

## Strategies to Reduce Risk

### Report on Canada-Norway Dialogue # 4, April 15<sup>th</sup> 2024

Barbara Neis, Dialogue co-organizer and Sociologist from OFI-Memorial University moderated the session. She opened by welcoming participants and with Memorial University's Land Acknowledgement. She then provided a brief recap of the previous three Dialogue sessions. She noted that the first session explored different understandings of risk in relation to aquaculture. Dialogue session #2 focused on salmon aquaculture with an OFI-led presentation based on recent research on the global risk of mass mortality events and results from an MME risk assessment exercise. Dialogue session #2 also included a SINTEF presentation that introduced a framework for holistic risk assessment developed in Norway. In Dialogue session #3, focus shifted to an OFI-led presentation on weather and climate-related risk considerations for marine aquaculture, accompanied by a SINTEF presentation of research findings on holistic risk perspectives and New Production Systems.

Barb then reminded participants that presentation recordings and reports on each of these sessions can be found on the Coastal Futures website [Joint Ocean Frontier Institute-SINTEF Norway-Canada Dialogue on Marine Aquaculture Hazards and Risk Assessment - starting January 2024 | Social Licence & Aquaculture | Atlantic Canada \(coastalfutures.ca\)](https://coastalfutures.ca), which is maintained by Dialogue co-organizer and Memorial Geographer, Charlie Mather.

Dialogue session #4 began with two linked presentations (one by Ingunn Marie Holmen from SINTEF and one by Barb Neis at Memorial/OFI). The intent of the presentations was to introduce and provide preliminary findings from an ongoing project comparing aquaculture injury risk and occupational health and safety regulatory regimes in Norway and Canada. These presentations were followed by one by Hans Bjelland from SINTEF Ocean entitled: Holistic governance of aquaculture to achieve sustainable value creation – recommendations from a Norwegian Official Committee. The discussant for Dialogue Session #4 was Dave Love, an aquaculture OHS researcher from Johns Hopkins in the United States.

Before Ingunn started to present, Barb provided a bit of context for the joint initiative behind the first two presentations. The team working on this initiative includes Ingunn and Trine Thorvaldsen at SINTEF and Barb, Lissandra Cavalli and Angela Antle with OFI. The initiative grew out of our collective engagement with an FAO-sponsored global desktop scoping review of knowledge about aquaculture occupational health and safety (OHS). The initiative was led by Andrew Watterson at Stirling University, discussant in Session #1. It resulted in a number of country/region profiles, a synthesis report and some publications (see list of references below). This review identified significant global gaps in research on OHS relative to the massive investments that have gone into researching such issues as animal health and reducing fish escapes. It also synthesized evidence documenting multiple and diverse OHS hazards in the sector and evidence pointing to high injury and fatality rates relative to average rates in those few jurisdictions where data are available. Globally, the review found major data gaps around adoption and implementation of regulatory standards, industry practices, and health and safety management systems, as well as key challenges to regulatory effectiveness in many jurisdictions. These challenges were related to constraints on injury surveillance linked to the tendency to locate aquaculture administratively under agriculture and fisheries; jurisdictional fuzziness linked to the operation of

marine aquaculture under, for example, split jurisdiction between departments and agencies, and a general lack of aquaculture specific laws and regulations (Watterson et al. 2019; Neis and Watterson, 2022). In Norway, attention to aquaculture workers' health and safety is high compared to many other countries, including Canada, and AOHS is better researched and monitored there than anywhere else globally. In contrast, in Canada such research is in its infancy. The scoping review concluded that, at that time, Norway's aquaculture OHS governance represented the gold standard suggesting that other jurisdictions could learn from comparisons between how their system operates and those operating elsewhere.

So, the intent of the joint and ongoing initiative Ingunn and Barb presented on in Dialogue session #4 is to explore how regulatory frameworks for marine aquaculture OHS currently work in Norway and Canada, including some of the challenges for regulatory effectiveness, and to identify things the two countries can learn from each other about ways to improve regulatory effectiveness for marine aquaculture OHS in the different contexts. Given time constraints, they were only able to touch on a few of the key issues and findings to date.

Ingunn Marie Holmen is the Research Manager for fisheries technology in SINTEF Ocean. Her presentation was based on research done by her, as well as by Trine Thorvaldsen and other colleagues. She opened with the figure showing five aquaculture risk dimensions for the operational phase of Norwegian fish farming used in past presentations. She also presented the SINTEF figure on the regulatory framework for safety and risk management in Norwegian fish farming identifying the five Norwegian authorities with jurisdiction over different areas of safety and risk management. She noted that this regulatory framework means requirements for risk management are found in multiple regulatory documents and that these regulations are quite fragmented. This means that work related to these regulations and to risk may not be well coordinated. She reminded participants that their research has shown the need for more holistic risk management but today, her focus will be on risk to workers' occupational and safety and the two main authorities with some responsibility for this in Norway, the Maritime Authority and the Labor Inspection Authority.

The Maritime Authority is responsible for the safety of maritime personnel on vessels, while the Labour Inspection Agency has jurisdiction of OHS on fish farms and the workers employed by the fish farm companies. At present in Norway, there is no connection between the technical requirements for fish farms and the OHS requirements. This has consequences because it means that there is no requirement in the technical requirements for manufacturers in the design phase for fish farms to assess the OHS risk for future work operations. There is only a requirement to document sufficient technical and end-of-work conditions. One consequence of this is that they have exposed locations in Norway that have had to be abandoned because conditions were too tough for both the workers and the fish. It is the regulatory responsibility of the customer purchasing these fish farm technologies, the fish farm company, to do an OHS-focused risk assessment for the equipment or fish farm component once it is installed. Unfortunately, the fish farmers have no routines for doing this before the fish farm has been established. OHS has so far never been a driver for technological innovations in the aquaculture industry in Norway. She stressed, however, that Norway does have good OHS regulations in place. These are found in their overall Work Environment Act.

At this point, Ingunn shifted her focus to present data on occupational accidents in Norwegian fish farming operations. She noted that it is important to report injuries and fatalities and to analyse

industry-wide occupational accident data because related rates and trends provide an important and objective safety indicator at all organizational levels. For the regulatory authorities, these numbers can help benchmark assessments of the effectiveness of OHS regulations and inspections. They can also be used as input into developing regulations and mandatory requirements and to help guide the focus for inspections or audits by the Authority. At the industry level, knowledge about OHS performance is important input for the aquaculture organizations and for their member companies, as well as for authorities and politicians. At the company level as well, knowledge about the chain of events and contributing causes for injuries provides valuable inputs into their own risk assessments and mitigation actions at the level of vessels and fish farms. Companies are interested in learning from each other's mistakes and information about occupational accidents is shared through informal channels in the industry.

In Norway, over the past five years, the Maritime Authority has gradually improved how they use accident data for follow-up within fisheries and aquaculture. Ten years ago, they did not do detailed analyses of these data themselves so SINTEF did this work by getting funds for projects or by relying on their own funds. As a result, SINTEF is the only institution in Norway to have a time series of detailed data that goes back to the 1980s. Time series are important but it is essential to understand the regulatory, technical, and organizational changes that have happened in the industry in order to interpret the trends. One of the things they think they see is a change in reporting routines in the industry in recent years. The reporting thresholds are lower and there has been a change in how the authorities require registration of incidents from the point of view of seriousness or consequences. So, everything is registered now owing to an increased focus on near misses and what can be learned from them.

The most recent analysis they have done of occupational accidents in the Norwegian fish farming industry at SINTEF uses three different sources of data. Of course, there is some under-reporting, but they think these are mainly minor injuries. They think their fatalities data capture 100% of fatalities.

The three data sources are data from the Norwegian Labour Inspection Authority, data from the Norwegian Maritime Authorities, and their own database for fatal occupational accidents which draws not only on these other sources but also on a scan of media reports.

Using these data, when they compare fatalities in the fish farming industry with other Norwegian industries for the year 2022, they find aquaculture ranks fifth in terms of number of fatalities but it is important to also consider the number of employees across these sectors, i.e. the fatality rate per 1,000 workers. In terms of fatality rates, fishing is the highest, followed by agriculture, and then fish farming in third place. There are more fatalities in construction and building but that sector has more than 240,000 employees so the actual rate is lower.

In terms of fish farm accidents registered by the Labour Inspection Authority from 2011 to 2022, the injury rate per 1,000 employees has been decreasing over this time, but it is still high. The data from the Maritime Authority show accidents on board service vessels in the fish farming industry including well boats, boats carrying fish and doing operations on, for instance, fish treatment. These vessels also include cargo vessels delivering, for example, fish food to the farms. These data show a considerable increase in registered occupational accidents after 2016. There are a couple of possible reasons for this: there were new regulations introduced in 2015 and 2017 for smaller cargo vessels. In 2015, the Norwegian Maritime Authority introduced a regulation for cargo vessels below 24 meters and this

formally placed a responsibility on the Maritime Authority to follow up with vessels in this category. In 2017, new requirements for safety management systems were implemented for work boats and service vessels at fish farms. So, they think these regulatory changes could explain the increase in the number of registered accidents in these data. In addition, the overall number of vessels has increased, along with the number of operations.

Returning to the accident data from the Norwegian Labour Inspection Authority, these show fall accidents, crushed and trapped accidents, and impact/blow by objects as the three most frequent events. The same sorts of accident types are also found in the data from the Maritime Authorities for work on vessels, however, the three most frequent are impact/blow, fall on board, stab/cut accidents.

They have published these data in a Norwegian report and they will make that report available. They will also publish the results in English internationally in the future.

The third data source is the data from the SINTEF Ocean database and it shows there were 38 fatalities in the sector between 1982 and 2022. Many of the fatalities were due to the loss of vessels, also to man overboard, blows from objects. The data show that in the first couple of decades, loss of vessels was the most common fatality mode but after 2000, hazards and undesired events during work operations at the fish farms are the most frequent causes.

Ingunn then talked about the challenges regarding risk assessments. When she analyses data on accidents in fish farming, what she finds is complex causality with several contributing factors. A common cause is poorly implemented risk management. There might not be risk assessments or those that are done may not be used in decision-making. Also, operators may not be aware of all of the hazards during operations, and procedures might be changed during an operation without assessing the risk of making those changes. We continue to see serious accidents and this is why they decided, some years ago, to take a look at the risk assessment practices in the aquaculture industry. When they did that they found that the companies might have difficulty finding the time to gather all the relevant personnel who should participate in the analysis and, as a result, risk assessments were performed only at the managerial level. Secondly, some of the participants in risk assessments were not motivated by the task, seeing it instead as an unavoidable exercise intended to satisfy the demands of the authorities or of their own management. Thirdly, those requiring risk documentation might be more concerned about making sure there are checkmarks and numbers in all of the columns than with checking to see if the safety level is actually acceptable. In this context, risk assessment becomes a desktop exercise rather than actually influencing what is being done. Fourthly, the scope of the risk assessments may be too broad and it could take several days to perform risk assessments for all of the relevant parts of the operation. So, some operations might be omitted due to limited time. Fifth and lastly, when the risk assessments are finalized, the follow-up work detailing action plans, improvements and procedures may not be prioritized. This then sends the wrong signal back down through the organization suggesting that the only purpose of the risk assessment is to satisfy the documentation requirements in the regulations.

Another challenge with all of this is, if you recall the regulatory framework outlined earlier with five different authorities who require risk assessments within each of their different jurisdictional areas, if their requirements are not coordinated, this means the fish farms might have to do risk assessments five times in five different systems. As noted in earlier presentations, SINTEF is working on this problem and the Directorate of Fisheries has picked up the idea of holistic risk assessments. They think this is a good way to improve the situation.

Ingunn concluded her presentation by acknowledging the funding provided by the Research Council of Norway.

*Relevant publications:*

1. Updated occupational accident analysis report (in Norwegian): Holmen, I. M., & Holen, S. M. (2023). Occupational accidents in the Norwegian aquaculture industry. [Arbeidsulykker i havbruk: Analyser av registrerte personulykker på havbruksanlegg og -fartøy.]: Report no. 2023:01398. SINTEF Ocean AS. <https://hdl.handle.net/11250/3109974>
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Barb Neis gave a presentation entitled *Improving Aquaculture Occupational Health and Safety Regulatory Effectiveness in Canada: Barriers and Opportunities*, co-authored with Lissandra Cavalli and Angela Antle. Barb started with a quick overview of marine aquaculture in Canada pointing out that the industry is found on both Canada’s Pacific and Atlantic coasts and within six provincial jurisdictions – but she noted they would focus on five of those jurisdictions: British Columbia on the Pacific coast and the Atlantic provinces of New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador. The industry is smaller than Norway’s with an export value of just over a billion dollars in 2021 and direct full-time equivalent employment (FTE) of approximately 7,000 in 2020, roughly half the size of employment in Norway’s fish farming sector. In contrast to Norway’s industry, which consists almost exclusively of finfish production (although there are some shellfish operations), shellfish makes up a larger share of Canada’s marine aquaculture industry, although its importance varies across provincial jurisdictions with Prince Edward Island’s industry almost completely based on shellfish. The shellfish sector consists largely of small and medium-sized enterprises producing mainly mussels and oysters,

whereas the finfish sector is dominated by a relatively small number of multi-national enterprises including several affiliated with Norwegian-based companies.

Barb then presented a figure providing a preliminary overview of regulatory responsibilities in Canada for the 7 regulatory areas outlined in Ingunn's framework for Norway including: technical requirements for vessels, technical requirements for fish farms, environmental requirements, requirements for preventing fish escapes, fish welfare and health requirements, food safety requirements and occupational health requirements. The Figure highlights, in a somewhat simplified way, the complex network of different federal and provincial agencies with some regulatory oversight for the different areas. In the case of health and safety (our focus here) – three things stand out: a similar split between maritime safety responsibility (vessels) and OHS regulatory responsibility. In Canada, vessel and to some degree crew safety are the responsibility of Transport Canada (a federal agency) while the health and safety of farm and other workers is a provincial responsibility. In the case of marine aquaculture, this means there are 5 separate provincial departments responsible for OHS, guided by different OHS Acts and regulations, plus Transport Canada. There is no single injury reporting agency in Canada, with such reporting mainly happening through provincial workers compensation boards in the form of injury/fatality compensation claims. This means there are five different agencies, again with somewhat different acts and regulations and different levels of coverage responsible for compensating injuries and documenting claims, although the Association of Workers' Compensation Board of Canada does assemble and can provide data from each of provincial jurisdictions. In some provinces workers compensation boards are also responsible for occupational health and safety inspections and injury prevention. In other provinces, these responsibilities are separate.

In Canada, OHS is managed based on an internal responsibility system where the employers and the workers have joint responsibility for OHS. Workers have three basic rights: the right to know about hazards, the right to participate in OHS management, and the right to refuse dangerous work. Participation in the internal responsibility system is generally supposed to include worker delegates in small enterprises and joint worker-management OHS committees in larger workplaces. The external part of the OHS system includes the development of OHS acts and regulations by provincial governments and inspections of workplaces by inspectors employed by government or workers' compensation boards. In two provinces, British Columbia and Nova Scotia, there are fishing safety organizations that have assumed some responsibility for aquaculture as well as fishing. Prince Edward Island has developed a Code of Practice for Aquaculture Safety. In some cases, aquaculture OHS, as mentioned in previous webinars, is also assessed by third party certification bodies as part of a wider assessment process. We are looking at third party certification in our research on regulatory regimes, and while this wasn't discussed in the presentation, Barb noted that recent research indicates the inclusion of OHS within such certification seems to be more common in aquaculture than in some other sectors like fishing and forestry.

If we think about some potential challenges for OHS regulatory effectiveness in Canada, similar to Norway, the split between maritime safety and OHS is a potential problem that could lead to gaps in regulation and inspection, as well as overlap and potential confusion around who is in charge. In Canada these jurisdictional siloes are somewhat more complex given that, on the OHS side, there are five different provincial agencies. Federally, we know the Transportation Safety Board has investigated some vessel-related aquaculture incidents but they and Transport Canada don't really distinguish between aquaculture and other types of maritime activities. There is some evidence in case law of court

challenges of OHS/vessel-related charges by companies that point to federal-provincial fuzziness related to jurisdiction over aspects of aquaculture OHS. This has implications for regulatory effectiveness (Shan and Ochs, 2022). Similar challenges exist in fishing, where it might be unclear which agency should be investigating and laying charges.

Picking up on Ingunn's presentation, a key potential threat to regulatory effectiveness of aquaculture OHS in Canada is challenges around injury and fatality surveillance. Ingunn did a good job of explaining why surveillance matters at all levels of OHS systems from government through to the company level. She provided a description showing how, in Norway, they have to draw on multiple sources of data from different agencies and from the media for fatalities – this takes time, expertise and resources.

In Canada, we have no agency like SINTEF Ocean that has funding to do injury and fatality surveillance at the level of the aquaculture sector, that has ongoing access to detailed data required for this, and can monitor and interpret trends. Generally speaking the only quantitative data available comes from claims to the multiple provincial compensation boards. It can be very challenging to access these data with sufficient information to monitor injuries and fatalities over time and compare across the different provincial jurisdictions for this relatively small and quite diverse sector. Where injury rate data are publicly available, they are often, as in some other countries, combined with fishing or other sectors. In the case of compensation claims, one problem is that not all aquaculture workers are necessarily eligible for compensation in all jurisdictions although this may be changing. In addition, there are well-known problems with under-reporting. Where subcontracting is common, it can be difficult to attribute aquaculture-related injuries to the sector as in the case of diving, for instance, where divers might work across multiple sectors. Diving can be one of the most hazardous activities in aquaculture. Anya Keefe, who is participating in this dialogue session, has just produced a report on diving and aquaculture in Canada for the Canadians Standards Association. The report can be found at the following link: <https://www.csagroup.org/article/research/assessing-the-needs-gaps-and-opportunities-for-occupational-diving-in-aquaculture/> Anya spoke to the report briefly in the Q and A. Finally, compensation claims data in Canada contain little information on cause and on the work tasks and work locations associated with injuries. Fatality data in compensation data, as appears to be the case in Norway, are somewhat undependable. Finally, even when we are able to access data directly from within compensation agencies, it is often (except in British Columbia) impossible to distinguish between finfish and shellfish aquaculture injuries in the data. This is a problem given the quite different types of operations and hazards associated with these two kinds of aquaculture.

We used short-term funding from OFI to support the work required to access and analyze compensation claims data for the past several years for the aquaculture sector from four provincial jurisdictions – Prince Edward Island did not provide data. For British Columbia, we only had access to the publicly available data on their website. The results of our analysis (published in Ochs et al. 2019), indicate that aquaculture compensation claim rates across 4 provinces have consistently exceeded provincial average rates and, keeping in mind challenges with comparisons, appear to exceed rates from other countries. In addition, there is no obvious downward trend in incident rates over time in Canada although this may have changed since the study ended.

The leading injury events for the sector are similar to those found in other countries with overexertion, falls, struck by or against objects and water transportation accounting for roughly 50% of events. We have no data on the precise hazards that might have triggered these events or the parts of the operation where they happened.

Findings from a separate analysis of Inspection reports from three jurisdictions can give us some insight into the kinds of hazards inspectors have identified in recent years in their reports. The most common type of deficiency noted in these reports, across all three jurisdictions, is deficiencies around general OHS requirements. These would include issues with protection of rights and duties, violations of requirements for safety plans, committees, records of training, and issues with weaknesses in required elements for OHS management. There are other types of deficiencies here as well though: issues with cranes, confined spaces (access/egress), with personal protective equipment (PPE), diving, electrical safety and with handling of chemicals. What is not here that we might expect to find given the results of our analysis of compensation claims, are deficiencies related to ergonomics, water transportation, etc. Perhaps water transportation deficiencies are addressed by Transport Canada? We don't yet know what types of inspections Transport Canada does in relation to aquaculture operations.

If we think of inspections as a key part of the external regulatory system and one of the ways to test how well the internal system is working, it is worth asking how well the inspection system is working to detect problems and improve prevention within aquaculture. The effectiveness of inspections depends in part on the fit between regulations and requirements and training, experience and access for inspectors. Given OHS is generally a provincial responsibility some key questions we might ask include: how many inspectors are there for the sector focused on aquaculture; how knowledgeable are they of the particular hazards in the sector; and what resources do they have to complete inspections (for example, do they have access to their own boats to allow them to visit the farm sites or do they have to rely on companies providing transportation)? There is also more general evidence from British Columbia indicating inspections might be less likely to lead to injury reduction in primary industries like aquaculture where they may not be as well linked to existing hazards/situations (Macpherson et al. 2021) that we should reflect on.

In conclusion, Canada, like Norway is planning and supporting significant future expansion/diversification of the aquaculture sector. It is a somewhat different industry from Norway's, smaller, more widely dispersed and more diverse. Its OHS regulatory framework, indeed all aspects of its regulation are more siloed and fragmented than in Norway due in part to federal-provincial jurisdictional issues. The Canadian industry is at least, and likely more hazardous, than the industry in Norway with multiple hazards, high injury rates, and a lack of ongoing surveillance of these. From an OHS perspective, the industry is largely invisible and aquaculture OHS is seriously understudied in Canada. Canadian OHS laws have only limited and focused requirements for risk assessments – i.e. when working alone, for example. As we have argued elsewhere in a recent paper based on a risk assessment of mass mortality events in salmon aquaculture focused on OHS, and as part of a new forthcoming analysis with an over-arching multi-dimensional risk assessment for MMEs led by Zaman Sajid (see references below), risk assessments are essential, particularly given the dynamism and complexity of the risks associated with the sector and plans for expansion. Despite some of the limitations described by Ingunn based on their research, such risk assessments could provide the basis for ongoing improvement versus simply striving to maintain the status quo.

In terms of future options, Canada is developing an aquaculture act that is designed to streamline aquaculture regulation and deal with the complexities caused by federal-provincial jurisdiction. Unfortunately, there is a lack of reference to OHS in any of the drafts we have seen. Adding a section on OHS to that act could help lay the foundation for stronger national leadership in this area, particularly if it has built-in requirements for ongoing and effective surveillance and for holistic risk assessments. In the meantime, we could develop for aquaculture, as has been done in British Columbia for fishing safety



[Initiatives - WorkSafeBC](#), memoranda of understanding to support collaboration and data sharing around safety between Transport Canada and provincial compensation and inspection agencies. In at least some cases the provincial health and safety inspectors in Atlantic Canada do not have access to their own vessels while they may have such access in British Columbia. It seems likely that access to their own vessels is essential for them to independently and relatively freely (taking into consideration biosecurity issues), access farms.

Developing comparisons and supporting an ongoing dialogue with Norway as we have tried to do in this series is good, particularly given the strong expertise there in areas of aquaculture OHS and risk assessment, as well as their leadership role in development, ownership and technology design and transfer in finfish aquaculture. However, Canadian researchers and others also need to develop stronger links to other jurisdictions like the US that are more similar to Canada from an industry complexity and regulatory perspective. This is one of the reasons why we have invited Dave Love from Johns Hopkins to be the discussant for this Dialogue session.

Finally, Canada lacks a comprehensive maritime safety research centre like SINTEF Ocean which includes OHS research and risk assessment capacity. The US recently established the National Institute for Occupational Health and Safety Centre for Maritime Safety and Health Studies. Given Canada borders on three oceans, has the longest coastline in the world, and is committed to growing engagement with the oceans, such a centre is needed in Canada and must include OHS and marine safety research capacity.

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The third presenter was Hans Bjelland, Research Director of the Aquaculture Department at SINTEF Ocean.

Hans opened by commenting that he would have loved to take part in the previous dialogues but unfortunately, he was not available. He was recently a member of a governmental committee and the work of that committee will be the focus of his presentation. The mandate of that committee was broader than OHS but there are, of course, linkages, and he said he would show us how they tried to incorporate some important perspectives on safety and risk management into the resulting report.

A disclaimer: he noted this is the first time he has presented this information to an international audience and that the presentation contains some unsanctioned translations. He also noted that he will be talking about aquaculture in general but his focus will tend to be the salmon industry and fish and aquaculture.

The background to the establishment of this committee was the need for a holistic look at the regulations for the Norwegian aquaculture industry. The committee was originally appointed by one government, but fairly quickly there was a change in governments so there were, as a result, some adjustments to the committee's mandate. The committee's report was submitted to government in September 2023 and there was a period for public feedback that lasted until January so this is ongoing work – not for the committee but for the Ministry – to allow them to access the feedback and develop policies. The Secretariat for the committee was based in the Ministry of Trade and Fisheries but they had some assistance from the Ministry of Finance and the Ministry of Local Government and Modernization.

In terms of background and the motivation for setting up this committee: the aquaculture industry has always been in development. It started out with hammers and nails and pens at or near the wharf. Since then it has attracted knowledge, investment and researchers who have developed breeding techniques, vaccines, feeds, and technical standards. Aquaculture technology is advancing rapidly and the service part of the industry has matured. Along the way, authorities and regulations have evolved and now there are questions about where they are headed. There are different production systems under development and he will talk a bit about the drivers for that.

At the moment, it is very much biology that places some limits on the development of the industry and these limits are the current driver for innovation. Aquaculture production, by its very nature is carried out in the commons and there are some limiting environmental conditions. In Norway, sea lice are the primary limitation to production growth and the government has put in place a traffic light system that is based on the models and assessments of how sea lice levels affect wild salmon populations. He

showed a map with red, yellow and green areas with colours representing whether or not they are allowed to increase production or production should be frozen or should be reduced. The system is currently up for public debate but it is designed to regulate production dynamically over time. This sea lice regulatory system is very much driving a lot of treatments for the salmon and this indirectly causes some major fish health concerns. As a result, they have an annual fish health report that is produced by the Veterinary Institute which is, unfortunately, rather grave reading at the moment. This past year, the Office of the Auditor General of Norway audited the ministry's work on preventing poor fish welfare and it raised some grave concerns; this is getting a lot of attention at the moment. And there are also other risks that the industry has to deal with. They also have an annual risk assessment done by the Institute of Marine Research focused on the biology and ecology along the coast that assesses a number of other risk factors. So, all of this was the background for the establishment of this committee.

The committee had a very broad scope and mandate. They were asked to design a comprehensive permit system for aquaculture for the future that would ensure sustainable development of the industry and the greatest possible value creation for society.

Hans then went through some of the main recommendations and perspectives in the report starting with some key recommendations.

One recommendation is that the state authorities should take over larger parts of the responsibility for coastal zone management. This is, of course, somewhat controversial and will be discussed a lot.

They also proposed the development of more generic permits to replace the detailed regulations in individual permits as there are today.

They proposed that government regulate environmental impact more directly. And some of the ways they proposed to do that would be to differentiate the regulations so that the requirements can be tightened in areas with unacceptable environmental impacts. For instance, in the sea lice traffic light system, there are production areas that have stayed red for many years and it is a common perception that this way of regulating based on some percentages for each period is not sufficient to handle all the challenges faced.

Finally, they recommended strengthening individual incentives to reduce environmental impacts while giving the actors flexibility to make their own trade-offs.

An important part of unlocking the potential that we see in the salmon farming and aquaculture industry is to take coastal zone planning and biosecurity seriously. That's not to say that it's not being done seriously at the moment, but they see potential in doing that more holistically and more strategically.

Hans indicated he was sorry for all the text and that he would be happy to distribute this presentation later.

In terms of reducing the disease burden in the industry, they proposed improvements to the zone structure. A number of studies have shown that there is a huge potential in sometimes reducing the number of sites in a particular locality, which can enable increased production at those that remain.

They see a need for increased coordination and note that the ways of coordinating production are different along the coast.

They see value in more strategic use of production areas including defining production areas for species that naturally interact and see potential in more strategic use of firebreaks or buffer zones between zones.

They see that some production methods will have less effect on biosecurity and recommend that some leeway should be given there.

And, as he has already said, state authorities should have more power and authority in relation to marine area planning and recommend establishing binding thematic aquaculture plans for municipal spatial planning.

In terms of the limiting environmental conditions for aquaculture production systems he spoke about earlier they recommend the development of a kind of budget based on what is an acceptable level of environmental influence. One recommended principle is that there should be an equal cost for equal conditions in terms of their impact, for example, on sea lice in the environment, irrespective of the type of aquaculture (land-based systems, closed containment systems in the sea and open cages). At the moment, these are treated differently in the regulatory system.

The committee noted that special, non-generic permits have alternative costs, and should therefore be limited in their use. For instance, there have been a lot of benefits from the development licenses to encourage technological innovation but they are very costly so the use of such license should be limited in the future. So, the big carrot in these recommendations is that, if you can develop and make use of new production technologies that have less effect on the environment, you should be allowed to increase your production. A combination of a price on emissions and public incentives should encourage reduced environmental impacts. So, they propose something he calls “environmental flexibility” (although he has heard that is not the best term) that allows for increased capacity through the use of zero or low emission technology with this concept integrated into the permit system for both current and future permits. They are now discussing how you could dynamically adapt production capacity based on the technology in use.

From the perspective of risk, Hans noted novel sites and production systems create novel challenges and knowledge needs. He presented an old image of a capsized closed containment system to make the point that they will need to handle risk differently in the future. Preventive and consequence-reducing measures, such as ensuring the safety of workers, fish welfare and preventing escapes, should reflect and be adapted for increased use of new production systems. These new systems have implications not only for occupational health and safety, but are also complex systems with a lot of new processes and operations and so fish welfare will have to be managed in the new systems and locations.

The production environment will be different both internally and externally so we need to develop methods and design methods and tools to work with to ensure these are robust structures.

A lot of new and somewhat novel marine operations are under development and there will be greater need for autonomy and instrumentation so they have identified implications for sludge water treatment and opportunities for new circular value chains that they have to develop along the way.

Overall, there is a need for holistic governance of aquaculture risks and while fish welfare and environmental impact get a lot of attention at the moment but these are related, based on their research at SINTEF and elsewhere, so that changes in fish treatment have OHS implications. They have

identified this in the committee's report. The government and the industry need to collaborate to develop and adapt new risk management strategies.

Hans concluded that the pace of technological development is already fast and they expect it to accelerate with the introduction of stronger incentives in the future. The committee undertook a comprehensive investigation and these are some of their recommendations. This is before the government and several parts of the government need to be involved. They expect a new parliamentary report based on the committee's report and public feedback in the spring of 2025. The industry is very eager to get started on addressing some of these issues and at the moment there is a kind of vacuum when it comes to adapting current regulations. Some details for the new resource rent tax will need to be worked out to support innovation and they are waiting for new regulations around land-based farming and also for an animal welfare report that is in process. And they now have a new, third minister who is handling all of this.

The Report Hans was speaking to can be found, in Norwegian, here:

<https://www.regjeringen.no/no/dokumenter/nou-2023-23/id2995224/?ch=1>

Barb introduced the discussant for Dialogue Session #4, Dr. Dave Love, a research professor at the Johns Hopkins Centre for a Livable Future in the Johns Hopkins Bloomberg School of Public Health. He opened by noting that this work on aquaculture occupational health and safety fits squarely within their policy focus on the right to decent work for food system workers, finding ways to increase transparency in food systems, and working to eliminate injustices within the food system. The project he has been working on was brainstormed at the I-FISH 5 conference in St. John's in 2018 and it was designed to fill gaps in knowledge about worker safety in U.S. aquaculture. Jillian Fry published the original paper which included work by others. Liz Nussbaumer is also now involved in this work. Dave gave a presentation on aquaculture OHS in the US starting with an introduction to the industry and then review of the OHS issues that exist. He noted that there is a long coastline in the U.S., as in Canada and Norway and there are thus lots of opportunities for aquaculture development. The U.S. shares a border with Canada in the Northeast and there, there is a Canadian-based company that raises salmon on a few farms in Maine. They also produce mollusks, seaweed and many different inland hatcheries. In the southeast US, there is a lot of freshwater aquaculture; catfish production is the biggest aquaculture industry in the US, followed by crawfish, both in freshwater systems. In the Pacific Islands, they have one of the world's largest shrimp hatcheries and expanding seaweed and some offshore finfish production. In Alaska, mariculture is expanding in lots of different ways. On the West coast, primarily in Washington state, there is also mariculture but it is worth noting that net pen aquaculture was recently banned in that state. Overall, the US has aquaculture on all coastlines. In terms of regulation, freshwater aquaculture is overseen by the U.S. Department of Agriculture and marine aquaculture is overseen by NOAA. That mixed agency oversight sometimes causes confusion. He discussed the number of farms associated with the different types of aquaculture and commented that mostly food fish, but also mollusk and shellfish, crustacean farms, make up about half of the production with the other half consisting of nonfood fish including sport fish, ornamental and bait fish and these also need to be considered in discussions of OHS. In terms of the number of workers in the sector—there are different estimates but there could be somewhere between 6,600 and 10,500 workers. Overall, US aquaculture ranks 18<sup>th</sup> globally.

In terms of OHS, Dave presented data on fatalities in the US aquaculture sector, comparing these to fatalities in fisheries. Fatality rates in fisheries are much higher than in aquaculture. Aquaculture is a

much smaller sector and there were only 11 fatalities in the period between 2006 and 2018, mainly diving-related and drownings (3 fatalities per 100,000). Aquaculture is two or three times riskier than the national average. In terms of injuries and illnesses in aquaculture versus fisheries, there are some problems with the data because in some years, the agency does not provide an estimate and in other years, aquaculture is clustered together with the lumber industry. So, they are not getting good data on injuries and illnesses in aquaculture. In commercial fishing, the injury rate is 5.2 per 100. There is variability in the rates with some years having higher rates and other years lower and there is the issue of under-reporting. In the case of aquatic food processing, the injury rate is about five per 100, higher than the national average. Types of injury events include use of heavy equipment, trips, slips and falls on wet surfaces, crushing injuries, exposure to chemicals and exposure to microbes such as such as *Vibrio vulnificus* wound infections. There are also injuries related to repetitive lifting. If you look at the food processing data, there are repetitive motion injuries, cuts and punctures with knives and tools. Barb presented the average injury rates in Atlantic Canada and BC and these ranged between 3 .5 and 11 .7 per 100. When we compare that with the U.S., we see U.S. aquaculture is roughly right in the middle with both Canada and the U.S. being higher than Norway.

Dave Love commented that he did not think he had seen these country-by-country comparisons before and it would be nice for us to get together and try to work off the same range of years to see if we can produce some better comparisons.

Like Barbara's team the one at Johns Hopkins also looked at violations recorded during occupational safety and health inspections, both federal and state inspections, at aquaculture operations. The results of this analysis are presented in their published paper (see references below). He took those results and generated a word generator cloud that indicates a lot of violations around electrical hazards, accessibility of emergency eye wash stations, in training, seatbelt usage and noise.

There are a number of laws and policies that govern aquaculture in the U.S. One of the most important is the Occupational Safety and Health Act of 1970 that provided the foundation for the U.S. Occupational Safety and Health Administration (OSHA). They also have chemical regulations including for chemicals that can be used in aquaculture and other sectors. These regulate their use and worker exposure. There are also labour standards requirements and there is the U.S. Coast Guard which regulates boating and provides information on boating safety. In addition, there are some state-specific protections for workers with California and Washington being two examples. Those are typically found in more liberal states. Finally, they have worker compensation funds, as in Alaska, but not all states have these funds. Workers who work in Alaska, even if they are not from Alaska, can tap into these worker compensation programs.

Despite the applicability of these diverse policies and regulations to aquaculture, there are lots of loopholes. For example, we have the problem of 'agricultural exceptionalism.' This refers to the exemption of agricultural workers from labour protections that apply in other industries and is relevant to U.S. fisheries and aquaculture. Department of Commerce tracing systems for agricultural workers use the same numbering and classification system as is used for fisheries and aquaculture workers. This means surveillance of fisheries and aquaculture workers is nested under agricultural activities where the agricultural exceptions that limit protections have their roots in slavery going back to before the 1840s and 1850s. Despite the end of slavery, those practices of agricultural workers having to work long hours for low pay have continued until today and this bleeds over into fisheries and aquaculture. These are

unjust practices that we need to weed out and some of these exemptions relate to enforcement. For example, OSHA cannot monitor/inspect commercial fishing and aquaculture businesses with less than ten employees. Seafood processing plants do not fall under these exemptions so those plants should be held to somewhat higher standards in terms of inspections.

To illustrate the significance of the exception within aquaculture in the U.S. he took data from the aquaculture survey of 2018 and mapped it out by farm size based on small, medium and large farms. They think the small farms probably have less than 10 workers but it is hard to say given data limitations, although they are bringing in less than \$100,000 in income so it is likely they have less than 10 workers. Most of the aquaculture farms are small farms so most are not going to have OSHA inspections and enforcement. There is more to this than only OHS, as there are also worker rights issues and issues with labour abuse that exist around the world in the fishing sector. Many people falsely assume they don't exist in the U.S. or Canada or other high-income countries but that is not the case. He gave some examples of recent examples of labour abuses in the U.S. including, for example, the use of forced labour on Hawaiian fishing boats where the captains were taking workers' passports and holding them and making them work on board for months. Another recent report documented labour abuses among crab pickers in Maryland where migrant workers from Mexico and South and Central American were being brought to the U.S. on visas and were being held in facilities near the processing plants working long hours, with lots of hand injuries and living in substandard housing. They were also receiving low pay and there were gender differences in their pay. Similar problems have been documented in the crawfish industry among crawfish processing plant workers in Louisiana. This year, there was a report of migrant child labor in fish processors in Massachusetts. These things may not be happening on the farms but they are part of the supply chains for aquaculture and fisheries products. These issues extend beyond OHS to intersect with social disparities across worker populations linked to power imbalances between employers and workers that make workers vulnerable to being exploited.

Finally, some new challenges. The U.S. offshore aquaculture policy is to move further offshore for large finfish production. The government is working on developing policy and regulatory tools to put this in place. There are several different relevant acts but none have been signed into law. He pointed to two acts that at present do not mention OSH and this is concerning. It means, he thinks, that they need to get a seat at the table to talk about these issues.

A few concluding thoughts: as seen in the data, the aquaculture industry is a hazardous industry. Offshore aquaculture will present new hazards and risks that need to be looked into and these need to be addressed in future policies. There is also need to better support aquaculture OSH, ideally using a worker-first approach including, for example, finding ways to help workers unionize and organize to help them protect their rights. As this session is doing well, there is a need to support collaboration across borders, think about risks along the supply chain, and reflect on ways sectors like fishing and aquaculture can support each other and work together.

The discussion/Q and A segment of the session opened with some comments by Anya Keefe, author of the recently released report she completed for the Canadian Standards Association entitled: Assessing the needs, gaps, and opportunities for occupational diving in aquaculture. This report can be found here: [Assessing the Needs, Gaps, and Opportunities for Occupational Diving in Aquaculture - CSA Group](#).

Anya summarized some of the key findings from her report including indications that diving in aquaculture is hazardous with divers in this sector experiencing higher risks of injury and mortality

compared to divers in other sectors. A scan of regulatory requirements for diving in aquaculture across provinces found gaps and inconsistencies in how occupational diving is regulated in Canada with regulations not always aligning with two standards in the CSA Group's suite of occupational diving standards. She also noted the lack of aquaculture-specific codes of practice to help interpret and comply with the regulations. The report looks at aquaculture occupational diving regulation in some other jurisdictions, examines the value of standardizing and harmonizing occupational diving requirements across Canada and of creating industry and task-specific guidance. It also describes the preferred option from the point of view of stakeholders for doing this. One of the opportunities for standardization identified in the report is through development of "clear guidance on how to perform a hazard and risk assessment." The needs for these assessments are referenced in the CSA diving standards and in occupational diving regulations, but these don't provide guidance including around "the question of what constitutes a contaminated environment. For example, would a regulator or interested party consider clearing fish mortalities diving in a contaminated environment?" (pg. 27).

Another participant commented that as industry requirements change, they will affect safety in other parts of the industry. For example, the use of submersible facilities will increase the risk of accidents for divers. And there is a broader problem of how vessels and other infrastructure are defined and regulated. A boat that is regulated as a fishing vessel but used as a cargo vessel in aquaculture creates problems for industry because its certifications are not recognized by Transport Canada. This raises questions about the specific needs of aquaculture and the diversity of regulations for this sector in Canada. At the same time, there has been a big shift in aquaculture in Canada around risk assessments and companies now have their own risk classifications which has led to a big improvement in the health and risk situation.

Dave Love posed a question to the group as a whole: One of the issues that has come up is the problem of accessing consistent and comparable data on injuries with good resolution. Given this, how much does it fall on us to advocate for policies that can generate better data. Alternatively, should we collect the data ourselves.

Ingunn commented that we should get regulators to get the companies to report. If they had to collect the data by questionnaires, there would be more gaps in the data than there would be in an official or public system. Even in Norway, however, where they have two authorities regulating OHS, they know there may be some overlap in the data. So, it has to be a regulatory requirement.

Hans Bjelland responded by commenting that some independent data collection is also useful. Ingunn referred to the data that they have collected with questionnaires, etc. She noted, however, that these data are not about the number of accidents. Instead, they focus on evaluating the work environment and subjective experience of the workplace. So this is a different kind of data than that which might be collected from regulators. In terms of fatalities, they have found it is possible to get a very accurate picture from newspapers because they write about all of the fatal accidents and that information is public. Barb commented that in the Canadian case, she was involved in the first academic research on aquaculture OHS and that resulted in a paper published in 2009 and identified many hazards throughout the sector. Between that time and the project she has reported on today, which has been going for a few years, nothing else was done. So that is the problem with counting on academic research to achieve sustained, informed injury surveillance and to help move forward discussions and OHS improvements at the level of both policy and industry organizations. Another problem in Canada is the very limited pool of OHS researchers in the country, the vast majority of whom are based in a couple of provinces and few if any of whom work on maritime OHS. The industry is dynamic, diverse, rural and remote, dispersed... if we are seriously committed to an industry that is safe and sustainable in the future and that values the lives and health of workers as much as those of the fish, we need to find ways to support sustainable



surveillance so we can rigorously monitor injury trends and causes and for holistic risk assessments that encompass OHS and work for this sector. That was behind her suggestions.

Charlie asked Dave about the structure of the industry in the US – with many small operations what obstacles are there to data collection? Is it feasible to get all of the small operators to report? He responded by saying that the large companies they have comply; they have to follow the rules and they have HR officers. But when you get to the smaller operators, it is a regulatory burden and there is a lack of knowledge and awareness of how to protect workers. There are a lot of gaps and reporting systems are not really well-developed in the US. Getting aquaculture more looped in to what is going on in other sectors is important because right now it is getting ignored. It is not a top priority.

Another participant commented that when looking at the injury rates/compensation claims for Nowy and how low these are and then comparing them to the Canadian data – one of the things about Canada is the enormous range in the rates. Why is there so much variation between provinces and within provinces over time? Why is it so up and down? Barb responded by saying this is a good question. One of the reasons for the volatility is that it is a small sector and a single incident in a year (as in fishing when you lose a vessel) might lead to a spike that year. She noted they had given up on fatality data for Canada because they couldn't trust the data from the Association of Workers' Compensation Boards of Canada because the classification for aquaculture included workers in other sectors including outfitting and that contributed to high fatality rates. We don't know why Nova Scotia's rates for those years are so high relative to other provinces. Part of the issue too is variability in the format and detail in the data we were provided by the different jurisdictions. In Newfoundland and Labrador, they only ever gave us a powerpoint presentation with summary data, but for Nova Scotia and New Brunswick, we were provided with the raw data. Prince Edward Island did not provide any data and the data we are using here for British Columbia is from what is publicly available on the website for WorkSafeBC. In a current project, researchers from the University of British Columbia have access to the internal WorkSafeBC data so that will give us a stronger sense of what is happening there. The problem is as researchers, we only have so much time and have limited resources when we rely on grant funding and we don't necessarily specialize in this particular kind of research. That is why, she thinks, we need some sort of mechanism for generating quality, comparable data that is accessible to researchers, as in BC, who can do their own analyses of these data and release the results publicly. Surveillance is critical if we are going to find ways to prevent injury and improve aquaculture OHS.

This concluded Dialogue session #4. Barb thanked all of the participants and thanked SINTEF Ocean, particularly Ingunn and Trine for the wonderful collaboration that they have supported over several years. She noted her hope that the collaboration will be sustained in some form into the future and ideally can be expanded to include US and possibly other researchers.