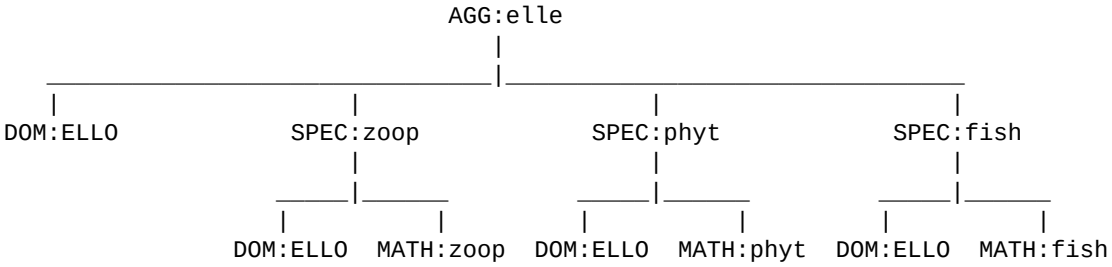
ellebo lake (Version: 0)

ECOBAS Documentation (ECOBAS_MIF 3.1) *

9th August 2004

1 Structure



2 AGG: ellebo lake (Version: 0)

Domain identifier: ELLOBO (see section: 9)
Author: Angelini,Ronaldo
Documented by: Benz,Joachim
Model (Origin of this mathematical formulation):
ELLOBO; A model for the plankton system of the Broa reservoir, Sao Carlos, Brazil
References: [Ang00]
Keywords: undefined

2.1 Structure of the aggregate

2.1.1 Declaration of variables

acronym	description
INPUT:	
$temperature$	temperature (of water)

2.1.2 Components

Name of module	Type of module
zooplankton (version: 0)	DYNAMIC
phytoplankton (version: 0)	DYNAMIC
fish (version: 0)	DYNAMIC

*Database: /eco6/benz/_ecobas/db/dbb/

2.1.3 Connections

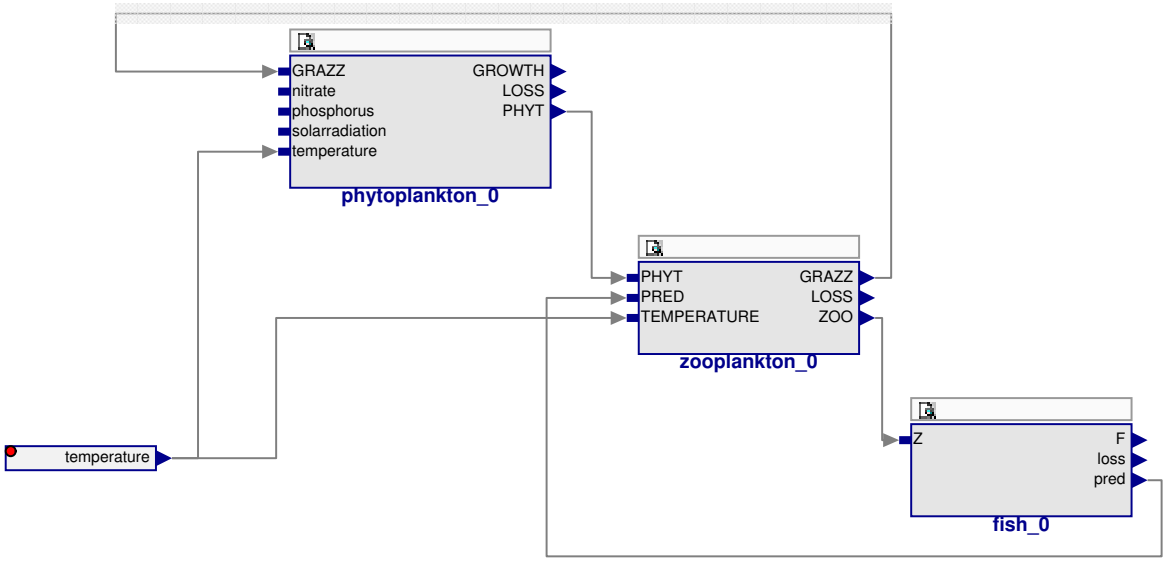
source module:$variable$	$\mapsto$	sink module:$variable$
phytoplankton_0:$PHYT$	$\mapsto$	zooplankton_0:$PHYT$
zooplankton_0:$GRAZZ$	$\mapsto$	phytoplankton_0:$GRAZZ$
zooplankton_0:ZOO	$\mapsto$	fish_0:Z
fish_0:$pred$	$\mapsto$	zooplankton_0:$PRED$
INPUT:$temperature$	$\mapsto$	phytoplankton_0:$temperature$
INPUT:$temperature$	$\mapsto$	zooplankton_0:$TEMPERATURE$

2.2 Description of Specification

Template Content

2.3 List of figures

Figure(1): ellebo_lake_0_s.eps



3 SPEC: zooplankton (Version: 0)

Instance of MATH module: zooplankton (Version: 1)
Domain identifier: ELLOBO (see section: 9)
Author: Petrere,Miguel
Author: Angelini,Ronaldo
Documented by: Noeding,Dirk
Model (Origin of this mathematical formulation):
ELLOBO; A model for the plankton system of the Broa reservoir, Sao Carlos, Brazil
References: [Ang00]
Keywords: biomass

3.1 Declaration of Quantities

acronym	unit	meaning	method	*value*	*range*	indomain
t	d				$0:365$	
ZOO_0	mug/l	*concentration*		0.1		
k_{phyt}	l/mug	–		1.0		
ZOO_{up}	mug/l	–		3.3		
ZOO_{low}	mug/l	–		0.8		
M_{zoo}	$1/d$	–		0.3		

continued on next page

continued from previous page

acronym	unit	meaning	method	value	range	indomain
$TEMPERATURE_{max}$	C	–		27.1		
C_k	mug/l	–		3.3		
K_z	$1/d$	–		0.5		
$PRED$	$mug/(l*d)$	–				
$TEMPERATURE$	C	–		23		
$PHYT$	mug/l	$biomass$		4.0		
ZOO	mug/l	$biomass$				
$PHYT_{av}$	$unitless$	–				
$GRAZZ$	$mug/(l*d)$	–				
M_{yz}	$1/d$	–				
$LOSS$	$mug/(l*d)$	–				

4 SPEC: phytoplankton (Version: 0)

Instance of MATH module: phytoplankton (Version: 0)
Domain identifier: ELLOBO (see section: 9)
Author: Angelini,Ronaldo
Documented by: Noeding,Dirk
Model (Origin of this mathematical formulation):
ELLOBO; A model for the plankton system of the Broa reservoir, Sao Carlos, Brazil
References: [Ang00]
Keywords: nitrogen, Phytoplankton, grazing, light, phosphor

4.1 Declaration of Quantities

acronym	unit	meaning	method	$value$	$range$	indomain
t	d					
$PHYT_0$	mug/l	$concentration$		1.0		
K_c	$1/d$	–		0.2		
K_{sr}	$mumol$	–		140		
K_{pd}	mug/l	–		1.1		
K_{nt}	mug/l	–		0.5		
G_{phyt}	$mug/l/d$	–		0.5		
$GRAZZ$	$mug/l/d$	–		0.0		
$solarradiation$	$mumol$	–				
$nitrate$	mug/l	–				
$phosphorus$	mug/l	–				
$temperature$	C	–		23		
$PHYT$	mug/l	–				
$GROWTH$	$mug/l/d$	–				
$LOSS$	$mug/l/d$	–				
G_{max}	$mug/l/d$	–				
MM_{sr}	$unitless$	–				
MM_{nt}	$unitless$	–				
MM_{pd}	$unitless$	–				

5 SPEC: fish (Version: 0)

Instance of MATH module: fish (Version: 1)
Domain identifier: ELLOBO (see section: 9)
Documented by: Noeding,Dirk
Model (Origin of this mathematical formulation):
ELLOBO; A model for the plankton system of the Broa reservoir, Sao Carlos, Brazil

References: [Ang00]
Keywords: biomass, Astyanax fasciatus, predation

5.1 Declaration of Quantities

acronym	unit	meaning	method	$value$	$range$	indomain
t	d					
K_l	$1/d$	–		0.5		
K_p	$1/d$	–		0.24		
Z	mug/l	–				
F	mug/l	–				
$pred$	$mug/(l*d)$	–				
$loss$	$mug/(l*d)$	–				

6 MATH: zooplankton (Version: 1)

Author: Petrere,Miguel
Author: Angelini,Ronaldo
Documented by: Noeding,Dirk
Model (Origin of this mathematical formulation):
ELLOBO; A model for the plankton system of the Broa reservoir, Sao Carlos, Brazil
References: [Ang00] [Joe83]
Keywords: biomass, population dynamics, zooplankton
Simtype: DYNAMIC

6.1 Declaration of Variables

acronym	type*	description	time scale	time agg.	intime/state type
DEPENDENT:					
$PHYT_{av}$	FM	availability of phytoplankton for grazing		none	
$GRAZZ$	FM	predation of zooplankton on phytoplankton		none	
M_{yz}	FM	temperatur dependent growth rate of zooplankton		none	
$LOSS$	FM	respiration and mortality of zooplankton		none	
STATE:					
ZOO	FM	biomass of zooplankton		none	CONTINUOUS
INPUT:					
$PRED$	FM	feeding by fish		none	
$TEMPERATURE$	FM	temperature of water		none	
$PHYT$	FM	biomass of phytoplankton		none	
CONSTANT:					
ZOO_0	FM	inital value of zooplankton biomass		none	
k_{phyt}	FM	constant used for phytoplankton availability		none	
ZOO_{up}	FM	upper limit of random mumber RANZOO		none	
ZOO_{low}	FM	lower limit of random number RANZOO		none	
M_{zoo}	FM	is the calibrated value for growth rate		none	

continued on next page

continued from previous page			
acronym	type*	description	
$TEMPERATURE_{max}$	FM	maximale temperature at Broa reservoir	none
C_k	FM	carring capacity for zooplankton	none
K_z	FM	respiration and mortality per day	none
TIME:			
t		time	

*) 1.character: alphanumeric(A) or float(F) or integer(I)
2.character: metric(M) or ordinal(O) or nominal(N)

6.2 Equation(s)

6.2.1 Initial state of the system $(t \doteq 0)$:

Bound: $ZOO = ZOO_0$ (1)

6.2.2 dynamics of zooplankton biomass Equationblock(1)

$$\frac{\mathrm{d}\,ZOO}{\mathrm{d}\,t} = GRAZZ - LOSS - PRED \quad (2)$$

$$LOSS = ZOO \cdot K_z \quad (3)$$

6.2.3 grazing Equationblock(2)

$$GRAZZ = M_{yz} \cdot PHYT_{av} \cdot (1 - \tfrac{ZOO}{C_k}) \cdot RUNIFORM(ZOO_{low}, ZOO_{up}) \quad (4)$$

$$M_{yz} = M_{zoo} \cdot 0.98^{TEMPERATURE - TEMPERATURE_{max}} \quad (5)$$

$$PHYT_{av} = k_{phyt} \cdot PHYT \quad (6)$$

6.3 Description of MATH module

Zooplankton in Broa reservoir is represented by Cladocera (13.8%), Copepod (81%) and Rotifers (5.4%). The dynamics of zooplankton is determined by 3 terms:

- grazing of phytoplankton (GRAZZ)
- respiration and mortality (LOSS) and
- feeding of zooplankton by fish (PRED)

Grazing is formulated according ODUM 1972(see: [Joe83], page83). The dependence of amount of zooplankton is formulated here by introducing a uniform distributed random variable.

7 MATH: phytoplankton (Version: 0)

Author: Angelini,Ronaldo
Author: Petrere,Miguel
Documented by: Noeding,Dirk
Model (Origin of this mathematical formulation):
ELLOBO; A model for the plankton system of the Broa reservoir, Sao Carlos, Brazil
Keywords: Phytoplankton, biomass dynamic
Simtype: DYNAMIC

7.1 Declaration of Variables

acronym	type*	description	time scale	time agg.	intime/state type
DEPENDENT:					
$GROWTH$	FM	growth rate of phytoplankton		none	
$LOSS$	FM	respiration and mortality of phytoplankton		none	
G_{max}	FM	Rate coefficient of temperature		none	
MM_{sr}	FM	light		none	
MM_{nt}	FM	nitrogen		none	
MM_{pd}	FM	phosphor		none	
STATE:					
$PHYT$	FM	Phytoplankton		none	CONTINUOUS
INPUT:					
$GRAZZ$	FM	predation of zooplankton on phytoplankton		none	
$solarradiation$	FM	light		none	
$nitrate$	FM	nitrogen		none	
$phosphorus$	FM	phosphor		none	
$temperature$	FM	temperature		none	
CONSTANT:					
$PHYT_0$	FM	inital biomass of phytoplankton		none	
K_c	FM	parameter of temperature function		none	
K_{sr}	FM	half saturation of solarradiation		none	
K_{pd}	FM	half saturation of phosphorous		none	
K_{nt}	FM	half saturation of nitrogen function		none	
G_{phyt}	FM	value is adjusted for the maximum growth rate		none	
TIME:					
t		time			

*) 1.character: alphanumeric(A) or float(F) or integer(I)
2.character: metric(M) or ordinal(O) or nominal(N)

7.2 Equation(s)

7.2.1 Initial state of the system $(t \doteq 0)$:

Bound: $PHYT = PHYT_0$ (7)

7.2.2 dynamics of phytoplankton Equationblock(1)

$$\frac{\mathrm{d}\,PHYT}{\mathrm{d}\,t} = GROWTH - LOSS - GRAZZ \tag{8}$$

$$LOSS = PHYT \cdot 0.5 \tag{9}$$

7.2.3 growth Equationblock(1)

$$GROWTH = G_{max} \cdot MM_{sr} \cdot MM_{pd} \cdot MM_{nt} \tag{10}$$

$$G_{max} = G_{phyt} \cdot \mathbf{e}^{K_c \cdot temperature} \tag{11}$$

$$MM_{sr} = \frac{solarradiation}{K_{sr}+solarradiation} \quad (12)$$

$$MM_{pd} = \frac{phosphorus}{K_{pd}+phosphorus} \quad (13)$$

$$MM_{nt} = \frac{nitrate}{K_{nt}+nitrate} \quad (14)$$

7.3 Description of MATH module

Phytoplankton is a collection of several species of algae. For growing we consider input of the nutrients nitrate and phosphor , temperature and light(solar radiation). LOSS describes the loss by respiration and mortality of phytoplankton. GRAZZ is the predation of zooplankton on phytoplankton.

8 MATH: fish (Version: 1)

Author: Angelini,Ronaldo
Documented by: Noeding,Dirk
Model (Origin of this mathematical formulation):
ELLOBO; A model for the plankton system of the Broa reservoir, Sao Carlos, Brazil
References: [Ang00]
Keywords: predation, fish
Simtype: DYNAMIC

8.1 Declaration of Variables

acronym	type*	description	time scale	time agg.	intime/state type
DEPENDENT:					
$pred$	FM	zooplankton biomass and predation rate		none	
$loss$	FM	keep alive rate and mortality of fish		none	
STATE:					
F	FM	population of fishs		none	CONTINUOUS
INPUT:					
Z	FM	calculated zooplankton biomass		none	
CONSTANT:					
K_l	FM	calculated fish mortality and keep alive rate per day		none	
K_p	FM	calculated zooplankton predation rate per day		none	
TIME:					
t		time			

*) 1.character: alphanumeric(A) or float(F) or integer(I)
2.character: metric(M) or ordinal(O) or nominal(N)

8.2 Equation(s)

8.2.1 Initial state of the system $(t \doteq 0)$:

Bound: $F = 10$ (15)

8.2.2 fish Equationblock(1)

$$\frac{\mathrm{d}\,F}{\mathrm{d}\,t} = \; pred - loss \tag{16}$$

$$pred = \; Z \cdot K_p \tag{17}$$

$$loss = \; F \cdot K_l \tag{18}$$

9 Domain: ELLOBO

9.1 Classification of Domain

Soil classification (FAO):	any
Soil texture (US-Soil classification):	any
Climate classification (Walther/Lieth):	**II** tropical and subtropical area
	swr dominant winter rain
Type of ecosystem (Ellenberg):	Oligotrophic_Lakes
	Mesotrophic_Lakes
Biological classification:	Fish Astyanay fasciats
	Phytoplankton serveral species
	Zooplankton Argyrodiaptomus furcatus
	Cladocera
	Rotifers

9.1.1 Description of Domain

mean depth 3.0m

References

[Ang00] Ronaldo Angelini. A model for the plankton system of the broa reservoir sao carlos, brazil. *Ecological Modelling*, 126:131–137, 2000.

[Joe83] S.E. Joergensen. *Application of Ecological Modelling in Environmental Management*, volume Part A. Elsevier Scientific Publishing Company, 1983.