

ECASA WP 2

Annotated sheet for indicators¹ related to the impact of aquaculture on the environment

1- Name of indicator, authors

Fish growth, FG, (UGOT)

2- Computation : Formulae, or model output.

Whenever possible, please use a range of 0-100. Ranking the results in few classes (five?) is another option for qualitative indicators.

The maximum theoretical fish growth compared to the actual fish growth reveals if the conditions of the farm are optimal or not.

$$\frac{dW}{dt} = a_0 W^b e^{\tau T}$$

Here T is temperature ($^{\circ}\text{C}$) and τ is an inverse temperature scale ($^{\circ}\text{C}^{-1}$) equivalent to the well known Q_{10} . Thus, when the temperature increases with $1/\tau$, growth increases by a factor e (2.718). Using τ equal to 0.080 ($^{\circ}\text{C}^{-1}$) implies that biochemical rates in fish double by a temperature increase of about 8.6 $^{\circ}\text{C}$. The parameters a ($\text{g}^{1-b} \text{day}^{-1}$) and b (non-dimensional) are constants for a given species, which can be determined from observations. a_0 is possibly a function of other abiotic factors than temperature. ($a=0.038$. $b=2/3$ for salmon)

3- List of data / parameters required for computation.

T - temperature cycle

$Fish\ species$

W - start and end weight

$Feed$ - composition and volume

¹ Please return these sheets to the WP 2 leader, BEFORE end of March 2005.

4- Description of scientific meaning, references

The growth is a function of local conditions such as temperature, oxygen/ammonium concentrations and deviations from maximum growth rates indicate suboptimal environmental conditions of the farm, or possibly disease if no changes in food availability for the intensive farm have been done. For the extensive farm it can also indicate change of food availability due to environmental changes. Growth functions under normal conditions are well established for most farmed species. Measurements are robust and reliable. When a deviation from normal is detected, the scientific challenge is to establish the nature of the change.

References: Stigebrandt A., 1999. Turnover of energy and matter by fish- A general model with application to salmon. *Fisken og Havet* No 5, p26.

<http://www.marsys.se/pdf/fiskohav51999.pdf>

Solidoro et al. 2000. Modelling the growth of *Tapes philippinarum* in Northern Adriatic lagoons. *MARINE ECOLOGY-PROGRESS SERIES* 199: 137-148.

5- Range of validity; please provide a description of the field of validity for the indicator, its limits, end points. Careful explanations should be given in a table

Class	Status	Description
I	$FG_{real} = FG_{teo}$	Optimal
II	$FG_{real} < FG_{teo}$	Not optimal

about the correspondence between the computed values and the impact (from positive

effect, no impact, moderate impact, high impact, unacceptable impact).

6-Type of aquaculture on which this indicator applies

The formulas are developed for farming in fish cages but should be suitable to develop for e.g. farming of mussels.

6- Relevant environments for this indicator

Open sea aquaculture
Cage aqua culture
Longlines
Intertidal, extensive aquaculture
Earthen pond aquaculture located on the shore line

8- Quotation. We will need to select the most appropriate indicators to be proposed for EIA and site selection. Please suggest a quotation for this indicator for the following

criteria (from A, perfectly adequate, to E, not relevant), to help evaluating the indicator within WP 4. Additional comments are welcome.

- Direct relevance to objectives : Rating A
- Clarity in design: Rating A
- Realistic collection or development costs : Rating A
- High quality and reliability : Rating A
- Appropriate spatial and temporal scale : Rating A
- Obvious significance : Rating A.

9- Data and models related to this indicator, available for use by WP 4. Please list the data and models output available at local, national or regional scales for use by ECASA. They may not correspond to the more theoretical list asked for in §3.

The fish sub-model of MOM calculates the maximum growth of specific species which are chosen in the model. The maximum growth is presented as the production cycle (days) for the fish to reach a given end weight from a given start weight, but can also be calculated for any give weight interval.

10- Suggestions for use by WP 5. Give examples of indicators/aquaculture/environments which can be field-tested during the course of WP 5.

Measurements are probably already done regularly at every farm by the farmer, but the availability of the data might be a concern.

ⁱ This document is intended to be used for internal work on ECASA workpackage. The final indicator sheet may include a format somewhat different. Please suggest any improvement for both the cojntent and the form of this document.