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Proceedings of the Regional Peer Review of the Marine Harvest Atlantic Canada Aquaculture Siting Baseline Assessments

Meeting Dates: May 28–31, 2019
Location: St. John's, NL

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

A Regional Peer Review process was held in St. John's, Newfoundland and Labrador (NL), from May 28–31, 2019 to provide advice for Marine Harvest Atlantic Canada's (MHAC) licenses for 13 sites located on the south coast of Newfoundland, in Bay Management Areas (BMAs) 9, 10, 11, and 12. The Proponent submitted a Baseline Assessment Report for each site.

Detailed notes of the discussion that followed each presentation were produced. This Proceedings Report includes abstracts and summaries of meeting discussions, as well as a list of research recommendations. The meeting's Terms of Reference, agenda, and list of participants are appended.

INTRODUCTION

Marine Harvest Atlantic Canada (MHAC) applied for 13 aquaculture licenses at various sites located on the south coast of Newfoundland. The site applications were submitted to the Province and referred to Fisheries and Oceans Canada (DFO) for siting advice. In accordance with the Aquaculture Activities Regulations (AARs), a Baseline Assessment Report for each site, which includes modelling of waste dispersal from site operations and an assessment of benthic communities before deposition, was submitted by the Proponent. The Regional Aquaculture Management Office requested DFO Science review the Baseline Assessment Reports and provide advice regarding the expected exposure zones for health treatment products and deposition of biochemical oxygen demanding matter, and the predicted consequences for species and habitats in the region.

The co-chairs reminded meeting participants that, as a part of the Canadian Science Advisory Secretariat (CSAS) process, the review was to be evidence-based, impartial, objective, and respectful; the Science Advice for Government Effectiveness (SAGE) principles apply to all discussions. The role of participants within the review process was to consider the appropriateness of the data, methods, and conclusions presented during the meeting.

The modeled deposition of biochemical oxygen demanding matter and the predicted consequences for species and habitats on the region presented in the baseline assessment were reviewed. Additional analysis on the expected exposure zones for health treatment products, sea lice management in the region, and the genetic impacts of aquaculture escapes on the wild salmon population were also presented and discussed. These baseline assessments provided some distribution data for sponges and corals in the region.

PROJECT OVERVIEW PRESENTATIONS

DFO AQUACULTURE SITE REVIEWS

Presented by C. Hendry

Abstract

No Abstract provided.

Discussion

DFO is working to provide a more consistent process for evaluating siting applications for aquaculture development. In addition to existing regulations that mitigate environmental exposure to aquaculture waste and therapeutants, DFO considers all available information when assessing potential impacts of aquaculture activities on fish and fish habitats.

Given the available survey methods and data type, the environmental monitoring and sampling requirements outlined in the AAR focus on the benthic environment. Participants questioned how pelagic fish habitat and seasonal/temporal dynamics would be incorporated into siting considerations. Risk assessments for other marine activities (e.g., oil and gas development) typically incorporate spatial and temporal dynamics when considering species vulnerability (i.e., which species are there, when, life history stage). As DFO develops more consistent approaches to risk assessment, the scope of interest in these reviews will be expanded. Meeting participants were encouraged to identify limitations and introduce potential concerns beyond the benthic exposure zones specifically described in the baseline reports.

Information on species presence and the location and timing of fishing activity in the region was collected by the Proponent from local stakeholders and fish harvesters. While the amount of engagement with Indigenous groups by the Proponent was clarified, it was questioned whether the amount was sufficient.

OVERVIEW OF DFO'S OPERATIONAL SCIENCE ADVICE FOR AQUACULTURE

Presented by I. Burgetz

Abstract

No Abstract provided.

Discussion

The development of a national siting framework and its application to diverse local conditions (e.g., Bay of Fundy and the south coast of Newfoundland) was discussed. The goal of the framework is to ensure a consistent and comparable set of tools, and the same pragmatic approach is used to evaluate aquaculture activities across a range of oceanographic and biological conditions. This meeting, for example, was the first implementation of a siting review approach (which has been used previously in the Maritimes Region) in the NL Region.

As per the Precautionary Approach (PA), it is best to mitigate risk at the siting stage, rather than intervene after environment has been impacted. The role and application of the PA during the evaluation of aquaculture activities was clarified. The PA provides guidance for management that incorporates caution when scientific knowledge is uncertain. In the context of aquaculture development, the PA indicates that the absence of science information should not postpone or prevent a management decision to mitigate potential environmental harm.

MARINE HARVEST ATLANTIC CANADA AQUACULTURE SITING BASELINE ASSESSMENTS (PROJECT OVERVIEW)

Presented by E. Barlow

Abstract

In 2017, MHAC purchased the assets of Gray Aqua Group as the base upon which to develop a 20,000 MT annual production salmon farming business in the proposed development area on south coast of Newfoundland. To date, 13 site licence applications have been submitted, and includes seven sites that were previously licensed and are being renewed. The Proponent reviewed historical data and collected data for each bay and site as required by the AAR. The data indicate the proposed sites are in deep water with pre-dominantly hard bottom. As per the AAR, a Baseline Assessment Report that includes an analysis of the site flora and fauna and potential rate of particle deposition of biochemical oxygen demanding (BOD) matter was submitted for each site.

The sea site systems will be engineered for exposed, high energy, and adverse conditions on the south coast of Newfoundland. All systems will be built to meet the Norwegian NS9415:2009 engineering standard for all components. The standard was developed to reduce system failure and the risk of escaped salmon. All farms will be built and managed with the goal to meet Aquaculture Stewardship Council (ASC) certification.

Twelve meetings were held in the proposed development area with stakeholders. Stakeholders indicated limited commercial and recreational use at the proposed site locations.

Discussion

The sampling and monitoring provisions of the AAR pertain primarily to aquaculture sites over soft substrate; participants questioned how these provisions can be applied to proposed sites, which are pre-dominantly hard bottom substrate. It was clarified that efforts to retrieve and process sediment and infaunal samples have been unsuccessful. Footage from remotely operated vehicles (ROV) indicates there is a thin layer of soft sediment deposited on top of hard, rocky substrate that may provide samples for analysis within the AAR framework at some of the proposed sites (e.g., Mare Cove South). The use of eDNA to assess the benthic community is being investigated by the Proponent. The ASC has accepted the use of eDNA as a tool for fulfilling the requirements of benthic monitoring to obtain ASC certification by salmon farmers in Norway.

The methods used to complete the ROV survey were clarified. A continuous video was recorded along each transect within each site. At 100 m intervals, the ROV paused and recorded a minimum of one minute of video around the predefined sample stations. Time at each station varied and the ROV was held in place to capture features and/or species at each station. The video recorded between sites was reviewed for changes in substrate or significant features (e.g., a school of herring), with fish counts completed at the 100 m stations. While it was not required of the AAR, the path between survey stations was recorded; however, the speed of the ROV prohibited a thorough analysis of the footage. Lasers were included to provide a measure of scale within video footage, but the total field of view recorded at each station was not controlled for species counts or biodiversity estimates. It was suggested that species accumulation curves could be used to assess whether this level of sampling was sufficient to identity fish or epifaunal communities. Participants noted that due to the limitations of the survey method, the benthos survey, while completed in accordance with the AAR, did not thoroughly characterize the sites. The timing of ROV surveys (May-September, depending on the site) also introduces some uncertainty. Due to seasonal spawning and movement patterns for many fish, repeat surveys may be necessary to fully characterize fish community and fish habitat in the proposed aquaculture sites.

There was a discussion of the proposed cage nets that will be used at the sites. While the nets have reduced catastrophic escapes in British Columbia (BC), there are indications of impacts on gill health. The nets are subject to regular cleaning, as a result, material is released into the water column which causes gill irritation. To mitigate the potential impact on fish health, the Proponent clarified their strategy of frequent net cleaning to which serves to minimize build-up.

Clarification was requested about the use of BMA 9 as a contingency site. There are potential scenarios where a site may require a longer than usual fallow period or a license is not granted that would require the use of BMA 9 sites as proposed.

The depositional model used to estimate the depositional contours of BOD matter was discussed. At each site, the deposition model incorporated bathymetry as well as the average and maximum current velocity that was derived from 30 days of current data recorded at three depths. The Proponent clarified that the depositional model, DEPOMOD, does not represent a projected time series, but a cumulative deposition over 22 months assuming constant conditions at a defined feeding rate.

The proposed aquaculture sites are located in narrow fjords in a region characterized by complex coastlines and strong influence from freshwater runoff, which impacts water stratification. Oceanographic research in this area (i.e., Bay d'Espoir and Fortune Bay) has identified seasonal current variation, and in particular, strong seasonality in the stratification; however, it was questioned whether these conditions are applicable to all of the proposed sites. The seasonal amplitude of near-surface temperature in this region, for example, is twice what has been recorded in BC waters. These BMAs are subject to strong seasonal cycles and may not be comparable to aquaculture developments on Canada's west coast. The collection of current data was completed in accordance with BC Guidelines (Province of BC and the Government of Canada 2017). It was suggested that the BC guidelines, which may apply to aquaculture development in the Bay of Fundy (BoF) and the BC coast, may not be appropriate for data collection on the south coast of Newfoundland and may not reflect local conditions. The need for guidance for the collection of current data in the seasonally dynamic environment on the south coast of Newfoundland was acknowledged; however, the absence of Newfoundland-specific guidelines should not prohibit the review of the data, tools, and applied methods.

It was noted that the use of mean currents in deposition models may result in unrealistic estimates due to variability in current direction and the depth levels selected for current monitoring may not be representative of the system as a whole. When simplifying the current profile in the dispersion modelling of settling particles, it was recommended that depth levels that are representative of the main water masses be selected. It was noted that a longer time series would be needed to assess seasonal effects on dispersion. Additional information on currents dynamics and seasonality may not be applicable to the DEPOMOD modelling procedure; however, if annual current data were available, a representative period could be selected for depositional modeling.

The potential for waste and sediment resuspension was discussed. DEPOMOD has been validated in the BoF with independent data in that region. In cases where the results of follow up surveys do not align/reflect DEPOMOD predicted deposition patterns, the discrepancies were attributed to wave action induced resuspension of aquaculture waste. Current meters typically do not collect wave data and depositional models do not incorporate wave influence, which is highly seasonal, directional, and dependent on depth; however, current meters indicate there is sufficient bottom energy which may induce resuspension. Resuspension is difficult to estimate (it is possible within the DEPOMOD model framework, but generally not recommended due to large uncertainties) and available resuspension rate estimates rarely include the organics-rich sediments associated with aquaculture waste. The oceanographic data presented indicate the general currents average less than 10 cm/s, but there are episodic high current events.

The Predicted Exposure Zone (PEZ) is a circular zone centered over the middle of the proposed cage array and represents the outer limit for potential exposure. It was questioned whether the sources of uncertainty in the PEZ estimate would change the generalized model outputs. It was suggested that available data and methods could provide more precise exposure zone estimates rather than the current order-of-magnitude estimate. The estimated exposure zone serves to outline an area to investigate for sensitive species or habitats, which could then be used to inform a risk assessment, if more detailed estimates of exposure are required. While more precise estimates of exposure may be possible, they may not support a more accurate assessment of potential impact on sensitive species and habitats. The PEZ model offers an estimate of the distance particles may travel, while DEPOMOD provides a deposition and accumulation estimate. While the two estimates are not directly comparable, the general agreement between the two models was reassuring to meeting participants.

POTENTIAL EXPOSURE ZONES ASSOCIATED WITH PROPOSED FISH FARMS

Presented by F. Page

Abstract

In this document, we describe a simple model, the Potential Exposure Zone (PEZ), that estimates the area exposed to discharges (feed, feces, in-feed drugs, and bath pesticides) resulting from finfish aquaculture activities. The PEZ provides an estimate of the spatial scale over which examination of information concerning the presence of species, habitats, and human activities should be examined for interactions of potential concern as part of an initial screening process for DFO aquaculture site assessments. The PEZ is a circle centered on the cage array with a radius equal to half the length scale of the cage array and a transport distance which is determined from a current speed and a transport time. PEZs are calculated for fourteen proposed Newfoundland marine finfish aquaculture sites. Benthic PEZs for waste feed, feces, and in-feed drugs are calculated using mid-depth current speeds and transport times based on the time required for particles to sink to the seabed. Pelagic PEZs for azamethiphos and hydrogen peroxide are calculated using 15 m sub-surface current speeds and a transport time based on the time required for the treatment dose concentration to dilute to a specified threshold. All calculated PEZs have radii ranging from O(100) to O(1,000) m with the exception of the PEZ associated with well-boat discharges for hydrogen peroxide which has a radius of 0 m since the assumed effective treatment concentration is less than the threshold concentration. Length scales estimated from the predicted deposition areas provided by the Proponent were consistent with the length scales of the benthic PEZs estimated using mean current speeds. It should be emphasized that the entire domain within a PEZ is unlikely to be exposed but with proper selection of the input variables (i.e., current speed, sinking rate, depth, dilution rate, and threshold concentration), the PEZs should encompass all exposed areas.

Discussion

Pesticide treatment methods and their potential impacts on the environment were discussed. Tarp treatments are not planned for use at the proposed sites; however, all actions permitted under the current regulations are considered when evaluating potential impacts to fish and fish habitat. During tarp treatments, a mesh net raises the fish to within a few meters of the surface and tarps are used to enclose the fish for a bath therapeutant treatment. After the prescribed exposure time, the tarp is removed. This treatment method introduces therapeutants to the surface layer, and participants noted this treatment could introduce risk of intertidal habitat exposure. Dye studies conducted in the BoF have found that therapeutants reach the shore, even when applied within regulations and good weather conditions. The impact of exposure from this treatment is dependent on concentration, frequency, and cumulative effects.

The lethal concentration of sea lice pesticides for lobster is 1,000-fold dilution, which takes approximately three hours under normal conditions. It was noted that intertidal exposure may be lower for the deep sites proposed on the south coast of Newfoundland; however, current velocity data in this region indicates that exposure of coastal lobster habitat is possible within the three-hour dilution window. Although these substances are approved by Health Canada for use in aquaculture, the approval process does not take into account site specific conditions.

Well boats offer more control of the fish treatment, including dosage, exposure time, and effluent management. It was suggested that the flexibility to dispose/release effluent may offer a mechanism to mitigate risk to coastal habitats. Due to time, fuel use, and cost considerations, well boats are not required to dispose/release effluent; however, this is a common risk mitigation practice in BC and Norway.

There were technical questions about the extent of the PEZ for some sites. Decay was not incorporated in the BOD exposure zone calculations since the time needed for decay to occur is longer than the time needed for organic matter to reach the bottom. A dilution threshold was identified for pesticides, with the PEZ calculated based on that value. Similarly, the PEZ for BOD could be adjusted if there were different concentration levels of interest. It was suggested that there is a threshold where an increase in organic matter could increase the growth and reproduction of benthic organisms, with the impact at the edge of the exposure zone shifting from negative to positive. Phytoplankton blooms may also interact with deposited material and impact settling rates; however, there is little research on this topic.

It was suggested that analysis of the overlap between the spatial scale of impact indicators from past production (e.g., bacterial mats) and PEZ predictions would support a risk assessment of the 1 g and 5 g carbon thresholds. A spatial comparison between commercial and sensitive species observation data with the predicted PEZ was recommended for future review processes.

The potential for aquaculture waste to result in hypoxic or anoxic conditions in deep pockets below proposed farm sites was discussed. The PEZ method and calculations were developed in New Brunswick (NB), where aquaculture sites are subject to strong currents and oxygen levels are high. Oxygen monitors were suggested to study questions concerning thresholds of impact as aquaculture development continues in NL.

The relevance of the PEZ to the baseline assessment reports, which present the DEPOMOD particle deposition models as an estimate of potential impact zones was questioned. Neither PEZ or DEPOMOD have been validated in NL and DEPOMOD incorporates more data from each site. There was concern that the boundaries associated with the PEZ could be interpreted as impact zones as opposed to an order of magnitude estimate of the size and location of potential exposure. There was general agreement between PEZ and DEPOMOD results at each of the sites. In NB, DEPOMOD predictions were validated with dye studies and circulation models (Chang et al. 2012, Page et al. 2009). The need to validate both models under local conditions was recognized. Other limitations include uncertainty around where the current velocity observations were spatially or temporally representative, and whether appropriate depth levels were selected.

Benthic surveys' data collected at previously stocked aquaculture sites in this area indicate that there are unexpected patterns of visual indicators of benthic impact (e.g., bacterial mats beyond the expected zone of impact). These limited results indicate that simple models like PEZ are not capturing the complex currents that may explain depositional patterns in these bays. However, the limited footprint predicted by DEPOMOD may be an underestimation based on the indicators that have been observed. When impacts are patchy and broadly distributed, a risk assessment requires either a precise model validated for a particular location or a precautionary consideration of a broader area on influence.

It was recommended that the meeting documentation, which describes the PEZ approach, outline how the dilution time is determined, how the vertical diffusion effect is estimated, and why the horizontal diffusion effect is not considered. It was also recommended that if conservative estimates of benthic exposure area from fish farm activities are to be applied, the maximum current measured should be used, regardless of depth, since horizontal, vertical, and temporal aspect of the ocean currents vary greatly in this region.

SPECIES AND HABITAT INTERACTIONS

CORALS AND SPONGES

Presented by B. Neves and V. Wareham-Hayes

Abstract

The baseline monitoring provides new distribution data for corals and sponges in Newfoundland, as limited information is available on coastal environments in the region. A literature scan found one publication of coral records in this area, including *Paragorgia arborea* and sea pens, supporting the finding that this area provides suitable habitat for these vulnerable coral species (Gagnon and Haedrich 1991).

Sea pens (order Pennatulacea) are colonial corals that can vary in size from less than 30 cm–2 m. Research indicates that sea pens provide nursery habitat for fish; up to 30 redfish larvae have been observed on a single sea pen in Newfoundland waters (Baillon et al. 2012). These species are also linked to ecosystem function and increased infaunal biodiversity in soft sediment habitats. Sea pens have also been found in association with Lantern fish (*Benthosema glaciale*) and Eelpout (*Lycodes esmarkii*) (Baillon et al. 2012). Sea pens can form extensive fields, spanning >1 km in Newfoundland waters (Baker et al. 2012).

Two sea pen species were reported in the baseline assessments reports: *Pennatula* sp. (likely *Pennatula aculeata*) and *Balticina* sp. However, *Balticina* is no longer considered a valid genus, and it is likely that these colonies are *Halipteris* sp. (also known as sea whip). Sea pens were observed in high densities on some of the ROV video transects, including juveniles and adults estimated to be up to 20 years old. In most cases, sea pens were recorded from videos outside the proposed cage footprint, but in some cases, they were found directly below proposed cages and well within the area of impact predicted by DEPOMOD.

Paragorgia arborea is a slow growing gorgonian coral that can reach high longevities, and like sea pens, provide complex habitat to other species. These corals live on hard substrate and form large colonies within the proposed Jervis Island lease site. Based on estimated growth rates from the literature and size measurements from videos, some of these colonies may be up to 80 years old.

Discussion

The extent of sea pen beds, their role as nursery habitat for other species, and the potential impact of aquaculture activities on this ecosystem was discussed. The nature and quality of the video surveys provided for review precluded a thorough assessment of sea pen extent in the proposed areas. Previous baseline assessment reports for aquaculture development were not required to monitor survey depths below 100 m, thus the information about coral distribution in this area is new. It was suggested that in cases where sea pens are identified within proposed lease sites, the baseline sampling resolution should be increased to confirm the extent or patchiness of sea pen fields and sea pen Genus/species/biodiversity. Sea pens are colonial organisms composed of many polyps, each with a mouth and a ring of tentacles that collects organic matter from the water column. There is concern that these organisms could be smothered by deposition from aquaculture nets, which would result in a loss of complex habitat, with potential impacts on other species.

The presence of sponges within the proposed lease sites was questioned. Large sponges were observed in the video footage from the Jervis Arm site; however, there is insufficient data to estimate age of these individuals. As filter feeders, sponges may be particularly vulnerable to deposition of waste from aquaculture activities.

It is not known whether the function of sea pens as nursery habitat is density dependent, and there is no reliable threshold to distinguish a group of individual sea pens from a sea pen field *in situ*. Sea pen density within proposed lease sites was extremely variable. At some stations, >20 sea pens were recorded within one minute of video footage, while 1–2 sea pens were recorded at other stations. Sea pens can withdraw into the sediment, so an absence of sea pens in the video footage may not reflect their presence at a site.

In BC, baseline monitoring has identified potential concerns related to sea whips (also from the order Pennatulacea) found near salmon net pens; there are published reports of areas where sea whip populations (*Halipteris willemoesi*) have been drastically reduced from hypoxia events (Chu et al. 2018). Although sea pens have been identified at all surveyed sites that have had previous salmon production in the past, a lack of data collection prior to the initiation of production prevents the assessment of potential changes in the abundance, condition, or distribution of species. Moving forward, the Proponent indicated a willingness to support and participate in ongoing research on corals and sponges in this area.

It was acknowledged that the benthic survey was completed in accordance with regulatory requirements and that formal guidance for conducting baseline assessment in this region, and at the depths surveyed, was limited. These baseline assessments represent the first surveys completed at depths between 100 m–300 m for aquaculture development in the region. It was noted that the AAR does not require data collection beyond depths of 300 m and that the Proponent had no access to service providers with the ability to access depths beyond 300 m. Due to the dynamic conditions on Newfoundland's south coast and the depth of the proposed sites, finer scale surveys were recommended. It was also recommended that guidelines for corals/sponges species identification and collection of physical samples developed by DFO (NL Region) would be helpful given inconsistencies in the taxonomic identification of some species (e.g., tube worms and sea whips).

Sponges were not identified as forming particularly large fields in the Proponent's report; however, large specimens were observed at some of the sites and their presence might have been underrepresented by the scale of the video analysis.

The baseline assessment report does not list juvenile fish habitat within the proposed sites; however, sea pens provide documented juvenile fish habitat (see Baillon et al. 2012). It was noted that corals and sponges found in this area are established Vulnerable Marine Ecosystem (VME) indicators and are internationally recognized as important species for conservation and that acquisition of further knowledge on these VMEs in the area is necessary.

GROUNDFISH

Presented by K. Lewis

Abstract

Since the DFO groundfish survey does not extend into the bays of the proposed lease sites, data on the proportion of recent survey biomass indices (2000–18) within the three strata directly adjacent and within a comparable depth range to the proposed sites were presented.

The proportion of survey biomass caught in this area varies annually and by species:

- 0.2–20% of Atlantic Cod DFO Research Vessel (RV) survey biomass;
- 3.4–16 % of Witch Flounder DFO RV survey biomass;
- 0.1–2% of American Plaice DFO RV survey biomass;
- 0.1–5% of Greenland Halibut (Turbot) DFO RV survey biomass.

The presenter recommended formally incorporating local ecological knowledge to better understand fish communities in the region.

Discussion

In a recent aquaculture siting exercise in the Maritimes Region, a literature review was used to address the gap of inshore fisheries data. A similar literature review for this region identified few studies that overlap with the proposed sites, and none were conducted at a scale relevant to this review. The baseline assessments did not report large aggregations of groundfish in this region; however, local ecological knowledge indicates there is redfish habitat within the proposed sites.

SPECIES AT RISK

Presented by R. Collins

Abstract

The south coast of Newfoundland includes general coastal habitat used by Atlantic Wolffish (*Anarhichas lupus;* listed as a Species of Special Concern by the *Species at Risk Act* [*SARA*] Schedule 1) and Lumpfish (*Cyclopterus lumpus;* assessed as Threatened by the Committee on the Status of Endangered Wildlife in Canada [COSEWIC]). These species use inshore rocky habitat for spawning, denning (i.e., egg guarding), and early larval habitat. Exposure of this habitat type to impact from aquaculture production is also likely to result in exposure of these at-risk species. This region may also provide habitat for Spotted Wolffish (*Anarhichas minor;* listed as Threatened by *SARA* Schedule 1).

Discussion

The concerns associated with the exposure of Atlantic Wolffish and Lumpfish habitat to aquaculture activities was discussed. A quantitative risk assessment is not possible based on available data; however, these species are known to have vulnerable life histories and habitats. There is the potential for deposition of aquaculture waste to impede access to nesting habitats or degrade these habitats (e.g., hypoxia, eutrophication). Atlantic Wolffish and Lumpfish guard their eggs throughout development and the larvae remain close to the den or nest site after hatching. These life stages are sensitive; mortality and morphological deformities can be induced by small changes in temperature, dissolved oxygen, or bacterial contamination rate (Pavlov and Moksness 1995, Foss et al. 2002).

The use of Lumpfish as cleaner fish was discussed. Within the aquaculture industry, Lumpfish are being used as a cold-water cleaner fish for the removal of sea lice from Atlantic Salmon (*Salmo salar*); however, proposals for imports of European Lumpfish have been rejected in the NL Region due to risks associated with impact of escapees on wild population genetic diversity.

It was noted that the presence of more farm sites in this area may increase attraction and associated risk for shark species, including Porbeagle (*Lamna nasus*; assessed as Endangered by COSEWIC), Shortfin Mako (*Isurus oxyrinchus*; assessed as Endangered by COSEWIC), and Spiny Dogfish (*Squalus acanthias*; assessed as Special Concern by COSEWIC).

MARINE MAMMALS AND TURTLES

Presented by L. Sheppard

Abstract

Although data are not available on the presence of marine mammals in the specific lease sites, the location of the proposed sites overlap with the distribution of several species, including Blue Whale (*Balaenoptera musculus*; listed as Endangered by *SARA* Schedule 1) and

Humpback Whale (*Megaptera novaeangliae*; assessed as a species of Special Concern by COSEWIC). North Atlantic Right Whale (*Eubalaena glacialis*; listed as Endangered by *SARA* Schedule 1) have been recorded nearby in Placentia Bay. Presence of North Atlantic Right Whale within the lease sites is possible, but likely a rare occurrence.

Two species of pinnipeds are found in this region. Harbour Seals (*Phoca vitulina concolor*) are expected to use this habitat year-round, and Grey Seals (*Halichoerus grypus*) migrate into this area during the summer months. Leatherback Turtle (*Dermochelys coriacea*; listed as Endangered by *SARA* Schedule 1) also migrate through this area; they are expected to arrive in the spring, stay for the summer months, and migrate south for the winter.

Increase of vessel traffic associated with aquaculture expansion introduces risk of ship strikes and noise pollution. Seal haul out sites may also be displaced. Attraction of marine mammals to the farm sites also increases the risk of entanglement.

Discussion

Sharks, seals, belugas, porpoises, and whales are routinely observed in the area and these observations could be recorded by the Proponent to support ongoing research on marine mammal behaviour and distribution. The Proponent employs non-lethal predator control measures (e.g., steel predator exclusion nets, regular net cleaning, removal of mortalities) and the proposed sites will be serviced by feed barges that deliver feed directly into nets with limited external exposure.

Marine mammal entanglement risk has declined over the last decade due to a change in mesh size. The most common marine mammal fatalities at aquaculture sites are Harbour Seal and California Sea Lion (*Zalophus californianus*); however, the vast majority are authorized fatalities. Under the Pacific Aquaculture Regulations and consistent with Marine Mammal Regulations, DFO authorizes fish farms in BC to undertake predator control of California Sea Lions or Harbour Seals that pose an imminent danger to the aquaculture facility or human life, after reasonable non-lethal deterrent efforts fail (DFO 2019a). Since 2011, 249 authorized fatalities and 35 accidental drownings were reported for California Sea Lion across all finfish aquaculture sites in BC. Over the same time period, 77 authorized fatalities and 43 accidental drownings were reported for Harbour Seal (DFO 2019b). Since 2014, there have been four reported Humpback Whale entanglements at aquaculture sites in BC, and two of these entanglements were fatal (DFO 2019b). In Newfoundland there have not been any reported cetacean entanglements with finfish aquaculture net pens to date; however, in 2018 a Humpback Whale was entangled in a gillnet deployed to capture escaped farmed salmon in Hermitage Bay (Coles 2018).

PELAGICS

Presented by A. Adamack

Abstract

Data on pelagic species is limited for the project area. Bottom trawls conducted in the area adjacent to the fjords during the spring and summer by the DFO Multispecies survey have consistently caught herring and Capelin (*Mallotus villosus*) in stratum 296, 298, 299, and 300.

Capelin are present (Templeman 1948, Dickson 1986, Richard 1987, Dawe et al. 1997); however, they appear to make limited use of the areas included within the proposed lease sites. The main concern for this species would be incidental predation by farmed Atlantic Salmon. Acoustic surveys of Capelin feeding in Northwest Atlantic Fisheries Organization (NAFO)

Division 3L indicate that the peak depth for Capelin biomass during spring acoustic surveys is generally between 140 m–280 m. Due to the limited vertical overlap between the depth of the salmon cages and the depth range of peak Capelin biomass, the limited portion of Capelin habitat within the area, and an apparent lack of Capelin spawning in Bay d'Espoir, the proposed aquaculture facilities here are unlikely to have a strong effect on Capelin.

Herring are an important forage species in the region and are present in sufficient numbers to support a commercial fishery (Tibbo 1956, Templeman 1966, Dickson 1986). Due to the positioning of the proposed cages in narrow fjords and the relative abundance of herring in the ecosystem, it is likely that wild herring will move past or interact with cages during the two-year production cycle. Loss of habitat or reductions in productivity due to the presence of the facility is expected to be small; however, potential disease transmission and/or propagation may be of concern. Some research indicates infectious salmon anemia virus (ISAV) can propagate in Atlantic Herring (*Clupea harengus*) and they may be an asymptomatic carrier of the ISAV (Nylund et al. 2002). Herring are known to move between bays and offshore areas, traveling tens or hundreds of kilometers (e.g., Wheeler and Winters 1984). Future research that investigates the effects of ISAV development time in herring, the transmissibility of ISAV between herring and salmon, and their swimming speed/endurance when infected could determine if there is potential to limit the spread of ISAV through the use of spatial barriers (i.e., physical distancing between sites).

Discussion

Recent reports and testing indicate that the Pacific strain of viral hemorrhagic septicemia virus (VHSV-4A) has been introduced to Atlantic waters (CFIA 2017). This transmission has been connected to the use of infected dead herring imported from BC as bait in lobster traps in Atlantic waters and is not considered to be a result of or connected to finfish aquaculture development. It was confirmed that numerous tests on herring for ISAV have been negative; however, VHS-4A has been detected in Placentia Bay herring (CFIA 2016). The Proponent indicated that their current disease management policy requires that all affected fish must be immediately removed from any site where ISAV is confirmed.

In BC, all aquaculture operators are required to submit incidental catch (live or not) and all identified mortalities, including wild fish. Pacific Herring makes up 90% of reported bycatch since 2011 (DFO 2019c). Anecdotally, the majority are released alive; however, the proportion of mortalities and live releases is not included in the publicly available data.

An extensive stomach contents analysis program carried out on farmed salmon in BC indicates that predation of wild fish was very low (0.1% prevalence in 2017). The most prevalent prey was herring, but consumption was considered very low overall (DFO 2018).

The influence of salmon pen presence on Atlantic Herring movement or behavior was discussed. Targeted studies have not been conducted on movement or behavior of herring to test if they leave historic areas to go to aquaculture farms. Anecdotal reports from BC farms indicate that Pacific Herring are attracted to the net pens. Generally, pelagic fish are attracted to structures in the water column (Klima and Wickham 1971). The mesh size should allow herring to move in and out of the salmon pens freely; however, it's possible that there is a behavioural barrier that prevents escape.

SHELLFISH

Presented by E. Coughlan

Abstract

The proposed sites are located within a productive area for American Lobster (*Homarus americanus*). The fishing area that extends from Fortune Bay to Port aux Basques accounts for 45% of lobster landings for all of Newfoundland. Lobster are fished in waters up to 90 m, which is significantly deeper than the fishery elsewhere in the province. The baseline reports did not report any observations of lobster in the ROV footage. However, lobster are cryptic (especially during the day) and are unlikely to be found by this type of survey. The baseline assessment did identify suitable lobster habitats at the proposed sites (i.e., boulders, bedrock, kelp).

Expansion of aquaculture development at the proposed sites increase the risk of anoxic or hypoxic conditions beneath cages that would impact lobster in the area. Exposure to pesticides that target sea lice could threaten lobster at all life stages. Concern about pesticide exposure is greatest at shallow sites with lower dispersion patterns and more prevalent juvenile lobster presence (Lawton and Lavalli 1995).

Discussion

It was noted that pesticides may have negative impacts on lobster, even in non-lethal exposure events. Behavioural changes, including reduced female reproductive success, have been reported after exposure to sub-lethal doses of sea lice pesticides (Burridge 2013). Research conducted in NB also found that sub-lethal pesticide exposure resulted in higher shipping mortality for lobsters, raising market concerns (Couillard and Burridge 2015). A recent study found no impact of salmon aquaculture on lobster abundance through an eight year before-after-control study at a production site in the BoF (Grant et al. 2019); however, this work does not apply to Newfoundland conditions.

Despite a decade of salmon aquacultures in the area, Fortune Bay remains a highly productive site for lobster. More research on dispersion patterns of both in-feed and bath pesticides should be conducted within the area to better understand exposure patterns of lobsters to these products.

SEA LICE MANAGEMENT AND WILD/FARMED SALMON INTERACTIONS

Presented by S. Saksida

Abstract

No Abstract provided.

Discussion

Based on publicly available reporting of therapeutant use in this region, there was a disproportionate increase in treatments following a modest increase of farms from 2016–17. Particle tracking would support management efforts by clarifying cycling and spreading rates of planktonic sea lice nauplii. If lice can be transferred between and within farms, this pest will spread rapidly and should be subject to a coordinated management strategy.

The legislated fallow period is considered sufficient to support effective sea lice management in an isolated BMA. However, DFO management also requires a good case definition to establish standards for sea lice management. If the number of lice increases, the risk of spillback of lice from the farm to wild juvenile salmon during migration also increases. The level of spillback depends on the number of lice that survive on the farmed fish over the winter. Counts are not conducted in the winter due to operational conditions and fish sensitivity. However, high infestation rates in the fall could result in some over winter survival. Risk of infection on returning salmon also depends on how long the wild fish stage in the saltwater before entering the river. If saltwater staging near farms is short, the impact of sea lice spill back may be less.

It was suggested that larger salmon cages could result in higher number of sea lice; relatively low lice density per fish can produce a large absolute number of sea lice, which could be exacerbated in larger cages. It was noted that sea lice presence can be exacerbated by an increased number of fish, which may not be correlated to cage size. Individual fish mortality depends on infection intensity (i.e., number of lice per fish). Previous research has shown that an infection of 10 lice is sufficient to kill a salmon smolt (Holst et al. 2003). A PA to aquaculture expansion is applied in Norway, where incremental growth is permitted only for farms that demonstrate effective sea lice management with a single treatment per cycle. A similar management regime may reduce the risk associated with aquaculture expansion in NL.

The swimming behavior of pelagic nauplii, and the use of passive particle tracking as an accurate estimate of connectivity was discussed. Analysis of genetic variation among sea lice between BMAs and hydrodynamic modelling with behaviour incorporated were suggested as potential alternatives for estimating connectivity. The nauplii and copepodid stages can swim vertically within the top 4–5 m; however, horizontal movement is extremely limited. Thus, particle tracking is a method that could be used to estimate sea lice movement at these life stages. To date, sea lice genetics has not been examined at the BMA level; however, the Proponent expressed interest in participating in any future research.

The BMA strategy is publicly available and connectivity studies were included in the design process to ensure that BMAs represented discreet management units. However, the presenter reiterated that the treatment data indicates connectivity and recommended a reassessment of the model. The BMA 9 has the highest level of risk of sea lice infestation due to potential exposure to lice nearby farms, introducing logistical barriers to coordinated sea lice management across connected farms. The Proponent expressed an intention to coordinate with neighboring companies in this scenario.

The timing of sea lice treatments and salmon migration were also discussed as important variables in determining the level of risk of sea lice to wild salmon. There are seven scheduled rivers in this region; however, there are at least 28 salmon rivers in this region and many more that are not monitored. In this area, wild salmon smolt runs begin in April and end by the first week of May, though stragglers may be migrating through the proposed farm sites until June. Tagging data indicate that both the Conne River and Little River stocks remain in the fjord for a period of about six weeks, which is a unique migration pattern. Current knowledge of salmon migration timing and patterns is based on tagging studies completed from 1987–98 (Dempson et al. 1999); it was suggested that these tagging studies should be repeated, as many conditions (human and environmental) have changed over the last decade. Adult salmon start returning to the rivers at the end of May, but most arrive in the middle of June and into the first week of July. The seasonal increase in sea lice infections begins in June and peaks in August and September, with the first treatment usually occurring in mid-June.

The analysis of sea lice treatment rates over time is limited due to changes in the definition of a single “treatment.” It was suggested that weight of therapeutant provides a more accurate index of treatment levels. Due to the limited publicly available data on sea lice infection rates and associated treatments, it is not possible to quantify the level of risk to fish and ecosystem health.

The need for increased data and transparency regarding sea lice infection and treatment in the region was expressed by meeting participants. The Conne River Atlantic Salmon population has very low marine survival rates (less than 1% in 2018–19) and there is concern that sea lice infections, associated with aquaculture, could be a contributing factor, which is difficult to track in the absence of a public reporting system. It is important to develop a better understanding of interactions between farmed salmon, sea lice, and wild salmon, including at-sea survival. Conne River was once the most important river for recreational salmon fishing in Newfoundland, and that productivity was an important part of why the Miawpukek First Nation was established in this area.

GENETIC IMPACTS ON WILD SALMON IN SOUTHERN NEWFOUNDLAND

Presented by I. Bradbury

Abstract

The potential genetic interactions resulting from the proposed finfish expansion involving 13 sites (1M individuals/site) in southern Newfoundland using a combination of empirical data, and both individual-based and dispersal modeling was presented. An eco-genetic individual-based Atlantic Salmon model (IBSEM) parameterized for southern Newfoundland populations, with regional environmental data and field-based estimates of aquaculture parr survival was used to explore how the proportion of escapees relative to the size of wild populations influences genetic and demographic change in the wild. Simulations suggest that both demographic decline and genetic change are predicted when the proportion of escapees relative to wild population size exceeds 10% annually. The occurrence of escapees in southern Newfoundland rivers (estimated population size approximately 22,000 individuals), both at present and under the proposed expansion scenario were predicted using river and site locations, simple models of dispersal for early and late escapees, and the best available data from Canada and Europe. Model predictions of escapee dispersal suggest that under the present regime, rivers characterized by the largest proportion of escapees relative to wild population size are located in the head of Fortune Bay and Bay d'Espoir (19 rivers total >10% escapees, max 15.6%) consistent with recent empirical evidence of escapees and hybridization. Under the proposed expansion, the number of escapees in southern Newfoundland rivers is predicted to increase by 49% (1.5X) and the rivers characterized by the greatest proportion of escapees relative to wild population size are predicted to occur in the Bay d'Espoir area (20 rivers total >10% escapees, max 24%).

Discussion

The author was commended for presenting a novel approach to assess wild/farmed salmon interactions. Significant effort was made to gather and synthesize information to provide specific models with sensitivity analyses and robust results. The results are supported by previous research (Wringe et al. 2018, Sylvester et al. 2019, Sylvester et al. 2018, Keyser et al. 2018, Hamoutene et al. 2018, Glover et al. 2017, Bolstad et al. 2017) and anecdotal observations in Conne River. Among monitored salmon rivers in Newfoundland, Conne River and Little River have shown the greatest population decline over the past 50 years. Previous efforts to track escapees have been spatially and temporally limited, and local river guardians have reported that farmed salmon arrive at these rivers throughout the year, beyond the sampling season. This approach allows the impact of escapes beyond the counting season to be estimated and considered.

Escape data (i.e., reported escapes or identified escapes) was clarified. Escape rate per unit production were calculated based on reported escape rate with a correction factor based on observed escapes, established by extensive research in Norway. A different escape rate could be used in the model, if supported by robust data. The chosen data represents the only validated peer reviewed published data on rates of escape per unit production. This approach was considered the most conservative option, in the absence of a ground-truthed escape rate for NL; however, other values were explored in a sensitivity analysis. It was noted that the Norwegian escape rate incorporates escapes from farms that uses technology that is not considered representative of the infrastructure that will be used at the proposed sites, which has been reported to reduce escapes due to net failure at MHAC farms in BC. It was requested that the model be re-run and incorporate reported escapes from BC farms; however, the BC escape rates are missing a ground-truthed correction factor for the reported escapes.

The minimum license requirements were considered in the risk assessment and provision of science advice, which considered the worst-case scenario with all sites stocked. Given the reliance of habitat area in the calculation, model outputs may be optimistic. The size of wild Atlantic Salmon populations in the region are likely overestimated, and the actual impacts are likely larger. It was suggested that model predictions are inaccurate since model parameters did not consider regional data or the impact of improved technology.

Validated escape estimates are needed to complete the model runs; however, the number of escaped fish may not be accurate as some escapes may go unreported. For example, an escape event in this region in 2015 was not identified until farmed salmon were caught during routine river monitoring. The level of hybridization estimated for this region of Newfoundland waters is comparable to, or higher than, hybridization rates in Norway; however, due to the small wild population size, this level of hybridization may be associated with higher risk. It was reiterated that the technology proposed for use at the site was more comparable to the technology used in BC than in Norway and it was suggested that the reported success of the technology should be accounted for when considering the risk to the wild population in the region. The Proponent was commended for their intention to use upgraded net infrastructure; however, these conditions are not guaranteed. Despite the reported reduction in escapes, the small wild population may still be significantly impacted by incidental escapes. For example, in a river that supports 200 wild salmon, the addition of 10–25 farmed fish would be enough to have a negative impact. There is also research that indicates small scale, trickle escapes are more detrimental than catastrophic escapes, due to the cumulative effect over time and the absence of sufficient selection pressure to remove them (Baskett et al. 2013).

The results of a sensitivity analysis, which explored changes to various parameters, were discussed. At an escape rate of 0.2, the model predicts little or no impact on the wild population. The author considered an escape rate of 0.2 represents a significant reduction in escape rate from the current conditions; with 0.4 and 0.8 having been shown to be more realistic scenarios based on research in Norway. Mitigation efforts may include a reduction of production level at each site, thereby reducing the number of fish onsite and number of potential escapes. The presented model incorporated fallow periods, assumed all sites were active at maximum tonnage during production cycles, and accounted for reported reductions in numbers of individuals during regular production cycles.

The scale of this analysis was discussed; specifically, participants questioned whether relocating a farm site would impact the model results. The spatial scale of genetic interaction and the presence of pre-existing salmon farms may make it difficult to apply this information to site-by-site decisions within a single BMA. In Iceland, for example, similar concerns have led managers to identify fjords and portions of the coast as unsuitable for aquaculture development. The maximum dispersal distance for this model was 200 km, which is smaller than some findings in Norway (e.g., maximum dispersal of 1,600 km escape dispersal recorded by Hansen and Youngson 2010) but larger than escapee dispersal distance measured in Newfoundland (e.g., maximum dispersal of 80 km recorded by Hamoutene et al 2018). Lower dispersal estimates were also included in the sensitivity analysis.

There was agreement that greater transparency regarding escape events is needed across the aquaculture industry. In the absence of systematic river monitoring by DFO or industry, Conne River community members sought out training from the Atlantic Salmon Federation to distinguish farmed salmon by physical features, size, and scale samples. Farmed salmon are consistently identified in Conne River, despite reports there were no escape events. Due to the decline of the Conne River stock, the Miawpukek band council has invested heavily in conservation and the community voluntarily gave up fishing rights 25 years ago. It was acknowledged that there will be incidental escapes on a regular basis. Industry and managers were urged to require public reporting of all escapes including the incidental losses, which the genetic models indicate play a significant role in farmed/wild salmon interactions.

SITE REVIEWS

The baseline report includes a list of commercial species observed at each site; however, the definition of commercial was unclear to many participants-many species that are commercially exploited in Newfoundland were omitted from these lists. A species was listed as commercial in the baseline report if it was reported to be directly harvested within the BMA during community consultations. It was noted that while a directed harvest for a species may not occur within the bay, the area provides habitat for many commercial species.

The definitions of a sensitive species and juvenile fish habitat used in the baseline reports was discussed. Atlantic Salmon, corals, and sponges were omitted from the list of sensitive species within the baseline report. Similarly, sea pens, which are known to provide habitat for larval redfish, were not included as juvenile fish habitat. The surveys and analyses were considered insufficient to characterize biodiversity at the proposed sites. The inability to characterize biodiversity was considered a limitation of the current regulations and guidelines. It was noted that a healthy and sensitive ecosystem may not have very high species richness. Discussions of commercial and sensitive species was broadened to include groundfish and shellfish harvested in adjacent waters (e.g., redfish, Snow Crab [*Chionoecetes opilio*], shrimp); Atlantic Salmon, corals and sponges were included in the discussion of sensitive species.

The regulatory definition of “population level effects,” as described by the AAR, was discussed. Within the department fish stocks, not biological populations, are managed. The effective scale of concern is smaller than the biological population level. With localized impacts (i.e., within a single bay) sufficient to trigger a management response.

BMA 12 - RENCONTRE BAY

Devil Bay

The proposed Devil Bay site reaches a maximum depth of 148 m; mean depth within the lease boundary is 104 m and the site is characterized as hard substrate. Commercially important species observed at this site include redfish, Atlantic Cod (*Gadus morhua*), shrimp, and Snow Crab.

Although there has not been previous production at this site, bacterial mats (a visual indicator of aquaculture deposition) were recorded at eight of ten transects. A review of the ROV video indicated that bacterial mats were small and likely to be naturally occurring.

It was noted that the PEZ for pesticides extends to the coast on both sides of the cage footprint, raising concern that therapeutants could impact coastal shellfish. Although lobster were not recorded in the baseline assessment, and coastal areas were not surveyed, lobsters are expected to use the coastal habitat within the PEZ. Therapeutant treatments are expected to be infrequent and follow approved usage regulations; however, even under regulated use, there may still be risk to exposed shellfish (describe above in Species and Habitat Interactions).

The Gorge

The proposed Gorge site reaches a maximum depth of 159 m and is characterized as hard substrate. Commercially important species observed at this site include redfish, Atlantic Cod, Northern Shrimp (*Pandalus borealis*), and Snow Crab. Soft corals and sponges were recorded at many video stations, often >20 individuals per station.

Little Bay

The proposed Little Bay site reaches a maximum depth of 248 m and is predominantly hard substrate. Commercially important species identified within the lease boundaries include Atlantic Cod and redfish (present in a school). Sensitive species recorded in the video survey include sea pens and several sponge species.

The presence of aquaculture can cause changes to the benthic community (Hamoutene et al. 2015; Salvo et al. 2017) and with slow-growing corals and sponges, recovery post-production would take decades.

Rencontre Bay

The proposed Rencontre Bay site reaches a maximum depth of 194 m and is predominantly hard substrate. The ROV video survey recorded several schools of redfish, including some individuals within the predicted deposition zone. High densities of anemones and soft corals were also observed; this may be indicative of redfish habitat. Other commercially important fish observed at this site include shrimp, Atlantic Cod and Atlantic Halibut (*Hippoglossus hippoglossus).*

The baseline report indicates there are “no sponge complexes” present in the Rencontre Bay site; however, there are observations of sponges, including records of >20 *Geodidae* sponges per station and some very large individuals. It was clarified that the threshold for a bed or complex was as 50% coverage of an organism at a station This definition was not considered appropriate for all benthic species and is not relevant for sponges in particular. A clearer definition of complex would be helpful in future analyses and reporting.

The coastal geomorphology of this site suggests that the cage array will be in a back eddy, which would make this site susceptible to cycling and reinfection.

BMA 11 - HARE BAY

Two scheduled salmon rivers enter Hare Bay (Dolland Brook and Morgan Brook); participants agreed that this proximity and exposure warrants a higher level of concern for impacts on wild salmon health within BMA 11.

Mare Cove South

The proposed Mare Cove South site is 2 km from the nearest proposed aquaculture site (North Bob Locke Cove). This site reaches a maximum depth of 204 m and is characterized as hard substrate. Bacterial mats and opportunistic polychaete complexes (OPC) were observed on three transects, possibly a remaining indicator of past production at this site. The proposed cage footprint has been shifted from the previous production footprint; however, the distance of this shift and area of overlap were not quantified or mapped for this meeting. Commercially important species observed at this site include redfish, Atlantic Cod, and American Lobster.

North Bob Locke

The North Bob Locke site reaches a maximum depth of 188 m and is characterized as hard substrate. Commercially important species observed at this site include redfish and shrimp. Soft coral and sponges were also observed in many of the video stations.

BMA 10 - FACHEUX BAY

Dennis Arm

There is additional uncertainty associated with the baseline assessment of this site due to the depth of the site and the analysis of still images, as per the AAR, rather than video footage. This lease site reaches 384 m; however, ROV surveys were limited to 300 m, as per the AAR. Most of the seabed was classified as hard substrate. Kelp beds are present, though not within the cage footprint.

Wild Cove

The Wild Cove site is characterized by hard bottom and reaches a maximum depth of 390 m. Like the Dennis Arm site, this depth introduces uncertainty into the baseline assessment, as depths below 300 m were not surveyed and still images were analyzed.

Wild Cove is the only proposed lease site where sea whips, a cold-water coral species, were observed. The baseline assessment reports these observations as *Balticina* sp.; however, this is no longer considered a valid genus, and it is likely that these colonies are *Halipteris finnmarchica*.

Indian Tea Point

The proposed lease site at Indian Tea Point reaches 274 m in depth and is characterized as hard bottom. Kelp beds are present within the lease site, though not directly below the proposed cage array. Commercially important species observed at this site include redfish, Atlantic Cod, and shrimp. Soft coral and several species of sponge were also recorded.

Potential visual indicators of past production (bacterial mats and OPC) were observed in the baseline assessment. The footprint of the previous cage array falls within the lease site; It was reported that the previous cage array does not overlap with the proposed cage array; however, the distance between the two cage arrays was not provided.

BMA 9 - OUTER BAY D’ESPOIR

The four sites within this BMA were presented by the Proponent as “contingency” sites that would not be used for production under normal conditions. This point was discussed at length, and meeting participants agreed that the conditions under which a site is stocked should not influence the consideration of potential harm or the resulting science advice.

In the event this BMA was stocked site by site, the most appropriate order or use was discussed. Currently, there is not enough data to support science advice about which sites within BMA 9 would be associated with the most or least environmental harm. There was consensus that a full production scenario (i.e., basic license conditions) should be considered when assessing potential risk. There is no federal requirement to prioritize stocking of sites. It was clarified that the role of this meeting was to identify areas of concern for management and that this advice will be incorporated into DFO’s advice to the leasing authority and any further monitoring.

The use of BMA 9 for salmon farming was questioned, citing risk of harm to the wild salmon population, local subsistence fisheries species, and the unique, biodiverse benthic and pelagic communities observed in this area. Of the four BMAs, BMA 9 was considered the least appropriate for aquaculture development. Wild salmon smolt migrate through Bay d'Espoir and spend an extended amount of time staging in the outer Bay d'Espoir. Mortality is high for this life stage, and the causes of mortality at sea are not well understood (Dempson et al. 2011). Managers were urged to consider the implication of additional, undefined risk to this salmon population. The baseline assessments and provided seafloor images indicate that BMA 9 represents a benthic biodiversity hotspot within the region. Specifically, participants noted the diversity of sponges recorded by ROV video footage in BMA 9 and the presence of a mesopelagic fish community that is distinct from the neighbouring Fortune Bay. The bathymetry of this BMA was also noted as a concern; the mouth of Bay d'Espoir forms a sill, which limits deep water circulation and increases the risk of hypoxia or anoxia at the seafloor. It was also noted that the proximity of farms managed by other companies also limits the ability of the Proponent to control and treat sea lice outbreaks.

Goblin Bay

The proposed Goblin Bay lease site reaches a maximum depth of 251 m and is characterized as hard bottom. Commercially important species observed at this site include redfish, Atlantic Cod, American Lobster, and shrimp. Many species of sponge were recorded; however, the number of reported species is considered an underestimate due to difficulties identifying species from ROV videos. Soft corals and sea pens were also observed.

Pass My Can

The proposed Pass My Can lease site reaches a maximum depth of 130 m, with the proposed cage footprint at approximately 50 m and positioned over hard substrate. Commercially important species observed at this site include redfish, shrimp, and Atlantic Cod, with two schools recorded in the survey videos. Several species of sponge, anemone, and macroalgae were also observed. This site falls within the migration pathway of Conne River salmon, a stock that is currently in decline and of high importance by the Miawpukek First Nation.

Pass My Can has been used for previous production by a different company, and it was suggested that the previous cage footprint be used, to limit the extent of benthic impacts. It was reported that the cage footprint was shifted due to poor siting, based on depth and proximity to shore.

Jervis Island

The proposed Jervis Island lease site reaches a maximum depth of 332 m and is positioned over hard bottom. Commercially important species observed by ROV footage at this site include redfish, Atlantic Cod, and shrimp. Redfish were observed as individuals, in small groups (2–12), and, on one transect, in a school of >20. This area is used for the Miawpukek subsistence fishery, the recreational cod fishery, and it was reported that commercial vessels also enter the bay for cod.

Sensitive species recorded at this site include three species of sponge, Atlantic Wolffish (*SARA* Species of Special Concern), and Bubblegum coral (*Paragorgia arborea*). A second species of gorgonian may also be present; however, species identification via video is limited. Rhodolith beds, an important habitat forming ecosystem, are also present at this site. Based on the images provided in the baseline report, the area was noted to have high benthic biodiversity. Due to the limitations of data collection (e.g., limited video coverage while travelling between sites, potential for mobile species to flee the ROV, challenges with sponge/coral identification), it is likely that the diversity is not fully captured in the baseline assessment reports. The oceanographic conditions at Jervis Island are unique. The high biodiversity may be related to higher nutrient retention in this bay due to the presence of a deep-water sill.

Butter Cove

The proposed Butter Cove lease site reaches a maximum depth of 338 m over hard substrate. Low currents were recorded at this site, which may contribute to higher deposition rates below proposed salmon cages. Commercial species observed at this site include redfish, shrimp, and Snow Crab. Sensitive species at this site include eelgrass, sponges, and sea pens. Skate egg cases (species unknown), kelp beds, and branched bryozoans were also observed.

GENERAL DISCUSSION

A 2014 review of aquaculture activities in Canada included a summary of water depths used for farm sites by province. Generally, salmon farms in the Maritimes are very shallow; the majority of farm site in NB and Nova Scotia waters are in less than 20 m (Brewer-Dalton et al. 2015). In BC, most farm sites are over 30 m with a mean depth of 71 m. Prior to these proposals, the mean depth for salmon farm sites in Newfoundland was 57 m. The proposals associated with this expansion are a significant departure from the conditions of previous developments and these farms will impact different habitats that have not been monitored in the past.

The impact of cumulative effects of aquaculture on the surrounding ecosystems was discussed. While cumulative effects should be examined/contemplated, it was considered beyond the scope of this meeting. The analysis of genetic impacts on wild salmon provides one form of cumulative effect analysis. In some cases, there is PEZ overlap between sites, but this meeting did not discuss the meaning of that overlap. It was recommended that future research should aim to provide a more thorough investigation of cumulative effects.

EXTERNAL REVIEW

Reviewed by S. Dufour

The meeting added important context to the baseline reports, including identification of sensitive species and habitats within the lease sites and PEZ. Sea pens and gorgonians were identified as sensitive species, due to their long generation time, delicate structures, and feeding behaviours. All sites are expected to provide some amount of suitable habitat for American Lobster, Wolffish, Lumpfish, and/or spawning grounds for Capelin and Herring, all of which may be sensitive to aquaculture development. However, this process lacked critical discussion of some important factors. There was no consideration of zooplankton interactions with aquaculture despite concern that sea lice therapeutants will impact crustacean larvae. In-feed drugs may persist for weeks, months, or years at the seafloor in deposited fecal matter; however, there was no discussion of environmental persistence and potential toxicity of aquaculture waste. Relevant information about wildlife attraction and rates of entanglement for the NL Region were also missing.

The exploration of genetic impacts of farm escapes on the wild salmon population through a predictive framework was very useful. In particular, the sensitivity analysis (i.e., what level of escapees is an acceptable level) can provide managers with valuable guidance on mitigation measures.

Overall, the process was useful as an exercise to identify knowledge gaps and provide recommendations for future work. However, there was some uncertainty about the type of advice sought by this meeting and the ability of participants to assess the consequences of aquaculture development with sufficient detail to satisfy management guidelines. There are inherent survey limitations that make it difficult to confirm presence of sensitive species and/or the proportion of a population that may be impacted. Furthermore, additional research is required to fully understand and quantify the effect on associated species (e.g., potential loss of habitat forming sea pens). These uncertainties should encourage precautionary decision making.

DISCUSSION

It was acknowledged that this site review falls within a regulatory framework that is evolving. The objective of this meeting was to provide advice to DFO Management regarding the potential impacts from 13 new salmon aquaculture sites within 4 BMAs on the south coast of Newfoundland. DFO Management will consider that advice along with many other factors and, in turn, provide guidance to the province, who makes the siting decision. In this context, the expectation is that the meeting has summarized the impacts of adding aquaculture sites to the area, including any site-specific conditions that may be of concern to DFO management when considering mitigation measures. It was noted that mitigation measures will be detailed in a later process on risk management. The scope of advice does not include prescription of the response (i.e., recommendation to move a site, reduce sites within a BMA). If the science indicates that some sites will be subject to significant negative impacts from aquaculture development, the responsibility of this meeting is to identify those sites. DFO management will then consider a range of mitigation measures that can be applied to reduce risk of harm.

CONCLUSIONS

Concern was expressed with the development of proposed farm sites within BMA 9. This area is used as traditional fishing area for the Miawpukek First Nation and falls within the migration route of the Conne River Salmon. This BMA is an area of high biodiversity; the baseline assessment and previous research indicate this BMA provides habitat for several sensitive species including vulnerable corals and sponges, and species at risk (i.e., wolffish).

RECOMMENDATIONS

Managers require a case definition to establish standards for sea lice management. The development of a case definition will inform studies of sea lice treatment over time and a better understanding of industry practices. Information on sea lice management and associated auditing (i.e., confirmed cases, infection density, treatment rates) should be transparent. Increasing accessibility of this information would support the study of the dispersal and dynamics of sea lice populations. Future research could investigate Trout as a proxy/indicator species for sea lice abundance before farm development or as a host during fallow periods.

There is uncertainty about farmed salmon escape rates and the absolute number of escapes. A systematic study of escapes, including groundtruthing of reported escapes through river monitoring, would be informative in Newfoundland and Labrador. This would also support further understanding of the cumulative genetic impacts of escaped farmed salmon on wild populations over time.

Current knowledge of Atlantic Salmon migration timing and patterns is based on tagging studies competed from 1987–98 (Dempson et al. 1999). It was recommended these studies be repeated to inform the level of interaction between migrating wild salmon, farmed salmon, and sea lice, as many conditions (human and environmental) have changed over the last decade.

Further research is required to assess the role and impact of cumulative effects related to overlapping exposure zones from adjacent farm sites, the presence of farms for repeated production cycles, or re-use of previously decommissioned farm sites, including the persistence of previously used drugs and pesticides.

If conservative estimates of benthic exposure area from fish farm activities are to be applied, the maximum current should be used regardless of depth since horizontal, vertical, and temporal aspects of ocean currents vary in this region.

Due to the stratification of currents in this region, modelling dispersion of settling particles from fish farms should consider local water structure. When simplifying the current profile, selected depth levels should be representative of main water masses. The number of layers and their depths vary seasonally, and a longer time series could assess water stratification and its influence on currents dynamics in this region.

In future baseline assessments, site maps should be presented with an overlay of the transects and the DEPOMOD exposure zone to support development of science advice at the meeting. Species accumulation curves should also be presented for each site, to provide context on the completeness of the survey.

The provision of guidelines for corals/sponge species identification and collection of physical samples for key species by DFO-NL would be considered helpful for future assessments. In addition, when sensitive species like sea pens and other corals are observed, the baseline assessment surveys should increase the resolution of video stations to confirm the extent or patchiness of these habitats.

This process could be improved by the development baseline data collection and analysis guidelines specific to the unique oceanographic and ecological conditions of NL, including but not limited to the above recommendations regarding monitoring of depth-stratified current and collection of data on vulnerable corals and sponges.

The need to validate DEPOMOD and PEZ models under local conditions was recognized. Comparisons between PEZ calculations, field data, and model outputs will help refine the PEZ approach and help determine what current data should be used and how to relate these to intensity and exposure.

Monitoring is required to demonstrate improved performance resulting from the Proponents chosen mitigation measures.

Suggested amendments to the baseline assessment reports include:

- The listing of corals (including gorgonians and sea pens) and sponges as sensitive species. Sea pens should also be listed as juvenile fish habitat.
- Language around the presence of commercial species and/or Species at Risk presence should be amended to “not recorded” instead of “not present” or “absent”-the methods employed by this survey cannot confirm absence.
- Management should consider that language around nearby salmon rivers should specify that the text refers only to scheduled rivers; there are many salmon rivers in the area that are not scheduled and were therefore omitted from the assessment.
- Management should consider listing Conne River and Little River as the relevant nearby salmon rivers in BMA 9 due to salmon migration patterns.

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APPENDIX I - TERMS OF REFERENCE

Review of the Marine Harvest Atlantic Canada Aquaculture Siting Baseline Assessments

Regional Peer Review Process-Newfoundland & Labrador Region

May 28-31, 2019
St. John's, NL

Chairpersons: Dounia Hamoutene and Robert Gregory

Context

Marine Harvest Atlantic Canada (MHAC) has applied for 13 aquaculture licenses at various sites located on the south coast of Newfoundland. The Proponent's site applications were submitted to the Province and referred to DFO for siting advice. In accordance with the Aquaculture Activities Regulations (AARs), the Proponent has submitted a Baseline Assessment Report for each site which includes modelling of the dispersal of waste from site operations, including the predicted contours of biological oxygen demand (BOD) at peak biomass.

The Regional Aquaculture Management Office has requested Science to review the Baseline Assessment Reports and provide advice based on the following questions:

1. Based on the available data for the site and scientific information, what is the expected exposure zone from the use of approved fish health treatment products in the marine environment, and the predicted consequences to susceptible species?
2. The Proponent has used a depositional model to predict the benthic effects (i.e.: deposition of biochemical oxygen demanding (BOD) matter) of the proposed aquaculture sites. Are the predicted benthic effects, as demonstrated by the output of the model used by the Proponent, consistent with the scientific knowledge of the potential impact of this operation?
3. What are the consequences to the species and habitats that exist within the proposed site's exposure zones, and where applicable, in the broader vicinity, focusing on species at risk, key commercial, recreational, and aboriginal (CRA) species and species vulnerable to aquaculture impacts? Are there predicted consequences to any critical or valuable habitats for species at risk, key CRA species?

Objectives

To respond to the above questions, the process will consider following objectives:

1. Estimate the predicted exposure zones (PEZ) associated with: a) the deposit of the majority of uneaten food and feces; b) use of regulated drugs; c) use of regulated pesticides, and; d) pests and pathogens.
2. Identify the species and habitats within each PEZ that would be susceptible to interactions/impacts associated with each exposure/pathway type. For example: a) effect of smothering from the deposit of excess feed and feces; b) toxicity of approved drugs used in aquaculture; c) toxicity of approved pesticides, and; d) disease associated with pests and pathogens (farm-to-farm; farm-to-wild).
3. Assess the consequences of these exposures, including: a) spatial/temporal extent of site-specific impacts; b) importance of the exposure area to life processes of susceptible fish species (key *SARA*, CRA etc.); c) relative to population-level impacts, considering status (*SARA* status, relative to reference points) and management regime.

4. Beyond the PEZ, identify other possible interactions of interest to DFO, associated with the site, specifically: a) entanglement and displacement of wild species (e.g., marine mammals, turtles, sharks, tuna, etc.); b) smothering of habitat or species associated with placement of infrastructure; c) attraction of wild species to the site (e.g., sharks, marine mammals), and; d) for conspecific species, genetic interactions (e.g., salmon, lumpfish, cunner).

Expected Publications

- Science Advisory Report
- Proceedings

Expected Participation

- DFO Science, Newfoundland and Labrador, Maritimes and NCR Regions
- DFO Ecosystems Management, Newfoundland and Labrador and Maritimes Region
- DFO Aquaculture Management Directorate, NCR
- Provincial Department of Fisheries and Land Resources
- Indigenous Communities/ Groups
- Aquaculture Industry
- Fish, Food and Allied Workers Union
- Academia

APPENDIX II - AGENDA

Agenda

Regional Peer Review Process-Review of the Marine Harvest Atlantic Canada Aquaculture Siting Baseline Assessments

Memorial Room

Northwest Atlantic Fisheries Centre, St. John’s

May 28-31, 2019

Chairpersons: Dounia Hamoutene and Robert Gregory

Tuesday, May 28 (0900-1700)

Activity	Presenter
Opening, Terms of Reference and Introductions	Chairpersons
Presentation: DFO Aquaculture Site Reviews	C. Hendry
Discussion	All
Presentation: Overview of DFO’s Operational Science Advice for Aquaculture	I. Burgetz
Discussion	All
Presentation: Marine Harvest Atlantic Canada Aquaculture Siting Baseline Assessments	E. Barlow
Discussion	All
Presentation: Potential Exposure Zones Associated with Proposed Fish Farms	F. Page
Discussion	All
Presentations: Comments on “First Order Triage Calculations for First Round of Newfoundland Proposed Sites” and Comments on “Marine Harvest Atlantic Canada Baseline Assessment Reports”	A. Ratsimandresy, S. Donnet, and G. Han
Discussion	All

Wednesday, May 29 (0900-1700)

Activity	Presenter
Group Discussion: Species and Habitat Interactions	Subject Matter Experts on: • Corals and Sponges • Groundfish • Species at Risk • Marine Mammals • Pelagics

Activity	Presenter
	• Shellfish
Discussion	All
Wild-Farm Interactions **Presentation:** Exploring the potential direct genetic impacts of the proposed Marine Harvest Atlantic Salmon (*Salmo salar*) aquaculture site expansion on wild salmon in southern Newfoundland	I. Bradbury
Discussion	All
Presentation: Potential effects of increasing Atlantic Salmon farm production on sea lice in south Newfoundland	S. Saksida
Discussion	All
Group Discussion: Attraction, entanglement and displacement of wild species	All
Discussion	All
Conclusions : BMA 9-Outer Bay d'Espoir • Butter Cove • Jervis Island • Pass My Can • Goblin Bay	All

Thursday, May 30 (0900-1700)

Activity	Presenter
Conclusions: BMA 10-Facheux Bay • Indian Tea Point • Wild Cove • Dennis Arm	All
Conclusions: BMA 11-Hare Bay • Mare Cove South • North Bob Locke Cove	All
Conclusions: BMA 12-Rencontre West • Devil Bay • Rencontre Bay • Little Bay	All

Activity	Presenter
• The Gorge	

Friday, May 31 (0900-1300)

Activity	Presenter
Reviewer Report	S. Dufour
Drafting of Sources of Uncertainty	All
Drafting of Summary Bullets	All
Drafting of Research Recommendations	All
Upgrading of working papers to research documents	E. Parrill
Next steps	E. Parrill
ADJOURN	Chairpersons

Notes:

- This agenda is fluid and may change.
- Breaks will occur at 10:30 and 2:30.
- Lunch will occur from 12:00–1:00 and is not provided. Food and beverages can be purchased from the cafeteria.

APPENDIX III - LIST OF PARTICIPANTS

Name	Affiliation
Aaron Adamack	DFO Science, NL Region
Allison Kendall	SIMCORP
Amanda Borchardt	Marine Harvest Atlantic Canada
Amber Messmer	DFO Science, NL Region
Andry Ratsimandresy	DFO Science, NL Region
Anne Cheverie	DFO Ecosystems Management, NL Region
Barbara Neves	DFO Science, NL Region
Bret Pilgrim	DFO Fish & Fish Habitat Protection Program, NL Region
Chris Hendry	DFO Science, NL Region
Craig Purchase	Memorial University of Newfoundland
Dale Richards	DFO Centre for Science Advice, NL Region
Daria Gallardi	DFO Science, NL Region
David Coffin	DFO Resource Management, NL Region
Dounia Hamoutene	DFO Science, NCR
Ed Porter	DFO Aquaculture Management Directorate, NCR
Elizabeth Barlow	Marine Harvest Atlantic Canada
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Jennifer Duff	DFO Communications, NL Region
Jóhan Joensen	Fish Food and Allied Workers Union
Jonathan Kawaja	Fisheries and Land Resources, Government of NL
Keith Lewis	DFO Science, NL Region
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Sonja Saksida	Technical Expert

Name	Affiliation
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Suzanne Dufour	Memorial University of Newfoundland
Vonda Wareham-Hayes	DFO Science, NL Region