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|---|---|
| **Name** | **Macrofauna presence** |
| **DPSIR classe** | Impact |
| **ECASA subgroups** | Benthos (macrofauna) |
| **ECASA code** | PRESENCE |
| **Proposed by participant** | University of Goteburg |
| **Definition, computation,** | To maintain a macrofauna at the sea bed below a net pen there is a maximum acceptable flux of organic matter ($F_{2max}$) from the farm to the bottom determined from<br>$F_{2\max} = \frac{\beta U_{bent}}{\alpha\eta}(O_{2i} - O_{2\min})$<br>where $U_{bent}$ is the horizontal current velocity just above the turbulent benthic boundary layer, so that $\beta\ U_{bent}$ is the effective velocity transferring oxygen to the bottom ($\beta \sim 2 \cdot 10^{-3}$), $\alpha$ is the fraction of the particulate organic matter from the farm that oxidises within the farm area, $\eta$ is the amount of oxygen necessary to oxidise 1 g of carbon to carbon dioxide and water (~3.5 $gO_2/gC$), $O_{2i}$ is the concentration of oxygen just above the turbulent benthic boundary layer and $O_{2min}$ the minimum oxygen level to sustain benthic infauna.<br>The actual sedimentation rate $F_2$ can be measured with sediment traps beneath a farm or calculated from MOM-system dispersion model. |
| **Data required** | $U_{bent}$ – the dimensioning current which is the minimum mean speed determined from a bottom current record (corrected from zero readings)<br>$O_{2i}$ – the concentration of oxygen just above the turbulent benthic boundary layer<br>$\alpha$ – the fraction of organic material not being transported away by currents or grazed by animals ($0 < \alpha < 1$). |
| **Summary, scientific meaning, implementation** | Marine farming can cause large environmental impacts on the sea bed due to fluxes of organic matter from the farm. Effects can occur immediately beneath a farm, in the intermediate and regional surrounding but can also harm the farmed species directly if water depth is shallow. Large fluxes of organic matter may result in insufficient oxygen supply to the sea bed. Anaerobic decomposition might prevail and resulting high hydrogen sulphide concentration give azooic sediments (Holmer and Christensen, 1992, Braaten et al, 1983, Hansen et al., 1991). The existence of a macrofauna, even of small opportunistic species, enhances organic matter decomposition and possibly prevent further accumulation of organic wast (Heilskov and Holmer, 2001).<br>The effects of flux of organic matter to the sea bed is integrated over time and are therefore convenient to monitor and cost-effective to measure (Hansen et al., 2001). |
| **Range of validity** | |

| Class | Status | Description |
|---|---|---|
| **I** | $F_2 < F_{2max}$ | Macrofauna |
| **II** | $F_2 > F_{2max}$ | No Macrofauna |

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| **Species concerned (fishes/molluscs)** | Fishes and molluscs |
| **Related type of aquaculture** | Existence of benthic macrofauna below a farm should be a relevant indicator for several types of aquaculture. The formulas are developed for farming in fish cages but should be suitable to develop for e.g. farming of mussels. |
| **Relevant environments for this indicator** | Existence of benthic macrofauna as an indicator of aquaculture impact on environments can be applied to farms in any type of semi-enclosed sea, like a fjord, bay or lagoon. |
| **Geographic scale** | Local |
| **Direct relevance to objectives** | A |
| **Clarity in design.** | A |
| **Realistic collection or development costs** | A |
| **High quality and reliability** | A |
| **Appropriate spatial and temporal scale** | A |
| **Obvious significance** | A |
| **advantages** | |
| **disadvantages** | |
| **references** | Braaten B, Ervik A, Boje E (1983) Pollution problems in Norwegian fish farms. Aquac Ireland 14:6–10<br>Hansen, P. K., A. Ervik, et al. (2001). "Regulating the local environmental impact of intensive, marine fish farming: II. The monitoring programme of the MOM system (Modelling-Ongrowing fish farms-Monitoring)." Aquaculture **194**(1-2): 75-92.<br>Hansen et al., 1991<br>Heilskov, A. C. and M. Holmer (2001). "Effects of benthic fauna on organic matter mineralization in fish-farm sediments: importance of size and abundance." ICES Journal of Marine Science **58**: 427-434.<br>Holmer, M. and Christensen, E., 1992. Impact of marine fish cage farming on metabolism and sulfate reduction of underlying sediments. *Mar. Ecol.: Prog. Ser.* **80**, pp. 191–201. |
| **State of validation recommendations** | |