



ENVIRONMENTAL ASSESSMENT OF SHELLFISH AQUACULTURE PROJECTS: GUIDELINES FOR CONSIDERATION OF ENVIRONMENT CANADA EXPERTISE



**Environmental Assessment Section
Pollution Prevention Division
Environmental Protection Branch
Environment Canada
Atlantic Region**

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This guidance document will be reviewed and updated on a regular basis.

Updates will be required to ensure the guidance reflects the most recent research findings, changes in aquaculture technologies and practices, and new legislative and policy initiatives. Comments or feedback on the content and format are welcome and will be incorporated into future revisions as appropriate.

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1.0 ENVIRONMENT CANADA AND THE ENVIRONMENTAL ASSESSMENT OF SHELLFISH AQUACULTURE PROJECTS

1.1 Introduction

Marine shellfish aquaculture involves the growing and harvesting of a variety of molluscan species including mussels, oysters, clams, and scallops. Seed (commonly referred to as spat) is collected for the species to be cultured and then is grown out using one of three grow-out technologies (bottom culture, near-bottom culture, or off-bottom). The marine aquaculture industry has been rapidly expanding in recent years to meet a demand that can not be met by the more traditional methods of harvesting wild shellfish populations.

Environmental management of aquaculture projects, from design through decommissioning, is a shared responsibility of both industry and government. Environmental assessment is a management tool directed at identification, analysis, mitigation and verification of impacts on important environmental values. An environmental assessment conducted under the *Canadian Environmental Assessment Act* is also directed at investigating how the environment (e.g. weather, water quality) can impact the project.

Environment Canada participates in the environmental assessment of shellfish aquaculture projects as an expert department with relevant information and knowledge. Project proponents and environmental assessors are encouraged to consult these guidelines to help ensure that this knowledge and information is incorporated early in the planning and design of a project and the conduct of an environmental assessment. Application of best practices and avoidance of environmental impacts ultimately contributes to the success of the industry.

1.2 Environment Canada's Mandate

Environment Canada's expertise stems from the Department's responsibility for administration of legislation and the associated regulations applicable to shellfish aquaculture projects. Environment Canada is also the lead federal department in promoting a variety of federal environmental policies and programs relevant to this industry. The potential applicability of Environment Canada's legislated mandate to the different phases of an aquaculture project is summarized in Table 1.

Table 1
Summary of Environmental Legislation and Potential Areas of Applicability

Legislation	Potential Applicability to Aquaculture
<i>Canada Wildlife Act</i>	Permits are required for any activities that take place in National Wildlife Areas.
Enables Environment Canada to provide information on species at risk. Regulations under the Act allow for the designation and management of National Wildlife Areas.	



Legislation	Potential Applicability to Aquaculture
<p><i>Canadian Environmental Protection Act</i> enables control of such environmental issues as:</p> <ul style="list-style-type: none"> • Toxic substances; • Pollution prevention and control at federal facilities; • Nutrients; • Disposal at sea. 	<p>Identification of chemical products to be used to determine applicability of New Substances Notification Regulations:</p> <ul style="list-style-type: none"> • Disposal at sea of dredged material, sludge and fish waste; • Control of toxic substances (preservatives, cleaning agents, etc.).
<p><i>Department of Environment Act:</i></p> <p>Enables the department to advocate the preservation and enhancement of the natural environment, including water, air and soil; renewable resources, migratory birds and other non-domestic flora and fauna.</p>	<p>Broad applicability to the provision of advice and promotion of best environmental practices in all phases of aquaculture.</p>
<p><i>Fisheries Act</i> (Section 36-3):</p> <ul style="list-style-type: none"> • Prohibits deposition of deleterious substances into waters frequented by fish. 	<p>Erosion and sedimentation during construction.</p> <p>Spills and releases of hazardous materials.</p>
<p><i>Migratory Birds Convention Act:</i></p> <ul style="list-style-type: none"> • Allows for the conservation and protection of migratory birds and associated habitats. The Act and its Regulations provide for designation and management of migratory bird sanctuaries, establishment of hunting restrictions and placement of controls on disturbing (e.g., killing, taking, injuring) birds, eggs, or nests for purposes other than hunting; • The regulations also prohibit the deposit of harmful substances into migratory bird habitat; • Migratory birds include those species described in the CWS Occasional Paper Birds protected in Canada under the Migratory Birds Convention Act. 	<p>Permits are required for certain activities that take place within migratory bird sanctuaries:</p> <ul style="list-style-type: none"> • Proximity to areas where concentrations of breeding, staging, or overwintering migratory birds are known to occur; • Disturbance during breeding, nesting and other sensitive periods; • Control and deterrence of birds attracted to the site. Permits may be required.

Environment Canada is also the lead federal department in administering and promoting a variety of federal policies and programs concerning the environment and the federal government's commitment to environmental protection and conservation including:



- The Canadian Shellfish Sanitation Program (CSSP), which is jointly administered by the Canadian Food Inspection Agency, Fisheries and Oceans Canada (DFO) and Environment Canada. The primary objective of the CSSP is to protect public health by ensuring that the waters from which bivalve molluscan shellfish (oysters, mussels, clams, and whole scallops) are harvested meet approved water quality criteria and that shellfish are handled, processed and transported in an approved manner;
- the "Toxic Substances Management Policy" outlines a framework for making science-based decisions on the effective management of substances that could harm the environment or human health;
- "Pollution Prevention - A Federal Strategy for Action", "A Guide to Green Government" and "Code of Environmental Stewardship" are among the policy and program documents outlining the federal government's emphasis on prevention of pollution at the source.
- the "Federal Policy on Wetland Conservation" which has the objective of promoting the conservation of Canada's wetlands to sustain their ecological and socio-economic functions.

These guidelines relay Environment Canada's recommendations on information to be presented, potential environmental effects to be addressed, and mitigation measures which should be considered in the environmental assessment of each phase of a shellfish aquaculture project. Accordingly, Sections 2.0 through 5.0 are specific to each of the individual project phases (i.e. siting and design, site preparation and construction, operation and maintenance, decommissioning). Section 6.0 focuses on how the environment and changes in the environment can impact aquaculture facilities. Section 7.0 discusses impact prediction and follow-up plans. The guidelines emphasize the value of taking proactive siting and design measures that would minimize the potential for impacts and allow the environmental assessment to be focused accordingly.

2.0 SITE SELECTION AND FACILITY DESIGN

2.1 Site Selection

Environmental conditions present constraints and opportunities in the siting of a shellfish growing operation. Consideration of environmental conditions is important to anticipating and avoiding many of the adverse impacts that could result from establishing an aquaculture project at a particular site. An understanding of other human activities in the area, weather, actions of surface waters and currents, shoreline processes, environmental quality, migratory birds and species at risk must be applied to the site selection and ultimately the assessment of an aquaculture project. Environment Canada is in possession of knowledge and information on these factors.

In support of an environmental assessment, the location of the proposed project should be clearly identified on good quality topographic maps along with any inlets, estuaries, or smaller bays. A site sketch should be prepared which includes the coordinates (latitude and longitude) and dimensions of the lease site and its relation to the shoreline to allow reviewers to visualize the layout of the proposed development.

2.1.1 Past and Existing Activities Influencing the Site



The assessment should document and take into account the following potential influences on the proposed project based on past and existing human use of an area:

- areas of known or suspected contamination;
- land-based sources of pollution including both point and non-point sources;
- existing infrastructure;
- proximity of other aquaculture operations;
- current and potential water-based uses and activities;
- disposal at sea sites.

2.1.2 Weather and Climate

Climate is an important factor in selecting a site for a shellfish aquaculture operation. It can also influence the choice of materials, sizing and placement of some structures, and possibly, seasonal accessibility. The following factors should be investigated as part of the assessment:

- ice conditions including the degree and seasonality of ice cover, ice drift velocity and associated stresses on structures;
- wind climatology including frequency of windspeeds above operational thresholds, as well as the return periods for extreme and design events;
- wave height climatology, return periods for extreme waves and design waves (this information may not be available for many areas, but can be derived from local wind data);
- water temperature, which will directly influence shellfish growth.

2.1.3 Water Quality and Hydrological Conditions

Water quality and productivity is of primary importance to the health and sustainability of aquaculture operations. Appropriate baseline information should be collected and evaluated in order to determine the suitability of the site and to track and verify any predicted changes resulting from the shellfish growing operation or other inputs to the receiving waters.

Water movement is a primary factor influencing the availability and distribution of food particles (i.e. phytoplankton) necessary for shellfish growth. The pattern and rate of particle renewal varies depending on the hydrography of the system. In estuaries, particle movement is generally influenced by river outflow while in coastal inlets, it is more strongly influenced by tidal currents. The carrying capacity of a water body used for shellfish growing can be defined as the stocking density at which production levels are maximized without affecting the availability of food and the habitat quality for natural populations of plants and animals. The assessment should discuss any studies that have been carried out to determine the carrying capacity.

Seasonal variation and changes in stocking density can make it difficult to accurately predict carrying capacity and therefore site specific data should be collected on an on-going basis. Along with phytoplankton abundance, important parameters to measure are salinity, pH, dissolved oxygen and temperature. Requirements for sampling for metals and toxic chemicals should be determined based on information gathered on past activities near the site and other sources of discharge and drainage that have been identified.



2.1.4 Classification of Shellfish Areas

Under the Canadian Sanitation Shellfish Program (CSSP), Environment Canada is responsible for monitoring bacterial water quality in shellfish growing areas. Based on results from water surveys conducted under the Shellfish Water Quality Protection Program, the department makes recommendations to the Shellfish Growing Area and Survey Classification Committees on the suitability of coastal waters for the harvesting of molluscan shellfish. Surveys are based on the sanitary and bacteriological water quality conditions and areas will be classified as *approved, conditionally approved or closed* to shellfish harvesting. Shellfish contamination can also result from the build-up of chemical substances such as metals, pesticides and chlorinated organic chemicals. The Shellfish Water Quality Protection Program also promotes pollution prevention, remediation and restoration of shellfish growing areas.

Also under the CSSP, Fisheries and Oceans Canada, regularly tests commercially harvested shellfish for bacterial contamination and maintains a marine biotoxin surveillance program of shellfish growing areas. The information collected under the CSSP is very important for any proponent establishing a shellfish operation and EC and DFO should be consulted very early in the planning stages. Further details on the CSSP and the *Shellfish Growing Area Classification Index* can be found at <http://www.ns.ec.gc.ca/epb/sfish/sfish.html> in the Atlantic Region and at http://www.pyr.ec.gc.ca/ep/shellfish/shell_e.htm in the Pacific and Yukon Region. Proponents can contact the appropriate regional office in the Quebec Region.

2.1.5 Disposal at Sea Sites

Environment Canada is responsible for approving disposal at sea activities under Section 127 of the *Canadian Environmental Protection Act*. Under the program, permits are required for the disposal of any material at sea except those resulting from offshore mineral exploration, the normal operation of ships, effluent discharge from a land-based source, or during an emergency. Permits typically govern such things as timing, handling, storing, loading and placement at the disposal site. The department maintains a database of approved disposal sites, and when evaluating a proposed shellfish growing operation, the proximity to any ocean disposal sites should be confirmed.

2.1.6 Migratory Birds, Species at Risk and their Habitats

Interactions with and conflicts between aquaculture operations and wildlife species have become significant management issues for proponents and regulatory agencies. The expanding aquaculture industry is increasingly using more coastal migratory bird habitat important for feeding, staging, wintering, and nesting. At the same time, concentrations of easily accessible shellfish are a tempting food source for a variety of migratory birds and mammals and attraction of predators can also result in direct competition for the habitat of species at risk.

Proponents are encouraged to consult with the local Canadian Wildlife Service (CWS) office of Environment Canada during the site selection process so that the potential for interactions is reduced and any negative impacts on migratory birds and species at risk are minimized. Avoidance of areas where migratory birds and species at risk may be significantly impacted by the construction and operation of an aquaculture project is the preferred approach. The



environmental assessment should include a description of the proposed project site with information on the terrain, biological settings, habitat types, and wildlife use. The site map should identify all environmentally significant areas and other types of protected areas within a 1 km radius of the proposed site that have been established, in part, to protect migratory birds, species at risk and their habitats. Among the designated areas that should be identified are:

- Migratory Bird Sanctuaries (<http://www.cws-scf.ec.gc.ca/hww-fap/nwambs/listmbss.html>);
- National Wildlife Areas (<http://www.cws-scf.ec.gc.ca/hww-fap/nwambs/listnwas.html>);
- Western Hemisphere Shorebird Reserve Network sites (<http://www.ns.ec.gc.ca/wildlife/wetlands.html>);
- Ramsar Sites, as identified by the Ramsar Convention (Convention on Wetlands of International Importance Especially as Waterfowl Habitat) (<http://www.cws-scf.ec.gc.ca/habitat/ramsar/eindex.html>);
- Important Bird Areas (<http://www.bsc-eoc.org/national/cmmn.html> or <http://www.ibacanada.com/>).

2.1.6.1 Migratory Birds

It is important that the potential for interactions with migratory birds and the shellfish operation be evaluated as early as possible in the planning of the project. Accordingly, attention should be given to identifying:

- Migratory bird species likely to be present, their seasonal occurrence, relative or absolute abundance, and population trends;
- Migratory bird concentrations such as breeding areas, colonies, spring and fall staging areas, and wintering areas;
- Ongoing or proposed migratory bird recovery, rehabilitation, remediation, or improvement plans. Recovery teams should be consulted for information on the status of these plans;
- Food sources and/or feeding areas for migratory birds.

2.1.6.2 Species at Risk

Several provincial jurisdictions have enacted regulatory protection for species at risk and pending federal legislation is intended to provide a legal definition of their habitat. Priority should be given to identifying any species at risk that are using the proposed site either permanently or temporarily. Specific attention should be given to identifying:

- The presence of species at risk listed with, or under review by, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), under provincial designations, and species ranking S1, S2, or S3 by the Nature Conservancy ranking system (used by Conservation Data Centres). Information on species listed by COSEWIC can be obtained at <http://www.speciesatrisk.gc.ca/Species/English/SearchRequest.cfm>;



- Ongoing or proposed species at risk recovery, rehabilitation, remediation, or improvement plans for species at risk. Recovery teams should be consulted for information on the status of these plans;
- Food sources and/or feeding areas for species at risk.

2.2 Design

Inherent in choosing a suitable location for growing shellfish is ensuring the project fits site conditions. The environmental assessment should include a review of preliminary design details and should identify the species to be cultured (provide common and scientific names) and the nature of the lease (e.g. new site, expansion or alteration, renewal). Opportunities for incorporating mitigative measures into the design such as those that will reduce interactions with migratory birds and species-at-risk should be discussed.

2.2.1 Shellfish Culture Methods

A variety of grow-out methods and techniques for the culture of shellfish species are available. The choice of grow-out method will differ depending upon the species to be cultured; climate and water conditions; stocking density; and, shore and bottom characteristics. Two of the most commonly used grow-out methods that are subject to environmental assessment are as follows:

Near-bottom or Off-bottom Culture

Shellfish are grown on table or tray-like structures that are often formed into multiple-layer stacks. Adequate water flow is important to ensure maximum growth rates which is sometimes difficult to maintain when the system is several tiers high.

Suspended Culture

Lengths of lines are suspended from the surface attached to floating rafts or buoys and anchored to the bottom. Shellfish are then hung on the lines using mesh tubing, bags or trays.

Some new technologies are being advanced including the use of suspended oyster culture using vexar bags. Other culture methods including inter-tidal may not be captured by federal or provincial environmental assessment processes, but many of the issues and protective measures discussed in these guidelines may still be applicable in relation to maintaining sound environmental management practices for these activities.

The environmental assessment should describe:

- The proposed grow-out strategy;
- Gear types and layout of anchoring and flotation systems;
- The estimated length of grow-out period.

2.2.2 Related Infrastructure and Equipment

The construction or use of any supporting facilities including the following should be discussed:



- Access roads, ramps, docks;
- Storage and processing facilities;
- On-site personnel accommodations and sanitary facilities;
- Facilities and equipment for harvesting and grading.

2.2.3 Reducing Interactions with Wildlife, especially Migratory Birds

Even with careful site selection, it will be necessary to take measures to prevent depredation by migratory birds. The Canadian Wildlife Service of Environment Canada will evaluate and provide guidance on such measures. As necessary, an operator can apply for a Scare Permit under the Regulations of the *Migratory Birds Convention Act*. However, the operator will be required to demonstrate that avoidance strategies were considered in the planning of the project and that effective depredation prevention technology is being used. Among the techniques that can be incorporated into the operational design to help in preventing bird depredation problems are:

- Removing perching areas;
- Installing barrier systems (netting, streamers, wires) over the grow-out site;
- Incorporating socking methods that reduce the vulnerability to predation (e.g. double-socking);
- Placing growing units at a sufficient depth below the water's surface.

Table 3
Summary of Site Selection and Facility Design

Potential Effects	Mitigative Measures
<p>Water quality:</p> <ul style="list-style-type: none"> • Consideration of effluent discharges and sources of contamination (Sec. 2.1); • Physical and chemical characteristics making site unsuitable for aquaculture (Sec. 2.1). 	<ul style="list-style-type: none"> • Confirm classification under Canadian Shellfish Sanitation Program (Sec. 2.1.4); • Identify potentially contaminated water sources and avoid siting where conflicts with other water users may arise or where there are already several sources of discharge into the receiving waters including other aquaculture facilities (Sec. 2.1.1); • Avoid siting in close proximity to ocean disposal sites (Sec. 2.1.5); • Undertake baseline water quality and water characterization studies (nutrient levels, carrying capacity); • Collect hydrographic climatic information (water depth, shoreline processes, wave data, shelter, circulation, flushing rates, precipitation)(Sec. 2.1.2, 2.1.3, 2.1.4).
<p>Modification, degradation, and loss of habitat of migratory birds and species at risk (Sec. 2.1.6).</p>	<ul style="list-style-type: none"> • Identify and avoid environmentally significant areas (e.g. Migratory Bird Sanctuaries, National Wildlife Areas), areas where species at risk are present, and areas supporting high concentrations of migratory birds (Sec. 2.1.6.1, 2.1.6.2); • Incorporate design features to make the site less attractive to migratory birds and other predators (Sec. 2.2.1, 2.2.4).



3.0 SITE PREPARATION AND CONSTRUCTION

3.1 Description of Activities

A variety of facilities and infrastructure such as access roads, buildings and docks may be needed to support a shellfish growing operation. Preparation for the construction of such facilities can involve clearing and grubbing of vegetation, excavation, dredging, infilling and grading. The following information should be provided in support of an environmental assessment:

- Time-frame and schedule for site preparation and construction activities;
- The areal extent of any disturbance both on-land and in-water;
- The methods, materials, and equipment to be used;
- Provisions for storage and handling of materials and response measures for spills or releases;
- Provisions for waste management.

3.2 Environmental Effects

Machinery, equipment, and personnel associated with construction activities represent sources of sensory disturbance (e.g. noise, light) to migratory birds and species-at-risk. Depending on the time of year, the result can be altered feeding patterns and disrupted breeding and staging activities. Certain species (e.g. cliff-nesting birds, colonial birds) are prone to panic and even temporary abandonment of nests by adult birds can cause an increase in predation of unguarded eggs and young. Species at risk are much more sensitive to disturbance and it is important that all activities be carried out so that adverse effects on these plants and animals are avoided.

Other potential effects are related to in-water work such as installation of growing structures causing resuspension of sediments and disturbance of land leading to erosion which can degrade water quality. Improper use, storage and disposal of toxic materials and wastes pose hazards to environmental quality, migratory birds and species at risk.

3.3 Building Best Practices into Project Management

3.3.1 *Avoiding Disturbance of Migratory Birds and Species-at-Risk*

The regulations under the *Migratory Birds Convention Act (MBCA)* place restrictive controls on disturbing (e.g., killing, taking, injuring) birds, eggs, or nests for purposes other than hunting and prohibit the deposit of harmful substances into migratory bird habitat. Strategies for enabling compliance with the *MBCA* and mitigating impacts on migratory birds and species-at-risk should include:

- Maintaining a buffer zone where no activity occurs in proximity of important habitat;
- Scheduling site preparation and construction activity outside of the breeding season for migratory birds and species at risk;
- Avoiding concentrations of migratory birds when using boats and other machinery;



- Educating construction personnel on measures to be taken in avoiding the disturbance of migratory birds and species at risk.

3.3.2 Maintaining Water Quality

All activities associated with establishing the shellfish growing operation should be carried out in a manner that ensures compliance with the general prohibition against the deposit of a deleterious substance into waters frequented by fish (Section 36, *Fisheries Act*) and Section 35(1) of the Migratory Birds Regulations under the *Migratory Birds Convention Act* which stipulates that "no person shall deposit or permit to be deposited oil, oil wastes or any other substance harmful to migratory birds in any waters or any area frequented by migratory birds." Measures should be in place to ensure no contaminated drainage or runoff enters the adjacent waters.

The CCME "Interim Marine and Estuarine Water Quality Guidelines for General Variables" (1996) recommend that human activities should not cause suspended solids levels to increase by more than 10% of the natural conditions expected at the time. The Guidelines also recommend that no solid debris including floating or drifting materials or settleable matter be introduced into marine and estuarine waters.

An erosion and sedimentation prevention and control plan should be developed and implemented to facilitate mitigation of adverse impacts on water quality. The plan should demonstrate a preventative approach with the first priority placed on avoidance followed by control and treatment of sediment-laden water. Elements of the plan should include:

- Scheduling construction activities to take into account seasonal constraints and to avoid periods of heavy precipitation (e.g. consult extended range [3-5 days] forecasts);
- Installing sedimentation control structures prior to any land disturbance and monitoring captured water prior to release;
- Ensuring natural water and drainage flows are retained and maintaining vegetated buffer zones between disturbed areas and watercourses or wetlands.

3.3.3 Management of Materials and Wastes

Construction activities may involve the use of hazardous substances such as petroleum products, fresh concrete, concrete additives, preservatives, paints, solvents, process chemicals, and cleaning agents. Hazardous wastes such as waste oil and residual chemicals may be generated as a result of using these products. A strategy for the management of materials and wastes should reflect consideration of the following best practices:

- Placing a priority on using the least toxic products;
- Storing materials, refuelling and maintaining equipment and machinery in a designated area away from any waterbodies/wetlands and in accordance with applicable regulations;
- Applying preservatives in a designated area and in accordance with manufacturer's instructions;



- Developing contingency plans to enable a quick and effective response to an event following the accidental spill or release of hazardous materials and substances. All spills and releases should be reported to the appropriate 24-hour emergency response line;
- Incorporating careful planning and purchasing to reduce the volume of surplus and waste material (e.g. order only the amount of material that is required, purchase pre-fabricated structures);
- Placing a priority on opportunities for reuse or recycling of products. Waste and surplus material should be disposed of at approved sites and in accordance with applicable provincial and municipal regulations.

Table 4
Summary of Site Preparation and Construction Activities

Potential Environmental Effects	Mitigation Measures
Impacts on migratory birds and species at risk (Sec. 3.2).	<p>Avoiding Disturbance of Migratory Birds and Species at Risk (Sec. 3.3.1):</p> <ul style="list-style-type: none"> • Schedule activities to occur outside sensitive periods (e.g. nesting, migration); • Establish and maintain a buffer zone around sensitive areas and species; • Minimize areal and temporal extent of disturbance; • Educate construction personnel on how to reduce disturbance.
Reduced water and habitat quality (Sec. 3.2).	<p>Avoiding and Minimizing Erosion and Sedimentation (Sec. 3.3.2):</p> <ul style="list-style-type: none"> • Coordinate activities within seasonal constraints; • Consult extended range weather forecasts; • Predetermine shutdown criteria for precipitation events; • Minimize areal and temporal extent of disturbance of soil and vegetation; • Maintain vegetated buffer zones; • Stabilize disturbed areas as soon as possible; • Direct sediment laden water to settling ponds or other control structures; • Monitor sediment and water and treat as required prior to release.
Spills or releases of hazardous products (Sec. 3.2).	<p>Management of Materials and Wastes (Sec 3.3.3):</p> <ul style="list-style-type: none"> • Consider use of less-toxic alternatives to hazardous products; • Designate areas for storage and refuelling, application of chemicals (e.g. preservatives) with proper containment that are away from watercourses/wetlands; • Prepare an Emergency Spill Response Plan; - Contain spills and treat contaminated soil and water as required.



Potential Environmental Effects	Mitigation Measures
Contamination/ degradation from solid waste accumulation (Sec. 3.2).	Management of Materials and Waste (Sec. 3.3.3): <ul style="list-style-type: none">• Order only the amount of materials necessary and purchase pre-fabricated structures where possible;• Collect all surplus material and look for opportunities for reuse and recycling;• Ensure material is disposed of at an approved location and in accordance with regulatory requirements.

4.0 OPERATION AND MAINTENANCE

Shellfish growing operations generally encompass the entire life cycle of the cultured species from the collection of seed, grow-out and harvesting. Grow-out techniques were reviewed in Section 2.0. The environmental assessment documentation should also include a description of seed collection and transfer, methods and equipment for harvesting stock, and whether grading and processing will take place onsite.

4.1 Overview of Environmental Effects of Shellfish Culture

Intensive shellfish culture can have effects on the surrounding water, microfauna, macrofauna, marine vegetation and sediments. A healthy and sustainable operation will incorporate best management practices that reflect pollution prevention principles.

4.1.1 *Changes in Phytoplankton Distribution and Abundance*

As shellfish obtain their total nutritional requirements from the surrounding environment, no food supplements are added to the water column. In fact, bivalve molluscan shellfish are such efficient filter feeders, there can actually be a net reduction in nutrient levels in the system. Studies have shown that approximately 40% of the total nutrients removed by shellfish feeding are directly returned to the water column, with 30% falling to the bottom as particulate matter and the remaining 30% removed during harvest (Massachusetts Aquaculture White Paper, 1995).

4.1.1.1 Monitoring the Quality of the Growing Environment

With good baseline information to provide a comparison, the operator should be able to detect changes in water quality and nutrient availability. Reduced shellfish growth rates measured during grading and harvesting can provide an indication of high rates of fouling and/or a need to reduce stocking densities. Phytoplankton levels should be monitored regularly and when shellfish are removed for grading, fouling organisms can be removed using solutions including fresh water and hydrated lime. If antifoulants will be applied to any infrastructure or equipment the products should be identified and the Material Safety Data Sheets and other relevant information to determine their suitability for use in the marine environment.



Faeces and pseudofaeces produced by cultured shellfish and fouling organisms along with shells falling from the culture structures can accumulate in volumes great enough to impact benthic organisms and to change bottom sediment quality depending on the dispersion characteristics of the waterbody and the intensity of shellfish culture in the area. Bottom characteristics and changes should be monitored in relation to predictions based on production and current and dispersion characteristics.

4.1.2 *Migratory Bird/Wildlife Interactions with Aquaculture Operations*

Operational personnel should be trained to avoid concentrations of migratory birds when travelling to and from aquaculture sites by boat. When disturbed, resting flocks use valuable energy required for successful migration or over-winter survival.

Even when all feasible avoidance and design features have been incorporated, the concentration of potential food at a shellfish farm remains an obvious attraction to predators. This can result in a number of problems for the operator including loss of product and damage to equipment.

The presence and activities of predatory birds in the vicinity of the operation should be regularly monitored by the operator. The species, approximate numbers, behaviour, and time of year should be documented and operators are encouraged to report to and seek advice from the Canadian Wildlife Service as appropriate. It is important that measures be implemented as soon as the presence of birds begins to interfere with the operation of the aquaculture site. Opportunities to improve operational practices that will reduce the attraction of birds to the site should be considered. Scare techniques should also be considered on a contingency basis, but should only be used on the lease site itself so as to allow birds to rest and feed on adjacent natural habitat.

4.1.2.1 Scare Techniques

As part of the assessment, the proponent should prepare a plan for preventing bird predation at the facility. This plan should be developed in consultation with and submitted to the Canadian Wildlife Service (CWS) and other appropriate regulatory authorities for review. A combination of scaring tactics, including visual and acoustic deterrent devices may be necessary. Bird scaring techniques have limitations and disadvantages and in many cases, are only temporary solutions because birds soon habituate to routine disturbances. If measures such as the use of firearms or aircraft are considered, a scare permit is required from the CWS. The CWS has introduced a policy for the issuance of scare permits for aquaculture operations which became effective September 1, 2000. Proponents should consult the policy early in the planning process.

Visual Deterrent Devices

Deterrent methods should be implemented as soon as birds are detected near the shellfish site so that feeding patterns do not become established. Among the common visual deterrents to consider are:

- Regular human presence;
- Tethered dogs;
- Scarecrows, moved often to reduce habituation;



- Flashing lights and night lighting;
- Water sprays from rotating sprinklers to repel certain birds, especially gulls and herons.

Acoustic Deterrent Devices

Noise deterrents can be used when depredation becomes a significant problem. Devices which produce a random pattern of sounds at different frequencies and intensities may be used to overcome bird habituation to repetitive disturbances. These may include whistles, sirens, firecrackers, recorded distress or predator calls, and automatic exploders.

While many scare techniques will assist in reducing migratory bird predation, operators must also consider the potential effects of the deterrents on the target species, as well the surrounding environment. For example acoustic deterrent devices can:

- Disturb nearby residents and sensitive wildlife;
- Alter normal bird movement patterns. This could become permanent and lead to appreciable loss of access to habitat;
- Interfere with animals' communication signals and with passive listening abilities, due to "acoustic masking";
- Damage the hearing of birds and other wildlife that are not deterred by the devices.

4.1.3 Solid Waste Management

Solid waste will be generated as part of the routine operations at a shellfish growing site and may accumulate in greater volumes during certain activities such as setting for grow-out and harvesting. Material such as torn or damaged bag and socking material should be immediately collected and disposed of at an approved location.

Cultured species that have been damaged or deemed unmarketable during grading or harvesting should be collected and disposed in an approved manner and location which will not lead to attraction of migratory birds and other predators.

Table 5
Operation and Maintenance Phase
Summary of Impacts and Mitigative Measures

Potential Effects	Mitigative Measures
Reduced carrying capacity of waterbody (Sec. 4.1.1).	Monitor water quality and phytoplankton distribution and abundance regularly. Adjust stocking densities accordingly to account for changes and seasonal variations (Sec. 4.1.1.1).
Accumulation of material beneath grow-out site affecting benthic organisms.	Visually inspect site bottom and monitor as appropriate and remove fouling organisms from grow-out lines during grading (Sec. 4.1.1.1)



Potential Effects	Mitigative Measures
Interactions with migratory birds (Sec. 4.1.2).	<p>Managing Migratory Bird Interactions:</p> <ul style="list-style-type: none">• Regularly monitor migratory bird activity (Sec. 4.1.2);• Consult the Canadian Wildlife Service (Sec. 4.1.2);• Incorporate visual and acoustic scare techniques (Sec. 4.1.2.1);• Promptly remove and dispose of unmarketable individuals and mortalities (Sec. 4.1.3).

5.0 DECOMMISSIONING

The environmental assessment should include consideration of facility decommissioning. Decommissioning should be viewed as a long-term approach to progressively restoring a site to a natural state that can support the desired natural values (e.g. fish and migratory bird habitats). This may be achieved through natural processes, the application of remedial technologies, or a combination of both. Implementation of the planning and operational practices advocated in these guidelines will help focus efforts on restoring or maintaining environmental quality once it is decided to cease aquaculture activities. The following considerations, articulated in the management goals for the operation, will help to ensure the site can be restored to the desired state:

- Compiling good baseline information, data from monitoring programs and thorough record-keeping will help to identify parameters that would be candidates for ongoing monitoring and determine a time line before water and site quality might be expected to reach acceptable levels;
- Maintaining the site in accordance with applicable environmental quality guidelines and standards throughout the operational life of the facility will help minimize remedial efforts;
- Documenting the history of other activities near the site will identify other potential influences on environmental quality;
- Incorporating progressive rehabilitation within a lease site where possible (e.g. if growing structures are moved to a new location on the lease site, monitor and implement appropriate rehabilitative measures as soon as possible).

6.0 EFFECTS OF THE ENVIRONMENT ON AQUACULTURE ACTIVITIES

For projects subject to assessment under the *Canadian Environmental Assessment Act*, there is a requirement to consider the effects of the environment on the project. Among the environmental parameters which can impact shellfish growing operations, are those related to climate and meteorological conditions and water temperature. The possible effects of changes in these factors are:



- Temperature - abrupt or drastic changes in the ambient water temperature can induce physiological stress on the cultured animals. Changes in production levels and incidents of high mortality rates have been attributed to water temperatures outside the seasonal norms;
- Waves - suspension structures must be designed and built to withstand repeated wave action and large waves that may result from storm events;
- Currents - excessively fast currents will stress shellfish, reduce growth rates, strain gear and moorings, and may resuspend and release contaminated waste material to downdrift areas;
- Ice - surface ice loads may damage gear and moorings, and impair access to the site;
- Precipitation and Runoff - seasonal fluctuations in precipitation can affect the volume, availability, and quality of the water supply and in and around the growing site.

Physical and biological changes in the environment which may be shaped by the effects of potential climate change scenarios could have implications for the aquaculture industry. Based on current climate change predictions, aquaculture activities could be affected by changes in hydrological variability, such as:

- Changes in precipitation leading to changes in water quantity and quality;
- An increase in average ambient air temperature may increase the temperature of surface water sources. Warmer waters may result in lower water and DO levels which could subsequently promote increased growth of algae and bacteria;
- Changes in the marine environment may affect shellfish production and aquatic biodiversity.

7.0 IMPACT PREDICTION AND FOLLOW-UP

7.1 Predicting and Mitigating Impacts

Impacts on the environment can be avoided or at least minimized if provisions are made to incorporate the applicable best management practices into the siting, design, and operation of an aquaculture facility. However, even with implementation of best management practices, an aquaculture facility will likely result in adverse environmental impacts and these should be predicted for key environmental resources of concern. In terms of Environment Canada's mandate, and as already established, these resources include migratory birds, species-at-risk, and aquatic systems. The information needed to predict impacts on these resources of concern or Valued Ecosystem Components has already been identified. In general, impact predictions:

- Should be presented as differences between the condition of a Valued Ecosystem Component without the project, and the condition of a Valued Ecosystem Component with the project, over a timeframe that takes into account the lifespan of the proposed facility;
- Must take into account cumulative effects. This requires consideration of how other past, present, and reasonably foreseeable projects and activities could combine with the impacts of the proposed aquaculture project.



- Should be expressed quantitatively where practicable with uncertainties clearly recognized.

Mitigation measures that build on the best practices already integrated into provisions for project management should be identified and implemented to alleviate the predicted impacts. With attention to these guidelines, however, the potential for impacts to be significant should be minimized and the need for mitigation should be reduced.

7.2 Verifying Predictions and Mitigation Effectiveness

A follow-up program should be designed to verify impact predictions, to establish the effectiveness of the mitigation measures implemented and to enable timely adjustments to management of the project. In light of the uncertainties in predicting impacts and in the effectiveness of mitigation, alternate management approaches and contingencies should be reviewed and prepared. In managing a project that is allowed to proceed, impact predictions should be adjusted to reflect changes to the project (e.g. expanding the site) and changes in the environment (e.g. warmer water temperatures) that can lead to 'different' environmental effects.

Repetitive and systematic monitoring of variables indicative of actual effects is important to follow-up. Monitoring standards to be considered in designing a follow-up program that can test impact predictions and mitigation effectiveness related to water quality, benthic communities, migratory birds and species at risk are set out below.

7.2.1 Verifying Predicted Impacts on Water Quality

Water sampling should be performed at consistent sites, the locations of which provide a representative sampling of the water body in terms of depth and circulation patterns. Sampling should also be reflective of seasonal variations in temperature, plankton levels, etc. The variables to be monitored include: temperature, suspended solids, dissolved oxygen, biochemical and chemical oxygen demand. Water quality will also be influenced by other activities occurring within the watershed and other identified sources of land-based discharge and runoff. This should be evaluated both in terms of potential cumulative effects on water quality and impacts on the growth and productivity of the shellfish growing operation.

7.2.2 Verifying Predicted Impacts on Marine Vegetation and Benthic Communities

Sediments beneath a growing site should be visually inspected and monitored regularly. Mortalities and damaged stock should be removed from the growing site as soon as possible. Effects on marine vegetation in shallow marine areas should also be monitored.

7.2.3 Verifying Predicted Impacts on Migratory Birds and Species at Risk

Regular monitoring of the behaviour and activities of migratory birds and species at risk found interacting with the aquaculture facility and in the vicinity of the site should be conducted. Monitoring may include maintaining records of types and number of birds and animals attracted to the site, and predation incidences.



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