1 Your Special Research Problem 1a: Knight/O'Conner

1a. Construct the system for the submodel with no cannabalistic morphs. Repeat the analysis of equilibrium points with this model. How sensitive is the fully populated equilibrium to the parameters in the model? Conduct a sensitivity analysis by varying each parameter by ten percent and recording the change in equilibrium values of for all populations. Report your findings in six tornado diagrams, and include a table of data from runs as an appendix.

2 Your Special Research Problem 1b:Arshad/Reznicek

1b. Construct the system for the submodel with no cannabalistic morphs. Repeat the analysis of equilibrium points with this model. All predation terms in this model are of the form $p_{AB}AB$, where A is consuming B. This term represents an insatiable predator– as B rises one single member of A continues to consume the same proportion of B per day without ever getting full. We can change this situation so the predator satiates by replacing B with $B/(k+B)$. Graph this function of B. You will see that it rises from zero to one, so that the maximum rate of consumption per predator is now p_{AB}. Repeat the analysis of equilibrium with all predation terms, using $k = .01$ to $k = .2$ in increments of .01. How do equilibrium populations of all populations respond to this parameter? Report your findings in six graphs of equilibrium versus k, and include a table of data from runs as an appendix.

3 Your Special Research Problem 1c: Anderson/Harad

1c. Construct the system for the submodel with no cannabalistic morphs. Repeat the analysis of equilibrium points with this model. The following system, which is not necessarily your system, displays a phenomenon called a "limit cycle". For a range of initial conditions, all solutions go to a periodic solution with the same period and amplitude. Note that the constants are quite different and return a high proportion of energy derived from predation back into growth. I had to run the system to $t = 10000$ (in 100000 time steps) to see the periodicity.

F=1, F' = (10*F*(1-F) - 2*B*F - 2*Y*F
B= .1, B' = (1*B*F - (.5*A + .5*J)*B -.001*B)
Y=.1, Y' = (.3*(A*B) - .05*Y*F - .01*Y)
J=0, J' = (.05*Y*F - .02*J*B -.001*J)
A=.1, A' = (.02*J*B - .001*A)

Find parameters that create a limit cycle in your model. Repeat the analysis of equilibrium points with this model. Then vary these parameters by ten percent in both directions and see if the cycle is still visible, and record how the amplitude and period vary. Report your findings in two graphs showing how amplitude and period vary for each parameter, and include a table of data from runs as an appendix. Be sure to report cutoff values where the cyclic behavior (appears or) disappears.

4 Your Special Research Problem 1d: Bertasius

1d. Construct the system for the submodel with no cannabalistic morphs. Repeat the analysis of equilibrium points with this model. The parameter q_{JA} describes the probability that J will mature into A rather than P. It has been conjectured that this parameter depends on environmental factors. Adjust the model so that A is able to obtain some of its food from a source other than those variables in the model (such as prey on land). This term will actually appear in the growth term for Y as kA. By varying k and q_{JA} you can get a sense of the effect this morphological decision has on equilibrium populations. Fix k and vary q_{JA} systematically through a range around the default value. Do this for k going from .1 and .9 in increments of .1. For each equilibrium value of Y, J, A, P report your findings as graphs, and include a table of data from runs as an appendix. What choices of k and q_{JA} optimize each of the four equilibrium populations?

5 Your Special Research Problem 2a: Hayashi/Wang

2a. Construct the system for the submodel with no paedomorphs. Repeat the analysis of equilibrium points with this model. How sensitive is the fully populated equilibrium to the parameters in the model? Conduct a sensitivity analysis by varying each parameter by ten percent and recording the change in equilibrium values of for all populations. Report your findings in six tornado diagrams, and include a table of data from runs as an appendix.

6 Your Special Research Problem 2b: Conley/Bessel

2b. Construct the system for the submodel with no paedomorphs. Repeat the analysis of equilibrium points with this model. All predation terms in this model are of the form $p_{AB}AB$, where A is consuming B. This term represents an insatiable predator– as B rises one single member of A continues to consume the same proportion of B per day without ever getting full. We can change this situation so the predator satiates by replacing B with $B/(k+B)$. Graph this function of B. You will see that it rises from zero to one, so that the maximum rate of consumption per predator is now p_{AB}. Repeat the analysis of equilibrium with all predation terms, using $k = .01$ to $k = .2$ in increments of .01. How do equilibrium populations of all populations respond to this parameter? Report your findings in six graphs of equilibrium versus k, and include a table of data from runs as an appendix.

7 Your Special Research Problem 2c: Maier/Ocampo

2c. Construct the system for the submodel with no paedomorphs. Repeat the analysis of equilibrium points with this model. The following system, which is not necessarily your system, displays a phenomenon called a "limit cycle". For a range of initial conditions, all solutions go to a periodic solution with the same period and amplitude. Note that the constants are quite different and return a high proportion of energy derived from predation back into growth. I had to run the system to $t = 10000$ (in 100000 time steps) to see the periodicity.

F=1, F' = (10*F*(1-F) - 2*B*F - 2*Y*F

B= .1, B' = (1*B*F - (.5*A + .5*J)*B -.001*B)

Y=.1, Y' = (.3*(A*B) - .05*Y*F - .01*Y)

J=0, J' = (.05*Y*F - .02*J*B -.001*J)

A=.1, A' = (.02*J*B - .001*A)

Find parameters that create a limit cycle in your model. Repeat the analysis of equilibrium points with this model. Then vary these parameters by ten percent in both directions and see if the cycle is still visible, and record how the amplitude and period vary. Report your findings in two graphs showing how amplitude and period vary for each parameter, and include a table of data from runs as an appendix. Be sure to report cutoff values where the cyclic behavior (appears or) disappears.

8 Your Special Research Problem 2d:Want/Kuster

2d. Construct the system for the submodel with no paedomorphs. Repeat the analysis of equilibrium points with this model. The parameter q_{YJ} describes the probability that Y will mature into J rather than C. It has been conjectured that this parameter depends on environmental factors such as the availability of a food source. The idea is that cannabalism is a response to scarcity. Adjust the model so that J has more or less food by changing either the growth rate of B, (a_B) or the carrying capacity for F (k, currently set to 1). Fix k and vary q_{YJ} systematically through a range around the default value. Do this for k going from 1 to 2 in increments of .1. Fix a_B and vary q_{YJ} systematically through a range around the default value. Do this for a_B going from .5 to 1.5 in increments of .1. For each equilibrium value of Y, J, A, C, K report your findings as graphs, and include a table of data from runs as an appendix. What choices of k and q_{YJ} optimize each of the four equilibrium populations? What choices of a_B and q_{YJ} optimize each of the four equilibrium populations?

9 Your Special Research Problem 3a:

3a. Construct the system for the submodel with no terrestrial adults. Repeat the analysis of equilibrium points with this model. How sensitive is the fully populated equilibrium to the parameters in the model? Conduct a sensitivity analysis by varying each parameter by ten percent and recording the change in equilibrium values of for all populations. Report your findings in six tornado diagrams, and include a table of data from runs as an appendix.

10 Your Special Research Problem 3b: Wilson/Strizich

3b. Construct the system for the submodel with no terrestrial adults. Repeat the analysis of equilibrium points with this model. All predation terms in this model are of the form $p_{AB}AB$, where A is consuming B. This term represents an insatiable predator– as B rises one single member of A continues to consume the same proportion of B per day without ever getting full. We can change this situation so the predator satiates by replacing B with $B/(k+B)$. Graph this function of B. You will see that it rises from zero to one, so that the maximum rate of consumption per predator is now p_{AB}. Repeat the analysis of equilibrium with all predation terms, using $k = .01$ to $k = .2$ in increments of .01. How do equilibrium populations of all populations respond to this parameter? Report your findings in six graphs of equilibrium versus k, and include a table of data from runs as an appendix.

11 Your Special Research Problem 3c: Rosenthal/Nagle

3c. Construct the system for the submodel with no terrestrial adults. Repeat the analysis of equilibrium points with this model. The following system, which is not necessarily your system, displays a phenomenon called a "limit cycle". For a range of initial conditions, all solutions go to a periodic solution with the same period and amplitude. Note that the constants are quite different and return a high proportion of energy derived from predation back into growth. I had to run the system to $t = 10000$ (in 100000 time steps) to see the periodicity.

F=1, F' = (10*F*(1-F) - 2*B*F - 2*Y*F

B= .1, B' = (1*B*F - (.5*A + .5*J)*B -.001*B)

Y=.1, Y' = (.3*(A*B) - .05*Y*F - .01*Y)

J=0, J' = (.05*Y*F - .02*J*B -.001*J)

A=.1, A' = (.02*J*B - .001*A)

Find parameters that create a limit cycle in your model. Repeat the analysis of equilibrium points with this model. Then vary these parameters by ten percent in both directions and see if the cycle is still visible, and record how the amplitude and period vary. Report your findings in two graphs showing how amplitude and period vary for each parameter, and include a table of data from runs as an appendix. Be sure to report cutoff values where the cyclic behavior (appears or) disappears.

12 Your Special Research Problem 3d: Tang/Wu

3d. Construct the system for the submodel with no terrestrial adults. Repeat the analysis of equilibrium points with this model. The parameter q_{YJ} describes the probability that Y will mature into J rather than C. It has been conjectured that this parameter depends on environmental factors such as the availability of a food source. The idea is that cannabalism is a response to scarcity. Adjust the model so that J has more or less food by changing either the growth rate of B, (a_B) or the carrying capacity for F (k, currently set to 1). Fix k and vary q_{YJ} systematically through a range around the default value. Do this for k going from 1 to 2 in increments of .1. Fix a_B and vary q_{YJ} systematically through a range around the default value. Do this for a_B going from .5 to 1.5 in increments of .1. For each equilibrium value of Y, J, A, C, K report your findings as graphs, and include a table of data from runs as an appendix. What choices of k and q_{YJ} optimize each of the four equilibrium populations? What choices of a_B and q_{YJ} optimize each of the four equilibrium populations?

13 Your Special Research Problem 4a: Palitz/Seehof

4a. Construct the system for the submodel with only cannabalistic morphs. Repeat the analysis of equilibrium points with this model. How sensitive is the fully populated equilibrium to the parameters in the model? Conduct a sensitivity analysis by varying each parameter by ten percent and recording the change in equilibrium values of for all populations. Report your findings in six tornado diagrams, and include a table of data from runs as an appendix.

14 Your Special Research Problem 4b: Wang/Kiam

4b. Construct the system for the submodel with only cannabalistic morphs. Repeat the analysis of equilibrium points with this model. All predation terms in this model are of the form $p_{AB}AB$, where A is consuming B. This term represents an insatiable predator– as B rises one single member of A continues to consume the same proportion of B per day without ever getting full. We can change this situation so the predator satiates by replacing B with $B/(k+B)$. Graph this function of B. You will see that it rises from zero to one, so that the maximum rate of consumption per predator is now p_{AB}. Repeat the analysis of equilibrium with all predation terms, using $k = .01$ to $k = .2$ in increments of .01. How do equilibrium populations of all populations respond to this parameter? Report your findings in six graphs of equilibrium versus k, and include a table of data from runs as an appendix.

15 Your Special Research Problem 4c: Vickers/Blackburn

4c. Construct the system for the submodel with only cannabalistic morphs. Repeat the analysis of equilibrium points with this model. The following system, which is not necessarily your system, displays a phenomenon called a "limit cycle". For a range of initial conditions, all solutions go to a periodic solution with the same period and amplitude. Note that the constants are quite different and return a high proportion of energy derived from predation back into growth. I had to run the system to $t = 10000$ (in 100000 time steps) to see the periodicity.

F=1, F' = (10*F*(1-F) - 2*B*F - 2*Y*F

B= .1, B' = (1*B*F - (.5*A + .5*J)*B -.001*B)

Y=.1, Y' = (.3*(A*B) - .05*Y*F - .01*Y)

J=0, J' = (.05*Y*F - .02*J*B -.001*J)

A=.1, A' = (.02*J*B - .001*A)

Find parameters that create a limit cycle in your model. Repeat the analysis of equilibrium points with this model. Then vary these parameters by ten percent in both directions and see if the cycle is still visible, and record how the amplitude and period vary. Report your findings in two graphs showing how amplitude and period vary for each parameter, and include a table of data from runs as an appendix. Be sure to report cutoff values where the cyclic behavior (appears or) disappears.

16 Your Special Research Problem 4d: Pedde/Agrawal

4d.Construct the system for the submodel with only cannabalistic morphs. Repeat the analysis of equilibrium points with this model. Wissinger *et al* [**?**] describes a series of experiments in which a habitat (tank) is loaded with a specific number of young of the year and "cannibals". These cannibals were actually paedomorphs that happen to also eat young of the year, but the authors could have easily chosen to use cannabilistic morphs instead. The results of the experiment are displayed in Figure 4. Field data is reported in Figure 6. Run a numerical experiment simulating the experiments described in the Wissinger paper. Does the model behave in the same way? Can you find parameters that give a good approximation of their results?

17 Your Special Research Problem 5a: Sottosanti/Wimer

5a. Construct the system for the submodel with only paedomorphs. Repeat the analysis of equilibrium points with this model. How sensitive is the fully populated equilibrium to the parameters in the model? Conduct a sensitivity analysis by varying each parameter by ten percent and recording the change in equilibrium values of for all populations. Report your findings in tornado diagrams, and include a table of data from runs as an appendix.

18 Your Special Research Problem 5b: Bornstein/Frank

5b. Construct the system for the submodel with only paedomorphs. Repeat the analysis of equilibrium points with this model. All predation terms in this model are of the form $p_{AB}AB$, where A is consuming B. This term represents an insatiable predator– as B rises one single member of A continues to consume the same proportion of B per day without ever getting full. We can change this situation so the predator satiates by replacing B with $B/(k+B)$. Graph this function of B. You will see that it rises from zero to one, so that the maximum rate of consumption per predator is now p_{AB}. Repeat the analysis of equilibrium with all predation terms, using $k = .01$ to $k = .2$ in increments of .01. How do equilibrium populations of all populations respond to this parameter? Report your findings in six graphs of equilibrium versus k, and include a table of data from runs as an appendix.

19 Your Special Research Problem 5c: Long/Zupan

5c. Construct the system for the submodel with only paedomorphs. Repeat the analysis of equilibrium points with this model. The following system, which is not necessarily your system, displays a phenomenon called a "limit cycle". For a range of initial conditions, all solutions go to a periodic solution with the same period and amplitude. Note that the constants are quite different and return a high proportion of energy derived from predation back into growth. I had to run the system to $t = 10000$ (in 100000 time steps) to see the periodicity.

F=1, F' = (10*F*(1-F) - 2*B*F - 2*Y*F

B= .1, B' = (1*B*F - (.5*A + .5*J)*B -.001*B)

Y=.1, Y' = (.3*(A*B) - .05*Y*F - .01*Y)

J=0, J' = (.05*Y*F - .02*J*B -.001*J)

A=.1, A' = (.02*J*B - .001*A)

Find parameters that create a limit cycle in your model. Repeat the analysis of equilibrium points with this model. Then vary these parameters by ten percent in both directions and see if the cycle is still visible, and record how the amplitude and period vary. Report your findings in two graphs showing how amplitude and period vary for each parameter, and include a table of data from runs as an appendix. Be sure to report cutoff values where the cyclic behavior (appears or) disappears.

20 Your Special Research Problem 5d: Du/Raghu

5d. Construct the system for the submodel with only paedomorphs. Repeat the analysis of equilibrium points with this model. Repeat the analysis of equilibrium points with this model. Wissinger *et al* [**?**] describes a series of experiments in which a habitat (tank) is loaded with a specific number of young of the year and "cannibals". These cannibals were actually paedomorphs that happen to also eat young of the year. The results of the experiment are displayed in Figure 4. Field data is reported in Figure 6. Run a numerical experiment simulating the experiments described in the Wissinger paper. Does the model behave in the same way? Can you find parameters that give a good approximation of their results?

21 Your Special Research Problem 6a: Nevola/Chu

6a. Construct the system for the submodel with only terrestrial adults. Repeat the analysis of equilibrium points with this model. How sensitive is the fully populated equilibrium to the parameters in the model? Conduct a sensitivity analysis by varying each parameter by ten percent and recording the change in equilibrium values of for all populations. Report your findings in six tornado diagrams, and include a table of data from runs as an appendix.

22 Your Special Research Problem 6b: Vaidjanathan/Brett

6b. Construct the system for the submodel with only terrestrial adults. Repeat the analysis of equilibrium points with this model. All predation terms in this model are of the form $p_{AB}AB$, where A is consuming B. This term represents an insatiable predator– as B rises one single member of A continues to consume the same proportion of B per day without ever getting full. We can change this situation so the predator satiates by replacing B with $B/(k+B)$. Graph this function of B. You will see that it rises from zero to one, so that the maximum rate of consumption per predator is now p_{AB}. Repeat the analysis of equilibrium with all predation terms, using $k = .01$ to $k = .2$ in increments of .01. How do equilibrium populations of all populations respond to this parameter? Report your findings in six graphs of equilibrium versus k, and include a table of data from runs as an appendix.

23 Your Special Research Problem 6c: Zahka/Raina

6c. Construct the system for the submodel with only terrestrial adults. Repeat the analysis of equilibrium points with this model. The following system, which is not necessarily your system, displays a phenomenon called a "limit cycle". For a range of initial conditions, all solutions go to a periodic solution with the same period and amplitude. Note that the constants are quite different and return a high proportion of energy derived from predation back into growth. I had to run the system to $t = 10000$ (in 100000 time steps) to see the periodicity.

F=1, F' = (10*F*(1-F) - 2*B*F - 2*Y*F
B= .1, B' = (1*B*F - (.5*A + .5*J)*B -.001*B)
Y=.1, Y' = (.3*(A*B) - .05*Y*F - .01*Y)
J=0, J' = (.05*Y*F - .02*J*B -.001*J)
A=.1, A' = (.02*J*B - .001*A)

Find parameters that create a limit cycle in your model. Repeat the analysis of equilibrium points with this model. Then vary these parameters by ten percent in both directions and see if the cycle is still visible, and record how the amplitude and period vary. Report your findings in two graphs showing how amplitude and period vary for each parameter, and include a table of data from runs as an appendix. Be sure to report cutoff values where the cyclic behavior (appears or) disappears.

24 Your Special Research Problem 6d: Boyd/Herron

6d. Construct the system for the submodel with only terrestrial adults. Repeat the analysis of equilibrium points with this model. This submodel is special because it is the only submodel in which Y is not prey. How do the predation rates of J and A on B affect the dynamics of the system? Vary p_{BJ} and p_{BA} systematically through a range around the default value to see the effect on equilibrium populations. Do this in increments of .05 for both parameters. For each equilibrium value of B, Y, J, A report your findings as graphs, and include a table of data from runs as an appendix. What choices of p_{BJ} and p_{BA} optimize each of the four equilibrium populations? What choices of p_{BJ} and p_{BA} optimize the total *Ambystoma* population?

25 Your Special Research Problem 6e: Willenbrock/Mattimore

6e. Construct the system for the submodel with only terrestrial adults. This submodel is special because it is the only submodel in which Y is not prey. How do the predation rates of J and A on B affect the dynamics of the system? One potential advantage for a lifecycle with terrestrial adults is the possibility that adults have the possibility of seeking prey other than B. Suppose A has a source of prey of the form kA (which assumes a constant supply of this prey independent of the behavior of A). How does this affect the system? You must split consumption p_{BA} into two parts that sum to $p_{BA}B$ which was the per capita consumption by A in the original model. Thus $k = (p_{BA} - r_{BA})B$ where a new, smaller r_{BA} replaces p_{BA}, and represents a behavioral decision by A to seek B as food rather than leave the pond. Repeat the analysis of equilibrium points with this model. Vary r_{BA} from zero to twice the default value of p_{BA} in ten increments. For each equilibrium value of B, Y, J, A report your findings as graphs, and include a table of data from runs as an appendix. What choice of r_{BA} optimizes each of the four equilibrium populations? What choice of r_{BA} optimizes the total *Ambystoma* population?

26 Your Special Research Problem 7a: Thaker

7a. Consider the full system. How sensitive is the fully populated equilibrium to the parameters in the model? Conduct a sensitivity analysis by varying each parameter by ten percent and recording the change in equilibrium values of for all populations. Report your findings in six tornado diagrams, and include a table of data from runs as an appendix.

27 Your Special Research Problem 7b: Deutsch/Cemenkoff

7b. Consider the full system. All predation terms in this model are of the form $p_{AB}AB$, where A is consuming B. This term represents an insatiable predator– as B rises one single member of A continues to consume the same proportion of B per day without ever getting full. We can change this situation so the predator satiates by replacing B with $B/(k+B)$. Graph this function of B. You will see that it rises from zero to one, so that the maximum rate of consumption per predator is now p_{AB}. Repeat the analysis of equilibrium with all predation terms, using $k = .01$ to $k = .2$ in increments of .01. How do equilibrium populations of all populations respond to this parameter? Report your findings in six graphs of equilibrium versus k, and include a table of data from runs as an appendix.

28 Your Special Research Problem 7c: Downs/Mui

7c. Consider the full system. The following system, which is not necessarily your system, displays a phenomenon called a "limit cycle". For a range of initial conditions, all solutions go to a periodic solution with the same period and amplitude. Note that the constants are quite different and return a high proportion of energy derived from predation back into growth. I had to run the system to $t = 10000$ (in 100000 time steps) to see the periodicity.

F=1, F' = (10*F*(1-F) - 2*B*F - 2*Y*F

B= .1, B' = (1*B*F - (.5*A + .5*J)*B -.001*B)

Y=.1, Y' = (.3*(A*B) - .05*Y*F - .01*Y)

J=0, J' = (.05*Y*F - .02*J*B -.001*J)

A=.1, A' = (.02*J*B - .001*A)

Find parameters that create a limit cycle in your model. Repeat the analysis of equilibrium points with this model. Then vary these parameters by ten percent in both directions and see if the cycle is still visible, and record how the amplitude and period vary. Report your findings in two graphs showing how amplitude and period vary for each parameter, and include a table of data from runs as an appendix. Be sure to report cutoff values where the cyclic behavior (appears or) disappears.

29 Your Special Research Problem 7d

7d. Consider the full system. The parameter q_{YJ} describes the probability that Y will mature into J rather than C. It has been conjectured that this parameter depends on environmental factors such as the availability of a food source. The idea is that cannabalism is a response to scarcity. Adjust the model so that J has more or less food by changing either the growth rate of B, (a_B) or the carrying capacity for F (k, currently set to 1). Fix k and vary q_{YJ} systematically through a range around the default value. Do this for k going from 1 to 2 in increments of .1. Fix a_B and vary q_{YJ} systematically through a range around the default value. Do this for a_B going from .5 to 1.5 in increments of .1. For each equilibrium value of Y, J, A, P, C, K report your findings as graphs, and include a table of data from runs as an appendix. What choices of k and q_{YJ} optimize each of the four equilibrium populations? What choices of a_B and q_{YJ} optimize each of the four equilibrium populations?

30 Your Special Research Problem 7e: Kim/Chu

7e. Consider the full system. The parameter q_{JA} describes the probability that J will mature into A rather than P. It has been conjectured that this parameter depends on environmental factors. Adjust the model so that A is able to obtain some of its food from a source other than those variables in the model (such as prey on land). This term will actually appear in the growth term for Y as kA. By varying k and q_{JA} you can get a sense of the effect this morphological decision has on equilibrium populations. Fix k and vary q_{JA} systematically through a range around the default value. Do this for k going from .1 and .9 in increments of .1. For each equilibrium value of Y, J, A, P, C, K report your findings as graphs, and include a table of data from runs as an appendix. What choices of k and q_{JA} optimize each of the four equilibrium populations?

31 Your Special Research Problem 7f

7f. Consider the full system. One potential advantage for a lifecycle with terrestrial adults is the possibility that adults have the possibility of seeking prey other than B. Suppose A has a source of prey of the form kA (which assumes a constant supply of this prey independent of the behavior of A). How does this affect the system? You must split consumption p_{BA} into two parts that sum to $p_{BA}B$ which was the per capita consumption by A in the original model. Thus $k = (p_{BA} - r_{BA})B$ where a new, smaller r_{BA} replaces p_{BA}, and represents a behavioral decision by A to seek B as food rather than leave the pond. Repeat the analysis of equilibrium points with this model. Vary r_{BA} from zero to twice the default value of p_{BA} in ten increments. For each equilibrium value of B, Y, J, A, P, C, K report your findings as graphs, and include a table of data from runs as an appendix. What choice of r_{BA} optimizes each of the four equilibrium populations? What choice of r_{BA} optimizes the total *Ambystoma* population?

32 Your Special Research Problem 7g: Fang/Jung

7g. Consider the full system. The parameter q_{YJ} describes the probability that Y will mature into J rather than C. It has been conjectured that this parameter depends on environmental factors such as the availability of a food source. The parameter q_{JA} describes the probability that J will mature into A rather than P. It has been conjectured that this parameter also depends on environmental factors. Adjust the model so that J has more or less food by changing either the growth rate of B, (a_B) or the carrying capacity for F (k, currently set to 1). Adjust the model so that A is able to obtain some of its food from a source other than those variables in the model (such as prey on land). This term will actually appear in the growth term for Y as jA. Vary the four parameters (the two q parameters, j and k) by 10 % up and down. Measure what effect these have on equilibrium values of B, Y, J, A, P, C, K and the total *Ambystoma* population. Report your findings as tornado diagrams, and include a table of data from runs as an appendix.