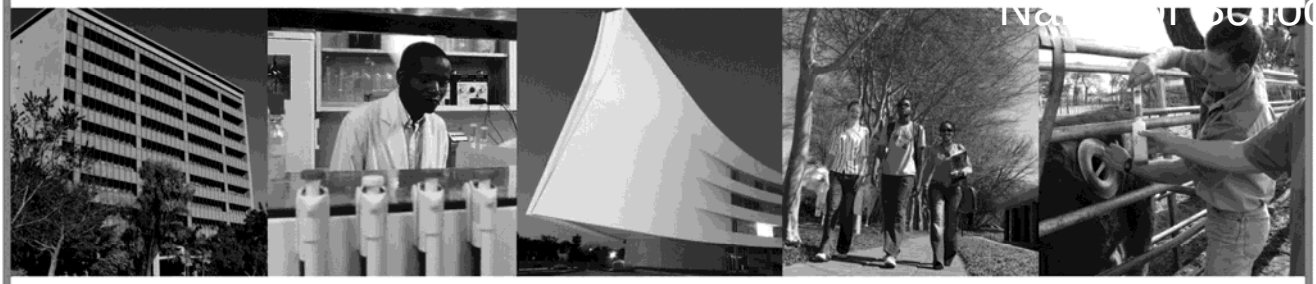
Fakulteit Natuur- & Landbouwetenskappe
Faculty of Natural & Agricultural Sciences

2014

Department of Zoology and Entomology

Population Ecology Zen351



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Leading Minds

POPULATION ECOLOGY (ZEN 351)
03th February – 24th March 2014 (28 lectures & 10 practicals)

Course leader:	Dr. P.J. Nico de Bruyn (Mammal Research Institute)
Responsible lecturers:	Dr. Nico de Bruyn, Dr. Jeff Garnas (FABI), Dr. Catherine Sole (Zoology)
Tutor:	Ms. Cathy Bester (Rm. 2-27, MRI)

SCHEDULE OF LECTURES, PRACTICALS AND TESTS:

Theory lectures:

Venue	**Room 2-11(Zoology building)**	
Times	Monday	07:30-08:20
	Monday	12:30-13:20
	Tuesday	13:30-14:20
	Friday	08:30-09:20

Practical classes: (compulsory for subject completion)

Venue	alternates between: **Room 2-11(Zoology building)** **Room 1-19 (Old Botany building)**	
Times	Tuesdays	14:30-17:20
	Thursdays	14:30-17:20

Class theory test:

Venue	Room 2-11 (Zoology building)
Date, time	07 March 2014, 17:30

Practical Exam:

Venue	Room 2-11 (Zoology building)
Date, time	20 March 2014, 14:30-17:20

Final examination: See examination timetable

Calculation of marks:

- Semester mark = (theory + practical marks) / 2
(theory and practical marks have 50:50 weighting)
- Final mark = (semester + exam marks) / 2
(semester and exam marks have 50:50 weighting)

RECOMMENDED READING*:*

Sinclair ARE, Fryxell J, Caughley G. 2006. Wildlife Ecology, Conservation and Management. 2nd ed. Wiley-Blackwell.

Molles MC. 2013. *Ecology: Concepts & Applications.* 6th ed. McGraw-Hill

Stiling P. 2012. *Ecology: Global Insights & Investigations.* 1st ed. McGraw-Hill

ILLNESS (TEST/EXAMS):
Compulsory doctor's certificate must be presented to the course co-ordinator with respect to the particular semester/practical test. Contact the course co-ordinator (Dr. PJN de Bruyn at (012) 420-2058) immediately, followed by the subsequent presentation of a doctor's certificate (to the **Faculty Office** of the relevant field of study in case of the **Examination**). NO doctor's notes from students may be accepted by the departments, lecturers, head of departments etc with respect to the formal **Examination in June 2012**. Also, **no sickness exam/test application that has been submitted after 3 days following the examination/test,** will be accepted.

CONSULTATION:
Thirty minutes after the conclusion of each lecture. Appointments outside consultation times can be arranged verbally or by telephone. **Dr. de Bruyn can be found in Room 2-26 in the zoology building, and Dr. Garnas in the 'FABI' building situated opposite the faculty administration building. The tutor, Ms. Cathy Bester, is also available for consultation with prior arrangement (Rm. 2-27 Zoology)**

PLAGIARISM:
One of the most **unethical** things any scientist can do is to pass off someone else's data, findings or ideas as their own. This is exactly what you are doing when you plagiarize someone else's work. The University views plagiarism in a **very serious** light, and will take **severe disciplinary action** against any student guilty of plagiarism.

There are several categories of plagiarism:

- **Copying material directly into submitted work ("cut-and-paste" plagiarism)**
  Included in this category of plagiarism, is copying sentences/paragraphs out of books or material off websites, and then rearranging words, or changing the sentence order. If it is absolutely necessary to use the exact words of another author (which it rarely is!), you MUST use "quotation marks" to indicate that you are quoting someone else. Bear in mind, though, that it is NOT acceptable to extensively quote other people in your assignments and essays.

- **Using someone else's findings or ideas without acknowledging the source**
  Any data from sources other your own work, and the ideas/conclusions of other authors, MUST be adequately referenced. A common error is to write an entire paragraph based on a published study, but to only include one citation at the end. This is not sufficient – every single statement that is based on someone else's work must be referenced.

IT IS YOUR RESPONSIBILITY TO MAKE SURE THAT YOU KNOW WHAT CONSTITUTES PLAGIARISM. The University has a website with more information – www.ais.up.ac.za/plagiarism/index.htm - make sure you visit this site and read the contents before submitting any work for this course. If you are in any doubt as to what plagiarism is, **it is your responsibility to consult your lecturer**.

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STUDY COMPONENT THEMES:

Theory (Zoology building Rm. 2-11) *New Mammal Research Institute building*

Unit	**Unit Theme**	**Lectures**
	INTRODUCTION TO POPULATION ECOLOGY	(1)
STUDY UNIT 1.	POPULATION GENETICS	(1)
STUDY UNIT 2.	INDIVIDUALS IN POPULATIONS	(1)
STUDY UNIT 3.	DISPERSAL, DISPERSION & DISTRIBUTION	(1)
STUDY UNIT 4.	BODY SIZE & POPULATION DENSITY	(1)
STUDY UNIT 5.	SEXUAL VARIATIONS IN POPULATIONS	(2)
STUDY UNIT 6.	LIFE HISTORY THEORY & POPULATION GROWTH	(2)
STUDY UNIT 7.	POPULATION SIZE & MANAGEMENT	(4)
STUDY UNIT 8.	DISEASE ECOLOGY	(1)
STUDY UNIT 9.	CONSERVING POPULATIONS	(3)
STUDY UNIT 10.	HUMAN POPULATION ECOLOGY	(1)
STUDY UNIT 11.	POPULATION DYNAMICS	(3)
STUDY UNIT 12.	AGE & STAGE STRUCTURED POPULATIONS	(2)
STUDY UNIT 13.	INVASIVE SPECIES	(1)
STUDY UNIT 14.	BIOLOGICAL CONTROL	(1)
	OVERVIEW & REVISION	(1)
+	SCIENTIFIC PAPER DISCUSSION	(2)

ZEN 351 – Population Ecology

COURSE OVERVIEW:

The course is intended to introduce students to fundamental concepts in population ecology. The application of these concepts to conservation of wildlife populations is studied. The course introduces the processes determining the abundance of organisms, how population abundance changes through time, identifying the demographic characteristics of a population and the techniques used for quantifying these characteristics. The impact of abiotic and biotic (e.g. competition, predation, disease) factors on the nature of population change and the dynamic behaviour of populations will be discussed. An important component of the course is introducing the quantitative methods and approaches used in population ecology to determine the status of populations. To this end, the practical component of the course consists of weekly lessons where, as well as being introduced to the use of several software packages, students obtain experience with some of the quantitative techniques relevant to the study of population ecology.

Entire courses could be offered on certain topics that will be covered in one or two lectures and as such students will not be experts in specific areas of population ecology at the completion of this course. However, students will have a solid knowledge of fundamental concepts, and some analytical techniques in population ecology and how these relate to management of wildlife species.

INTRODUCTION & ADMINISTRATION:
Introduction to population ecology: terminology and concepts

Number of lectures: 1 (lecture #1)

STUDY UNIT Theme 1: Population genetics
Number of lectures: 1 (lecture #2)
Reference: *Molles pg 77 – 85, & Sinclair pg 27 – 32, 292, & Stiling pg 30 – 43, Scientific article on ClickUP*

Population genetics is a central component of the broader study of population biology. Here we specifically investigate what the patterns of genetic variations are within populations, by assessing the genetic structure of these populations. Phenotypic variation among individuals in a population results from combined effects of genes and the environment, and the extent and source of variation therein is one of the most fundamental considerations in evolutionary biology and population ecology. The Hardy-Weinberg equilibrium model helps identify evolutionary forces that can change gene frequencies in populations.

Study Objectives:
After this theme, you should be able to:

- Describe what is useful about population genetics in practice.

- What are the major evolutionary forces responsible for the origin and maintenance of variation in natural populations?
- Explain the Hardy Weinberg equilibrium model and describe its uses.

STUDY UNIT Theme 2: Population level variation
Number of lectures: 1 (lecture #3)
Reference: *Molles pg 85 –98, & Sinclair pg 19 – 35, & Stiling pg 44 - 72*

This lecture focuses on the variation occurring between individuals within populations. Variation within populations can eventually lead to the existence of different species through natural selection, existence of boundaries between populations and different selective pressures existing between different populations.

Study Objectives:
- Discuss clines.
- Discuss the species concept.
- Discuss different models of speciation.

STUDY UNIT Theme 3: Dispersal, Dispersion & Distribution
Number of lectures: 1 (lecture #4)
Reference: *Molles pg 203 – 214, 223 – 228, & Sinclair pg 90 – 108, & Stiling pg 102 – 112, 149 - 171*

A central question to the population dynamics of any species is why a species occurs where it does. We look at dispersal, dispersion and distributions to describe the occurrence patterns of species. We look at the impact that the environment may have on the dispersal, dispersion and distribution of species.

Study Objectives:
- Define and explain dispersal, dispersion and distribution
- Give examples of dispersal, focusing on differences between individuals, causes of dispersal and the influence of mating systems.
- Discuss dispersion and the factors likely to play a role in each dispersion pattern.
- Discuss hypothetical distributions and explain how the factors interact to form a species boundary.
- Discuss the factors that limit distribution and give examples for each.
- Discuss the impact of scale on dispersion and distribution
- Discuss the importance of dispersal for metapopulations

STUDY UNIT Theme 4: Body size & populations
Number of lectures: 1 (lecture #5)
Reference: *Molles pg 215 – 217, & Sinclair pg 36 – 59, Scientific paper on ClickUP*

Food availability and utilization is one of the most important factors affecting population dynamics. How animals utilize food affect their body size, which affects

their density and in turn dictates their impact on their environments. This lecture examines the close relationship of a species with its food and how food can affect morphology and social and mating systems.

Study Objectives:

- Discuss the relationship between scaling, basal metabolic rate and gut capacity.
- Discuss different ruminant digestive strategies, how these relate to retention time and food quality.
- Discuss diet selection in African ungulates and how these affect social and anti-predator behaviour.
- Understand the Jarman Bell Principle and the implications thereof on population dynamics.
- Understand the implications of the energetic equivalence rule.

STUDY UNIT Theme 5: Sexual variation in populations
Number of lectures: 2 (lecture #6, #7)
Reference: *Molles pg 174 – 197, & Stiling pg 90 – 94, & Several scientific articles on ClickUP*

Social relations, from dominance relationships and reproductive interactions to cooperative behaviours are important to population ecology since they influence the contribution of present generations to future generations. These lectures investigate the phenomena of sexual segregation and associated hypotheses, as well as breeding strategies adopted by different species.

Study Objectives:

- Understand sexual segregation and the different hypotheses that may explain sexual segregation.
- Understand what drives sexual reproduction in different sexes.
- Discuss different forms of parental care.
- How does fitness affect sex ratios of offspring.
- Understand the Trivers-Willard hypothesis.
- Describe different mating systems.

STUDY UNIT Theme 6: Life history theory & population growth
Number of lectures: 2 (lecture #8, #9)
Reference: *Molles pg 230 – 236, 245 – 254, 263 – 282, & Sinclair pg 78 – 89, & Stiling pg 172 – 208, 340 – 343*

Given suitable environmental conditions, populations will manifest their great capacity for population growth. Conversely, populations will exhibit declines if environmental conditions become sub-optimal. Life history theory explores how animals survive in environments that may be variable in terms of resources. These lectures examine the factors that affect the rates and patterns of population growth. We look at how population growth is defined and the use of age distributions, life tables and survivorship curves to summarize survival patterns.

Study Objectives:

- Understand what life history theory means.
- Understand the differences between r and K selection.
- Understand which life history characteristics affect population growth.
- Use data from life tables to calculate life history parameters.
- Understand the three main types of population growth and express them in terms of rates of increase.

STUDY UNIT Theme 7: Population size & management
Number of lectures: 4 (lecture #10, #11, #13, #14)
Reference: *Sinclair pg 109 – 134, 219 – 243, 264 – 267, 297 – 310, 335 – 364, 379 – 381, & Stiling pg 428 – 442, & Scientific articles on ClickUP*

Estimation of population size can be done using direct and indirect methods. This theme looks at how exploited and non-exploited populations are counted. We investigate the goals of managing population size and methods of controlling populations. Thresholds for deciding when active management is needed are calculated using population viability analysis. This theme also investigates the role of island biogeography in conservation planning and landscape ecology. Harvesting of wildlife as a method for managing populations is discussed.

Study Objectives:

- Be able to choose a suitable method of counting a population and explain why you chose a certain method.
- Discuss indices of condition for populations and individuals.
- Discuss methods of controlling population size and potential drawbacks and advantages of these methods.
- Explain the effects of sex ratio and age structure on effective population size.
- What is population viability analysis and how is it implemented?
- How would you incorporate island biogeography theory into population management when designing conservation areas?
- Which population parameters would you consider when deciding to harvest wild populations?

STUDY UNIT Theme 8: Disease Ecology
Number of lectures: 1 (lecture #15)
Reference: *Sinclair pg 179 –195*

This theme looks at the influence of parasites and predation on population dynamics and how it spreads through a population. Examples of how parasites and diseases regulate populations, structure communities and affect conservation are discussed. We look at the differences between predation and parasites in terms of population dynamics. Different types of pathogens and their interactions with other limiting factors in a population are discussed.

Study Objectives:

- Be able to distinguish between different types of parasites and diseases.
- Be able to discuss the effects of parasites.
- Discuss the differences between endemic pathogens and epizootic diseases in terms of population parameters.
- Discuss the role of parasites and diseases on wildlife management and conservation with examples.

STUDY UNIT Theme 9: Conserving populations
Number of lectures: 3 (lecture #16, #17, #18)
Reference: *Sinclair pg 289 – 334, & Stiling pg 35 – 41, & Scientific articles on ClickUP*

This theme looks at why and how populations go extinct. The affects of small population size on extinction risk are assessed. This theme looks at effective population size both in terms of genetic variability and demographic variability. The effects of environmental change on populations are investigated and put into a conservation perspective.

Study Objectives:
- Explain how small populations cause the loss of genetic diversity.
- Explain why genetic diversity is important in population persistence.
- Calculate effective population size.
- Explain extinction threats due to environmental change.
- Explain differences in extinction types.
- Give examples of species that have gone extinct and list the reasons why they have gone extinct.
- Discuss conservation areas (importance, size, design)
- Understand Caughley's population paradigms.

STUDY UNIT Theme 10: Human population ecology
Number of lectures: 1 (lecture #20)
Reference: *Molles pg 257, & Stiling pg 209 – 212, Scientific papers on ClickUP*

Most of the significant environmental problems on earth can be linked to the human population. Apart from having a worldwide distribution, human populations are growing exponentially and are thus placing increasing pressure on the earth's resources. This theme reviews patterns of human distribution and abundance, population dynamics and growth.

Study Objectives:
- Discuss human population growth and age structure and explain how these are linked to socio economic growth.
- Is economic growth the answer to creating a sustainable human population?

STUDY UNIT Theme 11: Population dynamics
Number of lectures: 3 (lecture # 21, #22, #23)
Reference: *Sinclair pg 135 – 178*

One of the central themes in population ecology focuses on understanding the underlying causes of population fluctuations over time. Primary questions include: Why are many species rare in most years and then super-abundant in others? Why do some populations appear to cycle while other remain relatively stable? How do inter-species and community-level interactions drive population fluctuations? How do climate and other abiotic factors influence dynamics? And finally, can we use simple models to predict and understand population dynamics, and how might we tweak such models to add biological reality and/or more closely mimic observed patterns?

Study Objectives:
After this theme, you should be able to:

- Describe characteristics inherent to a population likely to influence its stability over time.
- Understand how the biotic community and abiotic environment influence population dynamics?
- Be able to draw and label a density dependent relationship (i.e., between population size and growth rate). Become equipped to explain how small (or large) changes to this relationship are likely to influence population dynamics.
- Utilize basic equations used to model density dependence and/or stochastic effects.
- Understand parameters that form the basics of population ecology (e.g., r, R, K, □, N, dN/dt, and □.

STUDY UNIT Theme 12: Age and stage structured populations
Number of lectures: 2 (lecture #24, #25)
Reference: *Sinclair pg 245 – 252*

For many organisms the predicted contribution of each individual to the next generation depends critically of that individual's age, size or developmental stage. In fact, entire classes of models have been developed that incorporate such structure into their basic logic and equations, and offer powerful methods for understanding and predicting population behavior. In this lecture series we will touch on the foundational principles and properties of these models by discussing life tables and Leslie matrices, two of the fundamental approaches for dealing with stage structured populations.

Study Objectives:
After this theme, you should be able to:

- Understand how age structure influences population dynamics.
- Understand the utility of life tables in designing conservation management plans and sustainable harvest practices.
- Calculate and interpret basic life table parameters.
- Construct and modify Leslie matrices based on basic birth and survivorship schedules.

- Understand how matrix algebra can be used to predict aspects of population behavior over time. Perform very basic matrix algebra operations.
- Explain the difference between transient and equilibrium dynamics.

STUDY UNIT Theme 13: Invasive species
Number of lectures: 1 (lecture #26)
Reference: *Scientific articles & readings on ClickUP*

Invasive species are often listed at the third most serious threat to biodiversity, after climate change and habitat loss. But what is it about invasive species that makes them so damaging to nonnative habitats? Are all invaders created equal, or do some pose a greater threat to ecosystem health and function than others? Here we discuss invasion biology – a field unto itself – from the perspective of population ecology, touching on the causes, consequences and potential for management of problematic exotic species.

Study Objectives:
After this theme, you should be able to:

- Evaluate and discuss the major hypotheses for why many invaders are so successful relative to their native counterparts.
- Cite examples and studies that have attempted test the central hypotheses of invasion biology, mentioned above.
- Discuss major pathways of invasion and describe typical mitigation strategies, including notable successes and failures.

STUDY UNIT Theme 14: Biological control
Number of lectures: 1 (lecture #27)
Reference: *Scientific articles & readings on ClickUP*

Numerous species impact negatively on human health and welfare, by vectoring disease, competing with humans for food or other plant products, or by otherwise impacting on human-managed or natural ecosystems. While in some cases direct pest control (e.g., culling, chemical control) can be effective, such methods are often costly, are difficult to apply over large areas, and may carry negative consequences for the environment or human health. An alternative strategy is to employ natural enemies (predators, parasitoids and pathogens) to control pest populations at tolerable levels. The philosophy and implementation of successful biological control is deeply rooted in population ecology, and a number of approaches exist. In this theme we discuss biological control in theory and practice, touching on a number of examples that highlight the successes as well as complications and potential pitfalls of this approach.

Study objectives:
After this theme, you should be able to:

- Discuss the conceptual framework underlying biological control, applying your understanding of density dependent population regulation.

- Cite examples of biological control successes and failures, and understand the basic steps required in developing a biocontrol program.
- Understand the potential pitfalls associated with biocontrol via both direct and indirect pathways.
- Explain the differences between the major classes of biocontrol agents (e.g., predators, pathogens, parasitoids, etc.) and cite the advantages and disadvantages of each.

Prescribed scientific articles (these WILL be questioned in test/ examination):
To be discussed in "Paper discussion class (Lecture #12)"

- Ripple WJ, *et al.* (2014) Status and ecological effects of the World's largest carnivores. *Science* 343: 1241484.

To be discussed in "Paper discussion class (Lecture #19)"

- Ehrlich PR, Ehrlich AH (2013a) Can a collapse of global civilization be avoided? *Proceedings of the Royal Society of London, B* 280: 20122845.

- Kelly MJ (2013) Why a collapse of global civilization will be avoided: a comment on Ehrlich & Ehrlich. *Proceedings of the Royal Society of London, B* 280: 20131193.

- Ehrlich PR, Ehrlich AH (2013b) Future collapse: how optimistic should we be? *Proceedings of the Royal Society of London, B* 280: 20131373.

For self study

- Burkepile DE, et al. (2013) Habitat selection by large herbivores in a southern African savanna: the relative roles of bottom-up and top-down forces. *Ecosphere* 4, art no. 139

Practical sessions for ZEN 351 - 2014

Practical session 1 – Thursday 06 February
Mark-recapture

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Practical session 2 – Tuesday 11 February
Discussion and analysis of mark-recapture

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Practical session 3 – Thursday 13 February
Role of body size in population ecology

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Practical session 4 – Tuesday 18 February
The use of animal movement data/analysis in population ecology

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Practical session 5 – Thursday 20 February
Sexual segregation and population ecology

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Practical session 6 – Tuesday 25 February
Introduction to the RAMAS software. Population growth & life tables

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Practical session 7 – Thursday 27 February
Report writing course

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Practical session 8 – Tuesday 04 March
RAMAS course on metapopulations

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Practical session 9 – Tuesday 11 March
Modelling population dynamics

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Practical session 10 – Tuesday 18 March
Stage-structured populations

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Practical EXAMINATION – Thursday 20 March