

## Appendix S-A

### Loop analysis: making predictions through signed digraphs

In what follows, we are showing how the loop analysis algorithm for predictions works using a simple model. In Figure S1 a simple tri-trophic linear chain comprises a resource (A), an intermediate consumer (B) and a final consumer (C). Loop analysis considers variations in the level of the variables as consequences of perturbations that permanently alter the rate of change of the variable. Suppose that  $c$  is the mortality of species A. If  $c$  is reduced (e.g. because of improved environmental conditions, or the establishment of a marine reserve), then the rate of change for A is expected to increase. We call this a “positive input”. It is formally represented in Figure S1 as the derivative of the growth function for A ( $\partial f(A)$ ) in respect to the variation of  $c$  ( $\partial c$ ). Because parameters in the equations for the growth rate of variables (i.e.  $dA/dt = f(A, B, c, d, e, \dots)$  in which  $c, d, e$  are parameters) define the equilibrium points for the system, changes in parameter values define new equilibrium points with new values for the level of the variables. This parameter variation may influence the abundance of all variables in the model. Loop analysis algorithms predict the direction (increase, decrease, no variation) of change for the level of the variables.

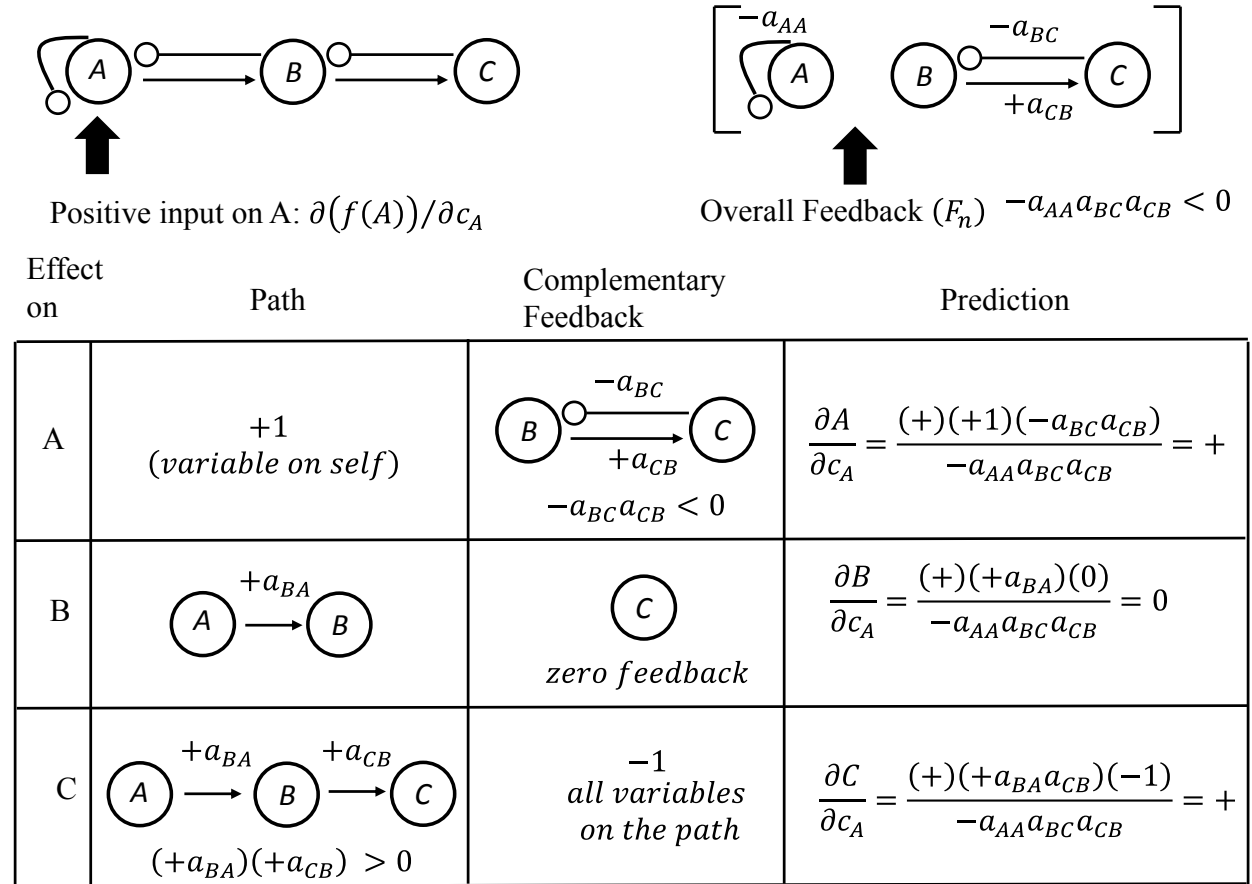
The loop analysis algorithm and its structural elements, with examples of calculations, are visually represented in Figure S1.

The following formula summarizes the elements of the algorithm:

$$\frac{\partial x_j}{\partial c} = \frac{\sum_{i,k} \left[ \frac{\partial f_i}{\partial c} \right] \times [p_{ji}^{(k)}] \times [F_{n-k}^{(comp)}]}{F_n}$$

Besides the sign of the input, determined by the term  $\left[ \frac{\partial f_i}{\partial c} \right]$ , the loop formula makes use of the concepts of path, circuit, complementary feedback, and overall feedback. These refer to structural elements that can be identified in any graph. Their meaning can be fully understood by referring to the correspondence between matrix algebra and the formalism of loop analysis (see Levins 1975, Puccia and Levins 1985). In the above formula,  $c$  is the changing parameter (e.g., mortality, fecundity, predation rate);  $[\partial f_i / \partial c]$  designates if the growth rate of the  $i$  –  $th$  variable is increasing (+) or decreasing (–);  $[p_{ij}^{(k)}]$  is the pathway connecting the variable that undergoes parameter change,  $x_i$ , with that whose equilibrium value is being calculated,  $x_j$ , and that includes ( $k$ ) variables. The last factor of the numerator is the complementary feedback  $[F_{n-k}^{(comp)}]$ , which buffers or reverses the effect of the pathway; it is the feedback formed by the ( $n - k$ ) variables that remain in

the system after the ( $k$ ) variables that are on the path are excluded. The term  $[F_n]$  indicates the overall feedback of the system, which is a measure of the inertia of the systems to change. Criteria to identify such elements in the example graph are provided by using the scheme depicted in Figure S1



**Figure S1.** Signed-digraph of a three trophic level linear chain. Paths, complementary subsystems, and feedbacks used to calculate expected changes in the equilibrium level of the variables, in response to a positive input on A. The first term of the numerator in the formula under the Prediction header is the sign of the input (+).

**Circuits and Feedbacks.** In loop analysis, a pathway that starts at one node and, by following the direction of links, returns to it without crossing intermediate nodes more than once is called a loop, or circuit. Any circuit produces a feedback that can be either positive or negative, depending on the product of the signs of the links that form the loop. As there may be circuits of different length (with 1, 2, 3, ...,  $k$  variables involved), in a given system there are as many levels of feedback as variables. Each level of feedback considers all the circuits (feedbacks) involving that particular number of variables. In the system of Figure S1 there are 3 levels of feedback. The first level of feedback comprises the only one variable circuit that is present in the system: the self-damping on variable A.

Two resource-consumer interactions [ $A_0 \rightarrow B$ ] and [ $B_0 \rightarrow C$ ] produce two feedbacks of the second level, and the three variable feedback shown in Figure S1 (overall feedback) form the third level of feedback, which is created by two independent loops: the self-damping on variable A and the resource consumer interaction involving B and C.

**Overall Feedback ( $F_n$ ).** The overall feedback is computed only once and corresponds to the highest possible level of feedback in a system. It can be calculated from single circuits linking all the variables in the system, or as a combination of shorter circuits involving smaller subsets of variables. In the hypothetical chain of three trophic levels depicted in Figure S1, the overall feedback corresponds to a third level of feedback (that is a feedback effect involving all three variables). Because the three variables cannot be connected simultaneously in unique circuits, the overall feedback comprises all the products of disjunct loops that have a combined number of variables equal to 3. That is,  $F_n$  is composed by the self-damping on A (a self-effect link is a loop of length 1) plus the two-node loop [B-C]. Its sign is obtained by multiplying the signs of the links involved, and this sign is further multiplied by  $(-1^{m+1})$ , where  $m$  is the number of disjunct loops entering the feedback. As the links involved are two negative and one positive, and there are two disjunct loops, the overall feedback is negative.

**Path [ $p_{ij}^{(k)}$ ].** A path is a series of links starting at one node and ending on another node, without crossing any variable twice. Suppose a positive input occurs on A (its rate of change increases,  $\left[\frac{\partial f_i}{\partial c}\right] > 0$ ). To predict the new equilibrium of C, the path along which the effect travels is the positive link from A to B and the arrow from B to C. Its sign, given by the product of the signs of the links that form the path, is positive.

**Complementary Feedback ( $F_{n-k}$ ).** The complementary feedback is the feedback that groups all the variables in the complementary subsystem. The complementary subsystem is what remains after the ( $k$ ) variables in the path are excluded. In Figure 1, for a positive input on A and effect on B, the complementary subsystem is formed only by C (A and B are on the path). Because C has no self-effect link, in this example there will be a null (0) complementary feedback. A path from a variable to itself is equal to 1, while if all the variables are in the path (i.e., input to A and effect on C) there is no complementary subsystem, and the complementary feedback is equal to -1. These are two algebraic conveniences that are formally explained in Levins (1975) and Puccia and Levins (1986). Summation in the loop formula considers the fact that two variables can be connected by more than one path.

Using linear algebra, we obtain the same prediction as the graphic algorithm and the net effect (the sum of the direct effect plus all the individual indirect effects) on species  $i$  resulting from an input on species  $j$  is given by the element of the inverse community matrix:

$$\frac{\partial \vec{x}^*}{\partial c_h} = (A_h)^{-1} \left( -\frac{\partial \vec{F}}{\partial c_h} \right)$$

$$\text{if } \left( \frac{\partial \vec{F}}{\partial c_h} = +1 \right) \text{ then } \frac{\partial \vec{x}^*}{\partial c_h} = -(A_h)^{-1}$$

This means that  $(A_h)$  must have a non-zero determinant and must admit an inverse matrix  $(A_h)^{-1}$  whose eigenvalues have to satisfy the Lyapunov condition of stability.

For simplicity, the vector  $\left(-\frac{\partial \vec{F}}{\partial c_h}\right)$  is considered equal to one because there is no

quantitative information about the inputs. A summary table of predictions can be produced from the simulated matrices that satisfy stability conditions. In the overall table, the variables' response is quantified as the percentage of positive signs, negative signs and zero values obtained from the matrices. The sign of the prediction is determined by a set of rules regarding the percentages of cases in which +, - and 0 appear in any given entry of the table, as we explained in the main body of the paper.

## References

Levins, R. 1975; R. Evolution in Communities Near Equilibrium. M.L. Cody, J. Diamond (Eds.), Ecology and Evolution of Communities, Belknap Press, 16-50.

Puccia, C., and R. Levins. 1985. *Qualitative Modeling of Complex Systems*. Cambridge, MA: Harvard University Press.

**Table S1. Example of pathways and their signs (Model 1).**

a. Pathways from FS to AS:

FS $\rightarrow$ AS (-)

FS $\rightarrow$ LS $\rightarrow$ AS (+)

FS $\rightarrow$ MC $\rightarrow$ MI $\rightarrow$ AE $\rightarrow$ AS (+)

FS $\rightarrow$ MC $\rightarrow$ MI $\rightarrow$ AE $\rightarrow$ LE $\rightarrow$ LS $\rightarrow$ AS (+)

FS $\rightarrow$ MC $\rightarrow$ MI $\rightarrow$ LE $\rightarrow$ LS $\rightarrow$ AS (-)

FS $\rightarrow$ LS $\rightarrow$ LE $\rightarrow$ LC $\rightarrow$ MI $\rightarrow$ AE $\rightarrow$ AS (+)

FS $\rightarrow$ LS $\rightarrow$ LC $\rightarrow$ MI $\rightarrow$ AE $\rightarrow$ AS (-)

FS $\rightarrow$ LS $\rightarrow$ LE $\rightarrow$ ME $\rightarrow$ MC $\rightarrow$ MI $\rightarrow$ AE $\rightarrow$ AS (-)

b. Pathways from FS to LS:

FS $\rightarrow$ LS (-)

FS $\rightarrow$ AS $\rightarrow$ LS (-)

FS $\rightarrow$ MC $\rightarrow$ MI $\rightarrow$ LE $\rightarrow$ LS (+)

FS $\rightarrow$ MC $\rightarrow$ MI $\rightarrow$ AE $\rightarrow$ AS $\rightarrow$ LS (+)

FS $\rightarrow$ MC $\rightarrow$ MI $\rightarrow$ AE $\rightarrow$ LE $\rightarrow$ LS (-)

FS $\rightarrow$ AS $\rightarrow$ AE $\rightarrow$ LE $\rightarrow$ LS (+)

FS $\rightarrow$ AS $\rightarrow$ AE $\rightarrow$ ME $\rightarrow$ MC $\rightarrow$ MI $\rightarrow$ LE $\rightarrow$ AS (-)

FS $\rightarrow$ AS $\rightarrow$ AC $\rightarrow$ MI $\rightarrow$ LE $\rightarrow$ LS (-)

FS $\rightarrow$ AS $\rightarrow$ AE $\rightarrow$ AC $\rightarrow$ MI $\rightarrow$ LE $\rightarrow$ LS (+)

**Table S2. Simulations' output.** For each of the 5 models (see Figure 2 in the main article), the community matrix, the three matrices reporting the percentage of +, - and 0 obtained in the simulation, and the overall table of predictions are reported.

## Model 1

"Community matrix"

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	-1	-1	1	1	0	0	1	0	0	0	0	0	0	0
AE	-1	-1	1	0	-1	0	0	-1	0	0	0	0	0	0
AC	0	0	-1	0	0	0	0	0	0	0	0	0	1	0
LS	-1	0	0	-1	-1	1	1	0	0	0	0	0	0	0
LE	0	0	0	-1	-1	1	0	-1	0	0	0	0	0	0
LC	0	0	0	0	0	-1	0	0	0	0	0	1	0	0
FS	-1	0	0	-1	0	0	-1	0	1	0	1	0	0	0
ME	0	0	0	0	0	0	-1	-1	1	0	0	0	0	0
MC	0	0	0	0	0	0	0	-1	-1	0	0	1	0	0
NE	0	0	0	0	0	0	-1	0	0	-1	1	0	0	0
NC	0	0	0	0	0	0	0	0	0	-1	-1	0	1	0
MI	0	-1	0	0	-1	0	0	-1	0	0	0	-1	0	1
NI	0	0	0	0	0	0	0	0	0	-1	0	0	-1	-1
JO	0	0	0	0	0	0	0	0	0	0	0	0	1	-1

Percentage of " + "

	AS	AE	AC	LS	LE	LC	FS	ME
AS	84.92683	14.34146	46.82927	37.31707	65.02439	48.34146	91.56098	28.92683
AE	14.19512	94.04878	76.00000	64.43902	19.70732	26.87805	29.46341	52.34146
AC	52.00000	20.92683	85.31707	44.82927	42.39024	30.92683	78.34146	35.46341
LS	8.48780	80.78049	36.68293	84.82927	16.58537	50.97561	44.97561	57.17073
LE	80.73171	26.00000	52.34146	11.31707	95.90244	73.60976	72.00000	19.31707
LC	52.00000	20.92683	16.78049	44.82927	42.39024	90.09756	78.34146	35.46341
FS	49.65854	55.17073	56.09756	8.68293	76.14634	33.36585	84.00000	21.41463
ME	55.41463	28.78049	26.04878	79.17073	29.56098	53.31707	37.60976	88.63415
MC	49.70732	37.41463	33.02439	19.07317	61.12195	28.87805	85.60976	8.97561
NE	50.34146	44.82927	43.90244	91.31707	23.85366	66.63415	16.00000	78.58537
NC	49.65854	55.17073	56.09756	8.68293	76.14634	33.36585	84.00000	21.41463
MI	52.00000	20.92683	16.78049	44.82927	42.39024	30.92683	78.34146	35.46341
NI	49.65854	55.17073	56.09756	8.68293	76.14634	33.36585	84.00000	21.41463
JO	49.65854	55.17073	56.09756	8.68293	76.14634	33.36585	84.00000	21.41463

	MC	NE	NC	MI	NI	JO
AS	76.68293	10.24390	78.24390	69.70732	81.85366	45.90244
AE	35.07317	66.14634	35.56098	47.70732	40.29268	56.34146
AC	57.75610	15.60976	47.95122	87.80488	87.85366	78.00000
LS	55.70732	54.87805	48.87805	45.90244	45.85366	46.34146
LE	32.09756	30.09756	61.70732	59.80488	65.36585	52.73171
LC	57.75610	15.60976	47.95122	87.80488	87.85366	78.00000
FS	57.07317	25.21951	82.04878	42.39024	60.29268	29.31707
ME	83.56098	48.87805	25.46341	77.51220	64.78049	80.00000
MC	87.46341	16.53659	69.70732	68.63415	77.85366	53.95122
NE	42.92683	96.92683	85.51220	57.60976	81.21951	24.00000
NC	57.07317	3.07317	96.92683	42.39024	82.73171	12.78049
MI	57.75610	15.60976	47.95122	87.80488	87.85366	78.00000
NI	57.07317	3.07317	14.48780	42.39024	97.90244	4.04878
JO	57.07317	3.07317	14.48780	42.39024	97.90244	96.78049

Percentage of " - "

	AS	AE	AC	LS	LE	LC	FS	ME
AS	15.07317	85.65854	53.17073	62.68293	34.97561	51.65854	8.43902	71.07317
AE	85.80488	5.95122	24.00000	35.56098	80.29268	73.12195	70.53659	47.65854
AC	48.00000	79.07317	14.68293	55.17073	57.60976	69.07317	21.65854	64.53659
LS	91.51220	19.21951	63.31707	15.17073	83.41463	49.02439	55.02439	42.82927
LE	19.26829	74.00000	47.65854	88.68293	4.09756	26.39024	28.00000	80.68293
LC	48.00000	79.07317	83.21951	55.17073	57.60976	9.90244	21.65854	64.53659
FS	50.34146	44.82927	43.90244	91.31707	23.85366	66.63415	16.00000	78.58537
ME	44.58537	71.21951	73.95122	20.82927	70.43902	46.68293	62.39024	11.36585
MC	50.29268	62.58537	66.97561	80.92683	38.87805	71.12195	14.39024	91.02439
NE	49.65854	55.17073	56.09756	8.68293	76.14634	33.36585	84.00000	21.41463
NC	50.34146	44.82927	43.90244	91.31707	23.85366	66.63415	16.00000	78.58537
MI	48.00000	79.07317	83.21951	55.17073	57.60976	69.07317	21.65854	64.53659
NI	50.34146	44.82927	43.90244	91.31707	23.85366	66.63415	16.00000	78.58537
JO	50.34146	44.82927	43.90244	91.31707	23.85366	66.63415	16.00000	78.58537

	MC	NE	NC	MI	NI	JO
AS	23.31707	89.75610	21.75610	30.29268	18.14634	54.09756
AE	64.92683	33.85366	64.43902	52.29268	59.70732	43.65854
AC	42.24390	84.39024	52.04878	12.19512	12.14634	22.00000
LS	44.29268	45.12195	51.12195	54.09756	54.14634	53.65854
LE	67.90244	69.90244	38.29268	40.19512	34.63415	47.26829
LC	42.24390	84.39024	52.04878	12.19512	12.14634	22.00000
FS	42.92683	74.78049	17.95122	57.60976	39.70732	70.68293
ME	16.43902	51.12195	74.53659	22.48780	35.21951	20.00000
MC	12.53659	83.46341	30.29268	31.36585	22.14634	46.04878
NE	57.07317	3.07317	14.48780	42.39024	18.78049	76.00000
NC	42.92683	96.92683	3.07317	57.60976	17.26829	87.21951
MI	42.24390	84.39024	52.04878	12.19512	12.14634	22.00000
NI	42.92683	96.92683	85.51220	57.60976	2.09756	95.95122
JO	42.92683	96.92683	85.51220	57.60976	2.09756	3.21951

Percentage of " 0 "

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ME	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JO	0	0	0	0	0	0	0	0	0	0	0	0	0	0

"Table of predictions"

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	+	-	0*	?-	?+	0*	+	?-	+	-	+	?+	+	0*
AE	-	+	?+	-	?-	0*	?-	?+	?-	0*	0*	0*	0*	0*
AC	0*	-	+	0*	0*	?-	+	?-	0*	-	0*	+	+	+
LS	-	+	?-	+	-	0*	0*	0*	0*	0*	0*	0*	0*	0*
LE	+	?-	0*	-	+	?+	?+	-	?-	?-	?+	0*	?+	0*
LC	0*	-	-	0*	0*	+	+	?-	0*	-	0*	+	+	+
FS	0*	0*	0*	-	+	?-	+	-	0*	?-	+	0*	?+	?-
ME	0*	?-	?-	+	?-	0*	?-	+	+	0*	?-	+	?+	+
MC	0*	?-	?-	-	?+	?-	+	-	+	-	?+	?+	+	0*
NE	0*	0*	0*	+	-	?+	-	+	0*	+	+	0*	+	-
NC	0*	0*	0*	-	+	?-	+	-	0*	-	+	0*	+	-
MI	0*	-	-	0*	0*	?-	+	?-	0*	-	0*	+	+	+
NI	0*	0*	0*	-	+	?-	+	-	0*	-	-	0*	+	-

JO 0\* 0\* 0\* - + ?- + - 0\* - - 0\* + +

## Model 2

"Community matrix"

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	-1	-1	1	1	0	0	1	0	0	0	0	0	0	0
AE	-1	-1	1	0	-1	0	0	-1	0	0	0	0	0	0
AC	0	0	-1	0	0	0	0	0	0	0	0	1	0	0
LS	-1	0	0	-1	-1	1	1	0	0	0	0	0	0	0
LE	0	0	0	-1	-1	1	0	0	0	0	0	0	0	0
LC	0	0	0	0	0	-1	0	0	0	0	0	0	1	0
FS	-1	0	0	-1	0	0	-1	0	1	0	1	0	0	0
ME	0	0	0	0	0	0	-1	-1	1	0	0	0	0	0
MC	0	0	0	0	0	0	0	-1	-1	0	0	1	0	0
NE	0	0	0	0	0	0	-1	0	0	-1	1	0	0	0
NC	0	0	0	0	0	0	0	0	0	-1	-1	0	1	0
MI	0	-1	0	0	-1	0	0	-1	0	0	0	-1	0	1
NI	0	0	0	0	0	0	0	0	0	-1	0	0	-1	-1
JO	0	0	0	0	0	0	0	0	0	0	0	0	1	-1

Percentage of " + "

	AS	AE	AC	LS	LE	LC	FS	ME
AS	86.74699	12.73666	45.78313	40.40448	63.42513	49.65577	91.52324	36.44578
AE	14.54389	94.44923	78.91566	51.46299	25.47332	26.24785	38.72633	28.61446
AC	51.41997	21.60069	84.50947	44.14802	39.02754	30.63683	80.76592	30.37866
LS	6.49742	86.61790	44.62134	80.37866	18.76076	49.91394	51.50602	33.73494
LE	90.74871	7.91738	38.72633	20.09466	94.79346	79.86231	64.58692	52.15146
LC	51.41997	21.60069	16.56627	44.14802	39.02754	92.03959	80.76592	30.37866
FS	53.91566	46.55766	48.92427	7.96041	79.25990	35.28399	84.50947	32.44406
ME	48.36489	36.53184	30.59380	83.26162	24.35456	50.30120	34.63855	89.37177
MC	54.08778	31.84165	31.84165	17.34079	63.51119	31.45439	85.92943	10.71429
NE	46.08434	53.44234	51.07573	92.03959	20.74010	64.71601	15.49053	67.55594
NC	53.91566	46.55766	48.92427	7.96041	79.25990	35.28399	84.50947	32.44406
MI	51.41997	21.60069	16.56627	44.14802	39.02754	30.63683	80.76592	30.37866
NI	53.91566	46.55766	48.92427	7.96041	79.25990	35.28399	84.50947	32.44406
JO	53.91566	46.55766	48.92427	7.96041	79.25990	35.28399	84.50947	32.44406

	MC	NE	NC	MI	NI	JO
AS	88.72633	9.29432	75.21515	73.10671	84.59552	50.60241
AE	16.17900	61.83305	45.95525	40.83477	39.19966	44.79346
AC	55.03442	13.94148	48.75215	89.54389	88.81239	78.14114
LS	34.81067	52.62478	58.39071	36.61790	41.82444	35.92943
LE	64.28571	29.30293	43.11532	80.24957	76.89329	73.92427
LC	55.03442	13.94148	48.75215	89.54389	88.81239	78.14114
FS	75.38726	22.03098	78.14114	51.80723	66.69535	36.44578
ME	81.11015	53.82960	24.82788	72.54733	59.98279	77.45267
MC	92.81411	14.97418	66.56627	73.02065	80.98107	57.18589
NE	24.61274	97.03098	86.53184	48.19277	79.43201	21.90189
NC	75.38726	2.96902	95.05164	51.80723	86.35972	17.16867
MI	55.03442	13.94148	48.75215	89.54389	88.81239	78.14114
NI	75.38726	2.96902	13.46816	51.80723	98.45095	5.59380
JO	75.38726	2.96902	13.46816	51.80723	98.45095	96.68675

Percentage of " - "

	AS	AE	AC	LS	LE	LC	FS	ME
AS	13.25301	87.26334	54.21687	59.59552	36.57487	50.34423	8.47676	63.55422
AE	85.45611	5.55077	21.08434	48.53701	74.52668	73.75215	61.27367	71.38554
AC	48.58003	78.39931	15.49053	55.85198	60.97246	69.36317	19.23408	69.62134
LS	93.50258	13.38210	55.37866	19.62134	81.23924	50.08606	48.49398	66.26506
LE	9.25129	92.08262	61.27367	79.90534	5.20654	20.13769	35.41308	47.84854
LC	48.58003	78.39931	83.43373	55.85198	60.97246	7.96041	19.23408	69.62134
FS	46.08434	53.44234	51.07573	92.03959	20.74010	64.71601	15.49053	67.55594
ME	51.63511	63.46816	69.40620	16.73838	75.64544	49.69880	65.36145	10.62823
MC	45.91222	68.15835	68.15835	82.65921	36.48881	68.54561	14.07057	89.28571
NE	53.91566	46.55766	48.92427	7.96041	79.25990	35.28399	84.50947	32.44406
NC	46.08434	53.44234	51.07573	92.03959	20.74010	64.71601	15.49053	67.55594
MI	48.58003	78.39931	83.43373	55.85198	60.97246	69.36317	19.23408	69.62134



NI	46.08434	53.44234	51.07573	92.03959	20.74010	64.71601	15.49053	67.55594
JO	46.08434	53.44234	51.07573	92.03959	20.74010	64.71601	15.49053	67.55594
	MC	NE	NC	MI	NI	JO		
AS	11.27367	90.70568	24.78485	26.89329	15.40448	49.39759		
AE	83.82100	38.16695	54.04475	59.16523	60.80034	55.20654		
AC	44.96558	86.05852	51.24785	10.45611	11.18761	21.85886		
LS	65.18933	47.37522	41.60929	63.38210	58.17556	64.07057		
LE	35.71429	70.69707	56.88468	19.75043	23.10671	26.07573		
LC	44.96558	86.05852	51.24785	10.45611	11.18761	21.85886		
FS	24.61274	77.96902	21.85886	48.19277	33.30465	63.55422		
ME	18.88985	46.17040	75.17212	27.45267	40.01721	22.54733		
MC	7.18589	85.02582	33.43373	26.97935	19.01893	42.81411		
NE	75.38726	2.96902	13.46816	51.80723	20.56799	78.09811		
NC	24.61274	97.03098	4.94836	48.19277	13.64028	82.83133		
MI	44.96558	86.05852	51.24785	10.45611	11.18761	21.85886		
NI	24.61274	97.03098	86.53184	48.19277	1.54905	94.40620		
JO	24.61274	97.03098	86.53184	48.19277	1.54905	3.31325		

Percentage of " 0 "

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ME	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JO	0	0	0	0	0	0	0	0	0	0	0	0	0	0

"Table of predictions"

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	+	-	0*	0*	?+	0*	+	?-	+	-	+	?+	+	0*
AE	-	+	+	0*	?-	?-	?-	?-	-	?+	0*	0*	?-	0*
AC	0*	-	+	0*	?-	?-	+	?-	0*	-	0*	+	+	+
LS	-	+	0*	+	-	0*	0*	?-	?-	0*	0*	?-	0*	?-
LE	+	-	?-	-	+	+	?+	0*	?+	?-	0*	+	+	?+
LC	0*	-	-	0*	?-	+	+	?-	0*	-	0*	+	+	+
FS	0*	0*	0*	-	+	?-	+	?-	+	-	+	0*	?+	?-
ME	0*	?-	?-	+	-	0*	?-	+	+	0*	-	?+	0*	+
MC	0*	?-	?-	-	?+	?-	+	-	+	-	?+	?+	+	0*
NE	0*	0*	0*	+	-	?+	-	?+	-	+	+	0*	+	-
NC	0*	0*	0*	-	+	?-	+	?-	+	-	+	0*	+	-
MI	0*	-	-	0*	?-	?-	+	?-	0*	-	0*	+	+	+
NI	0*	0*	0*	-	+	?-	+	?-	+	-	-	0*	+	-
JO	0*	0*	0*	-	+	?-	+	?-	+	-	-	0*	+	+

## Model 3

"Community matrix"

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	-1	-1	1	1	0	0	1	0	0	0	0	0	0	0
AE	-1	-1	1	0	0	0	0	-1	0	0	0	0	0	0
AC	0	0	-1	0	0	0	0	0	0	0	0	1	0	0
LS	-1	0	0	-1	-1	1	1	0	0	0	0	0	0	0
LE	0	0	0	-1	-1	1	0	-1	0	0	0	0	0	0
LC	0	0	0	0	0	-1	0	0	0	0	0	1	0	0
FS	-1	0	0	-1	0	0	-1	0	1	0	1	0	0	0
ME	0	0	0	0	0	0	-1	-1	1	0	0	0	0	0
MC	0	0	0	0	0	0	0	-1	-1	0	0	1	0	0
NE	0	0	0	0	0	0	-1	0	0	-1	1	0	0	0
NC	0	0	0	0	0	0	0	0	0	-1	-1	0	1	0
MI	0	-1	0	0	-1	0	0	-1	0	0	0	-1	0	1

NI 0 0 0 0 0 0 0 0 0 0 -1 0 0 -1 -1  
 JO 0 0 0 0 0 0 0 0 0 0 0 0 0 1 -1

Percentage of " + "

	AS	AE	AC	LS	LE	LC	FS	ME
AS	83.35221	15.85504	44.69611	50.77388	38.69385	33.03133	90.48698	43.18611
AE	22.31031	93.01623	85.69271	35.03209	54.51114	41.63835	37.63684	27.89732
AC	42.61986	22.95206	87.31597	62.77841	15.66629	18.27105	72.78218	50.32088
LS	6.34202	83.88071	41.33635	79.01095	30.46433	62.24991	48.24462	42.24236
LE	86.74972	18.27105	45.86636	14.60929	92.63873	73.68818	73.27293	26.50057
LC	42.61986	22.95206	14.94904	62.77841	15.66629	88.48622	72.78218	50.32088
FS	56.02114	47.94262	53.86938	4.75651	85.99471	34.76784	87.91997	17.74254
ME	41.71385	38.12760	28.31257	89.99622	8.19177	43.79011	31.67233	91.92148
MC	49.94337	33.63533	31.33258	22.65006	54.13364	21.70630	87.46697	11.74028
NE	43.97886	52.05738	46.13062	95.24349	14.00529	65.23216	12.08003	82.25746
NC	56.02114	47.94262	53.86938	4.75651	85.99471	34.76784	87.91997	17.74254
MI	42.61986	22.95206	14.94904	62.77841	15.66629	18.27105	72.78218	50.32088
NI	56.02114	47.90487	53.83163	4.75651	85.95696	34.76784	87.88222	17.74254
JO	56.02114	47.90487	53.83163	4.75651	85.99471	34.76784	87.91997	17.74254

	MC	NE	NC	MI	NI	JO
AS	87.31597	11.58928	76.67044	67.64817	81.23820	44.84711
AE	16.53454	57.07814	35.18309	58.36165	51.03813	62.70291
AC	68.10117	19.47905	41.37410	91.88373	87.35372	82.25746
LS	42.77086	50.28313	49.30162	49.75462	50.13213	49.11287
LE	43.22386	27.67082	61.57040	64.85466	68.89392	53.11438
LC	68.10117	19.47905	41.37410	91.88373	87.35372	82.25746
FS	58.73915	20.27180	84.59796	46.28162	65.87391	30.57758
ME	81.27595	54.92639	20.00755	76.06644	59.00340	81.46470
MC	89.31672	13.74103	66.81767	74.44319	82.29521	58.02190
NE	41.26085	97.31974	82.97471	53.71838	79.35070	25.36806
NC	58.73915	2.68026	96.97999	46.28162	85.57946	13.70328
MI	68.10117	19.47905	41.37410	91.88373	87.35372	82.25746
NI	58.70140	2.68026	17.02529	46.24387	97.99924	3.66176
JO	58.70140	2.68026	17.02529	46.28162	97.99924	95.92299

Percentage of " - "

	AS	AE	AC	LS	LE	LC	FS	ME
AS	16.64779	84.14496	55.30389	49.22612	61.30615	66.96867	9.51302	56.81389
AE	77.68969	6.98377	14.30729	64.96791	45.48886	58.36165	62.36316	72.10268
AC	57.38014	77.04794	12.68403	37.22159	84.33371	81.72895	27.21782	49.67912
LS	93.65798	16.11929	58.66365	20.98905	69.53567	37.75009	51.75538	57.75764
LE	13.25028	81.72895	54.13364	85.39071	7.36127	26.31182	26.72707	73.49943
LC	57.38014	77.04794	85.05096	37.22159	84.33371	11.51378	27.21782	49.67912
FS	43.97886	52.05738	46.13062	95.24349	14.00529	65.23216	12.08003	82.25746
ME	58.28615	61.87240	71.68743	10.00378	91.80823	56.20989	68.32767	8.07852
MC	50.05663	66.36467	68.66742	77.34994	45.86636	78.29370	12.53303	88.25972
NE	56.02114	47.94262	53.86938	4.75651	85.99471	34.76784	87.91997	17.74254
NC	43.97886	52.05738	46.13062	95.24349	14.00529	65.23216	12.08003	82.25746
MI	57.38014	77.04794	85.05096	37.22159	84.33371	81.72895	27.21782	49.67912
NI	43.94111	52.05738	46.09287	95.20574	13.96753	65.19441	12.08003	82.21971
JO	43.97886	52.05738	46.09287	95.24349	14.00529	65.19441	12.08003	82.21971

	MC	NE	NC	MI	NI	JO
AS	12.68403	88.41072	23.32956	32.35183	18.76180	55.15289
AE	83.46546	42.92186	64.81691	41.63835	48.96187	37.29709
AC	31.89883	80.52095	58.62590	8.11627	12.64628	17.74254
LS	57.22914	49.71687	50.69838	50.24538	49.86787	50.88713
LE	56.77614	72.32918	38.42960	35.14534	31.10608	46.88562
LC	31.89883	80.52095	58.62590	8.11627	12.64628	17.74254
FS	41.26085	79.72820	15.40204	53.71838	34.12609	69.42242
ME	18.72405	45.07361	79.99245	23.93356	40.99660	18.53530
MC	10.68328	86.25897	33.18233	25.55681	17.70479	41.97810
NE	58.70140	2.68026	17.02529	46.28162	20.64930	74.63194
NC	41.26085	97.31974	3.02001	53.71838	14.42054	86.29672
MI	31.89883	80.52095	58.62590	8.11627	12.64628	17.74254
NI	41.22310	97.31974	82.97471	53.71838	2.00076	96.33824
JO	41.26085	97.31974	82.97471	53.71838	2.00076	4.07701

Percentage of " 0 "

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC
AS	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0 0
AE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0 0
AC	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0 0
LS	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0 0
LE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0 0
LC	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0 0
FS	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0 0
ME	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0 0
MC	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0 0
NE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.03775	0 0
NC	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0 0
MI	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0 0
NI	0.03775	0.03775	0.0755	0.03775	0.0755	0.03775	0.03775	0.03775	0.07550	0 0	0 0
JO	0.00000	0.03775	0.0755	0.00000	0.0000	0.03775	0.00000	0.03775	0.03775	0.03775	0 0

	MI	NI	JO
AS	0.00000	0	0
AE	0.00000	0	0
AC	0.00000	0	0
LS	0.00000	0	0
LE	0.00000	0	0
LC	0.00000	0	0
FS	0.00000	0	0
ME	0.00000	0	0
MC	0.00000	0	0
NE	0.00000	0	0
NC	0.00000	0	0
MI	0.00000	0	0
NI	0.03775	0	0
JO	0.00000	0	0

"Table of predictions"

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	+	-	0*	0*	?-	?-	+	0*	+	-	+	?+	+	0*
AE	-	+	+	?-	0*	0*	?-	?-	-	0*	?-	0*	0*	?+
AC	0*	-	+	?+	-	-	?+	0*	?+	-	0*	+	+	+
LS	-	+	0*	+	?-	?+	0*	0*	0*	0*	0*	0*	0*	0*
LE	+	-	0*	-	+	?+	?+	?-	0*	?-	?+	?+	?+	0*
LC	0*	-	-	?+	-	+	?+	0*	?+	-	0*	+	+	+
FS	0*	0*	0*	-	+	?-	+	-	0*	-	+	0*	?+	?-
ME	0*	?-	?-	+	-	0*	?-	+	+	0*	-	+	0*	+
MC	0*	?-	?-	-	0*	-	+	-	+	-	?+	?+	+	0*
NE	0*	0*	0*	+	-	?+	-	+	0*	+	+	0*	+	?-
NC	0*	0*	0*	-	+	?-	+	-	0*	-	+	0*	+	-
MI	0*	-	-	?+	-	-	?+	0*	?+	-	0*	+	+	+
NI	0*	0*	0*	-	+	?-	+	-	0*	-	-	0*	+	-
JO	0*	0*	0*	-	+	?-	+	-	0*	-	-	0*	+	+

## Model 4

"Community matrix"

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	-1	-1	1	1	0	0	1	0	0	0	0	0	0	0
AE	-1	-1	1	0	0	0	0	-1	0	0	0	0	0	0
AC	0	0	-1	0	0	0	0	0	0	0	0	1	0	0
LS	-1	0	0	-1	-1	1	1	0	0	0	0	0	0	0
LE	0	0	0	-1	-1	1	0	0	0	0	0	0	0	0
LC	0	0	0	0	0	-1	0	0	0	0	0	1	0	0
FS	-1	0	0	-1	0	0	-1	0	1	0	1	0	0	0
ME	0	0	0	0	0	0	-1	-1	1	0	0	0	0	0
MC	0	0	0	0	0	0	0	-1	-1	0	0	1	0	0
NE	0	0	0	0	0	0	-1	0	0	-1	1	0	0	0
NC	0	0	0	0	0	0	0	0	0	-1	-1	0	1	0
MI	0	-1	0	0	-1	0	0	-1	0	0	0	-1	0	1
NI	0	0	0	0	0	0	0	0	0	-1	0	0	-1	-1

Percentage of " + "

	AS	AE	AC	LS	LE	LC	FS	ME
AS	87.14910	10.85465	44.38553	48.28447	38.67748	33.15658	94.91578	37.89769
AE	22.83219	93.32502	85.21522	32.03369	58.82720	42.63880	37.61697	22.70742
AC	43.38740	22.08359	88.55271	53.33749	17.52963	15.62695	83.37492	27.97879
LS	5.36494	87.52339	42.45165	76.07611	33.00062	63.03805	49.25140	28.38428
LE	92.70119	5.80162	36.11978	25.04679	89.83157	77.23019	68.27823	54.99064
LC	43.38740	22.08359	16.03244	53.33749	17.52963	91.70306	83.37492	27.97879
FS	58.67124	40.04991	47.50468	5.05303	84.74735	31.87773	88.67748	31.72177
ME	38.39676	41.89021	29.94386	89.55084	8.35933	42.23331	33.21896	89.23893
MC	52.74485	29.66313	28.13475	19.96257	54.49158	20.24329	91.26638	8.04741
NE	41.32876	59.95009	52.49532	94.94697	15.25265	68.12227	11.32252	68.27823
NC	58.67124	40.04991	47.50468	5.05303	84.74735	31.87773	88.67748	31.72177
MI	43.38740	22.08359	16.03244	53.33749	17.52963	15.62695	83.37492	27.97879
NI	58.67124	40.04991	47.50468	5.05303	84.74735	31.84654	88.67748	31.72177
JO	58.64005	40.04991	47.50468	5.05303	84.74735	31.81535	88.67748	31.72177
	MC	NE	NC	MI	NI	JO		
AS	92.91953	8.14099	82.84467	71.36619	84.31067	43.73051		
AE	12.60137	57.42358	35.52714	56.70618	50.56145	61.10418		
AC	56.76856	12.50780	52.24579	92.85714	91.11042	79.75671		
LS	29.94386	52.46413	51.99626	42.57642	45.72676	42.88833		
LE	70.61759	25.67062	47.84779	82.09607	78.54024	73.08172		
LC	56.76856	12.50780	52.24579	92.85714	91.11042	79.75671		
FS	78.85215	16.99938	81.09794	56.92452	72.36432	36.36931		
ME	78.32190	55.36494	23.83032	73.58079	59.07673	79.91266		
MC	94.72863	10.66750	70.96070	78.97692	86.18216	59.01435		
NE	21.14785	98.44042	84.77854	43.07548	76.88709	19.83780		
NC	78.85215	1.55958	96.10106	56.92452	89.70680	17.40487		
MI	56.76856	12.50780	52.24579	92.85714	91.11042	79.75671		
NI	78.85215	1.55958	15.22146	56.89333	99.25140	4.83468		
JO	78.85215	1.55958	15.22146	56.86213	99.25140	97.31753		

Percentage of " - "

	AS	AE	AC	LS	LE	LC	FS	ME
AS	12.85090	89.14535	55.61447	51.71553	61.32252	66.84342	5.08422	62.10231
AE	77.16781	6.67498	14.78478	67.96631	41.17280	57.36120	62.38303	77.29258
AC	56.61260	77.91641	11.44729	46.66251	82.47037	84.37305	16.62508	72.02121
LS	94.63506	12.47661	57.54835	23.92389	66.99938	36.96195	50.74860	71.61572
LE	7.29881	94.19838	63.88022	74.95321	10.16843	22.76981	31.72177	45.00936
LC	56.61260	77.91641	83.96756	46.66251	82.47037	8.29694	16.62508	72.02121
FS	41.32876	59.95009	52.49532	94.94697	15.25265	68.12227	11.32252	68.27823
ME	61.60324	58.10979	70.05614	10.44916	91.64067	57.76669	66.78104	10.76107
MC	47.25515	70.33687	71.86525	80.03743	45.50842	79.75671	8.73362	91.95259
NE	58.67124	40.04991	47.50468	5.05303	84.74735	31.87773	88.67748	31.72177
NC	41.32876	59.95009	52.49532	94.94697	15.25265	68.12227	11.32252	68.27823
MI	56.61260	77.91641	83.96756	46.66251	82.47037	84.37305	16.62508	72.02121
NI	41.32876	59.95009	52.46413	94.94697	15.25265	68.12227	11.32252	68.24704
JO	41.29757	59.91890	52.49532	94.94697	15.25265	68.12227	11.32252	68.24704
	MC	NE	NC	MI	NI	JO		
AS	7.08047	91.85901	17.15533	28.63381	15.68933	56.26949		
AE	87.39863	42.57642	64.44167	43.29382	49.43855	38.89582		
AC	43.23144	87.49220	47.75421	7.14286	8.88958	20.24329		
LS	70.05614	47.53587	48.00374	57.42358	54.27324	57.11167		
LE	29.38241	74.32938	52.15221	17.90393	21.45976	26.91828		
LC	43.23144	87.49220	47.75421	7.14286	8.88958	20.24329		
FS	21.14785	83.00062	18.90206	43.07548	27.63568	63.63069		
ME	21.67810	44.63506	76.16968	26.41921	40.92327	20.08734		
MC	5.27137	89.33250	29.03930	21.02308	13.81784	40.98565		
NE	78.85215	1.55958	15.22146	56.92452	23.11291	80.16220		
NC	21.14785	98.44042	3.89894	43.07548	10.29320	82.59513		
MI	43.23144	87.49220	47.75421	7.14286	8.88958	20.24329		
NI	21.14785	98.44042	84.77854	43.07548	0.74860	95.16532		
JO	21.14785	98.44042	84.77854	43.07548	0.74860	2.68247		

Percentage of " 0 "														
	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.00000	0.00000	0	0
AE	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.03119	0.00000	0	0
AC	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.00000	0.00000	0	0
LS	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.00000	0.00000	0	0
LE	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.00000	0.00000	0	0
LC	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.00000	0.00000	0	0
FS	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.00000	0.00000	0	0
ME	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.00000	0.00000	0	0
MC	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.00000	0.00000	0	0
NE	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.00000	0.00000	0	0
NC	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.00000	0.00000	0	0
MI	0.00000	0.00000	0.00000	0	0	0.00000	0	0.00000	0	0	0.00000	0.00000	0	0
NI	0.00000	0.00000	0.03119	0	0	0.03119	0	0.03119	0	0	0.00000	0.03119	0	0
JO	0.06238	0.03119	0.00000	0	0	0.06238	0	0.03119	0	0	0.00000	0.06238	0	0

"Table of predictions"

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	+	-	0*	0*	?-	?-	+	?-	+	-	+	?+	+	0*
AE	-	+	+	?-	0*	0*	?-	-	-	0*	?-	0*	0*	?+
AC	0*	-	+	0*	-	-	+	?-	0*	-	0*	+	+	+
LS	-	+	0*	+	?-	?+	0*	?-	?-	0*	0*	0*	0*	0*
LE	+	-	?-	?-	+	+	?+	0*	?+	?-	0*	+	+	?+
LC	0*	-	-	0*	-	+	+	?-	0*	-	0*	+	+	+
FS	0*	0*	0*	-	+	?-	+	?-	+	-	+	0*	?+	?-
ME	?-	0*	?-	+	-	0*	?-	+	+	0*	-	?+	0*	+
MC	0*	?-	?-	-	0*	-	+	-	+	-	?+	+	+	0*
NE	0*	0*	0*	+	-	?+	-	?+	-	+	+	0*	+	-
NC	0*	0*	0*	-	+	?-	+	?-	+	-	+	0*	+	-
MI	0*	-	-	0*	-	-	+	?-	0*	-	0*	+	+	+
NI	0*	0*	0*	-	+	?-	+	?-	+	-	-	0*	+	-
JO	0*	0*	0*	-	+	?-	+	?-	+	-	-	0*	+	+

## Model 5

"Community matrix"

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO
AS	-1	-1	1	1	0	0	1	0	0	0	0	0	0	0
AE	-1	-1	1	0	0	0	0	0	0	0	0	0	0	0
AC	0	0	-1	0	0	0	0	0	0	0	0	1	0	0
LS	-1	0	0	-1	-1	1	1	0	0	0	0	0	0	0
LE	0	0	0	-1	-1	1	0	-1	0	0	0	0	0	0
LC	0	0	0	0	0	-1	0	0	0	0	0	1	0	0
FS	-1	0	0	-1	0	0	-1	0	1	0	1	0	0	0
ME	0	0	0	0	0	0	-1	-1	1	0	0	0	0	0
MC	0	0	0	0	0	0	0	-1	-1	0	0	1	0	0
NE	0	0	0	0	0	0	-1	0	0	-1	1	0	0	0
NC	0	0	0	0	0	0	0	0	0	-1	-1	0	1	0
MI	0	-1	0	0	-1	0	0	-1	0	0	0	-1	0	1
NI	0	0	0	0	0	0	0	0	0	-1	0	0	-1	-1
JO	0	0	0	0	0	0	0	0	0	0	0	0	1	-1

Percentage of " + "

	AS	AE	AC	LS	LE	LC	FS	ME
AS	83.62847	16.43836	48.94754	41.79753	48.17908	34.38022	93.55162	20.84865
AE	12.22853	94.82125	82.15837	59.17140	30.83862	38.42299	20.11360	65.08520
AC	45.53959	23.15403	89.54227	51.55363	22.45239	15.60307	79.88640	30.80521
LS	7.51754	81.22285	35.51620	86.83595	21.11594	60.37421	43.76879	66.32142
LE	81.25626	23.98931	52.75643	8.72035	95.75677	72.26863	74.07284	9.48881
LC	45.53959	23.15403	16.70565	51.55363	22.45239	88.00535	79.88640	30.80521
FS	51.62045	52.32208	55.89709	4.64417	86.46843	35.21550	85.16539	14.46709
ME	47.21016	33.37788	24.15636	88.60675	9.55563	41.59706	36.98630	91.91447
MC	46.87604	36.25125	33.41129	20.14701	56.99967	21.48346	87.37053	6.88273
NE	48.37955	47.67792	44.10291	95.35583	13.53157	64.78450	14.83461	85.53291
NC	51.62045	52.32208	55.89709	4.64417	86.46843	35.21550	85.16539	14.46709
MI	45.53959	23.15403	16.70565	51.55363	22.45239	15.60307	79.88640	30.80521

NI	51.62045	52.28867	55.89709	4.64417	86.46843	35.21550	85.16539	14.46709
JO	51.58704	52.28867	55.89709	4.64417	86.43502	35.21550	85.16539	14.40027
	MC	NE	NC	MI	NI	JO		
AS	79.31841	10.12362	84.29669	62.11159	79.45205	37.72135		
AE	27.46408	66.72235	15.03508	72.33545	51.58704	81.72402		
AC	58.46976	15.20214	49.44871	89.97661	88.74039	77.88172		
LS	61.37655	52.72302	41.76412	57.50084	51.98797	58.43635		
LE	24.65753	29.00100	67.15670	56.53191	65.18543	45.94053		
LC	58.46976	15.20214	49.44871	89.97661	88.74039	77.88172		
FS	53.62513	21.65052	83.02706	44.97160	63.84898	28.76712		
ME	88.43969	52.15503	23.35449	77.74808	63.14734	82.05814		
MC	87.43735	13.83228	70.49783	73.13732	81.52355	54.66088		
NE	46.37487	97.19345	82.75977	55.02840	79.38523	25.42599		
NC	53.62513	2.80655	96.55864	44.97160	85.16539	12.49582		
MI	58.46976	15.20214	49.44871	89.97661	88.74039	77.88172		
NI	53.62513	2.80655	17.24023	44.93819	98.26261	3.64183		
JO	53.62513	2.80655	17.24023	44.90478	98.26261	95.95723		

Percentage of " - "

	AS	AE	AC	LS	LE	LC	FS	ME
AS	16.37153	83.56164	51.05246	58.20247	51.82092	65.61978	6.44838	79.15135
AE	87.77147	5.17875	17.84163	40.82860	69.16138	61.57701	79.88640	34.91480
AC	54.46041	76.84597	10.45773	48.44637	77.54761	84.39693	20.11360	69.19479
LS	92.48246	18.77715	64.48380	13.16405	78.88406	39.62579	56.23121	33.67858
LE	18.74374	76.01069	47.24357	91.27965	4.24323	27.73137	25.92716	90.51119
LC	54.46041	76.84597	83.29435	48.44637	77.54761	11.99465	20.11360	69.19479
FS	48.37955	47.67792	44.10291	95.35583	13.53157	64.78450	14.83461	85.53291
ME	52.78984	66.62212	75.84364	11.39325	90.44437	58.40294	63.01370	8.08553
MC	53.12396	63.74875	66.58871	79.85299	43.00033	78.51654	12.62947	93.11727
NE	51.62045	52.32208	55.89709	4.64417	86.46843	35.21550	85.16539	14.46709
NC	48.37955	47.67792	44.10291	95.35583	13.53157	64.78450	14.83461	85.53291
MI	54.46041	76.84597	83.29435	48.44637	77.54761	84.39693	20.11360	69.19479
NI	48.37955	47.67792	44.03608	95.35583	13.53157	64.78450	14.83461	85.53291
JO	48.37955	47.64450	44.03608	95.28901	13.53157	64.75109	14.83461	85.53291
	MC	NE	NC	MI	NI	JO		
AS	20.68159	89.87638	15.70331	37.88841	20.54795	62.27865		
AE	72.53592	33.27765	84.96492	27.66455	48.41296	18.27598		
AC	41.53024	84.79786	50.55129	9.98998	11.25961	22.11828		
LS	38.62345	47.27698	58.23588	42.49916	48.01203	41.56365		
LE	75.34247	70.99900	32.84330	43.46809	34.81457	54.05947		
LC	41.53024	84.79786	50.55129	9.98998	11.25961	22.11828		
FS	46.37487	78.34948	16.97294	55.02840	36.15102	71.23288		
ME	11.56031	47.84497	76.64551	22.25192	36.85266	17.94186		
MC	12.56265	86.16772	29.50217	26.86268	18.47645	45.33912		
NE	53.62513	2.80655	17.24023	44.97160	20.61477	74.57401		
NC	46.37487	97.19345	3.44136	55.02840	14.83461	87.50418		
MI	41.53024	84.79786	50.55129	9.98998	11.25961	22.11828		
NI	46.37487	97.19345	82.75977	55.02840	1.73739	96.35817		
JO	46.34146	97.19345	82.75977	54.99499	1.73739	4.04277		

Percentage of " 0 "

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC
AS	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
AE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
AC	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
LS	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
LE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
LC	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
FS	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
ME	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
MC	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
NE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
NC	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
MI	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
NI	0.00000	0.03341	0.06682	0.00000	0.00000	0.00000	0	0.00000	0.00000	0	0
JO	0.03341	0.06682	0.06682	0.06682	0.03341	0.03341	0	0.06682	0.03341	0	0
	MI	NI	JO								
AS	0.00000	0	0								

```

AE 0.00000 0 0
AC 0.03341 0 0
LS 0.00000 0 0
LE 0.00000 0 0
LC 0.03341 0 0
FS 0.00000 0 0
ME 0.00000 0 0
MC 0.00000 0 0
NE 0.00000 0 0
NC 0.00000 0 0
MI 0.03341 0 0
NI 0.03341 0 0
JO 0.10023 0 0

```

"Table of predictions"

```

      AS AE AC LS LE LC FS ME MC NE NC MI NI JO
AS + - 0* 0* 0* ?- + - + - + ?+ + ?-
AE - + + 0* ?- ?- - ?+ ?- ?+ - ?+ 0* +
AC 0* - + 0* - - + ?- 0* - 0* + + +
LS - + ?- + - ?+ 0* ?+ ?+ 0* 0* 0* 0* 0*
LE + - 0* - + ?+ ?+ - - ?- ?+ 0* ?+ 0*
LC 0* - - 0* - + + ?- 0* - 0* + + +
FS 0* 0* 0* - + ?- + - 0* - + 0* ?+ ?-
ME 0* ?- - + - 0* ?- + + 0* - + ?+ +
MC 0* ?- ?- - 0* - + - + - ?+ ?+ + 0*
NE 0* 0* 0* + - ?+ - + 0* + + 0* + ?-
NC 0* 0* 0* - + ?- + - 0* - + 0* + -
MI 0* - - 0* - - + ?- 0* - 0* + + +
NI 0* 0* 0* - + ?- + - 0* - - 0* + -
JO 0* 0* 0* - + ?- + - 0* - - 0* + +

```

**Table S3. Sensitivity Analyses.** Number of cases in which each prediction matrix differs from all other matrices in a series of pairwise comparisons.

a. Numbers based on tendencies of changes (i.e. including ?+ and ?). The greatest difference is between models 2 (M2) and 3 (M3) (55 cases, corresponding to 28% of the total number of comparisons). The average difference computed considering all comparisons is 20%.

	M1	M2	M3	M4	M5
M1	0	39	42	50	29
M2	0	0	55	25	46
M3	0	0	0	40	34
M4	0	0	0	0	43
M5	0	0	0	0	0

b. Numbers re-calculated (from Table S3a) when tendencies are transformed in signs (i.e. ?+ becomes + and ?- becomes -). The largest difference is between models 2 and 3 (35 cases): their predictions differ in 17% of the comparisons. The average difference is 12%.

	M1	M2	M3	M4	M5
M1	0	25	28	31	15
M2	0	0	35	15	27
M3	0	0	0	24	24
M4	0	0	0	0	25
M5	0	0	0	0	0



**Table S4. Control over lobster effort through regulation.** In this model, control is exerted by a governmental agency (GA) that is represented in the graph as a “predator” on LE (lobster fishing effort). This represents the situation where a controlling factor (GA, in this case) reacts promptly to any variation in the level of effort, bringing it back to its original level. This control is possible because of the negative feedback between GA and LE and because GA is not self-damped. Without self-damping, GA responds only to LE. Its response is typical of a negative feedback that exerts a buffering effect. Moreover, LE remains unaffected by any input entering the system because GA, being non self-damped, makes the complementary feedback of all pathways to LE null. Therefore, GA protects LE against the effect of variations in the system. The table of predictions is reported below. The table shows that LE changes only for variations in the rate of change of the governmental agency which controls it.

	AS	AE	AC	LS	LE	LC	FS	ME	MC	NE	NC	MI	NI	JO	GA
AS	+	?-	?-	0*	0	0*	+	0*	+	-	?+	-	0*	?-	?+
AE	-	+	+	-	0	-	0*	-	-	0*	?-	+	+	+	-
AC	+	-	-	?+	0	?+	?+	+	+	?-	0*	-	0*	?-	+
LS	-	+	?+	0*	0	0*	0*	-	?-	0*	0*	+	?+	?+	-
LE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+
LC	+	-	-	?+	0	+	?+	+	+	?-	0*	-	0*	?-	+
FS	?-	?+	?+	-	0	-	?+	?-	0*	?-	0*	?+	?+	0*	0*
ME	?+	-	-	+	0	+	0*	+	+	0*	0*	?-	0*	?-	?+
MC	+	-	-	?+	0	?+	?+	+	+	?-	0*	-	0*	?-	+
NE	?+	?-	?-	+	0	+	?-	?+	0*	+	+	?-	+	-	0*
NC	?-	?+	?+	-	0	-	?+	?-	0*	-	+	?+	+	-	0*
MI	+	-	-	?+	0	?+	?+	+	+	?-	0*	-	0*	?-	+
NI	?-	?+	?+	-	0	-	?+	?-	0*	-	-	?+	+	-	0*
JO	?-	?+	?+	-	0	-	?+	?-	0*	-	-	?+	+	+	0*
GA	?-	?+	?+	?+	-	-	0*	?+	0*	0*	0*	?+	0*	?+	?+

**Figure S1. Control over lobster effort through regulation (see Table S4).**

