Population Fluctuations and Extinctions of Small Rodents in Coastal Southern California

Andrew R. Blaustein
Department of Zoology, Oregon State University, Corvallis, Oregon 97331, USA

Summary. The population dynamics of three sympatric rodents, Microtus californicus, Mus musculus, and Reithrodontomys megalotis, was studied at four sites in coastal southern California. The study was undertaken to determine the extent of local demographic diversity in rodent populations.

The populations of all rodent species became extinct on one site, while on another site the populations fluctuated widely and on two other sites the populations remained relatively stable. The most common species, Reithrodontomys, exhibited differences in reproduction, age class structure, recruitment, and survivorship on the two sites which were monitored for relatively long terms. Immigration was the main source of new individuals entering the sites where the Reithrodontomys population was most persistent.

On a local scale, some life history characteristics are affected in a density dependent fashion. When viewed on a global scale, the non-equilibrium nature of the rodent populations becomes clear.

Introduction

There is an increasing appreciation for understanding the importance of disturbances and non-equilibrium situations within ecological systems and how they influence processes such as extinction and population regulation. Models proposed by Hutchinson (1951) and Skellam (1951) on non-equilibrium coexistence explain how two ecologically similar species could coexist in a patchy environment. In Hutchinson's model, an inferior competitor can exist with a superior competitor if the superior competitor can invade such patches and colonize the area. Immigration was the main source of new individuals entering the sites where the Reithrodontomys population was most persistent.

Non-equilibrium states as influenced by local population extinctions is the essence of the population regulation model proposed by Andrewartha and Birch (1954). They reasoned that a species consists of many local populations that vary independently. Some local populations may go extinct and colonists from extant populations will repopulate these areas. The scheme of Andrewartha and Birch (1954) does not require density dependent action within a local population. All that is required is a positive intrinsic rate of growth, r_m, some of the time in most populations and sufficient interchange between populations to recolonize places where random extinction has occurred. Random extinction can occur through biotic or abiotic disturbances (see Connell 1978; Sousa 1979). The importance of non-equilibrium population dynamics in the Andrewartha and Birch (1954) sense has been suggested by field studies of invertebrates (see Ehrlich 1965; Menge 1979; Spight 1974 for examples). Aside from "cycling" rodent populations (see Krebs and Myers 1974) local population extinctions of vertebrates are less well known but may be more common than is generally believed (see for examples: Errington 1963; Leck 1979; Lidicker 1966; Willis 1974). Furthermore, Lidicker (1978) predicts that demographic diversity among rodents is expected among different populations of the same species.

To test the Andrewartha and Birch (1954) model, I monitored rodent populations in Santa Barbara, Co., California. It was my hypothesis that these populations would show differences in demographic parameters which would influence both local and global population changes. To support the model, the existence of population size asynchrony must be established. Some populations should be at high density, while others should be at low density. As further support for the model, dispersal to areas of low density should be observed. It is important to document these differences for another reason. Many ecological studies of vertebrates are conducted on only one site for relatively short time spans. These short term studies may not give us an accurate ecological picture of the system (see Hayne 1978 and Wiens 1977 for discussions).

Materials and Methods

Study Areas

Four live-trap grids were established in the vicinity of the University of California, Santa Barbara, campus (Fig. 1). The climate in this area is Mediterranean-like with moderate temperatures throughout the year. There is a summer drought and winter rainy season. Frost is rare. Blaustein (1978) provides detailed climatological data. Grids were as large as possible, given the terrain. Natural barriers (i.e., inlets, hedge rows, and trees) bordered each grid. Areas were chosen to be as similar as possible in vegetation and terrain.

Goleta Slough grid 1 (9 x 9 configuration with 10 m spacing) was located about 1.6 km from the Pacific Ocean in a disturbed (= introduced plant species) grassland bordering a coastal salt marsh. The dominant plants were grasses (Bromus, Lolium and Arenaria) with inter-
Fig. 1. Map showing study areas where grids were placed

spersed coyote bush (Baccharis pilularis). Trapping was conducted from July 1974 through June 1976 for a total of 23,004 trap periods (one trap check = one trap period).

Goleta Slough grid 2 (8 x 8.5 m spacing) was located about 100 m from the southeast border of Goleta Slough 1. Dominant vegetation on this grid consisted of the grasses Bromus, Lolium and Avena. The southern portion of the grid had a stand of fennel (Foeniculum). Trapping was conducted from February through May, 1975 for a total of 1,792 trap periods.

The Devereux grid (9 x 9, 10 m spacing) was located on the University of California Coal Oil Point Reserve and was about 0.8 km from the ocean in a coastal strand community and adjacent disturbed grassland. Bush lupine (Lupinus arboreus) and beach primrose (Camissonia cheiranthifolia) dominated the strand. Wild mustard (Raphanus sativus) and the grasses Bromus, Lolium, and Hordeum dominated the grassland. Baccharis pilularis was found throughout the grid, except on the extreme northeast portion, which was sandy. Trapping was conducted in February 1974 and from July 1974 through March 1976 for a total of 13,527 trap periods.

The Lagoon Central grid (7 x 7, 8 m spacing) was located on a coastal bluff in a disturbed grassland community. Dominant vegetation was Bromus, Raphanus and Lupinus arboreus. Trapping was conducted in February and March, 1976 (total = 441 trap periods). Blau-stein (1978, 1980) provides further details concerning grid structure and placement.

Trapping Procedures

Rodents were live-trapped on grids, with large Sherman aluminum live-traps baited with a mixture of rolled oats and sunflower seeds. Upon capture, I noted species, weight (to the nearest 0.5 g) sex, relative age (adult, subadult, juvenile) reproductive condition, and trap coordinates. All rodents were marked individually by toe-clipping and ear-notchting. Animals were released at their points of capture.

Trapping was conducted for at least three consecutive days per month on Goleta Slough grid 1 and at Devereux. Traps were checked at dawn, noon and dusk on these grids. Two trapping sessions were conducted on Goleta Slough grid 2. The first session lasted from 18 February to 3 March 1975 (12 days, 768 trap periods). The second session lasted from 9 April through 21 May 1975 (16 days, 1,024 trap periods). Traps were checked at dawn, as they were during the 9 day session on the Lagoon Central grid.

Density estimates on the Goleta Slough 1 and Devereux grids were based on the minimum number of individuals known to be alive during a three day monthly trapping session.

Analysis of Demographic Parameters

Since it was not possible to determine exact ages, rodents were placed into one of three age classes based on a combination of pelage and weight characteristics: adults, subadults and juveniles (DeLong 1967; Fisler 1965; Hooper 1952; Krebs 1966; McCabe and Blanchard 1950).

Dates of first and last capture of individuals provided a crude estimate of survival; however, it cannot be known for sure whether animals that are no longer captured have died, moved away or will no longer enter traps. Survivorship was computed for animals on the Goleta Slough grid 1 and at Devereux.

Females were placed into three reproductive classes: reproductively active - pregnant or lactating; potentially reproductive - show signs of estrous cycling as exemplified by having perforated vaginal orifices; non-reproductive - non-pregnant, non-lactating females which showed no signs of estrous cycling. Males were classified as having abdominal testes (reproductively inactive) or testes which have descended into the scrotal sac (reproductively active).

Recruitment refers to the rate at which individuals enter the populations due to natality or immigration. It is not certain which of these two sources is most important at any given on the study areas, but if reproduction is low, one can infer that immigration was an important source of new animals entering a particular area. If new animals were adults it is likely immigration occurred.

Variance-ratio tests (F-test, Bailey 1972; p. 50) were used to test the equality of variances before testing differences between sample means. If the variances were statistically different from one another