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## Optimal management strategies to control mammal populations incorporating behaviourally mediated indirect effect

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Overpopulated mammal populations cause damage to agricultural crops in Japan. We need to keep population sizes at appropriate levels. When we determine management plans, we have to deal with various uncertainties such as population size, population growth rate, and agricultural damages caused by mammals due to lack of sufficient data. It is important to reduce those uncertainties and allocate hunting effort under limited budget.

Prey populations change their behaviour due to presence of predators. Predation risk could cause behavioural changes of prey such as vigilance at the cost of time spent grazing, and population growth rates of prey may decrease without predation itself (the effect is called as behaviourally mediated indirect effect). It is possible that population decline in Japan decreases negative impacts of human activities on mammal populations. In addition the agricultural damage could affect human activities. Hence it is important to incorporate the behaviourally mediated indirect effect for effective mammal managements.

We will introduce a population model incorporating a behaviourally mediated indirect effect for a management of wild boars (*Sus scrofa*) in Chiba prefecture, Japan. First we estimate population densities and population growth rates using Bayesian model averaging. Second we estimate relationship agricultural damages and population densities in heterogeneous landscapes. Last we derive optimal allocations of hunting efforts to minimize expected damages to agricultural crops. We discuss how incorporating the behaviourally mediated indirect effect is important for effective wild boar management.

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