Appendix B: Theoretical comparison of collective vs. independent management for the planting of natives.

Similar to removal, the benefits from planting natives are direct and indirect (Table B1). The direct benefits from planting are recognized under both management scenarios, and include increases in the growth rate of natives, $G_{x_i}^{x_i}$, as well as their benefits $B_i'(x_i)$. Also recognized under collective and independent management is the indirect benefit of planting and the reduction in damages due to decreased invader population growth, $C_{H_i}'(H_i)G_{x_i}^{y_i}$. However, collective management also accounts for the indirect benefits of natives dispersing onto the neighboring property. Native dispersal results in higher native population sizes and subsequent reduced need (and cost) to plant natives, $C_{P_j}'(P_j)G_{x_i}^{x_j}$, and reduced costs to remove invasives, $C_{H_j}'(H_j)G_{x_i}^{y_j}$, because the natives are assumed to be able to compete effectively with the invaders.

The number of natives planted over time for collective vs. independent management shows a similar pattern to the removal scenario. Again, properties acting independently will undermanage initially, in this case by planting fewer natives, relative to collective management, but will plant natives over longer time periods (Fig. 1 main text). Under independent management, planting natives over time declines at a slower rate than collective management because independent management ignores the planting efforts of neighbors and dispersal of native plants onto their property. In contrast, collective management will initially plant more than independent management because collective management recognizes the additional indirect benefit of increased movement of natives onto their neighbor's property. Higher initial planting under collective management implies that there would be a reduction in the invader's population growth rate due to increased competition with natives.

Net benefits vary between collective and independent management due to differences in planting rates. Collective management experiences larger planting costs in the initial periods compared to independent management because of higher initial planting rates. However, larger up-front planting costs under collective management are offset by increased benefits over time from an increase in native population size. In contrast, independent management has lower initial planting costs that extend over a longer time period. Overall, differences in the net benefits of collective and independent management will depend on the relative costs of planting and how the planting rates impact native and invasive species.

Table B1. Dynamic optimization solutions for the planting of natives for the initial number of natives planted and planting over time under collective and independent management. The number of natives planted was determined where the marginal costs from planting equaled the marginal benefits.

Management scenario	Initial planting	Planting over time
Collective	$C'_{P_i}(P_i) = \frac{\omega_p + C'_{P_j}(P_j)G_{x_i}^{x_j} - C'_{H_j}(H_j)G_{x_i}^{y_j}}{(\rho - G_{x_i}^{x_i})}$	$\frac{dP_i}{dt} = \theta_p - \frac{C'_{P_j}(P_j)G_{x_i}^{x_j} + C'_{H_j}(H_j)G_{x_i}^{y_j}}{C''_{P_i}(P_i)}$
Independent	$C'_{P_i}(P_i) = \frac{\omega_p}{(\rho - G_{x_i}^{x_i})}$	$\frac{dP_i}{dt} = \theta_p$

Notes: Variable definitions are: C_H, C_P, cost functions; H_i, number of invaders removed each period in property i; P_i, number of natives planted each period in property i; G, native and invasive growth function; ρ, discount rate; ω_p, variable used to simplify the optimal removal equations where $\omega_p = B'_i(x_i) - C'_{H_i}(H_i)G_{x_i}^{y_i}$; θ_p, variable used to simplify the optimal removal equations where $\theta_p = \left[C'_{P_i}(P_i)/C''_{P_i}(P_i)\right](\rho - G^{x_i}_{x_i}) - \left[\omega_p/C''_{P_i}(P_i)\right]$. Definitions of the subscripts are: i, j, properties 1 and 2; p, represents that we are indicating ω and θ in the optimal planting conditions; x, number of individuals of native; and y, number of individuals of invader.