Land-Use Intensity and Ecosystems Stability

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the ecological network model

\[
\frac{\Delta \tilde{y}}{\tilde{y}} = \tilde{r} + \tilde{M} \cdot \tilde{y} - \tilde{H}
\]

\[
\frac{\Delta \tilde{r}}{\tilde{r}} = \frac{r}{\tilde{r}} \left[ \tilde{r} - \frac{\tilde{a}}{\tilde{r} \tilde{M} \tilde{C}} \right] + \frac{\tilde{a}}{\tilde{r} \tilde{M} \tilde{C}} - \tilde{A} - \frac{\tilde{p}}{\tilde{r} \tilde{M} \tilde{C}} \tilde{r} - \tilde{H}
\]

\[
\Delta \tilde{C}
\]

consumers

primary producers

harvest of producers

interactions

- competitive - limiting similarity -
- trophic - minimum potential niche model -

\( a = \begin{bmatrix} a_{11} & 0 & \ldots & 0 \\ 0 & a_{22} & \ldots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \ldots & a_{n,n} \end{bmatrix} \)

\( c(\cdot) = X^{-1} q(j) \) where \( X = \begin{bmatrix} 1 & -1 & \ldots & -1 \\ -1 & 1 & \ldots & -1 \\ \vdots & \vdots & \ddots & \vdots \\ -1 & -1 & \ldots & 1 \end{bmatrix} \)

conclusions

- equilibria with positive densities tend to be locally stable and their frequency decrease with species richness;
- the intensity of harvest decrease the frequency of positive local stable equilibria and increase the variability in the total biomass remaining;
- an homogeneous distribution of harvest among producer species reduce overall impacts on ecosystem stability, as well as uncertainty on yields;
- the communities with low richness are prone to more heterogeneous dynamics in response to harvest and provide lower yields;
- a biomimetic harvest configuration may reduce impacts while increasing the yields.

results

ecosystem stability

Frequency of local stable and unstable equilibria found in 1000 sample networks generated for communities with species richness from 4 to 20 species, together with the stable equilibria found with positive densities.

Standard deviation of the mean total biomass across time on the set of previously stable configurations after the introduction of harvest. The solid lines present the median standard deviation and the colored areas represent the 10th and 90th percentiles of all communities with a given richness.

ecosystem productivity

Mean across time of the total yield obtained for communities with different richnesses and harvest distributions. The solid lines present the median total yield and the colored areas represent the 10th and 90th percentiles of all sample communities with a given richness. The set of communities with stable configurations before harvest is used.

bibliography


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