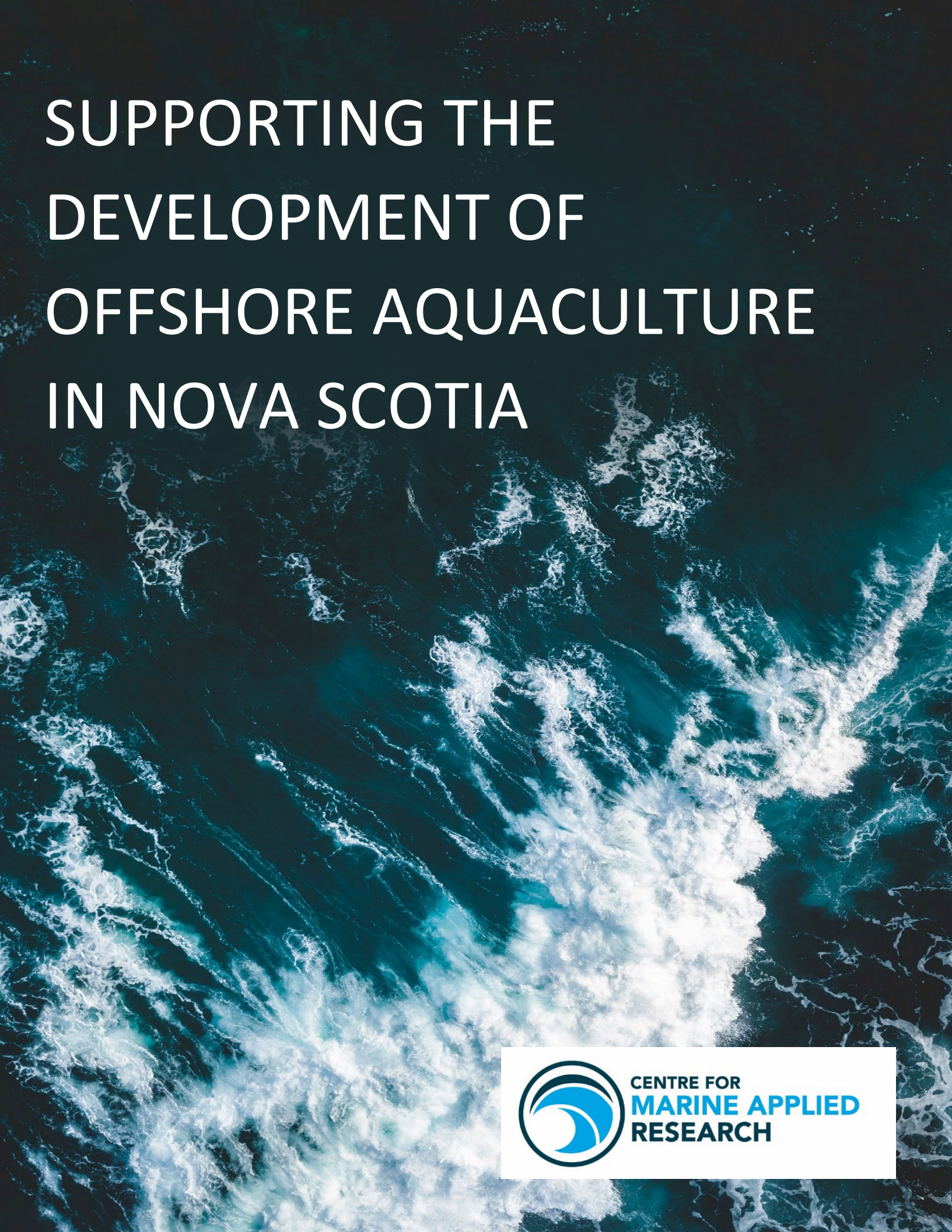
SUPPORTING THE DEVELOPMENT OF OFFSHORE AQUACULTURE IN NOVA SCOTIA



CENTRE FOR MARINE APPLIED RESEARCH

Supporting the Development of Offshore Aquaculture in Nova Scotia

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Executive summary

Developing aquaculture facilities further offshore has the potential to significantly increase production while avoiding some of the environmental issues and conflicts currently faced by the coastal aquaculture industry. As a result, offshore aquaculture development is rapidly gaining momentum in many countries.

Currently, the term 'offshore aquaculture' lacks a standard definition and is used to describe a wide diversity of operations in a variety of depths and distances from the coast. For the purposes of this report, offshore aquaculture was defined as occurring more than 3 km from land. Based on this definition, there are only 10 offshore aquaculture operations around the globe that are in full, commercial operation. Of these, 4 culture shellfish, 6 culture finfish, and most are situated within 15 km of the coast in less than 80 m depth. These offshore aquaculture operations are located within waters belonging to Panama, Norway, Mexico, Australia, New Zealand, England, Costa Rica, and Canada.

Due to the large size of Canada's open ocean and proximity to key markets, there is strong potential to develop offshore aquaculture in Canadian waters, particularly off the coast of Nova Scotia. However, the prospect of developing offshore aquaculture in Canada raises some important questions regarding federal and provincial jurisdiction.

The Provincial Government of Nova Scotia has a long history of being the lead aquaculture regulator in Nova Scotia. However, the exact borders separating Nova Scotian provincial waters from federal offshore waters remains undefined. Currently, there is no comprehensive legal system for regulating aquaculture in federal offshore waters. Consequently, the pending Federal Aquaculture Act may include regulations to lease and license offshore aquaculture facilities. However, to avoid continuing uncertainty, its implementation would need to be predicated by a clearly defined provincial-federal offshore border separating the two jurisdictions.

Overall, this regulatory uncertainty presents a challenging environment to any investors considering developing offshore aquaculture in Nova Scotia. Therefore, we propose at least four possible solutions to offshore aquaculture regulation in Nova Scotia.

- **Option 1:** Wait for the pending Federal Aquaculture Act to be completed and implemented. However, details on the new legislation and the anticipated enactment date are unknown. Also, provincial and federal borders remain undefined for the time being.
- **Option 2:** Designate the Nova Scotia Department of Fisheries and Aquaculture as the lead regulator of all aquaculture occurring within the Canada-Nova Scotia Offshore Area. This would allow the provincial regulator to implement their existing regulatory regime in offshore waters.
- **Option 3:** Expand the mandate of the joint federal-provincial Canada-Nova Scotia Offshore Area Petroleum Board (CNSOPB) to include regulation of offshore aquaculture.
- **Option 4:** Create a new joint federal-provincial regulatory board, set up in a similar fashion to the Petroleum Board, with the authority to regulate offshore aquaculture.

All four options have various advantages and disadvantages, but could help support the development of offshore aquaculture in a manner that is sustainable, safe, and beneficial to the province of Nova Scotia.

1. Introduction

1.1. Aquaculture from a global perspective

The world's population is projected to increase from 8 to 10 billion in the next 30 years (U.N. 2019). To feed a population of this size, it has been estimated that food production may need to increase by as much as 70% (Hunter et al. 2017). Meeting this demand without causing irreversible damage to the environment is argued to be one the most important challenges facing society today (Pretty et al. 2010, FAO 2018a). Agriculture is already the largest single user of freshwater on the planet, the greatest source of greenhouse gasses, and the biggest driver of habitat and biodiversity loss (Ramankutty et al. 2018). It will therefore be difficult to increase agricultural food production without causing further environmental degradation. There is also little room for increased harvest of wild aquatic organisms, such as fish and shellfish, as a third of wild stocks are currently considered to be fished beyond sustainable biological limits (FAO 2018b). Consequently, many are looking to aquaculture to help meet the world's growing food demand (Merino et al. 2012, Gentry et al. 2017, O'Shea et al. 2019).

'Aquaculture' describes the culture of aquatic plants (e.g., seaweeds and algae) and animals (e.g., finfish and shellfish) grown in the sea, areas of freshwater, or in tanks on land. Aquaculture's contribution to global food security has been growing in importance for decades (Reid et al. 2019). Overall, global aquaculture production has doubled approximately every 10 years since 1950 (Figure 1). In contrast, the amount of fish and shellfish harvested from wild populations has not increased since 1996 (Pauly and Zeller 2016, FAO 2018b). As a result, global aquaculture production in 2019 was estimated to exceed wild harvests by 24 million metric tonnes (FAO 2021). Aquaculture also has important social and economic benefits as the industry is estimated to employ over 19 million people worldwide, and current production levels generate over USD $250 billion a year in first sale value (FAO 2018b, Tacon 2020).

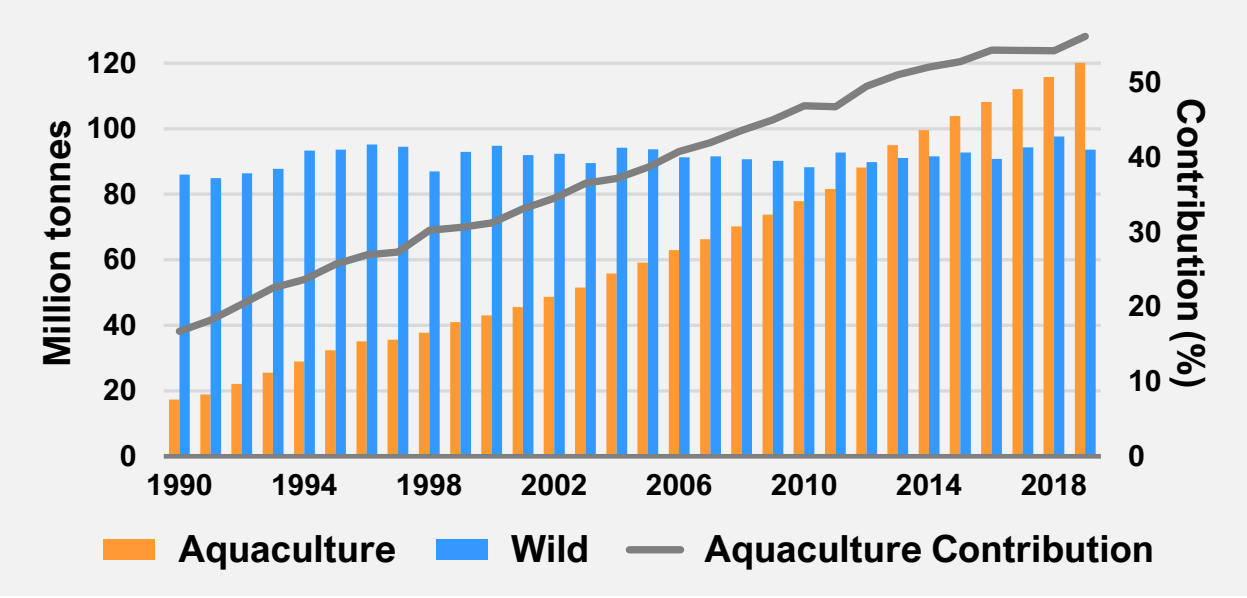

Figure 1 | The amount of biomass harvested from wild and cultured aquatic populations since 1990. The line indicates the percentage contribution aquaculture makes towards global freshwater and seafood production. Data from FAO (2021).

1.2. Aquaculture in Canada

The Canadian aquaculture industry has undergone significant growth since the mid-1980's (Figure 2). As a result, Canada is now the fourth largest producer of farmed Atlantic salmon (*Salmo salar*) in the world (Fisheries and Oceans Canada 2020e). In 2020, total aquaculture production reached 170,805 metric tonnes and generated over CAD $1 billion in first sale value (values are ~8.7 % lower than the previous year due to COVID-19). Atlantic salmon represents approximately 74 % of all Canadian aquaculture by value and 63 % by weight. The remainder is comprised primarily of mussels, oysters, scallops, and other molluscs (Fisheries and Oceans Canada 2021). Of the coastal provinces, British Columbia is the largest aquaculture producer, followed by Prince Edward Island, New Brunswick, Newfoundland, Nova Scotia, and finally Québec.

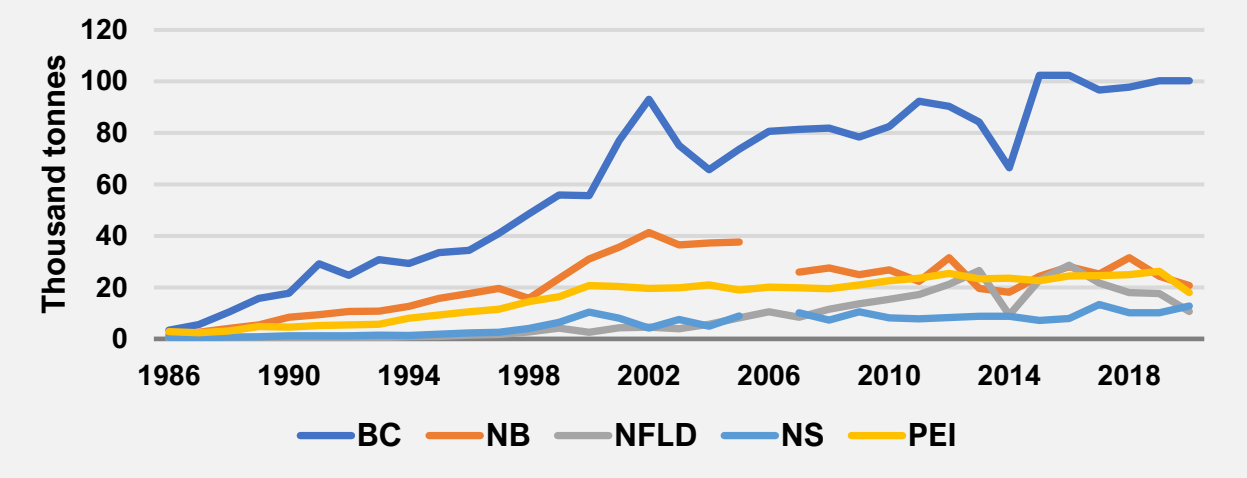

Figure 2 | Aquaculture production in coastal Canadian provinces. BC = British Columbia, NB = New Brunswick, NFLD = Newfoundland, NS = Nova Scotia and PEI = Prince Edward Island. Québec has been excluded due to substantially lower production values. Data from Fisheries and Oceans Canada (2021). Gaps represent years with no available data.

1.3. Aquaculture in Nova Scotia

The aquaculture industry in Nova Scotia has undergone substantial growth since the early 1990's, with production increasing five-fold since 1995 (Figure 3). This growth is mostly due to the expansion of the Atlantic salmon industry, and to a much lesser extent, for steelhead / rainbow trout (*Oncorhynchus mykiss*). In total, finfish aquaculture now represents 91 % of all aquaculture production by weight (1,584 tonnes in 2020) and 88 % by value (CAD $79.5 million in 2020).

Although finfish aquaculture dominates production and value in Nova Scotia, there are currently many more marine aquaculture leases licensed for shellfish than finfish. At present, there are 204 aquaculture leases in Nova Scotia (Nova Scotia Department of Fisheries and Aquaculture 2020c). Of these, 35 are for finfish, 169 are for shellfish, and two are for a combination of both. In terms of distances from the shore, 197 leases are situated within 1 km of the coast, eight are between 1 – 2 km from the coast, and the final lease is an experimental site located 3 km off the coast of Weymouth in St. Mary's Bay. Approximately 85% of all existing leases occur in waters less than 10 m deep. The two deepest leases occur in depths of 45 m and 60 m, and both are licensed for Atlantic salmon production.

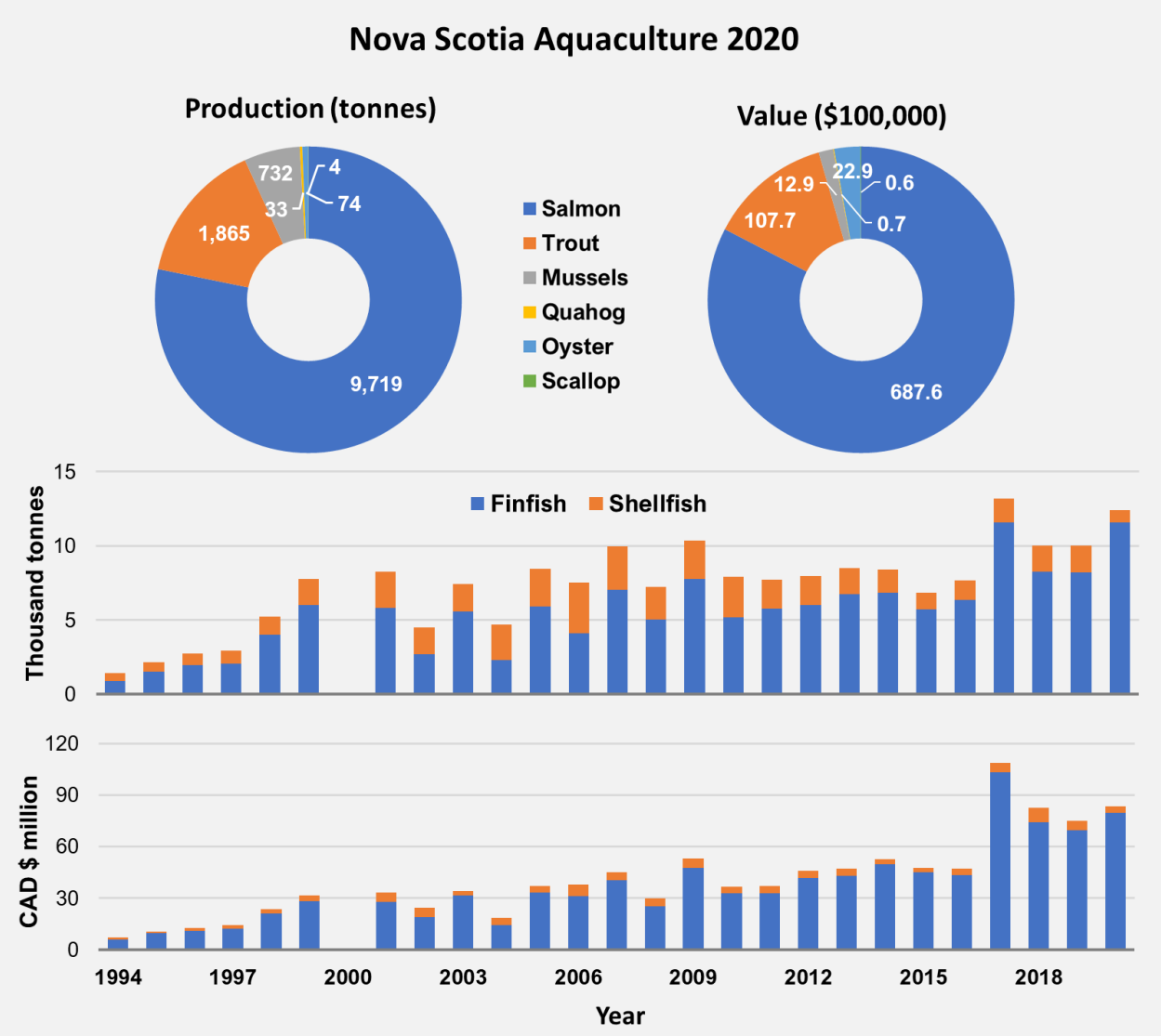

Figure 3 | Aquaculture production levels and value in Nova Scotia for 2020 divided by species (top) and over time (bottom) divided by finfish and shellfish. Salmon = Atlantic salmon, trout = rainbow and brook trout, mussel, = blue mussel, oyster = American oyster, scallop = sea scallop. Data from Nova Scotia Department of Fisheries and Aquaculture (2020b).

Most aquaculture operations in Nova Scotia are situated in coastal rural areas which have broadly been identified as in need of economic growth and development (oneNS 2014, CRRF 2015). Therefore, by directly employing over 870 people within the province, and using a diverse range of local services and contractors, aquaculture plays an increasingly important role in supporting the communities and economies of coastal rural Nova Scotia (Nova Scotia Department of Fisheries and Aquaculture 2020c). The development of aquaculture is also viewed as a strategic 'inclusive economic growth' opportunity for coastal and rural communities in Nova Scotia (Nova Scotia Department of Fisheries and Aquaculture 2019). Inclusive economic growth describes the Provincial Government's aim to build and promote a more innovative and diverse economy accessible to all.

2. Making the case for offshore aquaculture

As the aquaculture industry expands, it is increasingly competing with other sectors and water users for available space (Buck and Langan 2017, Klinger et al. 2017). In addition, open-water aquaculture can be negatively affected by a wide range of environmental stressors while generating impacts on the wider environment (see Sections 2.1 – 2.6). These are some of the key reasons why some stakeholders have a negative perception of aquaculture and may voice their opposition towards further expansion (Froehlich et al. 2017, Flaherty et al. 2018). Globally, most marine aquaculture operations are located within sheltered, coastal areas (Morro and Rey Planellas 2021). However, developing aquaculture further offshore, in the open ocean, could enable a significant increase in global aquaculture production while potentially avoiding / mitigating these issues (Holmer 2010, Klinger and Naylor 2012, Klinger et al. 2017, O'Shea et al. 2019). Consequently, the development of offshore aquaculture is rapidly gaining momentum in many countries around the world (O'Shea et al. 2019).

Due to the size of its open ocean and proximity to key markets (e.g., USA), there is very strong potential for development of offshore aquaculture in Canadian waters, particularly off the coast of Nova Scotia (CCFAM 2015). This section summarises some of the issues facing coastal aquaculture in Nova Scotia and how offshore aquaculture may potentially mitigate them.

2.1. Lower visual impact

In Nova Scotia, visual impacts are one of the primary concerns for residents living near proposed and existing aquaculture operations (Mirto et al. 2010, Mulligan 2017, Willick 2018, CTV 2019). Open-water aquaculture requires a diversity of infrastructure including nets, ropes, buoys, and larger semi-permanent structures such as walkways and feed barges. These alter the appearance of the landscape and can be perceived by stakeholders to negatively affect the surrounding aesthetic, local tourism, and real estate prices (Bavinck et al. 2017, Willick 2018). However, by being located further from the coast, offshore aquaculture facilities should be beyond the line of sight for most coastal residents, potentially avoiding this long-standing conflict within the coastal zone (Knapp 2008, Holmer 2010).

2.2. Reduced environmental effects

One of the most well documented environmental effects of aquaculture is organic enrichment of the seabed (Brager et al. 2015, Price et al. 2015). This is caused by fish faeces and uneaten feed settling on to the seafloor, where it then becomes decomposed by bacteria. As this process consumes oxygen, organic enrichment can lead to declines in oxygen, alterations in sediment biochemistry, and reduced benthic biodiversity; that is, a lower number of individuals and species living within and on the seabed (Islam 2005, Holmer et al. 2007, Pusceddu et al. 2007, Hargrave 2010, Callier et al. 2013, Hamoutene et al. 2018). Aquaculture can also potentially lead to an increase dissolved nitrogen concentrations (Price et al. 2015, Howarth et al. 2019). Both of these factors were suggested to be responsible for a reduction in eel grass (*Zostera marina*) and benthic biodiversity in Port Mouton Bay, Nova Scotia[1] (Cullain et al. 2018). Eelgrass is known for its high biodiversity value and is identified as an Ecologically Significant Species (ESS) in Canada.

[1] The potential for aquaculture to impact eelgrass integrations is comprehensively reviewed in 'Managing Aquaculture and Eelgrass Interactions in Nova Scotia' by Howarth et al. (2021).

Since offshore aquaculture is located further from the coast in deeper waters, it has greater exposure to waves and ocean currents, which should result in greater flushing, dispersion and dilution of organic materials, and therefore, minimize any negative environmental impacts (Sara et al. 2006, Borja et al. 2009, Lovatelli et al. 2013, Gentry et al. 2017, Morro et al. 2021, Sanz-Lazaro et al. 2021). This could permit growers to increase production levels and culture animals at higher stocking densities while causing fewer unintentional effects on the wider environment (Holmer 2010, Cabre et al. 2021).

2.3. Less conflict with other sectors and users

A common concern stakeholders have regarding aquaculture is its potential to interfere with water recreation and navigation. In 2014, several applications for oyster and other shellfish farms were withdrawn in Pictou County due to public concerns that the farms would affect boating, swimming, and other recreational activities (SaltWire 2014). By being located further from the coast, offshore aquaculture may reduce user conflicts in the near-shore area. Furthermore, any potential conflicts offshore aquaculture may have with commercial / international shipping should be easily avoidable as the location of all prospective aquaculture sites must first be approved by Transport Canada under the *Canadian Navigable Waters Act* (R.S.C. 1985) and marked in accordance with the regulations.

Although Transport Canada approval is required for the placement of aquaculture infrastructure to ensure navigation remains unobstructed, marine aquaculture sites may still overlap with coastal fisheries. Aquaculture operations can potentially limit the amount of space available to fishing fleets by restricting the passage of fishing boats and the placement of their gear. This may particularly be the case for the lobster fishing industry as much of their fishing effort is focused near the coast in areas that are also suitable for aquaculture development (Figure 4). Aquaculture has also been criticized by the Nova Scotian lobster fishing industry for its potential environmental impacts. For example, some Nova Scotian lobster fishermen voiced strong opposition towards a proposed salmon farm in St. Mary's Bay in early 2020 (CBC 2020). Their reasons included organic enrichment of the seabed and the potential for salmon to eat lobster eggs, a relationship not reported in the scientific literature. Expanding the aquaculture industry offshore may mitigate these potential conflicts with the inshore lobster fishery in Nova Scotia, which typically has much higher catch rates than the offshore fishery (Figure 4).

Although offshore aquaculture has potential to generate less conflict with near-shore fisheries, it could conflict with offshore fisheries, such as groundfish, scallops (*Placopecten magellanicus*), herring (*Clupea harengusi*), and snow crab (*Chionoecetes opilio*) (Figure 5). Fishers in the USA recently voiced opposition towards the development of prospective offshore finfish farms due to their perceived effects on fish stocks and the wider environment, and their concern that offshore aquaculture might place cheaper seafood products into the market, which may compete with products from wild capture fisheries (Cooper 2019, IntraFish 2019). Thus, consulting with the fishing industry early into the process of scoping potential areas for offshore aquaculture development in Nova Scotia is recommended.

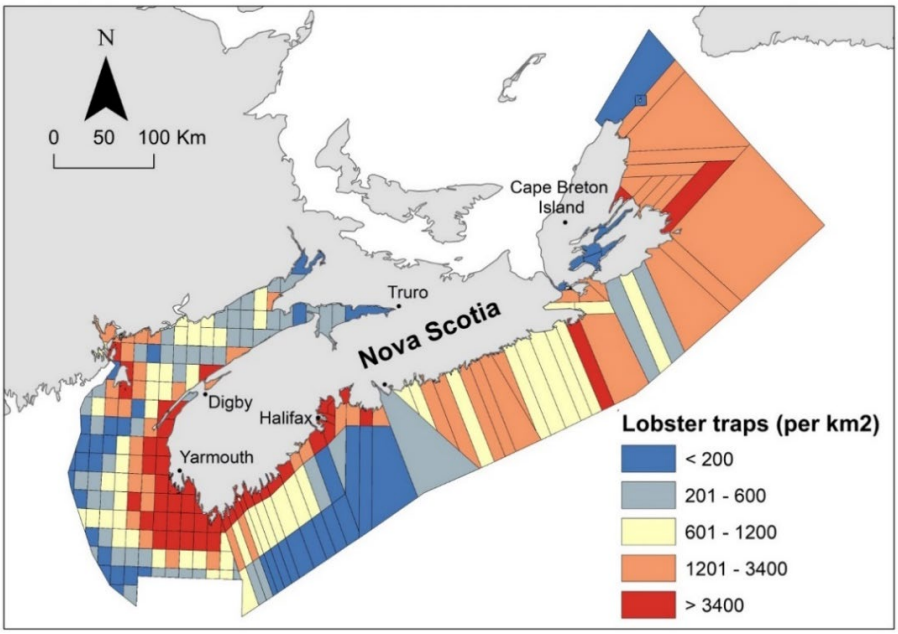

Figure 4 | Map of the average number of lobster pots deployed within reporting grids between 2010 – 2014 in Nova Scotia. Data is representative of Fisheries and Oceans Maritimes region only and does not include the Northumberland Strait or Gulf of St. Lawrence of the Gulf Region. Data from Fisheries and Oceans Canada (2018b).

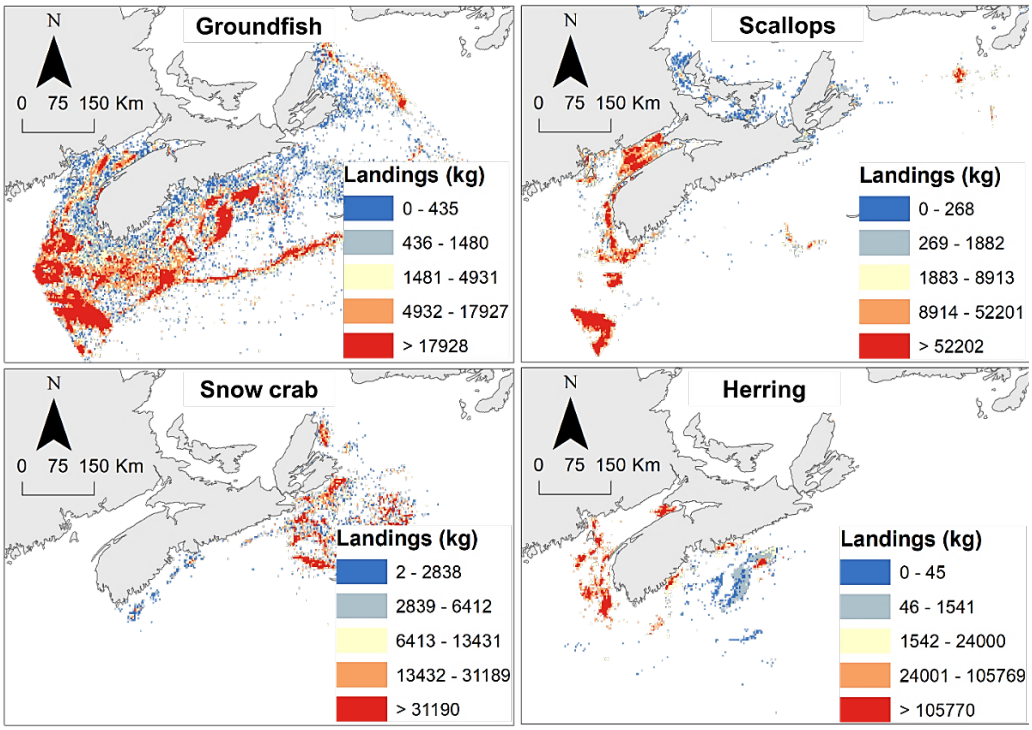

Figure 5 | Aggregate landed weight per 2 x 2-minute grid cell for several species / gear types between 2010 – 2014 in Nova Scotia. Except for scallops, data are representative of Fisheries and Oceans Maritimes region only and does not include the Northumberland Strait or Gulf of St. Lawrence of the Gulf Region. Data from (Fisheries and Oceans Canada 2019b).

2.4. Reduced disease and infection

As agriculture and aquaculture cultivate animals and plants in high densities, they can both be susceptible to parasites and diseases, which they can receive from or transmit to wild populations if health measures are inadequate. Diseases can come at a significant cost to growers. For example, to reduce risk of transmission, 700,000 farmed Atlantic salmon were culled in Shelburne Harbour following an outbreak of Infectious Salmon Anemia (ISA) in 2012 (CBC 2012). Consequently, potential disease transmission between farmed fish and wild populations is often cited as a key concern of local stakeholders (Globe and Mail 2013, Galparsoro et al. 2020). However, by being located outside the natural distribution of many coastal parasites and their intermediate hosts, offshore aquaculture has the potential to benefit from lower infection and transmission risk relative to coastal aquaculture (Holmer 2010, Kirchhoff et al. 2011, Morro et al. 2021).

Offshore shellfish aquaculture may particularly benefit from reduced infection risk and contamination. The harvesting of wild and farmed shellfish in Nova Scotia is frequently prohibited due to bacterial contamination from terrestrial wildlife, agricultural runoff, improperly functioning residential septic systems, and waste waster treatment plant failures during heavy rainfall events (Fisheries and Oceans Canada 2020a). Therefore, situating shellfish aquaculture operations further offshore could eliminate, or lower, the risk of bacterial contamination from these terrestrial and nearshore sources. In addition, diseases that commonly affect shellfish in coastal Nova Scotia (e.g., Multinucleate Sphere Unknown X or 'MSX disease' and Malpeque Disease) would likely be reduced in offshore waters (Lewis Clancy, NSDFA, *pers. comm*, June 2020).

2.4. Reduced genetic contamination

During storms, predator attacks, or even during regular maintenance operations, cultured organisms can escape from aquaculture facilities into the surrounding environment (Glover et al. 2017). Cultured individuals are usually genetically distinct from wild populations as they have been selected for commercially desirable traits such as faster growth rates and delayed maturity times. As escaped organisms can interbreed with wild populations, there is evidence that escapees can alter the natural genetic composition of wild populations (Naylor et al. 2005, Cross et al. 2008), which can lead to reduced immunity, and alterations in their behaviour and physiology (Keyser et al. 2018). As offshore aquaculture facilities are located further away from sensitive coastal habitat and river systems utilized by native wildlife, the risk of genetic interactions with certain wild populations may potentially be reduced (O'Shea et al. 2019).

2.5. Greater site availability and suitability of environmental conditions

The sea surrounding Nova Scotia, out to the 200 nautical mile limit of Canada's Exclusive Economic Zone (EEZ; see Section 4.1), covers an approximate area of 476,000 km^2 (Fisheries and Oceans Canada 2014). This is over two times the size of all the New England states combined. Thus, by considering areas beyond the immediate coastal zone, offshore aquaculture may benefit from having a much greater area available for site development.

One of the greatest challenges faced by finfish growers in Atlantic Canada are sudden and unexpected changes in water temperature and oxygen concentration. For example, in November 2019, unusually warm ocean temperatures led to depleted oxygen levels and the asphyxiation of approximately 1.8 – 2.6 million fish at a fish farm in Newfoundland (Bundale 2019, CBC 2019, Montgomery 2019b). Conversely, sudden drops in temperature below -0.7 °C can result in very high mortality levels within a very short time frame, a phenomenon known as 'superchill'. For example, a superchill event in 2015 caused the death of a large

number of fish at three Nova Scotian fish farms in Shelburne, Jordan Bay and the Annapolis basin (CBC 2015, CTV 2015), as well as 10,000 fish deaths in Liverpool Bay in 2019 (Willick 2019).

Overall, it can be difficult for growers to identify novel areas in coastal Nova Scotia that are suitable for finfish aquaculture but never experience superchill or sudden spikes in water temperature[2]. Thus, considering areas further offshore would undoubtedly offer greater site availability and greater diversity of environmental conditions. Nonetheless, a full assessment of offshore oceanographic and environmental parameters needs to be conducted in Nova Scotia (see Section 6.3) and it is likely that superchill even occurs in some offshore areas (Fisheries and Oceans Canada 2018a).

2.6. Less biofouling

Marine aquaculture requires ropes, buoys, nets, and other structures to be immersed in open seawater. Through a process known as 'biofouling', these structures inevitably get colonised by bacteria and diatoms, followed by larger organisms such as macroalgae, hydroids, mussels, and tunicates (Rittschoff 2000, Fitridge et al. 2012). If regular maintenance activities are not carried out, these fouling organisms can constrict net openings, reducing the flow of water, oxygen, and nutrients. This can limit the growth of cultured organisms and lead to negative impacts on their health and survival (Claereboudt et al. 1994). Excessive biofouling can also damage aquaculture infrastructure and the fouling organisms can compete with cultured shellfish for space and food (Adams et al. 2011).

As anti-fouling measures (such as mechanical cleaning of nets) are time consuming and expensive, they can account for 5 – 30 % of grower's operational costs (Claereboudt et al. 1994, Adams et al. 2011, Fitridge et al. 2012). Interestingly, a New Zealand study indicated that offshore mussel farms were subjected to lower levels of biofouling (Atalah et al. 2016). This was thought to be a result of their placement in deeper waters and over softer sediments located far from the intertidal zone, which may have acted as a barrier to coastal biofouling species with limited natural dispersal abilities. It is therefore possible that offshore aquaculture facilities may experience less biofouling in Nova Scotia.

2.7. Other advantages

In addition to the advantages detailed above, offshore aquaculture may benefit from greater water flow, oxygen cycling, and water quality (Morro et al. 2021). Cleaner, more oxygenated water, should result in reduced mortality, better feed conversion ratios, improved health, and a better quality end-product (Holmer 2010). These advantages, combined with those already described, may permit growers to stock organisms at higher densities and increase production in general. In the long-term, this could confer an economic advantage over coastal aquaculture despite the higher start-up and daily operational costs (see Section 3.1) likely associated with offshore aquaculture (O'Shea et al. 2019).

[2] Recent data suggests that superchill is very infrequent from Halifax to the south shore and up into middle of the Bay of Fundy, although it may still occur (Centre for Marine Applied Research 2022)

3. Current state of offshore aquaculture

3.1. Offshore aquaculture is not clearly defined

There is currently no standard definition of offshore aquaculture (Morro et al. 2021). Holmer (2010) and Buck and Langan (2017) defined offshore aquaculture as taking place at least 2 – 3 km from the coast. Due to their exposed locations, offshore aquaculture operations would likely experience strong ocean winds and waves up to 5 m in height (Holmer 2010, Buck and Langan 2017). Both Bostock et al. (2010) and Buck and Langan (2017) suggest that such high degrees of exposure will present challenges regarding site staff safety, and will require specialised robust structures, service vessels, and at least some degree of automated feeding and monitoring technology (Table 1). This will likely result in much higher operational costs than more traditional coastal aquaculture operations (Morro et al. 2021).

Table 1| Characteristics of offshore aquaculture (Bostock et al. 2010, Holmer 2010, Buck and Langan 2017).

Parameter	Coastal farming	Off-coast farming	Offshore farming
Physical setting	< 500 m from the shore < 10 m depth Within sight of the shore	0.5 – 3 km from the shore 10 – 50 m depth Usually visible from shore	> 2 – 3 km from the shore > 50 m depth Not visible from the shore
Exposure	Waves < 1 m height Local winds Local currents Strong tidal currents Sheltered by land masses < 90 ° angle of exposure	Waves < 3 – 4 m height Localized winds Localized currents Weak tidal currents Somewhat sheltered > 90 ° angle of exposure	Waves up to 5 m in height Oceanic winds Oceanic swells No tidal currents No shelter from land > 180 ° angle of exposure
Other	Site accessible in all conditions	Site accessible > 90 % of the time Some degree of automation required	> 80 % accessibility Service vessels Automated technologies Highly robust structures Higher risk to staff Higher operational costs

Froehlich et al. (2017) reviewed 70 biologically-focused science papers, published between 1999 to 2016, which had used the term 'offshore aquaculture'. Only 52 of the papers described a specific depth and / or distance from the coast. Of the 40 studies that specified a distance from shore, only half described a location within 3 nautical miles from the coast. A specified depth was only reported in 34 of the studies, with 24 describing a location in depths less than 30 m. In summary, the term 'offshore aquaculture', as it is currently used, tends to describe operations that are located closer to the shore and within shallower depths than may be first assumed.

3.2. Case studies

As detailed above, the term 'offshore aquaculture' lacks a standard definition and is currently used to describe a variety of different operations occurring across a wide range of depths and distances from the coast. Due to this ambiguity, it is difficult to identify the global number of offshore aquaculture facilities. In

compiling this report, many industry and media articles covering recent developments of offshore aquaculture facilities were reviewed. However, further research revealed that these sites were frequently situated close to the coast, often within bays and harbours, and many had yet to be stocked. In addition, the vast majority of these were not in commercial operation. Rather, they were being used for 'proof of concept' purposes or to support the research and development of new offshore technologies.

For the purposes of this report, we defined offshore aquaculture as being located > 3 km from land but did not impose any restrictions on water depth. Based on this definition, there are only 10 offshore aquaculture operations around the globe that are currently in full commercial operation (Figure 6). All are located within 20 km of the coast in depths greater than 25 m. This section reviews some of these case studies. Particular attention is given to Norway as they have demonstrated some significant leaps in offshore aquaculture technology and production capability in recent years (see Section 3.2.2). The USA is also comprehensively reviewed as their government is structured in a relatively similar way to Canada's. However, their only commercial offshore aquaculture facility was terminated in March 2020 (see Section 3.2.7).

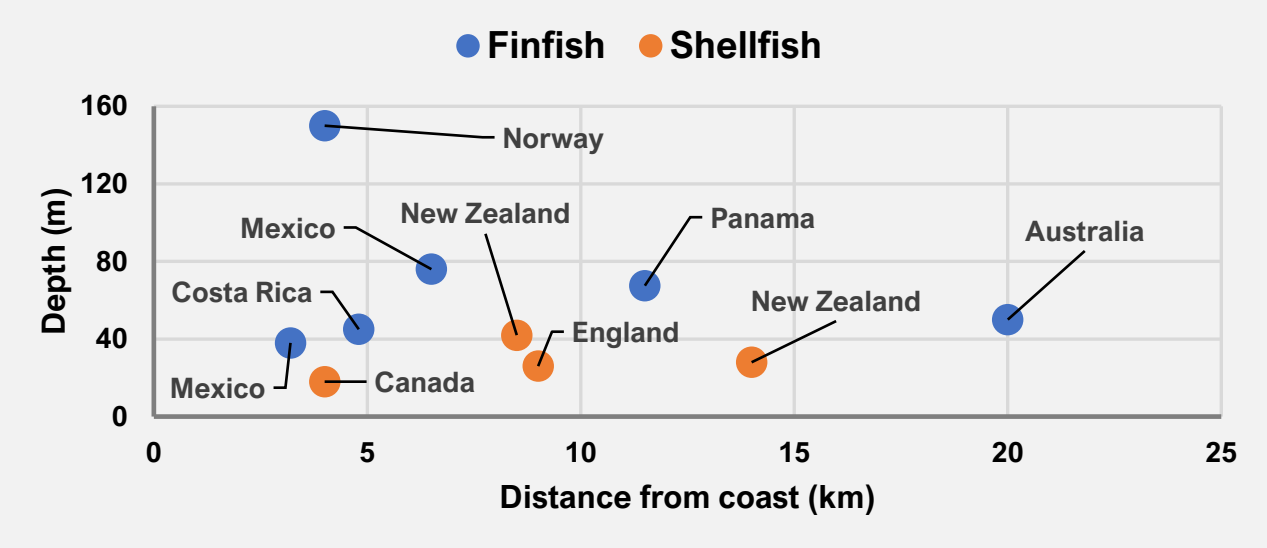

Figure 6 | The depths, distance from the coast, and country of location of offshore aquaculture facilities (> 3 km from the coast) that are currently in full commercial operation.

3.2.1. Panama

A company named Open Blue (www.openblue.com) produces around 1,500 metric tonnes of cobia (*Rachycentron canadum*) each year at their facility, located approximately 12 km from the north coast of Panama in depths of 65 – 70 m (Mahaney and Watt 2017, McGraw 2018, Montgomery 2019a). This facility consists of 20 InnovaSea SeaStations (Figure 7) which can be fully submerged to help avoid storm damage (InnovaSea 2020). Open Blue initially began their operations in Puerto Rico, however, they moved production to Panama after the United States (U.S.) Government capped their production levels (Montgomery 2019a). The company were unable to secure the necessary permits for expansion, prompting them to move to Panama (for more information on the USA, see Section 3.2.7).

Figure 7 | Two of Open Blue's InnovaSea SeaStation cages off the Panama coast. The cages are in their fully raised position to allow for net maintenance. Source: Open Blue.

3.2.2. Norway

Norwegian company, SalMar, are one of the largest producers of farmed Atlantic salmon in the world. They have over 100 licenses for open net-pen production of salmon in Norway, and partly own several companies that produce salmon in Iceland and Scotland (SalMar 2020a). Nearly all SalMar's open net-pen facilities are located close to shore. However, SalMar recently invested over CAD $1.4 billion in the design and development of a new offshore salmon facility, known as 'Ocean Farm 1' (Undercurrent News 2020).

Ocean Farm 1 is a semi-submersible, steel, cylindrical structure, measuring 110 m in diameter and 68 m in height (Figure 8). This facility has a total volume of 250,000 m^3, capable of holding 1.5 million fish, which can be divided between three separate holding areas by a sliding bulkhead (Ocean Farms 2016). There are over 20,000 sensors on the structure which monitor fish growth, health, feeding and environmental parameters (Undercurrent News 2020). The facility has a full-time staff of 4 – 7 workers, and the handling of fish can be performed without using external boats and equipment.

Figure 8 | SalMar's Ocean Farm 1 in the process of being towed to Norway from China. Source: SalMar.

After its construction in China, Ocean Farm 1 was towed to Norway in September 2017 (Ocean Farms 2019). The facility was then moored approximately 23 km off the coast of central Norway, approximately 4 km from a series of small islands, in depths of 150 m (BarentsWatch 2020, Ocean Farms 2020). Over 1 million salmon smolts were stocked and harvested the following September (SalMar 2020b). Production quantities

are not publicly available but the facility was expected to produce 143,000 metric tonnes in 2018 (Fletcher 2018). Ocean Farm 1 reportedly has very low rates of sea lice infection (0.01 female lice per fish) relative to SalMar's other facilities located closer to shore (Fletcher 2018).

Although SalMar initially framed Ocean Farm 1 as being less susceptible to fish escapes (Furuset 2020), it has experienced at least two major escape events since 2017 (Ocean Farms 2019). In September 2018, approximately 16,000 salmon escaped the facility after an inspection hatch was left open, which allowed water to enter the bulkhead. This caused the farm to tilt, temporarily dropping the outer ring below the water's surface. A second escape event then occurred in August 2020 at a time when it was stocked with 700,000 salmon (Aadland 2020). The exact number of escapees has not been publicly released but the company claims the number of fish which escaped in 2020 was "minimal" (Ramsden 2020b).

SalMar obtained 8 'development licenses' from the Norwegian Government for Ocean Farm 1 (Undercurrent News 2020). Development licenses are designed to encourage innovation in aquaculture technologies and expire shortly after a project's completion. Companies can then choose to convert their development licenses into a full commercial license for a much lower cost than what they could obtain through the Norwegian Government's annual license auction. Ocean Farm 1 made the transition to a full commercial license in July 2020 (The Fish Site 2020).

SalMar are now developing a larger facility known as the 'Smart Fish Farm' (Figure 9) which is based on the design of Ocean Farm 1. This facility is expected to have a wider diameter of 160 m, creating a total holding volume of 510,000 m^3, which would be capable of holding 3 million salmon divided between 8 separate holding areas (Drønen 2019). This is double the number of fish Ocean Farm 1 can hold. The central closed column will be equipped for fish extraction and processing. The project is expected to cost CAD $240 million and construction was expected to begin sometime in 2020 (Ramsden 2020a) but was delayed presumably due to COVID-19. SalMar recently applied for permission to site the facility between 40 – 100 km off the central coast of Norway for a maximum permitted biomass of 19,000 tonnes (Fish Farming Expert 2021).

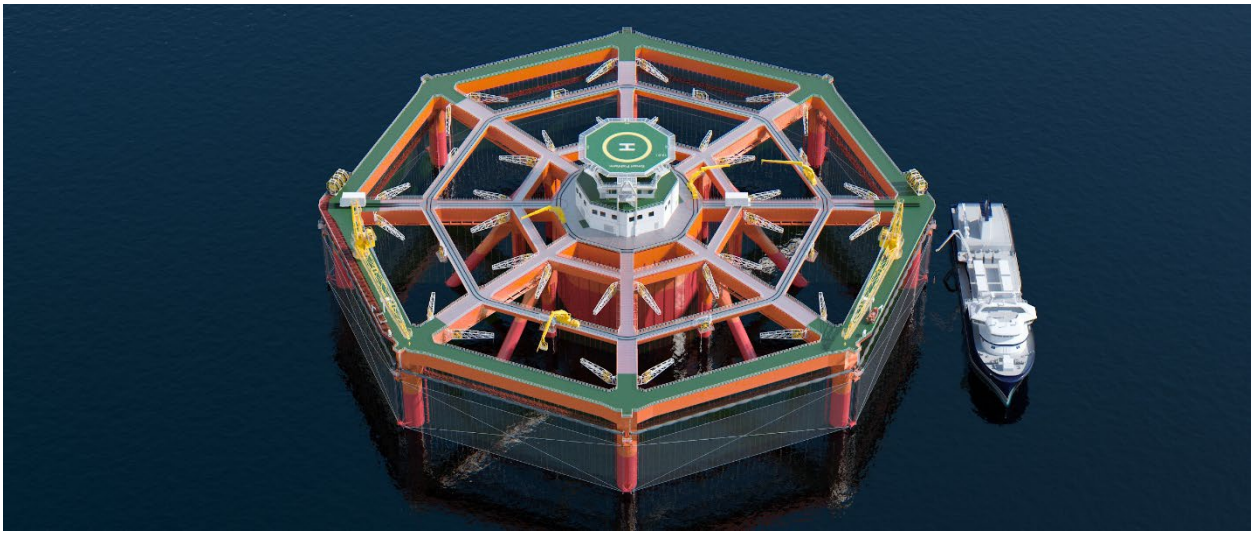

Figure 9 | Artist impression of SalMar's Smart Fish Farm, which is currently in design, and will be larger than Ocean Farm 1 and located further offshore. Source: MariCulture.

3.2.3. Mexico

The Kampachi Company (www.kingkampachi.mx) are one of two companies producing finfish in offshore Mexico. The company produces king kampachi (*Seriola rivoliana*) at their facility 6.5 km from the coast of La Paz, in the Gulf of California, at depths of 75 m. Despite its offshore location, the facility is well sheltered by Baja California, the Mexican mainland, and several small islands. Consequently, the farm consists of four Polarcirkel Plastic Pens manufactured by the AKVA Group (www.akvagroup.com), which are similar to pen designs currently used in coastal Nova Scotia by several growers (Figure 10). However, unlike conventional net-pens, these pens can be submersed to avoid rough oceanographic conditions and harmful algal blooms. The fish are fed by a standard air blower, which is switched to a water-borne feeding system when the cages are submersed (Fishfarmer 2019).

Figure 10 | The Polarcirkel Plastic Pens used by the Kampachi Company. Source: The Kampachi Company.

Earth Ocean Farms (www.earthoceanfarm.com), a portfolio company of Cuna Del Mar (www.cunadelmar.com), are also based in La Paz and have a facility located 3.2 km from the coast. This company grows totoaba (*Totoaba macdonaldi*) and Pacific red snapper (*Lutjanus peru*). Information on their operations is scarce, but it is known that the company use several fully submersible Aquapods (a design now owned by the InnovaSea group) in depths of around 38 m (Figure 11).

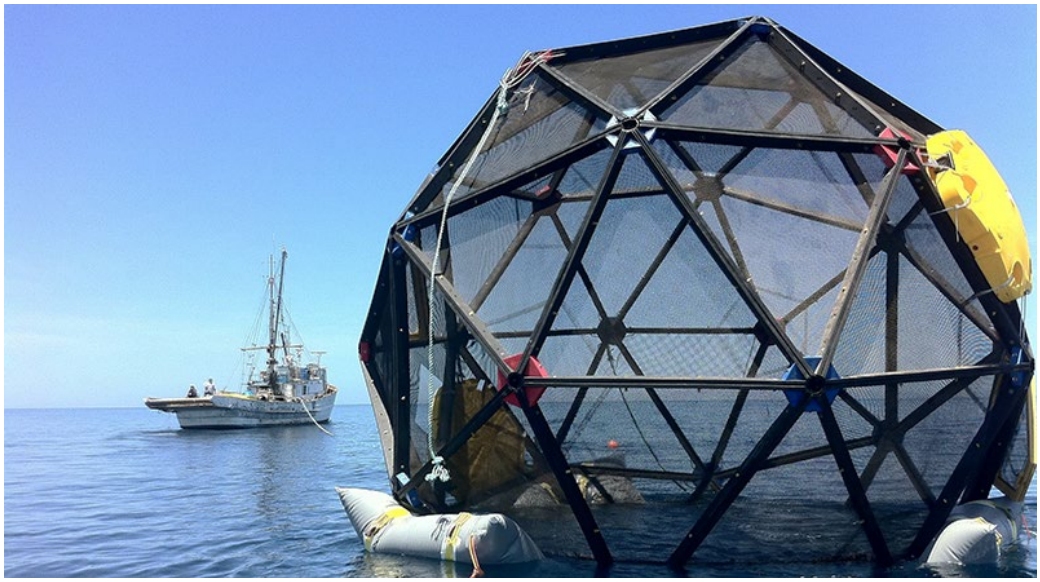

Figure 11 | The Aquapod system (in its raised position) used by Earth Ocean farms. Source: Earth Ocean farms.

The Mexican government has attempted to encourage further offshore aquaculture development in recent years. In 2017, the government pledged to invest between USD $50 – 70 million in infrastructure and other initiatives to support the development of new aquaculture operations within its waters (White 2017). Consequently, several U.S.-based aquaculture companies have recently moved their production to Mexican waters (Mahaney and Watt 2017).

3.2.4. Australia

Since the early 1990's, companies in South Australia have been catching live, wild, southern bluefin tuna (*Thunnus maccoyii*) and growing them to larger and more profitable sizes in offshore ranches. Generally, the industry catches tuna in the Great Australian Bight using purse-seiner vessels. They keep their nets submerged and then carefully tow their entire haul for journeys lasting up to 3 weeks (Ellis and Kiessling 2016). The tuna are then transferred to offshore ranches about 10 – 20 km from the coast of Port Lincoln. Depths range between 20 – 50 m and ocean swells can reach up to 2.5 m in height. As these conditions are relatively normal for traditional finfish operations, companies primarily use the standard circular pen system found in many parts of the world (Figure 12). Ranchers typically feed the tuna with baitfish, half of which is usually comprised of sardine (*Sardinops sagax*), using automated feeding and monitoring technology (Ellis and Kiessling 2016). Fish are ranched for a duration of 3 – 8 months, in which time the fish usually double in weight from approximately 15 – 20 kg to 30 – 40 kg (MBA 2016).

Due to their high quality and fat content, each tuna is typically worth over USD $500 to the Japanese market, which is the main exporter for this industry. In 2017, southern bluefin tuna ranching was conducted by 8 different companies in the Lincoln Offshore Aquaculture Zone and generates over USD $100 million annually (Oceanwatch 2018).

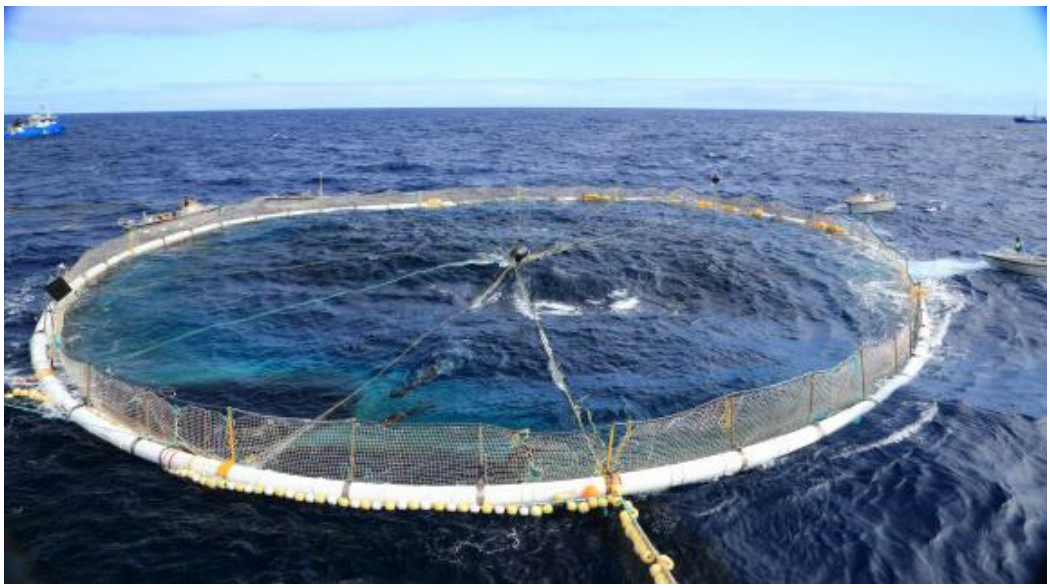

Figure 12 | Offshore tuna ranch in Port Lincoln, South Australia. Source: Australian Government, AFMA.

3.2.5. New Zealand

In response to growing interest from the aquaculture industry in expanding their operations, the New Zealand Government are currently reviewing their offshore aquaculture management and regulation practices (Stephanie Hopkins, New Zealand Ministry for Primary Industries, *pers. comm*, April 2020).

At present, there are two offshore aquaculture facilities in full commercial operation in New Zealand. Both produce green lipped mussels (*Perna canaliculus*) which is the primary aquaculture species in New Zealand. One facility, owned by Eastern Seafarms Ltd., is located approximately 8.5 km from the east coast of the North Island, in depths of 42 m. The second, owned by Ngāi Tahu Seafood Resources Ltd., is located approximately 14 km from the coast of Pegasus Bay, off the South Island, in depths of 28 m (Grant Hopkins, Cawthron Institute, *pers. comm*, May 2020). Overall, the New Zealand mussel farming industry is highly regarded on an international level. In fact, several New Zealand manufacturers export ropes, anchors, and floatation devices to aquaculture companies located around the world (e.g., see Section 3.2.6).

Several companies are also hoping to expand their finfish production to offshore waters. Ngāi Tahu Seafood Resources Ltd. (www.ngaitahuseafood.com) recently submitted an application to produce king salmon (*Oncorhynchus tshawytscha*) at a site located approximately 2 – 6 km from the north coast of Stewart Island, on the South Island, in depths of 20 – 40 m. Their proposal is for a 25 km^2 area containing up to 118 traditional circular net-pens (Clement 2019). Similarly, the New Zealand King Salmon Company (www.kingsalmon.co.nz) have submitted an application to produce king salmon at a site located approximately 6 – 12 km north of the Cape Lambert coast, within the Cooke Strait. Their proposal is for a 18 km^2 area in depths of 60 – 165 m (Elvines et al. 2019).

3.2.6. England

Offshore Shellfish Ltd. (www.offshoreshellfish.com) produce blue mussels (*Mytilus edulis*) at three facilities located between 4 – 9 km off the coast of Lyme Bay, in the English Channel, at depths of 22 – 30 m (Emma Sheehan, University of Plymouth, *pers. comm.* May 2020). Although some parts of the facility are still under construction, the company made their first harvest of 40,000 kg in February 2020 (Figure 12). Their set-up uses helical seabed screw anchors and ropes imported from New Zealand, and single headlines buoyed by a new design of vertical floats created by Offshore Shellfish Ltd. and Fusion Marine (Figure 13). These floats are more easily submerged by waves compared to traditional barrel-type surface floats, resulting in less vertical shaking, helping to prevent mussel dislodgement (FFE 2016, Waycott 2018).

3.2.7. USA

The USA has two levels of government, state and federal, making it similar to Canada's government structure in some respects (see Section 4.1). Generally, states have regulatory jurisdiction over commercial activities out to three nautical miles from the coast, except for Texas and Florida, which have jurisdiction out to nine nautical miles (reviewed in Montgomery 2019a). Aquaculture regulation varies greatly between states and some have no defined regulatory and permitting systems in place (reviewed in Lester et al. 2018). Several companies are currently examining the feasibility of establishing aquaculture facilities in federal waters, located outside of state boundaries (reviewed in Montgomery 2019a).

Figure 12 | A line of offshore cultured mussels are brought up for mechanical harvest. Source: Offshore Shellfish.

Figure 13 | Offshore mussel floats developed by Offshore Shellfish and Fusion Marine. Source: Fusion Marine.

In an attempt to designate a lead agency for permitting offshore aquaculture, and a clearly defined regulatory framework for the industry, the bipartisan *Advancing Quality and Understanding of American Aquaculture* (AQUAA) *Act* was introduced to U.S. Congress in 2020, the U.S. Senate in October 2021, and the U.S. House of Representatives in December 2021 (Fiorillo 2021). If approved, the resulting Bill would designate NOAA responsible for coordinating the federal permitting process for offshore aquaculture (Dawson 2020, Hill 2020). However, in August 2020, the U.S. Court of Appeals for the Fifth Circuit upheld a

2018 federal ruling that NOAA has no jurisdiction to regulate offshore aquaculture under existing national fisheries laws (Mayer 2020). The other elements of the AQUAA act are still under debate, meaning the federal regulation of offshore aquaculture remains uncertain.

To date, only one commercial-scale offshore aquaculture operation has existed in U.S. federal waters. The Catalina Sea Ranch (www.catalinasearanch.com) was created in 2014 and produced Mediterranean mussels (*Mytilus Galloprovincialis*) at a 100-acre facility, 10 km off the coast of southern California in depths of 45 m. However, the company declared bankruptcy in March 2020 after it was fined for a series of license violations. These violations were uncovered during a lawsuit for the wrongful death of a sailor whose boat capsized after entangling with some loose gear from the farm (Cart 2020). As a result, there are now no offshore aquaculture facilities currently located in U.S. federal waters.

A Presidential Executive Order, made by former President of the USA Donald Trump in May 2020, announced plans for the creation of 10 new 'Aquaculture Opportunity Areas' (AOAs) by 2025 (Fletcher 2020). These zones would be evaluated by NOAA as being environmentally, socially, and economically appropriate for the development of commercial aquaculture, and may accommodate multiple aquaculture operations rearing finfish, shellfish, and / or seaweed in state or federal waters. NOAA designated the first two AOAs in August 2020. These are located within federal waters off southern California and the Gulf of Mexico (NOAA 2020). Additionally, the Ocean Era (www.ocean-era.com) company, formerly known as Kampachi Farms, has received a permit from the Environmental Protection Agency (EPA) to create an offshore demonstration farm for 20,000 kampachi located 70 km off the coast of Florida (Spain 2020). The 'Velella Epsilon Aquaculture Project' is currently waiting structure approval from the US Army Corps of Engineers. However, in March 2021, the project was put on hold after President Joe Biden ordered courts to review past Executive Orders made by Donald Trump (Sapin 2021).

3.2.8. Canada, Québec

Based on the definition used in this report, there is currently one offshore aquaculture facility in Canada. This has been in operation since 2007 and produces oysters and mussels 4 km off the coast of the Magdalen Islands in waters approximately 19 m deep (reviewed in Lacoste et al. 2018, Efflam et al. 2020). The lease covers an area of approximately 2.5 km^2 and consists of > 200 longlines. For mussels, 3 m long socks are suspended at a depth of 9 m. The lease has a total annual production of around 200 tonnes. This site is unique in Québec as it resulted from a research and development project led by Merinov (www.merionv.ca). The regulation process was led by the provincial aquaculture regulator MAPAQ – le Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (Chris McKindsey, DFO, *pers. comm*, December 2021; Nicolas Toupoint and Flora Salvo, Merinov, *pers.comm*, March 2022).

4. Aquaculture regulations in Canada

There are several barriers which could impede the development of offshore aquaculture in Canada. One of the primary barriers is current ambiguity in which areas of sea fall under provincial or federal jurisdiction (see Section 4.2). Simultaneously, there is currently no comprehensive legal framework for aquaculture regulations in federal waters (see Section 4.4). While business investments inherently involve an element of risk, such regulatory uncertainty is widely considered to be unnecessary and avoidable (Mahaney and Watt 2017). As offshore aquaculture is still a new industry, limited experience means there is already uncertainty

around yields, costs, and revenue without the added complexity of regulatory uncertainty. Therefore, investors may be less likely to develop aquaculture in Canadian offshore waters without the security of a clear regulatory regime (Knapp and Rubino 2016, O'Shea et al. 2019).

Identifying possible options to resolve this regulatory uncertainty first requires an understanding of international law, federal and provincial jurisdictions, and knowledge of how aquaculture is currently regulated in Canada. These are reviewed in the following sections.

4.1. Canada's international borders

Canada's international borders extend from the land out to a distance specified by the United Nations Convention on the Law of the Sea (UNCLOS) *Law of the Sea Treaty* (U.N. 1982). Canada signed the Convention in December 1982, ratified it in November 2003, and referred to the UNCLOS agreements throughout the Federal *Oceans Act* (S.C. 1996). Under UNCLOS, coastal States (including Canada) have full sovereignty of their Territorial Sea, which typically extends from the low water mark out to 12 nautical miles (Figure 14). The only exception to a State's complete sovereignty within this zone is that vessels from all States must be allowed innocent passage. Therefore, aquaculture activities would only come into conflict with UNCLOS laws and regulations if they threatened commercial navigation (Lovatelli et al. 2013).

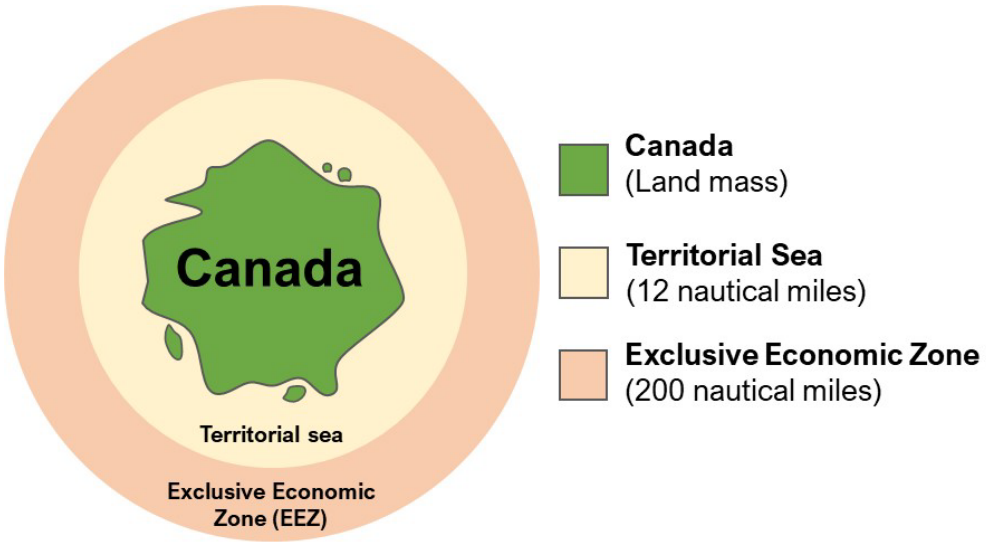

Figure 14 | Conceptual diagram representing Canada's international borders under the United Nations Convention on the Law of the Sea (U.N. 1982).

The next important international boundary is the Exclusive Economic Zone (EEZ), which extends from the low water mark out to 200 nautical miles. Within the EEZ, States have sovereign rights to explore and exploit natural resources including fossil fuels, renewable energy, minerals, and fish stocks. Coastal States also have jurisdiction to establish and use "artificial islands, installations and structures" (Mahaney and Watt 2017). Although untested, the sovereign rights to manage natural resources would undoubtedly allow coastal States to establish, regulate, and manage aquaculture operations up to the boundary of their EEZ (Lovatelli et al. 2013). Canada's right to permit and regulate such activities beyond its coastal waters arises under international law, just as it does for other industries such as fishing, oil and gas (Mahaney and Watt 2017).

Beyond the EEZ is the high seas / international waters. In this zone, coastal States have no specified rights over resources and UNCLOS specifies the right for all States to freedom of navigation, fishing, and to construct artificial islands and other installations (Mahaney and Watt 2017).

4.2. Provincial jurisdictional borders

In Canada, Provincial Governments generally have jurisdiction to regulate commercial activities occurring within their boundaries. However, the exact boundary of Nova Scotia (and many other provinces) is an area of uncertainty (Fitzgerald 1991, Doelle et al. 2006, Mahaney and Watt 2017). Generally, the Federal Government sees provincial jurisdiction extending from the land to the low water mark (Ballantyne 2016). However, there are four common exceptions[3] to this:

1. Juridical bays / *intra fauces terrae* (e.g., Halifax harbour, St. Margaret's Bay)
2. Historic bays (e.g., Conception Bay in Newfoundland)
3. Pre-Confederation descriptions / title (e.g., Bay of Fundy)
4. Pre-Confederation statutes (e.g., Georgia Strait in British Columbia)

The notion of juridical bays, or *intra fauces terrae* (Latin for "between the jaws of the land"), dates back to 1315 and allows many waters semi-enclosed by land (e.g., harbours, bays, and coves) to be considered part of the land, and therefore, to fall within provincial jurisdiction (Ballantyne 2016). However, exactly what constitutes a juridical bay is not clearly defined. For example, there are no specified maximum limits for the width, length, and depth of a juridical bay. Instead, the two general guiding principles for whether an area is a juridical bay is whether the curvature of the coastline looks like a bay, and whether the bay has historically been used by the province, both of which are open to interpretation.

Pre-Confederation descriptions / title and statutes also have relevance in Nova Scotia. The *Constitution Act* (1867) was enacted to unite Nova Scotia and New Brunswick, along with Québec and Ontario, into the Dominion of Canada (Black 1986). The Act stated that the two provinces "shall have the same limits as of the passing of this Act". Consequently, there are several arguments that Nova Scotia's borders extend beyond juridical bays, including:

- **Three-mile territorial sea:** Between the 17th and 20th century, the British Crown claimed rights over a three-mile territorial sea around its colonies, including Nova Scotia. This three-mile territorial sea was referred to multiple times in legal disputes at the time (reviewed in Fitzgerald 1991) and was internationally recognized prior to Canadian Confederation (Foley 1981). Thus, both Nova Scotia and New Brunswick can cite pre-Confederation statutes whereby jurisdiction over this territorial sea were exercised (Doelle et al. 2006).
- **Alexander boundary description:** Around 1621, James I made a large grant of territory, referred to as 'Nova Scotia', to Sir William Alexander (Foley 1981). This included areas of the continental

[3] 'Public harbours' are an exception to these exceptions. These are federal properties situated within provincial, inland waters (reviewed in Mahaney and Watt 2017).

shelf. It has been argued that all of the marine territory encompassed by the Alexander boundary description should be considered within Nova Scotia (reviewed in Foley 1981, Doelle et al. 2006).

- **Fishing grounds:** Various treaties, conventions, and maps created under English and French and rule show that fishing grounds located on the Scotian Shelf were considered to be an extension of, and included within, the territory of Nova Scotia (Foley 1981).

In summary, Nova Scotia and New Brunswick are legally entitled to the territorial boundaries and proprietary rights which they possessed prior to Confederation (Foley 1981). However, what exactly these boundaries are remains undetermined.

4.3. Provincial regulation of aquaculture

Aquaculture is jointly managed by Federal, Provincial, and Territorial Governments, the nature of which varies between provinces / territories (Fisheries and Oceans Canada 2020b). All aquaculture sites in Canada require a valid lease and licence. Leases entitle the owner / operator to install and use aquaculture gear in a specified area. Licences entitle the owner / operator to stock the facility, subject to conditions specified within the licence. Responsibility for issuing licenses and leases varies by province. In British Columbia, the province is responsible for issuing leases, while Fisheries and Oceans Canada (DFO) are responsible for issuing licences and ensuring operators comply with licence conditions. In Prince Edward Island, a management board containing members from DFO, the province, and the industry, share these responsibilities. While, for all other provinces and territories, provincial or territorial authorities issue both the lease and the licence (Fisheries and Oceans Canada 2020c).

4.3.1. Aquaculture regulation in Nova Scotia

Nova Scotia has a legally defined system for regulating aquaculture. The *Fisheries and Coastal Resources Act* (S.N.S. 1996) is the primary law governing aquaculture in Nova Scotia, along with the *Aquaculture Licensing and Leasing Regulations* (N.S. Reg. 347/2015) and *Aquaculture Management Regulations* (N.S. Reg. 348/2015). The Nova Scotia Department of Fisheries and Aquaculture (NSDFA) are the lead regulators of aquaculture in Nova Scotia, and are responsible for: issuing aquaculture licenses and leases; performing site visits and other administrative assessments; and specifying management measures regarding fish health, environmental monitoring, fish containment, and farm operations. A Memorandum of Understanding (MOU) between NSDFA and DFO provides authority to the provincial body to issue leases and licenses. Both NSDFA and DFO share the responsibility for environmental management and monitoring (Nova Scotia Department of Fisheries and Aquaculture 2020d).

In Nova Scotia, aquaculture license and lease applications either undergo an 'administrative' or 'adjudicative' decision process (reviewed in Nova Scotia Department of Fisheries and Aquaculture 2020e). The administrative decision process is overseen by NSDFA and covers applications for land-based operations as well as marine operations regarding: experimental licenses and leases; renewals of existing licenses and leases; assignments of existing licenses and leases; amendments to existing licenses and leases that do not result in the expansion of the site or the addition of finfish to a site that is currently not approved for finfish; and the approval of new licenses and leases in an approved Aquaculture Development Area (ADA). Decisions on administrative applications are made by the Aquaculture Administrator, who is an appointed employee of NSDFA. In contrast, the adjudicative decision process covers applications for new

marine licenses and leases outside of an approved ADA, amendments to existing licenses and leases that expand site boundaries, and amendments that add finfish to licenses that are not currently approved for finfish. Decisions for adjudicative applications are made by the independent Aquaculture Review Board (https://arb.novascotia.ca/). In addition to taxes and employment, Nova Scotia economically benefits from aquaculture development through secure option to lease fees, aquaculture licence and aquaculture lease application fees, and annually recurring lease and license fees (N.S. Reg. 347/2015).

All aquaculture applications are reviewed by NSDFA and network partners. Network partners consist of provincial and federal departments that have regulatory jurisdiction over certain aspects of aquaculture. This may involve several groups within DFO including the Fish and Fish Habitat Protection Program, Aquaculture Management, the Marine Planning and Conservation program, DFO Science, and various DFO fishery departments. Other federal departments like Environment and Climate Change Canada (ECCC), Transport Canada, and the Canadian Food Inspection Agency (CFIA) may also be involved in the process. Together, NSDFA and network partners evaluate the potential environmental and socio-economic impacts of aquaculture proposals based on published scientific research, physical and ecological data collected during baseline sampling, and public engagement during the scoping stage of the application project.

Evaluations and recommendations from NSDFA and network partners are then submitted to the Nova Scotia Aquaculture Review Board (if undergoing an adjudicative process) who hold an independent hearing, in which applicants and stakeholders (e.g., members of the public and local industries) present their evidence in support of, or opposition to, the application. The Board then decides whether the application is approved based on appropriate support data presented during the hearing, and from the recommendations received from NSDFA and network partners.

The systems governing aquaculture regulation in Nova Scotia changed in 2015 following recommendations from an independent review panel, known as the 'Doelle and Lahey Panel'(Doelle and Lahey 2014). These recommendations helped lead to updates to the *Fisheries and Coastal Resources Act*, as well as the creation of the *Aquaculture Management Regulations* and *Aquaculture Licence and Lease Regulations* (Terpenning 2018). In addition, preparation of a Farm Management Plan (FMP) became mandatory for each aquaculture licence and includes information on operator compliance with the *Aquaculture Management Regulations* with regards to fish health management, environmental monitoring, farm operations, and containment management (Nova Scotia Department of Fisheries and Aquaculture 2020a).

In summary, the Nova Scotia Government has a long history of regulating aquaculture in Nova Scotia. This regulatory system has evolved over time in response to past experiences and extensive consultations.

4.4. Federal regulation of aquaculture

4.4.1. Aquaculture Activities Regulations

Aquaculture is regulated at the federal level through several departments and agencies involving many interrelated pieces of legislation and regulations (Table 2). DFO is the primary department responsible for regulating aquaculture through the *Aquaculture Activities Regulations* (SOR/2015-177) which were created under the *Fisheries Act* (R.S.C. 1985). These regulations specify the conditions under which operators may: operate an aquaculture facility; undertake measures to treat their stock for disease and parasites; and deposit organic matter into the environment. They also establish specific restrictions aimed at minimizing

or mitigating potential negative impacts on wild fish and their associated habitats, and implement specific environmental monitoring and sampling requirements (Fisheries and Oceans Canada 2020b).

Table 2 | Examples of federal legislation that regulate aquaculture operations and the key department / agency responsible for its enactment and enforcement (Mahaney and Watt 2017, Fisheries and Oceans Canada 2020b).

Legislation	Key department / agency	Relevance to Aquaculture
Aquaculture Activities Regulations (SOR/2015-177)	DFO	Regulates almost all aspects of aquaculture including environmental monitoring and sampling.
Canadian Environmental Protection Act (S.C.2012) and the Fisheries Act (R.S.C. 1985)	Health Canada, ECCC, and DFO	Regulates the deposit of deleterious substances in Canadian waters.
Food and Drugs Act (R.S.C. 1985)	Health Canada	Regulates the safety of veterinary drugs administered in aquaculture operations.
Pest Control Products Act (S.C.2002)	Pest Management Regulatory Agency	Ensures pest control products, including those used in aquaculture, meet acceptable environmental and human safety standards.
Health of Animals Act (S.C.1990)	Canadian Food Inspection Agency	Responsible for managing and controlling animal diseases, including diseases affecting aquaculture.
Feeds Act (R.S.C. 1985) and the Food and Drugs Act (R.S.C. 1986)	Canadian Food Inspection Agency	Responsible for testing seafood products for safe human consumption.
Canadian Navigable Waters Act (R.S.C. 1985)	Transport Canada	Responsible for aquaculture facilities sited in navigable waters.
Safe Food for Canadians Regulations (SOR/2018-108) and the Canadian Shellfish Sanitation Program	Food Inspection Agency, ECCC, and DFO	The Canadian Shellfish Sanitation Program ensures that only shellfish that meet food safety and quality standards reach domestic and international markets.

4.4.2. Environmental Impact Assessments

Conducted under the *Canadian Environmental Assessment Act* (S.C.2012), Environmental Impact Assessments (EIAs) are a planning tool designed to inform provincial and federal regulators about the potential effects of a proposed activity before they permit or deny the activity. An EIA aims to:

- Identify potential adverse environmental effects;
- Propose measures to mitigate any adverse environmental effects;
- Predict potential significant adverse environmental effects, after mitigation measures are implemented; and
- Includes a follow-up program to verify the accuracy of the environmental assessment and the effectiveness of the mitigation measures (Impact Assessment Agency of Canada 2019).

EIAs are carried out by either the Impact Assessment Agency of Canada (IAAC), a responsible authority (e.g., the National Energy Board or the Canadian Nuclear Safety Commission), or by a review panel of individuals appointed by the Minister of the Environment and Climate Change. Regardless of who performs the assessment, EIAs can be conducted by just the Federal Government, or in cooperation with a Provincial or Territorial Government.

Only projects described within the *Regulations Designating Physical Activities* (SOR 2012-147), or those designated by the Minister of the Environment, require an EIA. As aquaculture is not mentioned on the *Regulations Designating Physical Activities*, a proposed offshore aquaculture facility should not need to undergo an EIA unless the Minister of the Environment and Climate Change decided it was in the public interest for it to be.

4.4.3. A new Federal Aquaculture Act

As the *Fisheries Act* was created when the Canadian aquaculture industry was still in its infancy, it does not fully consider industrial-scale aquaculture in its modern form. In fact, the current version of the *Fisheries Act* makes no reference to aquaculture (Mahaney and Watt 2017). This is because the principal aims of the *Fisheries Act*, and the resulting *Aquaculture Activities Regulations*, were to minimize any activities that may threaten wild capture fisheries or impact upon the wider environment. Instead, the regulatory conditions that directly support the aquaculture industry, such as leasing and licensing, commonly fall under the responsibility of the adjacent provinces (e.g., see Section 4.3). Consequently, the *Aquaculture Activities Regulations* alone do not provide a comprehensive legal regulatory scheme for the authorization, regulation, and support for aquaculture in Canadian offshore waters.

Due to these legislative gaps, a report by the Federal Advisory Council on Economic Growth in 2017 recommended the development of the new, pending, Federal Aquaculture Act (ACEE 2017). The Federal Aquaculture Act is expected to be drafted in 2022 and is currently undergoing consultation (Fisheries and Oceans Canada 2019a). As part of the consultation, DFO released a discussion document which states the Federal Aquaculture Act will include "a clear mechanism to enable alternative forms of aquaculture in federal jurisdiction, including offshore waters", and that under the Act, "the [Federal] Government would be able to develop regulations to lease and license offshore activities" (Fisheries and Oceans Canada 2020d). Lastly, the document states that the Federal Aquaculture Act will aim to "foster national consistency, while respecting federal, provincial, and territorial jurisdiction". However, given the exact borders of Nova Scotia's jurisdiction remain unclear (see Section 4.2), the implementation of a federal lead for offshore licencing and leasing under the pending Aquaculture Act would need to be predicated by an agreed border between provincial and federal jurisdiction (see Section 6.4 for further discussion) to avoid continuing uncertainty.

The present lack of a defined regulatory system for offshore aquaculture may impede the aquaculture industry from expanding into Canadian offshore waters. Section 6.4 discusses possible options for a regulatory regime for offshore aquaculture in Nova Scotia, including two possible options based on the model currently used for the offshore oil and gas industry (see Section 5).

5. The offshore oil and gas industry in Nova Scotia

The exploration and extraction of offshore oil and gas has been occurring off Nova Scotia since 1959 (Canada-Nova Scotia Offshore Petroleum Board 2018). Consequently, the Nova Scotian offshore oil and gas industry has experience in resolving many of the issues that would likely confront the development of aquaculture beyond coastal waters. These issues include provincial / federal jurisdiction, regulation, health and safety, environmental impacts, conflict with other users, and identifying the direction of flow of any economic benefits. This section describes the regulation of Nova Scotia's oil and gas industry and suggests how offshore aquaculture, located beyond coastal waters, could benefit from following a similar regulatory model. This information is largely based on a report by Mahaney and Watt (2017).

5.1. Regulation of the Nova Scotian offshore oil and gas industry

The discovery of oil near Sable Island in 1967 led to a dispute between the Canadian Federal Government, and the Provincial Governments of Nova Scotia and Newfoundland and Labrador (Denstedt and Thrasher 2007). This dispute mostly centred around who would be responsible for regulating an oil and gas industry in the Canada-Nova Scotia Offshore Area (Figure 15) and who would be the primary economic beneficiaries of royalties and other sources of revenue – the Federal Government or the adjacent provinces. The resolution to this dispute resulted in the creation of the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB), and the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB).

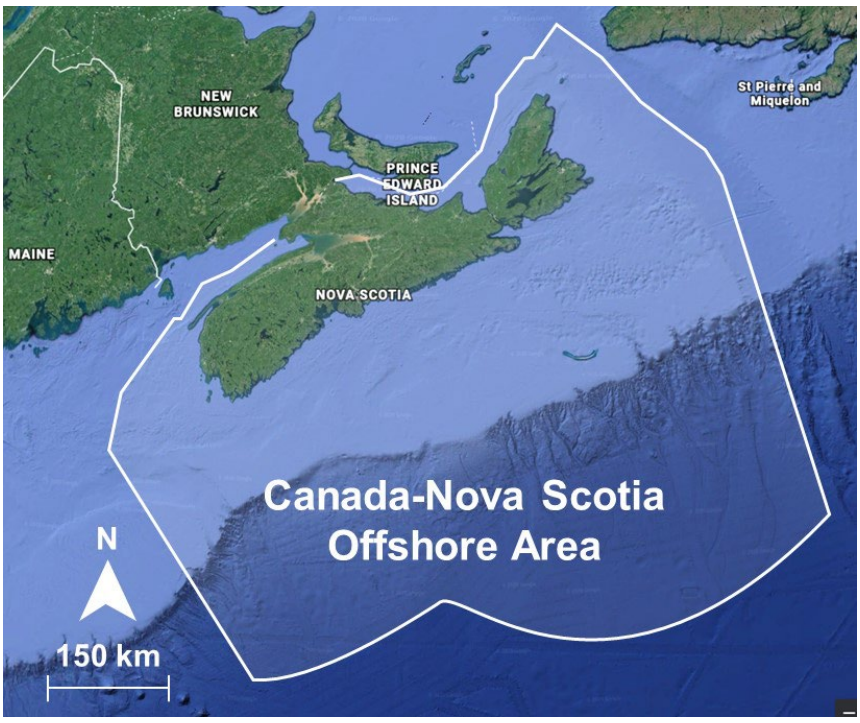

Figure 15 | Map indicating the extent of the Canada-Nova Scotia Offshore Area in which the CNSOPB have jurisdiction to regulate oil and gas exploration and extraction.

The CNSOPB is an independent joint agency, created by the Federal Government and Provincial Government of Nova Scotia, through the passing of the *Canada-Nova Scotia Offshore Petroleum Resources*

Accord Implementation Act (S.C.1988) and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act* (1987). An almost identical process occurred between the Federal Government and the Provincial Government of Newfoundland and Labrador, creating the C-NLOPB. Collectively, these acts are referred to as the *Accord Acts* or the 'Offshore Accords', and were created in full collaboration between the Federal and Provincial governments (Canada-Nova Scotia Offshore Petroleum Board 2020d).

In the Offshore Accords, both the Federal and Provincial Governments effectively agreed to settle their disputes and to work together to jointly establish a new regulatory system for the offshore oil and gas industry (Daniel Watt, McInnes Cooper, *pers. comm,* May 2020). This was achieved by the Federal and Provincial Governments creating parallel (or 'mirror') legislation for the joint federal-provincial management of petroleum resources in the Canada-Nova Scotia Offshore Area, as well as the Canada-Newfoundland and Labrador Offshore Area. The petroleum boards are jointly funded by the Federal and Provincial governments and comprise an equal number of members appointed by each of the Federal and Provincial Governments, and one jointly appointed chairperson.

The Offshore Accords established the CNSOPB as the sole regulator of oil and gas activity in the Canada-Nova Scotia Offshore Area. The CNSOPB have full regulatory supervision of operations throughout an offshore oil or gas project; from exploration through development, to decommissioning and abandonment (Canada-Nova Scotia Offshore Petroleum Board 2020c). Any of these activities must be conducted in accordance with the rules and requirements set in the legislation, and in compliance with any terms and conditions that may be affixed to an operating licence or work authorization issued by the CNSOPB. To receive an operating licence or work authorization, operators must demonstrate that the work meets CNSOPB standards with regards to: health and safety; industrial and employment benefits plans; resource evaluation, conservation and management; protection of the environment; and co-existence / compatibility with other ocean users and industries such as fishing and shipping (Canada-Nova Scotia Offshore Petroleum Board 2020b).

The Petroleum Boards' authority to issue authorizations is restricted only to the extent that the approvals and requirements cannot be inconsistent with the *Accord Acts* or regulations. The Petroleum Boards often use their authority to attach approvals and requirements to authorizations as a means of filling gaps in the Accord Acts (Denstedt and Thrasher 2007). Given the difficulty of aligning all the parties necessary to amend the *Accord Acts* or regulations, this practice allows the Petroleum Boards to regulate effectively even in circumstances that the original legislation does not address.

To assist in the implementation and enforcement of these rules and requirements, the CNSOPB developed a large number of other regulatory instruments including over 25 MOUs with other government organizations such as the Coast Guard, DFO, Transport Canada, Natural Resources Canada (NRCan), and ECCC (Canada-Nova Scotia Offshore Petroleum Board 2020a). These MOUs are used to coordinate activities and avoid duplication of efforts between CNSOPB and various governmental departments and were often created in response to a specific problem or dispute (Shanti Dogra, CNSOPB, *pers. comm*, May 2020).

The Petroleum Boards are independent regulatory agencies; their decisions on offshore management are final and not reviewable by the Provincial or Federal Government. However, the Offshore Accords reserve power for governments to reject "fundamental decisions" such as: announcing a call for bids; issuing a drilling order; issuing or attaching terms and conditions to a significant discovery licence or production

licence; and prohibiting the issuance of interests in a particular area or prohibiting an interest owner from carrying out an activity. Generally, the Federal and Provincial Governments acting together can reject any fundamental decision, while the Provincial Government acting alone may reject fundamental decisions related to development plans. The Federal Government also has the power to reject fundamental decisions if, in the Federal Minister of Natural Resource's opinion, the decision would impact national security of energy supply.

Through the Offshore Accords, the Federal Government essentially conceded that the adjacent provinces should be the primary economic beneficiaries of any offshore oil and gas activity. This was because the adjacent provinces were deemed the most likely to be impacted by an oil spill / gas leak, loss of employment, emergency, or workplace injury / death (Shanti Dogra, CNSOPB, *pers. comm*, May 2020). Thus, all revenues, except federal corporate income tax, are paid to the province (Black 1986).

In summary, the Offshore Accords and the CNSOPB were the product of political compromise between the Canadian Federal Government and the Provincial Government of Nova Scotia. For over 30 years, this negotiated solution has provided a reasonably stable, mostly cooperative, and relatively comprehensive joint regulatory regime governing oil and gas exploration and production in the Canada-Nova Scotia Offshore Area. It could, therefore, provide a promising model for regulating other ocean resource activities located outside provincial jurisdictional borders, such as offshore aquaculture (see Section 6.4).

6. Supporting the development of offshore aquaculture in Nova Scotia

6.1. Ongoing discussions with the aquaculture industry

Three of the largest aquaculture companies currently operating on, or expressed interest in expanding to, the east coast of Canada, were consulted for this report. This was to gauge industry interest and concerns regarding the development of offshore aquaculture in Nova Scotia.

One producer mentioned that, in collaboration with universities and other partners, they were actively involved in the research and development of new offshore aquaculture technologies. It is expected that offshore sites will be located in high energy sites and exposed to fast currents and large waves. They concluded that fish can be influenced by waves at considerable depths depending on wave height and the distance between wave peaks. When water movement is too fast, it becomes difficult for fish to hold their position, and can result in their injury or mortality. Developing systems that allow fish to avoid this, most notably submersible systems, will likely be key to any success in culturing fish in these higher energy conditions. However, species such as salmon must go to the surface to fill their swim bladder to maintain buoyancy. Thus, fish pens cannot be submersed indefinitely. The company representatives stated that, although they believed new offshore aquaculture technologies could survive some extreme oceanographic conditions, the fish themselves may not. Any offshore development must provide the correct species-specific conditions.

Another producer emphasized the importance of lease duration and investment security. Due to the high level of risk associated with offshore aquaculture, and because of the large investment of capital required to develop a new offshore operation, the duration of an offshore aquaculture lease would need to be much longer than the standard 20-year lease currently offered by the NSDFA. They specified that a minimum lease

of at least 30 years would be required to assure investment security. The same producer also mentioned they would have concerns about developing offshore aquaculture in the Bay of Fundy due to the combination of incredibly fast currents and exposure to high winds and waves. They said that, with present technology, an offshore aquaculture operation could tolerate fast currents, or high wave energy, but not both working in combination. The company also asked for clarification on the exact definition of "offshore".

The third producer expressed great support for the possible idea of an experimental offshore finfish farm in Nova Scotia. They said it would be valuable for several reasons including: (1) It could be used by the industry to trial new technologies within the same offshore waters they were considering expanding into; (2) It would test the offshore aquaculture legislation and regulatory regime in Nova Scotia; and (3) it would be an extraordinary public engagement tool to demonstrate technologies to communities and stakeholders, and possibly help to ease their concerns. The producer also mentioned that the relatively recent withdrawal from aquaculture application plans by Cermaq Canada Ltd. in Nova Scotia has increased investor concerns about developing new aquaculture sites in the province. However, they believe an experimental offshore farm could promote investment into Nova Scotia's offshore aquaculture industry.

Overall, all three producers expressed great interest in expanding their operations to more exposed, higher energy sites in Eastern Canada, which would utilise new offshore technologies and concepts. However, they said that these sites would still have to be located near the coast as they felt they were not ready to pioneer the development of 'true' offshore aquaculture in Canada at this time. They expressed interest in maintaining ongoing communications, and expressed great interest in any data, reports and analyses that support offshore aquaculture. They said such information will assist them in determining the feasibility of developing offshore aquaculture in Nova Scotia and will help improve their engineering and organic deposition models for new and existing sites.

6.2. Navy and Coast Guard

The Royal Canadian Navy (herein referred to as the 'Navy') carry out surface and sub-surface operations around the south of Nova Scotia in several areas (Figure 16). However, these areas are only used intermittently or over limited periods of time. If a firing practice or exercise area is going to be used, this information will be delivered to mariners via Canadian Coast Guard Marine Radio Broadcasts, and possibly local newspapers. There is only one military restricted ocean area in Nova Scotia based in Roach Cove, in the Bedford Basin (Coast Guard 2020). It is therefore unlikely the Navy would oppose offshore infrastructure elsewhere in Nova Scotia (Kevin Crew, Canadian Coast Guard, *pers. comm,* May 2020).

Working in high energy sites far offshore can be a risk to both ships and staff. Therefore, it is important to know how emergencies are handled within Nova Scotian waters. In the case of an emergency, such as search and rescue, the operation will be coordinated by the Canadian Coast Guard from the Regional Headquarters in Dartmouth, Nova Scotia. All federal assets, including Navy and Royal Canadian Air Force vessels and aircraft, can be brought in to assist with the operation if deemed necessary by the Coast Guard. This procedure does not change regardless of whether the emergency occurs 1 km or 200 km from the coast (Kevin Crew, Canadian Coast Guard, *pers. comm,* May 2020).

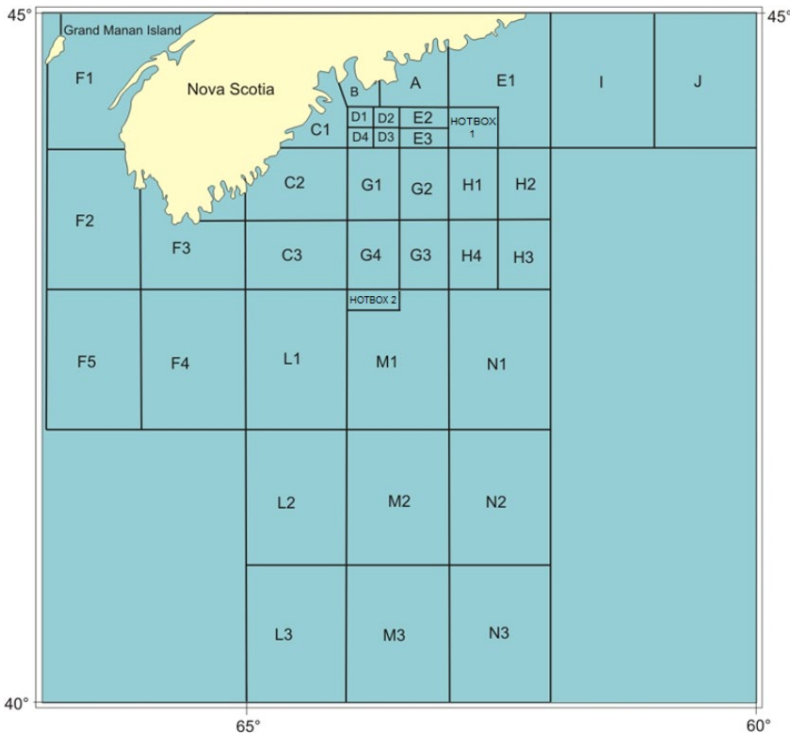

Figure 16 | All military Firing Practice and Exercise Areas in Nova Scotia. Excluding a small, restricted area in Roach Cove, Bedford basin. Source: Coast Guard (2020).

6.3. Data requirements and possible data sources

Scoping out potential areas for the development of offshore aquaculture will require a wide range of data (Table 3). These data can help determine if environmental conditions are suitable for aquaculture and help predict and minimize potential conflicts and environmental impacts. Many of these data are already collected and frequently updated by DFO and are available on the Government of Canada's Open Data platform (www.open.canada.ca/en/open-data). Also, in collaboration with other agencies, DFO are currently working on the Atlantic Canada Marine Atlas, which is expected to be online in 2022 (MacDonald and Ross 2020). This open-access platform will allow users to extract information for a wide variety of oceanographic, ecological, human-use, and management area data; all of which are very relevant to the development of offshore aquaculture.

One data type that may prove difficult to obtain is the long-term monitoring of water temperatures and oxygen concentration at multiple depths. Such data would be particularly important for finfish aquaculture. While there are a wide range of remote sensing data products that generate sea surface temperature data (such as NOAA's Pathfinder Project, and Operational Sea Surface Temperature and Sea Ice Analysis) they are limited to just the ocean's surface and are likely too coarse for aquaculture planning purposes.

Table 3 | Data to support potential locations suitable for offshore aquaculture development.

Data type	Variables of interest
Fishery	Fishing zones
	Fishing effort
Marine management	Marine protected areas
	Existing aquaculture lease sites
Navigational hazards	Offshore energy infrastructure (e.g., oil, gas, and renewables)
	Shipping traffic
Wildlife	Marine mammal & bird abundance and migration routes
	Sensitive and protected habitats
Oceanographic	Wind speed
	Wave height and direction
	Salinity
	Current speed and direction
	Temperature
	Bathymetry
	Sediment type
	Oxygen concentration
Biological	Plankton composition
	Primary production
	Occurrence of harmful algal blooms
	Aragonite saturation

6.4. Possibilities for offshore aquaculture regulation in Nova Scotia

As highlighted throughout this report, there is potential for offshore aquaculture to develop in Nova Scotia. However, federal / provincial jurisdictional borders remain undefined (see Section 4.2), and there is currently no comprehensive regulatory scheme for aquaculture in federal offshore waters (see Section 4.3.3). Overall, this regulatory uncertainty presents a challenging environment to any investors considering developing offshore aquaculture in Nova Scotia. Therefore, we propose at least four possible solutions to offshore aquaculture regulation in Nova Scotia.

6.4.1. Option 1: Federal regulation

DFO has proposed that the pending Federal Aquaculture Act may encompass the leasing and licencing of offshore aquaculture in Canada (Fisheries and Oceans Canada 2019a). However, as NSDFA is currently the lead aquaculture leasing and licencing authority in Nova Scotia (see Section 4.3.1), implementation of this pending Federal Act would need to be predicated by a clearly defined provincial-federal offshore border separating the two jurisdictions in order to avoid continuing uncertainty. In addition, the specifics of the act and date of implementation are still pending.

6.4.1. Option 2: Use the existing aquaculture licensing authority

Another option could be to designate NSDFA as the lead regulator of *all* aquaculture occurring within the Canada-Nova Scotia Offshore Area (Figure 15). This would allow NSDFA to implement their existing

regulatory regime to offshore waters. This could be achievable if the Federal Parliament are able to delegate the administration of a federal action, such as offshore aquaculture regulation, to an existing provincial department like the NSDFA. The advantage for this is that the NSDFA has relevant experience for issuing aquaculture licenses and leases, and already collaborates with DFO regarding industry compliance with the *Aquaculture Activities and Regulations*. However, unlike the Petroleum Boards, NSDFA are not independent of government, and they have limited experience with the legal and operational implications of working in offshore waters (Daniel Watt, McInnes Cooper, *pers. comm,* May 2020). Lastly, this option would still greatly benefit from a clear delineation between federal and provincial waters. Without this, the federal government would be delegating any authority they *might* have over offshore aquaculture in Nova Scotia, which is not a clear and long-term resolution to regulatory and jurisdictional uncertainty.

6.4.2. Option 3: Joint federal-provincial management through the Petroleum Board

A third option is for authority to go to the CNSOPB. The justifications for creating a joint federal-provincial regulatory system for offshore aquaculture in Canadian offshore waters are the same as those that led to the establishment of the Petroleum Boards (see Section 5.1). Firstly, Nova Scotia stands to gain the most from a safe, well regulated, and well-coordinated offshore aquaculture industry. These benefits include local employment, local spending, the issuing of service contracts to local businesses, and the fees associated with the application and issuance of aquaculture licenses and leases. Conversely, Nova Scotia stands to lose the most if the offshore aquaculture industry was poorly regulated, such as environmental impacts, increased risk of workplace injury or loss of life, and lost economic opportunities if offshore aquaculture negatively impacted other sectors, like fishing and tourism. The Offshore Accords set a legal precedent in which the Federal Government recognized the importance of federal-provincial cooperation, and the right for coastal province's to be the primary beneficiary of their adjacent ocean resources. These could also be applicable to offshore aquaculture.

Currently, there are only three oil and gas operations in the Canada-Nova Scotia Offshore Area (Figure 15) and all are in the process of being decommissioned and abandoned (Canada-Nova Scotia Offshore Petroleum Board 2021). Furthermore, the oil and gas industry have not submitted a proposal to the CNSOPB for further exploration since 2018 (Grant 2021). Consequently, there are discussions whether the CNSOPB should expand its mandate to incorporate renewable energies, such as tidal and wind (Shanti Dogra, CNSOPB, *pers. comm,* May 2020; Alisdair Mclean, Offshore Energy Research Association, *pers. comm*, December 12th 2021). Several legal experts in Nova Scotia have heavily argued for this outcome (see Raza and Reid 2021a, b).

NRCan recently published a discussion paper which addresses the Federal Government's plan to develop offshore renewable energy regulations (Natural Resources Canada 2021). While the paper states that the Federal Government are not ruling out joint regulation with adjacent provinces, the Federal Government are proceeding with developing their own regulations for offshore renewables and expect them to be finalized by 2024. This new legislation will designate the Canada Energy Regulator (CER) as the lead regulator of offshore renewables in federal offshore areas (Alisdair Mclean, Offshore Energy Research Association, *pers. comm*, December 12th 2021).

If the CNSOPB does take on regulatory responsibility for offshore renewable energy, it could provide a timely opportunity to expand their mandate further to include offshore aquaculture. The advantage of using the existing board is that it is already established to align both levels of government, encompassing various

other departments and agencies; a process which took several years of negotiation to achieve. However, a disadvantage is that the board is exclusively aimed towards regulating the oil and gas industry, which other than its location in the offshore environment, shares very little in common with aquaculture. Hence, the board would require, among other things, training, new staff and new procedures. Overall, it simply may not be optimal to build on, or adapt, existing procedures and policies which were originally developed for oil and gas industry (Daniel Watt, McInnes Cooper, *pers. comm,* May 2020).

6.4.3. Option 4: A new joint federal-provincial regulatory board

A fourth option is for the authority to go to a new joint federal-provincial regulatory board, set up in a similar fashion to the Petroleum Boards. This option has the advantage of creating an independent and specialised regulatory board that is wholly focused on regulating aquaculture within the Canada-Nova Scotia Offshore Area. However, the disadvantages of creating a new regulatory board are that it would take considerable amounts of negotiation and coordination between the Provincial and Federal Governments, and that there would likely be a significant learning curve for new board members.

6.5. Following recommendations from the Doelle-Lahey Panel

Regardless of how offshore aquaculture proceeds in Nova Scotia, it would be sensible for the new regulatory system to follow recommendations put forward by the Doelle-Lahey Panel (Doelle and Lahey 2014). This will help ensure it stays up to date with any changes in: industry practices and technology; general environmental conditions, whether due to climate change or other developments; conditions and circumstances in coastal communities; research-based understanding of the effects of aquaculture; and the practice and methodology of regulation, both in aquaculture and in other industries or regulatory fields from which the regulation of offshore aquaculture can learn.

7. Summary

The development of offshore aquaculture is globally gaining momentum in response to increasing space constraints in the coastal zone, and because offshore aquaculture has the potential to generate fewer conflicts and reduced environmental impacts. Due to the large size of Canada's open ocean and proximity to key markets, there is strong potential to develop offshore aquaculture in Canadian waters, particularly off the coast of Nova Scotia. However, the prospect of developing offshore aquaculture in Nova Scotia raises some important questions regarding federal and provincial jurisdiction.

The Provincial Government of Nova Scotia has a long history of being the lead regulator for commercial aquaculture in Nova Scotia. However, the exact borders delineating Nova Scotian provincial waters and federal offshore waters remains undefined. Currently, there is no comprehensive regulatory system for aquaculture in federal offshore waters. Consequently, the pending Federal Aquaculture Act may include regulations to lease and license offshore aquaculture facilities. However, to avoid continuing uncertainty, its implementation would need to be predicated by a clearly defined provincial-federal offshore border separating the two jurisdictions.

Overall, this regulatory uncertainty presents a challenging environment to any investors considering developing offshore aquaculture in Nova Scotia. Therefore, we propose at least four possible solutions to offshore aquaculture regulation in Nova Scotia.

- **Option 1:** Wait for the pending Federal Aquaculture Act to be completed and implemented. However, details on the new legislation and the anticipated enactment date are unknown. Also, provincial and federal borders remain undefined for the time being.
- **Option 2:** Designate Nova Scotia Department of Fisheries and Aquaculture (NSDFA) as the lead regulator of all aquaculture occurring within the Canada-Nova Scotia Offshore Area. This would allow the provincial regulator to implement their existing regulatory regime in offshore waters. This option would still greatly benefit from resolving provincial and federal borders.
- **Option 3:** Expand the mandate of the joint federal-provincial Canada-Nova Scotia Offshore Area Petroleum Board (CNSOPB) to include regulation of offshore aquaculture.
- **Option 4:** Create a new joint federal-provincial regulatory board, set up in a similar fashion to the Petroleum Board, with the authority to regulate offshore aquaculture.

All four options have various advantages and disadvantages, but could help offshore aquaculture develop in a manner that is sustainable, safe, and beneficial to the province of Nova Scotia.

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