

**Lecture 8: Population dynamics**

I. Introduction

A. Objectives

1. Introduce basic determinants of population dynamics
2. Review basic concepts of population models
3. Illustrate how population models are used in management contexts

B. Background and definitions

1. Population: individuals of a single species interacting and sharing the same space and gene pool
2. Why study population ecology?
3. Population dynamics
  - a. rates of increase
  - b. fluctuations in numbers of individuals
  - c. relationships of these to environmental factors

II. Rates affecting populations

A. Equation for predicting population size (N) at some future time (t):

$$N_t = N_0 + \text{Recruits} - \text{Deaths} + \text{Immigrants} - \text{Emigrants}$$

B. Mortality (M) – rate of death in a population in an interval of time

1. Survivorship curves

- a. general patterns

- b. Type III curve

2. Estimating mortality rate

C. Recruitment (R) – rate at which new fish are added to the adult population in an interval of time;  $f(\text{birth}, S)$

1. In fisheries, focus on harvest size, age

2. Related terms: year-class strength, cohort

3. Environmental determinants

## III. Models of regulation of animal abundance

A. For now, assume  $\Delta N/\Delta t = R-M$

“All models are wrong, but some are useful”

B. Density-independent (exponential) growth

1. Density-independent factors -- mostly abiotic

2. Exponential model of population increase

a.  $\Delta N/\Delta t = (R_1 - M_1)N$  or  $\Delta N/\Delta t = rN$

b. intrinsic rate of increase ( $r$ ) and population growth rate ( $\lambda$ )

c. using life tables

3. r-selected species

C. Density-dependent (logistic) growth

1. Density-dependent factors -- mostly biotic

2. Basic logistic model of population increase

a.  $\Delta N/\Delta t = rN(1-N/K)$

b. carrying capacity,  $K$

c. Leibig's law of the minimum

3. K-selected species

D. Other factors that could be incorporated into models

1. Competition with other species

2. Predation

3. Emigration and immigration

4. Environmental variability

E. The realism vs tractability tradeoff

#### IV. Applications

A. Stock-recruitment models

1. General form

2. Usefulness in predicting future stock / setting fishing quotas

3. Usefulness in estimating maximum yield

B. Population viability analysis

1. Predict future population size or determine viability, persistence

2. Organize and recognize gaps in data

3. Determine rates most influential to population growth

C. Limitations