AAR
Monitoring Standard
2018

Introduction

This Aquaculture Monitoring Standard (Monitoring Standard) will support the monitoring and sampling requirements of the *Aquaculture Activities Regulations* (AAR) under the *Fisheries Act*. This document provides the necessary level of detail to enable the owner or operator of an aquaculture facility to produce to the greatest extent possible, consistent and high quality data to support the implementation of the AAR.

This Monitoring Standard will be amended (in consultation with provinces) from time to time.

The most current version of the Monitoring Standard is available on the Fisheries and Oceans Canada (DFO) website http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/aar-raa-eng.htm

Definitions

"Containment Array" means an assembly of interconnected cages used to cultivate fish.

"Marine Worms" mean aggregates of opportunistic polychaetes that colonize organically enriched substrates.

"Reference Station" means a sampling station chosen to represent a background or natural state. Reference stations may be chosen as discrete sampling locations or contained along a transect representing a traditional "gradient" to "background" approach.

"Sampling Station" means a location where recording is carried out and any samples are collected.

"Soft Bottom Site" means, further to definition in AAR, a site where acceptable samples can be taken from the benthic substrate based on the grab acceptability criteria and sampler options related to oceanographic conditions and substrate type or classified as soft bottom based on provincial criteria.

"Transect" means a directional line, along which sampling stations are established or visual observations are made.

I. Survey for Baseline Information for New Sites and Expansion of Existing Sites [AAR section 8 and 9]

Predicted Contours [AAR paragraph 8(1)(*a*)]

1. (1) Calculate the rate of deposition of biochemical oxygen demanding (BOD) matter from the facility during maximum daily quantity of feed usage, using an aquaculture waste deposition model, and map the 1, 5, and 10 grams carbon per meter squared per day (g C/m^2/day) depositional contours.

(2) Site-specific oceanographic data will be used for model inputs. Using an aquaculture waste deposition model, input characteristics for food and fecal waste must be either accepted international standard values or operator measurements. Model simulations are not to include estimates of post-deposition particle resuspension.

Survey of Fish and Fish Habitat [AAR paragraph 8(1)(b)]

2. (1) When conducting surveys of fish and fish habitat, sampling stations along a transect or within a grid must be representative of the different physical/biological characteristics of the bottom habitat within the modeled 1 g C/m^2/day depositional contour and the entire lease, including reference stations where applicable.

(2) Sampling is not required within areas of the tenure or 1 g C/m^2/day depositional contour where depths exceed 300 m.

(3) If historical fish and fish habitat data for an expanded lease area demonstrates a homogeneous coverage of mud or sandy habitat, then only one video transect across the width of the entire lease in the direction of the dominant current and under the proposed array location is required.

(4) The fish and fish habitat benthic survey is to be conducted to identify species that are 1 cm or greater in length and the type of habitat present.

(5) All fish habitats/substrates must be identified.

Bathymetry Survey [AAR paragraph 8(1)(c)]

3. (1) A bathymetric survey must be conducted with a minimum resolution of 10 m contours to generate depth profiles, related to chart datum, within the modeled 1 g C/m^2/day depositional contour, as calculated in subsection 1(1), and covering the entire lease, including reference stations where applicable.

(2) Despite subsection 3(1), a bathymetric chart from the Canadian Hydrographic Service that includes depth profile contours in 10 m increments may be used instead of conducting a bathymetric survey**.**

(3) Echosounders, transducers, and associated equipment used to generate the bathymetric survey in subsection 3(1) must be calibrated to industry standards.

(4) Horizontal position fixing measurements must be carried out using a differential Global Positioning System (dGPS).

Benthic Substrate Monitoring [AAR paragraph 8(1)(d)]

4. (1) Information concerning the seabed will be collected within locations representative of the entire lease and the modeled 1 g C/m^2/day depositional contour, as calculated in subsection 1(1), including reference stations where applicable.

(2) In the case of an aquaculture facility that is located in tidal waters in or adjacent to:

(a) Quebec, Nova Scotia, New Brunswick, Prince Edward Island or Newfoundland and Labrador, collect samples of the benthic substrate in the center and at each corner of the lease boundary;

(b) New Brunswick, collect samples of the benthic substrate at the end of a 50 m transect from the lease boundary, in the direction of the dominant current;

(c) Quebec, Nova Scotia, or Prince Edward Island, collect samples of the benthic substrate between 100 to 300 m from the edge of the lease boundary, in the direction of the dominant current;

(d) British Columbia, collect samples of the benthic substrate at a minimum of two sampling stations (30 m and 125 m away from the cage edge) along two transects that align with the area of greatest predicted impact and with the dominant and sub-dominant current directions;

(e) If the containment array mentioned in paragraph 4(2)(d) is greater than 200 m in length and its long axis is perpendicular to the direction of the dominant current, additional sampling is required in the following manner:

(i) for every 200 m increment in length, establish additional transects with sampling stations at 30 and 125 m adjacent to each transect established in paragraph 4(2)(d);

(ii) transects must be parallel to each other and a minimum of 50 m apart;

(iii) based on the 5 g C/m^2/day contour, as calculated in subsection 1(1), the transects are to be located in the direction of maximum deposition as determined by the 5 g C/m^2/day contour.

(3) In addition to the criteria specified in the AAR subsection 10(2), the following relevant criteria must be complied with for benthic substrate sampling using grab or core devices :

(a) Obtain dGPS coordinates at each corner of the containment structure array and at all sampling stations, Readings are to be recorded in decimal degrees or Universal Transverse Mercator coordinates, using the North American Datum of 1983 as reference;

(b) The sampling device shall be of a weight and size to ensure sampler decent is vertical and directly below the area of deployment with no evidence of drift (angle in line is not noted);

(c) Collect at least 3 samples from each station. At least 5 failed attempts per station must occur and be documented before sediment sampling is abandoned;

(d) Overlying water is present (indicates minimal leakage) and must be removed prior to processing and storage by siphoning, not decanting;

(e) The overlying water is clear or not excessively turbid;

(f) The sediment-water interface is intact and relatively flat, with no sign of channeling or sample washout;

(g) There is minimal sediment loss.

(h) Obtain successive samples from substrate that has not been disturbed by previous sampling;

(i) Dispose of excess sediment in a manner that minimizes the possibility of contaminating subsequent samples;

(j) Collect at least one subsample that is representative of the top 2 cm of sediment within the sampler;

(k) Remove all non-sedimentary material, including all large shell fragments, fish, wood waste, and rock, before placing material in containers for analyses;

(l) Keep sampler level when retaining samples;

(m) Remove overlying water quickly from sample and avoid areas for subsampling where any overlying water may remain;

(n) The sampler is not overfilled so that the sediment surface is touching the top of the sampler;

(o) The core sampler was not inserted at an angle or tilted upon retrieval;

(p) All sampler attempts and sediment collections must be clearly documented by video or still

pictures to support sampling approach acceptability criteria.

(4) The following information concerning the seabed must be collected with samples collected:

(a) latitude/longitude using dGPS;

(b) depth;

(c) date and time of sampling;

(d) sediment texture and colour;

(e) photo of sediment sample;

(f) presence of gas bubbles;

(g) estimation of surface coverage of bacterial mats;

(h) estimation of surface coverage marine worms;

(i) presence of fish feces and feed;

(j) presence of flocculent organic material;

(k) free sulfide;

(l) redox;

(m) sediment grain size; and,

(n) percent organic matter and porosity only in Quebec, Nova Scotia, New Brunswick, Prince Edward Island, and Newfoundland and Labrador; or,

(o) total volatile solids in British Columbia.

(5) The following procedures must be complied with when measuring the concentration of free sulfide, redox, and sediment grain size in sediment samples:

(a) The concentration of free sulfide in the sediment samples must be determined within 36 hours of collection, except in British Columbia where sediment samples must be analyzed within 5 minutes;

(b) If the free sulfide concentration measurements are not carried out within 5 minutes of the sample being collected, subsamples must be stored between 2 and 5 °C until they are analyzed;

(c) Use a silver/sulfide probe with a sulfide sensitivity range of at least 0 to 19,900 μM and a accuracy of ± 5 % with an appropriate ion-selective electrode (ISE) or millivolt (mV) meter of 0.1 mV resolution;

(d) The probe must be calibrated using three to five serial dilutions of a standard sulfide solution, as required, beginning with the most dilute solution ;

(e) Sediment grain size distribution measurements must be recorded according to the Wentworth grain size scale as a percentage of the total subsample mass;

(f) Redox measurements must be conducted in the following manner:

(i) The redox combination electrode must have an appropriate ISE or mV meter;

(ii) Calibration of the probe must be completed before measurements are taken, and;

(iii) Redox values and temperature must be measured at the same time as the free sulfide.

(6) Where samples cannot be obtained as specified in subsections 4(2) and (3), visual monitoring must be conducted as specified in sections 5 and 6.

Exception

(7) Sampling is not required within areas of the tenure or 1 g C/m^2/day depositional contour where depths exceed 300 m.

Visual monitoring procedures [AAR paragraph 11(2)(a), (b), and (c)]

5. (1) Visual monitoring of the benthic substrate must be conducted in the following manner:

(a) Must use a handheld or dropped still camera, or diver-operated, towed, or remotely operated video camera;

(b) The weight of towed devices must allow for stable movement at a consistent depth without disturbing sediment substrate;

(c) Cameras used for underwater photography must illuminate the benthic substrate to an intensity balanced to the optical sensitivity of the lens such that a uniform field of view is visible;

(d) The optical resolution of the camera lens must be sufficient that organisms greater than 1 cm in size can be distinguished by the unaided eye and identified in a 0.5 m x 0.5 m horizontal field of view; magnification of species observed is acceptable, as necessary, for identification purposes;

(e) Diver-operated, towed, or remotely operated video cameras must be operated at a constant velocity that permits accurate identification of visual parameters;

(f) Original video must be transferred to digital format storage media with no post-survey video editing.

Visual monitoring locations [AAR paragraph 11(2)(a)(b) and (c)]

6 (1) In the case of an aquaculture facility that is located in tidal waters in or adjacent to Quebec, Nova Scotia, New Brunswick, or Prince Edward Island, images will be taken at the same stations specified in paragraph 4(2)(a).

(2) In the case of an aquaculture facility that is located in tidal waters in or adjacent to Newfoundland and Labrador, images must be recorded based on a 100 m^2 grids within the lease. At least one station must be established at the edge of the proposed containment array (0 m).

(3) In the case of an aquaculture facility that is located in tidal waters in or adjacent to British Columbia, images must be recorded along two transects that start at the edge of the proposed containment array, align with the area of greatest predicted impact and with the dominant and sub-dominant current directions and extend for a minimum of 140 m, with a maximum deviation of ± 20% from that bearing. Images must also be collected from reference stations during baseline surveys.

(4) Coordinates as established by a dGPS must be noted at the start and finish of each transect. The readings must be recorded in degrees minutes decimal minutes with 3 digits following the decimal point, using the North American Datum of 1983 as reference.

Exception

(5) Sampling is not required within areas of the tenure or 1 g C/m^2/day depositional contour where depths exceed 300 m.

Timing of Sampling [AAR paragraph 8]

7. Benthic substrate surveys or visual monitoring must be conducted prior to the introduction of fish to the site.

Recording of Baseline Survey Information [AAR subsections 8(1) and (3), and 9(1)]

8. The report of the baseline survey findings must include at a minimum:

(a) The observations recorded from the underwater surveys, including the unedited recorded images;

(b) A map with the locations of transects and habitat information generated during these transects at a minimum resolution of 1:5000, the bathymetry of the seabed at a resolution of 10 m contours; and the estimated footprint of deposition of biochemical oxygen demanding matter in 1, 5, and 10 g C/m^2/day contours;

(c) The results of sediment sampling as specified in subsection 4(4) or records of failed sediment sampling attempts as per 3(c).

(d) Unedited visual recordings must be submitted with the following information:

(i) positional data including all start and stop points and way points in between using corrected dGPS;

(ii) ocean depth of the location recorded; and for continuous video depths at a minimum of 10 m intervals;

(iii) date and time of sampling;

(iv) estimation of surface coverage of bacterial mats; and,

(v) estimation of surface coverage of marine worms.

II Procedures for Operational Monitoring [AAR section 10(1)]

Timing of Sampling [AAR paragraphs 10(1)(*a*) and (*b*)]

9. Benthic monitoring samples or video must be taken at the facility at least once during the production cycle at sea or every 24 months for farms with finfish continuously on site:

(1) In British Columbia, within 30 days of peak feeding or peak biomass;

(2) In Quebec, Nova Scotia, New Brunswick, Prince Edward Island , or Newfoundland and Labrador, between July 1 and October 31, close to peak feeding;

(3) During times when water and weather conditions minimize adverse effects on sampling quality and facilitate accurate sampling at stations.

Benthic Substrate Monitoring [AAR paragraphs 10(1)(a) and (b)]

10. (1) Where benthic substrate monitoring is conducted, the procedures as specified in section 4, excepting paragraphs 4(2)(a) and (b), must be followed. Sampling is not required within areas of the tenure or 1 g C/m^2/day depositional contour where depths exceed 300 m.

(2) Specifically for Quebec, Nova Scotia, New Brunswick, or Prince Edward Island, Table 1 is used to determine the number of sediment samples at 0 m stations and transects.

Exception

(3) Sediment grain size is not required to be measured during operational monitoring.

Visual Monitoring [AAR paragraph 11(2) (a)(b) and (c)]

11. (1) The procedures in subsection 5 will support compliance with the facility restocking threshold.

(2) In the case of an aquaculture facility that is located in tidal waters in or adjacent to Nova Scotia or New Brunswick:

(a) Observations from each transect will be made at 0 m, 10 m, 20 m, 30 m, 40 m and 50 m locations;

(b) The number of transects are indicated in Table 1, Column II based on the number of fish stocked, specified in Table 1, Column I.

(c) Cages along the outside perimeter of the cage configuration must be those selected for positioning of transects. Transects will be positioned starting with the cage with the highest biomass and proceeding in descending order, and in the direction of the prevailing water current;

(d) Compliance stations include all stations between 0 and 50 m.

(3) In the case of an aquaculture facility that is located in tidal waters in or adjacent to Newfoundland and Labrador:

(a) Observations must be recorded along a minimum of 6 transects, consisting of two perpendicular transects from each corner of the containment array and extending away from the array for 100 m with 20 m increments;

(b) Observations from each transect will be made at 0 m, 20 m, 40 m, 60 m, 80 m and 100 m locations;

(c) Additional transects must be recorded from and perpendicular to the middle of each side of an array that consists of more than 9 cages in a row;

(d) Compliance stations include all stations between 0 and 100 m.

(4) In the case of an aquaculture facility that is located in tidal waters in or adjacent to British Columbia, follow subsection 6(3) for sampling locations.

Exception

(5) Sampling is not required within areas of the tenure or 1 g C/m^2/day depositional contour where depths exceed 300 m.

Reference Stations [AAR subsections 10and 11]

12. (1) At least one reference station must be established as required according to the following criteria in the case of an aquaculture facility that is located in tidal waters in or adjacent to British Columbia, Quebec, Nova Scotia, New Brunswick , Newfoundland and Labrador, or Prince Edward Island:

(a) Either consisting of a transect outward from the lease boundary or as discrete stations that are not exposed to biochemical oxygen demanding matter deposited from the facility;

(b) In British Columbia, these are discrete stations between 0.5-2.0 km from the facility location;

(c) The reference station depth is within ± 10 m of the range of depths of the sampling stations as specified in subsection 4(2) and section 6;

(d) Topography, seabed type, current and tidal regimes, sediment grain size, and the amount of freshwater runoff influence are to be representative of the sampling stations, and;

(e) If it is determined that the seabed is composed of predominantly soft sediment, a minimum of one reference station will be established with a minimum of 3 sediment samples collected per station.

(f) If the seabed is determined to be predominantly not soft sediment, visual monitoring must be conducted as specified in section 11.

Recording of Operational Survey Information [AAR subsection 16]

13. (1) Recording of benthic surveys as per section 8.

Exception

(2) BOD modelling, fish and fish habitat surveys and bathymetric mapping is not required for operational monitoring.

Table 1: Number of Sampling Stations Required for Sediment and Visual Sampling (Nova Scotia and New Brunswick)

Column I	Column II	Column III	Column IV
Maximum number of fish within cage site array during production cycle	**Number of transects**	**Number of sampling stations (not including reference stations)**	**Number of samples (3 samples/station for soft bottom sites at 0 m from containment array)**
1-200,000	**2**	**2**	**6**
200,001-300,000	**3**	**3**	**9**
300,001-400,000	**4**	**4**	**12**
400,001-500,000	**4**	**5**	**15**
500,001-600,000	**4**	**6**	**18**
600,001-700,000	**4**	**7**	**21**
700,001-800,000	**4**	**8**	**24**
800,001-900,000	**4**	**9**	**27**
900,000-1,000,000	**4**	**10**	**30**