

Invasive Species in the Galapagos Islands Goats and Blackberry (Mora) Aida Castillo-Flores July 2008

Goat Kingdom: Animalia, Phylum: Chordata, Class: Mammalia, Order: Artiodactyla, Family: Bovidae, Subfamily: Caprinae Genus: *Capra*
Species: *aegragrus* Subspecies: *hircus*

Blackberry Kingdom: Plantae, Division: Magnoliophyta, Class: Magnoliopsida, Order: Rosales, Family: Rosaceae, Genus: *Rubus*, Species: *niveus*

Organisms are acted upon by evolutionary forces, living or dying and leaving descendants or failing to do so. The ability to disperse characterizes every species of plant and animal. It determines the rate at which organisms escape from their environments to find others that are ready for colonization and exploitation (Begon, Harper and Townsend, 1986). Humans act as vectors to disperse species enhancing their dispersal abilities, alien species become invasive species if they invade a natural system and are better competitors to the native species or become stronger predators. They also affect environmental factors such as soil or water, thus producing long-term changes in the ecosystem (Huenneke, 1988 in Schofield, 1989). Organisms evolving in archipelagoes do not have the same selective pressures as their counterparts on mainland areas and can be strongly negatively affected by invasive species. Browsing and trampling by herbivorous mammals, predation by ants or mammals, virulent diseases and frequent and intense fires are some of the forces that can change the ecosystems (Loope, et al. 1988)

Introduced mammals are major drivers of extinction. Feral goats (*Capra hircus*) are particularly devastating to the ecosystems of the Galapagos. Goats were abandoned in the Galapagos in former centuries by humans, including fishermen, pirates, and whalers, to ensure a fresh meat supply would be available to them in future trips. Almost all the main islands on the Galapagos (Floreana, Santa Fé, Española, Santa Cruz, San Cristóbal, Isabela, Pinta and Marchena) have suffered because of the goat's population growth. The numbers have increased on the order of thousands in just one decade. The devastating consequences of the population growth of the goats are due to early initial breeding age at 10 months old, short gestation periods, and the physiological capability of producing young twice a year (Rudge, 1969 in Watts and Conley, 1984) This capability increases the potential breeding rate above 100% because a given female is able to reproduce young more than once per year. Goats have shown a nonseasonal breeding pattern, with 71% of females breeding twice a year. Population doubling times are 2.3 to 7.3 years (Watts and Conley, 1984). Goats do not have any predators, adapt to adverse conditions and can thrive at all elevations in the Galapagos. They even drink salt water to survive in times of drought (Hoeck, 1984 in Schofield, 1989).

Goats convert forest to grassland by stopping regeneration and felling trees or girdling and killing them with their horns. They can eliminate a variety of endemic plants, like ferns, herbs, shrubs and trees. Generally, plants on goat-infested islands survive only in places inaccessible to goats (Schofield, 1989). Goats eat all kinds of plants, like the seedlings of *Bursera graveolens*, *Acacia spp.* As well as the common shrubs *Cordia spp*, *Cryptocarpus Pyriformis*, they have eliminated young trees of *Scalesia pedunculata*, *Zanthoxylum fagara* and *Psidium galapageium*, *Clerodendron molle*, *Opuntia echios*. Many species have been eliminated locally on several islands and many Galapagos animals are dependent on prickly pears, making the prickly pear a keystone species. If the prickly pear were to disappear, a domino effect would begin that would likely be catastrophic to animals such as cactus finches, mockingbirds, tortoises, and land iguanas. (Kricher, 2002)

Endemic birds, reptiles and other animals would disappear if they were restricted to an area with a habitat devastated by the browsing of the goats. In Santiago many palatable endemic plant species are often reduced to individuals hanging on in inaccessible bluffs. Northern Isabela Island has the largest giant tortoise population (estimated to be 15,000) in the Galapagos. Tortoises have been outcompeted in grazing by the more agile and versatile goats. Fewer nesting sites are available and microclimate critical to tortoise survival (including drip pools under summit forest and humid soils) are disappearing.

The goat problem was so prevalent that eradication programs have been put in place in the last 30 years. The Galapagos National Park Service, with the support of the WWF Fundación Natura and World Conservation, has eliminated goats from six islands of the archipelago: Española, Plaza Sur, Santa Fe Marchena, Rabida and Santiago. Isabela is a successful case of a goat eradication project in the Galapagos using advanced technology and methodologies, with ground hunters and trained dogs, aerial hunting, and the use of "Judas goats" wearing tracking collars to track the location of the herds (The thematic atlas of Project Isabela, 2006)

The five species of blackberry (local name: mora) are aggressive, invasive species that have had a negative impact on several Galapagos Islands. They compete with native and endemic species for light, water, and nutrients, and affect local agriculture. *Rubus niveus* present several characteristics common to invasive plants such as high reproductive allocation and high potential for acclimation.

Hill Blackberry (*Rubus niveus*) was introduced for agricultural purposes to San Cristóbal in the 1970's and has spread to Santiago, Santa Cruz, and Isabela Islands. Many bird species feed on the fruit and are responsible for localized spread. Mockingbirds (*Nesomimus parvulus*) are likely to be effective dispersers of this invasive plants, as they defecate seeds without lowering their viability (Buddenhagen and Jewell, 2006). Most cases of dispersal between islands are thought to be due to deliberate introductions by people.

R. niveus is one of the worst weeds threatening the Galapagos National Park. It has invaded open vegetation, shrubland and forest alike. It forms dense thickets up to 4 meters high, replacing native vegetation, and threatening many rare endemic plants. *R. niveus* renders farmland useless and is difficult and expensive to control. *R. niveus* can produce fruit within three months of germination, and sets thousands of seeds per bush per year. Fresh seeds are dormant and do not germinate until after being buried in the soil for at least three months. They can remain viable for many years in the soil, making eradication a long-term project. Under the right conditions of light and water, germination rate is high, and after encouraging the seeds to germinate, the seedlings can be sprayed with herbicide as part of an effective management program. (Charles Darwin Research Station Fact Sheet). *R. niveus* and other invasive plants have depleted the population of *Scalesia pedunculata* forest at Los Gemelos, Sta. Cruz Island. (Renteria and Buddenhagen, 2006)

R. niveus is also dispersed by rodents and this can have a negative effect in their reproduction because Danabhal et al, 2000 have found antifertility activity in female rats exposed to extracts of leaves.

Bibliography

1. Begon, M., Harper, J. and Townsend; Co. 1986. *Ecology* Sinauer USA
2. Buddenhagen, Chris; Jewell, Kelly J. 2006. Invasive plant seed viability after processing by some endemic Galapagos birds *Ornitologia Neotropical*. 17(1). 2006. 73-80.
3. Darwin Research Station
<http://www.darwinfoundation.org/en/galapagos/species/plants/introduced>.
Last updated 2006. Viewed on June 30, 2008
4. Dhanabal, S. P. ; Prasanth, Shibu; Ramanathan, M.; Elango, K.; Suresh, B. 2000. Validation of antifertility activity of various *Rubus* species in female albino rats *Indian Journal of Pharmaceutical Sciences*. 62(1). Jan.-Feb., 58-60.
5. Loop, L. et al. 1988. Comparative conservation biology of oceanic archipelagoes: Hawaii and the Galápagos. *Bioscience* 38(4):272-282
6. Kricher, J. 2002 *Galapagos*. This Archipelago. Smithsonian Institution Press, Washington
7. Kaiser, J. 2001. Galapagos takes aim at alien invaders. *Science* 293:590-593
8. Renteria, Jorge L.; Buddenhagen, Chris. 2006. Invasive plants in the *Scalesia pedunculata* forest at Los Gemelos, Santa Cruz, Galapagos *Galapagos Research*. 64 DEC. 31-35.
9. Schofield, E, 1989 Effects of introduced plants and animals on island vegetation: examples from the Galápagos Archipelago. *Conservation Biology* 3:227-238
10. Watts, T. and Conley, W. 1984 Reproductive Potential and theoretical rates of increase for feral goats populations. *Journal of Wildlife Management* 48:814-822
11. The thematic atlas of Project Isabela, 2006
www.darwinfoundation.org/files/library/pdf/Isabela_atlas.pdf
Last updated 2006. Viewed on June 30, 2008