeholder
- High-level monitoring, and
- Regular review of climate change impacts and adaptation responses.

4.3 Suggested next steps for wild capture seafood stakeholders

Several next steps are suggested for stakeholders in wild capture seafood. These are to:

- review adaptation responses in this report and operationalise as necessary;
- review the appropriateness of an adaptation framework for wild capture seafood;
- use this assessment as the central contribution to future wild capture seafood adaptation plans; and,
- maintain an understanding, and raise awareness, of relevant climate change impacts and advance appropriate response options.



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