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Rat Density on Diego Garcia: Implications for Eradication Feasibility

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Poster Presentation

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ABSTRACT: Introduced black rats are among the most invasive species to islands worldwide. In addition to agricultural impacts, rats are vectors of disease, cause damage to native flora and fauna, and negatively impact threatened/endangered species. Eradication efforts have met with mixed success. Success or failure of an eradication effort can depend on the population density of the target species, which can influence rodenticide sowing rates. We used snap trapping grids to estimate black rat densities in two different forest types on Diego Garcia: coconut forest and mixed species forest. Individual snap traps baited with fresh coconut were placed every 10 m in a 100-m × 100-m (1 ha) grid in the mixed forest and every 20 m in a 220-m × 220-m grid (4.8 ha) in the coconut forest. Traps were checked twice daily for 7 and 11 days in the mixed and coconut forest, respectively. In total, 914 rats were captured on the coconut forest grid and 125 rats were captured on the mixed forest grid. Rat density in coconut forest was 187 rats/ha (95% CI: 176-201) and 88 rats/ha (95% CI: 82-104) in mixed forest. Stomach contents were examined in 121 rats trapped in the mixed forest: 81% contained coconut along with other vegetation or meat, and 67% contained coconut exclusively. It is likely that the high rat density is driven by an abundant coconut food source resulting in a variable distribution of rats among habitat types. Planning for eradication will need to consider the variability of rodent densities across different habitats, with management strategies developed to address this variability.

KEY WORDS: black rat, British Indian Ocean Territory, Chagos Archipelago, Diego Garcia, *Rattus rattus*, rodent density

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INTRODUCTION

Introduced rats (*Rattus* spp.) are among the most invasive species to islands worldwide (Towns 2009). Unlike many other introduced species (dogs, cats, goats, mongooses), rat introductions are typically accidental. Rats are vectors of disease (Meerburg et al. 2009) and have been implicated in destruction of native habitat and declines in endangered species (Towns et al. 2006, Shiels et al. 2014). Efforts to eradicate rats from islands have met with mixed results (see Howald et al. 2007 for a review). One factor influencing the success or failure of any rodent eradication is the population density of the target species, which plays an important role in establishing sowing rates for rodenticides. Population densities can also vary depending on habitat type. Our objective was to estimate the population density of introduced rats in two forested environments [coconut (*Cocos nucifera*) forest and mixed forest] on the island of Diego Garcia.

STUDY AREA

Diego Garcia is the southernmost atoll of the Chagos Archipelago and lies approximately 7 degrees south of the equator in the British Indian Ocean Territory, southwest of the Maldives (Figure 1). The climate is tropical and temperatures average 27°C with annual mean

Figure 1. Location of Diego Garcia, British Indian Ocean Territory.

rainfall of 362.7 cm. From the 18th century until the early 1970s, much of the native vegetation on the atoll was converted to coconut plantations. By the early 1970s the coconut plantations had been closed and the western portion of the atoll was converted to a military installation (Sheppard et al. 2012). The eastern portion of the atoll is a nature preserve with restricted public access. The Chagos Archipelago is designated a "no-take protected marine area" (Sheppard et al. 2012) but illegal fishing has been documented in the past (Spalding 2006, Price and Harris 2009). The atoll boasts a large population of endangered green turtles (*Chelonia mydas*), hawksbill turtles (*Eretmochelys imbricata*) (Mortimer et al. 2000), and high population densities of coconut crabs (*Birgus latro*) (~230/ha) (Vogt 2005a).

METHODS

Rat densities were estimated at two sites on the northwest section of the atoll. Site One was near the main cantonment and was primarily *Cocos nucifera* mono-stand with some *Neisosperma oppositifolia* and *Morinda citrifolia* scattered in the understory. Site Two was mixed forest ~3 km from the main cantonment and was dominated by *Hernandia sonora*, *N. oppositifolia*, *C. nucifera*, and *M. citrifolia*. On Site One a grid of 144 Victor snap traps were placed in a 12 × 12 pattern with 20-m spacing for a total area of 4.84 ha. Traps at both sites were baited with fresh coconut and peanut butter (Figure 2). At Site One, traps were pre-baited for 2 days. Trapping was conducted for 11 consecutive days and traps were checked daily in the morning and afternoon and re-set as needed. On Site Two, a grid of 121 Victor snap traps were placed in an 11 × 11 pattern with 10-m spacing for a total area of 1 ha. Traps were baited with coconut and peanut butter and checked twice daily for 7 days and re-set as needed. On the 8th day, traps were checked in the morning and removed. All rats captured at Site Two were necropsied for stomach contents, reproductive condition, and liver condition.

Figure 2. Setting and baiting rat traps on Diego Garcia.

Population abundance was estimated with program MARK as a removal project (using the behavioral response model and setting recaptures to zero). Population density was estimated by adding a buffer strip to the trapping grid dimensions. The size of the buffer strip was based on home range estimates (half the home range width added to the grid dimensions) of rats outfitted with thread bobbins from Barbour Thread Company (Barbour Threads Inc., Hendersonville, NC). Each bobbin had 300 m of thread and weighed 4.5 grams. Rats were captured, weighed, measured, sexed, and a small patch of fur was shaved off of the back with an electric razor. The bobbin was wrapped with one strip of duct tape and secured to the rat's skin with super glue. Rats were then released at the point of capture. The thread was checked on following days. Thread position was recorded with a GPS every 5 m and when trees were climbed, the height of the thread was recorded. Home range was calculated by multiplying the length and width of the area of defined by the thread.

RESULTS

In total, 914 rats were captured at Site One and 125 rats at Site Two. At Site One, due to partial consumption by coconut crabs, 29 rats could not be weighed, measured, or sexed. Of the remaining rats 381 (43%) were male and 504 (57%) were female. At Site Two, 4 rats could not be weighed, measured, or sexed due to crab predation. Of the remaining rats 58 (48%) were female and 63 (52%) were male. The abundance estimates were 1,139 (95% CI: 1075-1229) and 142 (95% CI: 132-167) for Sites One and Two, respectively. The mean home range size for 7 rats with thread bobbins (4 in coconut forest, 3 in mixed forest) was 705 m^2, and a buffer strip of 27 m (square root of 705) was added to the trapping grids. The sampling area for Site One was 6.10 ha and 1.61 ha for Site Two. Rat density estimates were 187/ha (95% CI: 176-201) and 88/ha (95% CI: 82-104) for Sites One and Two, respectively (Figure 4). Stomach contents were examined in 121 rats trapped in the mixed forest: 81% contained coconut along with other vegetation or meat and 67% contained coconut exclusively (Figure 5).

DISCUSSION

Rat densities on Diego Garcia are among the highest recorded for this species. Our population estimate in a mixed forest is over 3 times the previous estimate of 25/ha (Vogt 2005b), but is still likely an underestimate. Throughout the trapping period in both forest types, an average of 38% of traps were found released without having captured a rat, rendering them unavailable to rats. We can only speculate as to how many of the empty but released traps would have trapped rats. Trap density in the mixed forest was 4 times higher (1 trap/83m^2 versus 1 trap/336m^2) than in the coconut forest site, and therefore was trapped out much quicker. Reinvasion following localized removal at the mixed forest site appeared to be swift, as captures began to increase 6 to 7 days after trapping began (Figures 6 and 7). Such rapid reinvasion highlights the importance of adequate bait application during any eradication attempt.

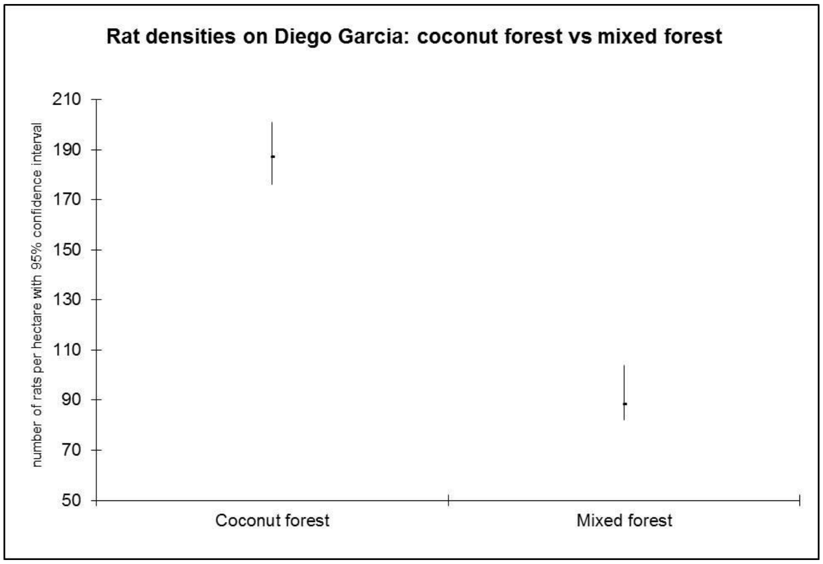

Figure 4. Rat densities in two forest types, Diego Garcia.

Figure 3. Rat fitted with thread bobbin for home range estimation, Diego Garcia.

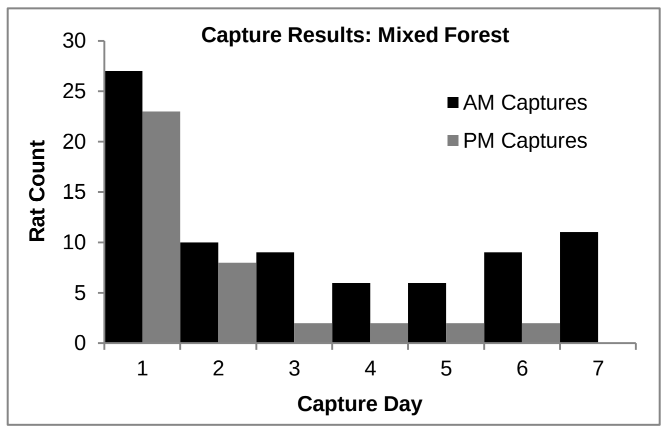

Figure 6. Daily rat count in mixed forest, Diego Garcia, September 2013.

Figure 5. Rat stomach contents showing coconut as a primary food source.

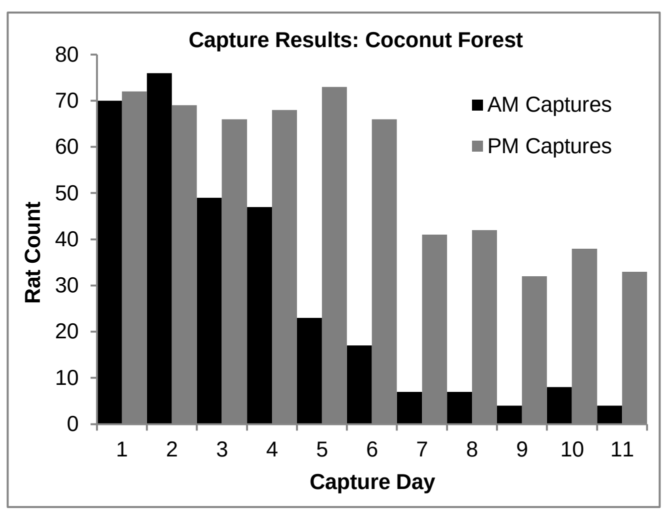

Figure 7. Daily rat count in coconut forest, Diego Garcia, September 2013.

Rat diets in the mixed forest consisted primarily of coconut, with some additional vegetable matter (likely *H. sonora* and *N. oppositifolia*) and a protein source, possibly from garden lizards (*Calotes versicolor*), geckos (*Lepidodactylus lugubrus*), or dead crabs. It is likely that in addition to the lack of natural predators, the high rat density is driven by an abundant coconut food source resulting in a variable distribution of rats among habitat types. Planning for eradication will need to consider the variability of rodent densities across different habitats, with management strategies developed to address this variability.

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