This memo outlines the proposed architecture for including the macroalgae growth model   
(MAL) of Broch et al. (2011) in DELWAQ

# State variables

There will be 4 new state variables:

1. MALS - MacroALgae Structural biomass
2. MALN - MacroALgae Nitrogen storage
3. MALP - MacroALgae Phosphorous storage
4. MALC - MacroALgae Carbon storage

These are described in Figure 1.

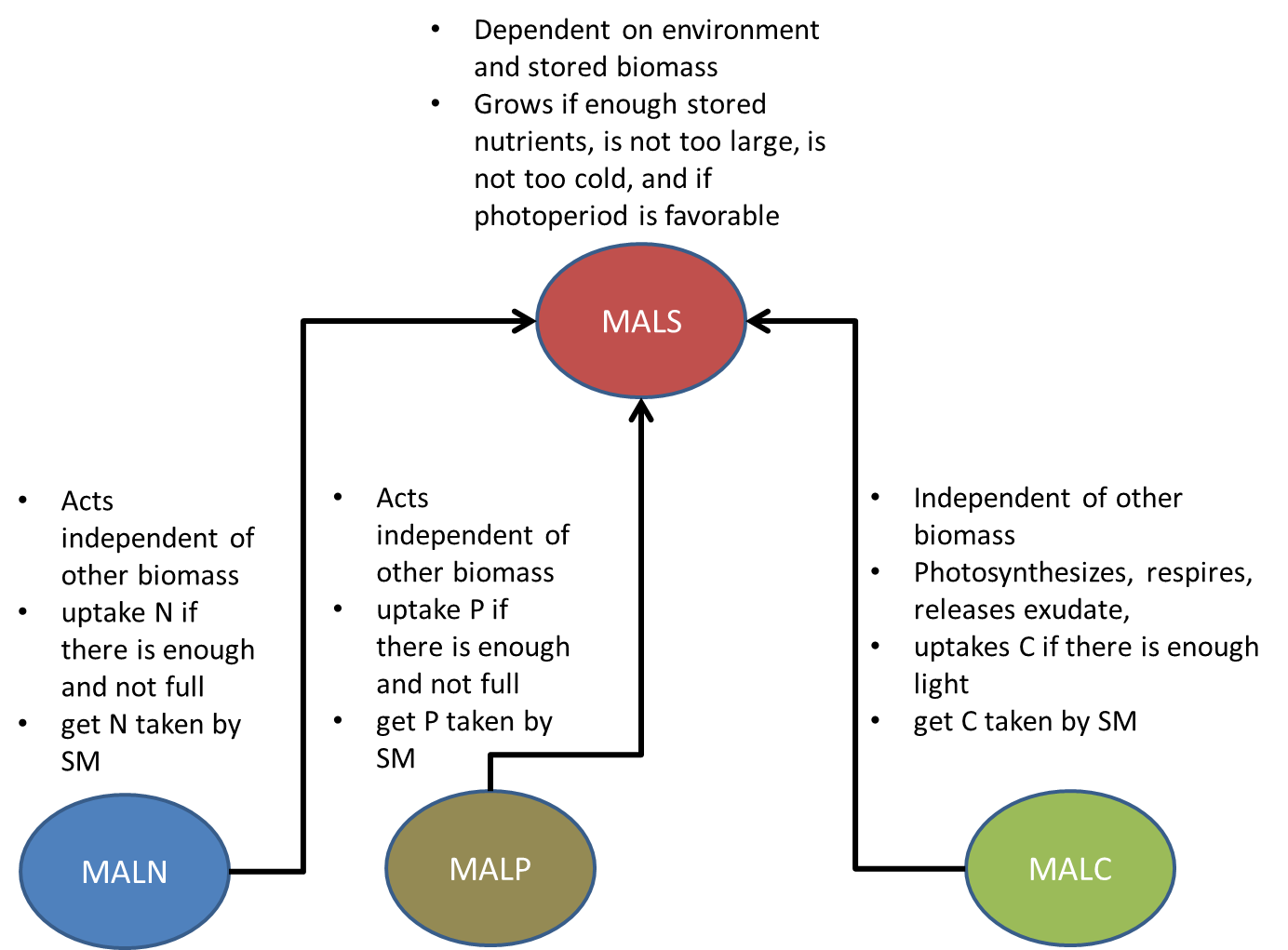


Figure 1- description of state variables

# Governing equations

The most important equations are listed here

## MALS

Change in biomass (gDM/day)

Control on specific growth rate (d-1)

Temperature function

Biomass density function

Photoperiod function

Specific mortality rate (d-1)

## MALN

Change in storage

Uptake rate of N to storage

## MALP

Change in storage

Uptake rate of N to storage

## MALC

Change in storage

Gross photosynthesis (production) rate

*Solve for Beta using Newton’s method, also not all of these temperatures are specified*

Respiration rate

Ratio Exudation

# Expected fluxes

## MALS

|  |  |
| --- | --- |
| **FROM** | **TO** |
| GroMALS | GroMALS |
|  |  |
|  |  |
|  |  |

## MALN

|  |  |
| --- | --- |
| **FROM** | **TO** |
| GroMALN | GroMALN |
|  | GroMALS |
|  |  |
|  |  |

## MALP

|  |  |
| --- | --- |
| **FROM** | **TO** |
| GroMALP | GroMALP |
|  | GroMALS |
|  |  |
|  |  |

## MALC

|  |  |
| --- | --- |
| **FROM** | **TO** |
| GroMALC | GroMALC |
|  | GroMALS |
|  |  |
|  |  |

## TIC

|  |  |
| --- | --- |
| **FROM** | **TO** |
| GroMALC | GroMALC |
|  |  |
|  |  |
|  |  |

## OXY

|  |  |
| --- | --- |
| **FROM** | **TO** |
| GroMALC | GroMALC |
|  |  |
|  |  |
|  |  |

## NO3

|  |  |
| --- | --- |
| **FROM** | **TO** |
| GroMALN | GroMALN |
|  |  |
|  |  |
|  |  |

## PO4

|  |  |
| --- | --- |
| **FROM** | **TO** |
| GroMALP | GroMALP |
|  |  |
|  |  |
|  |  |

## POC

|  |  |
| --- | --- |
| **FROM** | **TO** |
| GroMALS |  |
| GroMALC (exudate?) |  |
|  |  |
|  |  |

## PON

|  |  |
| --- | --- |
| **FROM** | **TO** |
| GroMALS |  |
|  |  |
|  |  |
|  |  |

## POP

|  |  |
| --- | --- |
| **FROM** | **TO** |
| GroMALS |  |
|  |  |
|  |  |
|  |  |

# Expected subroutine structure

## GroMALS

Calculate the change in biomass of MALS in each segment

**Input:**

MALNmin – minimum N in storage

MALPmin – minimum P in storage

MALCmin – minimum C in storage

## GroMALN (/GroMALP)

Calculate the change in nutrient storage

## GroMALC

Calculate the change in carbon storage

Takes TIC from the water based on rate of P

Produces O2 based on rate of R

## MALDIS

Determine distribution of biomass and storage over water column

Will rely on maximum height and maximum biomass density (g/m)

Can specify a min depth

Can specify a max depth

Plants will grow from min depth to max depth. Direction will depend on relative signs of min depth and max depth

There is inherently a planting density as well in g/m2. However we would not be able to distinguish between a few long plants and many short plants, which have the same biomass density in g/m2 but have much different effect on the ambient conditions.

To reduce this ambiguity we strive to maintain a length to weight ratio, or the g/m value

Basically, what it means is how much mass is required to get all of the algae in a m2 to grow a m in length? (g/m2 \* m) = g/m

If the seeding density is low, there will be a low value for this number. If is it high then more carbon is required to allow the whole group to extend its length

Every time step the biomass in each segment has its net change in biomass. It is then redistributed to satisfy the linear distribution with depth. If the net change was a loss, the plant gets shorter.

ExtVl