Creating an Aquaculture Coastal Classification System: Project Summary Report

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Executive Summary

Nova Scotia's coastline supports many activities and ecosystems. This makes it important to understand where aquaculture may present opportunities or restrictions. To help improve transparency and awareness around coastal suitability for aquaculture, the Government of Nova Scotia partnered with the Centre for Marine Applied Research to create the aquaculture Coastal Classification System (CCS).

The CCS is an interactive, science-based mapping tool created to support early planning and improve public understanding of coastal conditions in Nova Scotia. It offers a consistent, province-wide view of where marine aquaculture may face more or fewer challenges, based on environmental, regulatory, and marine-use considerations.

The CCS shows how suitable different areas may be for aquaculture, but it is not a decision-making tool and carries no legal or regulatory weight. It does not approve, reject, or determine the outcome of an aquaculture application. All applications must still undergo full site-specific regulatory review.

The CCS was developed using scientific information and input from experts, government departments, aquaculture industry representatives, and other stakeholders.

The work focused on four aquaculture species commonly farmed in Nova Scotia:

1. Atlantic salmon (*Salmo salar*);

2. Rainbow trout (*Oncorhynchus mykiss*);

3. Blue mussels (*Mytilus edulis*); and

4. American oyster (*Crassostrea virginica*).

All coastal waters within three kilometres of Nova Scotia's coastline were divided into 100 by 100 metre squares (or cells). Each square was given one of four ratings:

- **Restricted area** – Aquaculture is not permitted

- **Limited area –** These areas have low potential and may need extra management or mitigation

- **Moderate area** – These areas may be relatively suitable for aquaculture, but require further investigation

- **Good area** – These areas are generally expected to be well-suited for aquaculture development.

These ratings were based on a range of data layers, called criteria, chosen because they reflect environmental or regulatory conditions that can affect aquaculture activities. These criteria were grouped into three broad categories:

1. The conditions required for the health and well-being of farmed species,

2. The presence of sensitive species or habitats, and

3. Potential overlaps with other marine activities.

Each criterion was reviewed and scored based on how it may influence aquaculture potential, using available data, scientific research, expert input, and current aquaculture policies. All scores were placed on a shared scale so they could be compared and combined. Some criteria could not be scored consistently across the province. These were included as informational layers for transparency, but not used in the final suitability rating.

A range of methods was used to combine the criteria, so that final ratings reflected multiple factors and any important limitations were considered.

The results of the assessment, including the data layers, are available through the online mapping tool on the Government of Nova Scotia's website.

Background and Objectives

Aquaculture, the farming of fish, shellfish, and aquatic plants, is a key part of Nova Scotia's economy. In 2023, it employed nearly 800 people and contributed $120 million to the provincial economy[1]. As global demand for seafood increases, Nova Scotia is well-positioned to grow this sector responsibly and sustainably.

Developing an aquaculture Coastal Classification System

Aquaculture development cannot occur everywhere along the coast. There are a range of environmental, regulatory and human use factors and considerations that may influence the suitability of an area for aquaculture. The importance of proper site selection for marine aquaculture was highlighted in the 2014 Final Report of the Independent Aquaculture Regulatory Review for Nova Scotia, commonly known as the "Doelle-Lahey report." The report recommended developing a Coastal Classification System for marine finfish aquaculture (Doelle and Lahey, 2014).

In response, the Premier of Nova Scotia asked the Minister of Fisheries and Aquaculture in 2021 to create a system that would rate coastal areas based on their suitability for finfish aquaculture. In January of 2024, the project scope was expanded to include shellfish.

Currently, aquaculture suitability in Nova Scotia is evaluated on a site-by-site basis during the aquaculture scoping and licence and lease application process. While some datasets exist for select coastal regions, there has been no province-wide tool that brings together environmental, regulatory, and marine-use considerations to support early planning.

To address this gap, the Nova Scotia Government developed the aquaculture Coastal Classification System (CCS), a mapping tool that provides a consistent, province-wide view of how suitable different coastal areas may be for aquaculture development.

The objectives of the CCS were to:

- Complete broad (high-level) assessments to explore potential suitability of Nova Scotia's coastal waters for four types of aquaculture development;

- Create an accessible platform containing information associated with aquaculture development; and

- Identify general issues and help guide further research and data collection needed to support industry development.

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[1] Aquaculture statistics - Government of Nova Scotia, Canada

What species were assessed?

This assessment focused on year-round marine grow-out aquaculture for the species most commonly farmed in Nova Scotia, based on current aquaculture practices (**Figure 1**). These include Atlantic salmon (*Salmo salar*), Rainbow trout (*Oncorhynchus mykiss*), Blue mussels (*Mytilus edulis*), and the suspended culture of American oyster (*Crassostrea virginica).*
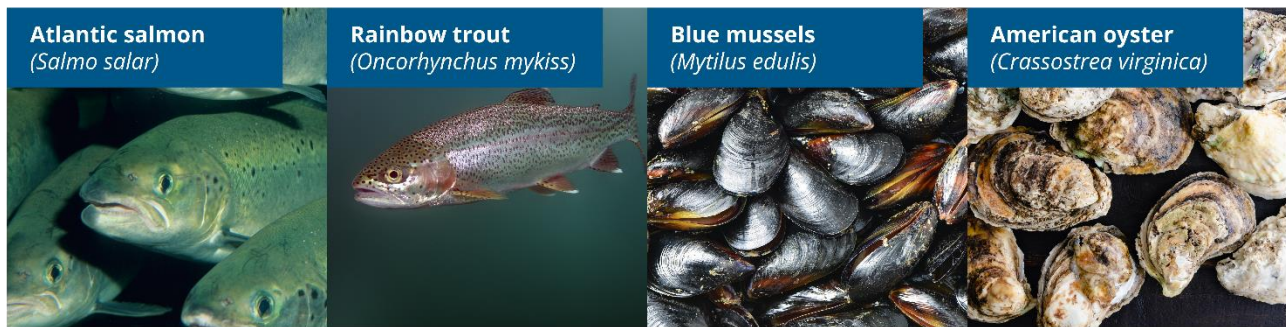

Figure 1. Species included in the aquaculture Coastal Classification System.

This assessment applies only to technologies, management practices, and procedures that are currently established and widely used within Nova Scotia. This assessment does not apply to experimental approaches, emerging technologies, and innovations, or region-specific practices that have not been widely adopted.

The area of assessment (AOA) encompassed all of Nova Scotia's near-shore coastal waters, up to three kilometres offshore, including major jaws of land (e.g. inlets and bays) (**Figure 2**). This assessment does not include areas further offshore, inland waters (e.g. rivers, lakes), land-based production, and brackish-water environments.
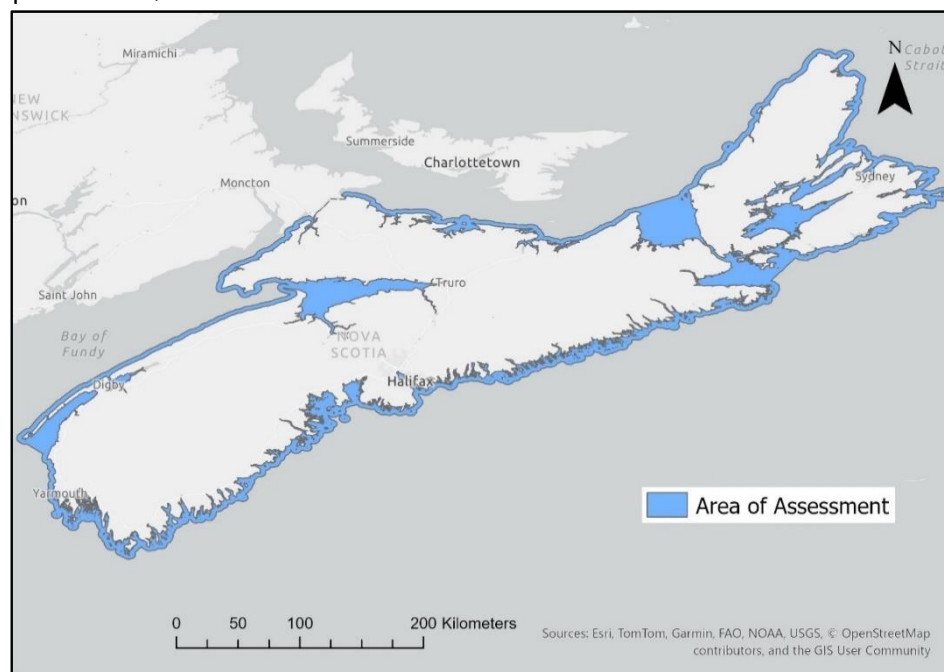

Figure 2. Area of assessment.

Who was involved and how?

The Coastal Classification System was developed by the Nova Scotia Department of Fisheries and Aquaculture (NSDFA). Scientific support was provided by the Centre for Marine Applied Research (CMAR). The project also included input from government agencies, researchers, aquaculture stakeholders, and the public. This joint approach helped guide criteria selection and ensured a broad range of perspectives were considered. The roles of each group are described below.

Nova Scotia Department of Fisheries and Aquaculture

As the project lead, the Department worked closely with partners to guide its design and delivery. It helped bring together the science, policy, and public input needed to develop a tool that supports transparency and responsible aquaculture planning.

Centre for Marine Applied Research

CMAR, a division of Perennia Food and Agriculture Corp., provided scientific support to the development of the CCS. This included completing the suitability assessments and developing the mapping tool that displays the assessment results.

CCS Data committees

CMAR formed three Data Committees to support the CCS's development:

a. **Biophysical Data Committee**: Experts in Nova Scotia's oceanographic conditions and how they affect the health and growth of farmed species.

b. **Ocean Use Data Committee**: Experts in coastal and ocean use in Nova Scotia, including marine spatial planning and marine management.

c. **Wild Salmon Data Committee**: Experts in wild Atlantic salmon and/or potential interactions between wild Atlantic salmon and aquaculture.

These committees provided technical advice by identifying data needs, reviewing methods, ensuring data quality, and advising on key decisions and assumptions.

Nova Scotia Aquaculture Science Advisory Committee (NSASAC)

The NSASAC conducted the final technical review and validation of all the decisions and assumptions made during the development of the CCS. The committee included experts in various scientific fields related to aquaculture regulation. It provided science-based recommendations to Nova Scotia's Minister of Fisheries and Aquaculture. Member details can be found on the NSDFA Website.

Government departments and agencies

NSDFA and CMAR met with various provincial and federal departments to present the tool, outline its intended use, and to discuss data-sharing opportunities.

Other interest holders

Community groups, environmental organizations, researchers, and industry representatives were also engaged. These interactions helped inform the development of the CCS and provided insight on local conditions, concerns, and priorities.

Crown Consultation with the Mi'kmaq of Nova Scotia

The CCS is a non-regulatory, province-wide planning tool and does not replace or alter the Crown's Duty to Consult the Mi'kmaq of Nova Scotia as required, on individual aquaculture licence and leasing applications.

The CCS does not include Indigenous cultural values or sites. These matters may need protected handling of information, consent-based sharing, and site-specific consideration and are more appropriately considered through the formal Consultation process on individual aquaculture licence and leasing applications, where nuance and context can be fully considered in the provincial decision-making process.

Public Engagement

The public was invited to provide feedback through an online survey focused on the proposed CCS criteria. The survey provided an opportunity for broader participation and feedback. A summary of public input is available in a *What We Heard* report on the NSDFA website.

Outcomes and anticipated use

The CCS is available to the public as an online mapping tool. It provides a province-wide view to support early conversations about marine areas that may present more or fewer challenges for aquaculture. It is designed for a wide range of users, including the public, planners, and industry representatives. It brings together environmental and regulatory information in one accessible place.

The tool includes maps showing overall suitability ratings based on multiple factors. Additional data layers show conditions like water depth, temperature, and other marine activities that may affect aquaculture. Together, this information helps identify where aquaculture may face fewer or greater challenges.

The CCS is meant to provide information to support early-stage exploration and provide regional context. It does not assess individual sites and is not used to make regulatory decisions. Decisions related to marine aquaculture sites – as per the *Aquaculture Licence and Lease Regulations* must still consider a range of site-specific environmental, regulatory, social, and cultural factors, including:

    a.   the optimum use of marine resources;

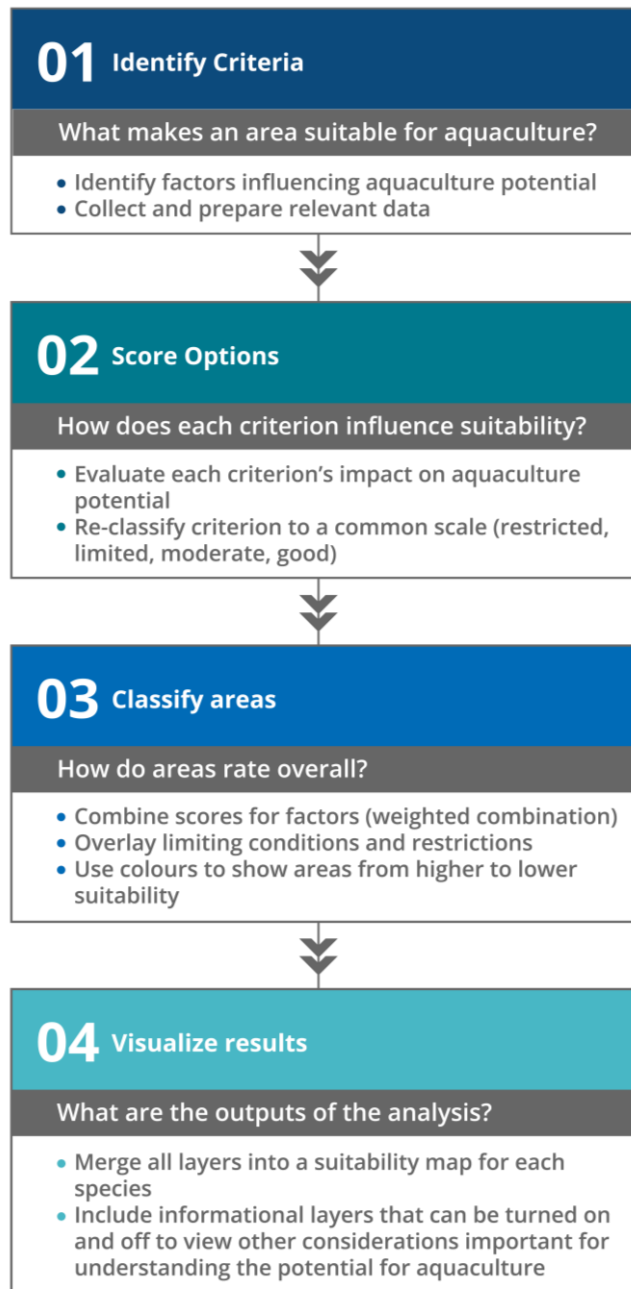   b.   the contribution of the proposed operation to community and Provincial economic development;

c.   fishery activities in the public waters surrounding the proposed aquacultural operation;

d.   the oceanographic and biophysical characteristics of the public waters surrounding the proposed aquacultural operation;

e.   the other users of the public waters surrounding the proposed aquacultural operation;

f.   the public right of navigation;

g.   the sustainability of wild salmon; and,

h.   the number and productivity of other aquaculture sites in the public waters surrounding the proposed aquacultural operation.

Importantly, the CCS does not replace or change Nova Scotia's aquaculture licencing and leasing process. All aquaculture applications must still go through full site-level regulatory review[2] (following the requirements and steps set out in the *Aquaculture License and Lease Regulations*). The Crown's Duty to Consult with the Mi'kmaq of Nova Scotia remains unchanged.

What the CCS Does	What the CCS Does Not Do
✓ Shares province-wide environmental, regulatory, and general human use considerations.	✗ Does not grant or deny aquaculture licences or leases.
✓ Supports early-stage exploration and public awareness.	✗ Does not replace regulatory reviews or site-level assessment.
✓ Provides consistent, centralized spatial data for all users.	✗ Does not fulfill or substitute the Duty to Consult.
	✗ It is not marine spatial planning.

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[2] For more information about laws and regulations related to regulatory processes for aquaculture, visit: https://novascotia.ca/fish/aquaculture/laws-regs/

Methods and Approach

01 Identify Criteria

What makes an area suitable for aquaculture?

- Identify factors influencing aquaculture potential
- Collect and prepare relevant data

02 Score Options

How does each criterion influence suitability?

- Evaluate each criterion's impact on aquaculture potential
- Re-classify criterion to a common scale (restricted, limited, moderate, good)

03 Classify areas

How do areas rate overall?

- Combine scores for factors (weighted combination)
- Overlay limiting conditions and restrictions
- Use colours to show areas from higher to lower suitability

04 Visualize results

What are the outputs of the analysis?

- Merge all layers into a suitability map for each species
- Include informational layers that can be turned on and off to view other considerations important for understanding the potential for aquaculture

The suitability assessments drew on techniques and methods from multicriteria decision analysis (MCDA) (Malczewski and Rinner, 2015) to evaluate the overall potential for aquaculture development in Nova Scotia.

These spatial assessments focused on defining, rating, and combining multiple evaluation criteria relevant to assessing the potential of an area for aquaculture production (**Figure 3**).

Similar types of assessments have been widely used to explore aquaculture potential (Chentouf et al., 2023) in similar global initiatives to assess suitability for aquaculture (Falconer et al., 2013; Porporato et al., 2020) and develop mapping tools to help identify where opportunities for aquaculture could exist (Aguilar-Manjarrez et al., 2008).

Figure 3. Process flowchart outlining steps in suitability assessments for aquaculture.

Step 1 – Identify Criteria

Selecting a location for aquaculture development requires reviewing many important factors. However, not all criteria can be assessed at a provincial scale. This assessment aims to capture the key considerations that would either constrain and/or limit the culture of species, or that producers would need to account for in placing or planning their aquaculture operations.

These assessments included criteria that focus on:

   a. The **biophysical conditions** required for the health and well-being of the farmed species (like exposure to extreme temperatures, ice conditions, water depth, etc.);

   b. Supporting **environmental protection and conservation** of significant habitats and species (like marine protected and conserved areas, critical habitats for species at risk, etc.); and,

   c. Reducing potential **overlaps with other marine activities** (like anchorage areas, vessel track lines, public coastal access points, etc.).

Criteria were selected using a structured science-based approach. Selection was guided by policy documents, scientific studies, and expert consultation.

Each criterion had to meet the following eight tests (**Figure 4**):

   1. **Relevance**: The science is clear that it influences suitability for aquaculture development.

   2. **Rateability**: The science is clear on how it influences suitability.

   3. **Clarity**: Its influence is easy to understand and explain.

   4. **Scale**: It can be assessed on a broad scale.

   5. **Data Accessibility**: The required data can be collected within project timelines.

   6. **Coastal Coverage**: The data is available for all of Nova Scotia's near-shore coastal waters.

   7. **Measurement Reliability**: It can be accurately measured within project timelines.

   8. **Redundancy**: It is different information and not already covered by other criteria.

Figure 4. Inclusion of criteria was based on information that met eight selection properties.

Data collection and processing

For all criteria, data were selected that represent the most authoritative and highest resolution available. Spatial data layers were acquired from public sources (such as the Government of Canada Open Data Portal and the Nova Scotia Open Data Portal), developed through 'in-house' analysis[3], or provided through engagement with provincial and federal government agencies. Data was checked for completeness and quality, and the most up-to-date sources were used.

Some datasets were provided in 'ready to use' formats. Others required processing to prepare them for the suitability analysis or inclusion in the web-based platform. Notes on data processing, as well as the source and data download locations of datasets can be found in **Appendix A**.

Step 2 – Criterion scoring

This step focused on determining how each criterion influenced the potential for aquaculture development. Scoring considered the risks to animal health, environmental conservation, and potential overlaps with other marine activities.

Conditions that may reduce or enhance the potential for aquaculture development were reclassified into a common scale:

> **Limited (1)**: Conditions are generally expected to have substantial challenges for aquaculture development and would require significant management or mitigation.

> **Moderate (2)**: Conditions are generally expected to be reasonable for aquaculture development, with further investigation needed to explore potential impacts or appropriate management and mitigation.

> **Good (3)**: Conditions are generally expected to be well-suited for aquaculture development.

This common scale allows different types of data to be compared and integrated into a unified view of aquaculture development potential.

We also identified whether a criterion may have limiting conditions that might reduce the suitability of an area, regardless of any other factor. Finally, we identified restrictions that would preclude aquaculture development due to spatial conflicts or legislative restrictions.

Scoring was guided by a comprehensive and science-based process, drawing on:

- **Scientific literature**: Best practices and thresholds for each criterion

- **Government policy**: Aquaculture planning, licencing, and leasing considerations

- **Stakeholder input**: Feedback from scientific experts, government partners, and aquaculture industry representatives

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[3] Using data produced or contracted for, and by, CMAR for this project, such as through CMAR's Coastal Monitoring Program.

Step 3 – Combine criteria

The final suitability maps were created using a geospatial overlay within a Geographic Information Systems (GIS) environment. The area of assessment was divided into a grid of 100 m-by-100 m cells (~1 hectare each). The resolution of each 'area' was determined based on the resolution of the underlying data layers and the relevance of the analysis. Each cell was mapped and assigned a suitability rating based on its combined criteria, combining three methods commonly used in GIS-based multicriteria decision analysis (GIS-MCDA).

Weighted Combination of factors

A Weighted Linear Combination (WLC) approach was used to combine the scores for each factor. Factors. This way, the final ratings reflect the suitability of areas when considering multiple factors. For this assessment, all factors were weighted equally to reduce subjective bias and variability across local contexts. The result is a suitability score for each location on a continuous scale of 1-3, which were then reclassified into descriptive ratings (limited = 1 – 1.66, moderate = 1.67 – 2.33, good = 2.34 – 3).

Overlaying limiting conditions

Next, a rule-based overlay (Greco et al., 2016) was used so that where a limiting condition is present, the area would be rated as either limited or moderate, depending on the conditions present. This step ensures that critical thresholds are enforced, and essential limitations are not overlooked or diluted through WLC.

Overlaying restrictions

Finally, a constraint overlay was used. Any area where restrictions are present, were assigned a restricted rating due to the presence of exclusionary restrictions that would preclude aquaculture.

Putting it all together

Together, these three MCDA methods ensure the final classification of areas is determined by the combined effect of multiple variables. This method also acknowledges the critical limiting conditions and restrictions to potential aquaculture development.

In summary, final ratings reflect either:

- A combination of factors that make an area have a specific overall rating for development potential, as determined through WLC; or

- The presence of a key condition (restriction or limiting condition) that influences aquaculture development potential, independent of any other criterion.

Suitability scores are presented in maps such that each 100-m by 100-m area was given one of four ratings (**Figure 5**).
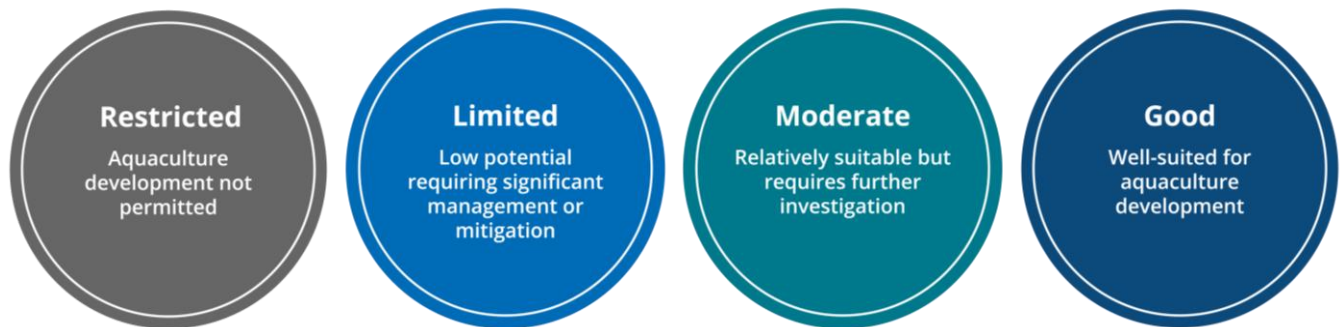

Restricted
Aquaculture development not permitted

Limited
Low potential requiring significant management or mitigation

Moderate
Relatively suitable but requires further investigation

Good
Well-suited for aquaculture development

Figure 5. Final suitability ratings and what they mean for potential aquaculture development.

Validation and quality control processes

Several steps were taken to ensure accuracy and reliability throughout the assessment. All methods and data sources were fully documented, including any applied processing and analysis.

Regular consultations with subject matter experts, industry stakeholders, and network partners helped ensure the most relevant, up-to-date information was included and the methods were sound. While every effort was made to ensure completeness and accuracy, any uncertainties and limitations are reported where relevant. If errors or omissions are identified, the tool will be revised.

Step 4 – Visualizing Results

The Coastal Classification System is publicly accessible through the Government of Nova Scotia website. A web-based mapping tool allows users to view the results of the suitability assessments and get more information about the criteria and data used during the assessment.

To provide users with additional, easily digestible information on the project inputs, data, and processes, the outputs were also aggregated onto an ArcGIS StoryMap. This StoryMap shares the outputs of the suitability analysis through a combination of text, interactive maps, and other multimedia content. It also explains the assessment methods, the relevance and scoring of each criterion, and more information on how to use the mapping tool.

The mapping tool includes multiple layers of information:

- **Suitability maps**: maps showing areas classified into "restricted", "limited", "moderate", or "good" aquaculture development potential, for each assessed species;

- **Data layers**: individual layers for each criterion and restriction used in the assessment; and

- **Informational data**: individual layers showing informational criteria.

The design of the mapping tool and StoryMap was developed with functionality and accessibility in mind. Accessibility audits and user testing were conducted on draft versions of the platform. The mapping platform is a 'living tool' as it will be regularly updated to maintain relevancy and provide necessary user support.

Criteria Included

The selected criteria reflect current marine conditions, sector needs, industry regulations, aquaculture practices, and technologies, as well as the existing state of knowledge and data availability at the time of the assessment.

Assessment Criteria

The final suitability ratings were determined through the scoring and aggregation of factors and the restrictions (Table 1). The specific criteria used varied depending on the species being assessed. This is because different species have unique biophysical needs, environmental interactions, and culture techniques.

Factors

Factors can either enhance or detract from aquaculture development potential. Each factor is individually scored, from lower to higher suitability, and then combined to calculate the overall suitability rating.

Restrictions

Restrictions identify areas where aquaculture is not allowed and are scored as restricted in final suitability maps. A restriction must identify a region that would completely exclude aquaculture due to direct spatial overlaps with infrastructure (e.g. submerged cables and pipelines), interference with designated activities or uses (e.g. anchorage areas), or areas considered legislatively restrictive (e.g. Marine Renewable Energy Areas).

Note: Both factors and restrictions may have limiting conditions present that would be combined through rule-based overlay.

Table 1. Criteria (factors and restrictions) used within suitability assessments for each species including how they were scored. *Indicates limiting conditions.

Atlantic salmon 🐟   Rainbow trout 🐟   Blue mussels 🦪   American oyster 🦪

Criteria	Data	Species	Rule/Score	Comments/Rationale
FACTORS				
Extreme Cold Exposure	Coastal Monitoring Program data - CMAR, supplemented by GHRSST Level 4 MUR Global Foundation Sea Surface Temperature	🐟 🐟	Areas with a high risk of extreme cold exposure are automatically 'limited'* in final maps. Medium risk areas have 'moderate' potential, and low risk areas have 'good' potential.	Extreme low water temperatures can pose significant mortality risks to finfish.
Extreme heat exposure	See above	🐟 🦪 🐟	Areas with a high risk of extreme heat exposure have 'limited', medium risk have 'moderate', and low risk areas have 'good' potential.	Prolonged exposure to warm waters can impair growth, reduce disease immunity, and in some cases, lead to mortality.
Bathymetry	General Bathymetric Chart of the Oceans (GEBCO); Canadian Hydrographic Service Non-Navigational (NONNA) Bathymetric Data	🐟 🐟	Depths below 10 metres are automatically 'limited'* in final maps.	Aquaculture operations must have sufficient water depth to accommodate infrastructure. Operations in shallow waters can have elevated welfare risks to cultured species and increase risks of bio- deposition on seafloor environments.
		🦪	Depths below 5 metres have 'limited' potential, and above 5 metres have 'good' potential.	
		🦪	Depths below 2 metres have 'limited' potential, and above 2 metres have 'good' potential.	
Drift ice risk	Ice products produced by NSCC's Applied Geomatics Research Group for CMAR	🐟 🐟	Areas with high risk of drift ice have 'limited', medium risk have 'moderate', and low risk areas have 'good' potential.	High risk areas increase potential exposure to ice that can damage infrastructure or lead to accidental escape of farmed fish into the marine environment.
		🦪 🦪	Areas with a high drift ice risk are automatically 'limited'* in final maps. Areas with medium risk have 'moderate' and low risk have 'good' potential.	In areas where gear cannot be submerged, drift ice can scour equipment and lead to mechanical damage and mortality of shellfish.

Criteria	Data	Species	Rule/Score	Comments/Rationale
Wind and wave conditions	[Nova Scotia Wind-generated Wave Exposure Atlas](#) - DSA Ocean for CMAR	🐟🐟	Maximum significant wave heights above 5.5 metres have 'limited', between 4 and 5.5 metres have 'moderate', and below 4 metres have 'good' potential.	High risk areas increase potential exposure to ice that can damage infrastructure or lead to accidental escape of farmed fish into the marine environment.
		🦪🦪	Maximum significant wave heights above 2 metres are automatically 'limited'* in final maps, between 1 to 2 metres have 'moderate' and under 1 metre have 'limited' potential.	
Critical habitat for species at risk	[Critical Habitat for Aquatic Species at Risk - Canada ; Critical Habitat for Species at Risk National Dataset - Canada](#)	🐟🦪 🐟🦪	Areas within a critical habitat for species at risk are automatically 'moderate'* in final maps.	Critical habitats are protected under the *Species at Risk Act* and would require further investigation of potential interactions with relevant species and habitats.
Marine protected and conserved areas	Includes Marine Protected Areas, Migratory Bird Sanctuaries, National Parks, National Wildlife Areas from [the Canadian Protected and Conserved Areas Database (CPCAD)](#)	🐟🐟	Marine protected and conserved areas are automatically 'limited'* in final maps.	Protected areas have regulatory preclusions that may limit aquaculture operations and require significant attention to ensure no negative impacts to protected species and habitats.
		🦪🦪	Marine protected and conserved areas are automatically 'moderate'* in final maps.	
AIS vessel density patterns	Automatic Identification System (AIS) track line data from 2019, 2020, and 2021 provided by Fisheries and Oceans Canada (DFO)	🐟🦪 🐟🦪	Areas identified as 'important vessel routes' are automatically 'limited'* in final maps. Areas 'on- channel' of navigational routes have 'limited', 'near- channel' have 'moderate', and 'off-channel' have 'good' potential.	Areas of higher vessel traffic may introduce navigational hazards due to overlap with aquaculture infrastructure and activities.
VMS Fishing vessel density patterns	Vessel Monitoring System (VMS) data from 2019, 2020, and 2021 provided by DFO	🐟🦪 🐟🦪	High traffic areas have 'limited', medium traffic areas have 'moderate', and low traffic areas have 'good' potential.	Areas of higher vessel traffic may introduce navigational hazards due to overlap with aquaculture infrastructure and activities.

Criteria	Data	Species	Rule/Score	Comments/Rationale
Public coastal access	• Coastal beaches (Ecological Land Classification, Protected beaches – Nova Scotia Department of Natural Resources (NSDNR) • Small craft harbours (DFO) • Public boat launch sites (NSDFA) • Marinas and yacht clubs (CMAR)		Areas within 100 m of a public access point are automatically 'limited'* in final maps.	Aquaculture within close proximity to areas used by the public to access the ocean may interfere with access to the ocean and coastal spaces for recreation, tourism, etc.
		RESTRICTIONS		
Anchorage areas	Canadian Anchorages and Anchorage areas		Areas associated with anchorage areas are 'restricted' for aquaculture. Areas within 200m of anchorage points are automatically 'limited'* in final maps.	Specified anchorage areas have restricted access and are not suitable for co- location with aquaculture. Navigational hazards are possible within proximity to these areas, due to the drift of vessels and potential inaccuracy in mapped point data.
Designated navigation features	Vessel Traffic Routes, includes Traffic Separation Zones, ferry routes, and recommended routes.		Areas associated with designated navigation features are 'restricted' for aquaculture. Areas within 200 m of ferry routes and recommended routes are automatically 'limited'* in final maps.	It is important to avoid potential overlaps with existing areas designated for navigation. Navigational hazards are possible within proximity to these areas due to potential inaccuracy in the mapped geometries of line data.
Marine Renewable Energy Areas	Provided by Nova Scotia Department of Energy		Areas within Marine Renewable Energy Areas (MREAs) are 'restricted' for aquaculture.	As per the Marine Renewable-energy Act, MREAs can not be designated in areas permitted/leased for aquaculture.
Submerged cables and pipelines	Provided by DFO		Areas associated with submerged cables and pipelines are 'restricted' for aquaculture. Areas within 500m are automatically 'limited'* in final maps.	Aquaculture should avoid areas where underwater cables and pipelines are present to prevent damage, avoid conflict with maintenance activities, and minimize potential safety hazards to operators.
At-sea disposal sites	Active and Inactive Disposal at Sea Sites in Canadian Waters		Areas within at-sea disposal sites are 'restricted' for aquaculture.	Aquaculture should not interfere disposal, maintenance, and management of dumped materials.

Informational Criteria

The suitability ratings were determined using the factors and restrictions described above. However, other considerations were included in the tool, allowing users to view additional information important to understanding suitability for aquaculture development.

Informational criteria are recognized as important considerations for aquaculture development but cannot be included within the suitability analysis due to data or knowledge limitations (**Table 2**). In some cases, data may be incomplete or not reliable enough to support consistent scoring. In others, what may make an area 'suitable' for aquaculture may vary widely, at local scales, across time, or depending on specific operations.

Table 2. Informational criteria identified.

Informational criterion	Data source	Comments/Rationale
CFIA Disease Regulated Areas	CFIA's online map for Multinucleate sphere unknown (MSX) and Perkinsus marinus (Dermo) Regulated Areas	The health of cultured species may be impacted by potential exposure to diseases. Area-specific information on virulence and presence of these diseases has not been mapped.
Shellfish Water Classification Program	Canadian Shellfish Sanitation Program (CSSP)'s Shellfish Harvesting map (DFO)	Under the CSSP, shellfish harvest areas are classified as to their suitability for harvesting shellfish, according to water quality standards and sanitary conditions. How the area is classified, as well as existing prohibition orders can affect a producer's ability to harvest or may imposing requirements for mitigation measures.
Wild salmon rivers	River significance levels from wild salmon river assessment - CMAR	Significant rivers for wild Atlantic salmon may be sensitive to disturbance from marine activities. Potential interactions and impacts to salmon and their habitats from aquaculture would vary considerably based on proposed operations, and there is little evidence on appropriate distances from rivers.
Important bird habitat	Bird habitat datasets within 100 m from the coast were combined: • Significant Species and Habitat Database (NSDNR) • Important Bird Areas (IBA) BirdLife International • Critical Habitat for Species at Risk National Dataset (ECCC) • Migratory Bird Sanctuaries from the Canadian Protected and Conserved Areas Database	Important migratory and protected birds are sensitive to disturbance from marine activities. Aquaculture site decisions should consider the potential for interaction with birds and their habitats. Potential interactions of aquaculture with birds and their habitats would vary considerably depending on the area, species, and aquaculture operations. In addition, recommended setback distances or required management and/or mitigation efforts would also vary.

Informational criterion	Data source	Comments/Rationale
Coastal wetlands	Canadian National Wetlands Inventory	Wetlands play an important role in coastal ecosystems and have various government protections. Potential interactions or impacts within these areas from aquaculture may be highly variable and required management and/or mitigations are highly site-specific.
Terrestrial protected areas/parks	Multiple layers showing protected areas and parks within the terrestrial environment were combined from: • The Nova Scotia Protected Areas System • Protected beaches provided by NSDNR • Wildlife Management Areas, provided by NSDNR	Potential interactions or impacts with these areas from aquaculture may be highly variable and situation- specific depending on ecosystem type, resident species, and proposed adjacent activities
Water lots	Property Identification (PID) data provided by GEONova	Water lots are parcels of marine space already owned or leased to specific entities.
Crown leases and easements	NSDNR's Crown Land dataset	Within existing crown leases and easements, aquaculture development may not be permitted, although the restrictions would vary depending on the aquaculture operation and the type of crown lease or easement.

Criteria not included

Some relevant criteria were excluded from the assessment because they did not meet the eight selection properties used to evaluate suitability for inclusion (see **Table 3**). These criteria are still important for aquaculture planning. Reasons for exclusion of some criteria included that the data did not have full coverage across the areas of assessment (for example, eelgrass), the data was too coarse resolution (for example, commercial fishing data), or that the criteria was more appropriately captured at more local scales (for example, water current and flushing)

Other criteria were out of the project's scope but are part of aquaculture site-level assessments. Some excluded criteria relate to:

- Assessing optimal growing conditions (for example, average temperatures)

- Identifying production needs (for example, access to infrastructure and roads)

- Understanding potential compatibilities or conflicts of aquaculture operations with local communities, cultures, and livelihoods

These types of factors are better addressed at site-level assessments and/or through consultation with individuals, communities, and rights-holders who may be affected by a proposed development.

Table 3. Examples (non-exhaustive list) of some criteria considered but not included

Criterion	Test(s) failed	Rationale
Average sea surface temperatures	Relevance	Relevant to identifying optimal growth conditions – not included in scope of assessment
Commercial fisheries catch data	Scale	Public datasets are available (e.g. the Eastern Canada Commercial Fishing Data) but are at coarse resolutions inappropriate for this assessment.
Eelgrass habitat	Coastal coverage, Data accessibility	Some mapped data available, such as datasets through the National Eelgrass Dataset for Canada (NetForce) are only available for some, but not all areas.
Sources of marine pollution	Redundancy	Already accounted for in Canadian Shellfish Sanitation Program classification areas

Assessment Outputs

The results of the suitability assessments in support of the aquaculture Coastal Classification System are publicly accessible through the Government of Nova Scotia website.

The web-based platform consists of an online mapping tool and an ArcGIS StoryMap that will allow users to view the final suitability maps and get more information about the criteria and information used during the assessment.

Assumptions and considerations

Several assumptions were made during the development of the CCS. The following points outline key considerations and limitations that users should keep in mind when interpreting the results:

Purpose and Scope

- The assessment is designed to provide broad, province-wide suitability ratings for four commercial aquaculture species.

- Its goal is to highlight potential suitability on a regional level; not to assess individual sites.

Resolution of Results

- While the outputs are mapped at a 100 m^2 resolution, not all data layers are available at that level of detail.

- As a result, the assessment is not appropriate for site-specific evaluations.

Data Limitations

- Only criteria supported by measurable and available data across the entire province were included.

- Some relevant datasets were excluded due to gaps in availability or quality.

- The exclusion of certain factors does not imply they are unimportant, many of these will be assessed during lease and licencing reviews.

Not a Tool for Optimal Site Selection

- This tool does not identify the most productive or optimal sites for aquaculture.

- It also does not guarantee that sites with high ratings will be suitable for development.

- All aquaculture applications must undergo full site-specific regulatory review.

Not Suitable for Reviewing Existing Sites

- The CCS is not designed to evaluate the suitability of established aquaculture operations.

Up-to-Date Information

- The assessment reflects the most current data available at the time of the project.

- It does not capture real-time environmental conditions.

No Future Projections

- Long-term trends, such as the effects of climate change, are not accounted for.

- Seasonal and year-to-year variability (e.g. extreme weather) is also not included.

Next Steps

Continued revision and maintenance

Keeping the tool updated will help improve the accuracy and usefulness of the assessments. If or when new data becomes available, existing layers may be refined or new criteria may be added. The assessment framework was designed to be flexible, so it can adapt to these changes without requiring a full redesign.

Report on full technical details of the assessment

CMAR will prepare and submit a full technical report of the assessment. This report will include a detailed technical description of the methods applied, including how criteria were selected, mapped, scored, and combined to produce final suitability ratings. This report will also provide an exploration of assessment results. Further opportunities for research, data collection, and analysis to support future iterations of this assessment will also be discussed.

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Appendix A. Full list of datasets

Table A1. Criteria included in suitability assessments, with the source of data and notes on what units are represented by data layers, and the processing that was done on each layer to be included in the assessment.

Criterion	Source	Units	Data processing for source map
Extreme cold exposure	Coastal Monitoring Program data - CMAR, supplemented by GHRSST Level 4 MUR Global Foundation Sea Surface Temperature	Cold exposure risk: High risk Medium risk Low risk	Risk ratings were determined by classifying the annual likelihood of extreme cold exposure, which was calculated by how often temperatures reached at or below -0.7 °C and interpolated across the area of assessment (AOA). Sea surface data points were added for complete coverage.
Extreme heat exposure	Coastal Monitoring Program data - CMAR, supplemented by GHRSST Level 4 MUR Global Foundation Sea Surface Temperature	Heat exposure risk: High risk Medium risk Low risk	Risk ratings were determined by classifying the likelihood of exposure to extreme heat, which was calculated by how often heat stress events occurred in an area, defined by the length of time water temperatures reached a critical temperature for species, and interpolated across the AOA. Sea surface data points were added for complete coverage.
Bathymetry	General Bathymetric Chart of the Oceans (GEBCO); Canadian Hydrographic Service Non-Navigational (NONNA) Bathymetric Data	Water depth (in metres)	Elevation data from NONNA bathymetry was extracted for marine areas to identify water depths below sea level. Data gaps were filled with GEBCO datasets.
Drift ice risk	Ice products produced by NSCC's Applied Geomatics Research Group for CMAR	Drift ice risk: Low risk Medium risk High risk	Ice exposure risk was based on drift ice observations reported between 2014 – 2024, compiled through historical ice conditions across the AOA. In the case of shellfish aquaculture, risk was determined by considering drift ice frequency, as well as whether the bathymetry would be sufficient to avoid maximum drift ice thickness, or whether there is sheltering within the bay.
Wind and wave conditions	Nova Scotia Wind-generated Wave Exposure Atlas - DSA Ocean for CMAR	Maximum Significant Wave Height (in metres)	Based on wind-derived wave exposure modelling that identifies maximum wave height (m) reported across a 10-year period (2014-2024).

Criterion	Source	Units	Data processing for source map
Critical habitat for species at risk	[Critical Habitat for Aquatic Species at Risk - Canada ; Critical Habitat for Species at Risk National Dataset - Canada](#)	Presence / Absence	Critical habitat for species at risk in marine waters was identified.
Marine protected and conserved areas	[Canadian Protected and Conserved Areas Database (CPCAD)](#)	Presence / Absence	The presence of a marine protected and conserved area was identified by extracting any 'marine' area within the datasets.
AIS vessel density patterns	Automatic Identification System (AIS) track line data from 2019, 2020, and 2021 provided by DFO	Navigation channel class: Important vessel routes On-channel routes Near-channel routes Off-channel routes	Classes of navigation channels were identified based on calculating the density of AIS track lines and applying spatial analysis to identify density clusters.
VMS Fishing vessel density patterns	Vessel Monitoring System (VMS) data from 2019, 2020, and 2021 provided by DFO	Density: Low traffic Medium traffic High traffic	Fishing vessel traffic density classes were identified by calculating the density of VMS data points. Data was reclassified based on quartile distribution into evidence-based density classes.
Public coastal access	Multiple	Distance (in metres)	Locations of potential public coastal/ ocean access points were compiled from multiple sources. The distance (m) of areas to the nearest public coastal access point was calculated for each public access point site.
Anchorage areas	[Canadian Anchorages and Anchorage areas](#)	Presence / Absence	Anchorage area points were extracted. No additional processing was required.
Designated navigation features	[Vessel Traffic Routes](#)	Presence / Absence	Multiple features designated for navigational safety were compiled and include: traffic separation zones, ferry routes, and recommended routes.
Marine Renewable Energy Areas	Provided by Nova Scotia Department of Energy	Presence / Absence	Maps were brought into GIS. No additional processing was required.

Criterion	Source	Units	Data processing for source map
Submerged cables and pipelines	Provided by DFO	Presence / Absence	Known active subsea cables and pipelines were provided by network partners. No additional processing was required.
At-sea disposal sites	Active and Inactive Disposal at Sea Sites in Canadian Waters	Presence / Absence	Active at-sea disposal sites were extracted. No additional processing was required.
CFIA Disease Regulated Areas	CFIA's online map for Multinucleate sphere unknown (MSX) and Perkinsus marinus (Dermo) Regulated Areas	Presence / Absence	Declared infected areas and Primary Control Zones for both MSX and Dermo were extracted.
Shellfish Water Classification Program	Canadian Shellfish Sanitation Program (CSSP)'s Shellfish Harvesting map (DFO)	Presence / Absence	Layer extracted based on real-time map of openings and closures of Canadian harvesting areas for bivalve shellfish (i.e., mussels, oysters, clams, and scallops).
Wild salmon rivers	River significance levels from wild salmon river assessment - CMAR	Presence / Absence	River significance levels for wild Atlantic salmon plotted for rivers across Nova Scotia.
Important bird habitat	Multiple	Presence / Absence	Bird habitat datasets within 100 m from the coast were extracted and combined into a single layer, including data from:
Coastal wetlands	Canadian National Wetlands Inventory	Presence / Absence	Wetlands within 100 m from the coast were extracted.
Terrestrial protected areas/parks	Multiple	Presence / Absence	Multiple layers showing protected areas and parks within the terrestrial environment were combined.
Existing aquaculture leases	Aquaculture lease mapping tool (Nova Scotia)	Presence / Absence	Existing aquaculture leases, as well as existing rockweed leases.
Water lots	Property Identifiaction (PID) data provided by GEONova	Presence / Absence	Extracted privately and government-owned parcels.
Crown leases and easements	Crown Land	Presence / Absence	Extracted crown lease and easement data in the marine environment.