Calculus for the Life Sciences

M-CAST Presentation

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Calculus for the Life Sciences at SDSU

- Biology Majors take Calculus (6 Units) and Biostats (3 Units)
- Biology is impacted major – competitive prerequisites
  - Calculus I (Math 121) has 150-250 students/semester
  - Calculus II (Math 122) has 75-120 students/semester
- Wide diversity of students
  - 95% want to be Biology majors
  - Some have high school or community college Calculus
  - At other end, they have 8 year gap since last math course
- Courses have 2 hr Lectures and a 2 hr Computer Lab each week

Course Design

- Each topic introduced with **biological application**
  - Crickets chirping and temperature introduce lines
  - Prozac/drugs introduce exponentials
  - Mercury build up in fish described for antiderivatives
- Modeling and dynamical systems approach
- **Computer Lab**
  - Most problems based on real data
  - Use Excel and some Maple to solve – easily adaptable to other computer tools, like MatLab
  - Learn writing and graphing skills
- Many students return to say Lab skills were invaluable in upper division biology courses

Modeling and Dynamical Systems Approach

- Calculus I structure
  - Introduce modeling methods and review functions
  - Discrete dynamical models
    - Malthusian growth important and easily accessible
    - Linear discrete models – stability later connects to derivative
    - Growth important biological introduction to derivative
  - Derivatives applied to many biological problems

Modeling and Dynamical Systems Approach

- Calculus II structure
  - Nonlinear discrete dynamical models - Stability with derivative
  - Optimization
  - Trigonometric (sine and cosine) models
  - Linear differential equations - derive from discrete models
  - Solving other differential equations gives antiderivatives/integrals
  - Some qualitative analysis of differential equations and systems, like competition models

WeBWorK

- Open source through MAA under instructor control
- Great for managing large classes
- HW is done on WeBWorK
- Gets students to do HW
- Randomization minimizes cheating
- Gives immediate feedback to lectures
- Invaluable for managing Computer Labs

Computer Labs

- Unique experience for students
- Hands on work with computers and math models
- WeBWorK imposes accuracy, so scientific discipline
- Writing and graphing skills improve over the semester
- Students learn to appreciate the value of mathematics in their field of interest
- Work 2–3 problems each week
- Have developed over 70 Lab problems with over 50 adapted to WeBWorK (available from my web site)

Computer Lab Problem: Beetle Population Growth

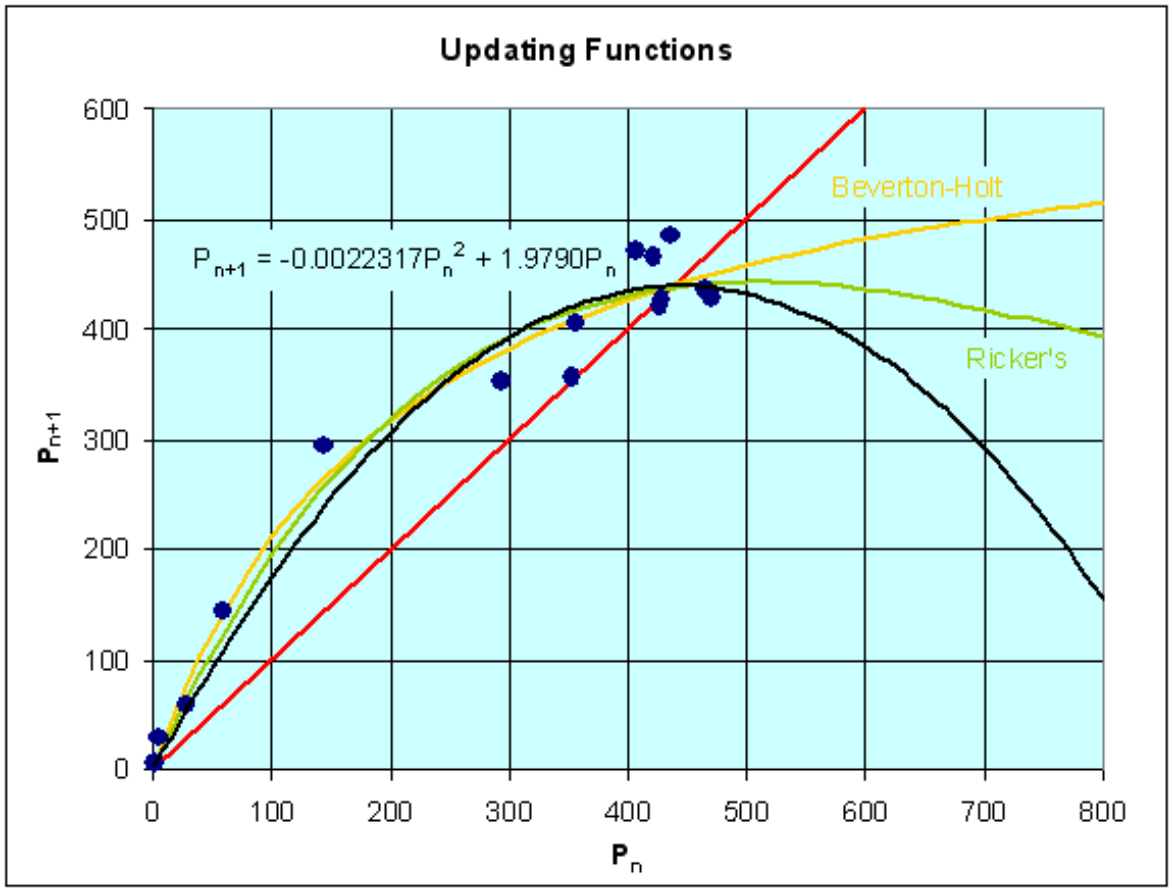
- Students given data (slightly randomized) from study of grain beetles growing with limited resources
- Examine a series of models of the form

$$P_{n+1} = F(P_n)$$

- Use tools in Excel to fit **updating functions** from logistic, Beverton-Holt, and Ricker's models
- Study dynamical systems properties of the models – equilibria and stability
- Study properties of functions – extrema, asymptotes
- Examine time series of different models

Computer Lab Problem: Beetle Population Growth

Will show WeBWorK problem and demonstrate some of Excel to solve this problem



Computer Lab Problem: Beetle Population Growth

Despite wide variation in model form, time series results are similar