

Extinction Risk in a Wood Frog Metapopulation under Environmental Contamination by tPCBs

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Introduction

US EPA conducting an Ecological Risk Assessment of Housatonic River, Mass. Contaminated with PCBs from GE plant.

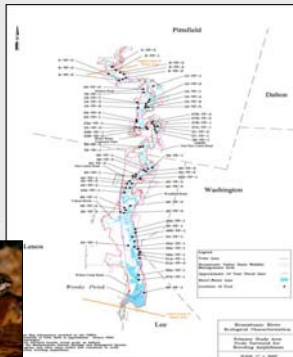
Amphibians declining worldwide.

Amphibians particularly sensitive to environmental toxins because of life history.

Wood frog (*Rana sylvatica*) most abundant breeding amphibian at Housatonic site.

Purpose

To model effects of tPCBs on population persistence of a metapopulation of wood frogs breeding in 27 vernal pools on the floodplain of Housatonic River.



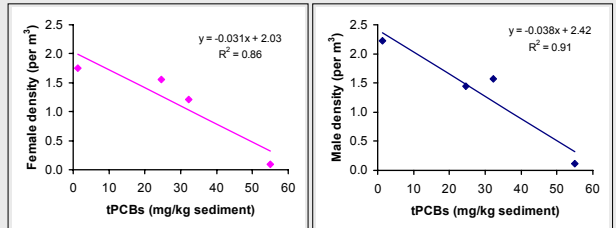
Parameterizing the Model

Initial abundances and vital rates estimated from field data at site and from literature.

tPCB concentrations measured in each vernal pool.

Malformations predicted from data collected at site.

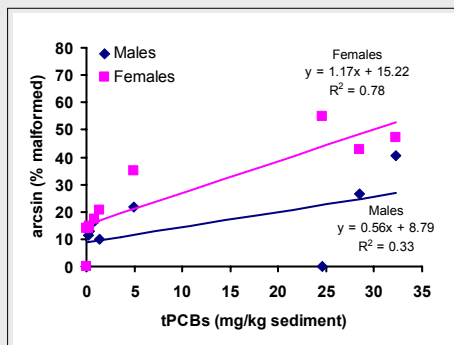
Abundance reduced by PCBs



(P=0.072)

(P=0.047)

Malformation caused by PCBs



Modeling Approach

Dynamic model projecting population trends 10 years into the future (terminal extinction risk and probability of decline).

Age and sex structured, yearly time steps.

Demographic and environmental stochasticity.

Migration between pools as a function of dispersal distance.

RAMAS Metapop (Akçakaya 2002).

Base Models and Impacts

Non-Declining Base Model

Impact 1: mortality = 50%, infertility = 100%

Impact 2: mortality = 100%

Impact 3: mortality = 50%, infertility = 50%

Declining Base Model

Impact 1: mortality = 50%, infertility = 100%

Impact 2: mortality = 100%

Impact 3: mortality = 50%, infertility = 50%

Sensitivity Analyses

Vital Rates:

Changed survival and fertility rates in Leslie matrices by $\pm 5\%$ and $\pm 10\%$

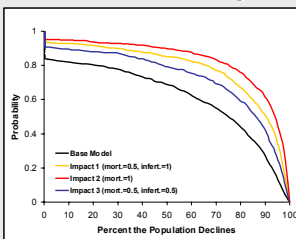
Density-Dependence:

- Ceiling model = carrying capacity 10X initial abundance

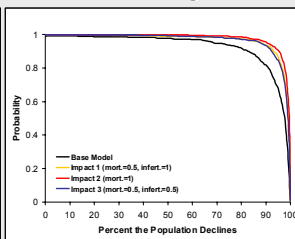
- Ricker-type model = compensatory

Probability of population decline after 10 years

Non-Declining



Declining



Population parameters after 10 years

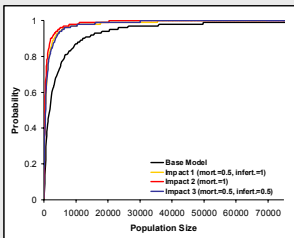
	Base	Impact 1	Impact 2	Impact 3
NON-DECLINING				
Min. abundance	21,822	7,616	5,637	9,816
Extinction duration	0.96	3.26	4.04	2.26
Time to extinction	20.0	11.0	8.5	11.5
DECLINING				
Min. abundance	5,560	1,604	1,129	1,643
Extinction duration	3.63	5.67	5.89	5.52
Time to extinction	7.5	5.1	4.5	5.7

(Impact 1: mort=50%, infert=100%; Impact 2: mort=100%; Impact 3: mort=50%, infert=50%)

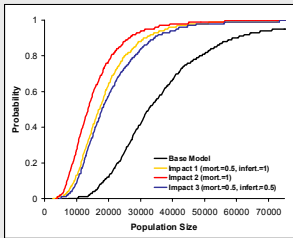
Sensitivity: Density-dependence

Terminal extinction risk
Declining base model

Ceiling density-dependence



Ricker density-dependence



Conclusions

PCBs negatively impacted Housatonic wood frog metapopulation:

- hastened population decline
- reduced population size
- increased likelihood of extinction

Effects exacerbated when population already in decline.

Conclusions

Sensitivity Analyses:

- increasing vital rates increased metapopulation persistence
- compensatory density-dependence improved metapopulation persistence

None of sensitivity manipulations completely removed negative effects of PCBs

Management implications

Acknowledgements



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