New balance in an ecosystem Nariyuki NAKAGIRI, Kei-ichi TAINAKA^a

Department of Mathematical Science, Ibaraki University, Mito 310-8512, JAPAN nakagiri@kei2.sys.eng.shizuoka.ac.jp

^aDepartment of Systems Engineering, Shizuoka University, Hamamatsu 432-8561, JAPAN tainaka@sys.eng.shizuoka.ac.jp

There have been a lot of studies on the effect of introductin of species. They mainly focused on a direct effect (short-term response); an example is an extinction caused by the introduction. In this report, we explore an indirect effect after the introduciton of new species; food web balnace should be qualitatively changed. For instance, an introduction of a kind of fish may influence on the fishery during long period.

Consider a two-dimentional latice consisting of two species of prey (X), and predator (Y).Each lattice site is labeled by X,Y, or O, where X (or Y) is the site ocuppied by prey (or predator), and O represents the vacant site.

$$X + Y \xrightarrow{pred} 2Y$$
 (1a)

$$X + O \xrightarrow{r_1} 2X, Y + O \xrightarrow{r_2} 2Y.$$
 (1b)

$$X \xrightarrow{d1} O, Y \xrightarrow{d2} O.$$
 (1c)

The above reactions respectively represent the predation (pred), reproduction of prey(r1, r2), and the death(d1, d2) of predator.

We assume that both species X and Y coexist with steady-state densities, and that the interactions (1a) and (1b) occurs between adjacent lattice points.

We carry out a perturbation experiment by computer simulation: At time t = 100, new species Z is introduced. This species



Figure 1: An example of population dynamics for the lattice model (100×100). The time dependence of both species X ,Y and Z are shown.

beats X but it is beaten by Y: the strength relation among species X, Y and Z corresponds to the Paper-Sissors-Rock game. An example of such balance is three kinds of fish; namely, saury, mackerel and sardine. Typical population dynamics is shown in Fig. 1. In this case, no extinction occurs by the introduction of species Z. However, after the introduction, food web balnace is qualitatively changed.

The change of balance may influence on the fishery of X. Before the introduction of Z, the species Y never goes extinct, if species X is largely excluded. Even though X is completely removed, Y can survive. On the other hand, after the introduction, Y becomes extinct by the advance of fishery. This is because a new balance is formed by an introducing of species Z.