Modeling population growth worksheet answers

After completing this module, students should be able to: Create patterns of population growth through STELLA. Distinguish between balancing (negative) and intensified (positive) feedback on population growth. Use the predator-looted model to explore trophic relationships and population dynamics. Explain how load capacity leads to population stabilization. Experiment with the Easter Island population and resource model to explore the conditions that allow sustainable use of resources compared to the collapse of civilization. The exercise discusses several basic principles of InTeGrate. In particular, it requires the use of system thinking, develops students' ability to use numerical modelling to create and test geoscientistic hypotheses, uses authentic population data and addresses a major problem facing society, population growth. This unit is intended to be used in a three to four-hour class period, which is reached once a week. It can be used as part of this modelling course or can be adapted as laboratory exercise courses in environmental science. For this module, students should come to class ready to take a short quiz about the assigned reading. They will then be guided by a series of performances designed to help them create and experiment with a number of simple models using the iconographic box modeling software STELLA (see Page 10). For those who learn to use STELLA, we recommend online play-along tutorials from isee systems. You can find them here: isee Systems Tutorials.In to use, students should read this: Unit 2 Student Reading. Before arriving in the classroom, students should take the following quiz to ensure that they have taken the assigned reading: Citizen Modeling Reading Quiz (Microsoft Word 2007 (.docx) 47kB Aug11 16). The answer key reading quiz can be found here: HidePopulation modeling quiz response key This file is only available to verified educators. If you are a teacher or faculty member and want to access this file, please enter your email address to be verified as a teacher. . For advanced courses, instructors may also want students to read and present in Bologna and Flores (2008) (the full quote is given below in the References and Resources section). In class, students should be provided with the implementation found here: Population modeling student exercise (Microsoft Word 2007 (.docx) 2.2MB Nov15 16) Answer key so that the task can be found here: HidePopulation modeling response key This file is only available to verified educators. If you are a teacher or faculty member and want to access this file, please enter your email address to be verified as belonging to Instructors can download a version of the lynx and bunny predator-loot model by clicking here: Lynx & hare predator-loot model (Stella model (v10 .stmx) 15kB Aug11 16), logistics growth model, clicking here: Logistics growth STELLA model (Stella model (v10.stmx) 7kB Aug11 16), and Easter Island model by clicking here: Easter Island collapse model (Stella model (v10 .stmx) 13kB Aug11 16). All models were created using STELLA Professional and should be opened in any future version of STELLA. If you're using a previous version of STELLA, you can find the full model graphics and equations in the answer key so you can reconstruct the models yourself. We usually publish student readings and assignments on the LMS site (e.g. Moodle, whiteboard, canvas). Students can open a task in Microsoft Word on the same computer they use to create each STELLA model, and then answer questions by typing directly into the document. Students can then either print a paper copy of the hand to the instructor or email it to a modified file instructor. It's easy to copy graphics and model graphics from STELLA and paste them into Word. Just select the items you want to copy, see the links in stella, and then paste them into Word. No need to export graphics to jpg. We teach a course in a three to four hour block once a week because we have discovered that models require a lot of uninterrupted time to build. If students have a 50 or 75-minute class period several times a week, they spend at least 20 minutes in subsequent class periods, trying to figure out where they were to use at the beginning of the week. This is not a good time of exercise, so the recommended three to four hour class session once a week. However, we also know that it can be difficult to support attention during this period. Therefore, we recommend allowing students the freedom to take breaks throughout the modeling session to get a snack or coffee. A typical four-hour class session could be divided into the following sections: a 20-minute discussion about reading to ensure that all students are familiar with the mathematics behind the model of 1.5 to 2 hours to create a model of 1.5 hours to conduct experiments for instructors who have more limited contact hours with their students, we recommend that the model of construction parts of this task be assigned as pre-beted a day or two before the same completed STELLA model. This would allow the instructor to determine whether student models are working properly, and provide feedback to prevent errors in construction, omissions in documentation, problems with unit conversions, and inappropriately sized time measures that could lead to lye pattern behavior. Class time could then be devoted to experimenting and analysis of results. If you have access to stella Class time is not possible because of computer lab planning or financial constraints that prevent students from buying their STELLA licenses, students might be asked to create a pencil and paper sketch of what their model should look like, annotated with equations and then sent to the instructor before class feedback. This should contribute to a faster construction time for the model in limited class hours. Barnosky, A.D., Matzke, N., Tomiya, S., Wogan, GOU, Swartz, B., Quental, T.B., Marshall, C., et al., 2011, Has earth's sixth mass extinction already arrived? Nature, v. 471, p. 51#147 #128. Bologna, M. and Flores, J.C., 2008, A simple mathematical model of society collapse applied to Easter Island, PPAS, v. 81, doi: 10.1209/0295-5075/81/48006. Cohen, J.E., 1995, how many people can Land support? New York: Ww Norton & Company, 532 p. Cook, RYE, Anchukaitis, K.J., Kaplan, J.O., Puma, M.J., Kelley, M., and Gueyffier, D., 2012, Pre-Columbian Defeeling as drought booster Mesoamerica, Geophysical Research Letters, v. 39, n. 16, article n. L16706. Diamond, J., 2005, Collapse: How Societies Choose to Fail or Succeed, New York: Viking Press, 575 p. Hunt, T., Rethink the Fall of Easter Island, American Scientist, September-October 2006. Kaufmann, R.K., and Cleveland, CJ, 2008, Environmental Science. Boston: McGraw Hill Higher Education, Chp. 5. Kolbert, E., 2014, Sixth Extinction: Unnatural History, New York: Henry Holt and the company's publishers. Merritts, D.J., Menking, K.M., and DeWet, A.P., 2014, Environmental Geology: Earth System Science Approach, 2nd edition. New York: W.H. Freeman, Chp. 7. New York: W.H. Freeman, Chp. 7. Mieth, A., and Bork, H.-R., 2005, History, Origin and extent of soil erosion on Easter Island (Rapa Nui), Catena, v. 63, pp. 244-260. Ricklefs, RE, 2008, Economics of Nature, 6th Edition. New York: W.H. Freeman, 15, 18. Turner, B.L., II, and Sabloff, J.A., 2012, Classic Period Collapse of the Central Maya Lowlands: Insights for Man and Acirc;€“ environmental relationship sustainability, Proceedings of the National Academy of Sciences, v. 109, p. 13908-13914. Additional web resources are as follows: Page 2 These materials have been revised to alignment with the next generation of scientific standards as described below. Visit InTeGrate and NGSS to learn more. OverviewIn this unit, students develop a simple computational climate model to test the relative impact of several coercion mechanisms, including parasols and albedo, on Earth's temperature. Scientific and technical practicesMother and computational thinking: use simple limit things to test mathematical manifestations, computer programs, algorithms or process or system simulations to see if the model makes sense when comparing the results with what is known about the real world. Mathematics and computational thinking: Create and/or review a computational model or a simulation of a phenomenon, a device, process, or system. HS-P5.1:Using mathematical and computational thinking: applies coefficients, courses, percentages and unit conversions in the context of complex measurement problems involving quantities of derived or composite units (e.g. mg/ml, kg/m3, acre footprints, etc.). HS-P5.5: Development and use of models: develop, review and/or use a model based on evidence to illustrate and/or predict the relationship between systems or between components of HS-P2.3: model development and use: develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyse and/or solve problems. HS-P2.6:Cross Cutting ConceptsScale, Proportion and Quantity: Time, space and energy phenomena can be observed on different scales, using models to study systems that are too large or too small. MS-C3.1: Systems and system models: models (e.g. physical, mathematical, computer models) can be used to simulate systems and interactions, including energy, matter and information flows, on different scales and between systems. HS-C4.3:Stability and change: Feedback (negative or positive) can stabilise or destabilise the system. HS-C7.3: Stability and change: Changes and change rates can be quantified and modeled over a very short or very long period of time. Some system changes are irreversible. HS-C7.2: Cause and effect: Systems may have different causes that may not have the same effect. HS-C2.4: Energy and the issue: changes in energy and substances in the system can be described in terms of energy and substance flows, from and from it. HS-C5.2: Disciplinary Core IdeasWeather and Climate: Earth's global climate systems are based on electromagnetic radiation from the sun, as well as its reflection, absorption, storage and redistribution between the atmosphere, oceans and earth systems, and the recurrent radiation of this energy in space. HS-ESS2. D1: Electromagnetic radiation: When light or longer wavelength electromagnetic radiation is absorbed into matter, it is usually converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells HS-PS4. B2: Performance ExpectationsEarth's Systems: Use a model to describe how differences in energy flows to and from terrestrial systems cause climate change. HS-ESS2-4: Page 3 These materials have been revised to alignment with next generation scientific standards as described below. Visit InTeGrate and NGSS to learn more. OverviewIn this unit, students develop a computational model that replicates the Daisyworld model from It's a simple model of the climate system the temperature effects of albedo. Scientific and technical practicesMother and computational thinking: use simple limit things to test mathematical manifestations, computer programs, algorithms or process or system simulations to see if the model makes sense when comparing the results with what is known about the real world. HS-P5.4:Using mathematical and computational thinking: Create and/or review a computational model or a simulation of a phenomenon, a device, process, or system. HS-P5.1: Obtaining, evaluating and cryptising the scientific literature adapted for use in the classroom to identify central ideas or conclusions and/or obtaining scientific and/or technical information to gather complex evidence, concepts, processes or information provided in the text, paraphrasing them in simpler but still precise terms. HS-P8.1:Development and use of models: develop, review and/or use a evidence-based model to illustrate and/or predict the relationship between systems or between the HS-P2.3 components of the system: model development and use: develop a complex model that allows the manipulation and testing of the proposed process or system. HS-P2.5: Clarification and design Solutions: Create a quantitative and/or qualitative requirement for the relationship between dependent and independent variables. HS-P6.1:Transverse ConceptsSystems and System Models: When researching or describing the system, the system boundaries and initial conditions must be defined and their inputs and outputs analysed using models. HS-C4.2: Systems and system models: models (e.g. physical, mathematical, computer models) can be used to simulate systems and interactions, including energy, matter and information flows, on different scales and between systems. HS-C4.3:Stability and change: Feedback (negative or positive) can stabilise or destabilise the system. HS-C7.3: Energy and the issue: changes in energy and substances in the system can be described in terms of energy and substance flows, from and within this system. HS-C5.2: Disciplinary Core IdeasWeather and Climate: Earth's global climate systems are based on electromagnetic radiation from the sun, as well as its reflection, absorption, storage and redistribution between the atmosphere, oceans and earth systems, and the recurrent radiation of this energy in space. HS-ESS2. D1: Electromagnetic radiation: When light or longer wavelength electromagnetic radiation is absorbed into matter, it is usually converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells HS-PS4. B2: Performance ExpectationsEarth's Systems: Use a model to describe how variations in energy flow to and from Earth systems climate action. HS-ESS2-4: HideThis material was developed and revised using the InTeGrate training materials development process. This rigorous, structured process includes: team-based development to ensure that materials are suitable for a number of educational settings. several iterative feedback and feedback cycles in the development of materials with input from the authoring team from both project editors and external evaluation team. real material testing in the classroom in at least 3 institutions with an external overview of pupil assessment data. multiple tests to ensure that materials comply with inTeGrate material sections, which co-cate the best practices in curriculum development, student evaluation and pedagogical techniques. expert examination of the accuracy of the scientific content. This page was first published: September 15, 2017 Students study Daisyworld, a self-regulating system model that includes positive and negative feedback. Daisyworld is the planet on which black and white daisies are the only ones that grow. The model explores the effects of ever-increasing solar brightness on daisy populations and resulting in planetary temperatures. The growth function of daisies allows them to modulate the planet's temperature for many years, warming early as radiation-absorbing black daisies grow, and cooling it later as reflective white daisies grow. Eventually, the sun's brightness increases beyond daisies' ability to modulate the temperature and they die, resulting in a sharp increase in planetary temperatures. Daisyworld was conceived by Andrew Watson and James Lovelock to illustrate how life could be partly responsible for regulating Earth's temperature as the sun's brightness increased over time. This exercise guides students through some mathematics behind modeling and uses the modeling program STELLA to visualize the results. Did you use this activity? Share their experiences and modifications After completing this module, students should be able to: Create Watson and Lovelock's Daisyworld model Distinguish positive and negative feedback Assess the impact of changing growth and mortality rates on system behavior Assess changes in albedo effects on system behavior Assess the effects of changing different heat conduction scenarios on system behavior Explain the weak youth solar paradox Explain the concept of homeostasis Prove understanding of it that systems can be exhibited in several stable countries, as well as hysteresis This task addresses a number of guiding principles of the InTeGrate program. In particular, it requires the use of systems of thinking, develops students' ability to use numerical modeling to create and test geoscientic hypotheses, develops an understanding of positive and negative feedback, and explores the two main ideas of the Earth Weak Young Sun Paradox and Gaia Hypothesis. This unit is intended to be used in a three to four-hour class period, which is reached once a week. It can be used as part of this modelling course or can be adapted as laboratory exercise courses in environmental science. In this course, students must enter a classroom that is ready to take a short quiz on the assigned reading. They will then be guided by a series of performances designed to help them create and experiment with a number of simple models using the iconographic box modeling software STELLA (see Page 10). Students should have access to Microsoft Excel or similar spreadsheet software to allow them to graph growth functions at the beginning of the lab. For those who learn to use STELLA, we recommend online play-along tutorials from isee systems. You can find them here: isee Systems tutorials. In addition to Watson and Lovelock paper, students should complete Unit 4 Student Reading, which contains additional background information as well as some explanations for some of the maths involved. Students should complete the Daisyworld reading quiz (Microsoft Word 2007 (.docx) 62kB Aug111 16) before going to class. HideDaisyworld reading quiz answer key This file is only available to verified educators. If you are a teacher or faculty member and want to access this file, please enter your email address to be verified as a teacher. can be found here. Students in the class must provide a copy of the Daisyworld exercise (Microsoft Word 2007 (.docx) 36kB Nov30 16). HideDaisyworld Response key This file is only available to verified educators. If you are a teacher or faculty member and want to access this file, please enter your email address to be verified as a teacher. contains answers as well as tips and strategies that instructors can use to guide students through exercises and information about typical stumbling blocks. Instructors can download a version of the STELLA Dasiyworld model by clicking here: Documented Daisyworld Model (Stella Model (v10 .stmx) 29kB Aug11 16). The model was created using STELLA Professional and must open any new version of STELLA. If you're using a previous version of STELLA, you can find the full model graphics and equations in the answer key so you can reconstruct the model yourself. We usually publish student readings and assignments on the LMS site (e.g. Moodle, whiteboard, canvas). Students can open a task in Microsoft Word on the same computer on which they use the STELLA model design, and then answer questions by typing directly into the document. Students can then print a copy of the paper to pass on the send your modified file to the instructor. It's very simple to copy graphics and model graphics from STELLA and paste them into Word. Just select the items you want to copy, see the links in stella, and paste them into Word. No need to export graphics to jpg. We teach a course in a three to four hour block once a week because we have discovered that models require a lot of uninterrupted time to build. If students have a 50 or 75-minute class period several times a week, they spend at least 20 minutes in subsequent class periods, trying to figure out where they were to use at the beginning of the week. This is not a good time of exercise, so the recommended three to four hour class session once a week. However, we also know that it can be difficult to support attention during this period. Therefore, we recommend allowing students the freedom to take breaks throughout the modeling session to get a snack or coffee. A typical 4-hour class session could be divided into the following sections: a 20-minute discussion about reading to ensure that all students are familiar with the math behind the model, especially the Fourier Law of Heat Conduction. 1.5 to 2 hours to create a model of 1.5 hours to conduct experiments for instructors who have a limited number of contact hours with their students, we recommend that the model construction parts of this task be assigned as a pre-lab put a day or two before class along with the completed STELLA model itself. This would allow the instructor to determine whether student models are working properly, and provide feedback to prevent errors in construction, omissions in documentation, problems with unit conversions, and inappropriately sized time measures that could lead to lye pattern behavior. Class time could then be devoted to experimenting and analysis of results. If access to STELLA outside of classroom time is not possible because of computer lab schedules or financial restrictions that prevent students from buying their STELLA licenses, students could be asked to create a pencil and paper sketch of what their model should look like, annotated with equations and then sent the instructor before class feedback. This should contribute to a faster construction time for the model in limited class hours. The answers to the exercise questions are in the answer key of this chapter (see Description and training materials (see Description and Teaching Materials above). Instructors can download the assessment section for modeling use here: Grade rubric (Microsoft Word 2007 (.docx) 121kB Jan8 15). Instead of assigning a point value to each task, we use a holistic approach that determines the extent to which the student has correctly created the model, provided the appropriate documentation of equations and units, carefully answered questions throughout the task, lists and numbers in response to questions. Watson, AJ, and Lovelock, J.E., 1983, Biological homeostasis of the world's environment: a parable of Daisyworld, Tellus, v. 35B, p. 284-289.