

Modélisation d'écosystèmes: Evaluation des stations d'épuration en terme d'elimination des micropolluants

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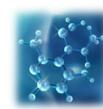
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Canada Research Chair
in Water Quality Modeling



WWTPs: Effluent characterization



- Researchers
- Engineers
- Decision-makers

Objective:

- Improve WWTP design/operation
- Minimize the impact on the receiving waters



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WWTPs: Ecotoxicological context

Protect ecosystem services

- Supporting services
- Provisioning services
- Regulating services
- Cultural services



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WWTPs: Ecological criteria

Phyto: primary producer (N & P cycles)

- Production with min and max thresholds

Index of diversity (D) (Simpson 1949)

$$D = 1 - \sum (p_i)^2$$

D_{phyto}, D_{zoo}, D_{fish}

- D = values from 0 to 1
- p_i = proportion of individuals of species i



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WWTPs: Ecological criteria

Effluent

WWTP [MPs]

Typical ecosystem

?

Population dynamics



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WWTPs: Ecological benchmarking

Effluent



[MPs] 1

Ecosystem

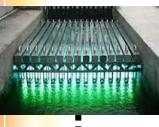


Bio-effect 1



[MPs] 2

Bio-effect 2



[MPs] 3

Bio-effect 3

The best
WWTP?



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Eco-benchmark: Micropollutants

Numerous micropollutants (MPs) & different effects

- Class with common mechanism
(*e.g. endocrine disrupters*)
- Bio-effects rather than [MPs]



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Eco-benchmark: Endocrine disruption

- Laboratory studies = individual
- Field studies = population
- Models = individual & population

What happens at the ecosystem level?



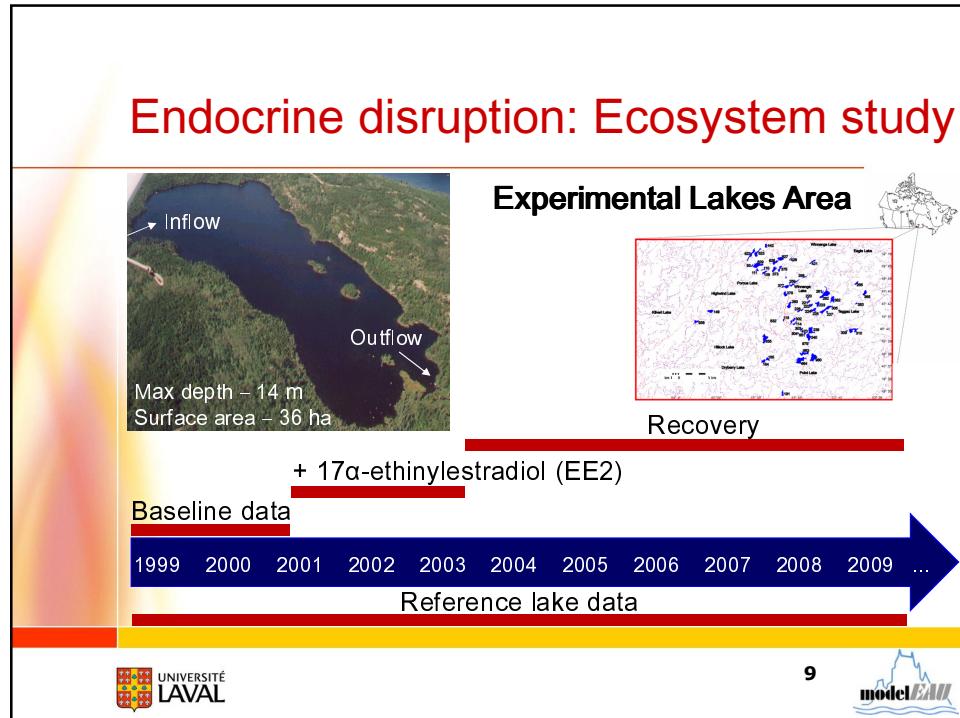
*Joanne Parrott



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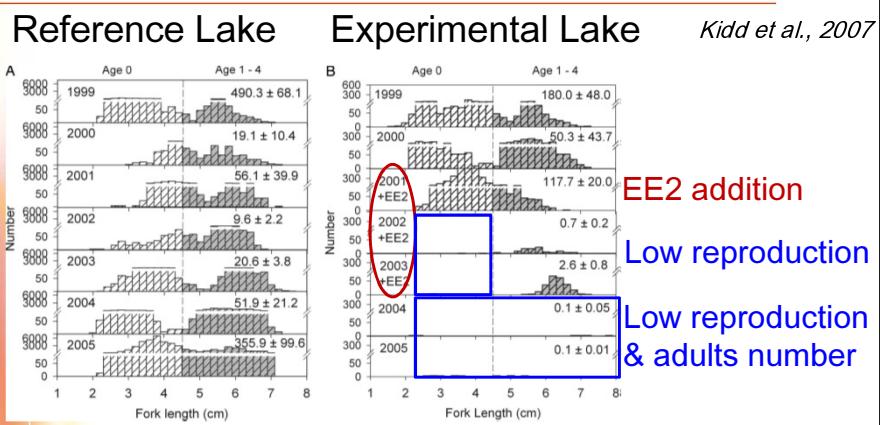


Endocrine disruption: Ecosystem study



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EE2: Collapse of *fathead minnow*



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Endocrine disruption in the other fish species



Endocrine disruption: Ecosystem

Ecosystem experimental study:

- Just one shot!



Ecosystem models:

- Required to better understand endocrine disruption and to be able to predict risk
- 0 studies found in the literature



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Objective of the study

Developing an **ecological benchmark model** for characterizing WWTP effluents:

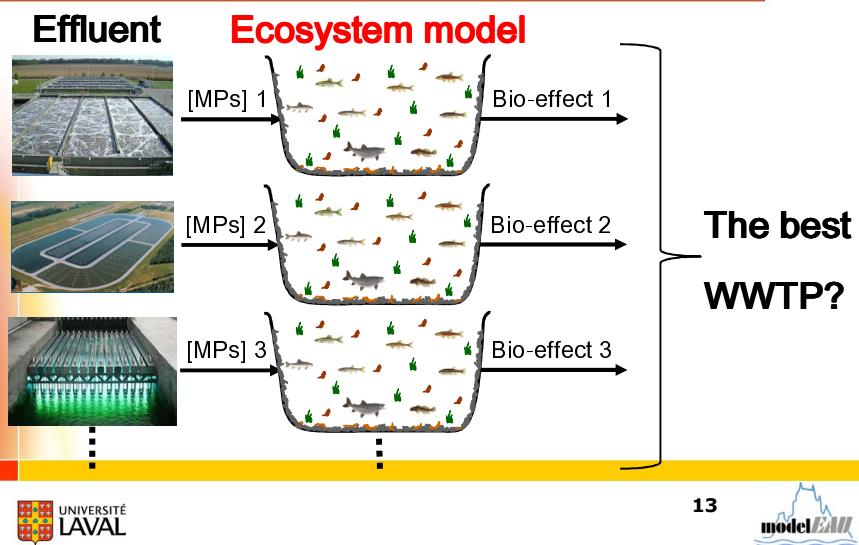
- Modelling a typical aquatic ecosystem
- Predicting the impact of endocrine disrupters



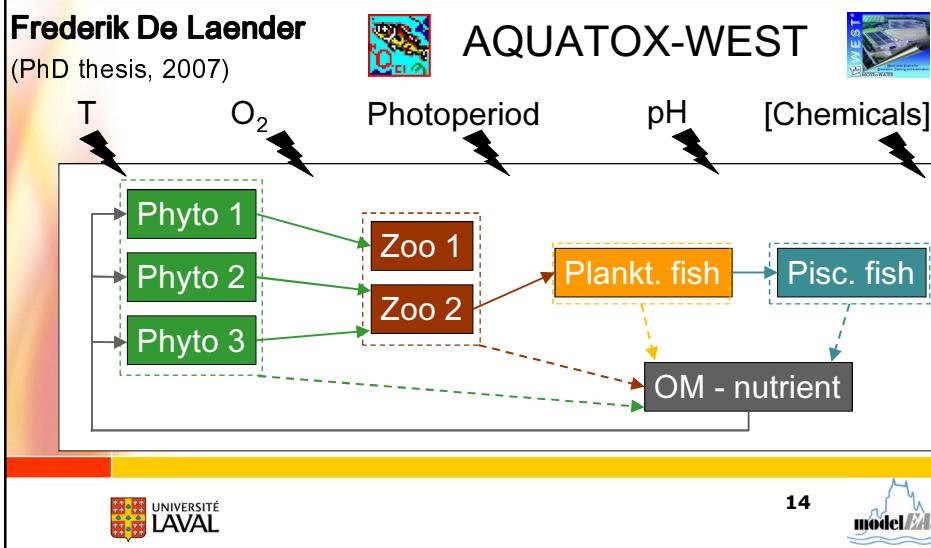
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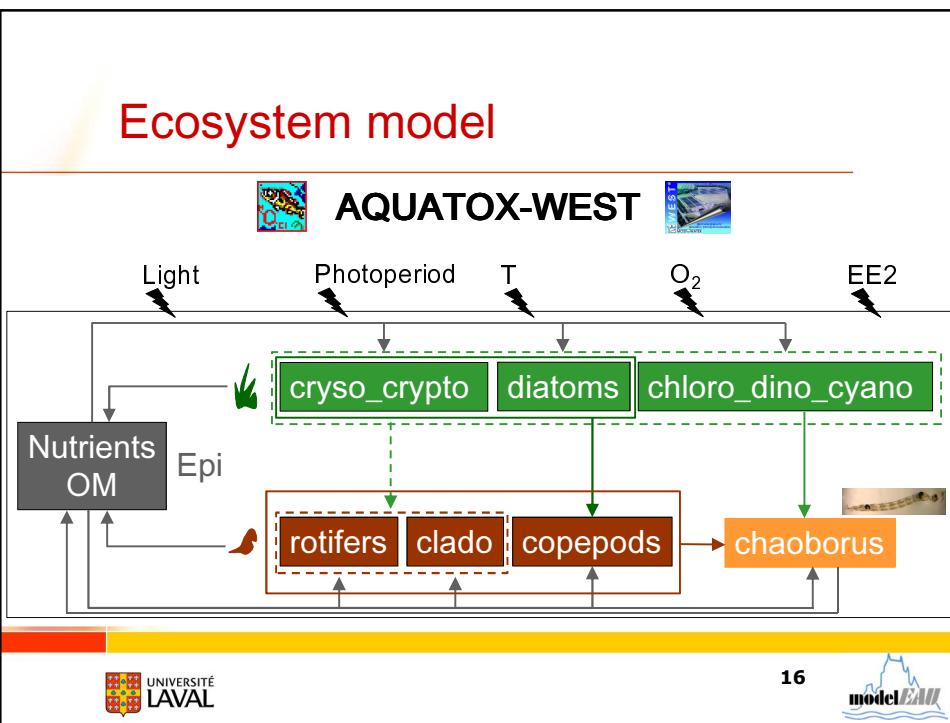
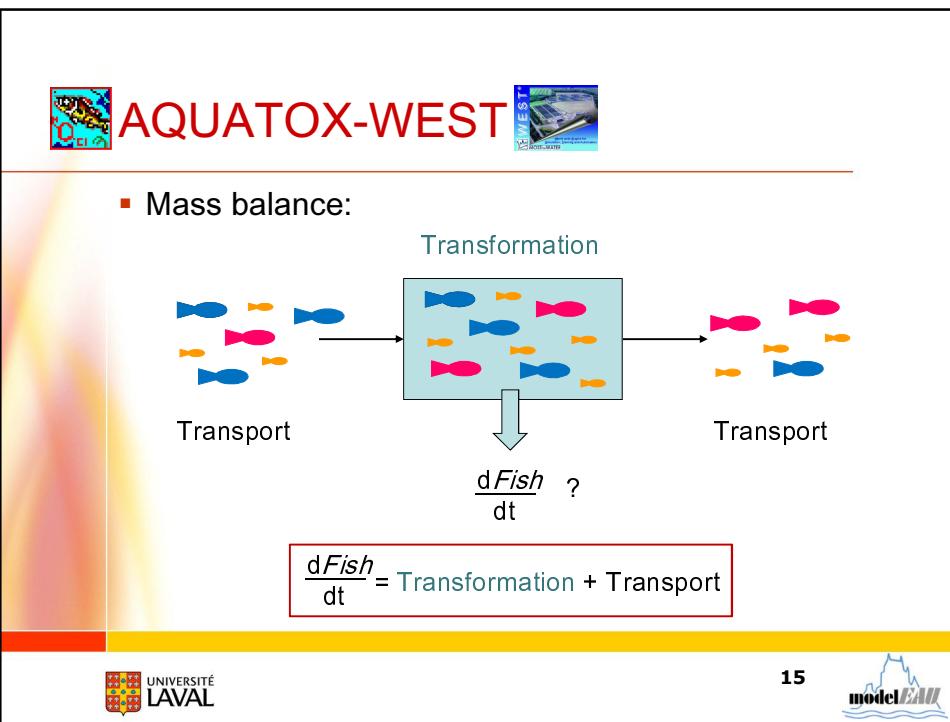


WWTPs: Ecological benchmarking



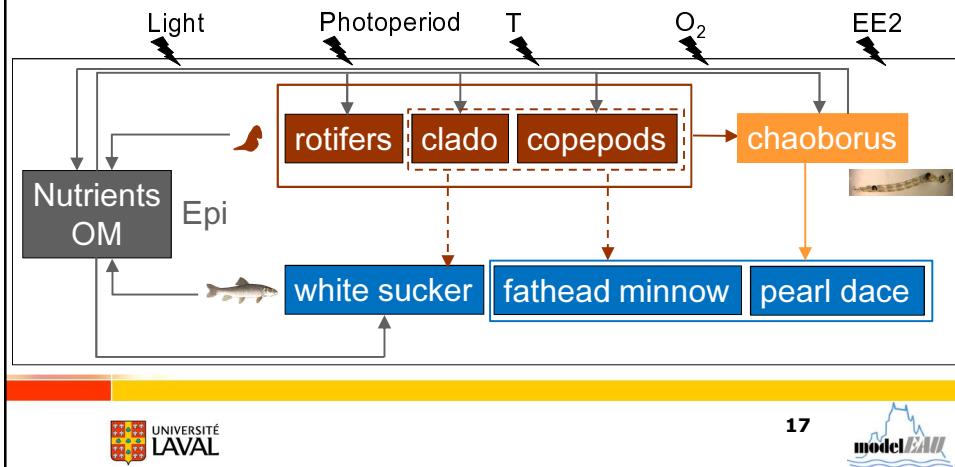
Ecosystem model





Ecosystem model

 AQUATOX-WEST 

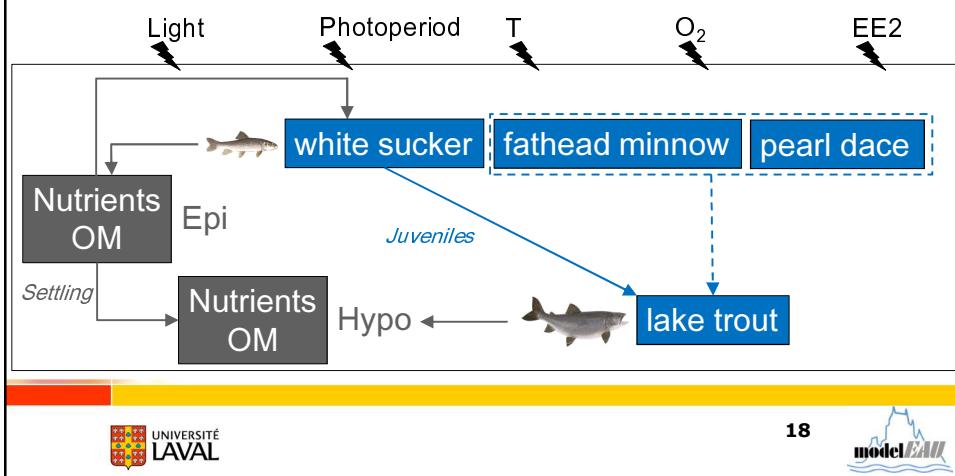


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Ecosystem model

 AQUATOX-WEST 

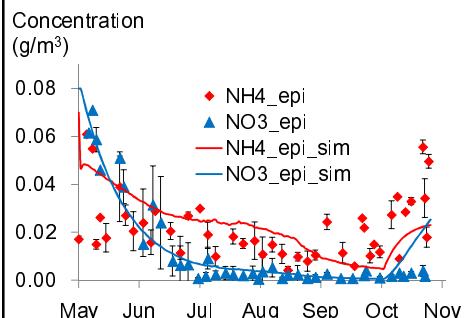


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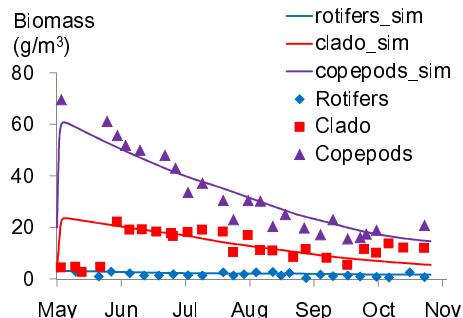


Modelling results: Calibration

Nutrients



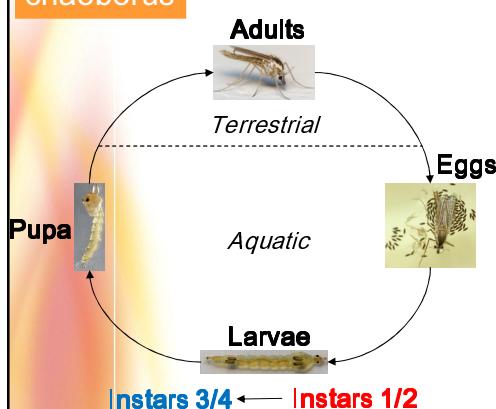
Zooplankton



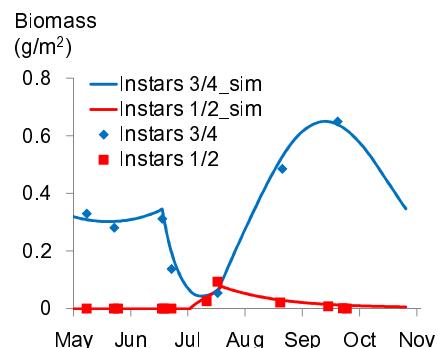
Modelling results fit experimental data

Modelling results: Calibration

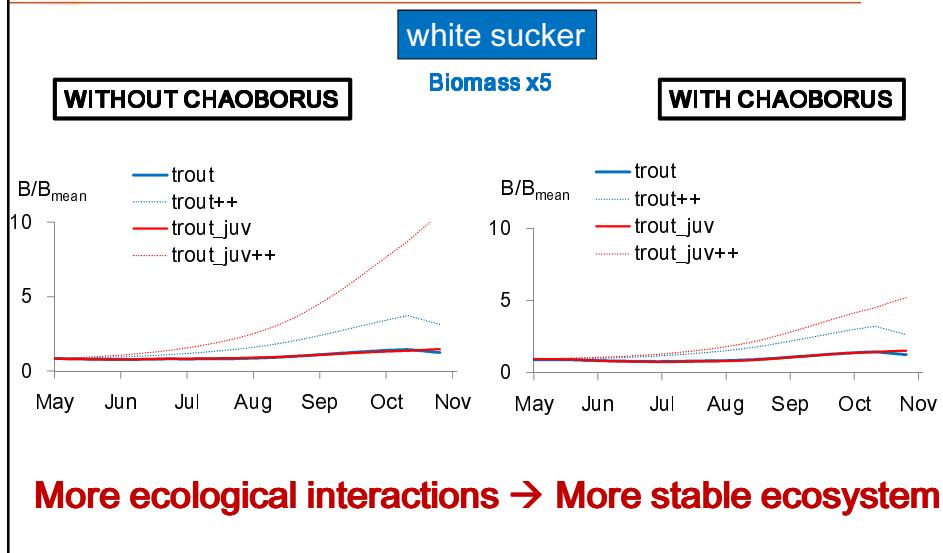
chaoborus



Key species in ecological interactions



Modelling results: Sensitivity analysis



Model Development: Conclusion

Calibration:

- Modelling results fit experimental data

Sensitivity analysis:

- Initial population x5 and $\div 5$ for each species
- Assessing interactions in the ecosystem
- Shows the potential of the model

EE2: Ecosystem-level effects

Direct effects of EE2:

- Mainly on fathead minnow
- Pretty well understood

Indirect effects of EE2: *Kidd et al., 2014*

- Food web responses rarely studied
- Experimental data show some indirect effects
- More answers with the ecosystem model

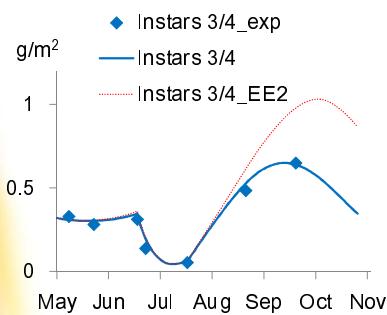


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EE2: Indirect effects

Chaoborus

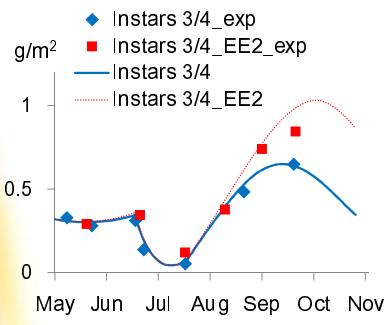


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EE2: Indirect effects

Chaoborus



Plankton and nutrients

2002

No significant changes
= compensatory mechanisms

After 2002

Increase of rotifers and
cladocerans



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EE2: Indirect effects

Importance of ecosystem-level effects
when assessing the risk of chemicals
in aquatic environments.



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Conclusion

Final step = Ecological benchmarking of WWTPs

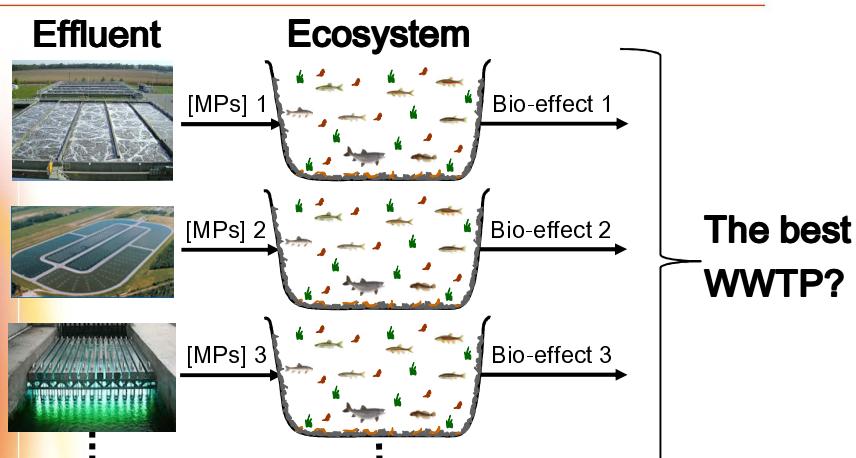
- **STRUCTURE** = A typical aquatic ecosystem
- **INPUT** = WWTP effluents for different configurations
- **OUTPUT** = Ecosystem changes due to the exposure to MPs



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WWTPs: Ecological benchmarking



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Acknowledgement

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Welcome to the Freshwater Institute



For more questions: ludiwine.clouzot.1@ulaval.ca

