

ECASA indicator

Name	Total Organic Carbon												
DPSIR class	Impact												
ECASA sub-group	Sediment												
ECASA code	TOC												
Proposed by participant	8 – University of Crete												
Definition, computation,	Measurement of the Total organic Carbon into the sediment. The TOC content of the surficial layer of sediment give an indication of the carbon fluxes oming from the water column												
Data required	TOC analyses, main sediment characteristics												
Summary, scientific meaning, implementation	Total Organic Carbon in a good indicator of benthic enrichment. It has recently been shown (Hyland et al. 2005 in press) that TOC can be used as an indicator of stress, correlating well with species richness. Although at low values the TOC-species relationship is weak (due to contribution of various other stressors) at high values, TOC becomes the main driver of benthic ecological change.												
Range of validity	<table border="1"> <thead> <tr> <th><u>TOC (mg g⁻¹)</u></th> <th><u>Disturbance Classification</u></th> <th><u>EcoQ (sensu WFD)</u></th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> </tr> </tbody> </table>	<u>TOC (mg g⁻¹)</u>	<u>Disturbance Classification</u>	<u>EcoQ (sensu WFD)</u>									
<u>TOC (mg g⁻¹)</u>	<u>Disturbance Classification</u>	<u>EcoQ (sensu WFD)</u>											
Species concerned (fishes/molluscs)	All fishes and molluscs reared												
Related type of aquaculture	Tested for fish farms, but suitable for intertidal trestle culture, suspended culture.												
Relevant environments for this indicator	Intertidal and subtidal soft-bottom environment, under moderate hydrodynamics												
Geographic scale	Local effects: degradation of organic matter prevents from using indicator far from the origin of impact.												
Direct relevance to objectives													
Clarity in design.													
Realistic collection or development costs													
High quality and reliability													
Appropriate spatial and temporal scale													
Obvious significance													
advantages	Relates to the original impact of aquaculture, which consists in rejects of organic matter												
disadvantages	Background natural fluxes are contributing to the TOC contents of the sediment, as well as uneaten food, and should be considered when possible												
references	Hyland J., Balthis L., Karakassis I., Magni P., Petrov A., Shine J., Vestergaard O. Warwick R. (2005) Organic carbon content of sediments as an indicator of stress in the marine benthos. <i>Mar. Ecol. Prog. Se</i> , 295 : 91-103r												
State of validation	XXX												
recommendations	XX												

ECASA indicator

Name	Total organic Carbon in surficial sediment
DPSIR classe	Impact
ECASA subgroups	Sediment
Proposed by participant	14 - university
Definition, computation,	A "relative" rank can be obtained by considering the ratio between the value of the measure at the impacted and reference site. An enrichment in sediment TOC between 40 and 60 % was detected beneath off-shore mussel farms located at different european sites (Aleffi et al., submitted; Chamberlain, 2002), see tab. 1. The calculation of this ratio, implies the application of a control or multi-control sampling strategy (Danovaro et al., 2004; Chamberlain, 2002; Porrello et al., in press).
Data required	Organic Carbon concentrations are expressed as % of C in sediment. The concentration can be referred to the whole 6 to 10 cm core or to the surficial sediment (1 to 1.5 cm) (Chamberlain, 2002; Aleffi et al., submitted to ICES).
Summary, scientific meaning, implementation	The production of biodeposits (faeces and pseudofaeces) due to mussel cultivation, can cause an increase in the flux of organic carbon towards the sediment and, thus, to an enrichment of organic matter in the sediment. In turn, this process leads to an increase in the bacterial degradation activity, which causes a depletion of dissolved oxygen in the interstitial water and an increase in the sulphide concentration, since, in the absence of DO, sulphate reduction is one of the main organic matter degradation paths in marine waters (Kristensen, 2000).
Range of validity	All
Species concerned (fishes/molluscs)	All
Related type of aquaculture	Shellfish culture: <ul style="list-style-type: none"> • Longlines (Aleffi et al., submitted; Martincic 1998; Chamberlain, 2002) • Rafts (Chamberlain, 2002) Marine cages (Porrello et al., in press)
Relevant environments for this indicator	Sheltered areas (Chamberlain, 2002). Coastal waters not protected by bays (Aleffi et al., submitted; Martincic, 1998).
Geographic scale	local
Direct relevance to objectives	A
Clarity in design.	A
Realistic collection or development costs	B
High quality and reliability	B
Appropriate spatial and temporal scale	B
Obvious significance	B

advantages

**disadvantages
references**

May feed Organic Carbon deposition models, as DEPOMOD (Cromeey et al., 2002)

- Aleffi, I.F., Bettoso, N., Solis-Weiss, V., Tamberlich, F., Predonzani, S., Fonda-Umani, S., submitted to ICES – Journal of Marine Science. Effects of suspended mussel culture on the macrozoobenthos in the Gulf of Trieste (Northern Adriatic Sea, Italy).
- Danovaro et al., 2004. Sustainable impact of mussel farming in the Adriatic Sea (Mediterranean Sea): evidence from biochemical, microbial and meiofaunal indicators. *Marine Pollution Bulletin* 49: 325-333.
- Chamberlain, J., 2002. Modelling the environmental Impacts of Suspended Mussel (*Mytilus edulis* L.) Farming. Ph-D Thesis, Napier Univeristy, Edimburgh.
- Christensen, P.B., Glud, R.N., Dalsgaard, T., Gillespie, P., 2003. Impacts of longline mussel farming on oxygen and nitrogen dynamics and biological communities of coastal sediments. *Aquac.* 218: 567-588.
- Martincic, B., 1998. Modello di Carrying capacity applicato alle mitilicoltura in sospensione. Ph-D Thesis in aquaculture, University of Florence, Pisa and Udine. Porrello, S., Tomassetti, P., Manzueto, L., Finioia, M.G., Persia, E., Mercatali, I., Stipa, P., in press. The influence of marine cages on the sediment chemistry in the Western Mediterranean Sea. *Aquac.*
- Porrello, S., Tomassetti, P., Manzueto, L., Finioia, M.G., Persia, E., Mercatali, I., Stipa, P., in press. The influence of marine cages on the sediment chemistry in the Western Mediterranean Sea. *Aquac.*

**State of validation
recommendations**