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Ecology

SimBio's ecology modules include our newer **SimUText Ecology®** interactive chapters, which can be used to supplement or to replace traditional textbooks, as well as our long-popular **EcoBeaker®** suite of virtual labs, which work well as homework or in-class exercises. Labs either use accompanying workbooks **(WB)** or are tutorial-style **(T)**, with onscreen instructions and integrated instant feedback (like the chapters). Labs with the 101 label were designed for intro-level courses. Unless noted, all ecology modules include optional auto-graded questions, which can be especially helpful for larger classes. Your SimUText can include any combination of SimBio modules.

POPULATION ECOLOGY

Population Growth explores population dynamics and population growth models using a weed species, a crop pest, and an endangered salamander as model organisms. Simulations help clarify topics, which include density-dependent and density-independent factors, metapopulation dynamics, and factors generating variability.

Life History introduces fundamental life history trade-offs, setting the stage for students to explore demography, life tables, survivorship curves, and strategies of allocation. Simulated experiments involve several interesting model organisms, including humans!

101 **Isle Royale (T/WB)** This very popular lab, updated to include onscreen instructions and feedback for students, explores important population biology concepts, including exponential and logistic growth and carrying capacity. The lab investigates predator-prey dynamics using the classic system of moose and wolves on an island in Lake Superior. An unexpected twist at the end creates a great topic for discussion.

101 **Understanding Population Growth Models (T)** Students experiment with simulations of engaging creatures whose populations are undergoing exponential and logistic growth. Through guided exploration, students discover what is meant by N, r, K, and dN/dt in population growth models, and apply the models to make predictions.

ORGANISMAL ECOLOGY

Behavioral Ecology examines the adaptive value of a wide variety of behaviors and presents a range of models that lend insight into how these behaviors evolved. Topics include optimal foraging, game theory, sexual selection and sexual conflict, cooperation and the "problem with altruism".

Physiological Ecology explores aspects of physiology that impact ecology, focusing on temperature and water and how these factors affect plant communities around the globe. Includes sections on the heat and water balance equations, adaptation vs. acclimation, different types of photosynthesis, water balance, and heterotrophic ingestion.

Evolution for Ecology This popular chapter explores evolutionary mechanisms (natural selection, genetic drift, migration, and mutation) from an ecological perspective. Interactive exercises and examples include investigations of stickleback evolution and the evolution of resistance to pesticides and antibiotics.

Biogeography explores how large-scale and global patterns of biodiversity relate to landscapes, emphasizing conservation applications. Topics covered include air and water circulation, biomes, measures of diversity, species-area curves and island biogeography, paleoecology and geologic-time impacts on diversity.

SimBio Virtual Lab

SimBio Interactive Chapter

SPECIES INTERACTIONS

Competition covers intraspecific and interspecific competition, including niches, logistic growth, Lotka-Volterra equations, and isoclines. Powerful interactives, such as manipulable phase plane plots of the Lotka-Volterra competition equations, let students dynamically explore important quantitative models.

Predation, Herbivory and Parasitism introduces exploitative interactions between species. Includes classifications of each type of interaction and prey responses to exploitation, Lotka-Volterra predation equations, functional responses, and an exploration of the Red Queen hypothesis.

101 **How Diseases Spread (T) - Updated for Winter/ Spring 2021** This intro-level lab explores the fundamentals of epidemiology with inquiry-based simulations and other interactive tools. Drawing on examples from the current COVID-19 pandemic, your students will learn the basics of infectious disease, how disease models work, and how approaches like social distancing and vaccination help control disease spread.

101 **Niche Wars (WB)**, the "bunny lab", explores ecological niches and the competitive exclusion principle using a fun simulation model. Students are guided through parameter manipulation to ask questions about coexistence. The last (optional) part of the lab is an open-ended activity that can be integrated with more advanced topics, such as Lotka-Volterra models.

Top-Down Control (WB) (formerly Aquatic Trophic Cascades) simulates the classic experiment of adding fish to a fish-free lake and observing the effects across different trophic levels. Students are challenged to generate and test hypotheses to explain the trophic cascades and competitive dynamics they observe in the lake.

COMMUNITY ECOLOGY

Community Dynamics uses simulated case studies from Yellowstone National Park to explore succession and disturbance, food chains and food webs, trophic cascades, top-down vs. bottom-up effects, community stability, ecosystem engineers, and keystone and dominant species.

101 **Keystone Predator (WB)** recreates R.T. Paine's famous experiments in the marine intertidal involving the sea star (Pisaster) and other species. Students transplant species to determine competitive relationships and sample gut contents to construct a food web. They use their data to predict what will happen when each predator is removed from the system, and then test their predictions.

101 **Keystone Predator (T)** is a tutorial-style version of the workbook-based lab described above. Engaging new tools and instant feedback reinforce key ideas, letting students delve deeper into the importance of indirect effects. In addition, a "playground" at the end lets students tinker with the underlying model, encouraging open-ended exploration.

101 **Intermediate Disturbance Hypothesis (WB)** first explores succession in a disturbance-free system. Then, students play with fire! By systematically varying the fire regime, they discover that diversity is highest at intermediate levels of disturbance. This lab is straightforward and emphasizes data collection and analysis, making it suitable for all levels.

The Barnacle Zone (WB) (formerly Barnacles and Tides) simulates Connell's classic experiments, investigating why two species of barnacle have distinct distributions in the rocky intertidal zone of Scotland. This is a great lab if you want to give your students practice designing and conducting experiments.

SimBio Virtual Lab

SimBio Interactive Chapter

ECOSYSTEM ECOLOGY

Ecosystem Ecology In this chapter, our growing ecological footprint and reliance on ecosystem services provide context to explore and learn about the flow of energy through ecosystems, primary production and respiration, secondary production, consumer and detrital food chains, transfer efficiencies, and energy flow diagrams.

Nutrient Cycling This important chapter, updated for 2020, examines biogeochemical cycles across scales. Engaging interactive diagrams and simulations elucidate key concepts such as flux-and-pool models, cycles for essential macronutrients, and nutrient pollution. With guidance, students interpret global human impacts on nutrient cycles and learn how scientists use nutrient budgets to solve real-world nutrient mitigation challenges.

Decomposition - Updated for Summer 2021 Updated in 2021, this chapter explores how life after death impacts ecological systems, using LTER network data, interactive forensic science and climate change simulations, and other inquiry-driven activities. Investigating the "decomposition triangle", students discover how decomposer organisms, litter quality, and the physical environment affect decomposition rates.

Liebig's Barrel and Limiting Nutrients (WB) has students cultivate virtual algae and deduce which of three nutrients is limiting for several species. Based on their data, they then predict the outcome of competition between species. Finally, they manipulate death rates along with nutrients to explore R* competition and the "paradox of the plankton".

101 **Nutrient Pollution (T/WB)** This lab, recently updated to include onscreen instructions and instant feedback, features engaging experimental systems for students to investigate how and why eutrophication and biomagnification of toxins can result in serious problems for aquatic communities. It is suitable for introductory biology and environmental science classes.

APPLIED ECOLOGY

101 **Understanding Experimental Design (T)** This innovative lab was developed as part of an NSF cyberlearning grant to SimBio. It uses an engaging simulated disease system and instant personalized feedback to help students overcome confusions and provide reinforcement on how to design experiments and to summarize and interpret results. Concepts covered include systematic variation, control treatments, replication, and scope of inference. This lab uses both ecological and evolutionary examples, and would work well in almost any non-majors or introductory biology course.

Climate Change builds an understanding of the scientific evidence that climate is changing and elucidates the physics underlying global temperatures, the evidence for human impact on climate, and how changing temperatures affect ecological systems.

101 **Nutrient Pollution (T/WB)** This lab, recently updated to include onscreen instructions and instant feedback, features engaging experimental systems for students to investigate how and why eutrophication and biomagnification of toxins can result in serious problems for aquatic communities. It is suitable for introductory biology and environmental science classes.

Patchy Prairies (WB) simulates a population of endangered butterflies, challenging students to propose and justify a habitat restoration scheme that will maximize survivorship. Students investigate edge effects and how landscape features (e.g., corridors and stepping stones) affect populations, and then explore how models can help guide research. This module does not (yet) include auto-graded questions.

SimBio Virtual Lab

SimBio Interactive Chapter

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