Conserving the last of the wild: pumas and wild camelids in the semiarid landscapes of the Argentinean Andes

Final report (Jan 2008-May 2011)

GRANTEE INFORMATION	
GRANT: Rufford Booster Grant	
PRIME CONTACT/JOB TITLE: Emiliano Donadio – PhD student	
ORGANIZATION/INSTITUTION: University of Wyoming	
EMAIL: emiliano@uwyo.edu	**REPORT DATE: May 22nd 2011**
ACADEMIC ADVISOR: Steven W. Buskirk, marten@uwyo.edu	

SECTION 1: EXECUTIVE SUMMARY

Executive Summary:

In the semiarid landscapes of South America numbers of the only two native large herbivores, guanacos and vicuñas, dramatically declined, perhaps by more than 90%, during the last century. Historically, guanacos and vicuñas were the main prey of the puma. This predatory interaction has been lost through most of the original zone of distribution of these species following the widespread reduction of guanaco and vicuña populations. The consequences of such loss on the biological diversity of temperate South America remain unknown.

In the Argentinean Andes, at 3,000-6,000 m elevation, San Guillermo National Park harbors virtually intact plant and vertebrate communities that are seriously altered almost everywhere else in southern South America. The 150,000-ha park, established in 1998, is the core of the San Guillermo Biosphere Reserve, which encompasses almost 1,000,000 ha. Notably, San Guillermo National Park protects the largest coexisting populations of guanacos and vicuñas - and their only effective predator, the puma. Our preliminary work in San Guillermo National Park shows that camelids compose most of the diet of pumas, reflecting the high densities of camelids and the almost total absence of exotic herbivores in the park. Because of this, San Guillermo National Park appears as a unique conservation jewel, where key native wildlife species still interact as they used to do it before Spaniards colonized the continent.

Between January 2008 and April 2011, we studied through experimental and observational research, whether predation by a top native predator, the puma, on a native large herbivore prey species, the vicuña, influenced biological communities. Understanding gained on how the interaction camelid-pumas affected biological communities provided us with unique insights into the functioning of semiarid communities and ecosystems in which the effects of humans are minimal.

Overall, we found that pumas and vicuñas interact strongly, with pumas heavily preying upon vicuñas. Such interaction results in a mosaic of risky and safe habitats for vicuñas. In the former (canyons and meadows) vicuñas spend less time foraging and more time vigilant; in the latter (flat open plains) vicuñas spend more time foraging and less time vigilant. Also, vicuñas responded to puma predation by using grazing areas located away form rocky outcrops, where pumas could hide. Such behavioral responses appear to have strong effects on vegetation sexual reproduction, vegetation height and biomass production; not such strong effect was observed on vegetation cover. In risky habitats puma predation on vicuñas have a positive effect on these vegetation attributes while in open flat plains vicuñas have a negative effect on the same attributes. Therefore, it seems that pumas "protect" vegetation from vicuña grazing in risky habitats. The opposite occurs in safe habitats. Finally, despite the clear effects on vegetation we did not find any effect on invertebrate communities and small vertebrates (i.e., lizards and rodents).

SECTION 2: RESEARCH RESULTS

2-1: Goals

To evaluate our working hypothesis, we set several research goals.

Goal 1: Analyze the spatial distribution of puma predation on SAC in the semiarid landscapes of the Argentinean Andes.

Activity 1A: Compare topographic and vegetation features associated with camelid carcasses (puma kills – non puma kills) that may define risky habitats for SAC

Goal 2: Investigate whether a behaviorally mediated trophic cascade triggered by pumas, and mediated by the risk of predation perceived by SAC, creates a mosaic of habitats that differ in the structure of vegetation, and abundance and diversity of plants, small vertebrates and invertebrates

Activity 2A: To assess behavioral responses of camelids to puma predation

Activity 2B: To analyze the impact of camelids on vegetation and fauna

Activity 2C: To analyze camelid use of risky and safe habitats

2-2: Results

Puma predation on vicuñas - Our data suggest that pumas and camelids interact strongly. Analyses of adult vicuña carcasses and newborn survival show that pumas are the main mortality factor for vicuñas. A high percentage of adult (> 2 years old) and sub-adult (1 to 2 years old) vicuña carcasses (96.9%, $n = 98$) show signs of puma predation suggesting that pumas account for most of adult and sub-adult vicuña mortality. Results from radio-marked vicuña newborns, monitored from birth to death or 12 months of age, show that pumas also kill a large number of juvenile individuals (at least 50% in 2008, n[1] = 4, total individuals marked = 7; at least 42% in 2009, n[1] = 12, total individuals marked = 42, and; 90% in 2010, n[1] = 11, total individuals marked = 41). Based on femur bone marrow consistence, adult and sub-adult vicuñas killed by pumas were in good nutritional condition: 61% of them presented a solid bone marrow (good) while only 39 presented a gelatinous (bad) bone marrow. Sex did not seem to have any effect on vicuña vulnerability to puma predation. For adult and sub-adult vicuña carcasses killed by pumas 31.6 were females, 31.6 were males and 36.7 were undetermined (total carcasses observed 79). Similar results were observed for radio-marked juvenile (< 1 year old) vicuñas.

[1] *n* refers to number of marked newborn carcasses that showed clear signs of puma predation; in some cases cause of death could not be determined; therefore *at least* represents a conservative estimate

Spatial distribution of puma kills – Puma kills were not distributed at random in the landscape. Although vicuñas were killed in all 3 habitats (canyons, meadows and flat open plains), they were killed by pumas more that expected (based on habitat area) in habitats *a priori* defined as risky, canyons and meadows, and less than expected in the habitat *a priori* defined as safe, open plains. Overall, canyons and meadows had higher vegetation cover and higher vegetation height than open flat plains. Also, canyons had more pronounced slopes and shorter distances to rocky outcrops than the other 2 habitats. Our results suggest that complex vegetation and topographical features benefit the hunting strategy (ambushing) of pumas; therefore increasing the risk of predation for vicuñas in habitats such as canyons and meadows.

Vicuña responses to puma predation – Vicuñas responded to the different levels of predation pressure suggested by vicuña carcass distribution. Such responses followed two different strategies. First, vicuñas tended to avoid areas close to canyons with rocky outcrops where puma activity and likely puma hunting success appear to be higher. They also used flat open plains more than canyons as shown by counts of vicuña latrines in line transects. Meadows, despite being a risky habitat, were highly used probably because meadows have high availability of food resources particularly during winter months when food resources are almost nil in the plains. Second, vicuñas increased vigilant and decreased foraging times in areas with tall vegetation and high plant cover (i.e., meadows) or complex topographical structures (i.e., canyons with rocky outcrops where pumas could hide). Indeed, in meadows and canyons individual and group vigilant budgets where higher than in flat open plains. Individual vicuñas in meadows tripled the amount of time spent vigilant when compared to vicuñas in the open plains. Likewise, in meadows and canyons the percentage of vicuñas vigilant within groups at any given time was 3.5 to 4 times higher than that of vicuñas groups grazing in the flat open plains.

Effects on vegetation – Behavioral responses of vicuñas to varying levels of puma predation appeared to have an impact on vegetation; the size of the impact was habitat-driven. In the flat open plains, where vicuñas spend most of the time feeding, our experimental exclosures had a large impact on grasses. In fact, in this habitat grasses were 3.0 times taller inside than outside exclosures. Likewise, grass seed-heads were 28.0 times more abundant inside than outside exclosures. Also, green plant biomass was 6.5 times higher inside exclosures. Conversely, no effect of the exclosures was observed on vegetation cover. In canyons and meadows, where vicuñas spent more time vigilant, our experimental exclosures had a small impact on grasses. Here, grasses were only 1.2 to 1.3 times taller inside than outside exclosures; grass seed-heads were only 1.8 times more abundant inside than outside exclosures (only

canyons) and; green plant biomass was just 1.3 to 1.6 times higher inside exclosures. In these two habitats no effect of exclosures was observed on vegetation cover.

Effects on fauna – Changes in vicuñas behavior depending on the level of predation risk and concomitant changes in vegetation affect neither invertebrate abundance nor biomass. Similarly, no change in lizard abundance was observed.

SECTION 3: OTHER PROJECT ACCOMPLISHMENTS

3-1: Training and educational accomplishments:

During the duration of the project we hosted 30 undergraduate and graduate students including 26 Argentinean students from 7 different universities from all regions of Argentina, and 4 international students from Mexico, Spain and France. Also, 7 park rangers, and 3 provincial conservation agents collaborated with this project. All of them received intensive training in different field (transect sampling, behavioral observations, vegetation sampling, scat collection and identification, track identification, and field necropsies, small vertebrate and invertebrate trapping, marking and handling) and lab techniques (transect and behavioral data analysis, sample extraction and storage).

Finally, one of the undergraduate students conducted research for her honor thesis under my direction within the framework of my project. She expects to defend her thesis (and graduate) in middle September 2011.

3-2: Presentations in professional meetings: Together with three of my volunteers (all undergraduate students), I presented 2 posters at the XII Argentinean Mammalogy Meeting (early November 2008), 2 posters at the XIII Argentinean Meeting of Ecology (late November 2008), 3 posters at the 10th International Theriological Meeting, 1 poster at the 90th ASM annual meeting, and 3 posters at the XXIII Argentinean Mammalogy Meeting (early Novemebr 2010) [Total presentations: 11; see 3.5 for a list of presentations].

3-3: Public talks, seminars and articles: During 2008, based on previously gathered data and preliminary data collected during this project, I presented a public talk titled: *The ecological importance of the protected areas of northwestern Argentina*. I presented this talk before a diversity of audiences at the Argentinean Institute for Research in Arid Zones (Mendoza, May 2008), National University of Cuyo (Mendoza, June 2008), Argentinean National Park Service Northwestern Region (Salta, August 2008), Laguna Los Pozuelos National Monument (Jujuy, August 2008), and National University of San Luis (November 2008). This talk highlights the importance of conserving several protected areas of northwestern Argentina based on the persistence in those areas of ecologically important interactions. The presentation emphasizes the outstanding conservation status of San Guillermo National Park (my study site) and warns against the uncontrolled development of open-pit large-scale mining operations nearby the park.

Also, I developed the talk *An (im)perfect monitoring: thoughts on biologists, mining and conservation*. This talk deals with ethic challenges faced by biologists working for mining companies and also analyze and evaluate the Environmental Impact Assessments presented by mining companies working nearby San Guillermo National Park. This talked was presented at the Argentinean Meeting of Mammalogy (early November 2008), the National Park Administration Agency Central Branch, Cordoba (early November 2008), the Center for Applied Ecology, Neuquén province (early April 2009), National University of La Plata, Buenos Aires province (August 2009) and the Department of Zoology, University of Wyoming (October 2009).

Finally, I was invited by the house of representatives of Mendoza province (May 2011) to present a talk dealing with the quality of the Environmental Impact Assessment presented by a mining company that plans to operate in the Andes of Mendoza province.

Overall I gave 11 oral presentations dealing with wildlife, ecology and conservation how large-sacle open-pit mining operations could affect them.

Over the last 3 years, I published 3 papers in peer-reviewed journals dealing with wildlife ecology and conservation at San Guillermo National Park. In these papers I presented results of my studies in the area as well as discussing the involvement of scientists in the evaluation and control of mining operations in the Andes range. Also we designed and implemented a monitoring plan for biodiversity for San Guillermo Biosphere Reserve, which includes the park and the surrounding provincial reserve (see 3.6).

3-4: Funding: Extra funding for the project was obtained from American Society of Mammalogists (Grant-in-Aid of Research), Program in Ecology (Program in Ecology Summer Fellowship), Wildlife Conservation Society, Cleveland Metropark Zoo (Scott Neotropical Fund Program), National Geographic (Committee for Research and Exploration Grant), University of Wyoming (Menkens Grant [Dept. of Zoology], Plummer Scholarship [School of Renewable Resources], and Posse Program), CREO (Conservation, Research and Education Opportunities), and a private donor.

3-5: List of presentations at professional meetings ([1] undergraduate student):

- ✓ **Donadio E.**, C.M. Ruiz Blanco, R.D. Crego, S.W. Buskirk. & A.J. Novaro. 2010. Survival rates and mortality factors of juvenile vicuñas *Vicugna vicugna* in the high Andes of northwestern Argentina. In Spanish. XXIII Argentine Meeting of the Theriological Society, Bahía Blanca, Argentina.

- ✓ Perrig P.L., **E. Donadio**, J.A Pereira & D. Gómez. 2010. Use of meadows by wild South American camelids and pumas *Puma concolor* in the mountain range of San Juan province, Argentina. In Spanish. XXIII Argentine Meeting of the Theriological Society, Bahía Blanca, Argentina.

- ✓ Ruiz Blanco C.M, **E. Donadio**, R.D. Crego, S.W. Buskirk & A.J. Novaro. 2010. Puma *Puma concolor* predation on vicuñas *Vicugna vicugna*: evidence for a behaviorally mediated trophic cascade. In Spanish. XXIII Argentine Meeting of the Theriological Society, Bahía Blanca, Argentina.

- ✓ **Donadio E.**, M. Ruiz Blanco[1], R. Crego[1], S.W. Buskirk & A.J. Novaro. 2010. Birth weight and sex as factors affecting juvenile vicuña survival. Proceedings of the 90th Annual Meetings of the American Society of Mammalogists to be held in Laramie, WY, June 2010.

- ✓ Ruiz Blanco M. [1], **E. Donadio**, R. Crego[1], S. Buskirk & A. Novaro. 2009. Foraging and vigilant budgets in vicuñas *Vicugna vicugna*: habitat type overrides group size. 10th International Mammal Congress, Mendoza, Argentina.

- ✓ **Donadio E.**, D.B. McDonald, A.J. Novaro, J.N. Pauli & S.W. Buskirk. 2008. Effects of introduced prey species on native predator communities: a comparative study in semiarid habitats of Argentina (in Spanish). Proceedings of the XXIII Argentinean Meeting of Ecology, San Luis, Argentina.

- ✓ Crego R.D. [1], C.M. Ruiz Blanco[1], **E. Donadio**, S.W. Buskirk & A.J. Novaro. 2008. Vigilance and foraging budgets in vicuñas *Vicugna vicugna* and its relationship with habitat structure (in Spanish). Proceedings of the XXIII Argentinean Meeting of Ecology, San Luis, Argentina.

- ✓ **Donadio E.** 2008. An (im)perfect monitoring: thoughts on biologists, mining and conservation. Conference at the XXII Argentine Meeting of the Theriological Society, Villa Giardino, Argentina.

- ✓ **Donadio E.**, C.M. Ruiz Blanco[1], R.D. Crego[1], A.J. Novaro & S.W. Buskirk. 2008. Capturing and marking with ear-tag transmitters newborn vicuñas (*Vicugna vicugna*) at San Guillermo Nacional Park, Argentina (in Spanish). Proceedings of the XXII Argentine Meeting of the Theriological Society, Villa Giardino, Argentina.

- ✓ **Donadio E.**, M. Vitali[1], A. Wurstten[1], V. Salvador[1], J. Zanon[1], M.J. Veinticinco[1], M. Monteverde, A.J. Novaro & S.W. Buskirk. 2008. Wild South American camelids and their importance in the diet of pumas *Puma concolor*: a regional evaluation at seven protected areas of northwestern Argentina (in Spanish). Proceedings of the XXII Argentine Meeting of the Theriological Society, Villa Giardino, Argentina.

3-6: List of publications:

- ✓ **Donadio E.**, A.J. Novaro, S.W. Buskirk, A. Wurstten[1], M. Vitali[1] & M. Monteverde. 2010. Evaluating a potentially strong trophic interaction: pumas and wild camelids in protected areas of Argentina. *Journal of Zoology* 280: 33-40.

- ✓ **Donadio E**. 2009. Ecologists and large-scale mining operations, thoughts about why and how become involved in the mining-environmental conflict [In Spanish] *Ecología Austral* 19 (3):247-254.

- ✓ **Donadio E.**, M.L. Merino & M.J. Bolgeri[1]. 2009. Diets of two coexisting owls in the high Andes of northwestern Argentina. *Ornitología Neotropical* 20 (1):136-141.

- ✓ Di Martino S. & **Donadio E.** 2009. Biodiversity monitoring plan for San Guillermo National Park. Administration de Parques Nacionales, Argentina.

3-7: Other accomplishments:

We developed and interactive power-point, which includes movies, aimed to teach ecology in primary and secondary schools using our field data. In this power point, student become field ecologists and have to gather, analyze, present and interpret data form our own study site. The power point is being used by the University of Wyoming in one of its outreach programs.

We developed a documentary of the park. This documentary has been given to the head of San Guillermo National Park. The documentary will be used by park rangers when giving talks in schools and other institutions.

We organized a scientific collection of vicuña, guanaco and puma skulls. The collection has around 400 specimens, each of them with an individual code that can be linked to a digital data base with ancillary information. The collection is housed at the headquarters of San Guillermo National Park and can be freely visited by researchers. We expect the collection will highlight the importance of the park as a source of scientific information.