tivity (Schindler 1990). In this case, species richness has low inertia and may be an important property to monitor, as it is often the harbinger of more profound and irreversible ecosystem changes.

Properties of ant assemblages show different degrees of inertia relative to similar stressors. For example, an Australian mallee ant assemblage retained its entire species complement following a hot woodland fire (Andersen and Yen 1985). An ant assemblage in an English heathland, in contrast, was dramatically changed by fire (Brian et al. 1976). Likewise, logging will likely have a greater impact on insect diversity in a Neotropical forest, where the canopy is rich with insects (including ants), than in a temperate pine woodland, where insect diversity may be concentrated on the ground (Jeanne 1979; Erwin 1986; Blackburn et al. 1990). Thus one of the first steps in a remediation program is to determine the actual impact of the stressor.

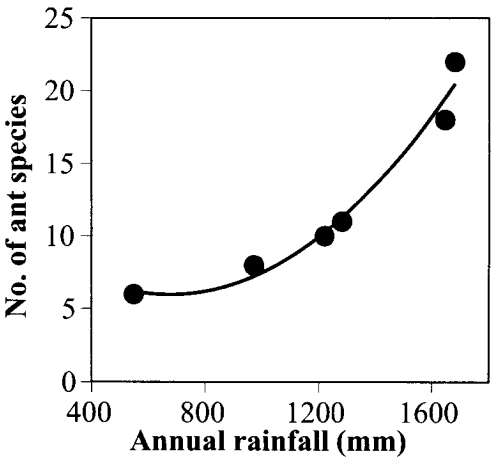

Figure 7.5. Fitted line for the relationship between the number of ant species in 3-year-old rehabilitated mines and annual rainfall for a range of sites throughout Australia. Adapted from Majer (1992).

Resilience

Resilience reflects an ecosystem's ability to recover the properties of matched control sites. Resilient ecosystems recover quickly and converge on original ecosystem properties. What properties of ant assemblages yield high resilience?

One important factor appears to be rainfall (Fig. 7.5). Species richness on six 3-year-old mine sites increased most rapidly in sites with the highest amount of rainfall (Majer 1992). In tropical rainforests, wetter sites with higher productivity and higher levels of ant activity recovered ant density and diversity on 1-m^2 plots more quickly than drier sites (Kaspari 1996a). Ant density and diversity in rainforests may be quite resilient to drought. A severe El Niño drought in a seasonal Panama rainforest decreased ant densities to their lowest recorded values (as measured by Berlese funnels), yet the drought's signature had disappeared only a few weeks into the wet season (Wheeler and Levings 1988). Recovery of drier sites may be much slower without extra remediation efforts.

A second factor that must enhance resilience is proximity of the disturbed area to sources of new immigrants, or "propagules" (MacArthur and Wilson 1967). Large-scale perturbations should recover species richness more slowly than small-scale perturbations embedded within pristine habitat. Species richness of ants in recovering bauxite mines decreased with increasing distances from the forest border (Majer 1980). The processes by which species richness—and other properties such as productivity and biomass—may recover from perturbation deserve further investigation.

Malleability

Some disturbed ecosystems may never recover to control levels. Instead, they may reach a different, stable set of properties. Malleability is the difference between the disturbed ecosystem's final properties and those of the control plots. The greater the difference, the more malleable the ecosystem (Westman 1986).