Environmental Impacts of Fisheries

Contents

Post-workshop summary of impacts 1
ELICITATION RECORD – Part 1 7
ELICITATION RECORD – Part 2: Outcome 1 11
ELICITATION RECORD – Part 2: Outcome 2 17

Post-workshop summary of impacts

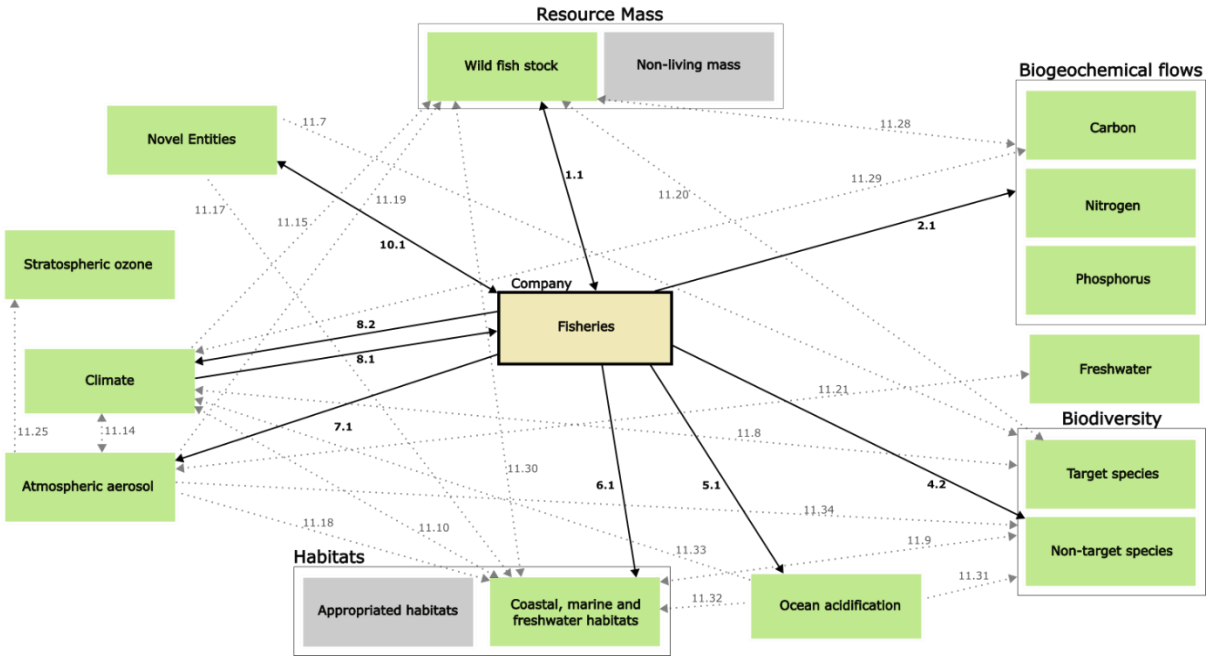

Figure 1. Conceptual systems diagram showing potential interactions between a company (yellow box) and various environmental dimensions. Dimensions are based on processes captured by the planetary boundaries framework, with the addition of natural resources. Solid lines represent direct impacts and/or dependencies of the company on various environmental dimensions. Dashed lines represent interactions between environmental dimensions. Viewed together, solid, and dashed lines represent the indirect impacts and dependencies of the company. Numbers refer to Tables 2 and 3 in this document. Boxes are shaded depending on if mechanistic links (i.e. arrows) are present (green) or not (grey).

Table 1. Direct environmental impacts and dependencies of wild-caught fisheries sector, shown as solid lines in figure 2. Links between a company operating in this industry, and the different environmental dimensions, are visually represented in Figure 1. References are numbered, 'W' indicates data from the expert elicitation workshop.

No.	Category	Sub-category	Impact, Dependency or Both	Description of Mechanisms	References
1.1	Resource mass	Wild fish stock	Both	Use of living biomass as input. However, overextraction can lead to resource depletion, e.g. overfishing leading to fish stock collapse.	1
2.1	Biogeochemical flows	-	Impact	Removal of fish causes effects on biogeochemical cycles of N, P and C.	W
4.2	Biodiversity (non-target species)	-	Impact	Direct impacts on biodiversity due to by-catch of non-target species	1
5.1	Ocean acidification	-	Impact	Emissions of CO_2 from fishing vessels increase the acidity of surface seawater	2
6.1	Habitats	Coastal, marine and freshwater	Impact	Impacts on native habitats includes habitat destruction and fragmentation from certain types of fishing gear and dynamite fishing. Pollution impacts habitat quality, including plastics, hazardous substances, scrubber discharge water, sound and light.	1, W
7.1	Atmospheric aerosol	-	Impact	Fishing vessels emit various aerosols, including primary aerosols (particle emissions from diesel engines, including black carbon) and secondary aerosols, including NO_x and SO_x.	3
8.1	Climate	-	Dependency	Climate regulation contributes to the operation of fisheries, e.g. weather conditions, ice in store rooms	W
8.2	Climate	-	Impact	Fishing vessel emissions contribute to climate change, especially CO_2 and black carbon (BC), but also CH_4.	1, 3
10.1	Novel entities	-	Both	Fishing operations use novel entities, e.g. plastic fishing gear, fuels for vessels. They also cause pollution, including fuel discharge from vessels, oil spillages, dumping of plastics waste, and abandoned, lost or dumped fishing gear.	1, 3, 4

Table 2. Interactions between environmental processes relevant to fisheries sector, shown as dashed lines in figure 1. Links are visually represented in Figure 1. References are numbered, 'W' indicates data from the expert elicitation workshop.

No.	Categories	Description of Mechanisms	References
11.7	Biodiversity, Novel entities	Impact of novel entities on biodiversity, e.g. marine debris (especially plastic) has deleterious effects on wildlife. Increasing numbers of species are affected by entanglement or ingestion of plastic debris, including marine turtles, marine mammals, seabirds, fish and invertebrates.	5
11.8	Biodiversity, Climate	Climate and biodiversity are connected. Climate change and biodiversity loss are mutually reinforcing; resolving either issue requires consideration of the other, e.g. physical components of climate change, such as temperature, salinity, pH and oxygen affect biodiversity. Climate change is a key driver of biodiversity loss.	6
11.9	Biodiversity, Habitats (Coastal, marine and freshwater)	Interactions between native habitats and biodiversity, e.g. spatial patterns of fish biodiversity is strongly associated with forest cover in some rivers. Conversion of primary old-growth forests to secondary habitats may cause loss of multiple animal-mediated ecosystem services. Predation on salmon by bears is an important ecosystem process and can determine nutrient cycling through terrestrial or aquatic pathways.	7, 8, 9
11.10	Habitats (Coastal, marine and freshwater), Climate	Interactions between native habitats and climate regulation, e.g. sufficient native habitat in critical carbon-rich ecosystems would provide substantial benefits for climate mitigation.	6
11.14	Atmospheric aerosol, Climate	Aerosols have complex interactions with the climate system. They have both a cooling effect, by reflecting incoming solar radiation, and a warming effect, by absorbing heat radiation and changing surface albedo, but the net impact is a cooling effect. Uncertainty arises from complexity of aerosol absorption and impacts of aerosols on cloud microphysics.	2, 10
11.15	Climate, Living biomass	Climate processes are connected to physical components including temperature, salinity, pH and oxygen. These affects state, composition and location of fish stocks. Climate change will reduce the maximum catch potential of tropical fish stocks.	11, 12
11.17	Habitats (Coastal, marine and freshwater), Novel entities	Habitat pollution, e.g. marine pollution of hazardous substances, plastic, oil and fishing gear by fishing vessels	3, 4
11.18	Atmospheric aerosol, Habitats (Coastal, marine and freshwater)	Aerosols have harmful impacts on habitats, e.g. ozone is a significant cause of air pollution damage to plants.	13
11.19	Atmospheric aerosol, Biomass	Aerosols have harmful impacts on flora and fauna, e.g. ozone dissolved in water is known to be toxic to fish.	13
11.20	Living biomass, Biodiversity (Target species)	The extraction of fish stocks affects ecosystem structure and function and harms biodiversity, e.g. overextraction of fish affects the entire ecosystem, especially where there is little functional	1, 14, W

		diversity, such as where the extracted fish species is the key predator. Fishing also particularly affects genetic diversity of targeted species. Fisheries are dependent on biodiversity via fish stocks. Functional biodiversity supports healthy fish stocks while genetic biodiversity is inherent to healthy fish stocks.	
11.21	Atmospheric aerosol, Freshwater	Aerosols influence the hydrological cycle by altering mechanisms that form precipitation in clouds. Aerosols may substantially influence the Asian monsoon circulations.	15, 16
11.25	Atmospheric aerosol, Stratospheric ozone	High stratospheric aerosol loading reduces the ozone depletion potential (ODP) of N_2O, because NO_x is converted to HNO_3 on aerosol surfaces. In addition, aerosols affect ozone loss through Cl_y chemistry.	17
11.28	Living biomass, Biogeochemical flows	Fish stocks are part of biogeochemical cycles, because C, P and N are the building blocks of life. Hence, biogeochemical flows are central to maintaining fish stocks.	W
11.29	Climate, Biogeochemical flows (Carbon)	The carbon cycle is closely connected to climate stability and change. One mechanism is that marine biomass functions as an oceanic biological pump. It sequesters carbon by transferring particulate and dissolved organic carbon from the surface to the deep ocean carbon sink, thus playing a key role in the global carbon cycle.	18
11.30	Habitats (Coastal, marine and freshwater), Living biomass	Fish stock depends on habitats, e.g. nursery habitats. Fish stocks also contribute to maintaining habitats.	1, W
11.31	Ocean acidification, Biodiversity	Many marine organisms are highly sensitive to changes to ocean CO_2 chemistry, especially those using carbonate ions to form calcium carbonate shells or structures. Ocean acidification could be deleterious to such organisms, which would constitute a major disturbance to marine ecosystems with highly uncertain impacts. Marine plankton are also vulnerable.	2
11.32	Ocean acidification, Habitats (Coastal, marine and freshwater)	Ocean acidification may have serious impacts on coral and other reef communities.	2
11.33	Ocean acidification, Climate	Oceans remove a large proportion of anthropogenic CO_2, but acidification threatens the ability of oceans to continue to function as a carbon sink.	2
11.34	Atmospheric aerosol, Biodiversity	Aerosols have harmful impacts on flora and fauna, e.g. exposure to ozone can kill freshwater fish.	2, 19

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ELICITATION RECORD – Part 1

The Workshop Context

Elicitation title	Essential Environmental Impact Variables
Workshop	Wild-caught Fisheries
Date	9 November 2022
Part 1 start time	9am

Attendance and roles	Facilitator, Note taker, Experts 1, 2 and 3
Purpose of elicitation	1. Assessment of background review: assess the background review of impacts and ensure that all significant and salient impacts from an industry on the environment are captured in the conceptual systems diagram and the associated tables. 2. Assessment of greatest impact: assess which of these impacts have the greatest impact on the environment. By 'greatest' we mean that impacts have either 1) a large globally cumulative impact; or 2) impacts that are locally incurred but are identified as generally having the largest local effect.
This record	Participants are aware that this elicitation will be conducted using an adapted Sheffield Elicitation Framework, and that this document, including attachments, will form a record of the session.
Orientation and training	Participants received a pre-workshop participant brief.
Participants' expertise	<u>Expert 1</u> *Expertise:* Impacts in seafood industry, industrial scale rather than small scale. Mostly global scale resolution of analysis. Additional work on private sector on seafood and ocean economy – know about discrepancies between impacts vs. reporting, and finance, ESG narrative. <u>Expert 2</u> *Expertise:* Wild fish stock – what are components, feedbacks. Ecologist by training, modelling fish stocks and fisheries effects on

	stocks. Biogeochemistry. Atlantic scale risk assessment. Arctic, Baltic sea and now Black sea, with similar issues. Expert 3 *Expertise:* Limnology, marine food-webs, status of marine ecosystems.
Declarations of interests	No competing interests
Strengths and weaknesses	Expert 1 *Strengths:* Marine fishing – use, impact, interaction. *Weaknesses:* Freshwater fishing – leisure, tourism, subsistence. Expert 2 *Strengths:* Fish stocks, ecology, biogeochemistry. Atlantic, Artic, Baltic and Black Sea. *Weaknesses:* Freshwater fishing. Gear also not strongest. Expert 3 *Strengths:* System level with other sectors and components beside fisheries. Marine in general and also Baltic, climate impacts, cumulative drivers. Assessments, e.g. health index. *Weaknesses:* Not so much with fisheries, more the system level
Evidence	*Clarifying question asked:* (Expert 1) Ultimately what do you hope to communicate to finance? *Answer:* (Facilitator) First step: systems understanding and broad perspective on impacts. Second step: what are most important for those sectors? Compare diagrams to see similarities and differences between sectors. Translate into reportable variables for companies. Data should be useful for greatest number of people – finance, external partners,

	researchers, NGOs, public. Currently, relative metrics, hard to compare. *Follow-up:* (Expert 1) a lot of indirect variables will probably be very hard to measure and have metrics for. Biodiversity, I would expect to be essential. How to measure it. *Clarifying question asked:* (Expert 1) There are already essential biodiversity variables, and climate, have you linked them? *Answer:* (Facilitator) Yes – we want it to be complementary. Those are about monitoring. State of stocks, biodiversity. Not to replace those. Interlinkages between company and biodiversity. Practices of company, not status of biodiversity, e.g. fisheries – gear, practices. *Question:* (Expert 1) GRI 304 is soon to be released and looking at biodiversity, taking to whole new level. Was focused on protected areas. The resolution will be insane. Ecosystem, indirect links, cumulative impact. Could be really good. Those companies either have to step out or comply. Still voluntary. *Answer:* (Facilitator) We are not necessarily working towards highest possible resolution. Requires whole teams to go out and measure. Bias towards very big companies. We are ok with slightly less high resolution but that it is possible for many to report. Financial reporting has some things compulsory. Great with rich information, if only a few have capacity, no comparison. Shouldn't be black box where they derive metrics, report on no. threatened species. Can't see how they decided. TNFD talking about priority areas – do you have activities in areas of high biodiversity concern. Then you would lose data on impacts that aren't 'high priority'. We want all impacts for all activities. *Question:* (Expert 1) Sector specific? Or ambition to standardise across? *Answer:* (Facilitator) Want to standardise what is same across all. For those that aren't possible, because unique. But the framework aims to find a standardised language for it. Acknowledging we are only looking at primary sectors – resource extraction. Not processing, retail. *Question:* (Expert 3) Issues with stable climate. Why stable? *Answer:* (Facilitator) Partly based around PBs, which has climate change. Using dependency language.

Structuring	The variables were not elaborated or rephrased at this stage.
Definitions	1. Assessment of background review of impacts, ensuring all significant and salient impacts from an industry sector on the environment are captured. 2. Assessment of which are the *greatest* impacts on nature, meaning that impacts have either 1) a large globally cumulative impact, or 2) impacts are more locally incurred but are the largest for individual firms.

Part 1 end time	9:41
Attachments	

ELICITATION RECORD – Part 2: Outcome 1

Eliciting Expert Knowledge on Qualitative Outcomes

Elicitation title	Essential Environmental Impact Variables
Workshop	Wild-caught Fisheries
Date	9 November 2022
Outcome	1. Assessment of background review: assess the background review of impacts and ensure that all significant and salient impacts from an industry on the environment are captured in the conceptual systems diagram and the associated tables. Specify if any impacts are missed, should be rewritten/rephrased or removed.
Anonymity	Experts are identified as Experts 1, 2 and 3 (aligned across all elicitation records). Comment from a fourth expert (Expert 4) were collected before the workshop and brought into the discussion.
Start time	9:50 am

Definition	Assessment of background review of impacts, ensuring all significant and salient impacts from an industry sector on the environment are captured.
Evidence	A participant brief was provided in advance, containing a background review and evidence.
Individual elicitation	**Missed –** Expert 2: Biogeochemical flows are connected as there are effects on N and P cycles through removal of fish. Not sure if direct or via fish stock. BGC flows are central to maintaining fish stocks, because P and N are building blocks of life. Not sure how big an impact fisheries have on BGC flows, that is debated. Nitrogen from the fleets used to be a big emission, airborne NOx. There was a Directive, not sure if still the case. Carbon – effect is from fisheries to carbon – alters primary productivity Expert 1: the 'whale pump' for carbon – could be a link between resource mass and stable climate. Literature on biogeochemical flows. Fishing fleet emits, but also the biomass they remove takes away that carbon sink Stratospheric ozone and aerosols – not quite area of expertise but freezing capacity of fishing industry was important. Those substances linked to ozone depletion. Biogeochemical flows (same as Expert 2's point) – links to resource mass and habitat. Eutrophication and algal blooms. Habitat connects to resource mass. Stable climate – the impact of trawling on remobilising sediment carbon (Sala study).

	Missed pollution. It is captured in Novel Entities and Habitat to some extent, but not clear. In Novel entities, includes plastic, oil, fuel, chemical spillage. That is pollution from other sectors (land, oil rig) impacting habitat. <u>Expert 3:</u> I think pollution should be there, plastic etc. Space is an issue – are other sectors included? Because in coastal areas there is no space, due to renewable wind power and other activities. So there is a space issue. *Clarifying question:* (Facilitator) Would you say it is impacting the resource? *Answer:* (Expert 3) Impacts fisheries. Both positive and negative. Sometimes good for fish, MPAs, more space. **Rewritten/Rephrased –** <u>Expert 2</u> Rephrase 'freshwater' as 'water quality' Novel entities does not resonate for things like ghost gear and pollution. A better category would be 'trash'. In general, more links through wild fish stock and not fisheries. Habitat has direct impact on wild fish stock, and through stock, fisheries. However, fisheries affect habitats directly. Say biodiversity, through bycatch, that is a direct impact. However, if it through taking out fish, that is through fish stocks. Non-living mass – I would call it 'living resource' or 'non-living resource', mass is a bit strange. <u>Expert 1:</u> Freshwater impacts fish resource and habitat, but not fishing operations directly. <u>Expert 3:</u> For climate, I would have a box between climate and physical components: temperature, salinity, pH, oxygen. Climate is about the atmosphere. Those physical things affect stocks and biodiversity. Freshwater – would also call it water quality More links to fish stocks, not fishery. Fisheries goes out to climate and habitat. Instead of Novel entities, plastic or ghost nets Pollution – could have in BGC flows. Or hazardous substances separate. *Clarifying question:* (Facilitator) Pollution can be a generic term. What do you think is pollution? *Answer:* (Expert 3) I think of hazardous substances, plastic. **Removed –**

	<u>Expert 1:</u> Freshwater – not relevant to sector <u>Expert 3:</u> Would skip ozone and aerosol and have link directly to climate, remove boxes. Did not understand non-living mass
Matches/ Mismatches	All agreed that the freshwater category did not work well. All agreed that novel entities was not the best term, and preferred pollution, including plastic pollution. Disagreement on whether stratospheric ozone should be included, with Expert 1 suggesting it should be included and Expert 3 against. There was agreement to add the impact on the carbon sink of fish stocks and disturbance of sediment Carbon by trawling. There was discussion around changing the arrows and agreement on shifting some arrows from fisheries to fish stocks. There was also suggestions to add boxes. Expert 3 suggested to separate climate from physical components caused by climate change, i.e. pH, salinity, temperature and oxygen. Expert 3 also raised the issue of space. Expert 2 pointed out that fish catch is a key variable, unclear where it is on the diagram.
Group discussion	**Ozone and Aerosol** Expert 3 said it did not need to be there. Expert 1 suggested it could be there more due to the freezing capacity. Expert 3 clarified that it is valid but does not match the level of detail or resolution in the other components. Expert 1 agreed with that and raised the issue of applying the PB framework. Facilitator confirmed that we should check the latest on ozone and freezing and also Nitrogen – whether the effluents are in the water or air, might have changed in recent years. Expert 3 said that due to scrubber, release a mix of chemicals into water rather than air. Expert 2 pointed out toiled effluents probably also released. **Components of biodiversity** Raised Expert 4's suggestion to split up biodiversity to different components. Expert 3 felt it was a good idea and shows the distinction between targeted and non-targeted species with different impacts. Targeted species had more genetic impacts. Expert 1 felt it was scientifically valid, but hard to pitch in a corporate context. Expert 2 raised it was under the umbrella of biodiversity so depends what level of detail one wants to go into. Expert 1 pointed out that splitting diversity into genetic and functional would better encompass freshwater systems, e.g. studies on salmon show loss of genetic diversity. **Pollution and Sound**

	Expert 4 raised the point of sound. Expert 1 agreed with this, raised the distinction between land and ocean based production. Noise important in ocean because there are sensitive species there, whereas noise on land becomes about human wellbeing. Expert 3 pointed out that pollution is a tricky category because biogeochemical flows were separated out due to PB framework. He also noted that sound pollution is on the EU agenda. Expert 1 raised light pollution, and Expert 2 raised explosions and dynamite. **Climate** Expert 3 again argued that it is strange to have a direct link from climate to fisheries. It should be through physical components of salinity, temperature, pH, oxygen. Expert 2 added it has an effect on the fish, due to ice conditions. Expert 2 clarified there are two effects of climate: one on the operation of fisheries, e.g. weather conditions, ice in store rooms. The other is an impact on the fish stocks. Expert 1 pointed out that the carbon cycle point might apply much more to marine systems, e.g. no whales in freshwater systems. Expert 2 replied it was more than whales. Expert 1 replied doesn't know how industrial freshwater fishing is. The others agreed this was a gap and we might need and expert on lakes. **Freshwater - category** Expert 2 pointed out that in the PB framework, freshwater refers to freshwater use. Might need more explanation about what is included in freshwater. Suggested to call it 'water quality', which is more intuitive for both freshwater and marine fisheries. Expert 1 would subsume it within habitats as 'habitat quality'. Struggled to understand the appropriateness of the category freshwater in the fishing sector – more intuitive for sectors like livestock and crops. Expert 2 reiterated that it would be water quality, and the category of freshwater use in planetary boundaries is defined as water resources for uses such as drinking and irrigation, not about the water body itself. Expert 3 agreed with the suggestion to rename it 'water quality'. *Clarifying question:* (Expert 1) How do you distinguish between that and habitat? Or is it e.g. pH, acidification, oxygen. *Response (Expert 3):* Physical things driven by climate: temperature, salinity, pH, oxygen. Then, biogeochemical – carbon should be in BGC flows and there should be link to climate and fish stocks. Refer to Nash paper about Marine planetary boundaries. In comments, Expert 4 asked whether it was helpful to have a separate category of good water quality, thus making a similar point. **Freshwater - links** Expert 2 said the link should not go from freshwater to fisheries – if it is about water quality sustaining fish, it should go via fish stocks.

	Expert 1 agreed with Expert 2 that Freshwater impacts fish resource and habitat, but not fishing operations [directly]. Expert 3 also agreed about more links to fish stocks, not fisheries. **Habitat and Biodiversity** Expert 3 would call it a direct effect (of fisheries) on habitat and biodiversity. Expert 1 said, the issue is scale: whereas extraction is targeted, the others have more systemic and complex impacts. Expert 2 clarified the mechanisms for biodiversity impact: through species extraction, bycatch and trawling. Expert 1 added that habitats feed back into fisheries and climate. Expert 2 stated the links are habitat to climate, habitat to resource, climate to fishing. Expert 3 said that the distinction between habitat and biodiversity is tricky. Some biodiversity people say habitat and species, for others habitat is already biodiversity – like mangroves. Expert 1 added that habitats and biodiversity are relevant to discussions in companies, e.g. race to net positive for nature.
Group elicitation	**Missed –** Biogeochemical flows (more connected, also include carbon) Carbon cycle links more clearly to climate (through resource mass) Potential missed ozone from freezing capacity (check) Airborne nitrogen emission from ships (check), Make pollution category more visible (not just novel entities – include plastics, chemicals/hazardous substances, scrubber release, sound, light, dynamite) **Re-written/re-phrased –** Looking over direct/indirect links especially dependencies – go through fish stock. Stable climate, just climate. Highlight the intermediate steps through biophysical components such as pH, salinity, temperature, oxygen. Highlight the distinction in biodiversity between target and non-target and role of genetic diversity (e.g., salmon). Freshwater- rewritten to include marine water quality. Or highlight direct use is not applicable to fisheries. Reroute direct links through habitats or resource. **Removed –** None
Chosen outcome	See above
Discussion	Noted a lack of expertise on freshwater fishing and lakes. Noted limitations of using categories from PB framework, (e.g. freshwater, novel entities were not the best categories)

End time	12:00
Attachments	

ELICITATION RECORD – Part 2: Outcome 2

Eliciting Expert Knowledge on Qualitative Outcomes

Elicitation title	Essential Environmental Impact Variables
Workshop	Wild-caught Fisheries
Date	9 November 2022
Outcome	2. Assessment of greatest impact: assess which of these impacts have the greatest impact on the environment. By 'greatest' we mean that impacts have either 1) a large globally cumulative impact; or 2) impacts that are locally incurred but are identified as generally having the largest local effect.
Anonymity	Experts are identified as Experts 1, 2 and 3 (aligned across all elicitation records). Comment from a fourth expert (Expert 4) were collected before the workshop and brought into the discussion.
Start time	9:50 am

Definition	Assessment of which are the *greatest* impacts on nature, meaning that impacts have either 1) a large globally cumulative impact, or 2) impacts that are locally incurred but are identified as generally having the largest local effect.
Evidence	A participant brief was provided in advance, containing a background review and evidence.
Individual elicitation	<u>Expert 2:</u> 1. Fisheries to wild fish stocks. 2. Fisheries to biodiversity – changes to ecosystem function due to removal of top predator and sometimes bycatch 3. Trash and other pollution – long term effects of plastic pollution and chemical compounds. Plastics include microplastics, larger plastics and fishing gear. Pollutants include chemical compounds, some of which are persistent. The key is less magnitude and more the persistence. <u>Expert 1:</u> 1. Habitat 2. Biodiversity 3. Resource mass Resource mass is direct but most contained. The indirect impacts on habitats and biodiversity have a much broader ramification on the system than simple extraction. For instance blue carbon habitats

	(seagrass, mangrove…) impact climate. They are very linked too (habitats and biodiversity). <u>Expert 3:</u> 1. Either biodiversity and/or habitat. Habitat can be defined in many ways and is formed *with* biodiversity. 2. For coastal, cumulative ones of eutrophication and hazardous substances 3. For offshore [marine] ecosystems, climate. *Clarifying question*: (Facilitator) Mainly direct emissions? *Answer:* (Expert 3) Sea surface temperature, pH… impact is on fish stocks <u>Expert 4</u> 1. Removal of living biomass 2. Biodiversity impacts on non-target species 3. Climate impact (oceanic carbon pump, emissions, sediments) 4. Invasive species – large and unpredictable
Matches/ Mismatches	Resource extraction important to experts 1,2 and 4, but was not on Expert 3's list because expert 3 placed it within biodiversity. Biodiversity important to all. Climate important to experts 3 and 4, but not experts 1 and 2. Expert 4 raised invasive species, Expert 3 mentioned eutrophication. Pollution was mentioned specifically by expert 2 and 3 but may have been captured under 'habitats' for the others.
Group discussion	**Resource Extraction** Experts 1 and 2 both listed resource extraction (impact of fisheries on fish stocks) as one of their greatest impacts. They were surprised at Expert 3's omission of this. Expert 3 clarified view on fish stocks as part of biodiversity. Expert 2 responded by saying that a stock collapse would lead to no fish in the ecosystem, hence, significant. Expert 1 pointed out you could have also have extraction without collapse, but this still has impacts on habitats and biodiversity. Expert 3 clarified that fish stock collapse does have a big impact. However, fish extraction can be at a sustainable rate. Expert 2 pointed out a big difference in mechanisms: destroying biodiversity or habitats has big and long-term effects. This happens via species extraction, or by-catch. **Invasive species** Expert 4 felt it was one of the greatest impacts because it was large and unpredictable. Expert 1 disagreed and said it was an issue but

	not more important than habitat degradation. Expert 2 pointed out the unpredictability and novelty of the impact is what makes it important. Expert 1 argued that other activities are more harmful regarding invasive species, namely shipping, ballast waters, pipelines. The oil and gas sector would have a huge impact. Expert 2 agreed. Expert 1 suggested that invasive species could be included within biodiversity rather than putting it in its own category. **Pollution** Expert 1 was not uncomfortable with pollution being there. It would be very linked to habitat and biodiversity, perhaps a medium to habitat degradation. Expert 2 elaborated the impact pathways of pollution. It affects different shallow habitats and long-lived species. The problem is long-term persistence, though effects now are not as high. Difficult to ascertain the magnitude of impact. Could be a bias in stakeholder dialogues as it is easy to see this pollution. However, it is an issue with fishing sector, old fishing gear and other litter. Some of the stakeholders work in fishing, they also had access to scientific material. Expert 3 added there is a feedback because ghost gear affects fishing due to entanglements. In the interests of industry to have fewer ghost nets. Expert 1 said that ghost nets have an impact on biodiversity because mammals, dolphins, sharks, turtles are all hindered by it.
Group elicitation	**Capture/Extraction of resource mass** Reason: Important due to the direct impacts **Habitats** Reason: Due to the indirect through species extraction, cascading effects. Also through direct effects, through trawling. **Biodiversity** Reason: Due to the indirect through fish extraction, cascading effects. Also direct, through bycatch. Invasive species effects on biodiversity. **Pollution/Waste** Reason: Effect of impact is not so high at moment, but persistence makes it great. (E.g., gear)
Chosen outcome	• Capture/Extraction of resource mass • Habitats • Biodiversity • Pollution/Waste
Discussion	Climate somehow was not included on the final group list, though no firm reason given.

End time	12pm
Attachments	