*Welcome to the PhD-course:*

# Matrix models and population dynamics:

# applications in conservation and ecotoxicology

(3HEC/ECTS)

*May 22-23 and May 29-31 2017*

**Organizers: Drs. John E. Banks (California State University, Monterey Bay) and Alva Curtsdotter (SLU)**

*Learn about simple but powerful use of matrix models in modelling population dynamics, with applications in conservation and ecotoxicology by the end of the spring semester 2017! This short course consists of a mixture of lectures, reading, and practices in coding (R)!*

*See attached Course plan and Schedule for detailed program!*

**When: 22-23 May** and **29-30th May** 2017 class room meetings and final report due 7 June.

**Where:** Ekologicentrum Ulls väg 16, 750 07 Uppsala, Lecture room F or Tammsalen (meetings ~10:00-14:00 or 9:00-13:00)

**Examination:** Written proposal of use of matrix models in your field or in literature.

**Prerequisites:** A basic knowledge of calculus (i.e. differential calculus) and R is recommended, but not necessary.

**Application:** Sign up for the course by sending an e-mail to Alva Curtsdotter (alva.curtsdotter@slu.se) and copy to (cc) Helena Bylund (helena.bylund@slu.se) **no later than April 31!**.

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## Matrix models and population dynamics: applications in conservation and ecotoxicology

**Drs. John E. Banks (California State University, Monterey Bay) & Alva Curtsdotter (SLU)**

### Objective

This is a short course in which students will learn about the use of matrix models in modelling population dynamics, with applications in conservation and ecotoxicology. The course will consist of a mixture of lecture, reading, and practice coding (R). Those taking the course will understand some basic linear algebra underlying simple matrix models as well as how the models may apply to conservation and other population dynamics studies. Students will also develop a plan to apply these methods to their own data, if applicable, or more generally a proposal on how to apply these methods within the student's field of research/interest.

### Prerequisites

A basic knowledge of R, basic calculus and basic algebra is recommended, but not necessary.

### Course contents (Summary outline):

*Introduction to linear algebra/matrix models*

- *a. Overview of matrix models, eigenvalues, eigenvectors.*
- *b. Matrix calculations*
- *c. Population projection, equilibrium solution matrices.*
    - *i. Practise: Demonstration of coding for matrix population projections*

*Applications: Population projection*

- *a. Reptile conservation*
    - *i. Practise: Coding exercise I: matrix projections with data from turtle conservation (Carretta carretta)*
- *b. Sensitivity analysis: open and closed form derivation*
    - *i. Practise: Demonstration of coding for sensitivity analysis ( R).*

*Applications: Ecotoxicology*

- *a. Effects of pesticides on population persistence*
    - *i. Coding exercise II: Effects of pesticides on parasitoid wasps/Daphnia/fruit flies.*

*Final report deliverable (proposal of use of matrix models in students' field w/literature).*

Classroom meeting times:

May 22$^{nd}$ and 23$^{rd}$, 10am-3pm; May 29$^{th}$, 10am-3pm; 30$^{th}$ , 9am-1pm, 31$^{st}$, 10am – 2pm.

**References**:

Caswell, H. 2001. Matrix population models: construction, analysis, and interpretation. Second edition. Sinauer Associates, Sunderland, Massachusetts, USA.

Morris, W. F., and D. F. Doak. 2002. Quantitative conservation biology: Theory and practice of population viability analysis. Sinauer Associates, Sunderland, Massachusetts, USA.

Stark, J. D., J. E. Banks, and R. Vargas. 2004. How risky is risk assessment? The role that life history strategies play in susceptibility of species to pesticides and other toxicants. *Proceedings of the National Academy of Sciences USA* 101: 732–736.

**Intended Learning Outcomes:**

- Students will understand basic mathematics behind matrix population models, and how they apply to population dynamics.
- Students will learn/understand how to write code (in R) to create simple population projections from provided data.
- Students will understand how to conduct sensitivity analyses for matrix models, and how to apply it to population dynamics analyses.

**Examination:**

Final, individual report: Proposal of use of matrix models in students' field w/literature.

# Matrix models and population dynamics: applications in conservation and ecotoxicology (3 ECTS)

**Drs. John E. Banks (California State University, Monterey Bay) & Alva Curtsdotter (SLU)**

**May – June 2017**

**Week ONE** (**May 22, 23**)

**Preliminary meetings w/Dr. Curtsdotter** – Introduction R programming, simple population models.
**Practice**: coding population projections.
**Lecture room:** Tammsalen 10:00 -15:00

**Week TWO (May 29-31)**

1. Classroom (**Monday 29 May, 10:00-14:00, Lecture room Tammsalen, Ekologicentrum**): *Introduction to linear algebra/matrix models*

    a. Overview of matrix models, eigenvalues, eigenvectors.
    b. Matrix calculations
    c. Population projection, equilibrium solution matrices.
        i. **Practice**: Demonstration of coding for matrix population projections

*2.* Classroom (**Tuesday 30 May, 9:00 -13:00, Lecture room Tammsalen, Ekologicentrum**): *Applications: Population projection*

    a. Reptile conservation
        i. **Practice**: Coding exercise I: matrix projections with data from turtle conservation (*Carretta carretta*)
    b. Sensitivity analysis: open and closed form derivation
        i. **Practice**: Demonstration of coding for sensitivity analysis (R).

3. Classroom (**Wednesday 31 May, 10:00-14:00, Lecture room F-salen, Ekologicentrum**): *Applications: Ecotoxicology*

    a. Effects of pesticides on population persistence
        i. **Practice**: Coding exercise II: effects of pesticides on parasitoid wasps/Daphnia/fruit flies.

**Week THREE** (**June 5-7**):

Final report due Wednesday 7 June (proposal of use of matrix models in students' field w/literature).