Acta Universitatis Agriculturae Sueciae

Doctoral Thesis No. 2021:7
Faculty of Natural Resources and Agricultural Sciences

Economic Studies on Wildlife Management and Conservation

Julian Eduardo Lozano Galindez

Economic Studies on Wildlife Management and Conservation

Julian Eduardo Lozano Galindez
Faculty of Natural Resources and Agricultural Sciences
Department of Economics
Uppsala

SLU
SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES

DOCTORAL THESIS
Uppsala 2020

Acta Universitatis agriculturae Sueciae
2021-7

Cover: Cloud word on shadow of a golden eagle
(photo: eagles.org)

ISSN 1652-6880
ISBN (print version) 978-91-7760-692-5
ISBN (electronic version) 978-91-7760-693-2

Uppsala
Print: SLU Service/Repro, Uppsala 2020

Economic Studies on Wildlife Management and Conservation

Abstract

The present research consists of four articles addressing wildlife management and conservation using different methodological approaches of applied economics. The thesis encompasses various economic analyses on three carnivore species mainly: the wolf (*Canis lupus*), the brown bear (*Ursus arctos*), and the lynx (*Lynx lynx*). Other wildlife species are also present to a relatively lesser extent: the moose (*Alces alces*), the roe deer (*Capreolus capreolus*), the wild boar (*Sus scrofa*), and the wolverine (*Gulo gulo*). The first three articles comprise applied analyses in Sweden, and the last article covers North America as well as Eurasia.

The first article uses revealed preference methods to address the impact of large carnivores and licensed carnivore hunting on hunting rental prices in Sweden. The results suggest that regulated carnivore hunting exerts a statistically significant and positive effect on hunting lease prices whilst carnivore presence influences lease prices negatively. The analysis is performed using least absolute deviation estimations to minimize the effect of outliers.

The second article expands the analysis of the first paper by implementing an unconditional quantile regression analysis. This methodological approach allows to study the effect of large carnivores over different segments of the hunting rental price distribution. The outcome confirms that carnivores reduce lease prices in the quantiles near the median, yet no significant impact is found for the lower quantiles.

The third article introduces a spatial dimension in the analysis. It formulates a dynamic bioeconomic model to estimate the effects of carnivores and hunting pressure on game harvests in Sweden. A linearized version of the bioeconomic model is then estimated using dynamic spatial econometrics. The model accounts for spatial and temporal dimensions in order to explore spatial effects in game harvests and estimate the value of the impact of large carnivores on the harvest of ungulate game. The results elicit dynamic spatial spillovers in roe deer and wild boar harvests. Lynx presence and human hunting pressure reduce roe deer and wild boar harvests, respectively. The wolf and the brown bear decrease moose harvests,

however moose does not exhibit spatial effects, seemingly due to Swedish hunting regulations for this particular species.

The last article explores the implications of immediate emotions on group outcomes for conserving two carnivore species, the wolf and the wolverine. By conducting an online public goods experiment, the study examines the degree of cooperation across group participants after inducing positive and negative emotions with audio-visual stimuli. The results indicate that positive emotions seemingly enhance cooperative behavior for wolf conservation yet no corresponding evidence is found for the wolverine. Furthermore, for a given induced emotion, monetary contributions do not differ significantly across the two animal species.

Keywords: Large carnivores, Wildlife management, Licensed hunting, Hedonic pricing, Spatial econometrics, Behavioral economics, Emotions, Conservation, Music

Author's address: Julian Eduardo Lozano Galindez, Swedish University of Agricultural Sciences, Department of Economics, Box 7013, SE-750 07 Uppsala, Sweden

Dedication

To nature with all its incommensurable beauty.
To those who die for others to live.
To those who live to make those who die worth their love.

Contents

List of publications 7

1. Introduction 9
   1.1 Overview 9
   1.2 Scientific context and meta-analysis 10
   1.3 Contributions and policy considerations 13

2. Summary of articles 15
   2.1 Paper I: Valuation of large carnivores and regulated carnivore hunting 15
   2.2 Paper II: Heterogeneous impacts of large carnivores on hunting lease prices 16
   2.3 Paper III: Spatio-temporal analysis of game harvests in Sweden 17
   2.4 Paper IV: On emotions and cooperative behavior for wildlife conservation 18

References 21

Acknowledgements 25

List of publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I. Lozano, J. E., Elofsson, K., Persson, J. and Kjellander, P. (2020). Valuation of large carnivores and regulated carnivore hunting. *Journal of Forest Economics*, Vol. 35 (4): 337-373.

II. Lozano, J. E., Elofsson, K. and Surry, Y. (2021). Heterogeneous impacts of large carnivores on hunting lease prices. *Land Use Policy*, Vol. 101, 105215.

III. Lozano, J. E., Elofsson, K. and Surry, Y. (2020). Spatio-temporal analysis of game harvests in Sweden. [Manuscript].

IV. Lozano, J. E. (2020). On emotions and cooperative behavior for wildlife conservation. [Manuscript].

1. Introduction

1.1 Overview

The present doctoral thesis emerges fundamentally from the necessity of policymakers to alleviate wildlife-human conflicts in areas where wildlife territories overlap with human economic and recreational activities. The existence of multiple benefits and costs of wildlife compels society to maximize the social net gains from this renewable resource. In pursuit of this, wildlife-human conflicts shall be assuaged insofar these entail economic costs to different societal agents.

Conflicts can arise because carnivores reduce the available game that hunters can harvest (Mensah et al. 2019), and predate on farmers' livestock and herders' reindeer (Treves et al. 2006, Widman and Elofsson 2018). Game species can also produce costs to other agents. For example, wild boars can reduce crop efficiency (Boyer et al. 2020), and deer overabundance can create severe browsing damage to forest trees and vegetation (Ericsson et al. 2012). On the other hand, the benefits that wildlife species can generate are manifold in number and substantial in magnitude. To mention a few, wildlife engenders commercial values (e.g., revenues from wildlife tourism and commercial hunting activities), cultural significance, balancing ecosystem processes, nutritional values (e.g., game meat), aesthetics, educational, ecological and ethical values (Chardonnet et al. 2002).

In spite of the unarguable ecological importance of large carnivores, recurring conflicts usually represent economic costs reflecting a negative impact of carnivore abundance on mostly farmers and hunters. These impacts can vary dependent on several factors such as the spatial distribution of ungulate game, the carnivore population density, landscape features and

human activities (Boman et al. 2003, Treves et al. 2004, Van Eeden et al. 2018, Widman and Elofsson 2018).

1.2 Scientific context and meta-analysis

The first three papers share a common purpose, which is to examine the economic implications of large carnivore presence on hunting values. The impact of large carnivores has been addressed previously in economic valuation studies. Bostedt and Grahn (2008) and Widman and Elofsson (2018) estimate cost functions to calculate the social costs of large carnivores associated with livestock predation in Sweden. Asheim and Mysterud (2004) quantify the economic loss of restoring viable carnivore populations for Norwegian sheep farming. Mensah et al. (2019) compute the costs of carnivores on hunters and landowners in South Sweden. Other empirical studies have examined the (positive) hunting values of different game species. Knoche and Lupi (2007) and Livengood (1983) provide deer hunting valuations in Texas and Michigan's Southern Lower Peninsula respectively. Mensah and Elofsson (2017) present the economic value of boar and fallow deer harvests. Little and Berrens (2008) and Lundhede et al. (2015) estimate marginal implicit prices for game harvests as core determinants of hunting lease transactions. However, in spite of regulated large carnivore hunting being suggested as a tool to reduce carnivore conflicts (Treves, 2009), none of the abovementioned has attempted valuation of regulated carnivore hunting. Paper I fulfills this purpose. It studies the impact of large carnivores on hunting lease prices by accounting for the effect of licensed carnivore hunting in Sweden. The analysis centers on establishing whether recreational benefits of regulated carnivore harvesting can potentially mitigate the potential costs of carnivore abundance caused by prey competition. Paper II extends this analysis by studying the economic impact of large carnivores along the entire hunting lease price distribution, i.e., it investigates if large carnivore valuations can vary across different price segments of the hunting sector. This has not been addressed in previous economic research. Because ample evidence in ecological studies indicates the differential effect of large carnivores on game abundance (Melis et al. 2009, Sand et al. 2012), Paper II conjectures that this varying carnivore effect may therefore carry over on hunting activities.

Both Papers I and II use the hedonic price method to decompose the hunting lease price into constituent attributes. Hedonic analysis is a revealed preference method, which has been previously used to determine the factors influencing hunting rental prices (Pope and Stoll 1985, Meilby et al. 2006, Zhang et al. 2006). Yet, the key methodological difference between Papers I and II is that the former uses least absolute deviations and ordinary least squares (OLS) to estimate the average impact of large carnivores on hunting lease prices, whereas the latter implements the unconditional quantile regression (UQR) technique to estimate the (heterogeneous) impact of carnivores along the overall hunting lease price distribution. The latter was inspired by an environmental economics study, Peeters et al. (2017), implementing the UQR method to investigate the potential heterogeneous effect of soil contamination along the distribution of farmland prices in Belgium. Papers I and II use a survey dataset of registered hunters in the official Swedish Hunters Registry. The common findings elicit that the wolf and the lynx exert a significant and negative effect on hunting lease prices. The second paper reveals that this effect varies along the hunting lease price distribution and it is seemingly non-significant for the lower tail. In addition, the first paper highlights the positive effect of licensed bear quotas on hunting lease prices, which in turn suggests that regulated bear hunting could mitigate the negative impact on hunters and landowners of increasing large carnivore populations.

Paper III continues and expands the analysis of the previous two studies by investigating spatial and time spillovers in ungulate game harvests across Swedish regions. Research in fishery economics has acknowledged the both spatial and time dimensions in renewable resources (Sanchirico and Wilen 2007, Smith et al. 2009). However, similar studies are scarce in the case of terrestrial mammals. Boman et al. (2003) incorporate the spatial dimension in wildlife management by developing a theoretical economic model to find the optimal geographical distribution of wolf populations provided the high dispersal capacity of this species. Extant ecological literature has recognized the potential of human hunters and large carnivores to change the spatial distribution and behavior of ungulates (Cromsigt et al. 2013, Thurfjell et al. 2017). If game species migrate to minimize predation risk (Kjellander et al. 2004, Hebblewhite and Merrill 2007), it can be inferred that benefits and costs of available game can spread to neighboring regions. For example,

hunters of neighboring locations can benefit because of increased game availability, whereas farming activities of neighboring areas can suffer due to increased wildlife damage (Rollins and Briggs 1996). These spillover effects can have short- and long-term implications on the impact of large carnivores on hunting values, and on the incidence of hunters on game populations. Paper III investigates empirically the presence of these spillover effects and its repercussions on the hunting valuations of ungulate game. The findings are interestingly diverse among the wildlife species. Unlike moose, there is sound evidence of spatial effects in roe deer and wild boar harvests. Lynx predation is the only variable found to decrease roe bags, and human pressure has a decreasing effect on wild boar bags. The results for moose indicate that wolf and bear reduce harvests, although the absence of dynamic spatial regimes can be partly due to Swedish regulations, which impose limits on moose harvesting numbers.

A comparison of Papers I, II and III elucidate the sensitivity of economic valuations to the different methodological approaches. The choice between least absolute deviations, ordinary least squares and spatial models can lead to different estimation of marginal implicit prices in terms of magnitude and significance. For instance, failure to account for the influence of outliers inflate the (negative) impact about 150% for lynx and 120% for wolf; and inflate the (positive) impact about 182% for the licensed bear quota. These factors are obtained by comparing the results between the marginal effects from the least absolute deviations and the ordinary least squares in Paper I. A similar calculation can be done in Paper II that leads to a similar conclusion. Comparing the marginal effects of the unconditional quantile method with those of ordinary least squares, the results in the latter are higher about 20% for the lynx, 10% for the wolf and 100% for the brown bear. The overestimation of the impacts is also evidenced in Paper III when the spatial dimension is ignored. By contrasting the marginal effects of lynx between the spatial and non-spatial models, the impact of the lynx is 7% to 26% greater in the non-spatial case.

Paper IV incorporates insights from psychology in the economic analyses of this doctoral research. By using behavioral economics, Paper IV studies the effect of emotions on group economic behavior toward conserving wildlife species. This is of utmost relevance to address human-wildlife conflicts considering that emotions are pervasive in such relationships and

thus can potentially influence attitudes toward conservation measures (Johansson et al. 2012, Hudenko 2012). Johansson et al. (2012) analyzes the impact of self-reported animal fear on the willingness to pay for carnivore conservation. The authors use stated preference methods of contingent valuation for that purpose. Conversely, Paper IV examines the impact of emotions on conservation behavior by introducing financial incentives that enable individuals to motivate actions based on true preferences as opposed to stated preferences. True preferences on wildlife conservation are revealed through the implementation of a public goods game with wildlife context. Because monetary incentives can depend on group decisions rather than individual choices, the public goods experiment allows to address cooperative behavior among several individuals. Paper IV explores the following question: can induced emotions enhance cooperative behavior for wolf and wolverine conservation? Emotions are induced through wildlife-related audiovisual material, and subsequently participants make a monetary contribution for conservation. The results indicate that positive emotions increase cooperative behavior toward wolf conservation, yet cooperative behavior toward wolverine conservation is unaffected by induced emotions. In line with Ericsson et al (2007), I infer that this finding is driven by the controversial and symbolic aspects of wolf species in relation to the wolverine.

Even if people can elicit fear toward large carnivores in general (Røskaft et al. 2003), Paper IV shows that the impact of emotions is different depending on the carnivore. Thus, in relation to the other three articles in this thesis, the fourth article illustrates that emotions affect monetary contributions to wolf conservation. Furthermore, affective factors can likely influence carnivore conservation outcomes, and shape attitudes in support of management measures aiming to reduce human-carnivore conflicts.

1.3 Contributions and policy considerations

The four papers reinforce the scientific knowledge in order to find mechanisms that enhance the societal net gains from conservation and provide better management tools. Although most articles of this work yield economic valuations of carnivores that are negative, these are estimations that pertain to a minority of citizens, mostly hunters and landowners. The

innovations in this thesis enhance empirical and methodological aspects in wildlife economics. These novelties can be summarized as follows. First, to investigate the effect of carnivore abundance while simultaneously considering the role of licensed carnivore hunting. Second, to examine potential heterogeneous effects of carnivores along the hunting lease price distribution by applying the unconditional quantile regression method. Third, to identify and estimate spillover effects in game harvests by implementing spatial econometrics techniques. Fourth, to introduce wildlife framing in a public goods experiment, in order to study the role of induced emotions on cooperative behavior toward the conservation of wolf and wolverine species.

The outcomes of this doctoral research provide relevant insights concerning policy implications. The results of the first paper notes the indirect benefits of increased brown bear populations, due to the possibility for regulated hunting, which exceeds the negative value that hunters attach to bear presence. In this regard, the paper invites to a further discussion on whether increased large carnivore populations can be made beneficial to hunters by providing regulated carnivore hunting opportunities. The second paper shows evidence that the strongest impact of large carnivores takes place in the mid-range segment of the hunting lease price distribution. As a result, policy intervention shall be targeted to locations within this price segment, where poaching incentives are likely greater and hunter-carnivore conflicts more pronounced. The third paper calls the attention of wildlife authorities about the importance of accounting for spatial spillovers in game harvests. The results yield that omission of spillover effects can possibly lead to misjudge the efficacy of management measures, as well as to miscalculate the economic impact of carnivore predation. The fourth paper points out that the effectiveness of policy instruments and management measures involving affective factors are plausibly dependent on the wildlife species. Policy mechanisms that induce positive emotions may have positive effects to enhance conservation of the wolf, but not of the wolverine. To that extent, conservation strategies aiming to affect attitudes through emotions ought to be tailored for those (controversial or symbolic) species more subject to greater intense emotional arousal.

2. Summary of articles

2.1 Paper I: Valuation of large carnivores and regulated carnivore hunting

Sweden is home to three terrestrial large carnivores: the wolf (*Canis lupus*), the brown bear (*Ursus arctos*) and the lynx (*Lynx lynx*). Hunters can benefit from watching these species, and also benefit from carnivore harvest when it is allowed. However, large carnivores prey on the game that hunters kill for meat and/or recreation, thus decreasing the game available in hunting areas. Consequently, hunters may be willing to pay relatively less for renting hunting grounds with carnivore presence, which also decreases the revenues of landowners renting those areas.

In this study, the goal is to determine whether large carnivore presence has on average a negative impact on hunters and on the landowners leasing out their properties for hunting activities. Simultaneously, the effect of licensed carnivore hunting is analyzed to observe if carnivore quotas can mitigate the potential negative effect of large carnivore abundance. Because there is evidence of a large hunting lease market in Sweden (Mattsson et al. 2008), we formulate a hedonic model and regress hunting lease prices on a set of constituent attributes. These attributes relate to variables capturing large carnivore abundance, licensed carnivore hunting quotas, and characteristics of the municipality, the hunting ground, and the hunting team. The covariates related to carnivore presence are indexes reflecting the population density within a municipality. The wolf index and the lynx index are measured in terms of family groups, whereas the brown bear index is based on bear individuals. Although the harvested game is a key attribute of hunting lease prices (Lundhede et al. 2015), this is not included in the

hedonic model but proxied with snow depth and forest productivity, in order to untangle the effect that carnivore presence can have on reducing game numbers.

Using a survey revealing the actual lease prices of 314 registered hunters in Sweden, we estimate the hedonic model by ordinary least squares and by least absolute deviations. The latter method is implemented to minimize the effect of outliers found in the dataset. The results indicate that the effect of large carnivores is indeed predominantly negative, but the effect of regulated carnivore hunting is statistically positive and thus can assist to compensate the economic costs of increasing carnivore numbers. A wolf territory has about 15% greater impact on hunting lease prices compared with a lynx territory, but the impact of the latter is considerably more robust and statistically significant as evidenced in a similar study by Mensah et al. 2019, and consistently confirmed in papers 2 and 3.

2.2 Paper II: Heterogeneous impacts of large carnivores on hunting lease prices

The second article continues and extends the analysis of the first paper using the same survey dataset and variables. The purpose is to determine the impact of large carnivores along the hunting lease price distribution. The motivation is to pinpoint price segments in the distribution where hunter-carnivore conflicts could be prominent because of negatively significant carnivore impacts. Hence, the areas comprising the price segments that are strongly affected by carnivore presence can be relatively more prone to carnivore-hunting conflicts than those where the lease price is unaffected.

This study estimates a hedonic model applying the unconditional quantile regression method, which allows to estimate the marginal effect of covariates (e.g., carnivore density) on the different parts of the outcome variable distribution, i.e., the hunting lease price. The functional form of the model allows to calculate marginal effects as a function of the carnivore presence, and independently of the lease price. As in the first paper, the covariates related to carnivore presence are indexes reflecting the population density within a municipality.

The results reveal the existence of heterogeneous effects of the wolf, the brown bear and the lynx presence regressors. The three species exert a

negative and significant influence on the middle-range of the distribution, that is, in the neighborhood of the median lease price. Conversely, the effect is non-significant for the lower quantiles, which indicates that the cheaper hunting areas are not influenced by carnivore presence. In addition, other key attributes also elicit varying impacts on lease prices, such as the potential game harvest (proxied by forest productivity), the size of the hunting ground, and the proximity of the hunting ground to the closest large city. Moreover, the results show that the brown bear is the carnivore with the least, though statistically significant, marginal effect among the three studied species.

2.3 Paper III: Spatio-temporal analysis of game harvests in Sweden

Conservation of wildlife poses numerous challenges to policymakers because the spatial distribution of wildlife populations can overlap and affect economic and recreational activities. These animals can migrate to different regions searching for food or avoiding hunters and carnivores, and therefore give rise to spatial spillover effects. As a result, benefits and costs of game can vary according to its spatial dynamics with the environment, including carnivore and human presence. This can have implications for policy, for example by impacting the cost-benefit ratio of a species.

Based on empirical data, this study examines and measures spatial spillovers of a number of wildlife species by implementing dynamic spatial econometrics methods. The applied spatial analysis is preceded by the formulation of a bioeconomic model that serves as a theoretical framework for the empirical estimations. For the purpose of the empirical analysis, the theoretical model is then linearized, and extended to include spatial interaction effects. The data comprises a panel of 9 years and 20 Swedish counties. We estimate the model for three different game species: the roe deer, the moose, and the wild boar. The dependent variable is the annual hunting bag per unit effort. The independent variables are the estimated populations of wolf, lynx, and brown bear respectively, as well as hunting effort (proxied by the number of hunting license holders).

Following conventional approaches in spatial econometrics studies (Elhorst 2014, LeSage and Pace 2009), we estimate four different spatial specifications for each game species and use the non-spatial case (fixed

effects model) as benchmark. As described in LeSage and Pace (2009), the selection of the best-fitting model is essentially based on three performance indicators: the Akaike's Information Criterion (AIC), the Bayesian Information Criterion (BIC), and the Log-likelihood function value (LL).

The results point out that the dynamic spatial-lag model (SAR) is the most suitable for roe deer harvests, which provides evidence of dynamic spatial dependence in this species. The lynx numbers are found to be a statistically significant variable decreasing roe deer bags within the county, and exerting indirect negative effects on roe deer species that propagate to adjacent counties. However, these spillover effects are only observed in the short term. The spatial error model (SEM) yields the best-fit for modelling wild boar harvests. This offers evidence of unobserved variables creating spillover effects, which are inferred to be associated with landscape characteristics not captured in the model (Gren et al. 2016). Human hunting is the only variable to influence wild boar harvests negatively within the counties with boar occurrence. The fixed effects model (i.e., the non-spatial model) is found to be the most appropriate specification for moose harvests, mainly because the spatial parameters are not found to be statistically significant. This latter result is inferred to be partly driven by the Swedish hunting legislation, where moose harvest thresholds are determined by the Country Administrative Boards. Instead, wolf and bear predation decreases moose harvests within the same county, but the absence of spatial effects suggest that none of the carnivore species create significant spillovers on moose harvests in neighbouring counties.

2.4 Paper IV: On emotions and cooperative behavior for wildlife conservation

Emotions are pervasive in human-wildlife relations, and their role is crucial in understanding economic decision-making and cooperative behavior (Hudenko 2012, Lerner et al. 2015, Drouvelis and Grosskopf 2016). By using behavioral economics and experimental methods, this study induces emotional states to address the influence of positive and negative emotions on cooperation for wildlife conservation. This effect is compared across two carnivore species, the wolf (*Canis lupus*) and the wolverine (*Gulo gulo*).

To address cooperation, a public good experiment is conducted to 246 individuals recruited online and randomly assigned to one out of four treatment conditions. A 2×2 factorial between-subject design is implemented. One factor corresponds to the induced emotion (happiness and fear), and the other factor corresponds to the wildlife species (wolverine and wolf). Positive (happiness) and negative (fear) emotions are evoked on participants by presenting audio-visual information. The experimental instructions as well as the audio-visual material are presented with a wildlife context. Individual contributions are framed to participants as investments to wolf (wolverine) conservation. Adding context to a public good game has been done in earlier research to analyze prosocial behavior to sustain the provision of a given public good, e.g., carbon emissions (Brick et al. 2016, Milinski et al. 2008). This study is the first of the family of framed public good experiments to address the impact of emotions on cooperation for wildlife conservation.

For the wolf species, the results indicate that induced positive emotions relatively increase contributions. Emotional states exert a significant influence on self-interested individuals as well as on altruistic givers. In addition, defection occurs more in the fear treatments whereas altruism is more frequent in the happiness treatment. On the other hand, emotional states do not affect contribution behavior in the wolverine case. Because the wolf is a more contentious animal compared to the wolverine (Ericsson et al. 2007), wolf management is seemingly more dependent on emotional responses. Hence, affective factors can be instrumental to formulate policies and initiatives to enhance wolf conservation. Because the effect of emotional factors can vary across agent groups, such measures and enterprises ought to be well targeted. Conversely, the wolverine conservation shall rely on different mechanisms to enhance cooperation which can be explored in future research, e.g., the cognitive (as to opposed to the affective) component of public attitudes. An additional finding in paper 4 is that voluntary contribution levels do not seem to differ between the wolf and the wolverine for individuals given the same emotional category. This could be explained either by the taxonomic proximity of the two species in relation to other (less known) animal classes, or by the knowledge and familiarity that participants grasp from the contextual cues and instructive material of the experiment.

References

Asheim, L. J. and I. Mysterud. (2004). Economic impact of protected large carnivores on sheep farming in Norway. *Sheep & Goat Research Journal* 4.

Boman, M., Bostedt, G. and Persson, J. (2003) The Bioeconomics of the Spatial Distribution of an Endangered Species: The Case of the Swedish Wolf Population. *Journal of Bioeconomics* 5: 55-74.

Bostedt, G. and Grahn, P. (2008) Estimating cost functions for the four large carnivores in Sweden. *Ecological Economics* 68: 517–524.

Boyer, K. S., Fairbanks, S. W., Rohla, C. and Webb, S. L. (2020) Surficial soil damage by wild pigs (Sus scrofa) decreases pecan harvest efficiency. *Crop protection* 128, 104992.

Brick, K., Visser, M. and Hoven, Z. (2016) Cooperation and Climate Change: Can Communication Facilitate the Provision of Public Goods in Heterogeneous Settings? *Environmental and Resource Economics* 64 (3): 421-443.

Chardonnet, P., Gerhold, R. and Jori, F. (2002). The value of wildlife. *Revue Scientifique et Technique (International Office of Epizootics)* 21 (1): 15-51.

Cromsigt, J. P. M., Juijiper, D. P. J., Adam, M., Beschta, R: L., Churski, M., Eycott, A., Kerley, G. I. H., Mysteryd, A., Schmidt K. and West, K. (2013) Hunting for fear: innovating management of human-wildlife conflicts. *Journal of Applied Ecology* 50: 544-549.

Drouvelis, M. and Grosskopf, B. (2016) The effects of induced emotions on pro-social behavior. *Journal of Public Economics* 134: 1-8.

Elhorst, E. (2014) *Spatial Econometrics: From Cross-Sectional Data to Spatial Panels*. Springer Briefs in Regional Science.

Ericsson, G., Kindberg, J. and Bostedt, G. (2007) Willingness to pay (WTP) for wolverine Gulo gulo conservation. *Wildlife Biology* 13: 2-13.

Ericsson, G., Sandström, C. and Ezebilo, Eugene E. (2012) Browsing damage by moose in Swedish forests: Assessments by hunters and foresters. *Scandinavian Journal of Forest Research* 27 (7): 659-668.

Gren, I-M., Häggmark-Svensson, T., Andersson, H., Jansson, G. and Jägerbrand, A. (2016) Using traffic data to estimate wildlife populations. *Journal of Bioeconomics* 18: 17-31.

Hebblewhite, M. and Merrill, E. H. (2007) Multiscale wolf predation risk for elk: does migration reduce risk? *Oecologia* 152 (2): 377-87.

Hudenko, H. W. (2012) Exploring the influence of emotion on human decision making in human-wildlife conflict. *Human Dimensions of Wildlife* 17: 16-28.

Johansson, M., Sjöström, M., Karlsson, J., & Brännlund, R. (2012). Is human fear affecting public willingness to pay for the management and conservation of large carnivores? *Society & Natural Resources 25*(6), 610-620.

Kjellander, P., Gaillard J. M., Hewison, M. and Liberg, O. (2004) Predation risk and longevity influence variation in fitness of female roe deer (Capreolus Capreolus L.). *Proc Biol Sci* 271 Suppl 5: S338-40.

Knoche, S. and F. Lupi. (2007). Valuing deer hunting ecosystem services from farm landscapes. *Ecological Economics* 64(2): 313–320.

Lerner, J. S., Li, Y., Valdesolo, P. and Kassam, S. (2015) Emotion and decision making. *Annual Review of Psychology* 66: 799-823.

LeSage, J. and Pace, R. K. (2009) *Introduction to Spatial Econometrics*. CRC Press. Taylor & Francis Group, LLC.

Little, J. and Berrens, R. (2008) The Southwestern market for big-game hunting permits and services: A hedonic pricing analysis. *Human Dimensions of Wildlife* 13: 143–157.

Livengood, K. R. (1983) Value of big game from markets for hunting leases: The hedonic approach". *Land Economics* 59(3): 287–291.

Lundhede, T. H., Jacobsen, J. B. and Thorsen, B. J. (2015). A hedonic analysis of the complex hunting experience. *Journal of Forest Economics* 21: 51–66.

Mattson, L., Boman, M. and Ericsson G. (2008). Jakten i Sverige: Ekonomiska Värden och Attityder Jaktåret 2005/06. [Adaptive Management of Wildlife and Fish.] Report 1. [In Swedish] Umeå, Sweden: Adaptiv förvaltning av vilt och fisk.

Meilby, H., Strange, N., Jellesmark, B. and Helles, F. (2006) Determinants of hunting rental prices: A hedonic analysis. *Scandinavian Journal of Forest Research* 21(1): 63–72.

Melis, C., Jędrzejewska, B., Apollonio, M., Bartoń, K. A., Jędrzejewski, W., Linnell, J. D., and Delehan, I. (2009). Predation has a greater impact in less productive environments: variation in roe deer, *Capreolus capreolus*, population density across Europe. *Global ecology and biogeography* 18(6): 724-734.

Mensah, J., Persson, J., Kjellander, P. and Elofsson, K. (2019). Effects of carnivore presence on hunting lease pricing in South Sweden. *Forest Policy and Economics* 106: 101–942.

Milinski, M., Sommerfeld, R. D., Krambeck, H., Reed, F.A. & Marotzke, J. (2008) The collective risk social dilemma and the prevention of simulated dangerous climate change. *PNAS* 105: 2291-2294.

Peeters, L., Schreurs, E. and Van Passel, Steven. (2017) Heterogeneous impact of soil contamination on farmland prices in the Belgian Campine Region: Evidence from Unconditional Quantile Regressions. *Environmental Resource Economics* 66: 135-168.

Pope, C. and Stoll, J. (1985) The market value of ingress rights for white-tailed deer hunting in Texas. *Southern Journal of Agricultural Economics* 17(1).

Rollins, K., & Briggs III, H. C. (1996). Moral hazard, externalities, and compensation for crop damages from wildlife. *Journal of Environmental Economics and Management* 31(3), 368-386.

Røskaft,E., Bjerke, T., Kaltenborn, B. P., Linnell, J. D. C. and Andersen, R. (2003) Patterns of self-reported fears toward large carnivores among the Norwegian public. *Evolution and Human Behavior* 24: 184-198.

Sanchirico, J. N., & Wilen, J. E. (2007). Sustainable use of renewable resources: Implications of spatial-dynamic ecological and economic processes. *International Review of Environmental and Resource Economics* 1(4), 367-405.

Sand, H., Vucetich, J. A., Zimmermann, B., Wabakken, P., Wikenros, C., Pedersen, H. C. and Liberg, O. (2012). Assessing the influence of prey–predator ratio, prey age structure and packs size on wolf kill rates. *Oikos,* 121(9): 1454-1463.

Thurfjell, H., Ciuti, S. and Boyce, M. S. (2017) Learning from the mistakes of others: How female elk (Cervus elaphus) adjust behavior with age to avoid hunters. *PLoS ONE* 12 (6)

Treves, A., Wallace, R., Naughton-Treves, L. and Morales, A. (2006) Co-Managing Human-Wildlife conflicts: A review. *Human Dimensions of Wildlife* 11: 383-396.

Treves, A. (2009). Hunting for large carnivore conservation. *Journal of Applied Ecology* 46(6): 1350-1356.

Van Eeden, L. M., Crowther, M., Dickman, C. R. and Newsome, T. M. (2018) Managing conflict between large carnivores and livestock. *Conservation Biology* 32 (1): 26-34.

Widman, M. and Elofsson, K. (2018) The costs of livestock depredation by large carnivores in Sweden 2001 to 2013. *Ecological Economics* 143: 188-198.

Zhang, D., Hussain, A., and Armstrong, J. B. (2004) Willingness to pay for hunting leases in Alabama. *Southern Journal of Applied Forestry* 28(1): 21–27.

Acknowledgements

Wholehearted gratitude to Iris Amparo, Eduardo and Denise; such three sublime human beings to whom I owe my whole bag of tricks. Very special thanks to Katarina Elofsson for the chance to embark me on this doctoral journey, also for being a constant available source of knowledge and aid. Thanks to Yves Surry, for the continued support, the amusing tête-à-têtes and for his funny cool French grumpy temper. Thanks to Justice, George and Franklin, because that Ghanian triumvirate was always game to *crack* my rather basic technical queries. Thanks to Jonathan for the chill companionship since starting the *trip* together. Thanks to Rob, to the Research Group, to the Department, and to my Alma Mater SLU. Thank y'all, F G A-♪

Acta Universitatis Agriculturae Sueciae

Doctoral Thesis No. 2021:7

This doctoral research encompasses four empirical studies, which apply economic valuation methods, (spatial) econometric techniques and behavioral economics to the management and conservation of wildlife. The first three papers are generally focus on Swedish large carnivores and the hunting sector. The fourth paper explores linkages across wildlife conservation, cooperative behavior and experimental methods for inducing basic emotions.

Julian Eduardo Lozano Galindez received his PhD education at the Department of Economics, Swedish University of Agricultural Sciences, Uppsala, Sweden. He holds a Master of Science (MSc) in Environmental and Natural Resource Economics, University of Copenhagen, Denmark. He holds a MSc in Industrial Engineering and a Bachelor of Arts in Economics, University of the Andes, Bogota, Colombia.

Acta Universitatis Agriculturae Sueciae presents doctoral theses from the Swedish University of Agricultural Sciences (SLU).

SLU generates knowledge for the sustainable use of biological natural resources. Research, education, extension, as well as environmental monitoring and assessment are used to achieve this goal.

Online publication of thesis summary: http://pub.epsilon.slu.se/

ISSN 1652-6880
ISBN (print version) 978-91-7760-692-5
ISBN (electronic version) 978-91-7760-693-2