

# Modeling the impact of endocrine disruptions on aquatic ecosystem: An experimental lake study

SETAC-Europe

Milan, Italy

**Ludiwine Clouzot**  
Chris Metcalfe, Karen Kidd, Peter A. Vanrolleghem

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Canada Research Chair  
in Water Quality Modeling



## Ecological risk assessment

▪ Before: Individual



*EC50*

▪ Now: Population modeling



▪ Ecosystem modeling?



Specific with too many bio-details

**Objective**

Develop simple models to identify critical changes



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# Modeling endocrine disruptions



Joanne Parrott

- Mechanism rather than endpoint:

- « Bottom-up approach »

3	Ecosystem	?	0
2	Population dynamics	<i>Distribution-based structured model</i>	++
1	Individual	<i>Testing hypotheses / Data analysis</i>	+

Literature

Objective

Ecosystem modeling as a tool for decision-makers



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# Ecosystem modeling...

- I. Model development
- II. Experimental lake area (ELA)
- III. ELA modeling
- IV. Conclusion



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## Do we use AQUATOX?

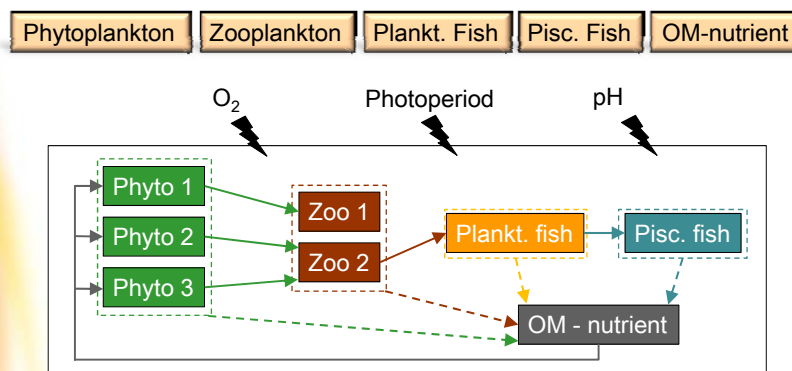
- AQUATOX = Fate and ecological effects of chemicals
- Endocrine disruptions: not considered
- Open source model: code is becoming very complex
- Objective: developing a simple model

Simplifying & adapting  
AQUATOX model

## AQUATOX-WEST

Frederik De Laender  
*PhD thesis (2007)*

- Object-oriented model



## Modeling endocrine disruptions



- Toxicity data based on EC50
- Reproductive endpoint
- Age / size classes for fish

### Endocrine disruptions

Scarce data → LOEC

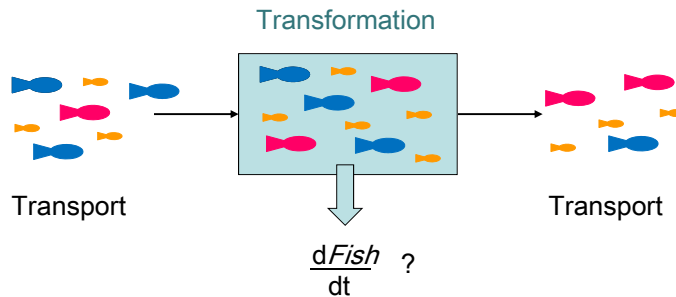
Intersex?

Juveniles & Adults F / M



Frederik De Laender  
*PhD thesis (2007)*

- Mass balance:



$$\frac{dFish}{dt} = \text{Transformation} + \text{Transport}$$

# AQUATOX-WEST

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

## Transformation

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

## Transport

- + Loading
- Washout
- + Washin
- ± Diffusion<sub>seg</sub>
- ± Migration
- Entrainment
- Fishing

# AQUATOX-WEST

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

## Transformation

- + Consumption
- Defecation
- Respiration
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- ~~+ Recruitment~~
- ~~- Promotion~~
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## Transport

- ~~+ Loading~~
- ~~- Washout~~
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- ~~± Diffusion<sub>seg</sub>~~
- ~~± Migration~~
- ~~- Entrainment~~
- ~~- Fishing~~

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



# AQUATOX-WEST



Frederik De Laender  
PhD thesis (2007)

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

Endocrine  
disruptions

## Transformation

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

## Transport

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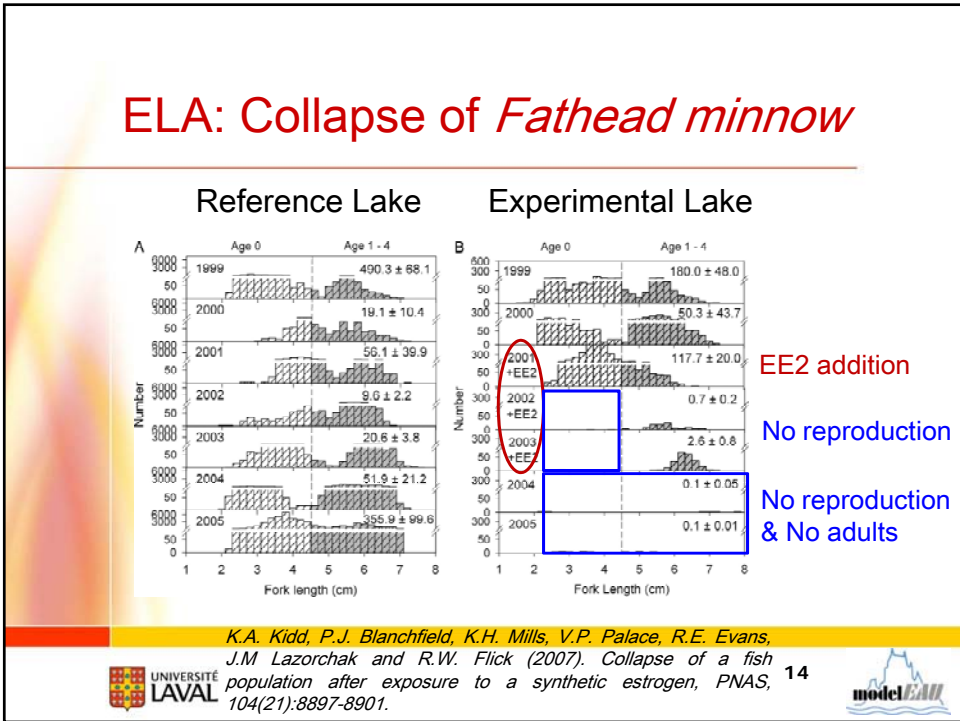
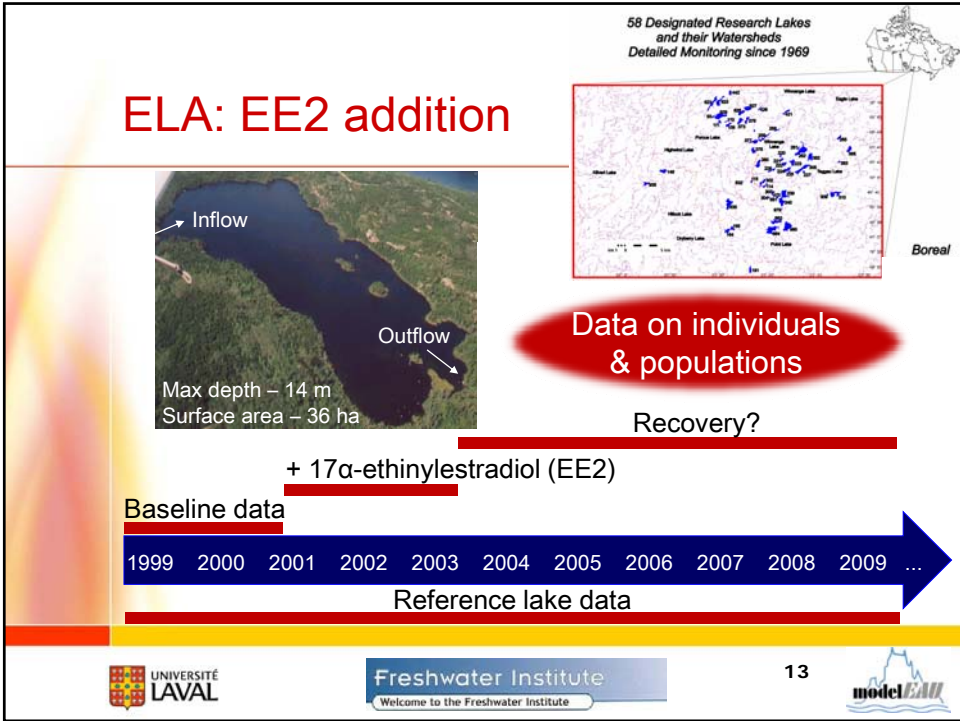
$$\frac{dBiomass_{animals}}{dt} = Consumption - Defecation - Respiration - Excretion - Mortality - Predation$$

$$+ Recruitment - Promotion - GameteLoss$$

Juveniles & Adults F / M

## Ecosystem modeling...

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## ELA: Hypotheses to be confirmed

- Fathead minnow:
  - Bioaccumulation
- Pearl dace:
  - Population decline: Lower effect
- White sucker:
  - The lowest impact
- Lake trout:
  - Indirect effects: Decrease of small fish
  - Bioaccumulation



*Palace et. al (2009). Interspecies differences in biochemical, histopathological, and population responses in four wild fish species exposed to EE2 added to a whole lake. Can. J. Fish. Aquat. Sci. 66: 1920-1935.*



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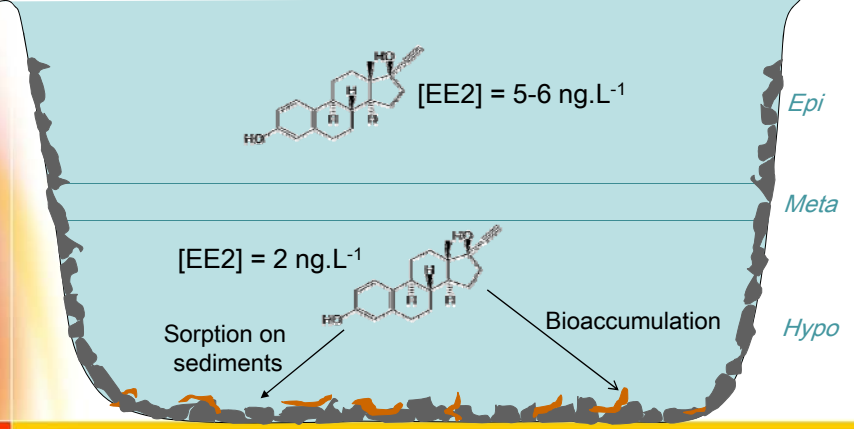




## ELA: EE2 distribution

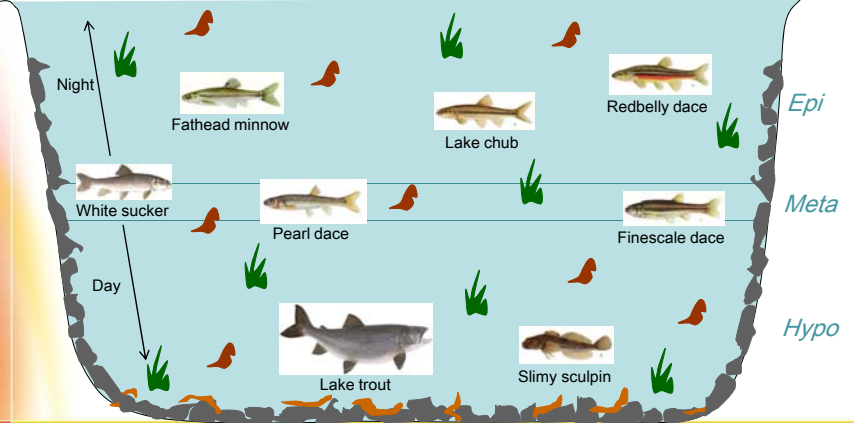


Benthic invertebrates

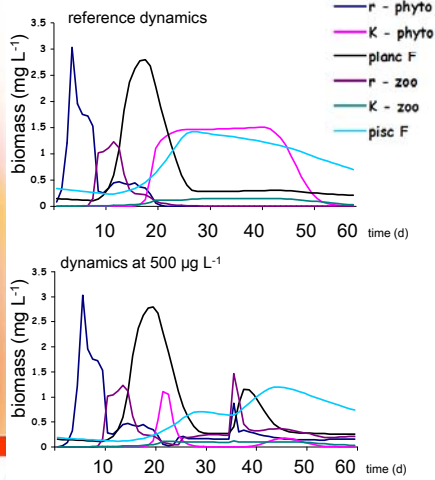


## ELA: Biomass

Benthic invertebrates Phyto Zoo Planktivore fish Piscivore fish



# ELA: Ecosystem dynamics



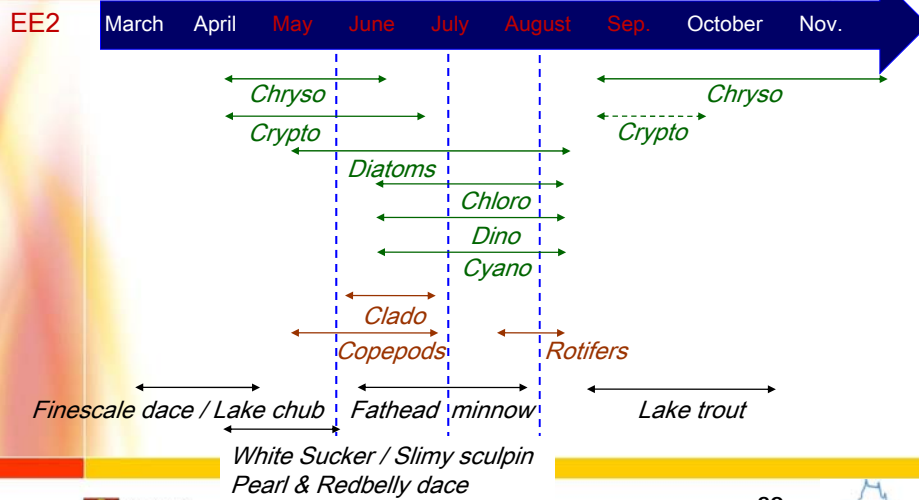
Frederik De Laender  
PhD thesis (2007)

Effect of Atrazine

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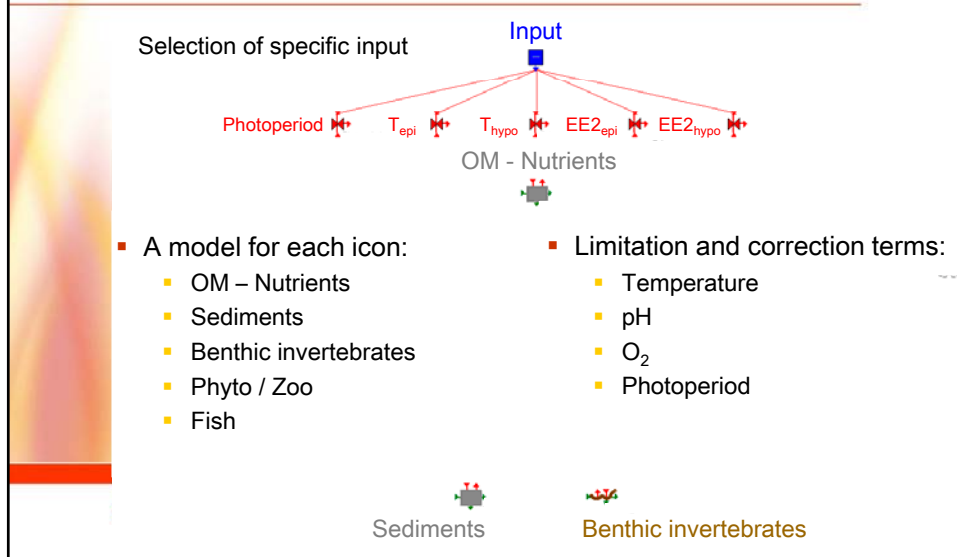
# ELA: Ecosystem dynamics



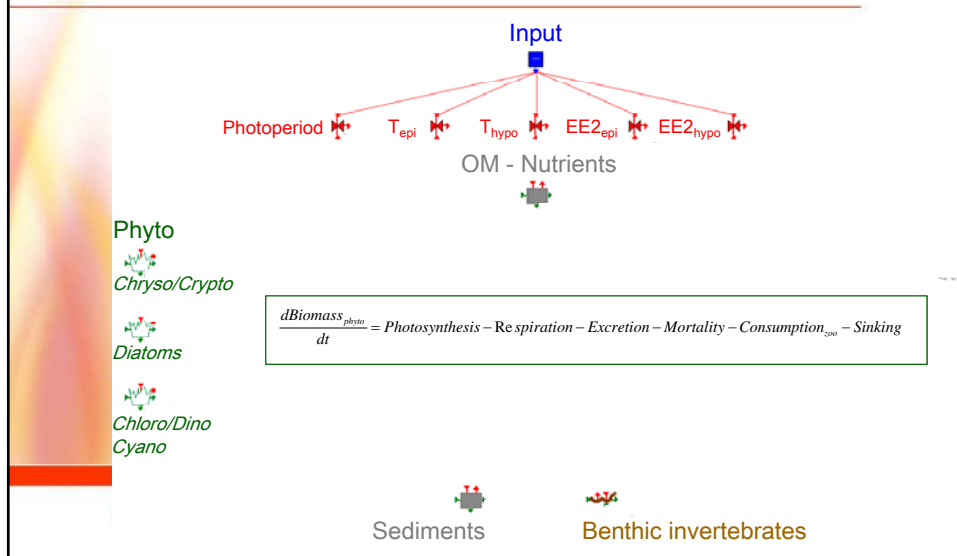
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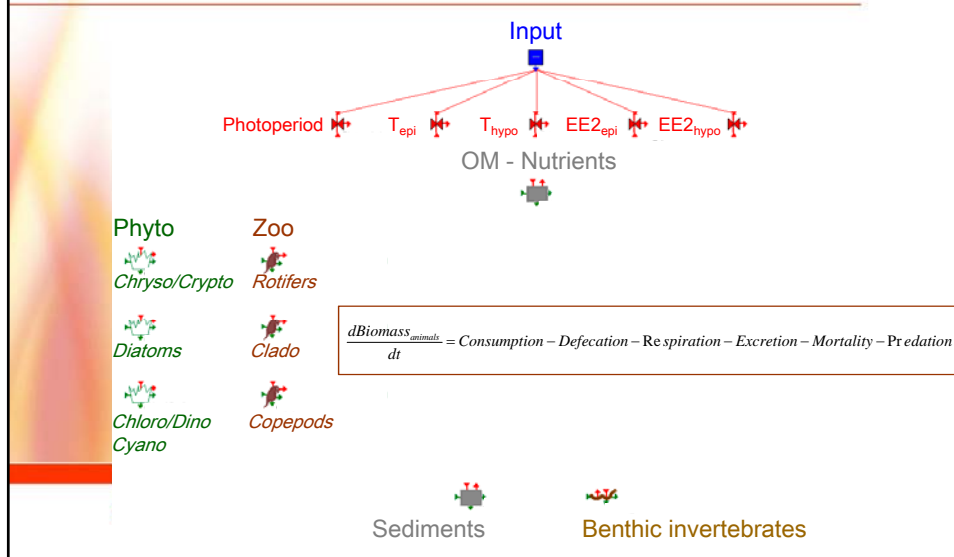
## ELA: model in WEST



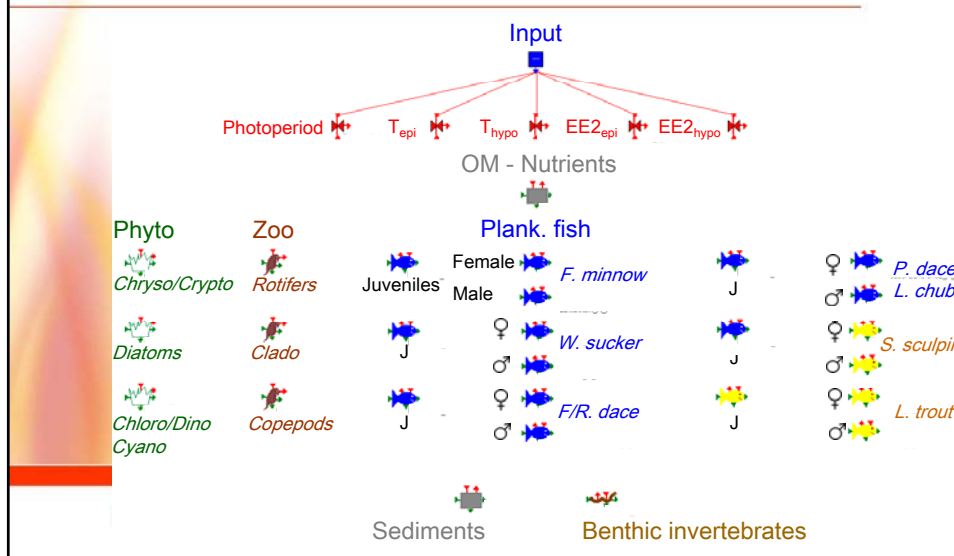
## ELA: model in WEST



# ELA: model in WEST



# ELA: model in WEST

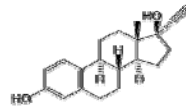


## What are the next steps?

- Modeling methodology: *ELA ecosystem*
  - Model development with baseline data
  - Calibration with EE2 data
  - Validation with recovery data and other lakes



- Endocrine disruptions: *EE2*
  - Literature review on toxicity data
  - Equations for reproductive endpoint & Bioaccumulation



## Ecosystem modeling...

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## Conclusion


First ecosystem model  
with endocrine disruptions

- Lake dynamics
  - Data analysis and interpretation
- Modeling software:
  - Choice of WEST combined with AQUATOX equations
- Ecosystem structure:
  - Built in WEST
- Reproductive endpoint:
  - Equations are being developed

## Acknowledgement

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