

An ecosystem model for risk assessment of aquatic environments impacted by endocrine disruptors

SETAC-Europe

Berlin, Germany

Ludwine Clouzot

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Canada Research Chair
in Water Quality Modeling



Modeling endocrine disruption

Mechanism rather than endpoint:

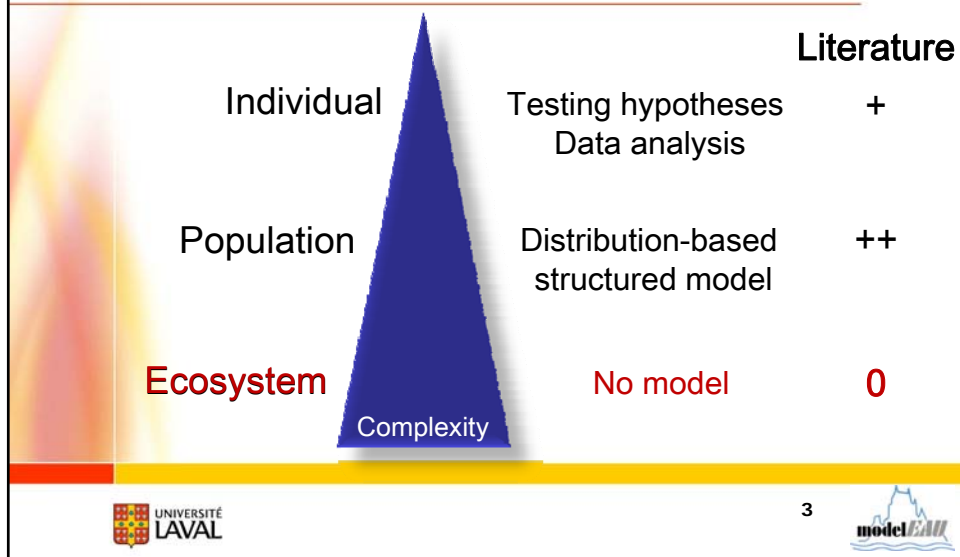
- Intersex fish
- Reproductive disturbances



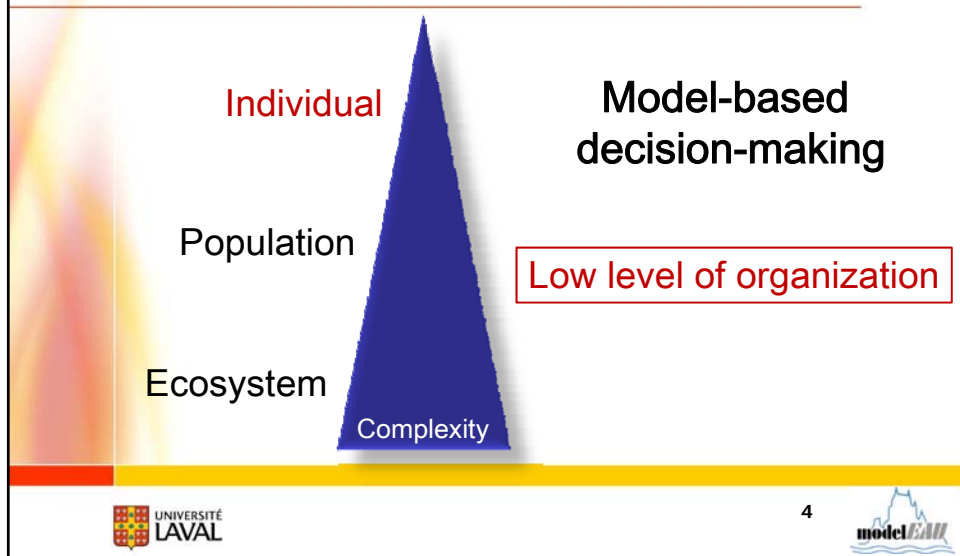
*Joanne Parrott



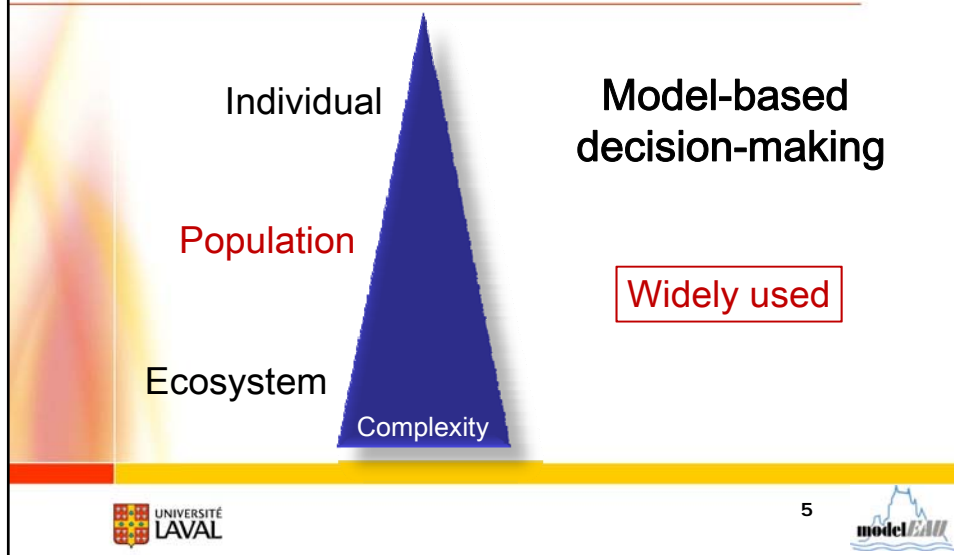
Modeling endocrine disruption



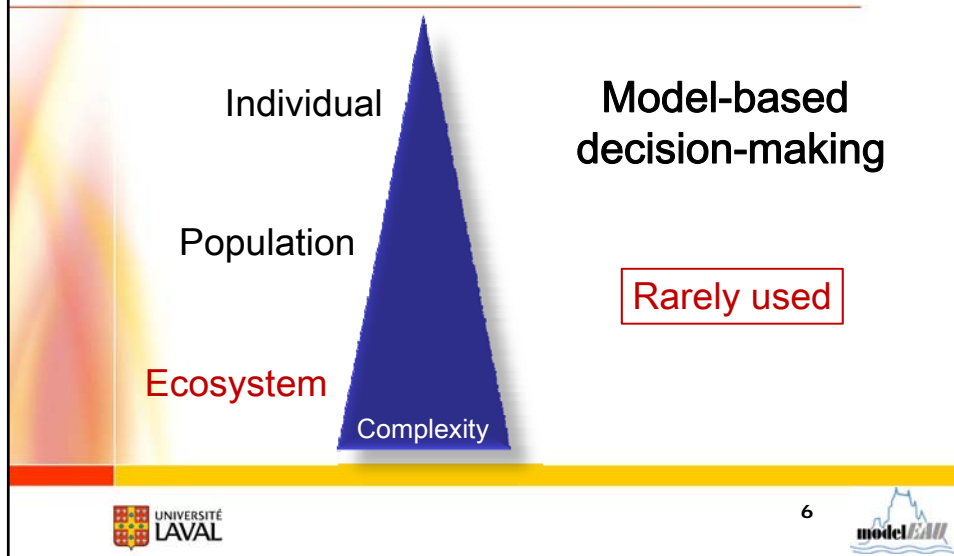
Ecological risk assessment (ERA)



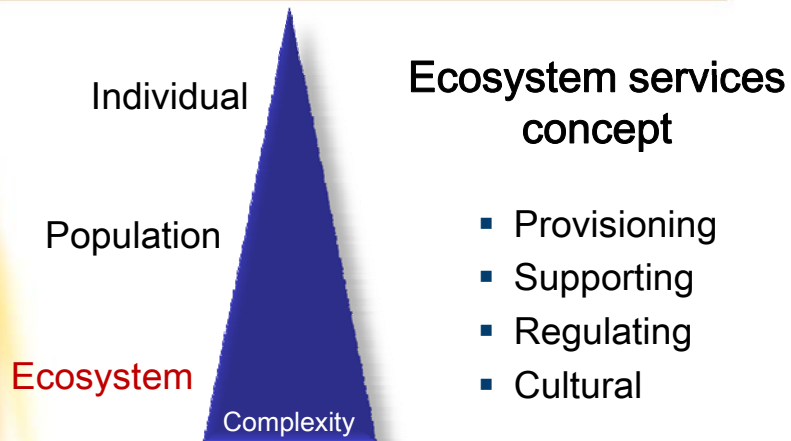
Ecological risk assessment (ERA)



Ecological risk assessment (ERA)



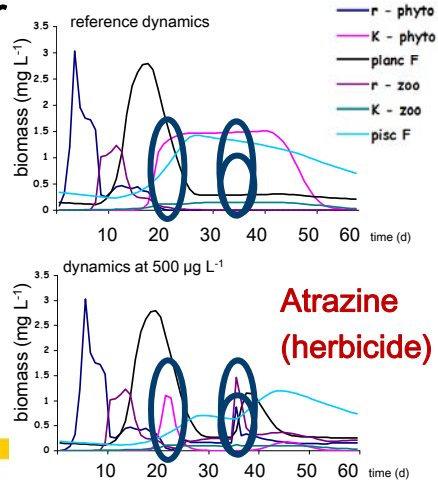
Ecological risk assessment (ERA)



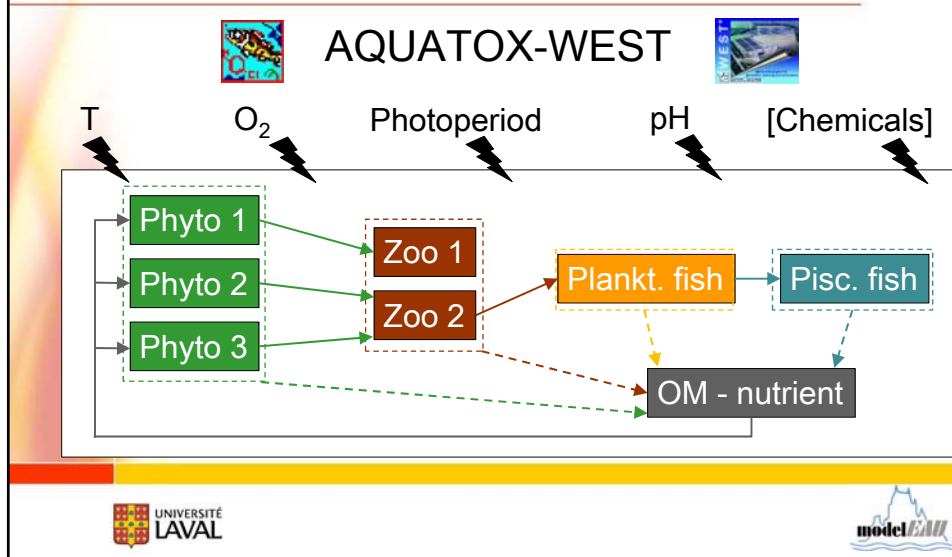
Ecological model: Acute toxicity

Frederik De Laender
(PhD thesis, 2007)

- Disappearance of one phyto
- Appearance of another phyto
- Appearance of one zoo



Ecosystem model: Object-oriented



Ecosystem model: F. De Laender

$$\frac{dFish}{dt} =$$

Transformation

- + Consumption
- Defecation
- Respiration
- Excretion
- Mortality
- Predation
- + Recruitment
- Promotion
- Gamete Loss

Transport

- + Loading
- Wash_out
- + Wash_in
- ± Diffusion_{seg}
- ± Migration
- Entrainment
- Fishing

Ecosystem model: F. De Laender

$$\frac{dFish}{dt} =$$

Transformation

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- ~~+ Recruitment~~
- ~~- Promotion~~
- ~~- Gamete Loss~~

Transport

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- ~~- Wash_out~~
- + Wash_in
- ± Diffusion_{seg}
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- ~~- Fishing~~

$$\frac{dBiomass_{animals}}{dt} = Consumption - Defecation - Respiration - Excretion - Mortality - Predation$$

Ecosystem model: L. Clouzot

$$\frac{dFish}{dt} =$$

**Endocrine
disruptions**

Transformation

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Transport

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$$\frac{dBiomass_{animals}}{dt} = Consumption - Defecation - Respiration - Excretion - Mortality - Predation$$

$$+ Recruitment - Promotion - Gamete Loss$$

Ecosystem model: L. Clouzot

Fish: Sex-classes

- Juveniles
- Males
- Females



Experimental data



58 Designated Research Lakes
and their Watersheds
Detailed Monitoring since 1969



Boreal

Data on individuals
& populations

Recovery?

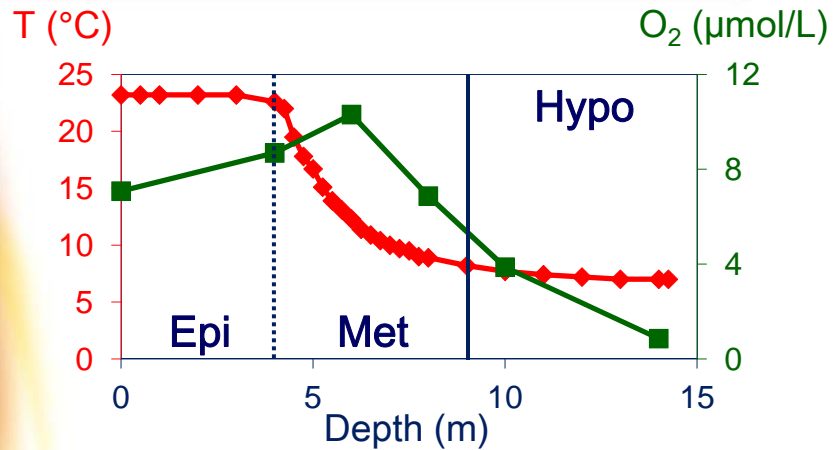
+ 17 α -ethinylestradiol (EE2)

Baseline data

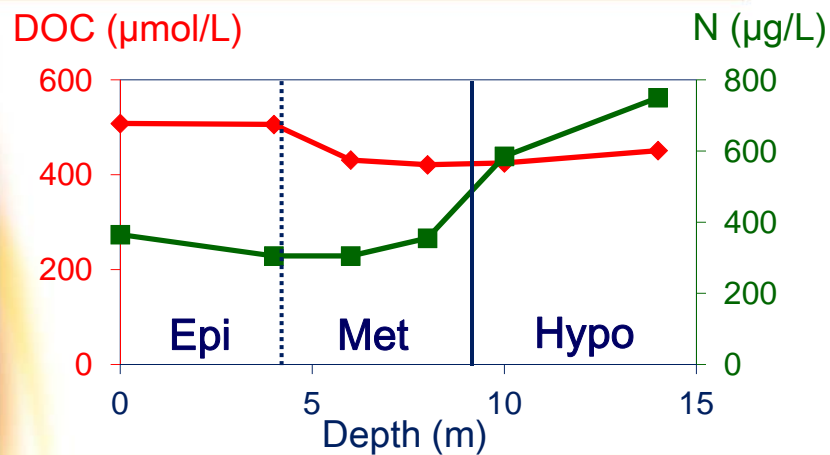
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 ...

Reference lake data

Experimental lake: Stratification



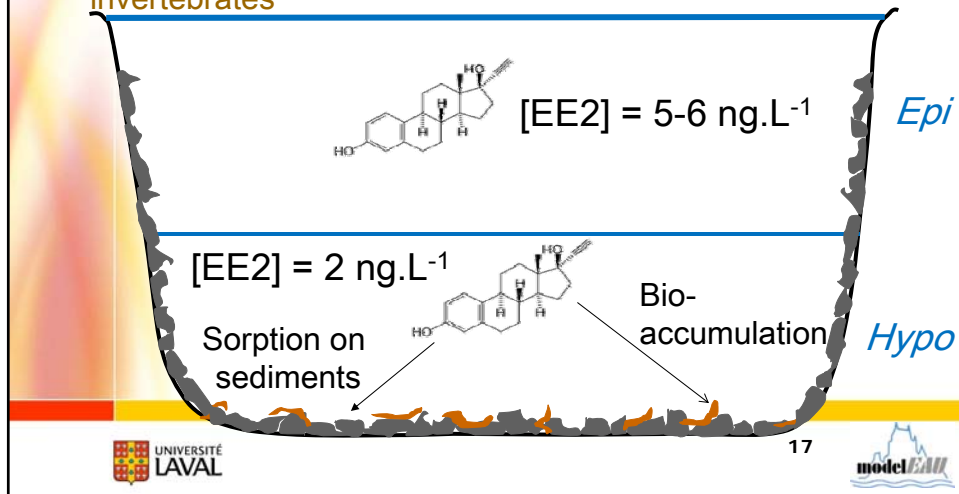
Experimental lake: Stratification



Experimental lake: EE2



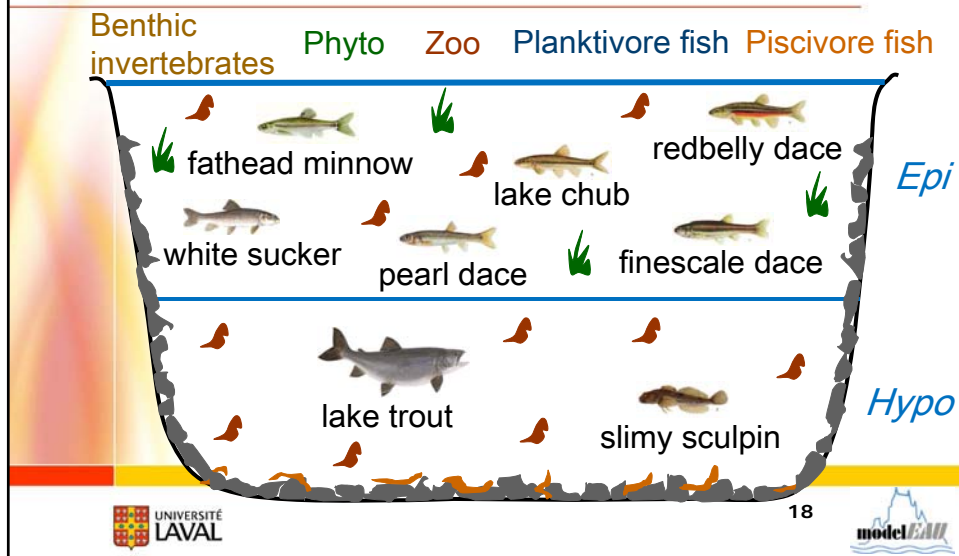
Benthic
invertebrates



Experimental lake: Biomass



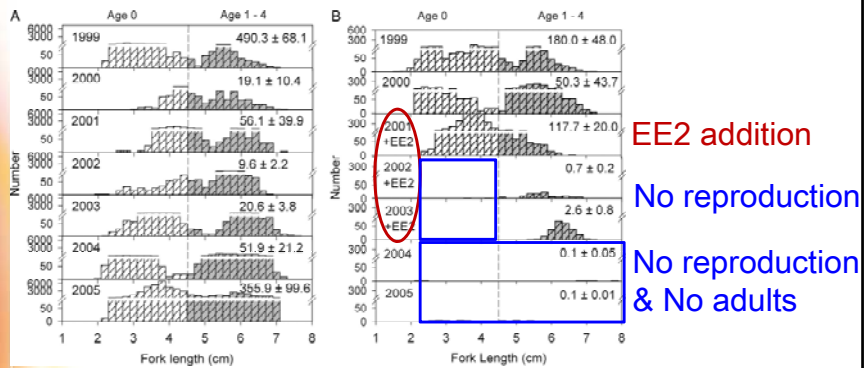
Benthic
invertebrates



EE2: Collapse of *fathead minnow*

Reference Lake

Experimental Lake



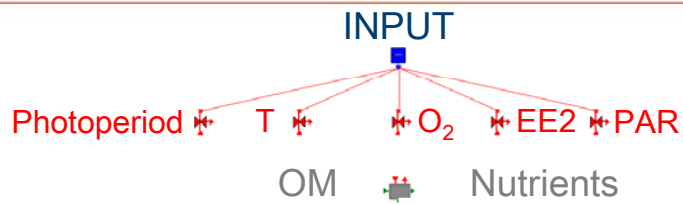
Kidd et al., 2007



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Ecosystem model: WEST

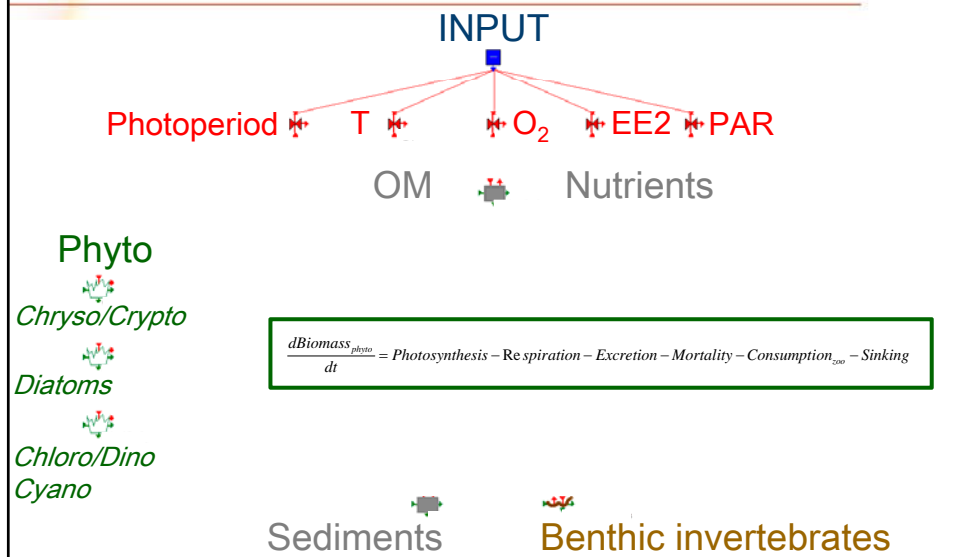


1 icon = 1 model

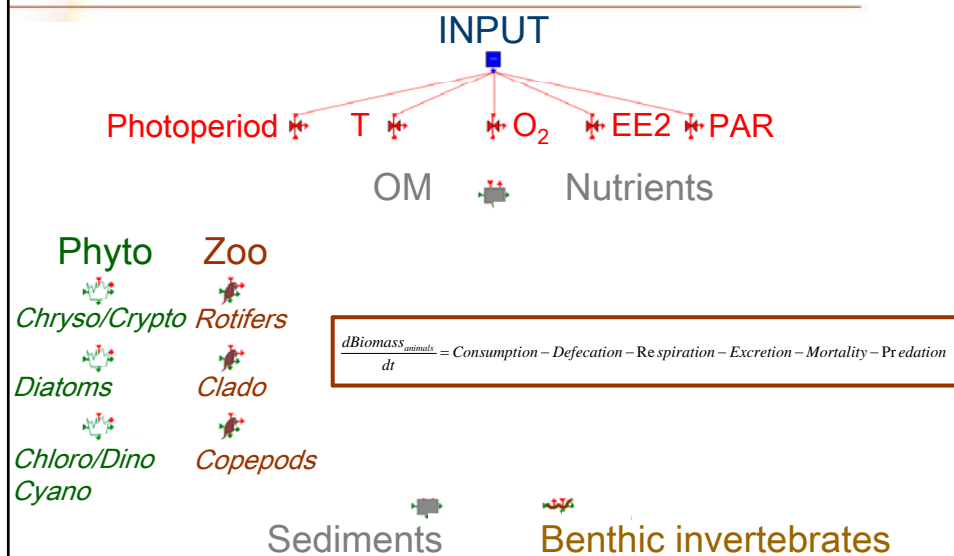
Sediments

Benthic invertebrates

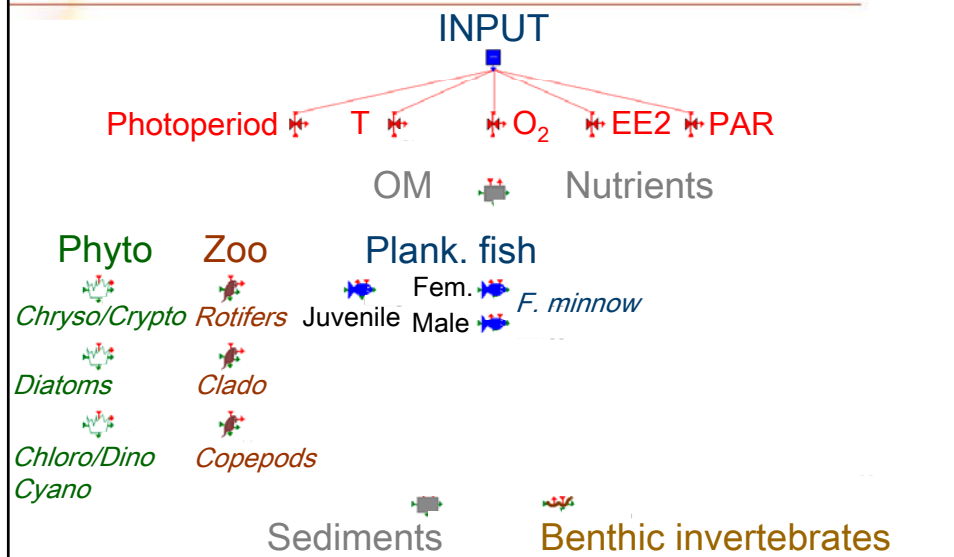
Ecosystem model: WEST



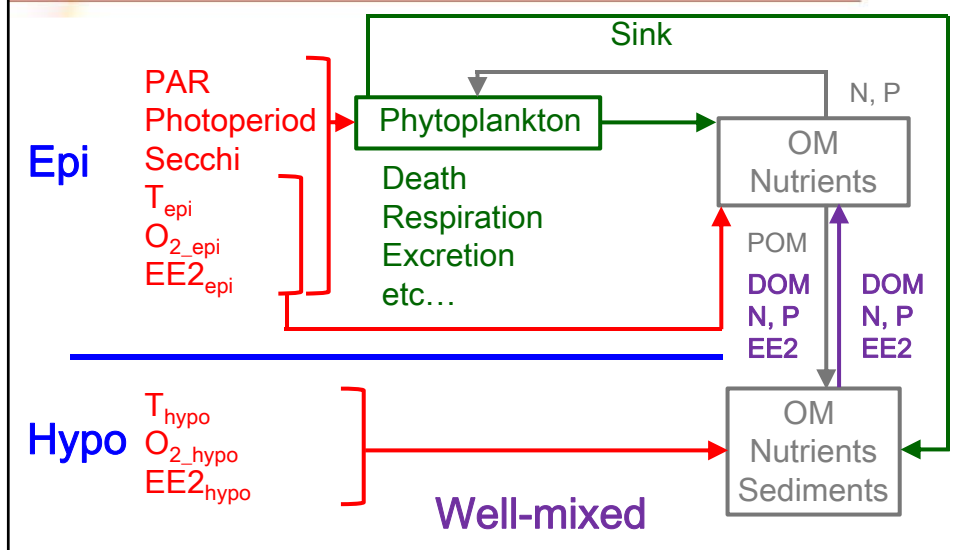
Ecosystem model: WEST



Ecosystem model: WEST



Modeling of lake dynamics



Modeling of lake dynamics

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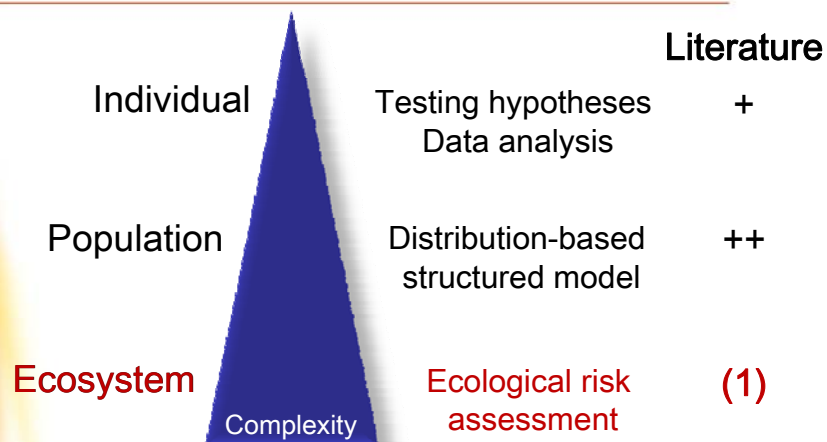
Transport

- + Loading
- Wash_out
- + Wash_in
- ± Diffusion_{seg}
- ± Migration
- Entrainment
- Fishing

Epi / Hypo

! Similar approach for river dynamics!

Conclusion



Conclusion

An ecosystem model for ERA:

- Simplified AQUATOX equations in WEST
- Lake dynamics:
 - Data analysis
 - Model development
- Endocrine disruptions:
 - Sex-classes
 - Reproductive factor

Acknowledgement

 Freshwater Institute
Welcome to the Freshwater Institute

Karen Kidd
Michael Paterson
Paul Blanchfield
Ken Mills
Michael Rennie
Alain Dupuis



Canada Research Chair
in Water Quality Modeling

