

WHAT HAPPENS WHEN YOU ADD RESOURCES SUPPORTED BY HUMAN ACTIVITIES TO A TUNDRA ECOSYSTEM?

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Snow geese are supported by human activities

Due to agricultural intensification in temperate areas, snow geese (*Anser caerulescens*) have dramatically increased. Snow geese migrate annually to arctic nesting grounds where they can induce an aggregation of their tundra predator, the arctic fox (*Vulpes lagopus*). Simultaneously, shorebird species breeding in the same habitats than geese (e.g. the semipalmated sandpiper, *Calidris pusilla*) are declining.

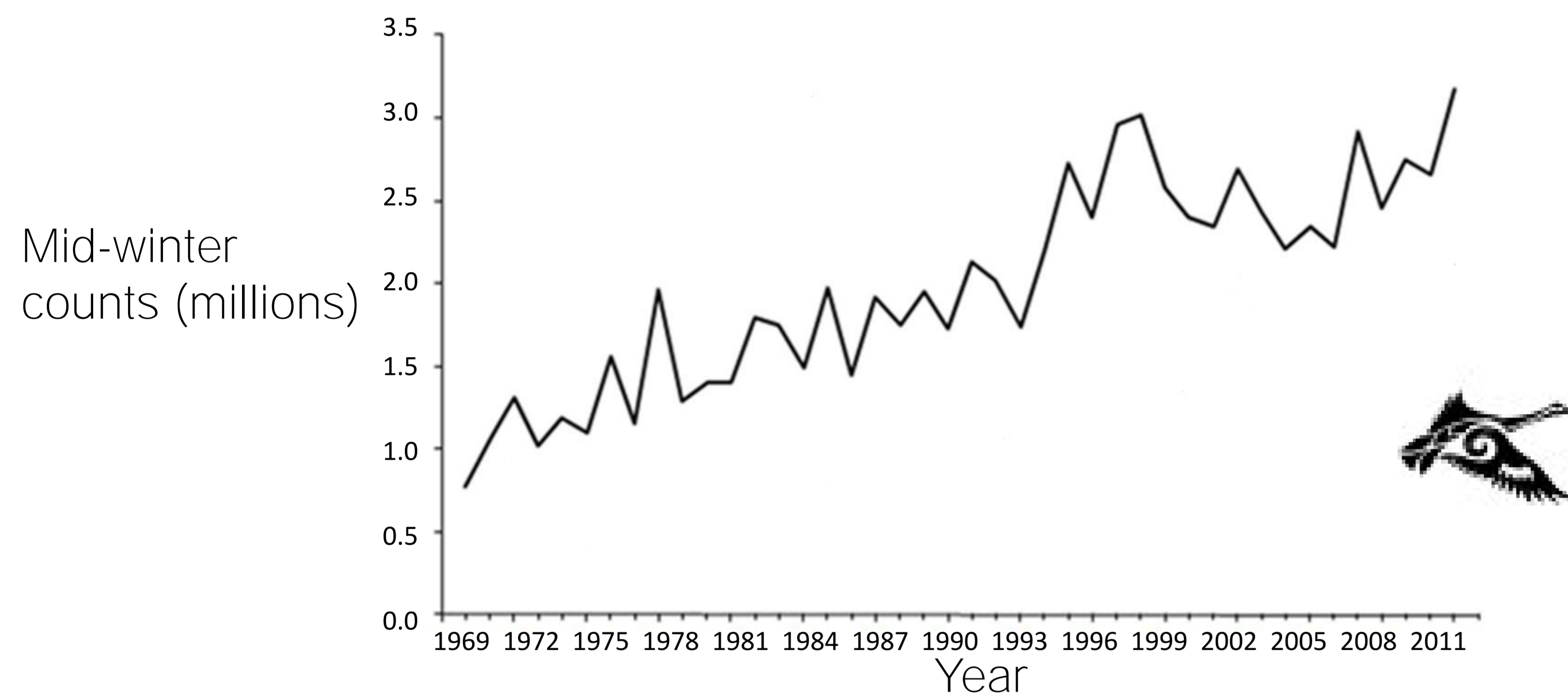
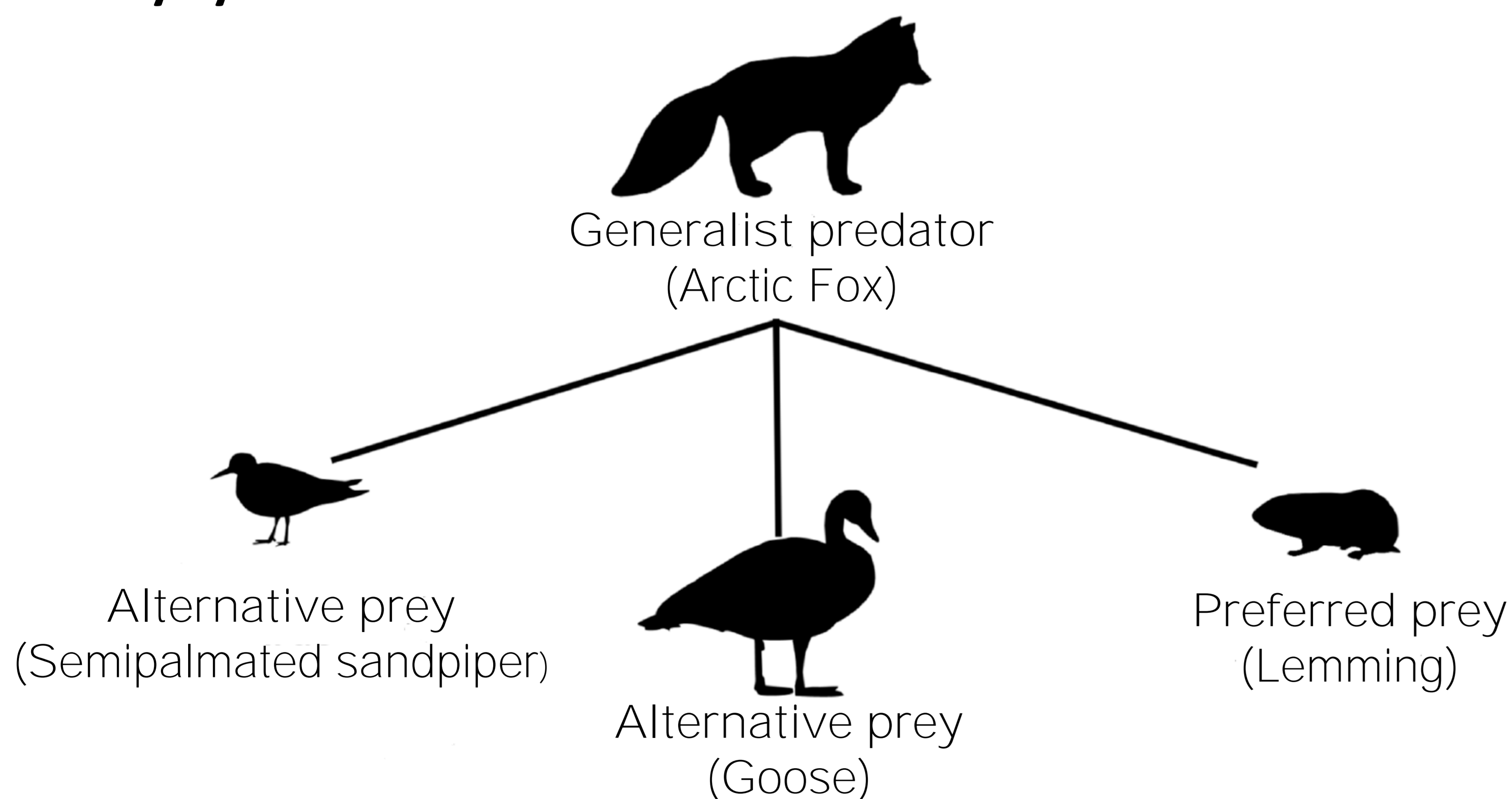


Fig 1. Demographic increase of lesser snow goose (from Kruse, 2011)

Objective

Model the impact of snow goose presence, supported by human activities, on the predation pressure exerted by the arctic fox on semipalmated sandpiper nests.

Study system that we will model



Material & Methods

We will use 3 differential equations for:

(1) Snow goose, (2) Semipalmated sandpiper, (3) Arctic fox. Lemming abundance (L) is included in the model by a simple cyclic equation

Preliminary model

Equations

$$(1) \quad \frac{dO}{dt} = w_O + Of - R \left(\frac{a_R v O f}{1 + a_R h_R O f} \right) - dO$$

$$(2) \quad \frac{dB}{dt} = Bf - R \left(\frac{a_R v B f}{1 + a_R h_R B f} \right) - dB$$

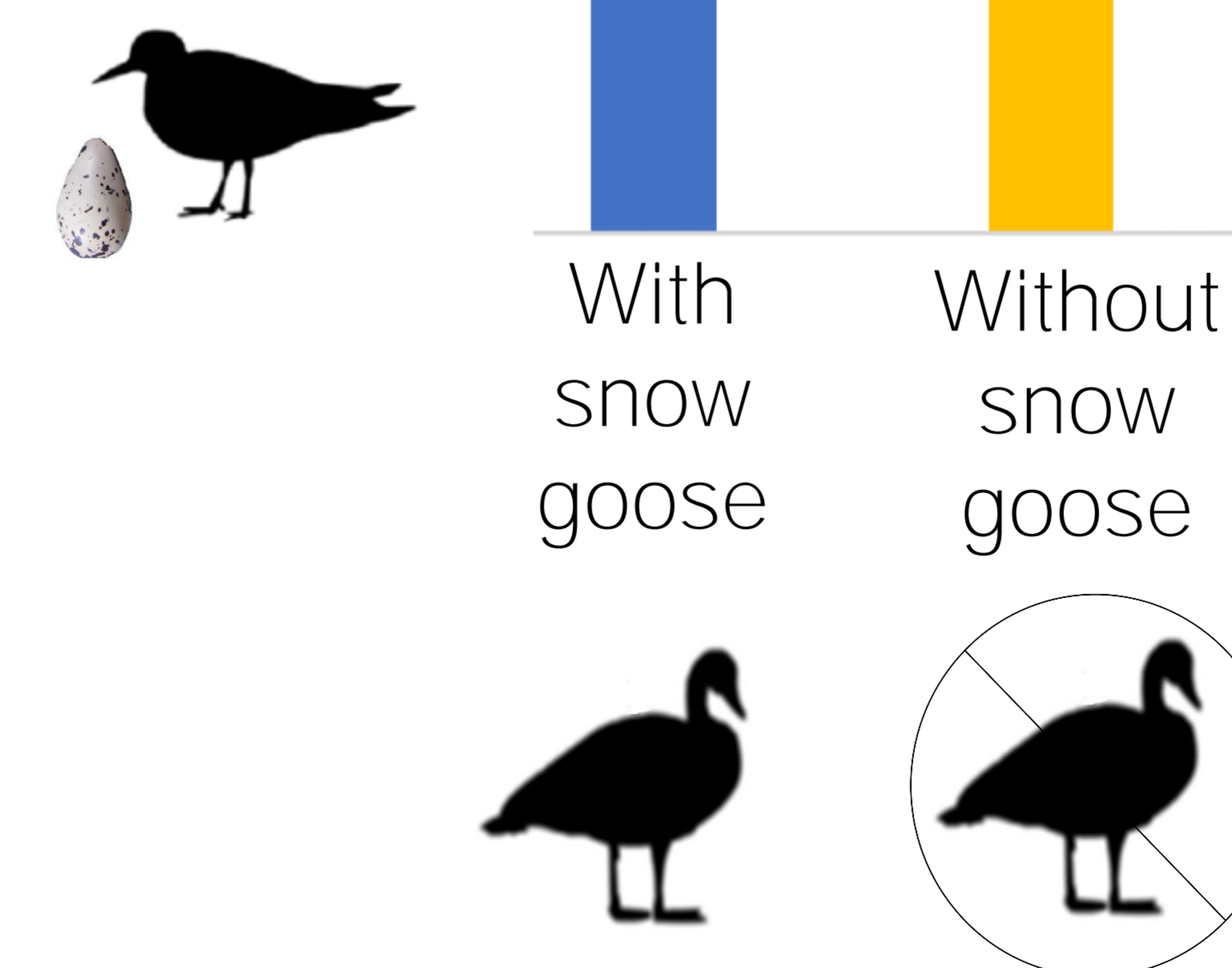
$$(3) \quad \frac{dR}{dt} = \epsilon_R R \left(\frac{a_R v (L + Of + Bf)}{1 + a_R h_R (L + Of + Bf)} \right) \left(1 - \frac{R}{K_R} \right) - d_R R$$

Parameters

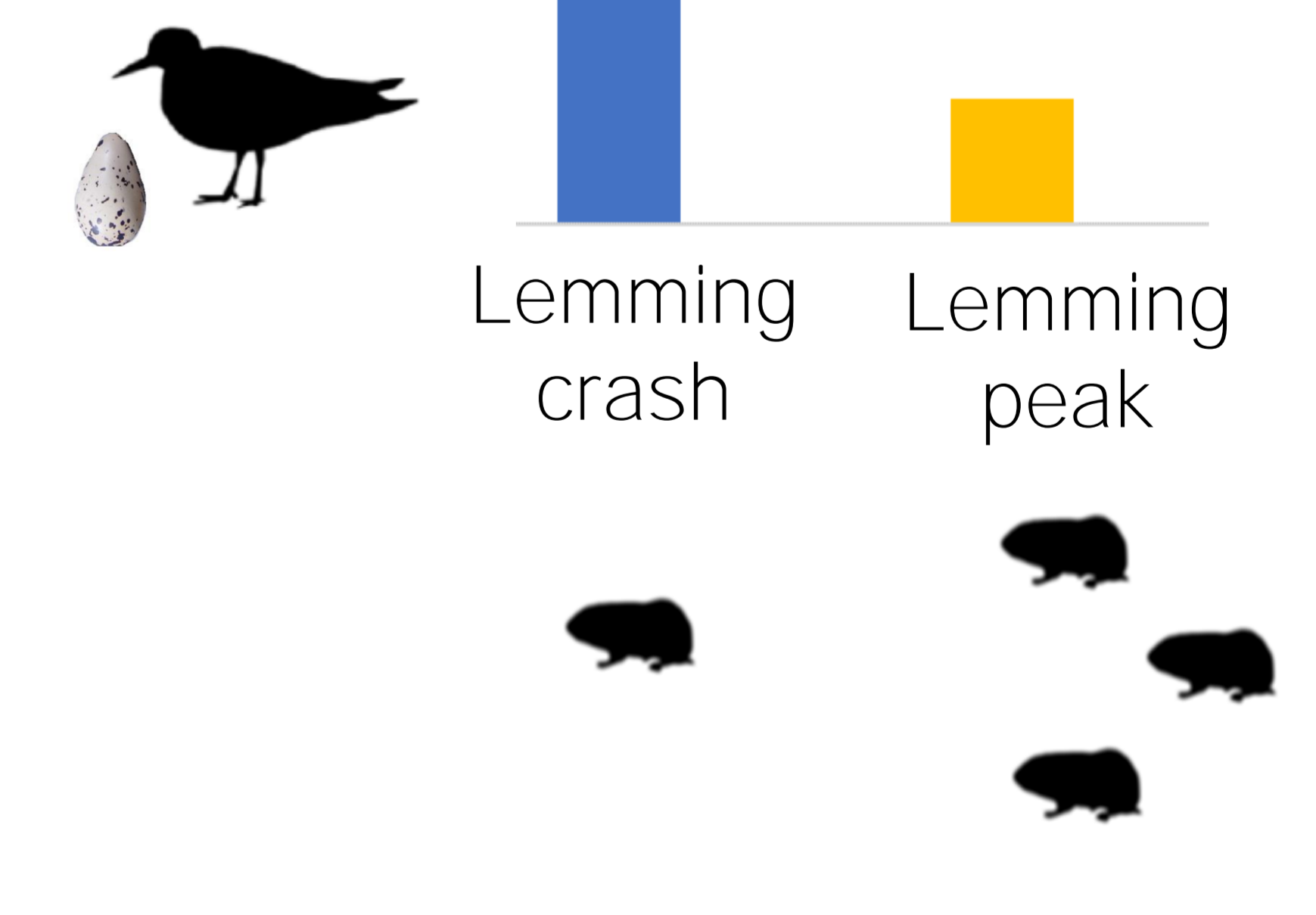
O	Snow goose abundance	d	Death rate
B	Semipalmated sandpiper abundance	a_R	Attack rate by the arctic fox
R	Arctic fox abundance	h_R	Handling time by the arctic fox
L	Lemming abundance	v_R	Total available time for the arctic fox
w_O	Number of adult snow goose arriving on the arctic site every year	ϵ_R	Conversion rate of consumed prey into new arctic fox through reproduction (efficiency)
f	Fertility (reproduction rate x mean clutch size by couple)	K_R	Support capacity of the arctic fox

Expected results

1) Predation rate on semipalmated nests



2) Predation rate on semipalmated nests



Take home message

Understanding the indirect impacts of human-induced perturbations on species of conservation concern such as shorebirds is crucial to better manage local and global actions. Using mathematical models to study ecological interactions is a key conservation tool. Such an interdisciplinary approach is highly needed to preserve global biodiversity in a rapidly changing world.