ROCKY MOUNTAIN
JOURNAL OF MATHEMATICS
Volume 20, Number 4, Fall 1990

A STERILE RELEASE MODEL FOR CONTROL OF A PEST WITH TWO LIFE STAGES UNDER PREDATION

HUGH J. BARCLAY AND P. VAN DEN DRIESSCHE

ABSTRACT. A model is presented in which sterile pests are released into a system consisting of a pest species with two life stages and a predator species. The release of steriles affects mainly predators and, as the release rate is increased, the predator equilibrium is eventually reduced to zero. In once case, however, a bifurcation exists and the system will collapse before the predators are eliminated.

1. Introduction. The sterile insect release method (SIRM) for pest control has been used effectively against screw-worms (*Cochliomyia omnivorax*) [**7**], melon flies (*Dacus cucurbitae*) [**12**], the codling moth (*Laspeyresia pomonella*) [**15**], and a few other insect species. It has been tried against many other species with mixed or little success, e.g., medflies (*Ceratitis capitata*) [**10**]. The reasons for success in some cases and not in others are often unclear. A few general principles have been postulated by modelling and by empirical or experimental inference; these include limitations on the technique by (i) lack of sterile male competitive ability [**1, 13, 17**], (ii) lack of complete sterilization [**8, 13**] and (iii) immigration of wild fertilized individuals [**9, 14**].

A feature which may assist the effectiveness of the SIRM is the existence of predatory or parasitic control on the pest species. This has been investigated by modelling [**3, 4, 5, 11**], but appears to have never been tested experimentally. The existence of a natural enemy may lower the required sterile release rate (in the absence of immigration of pests) for eradication of the pest species [**5**] and it may also destabilize the system so that eradication may be achieved at considerably lower than the theoretically prescribed sterile release rates [**3**]. On the other hand, the existence of more than one distinct life stage in the life cycle of the pest species also complicates the outcome of a sterile release program [**1**]. In order to shed further light on the population dynamics of this potentially useful pest control method, a model is proposed here which incorporates two life stages (larval and adult) for the pest species and, in addition, a monophagous predator which feeds on and depresses the