Vadim Sidorovich

Behaviour and ecology of the Eurasian lynx

A case of study in Naliboki Forest and Paazierre Forest, Belarus

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This scientific book gives the results of the long-term studies on the Eurasian lynx *Lynx lynx* in Belarus, mainly in Naliboki Forest and Paazierre Forest. Population structure, breeding, diet and prey supply as well as the variety of behavioural traits were considered. Among behavioural questions there were investigated sociality, hunting modes, mating and denning behaviour, territorial marking, sheltering and interspecific interference. The monograph presents not only the regional aspects of lynx biology, but also includes many new findings for the Eurasian lynx overall.

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Preface

When I met Professor Vadim Sidorovich for the first time, which took place in the Białowieża Forest, Poland, at the beginning of my scientific career, i.e. almost 30 years ago, already then I was very impressed with his extraordinary energy, enthusiasm and passion for field biology and discovering the secrets of nature. We went then for a field trip in search for the radio-collared male and female Eurasian lynx during the mating season. We found them very close to each other, what suggested that they might indeed have had their mating session on that day. Since we didn't want to disturb the cats, to make sure what happened between them, we decided to check the area the next day when they left, tracking them in the snow. Although at that time Vadim was mainly renowned as an expert on Mustelids, he eagerly joined the tracking of lynxes and showed his tremendous skill in predicting where to look for tracks and how to read animal behavior from them. And obviously, we found their tracks suggesting possible signs of courtship! Who knows, maybe it was during that short visit to Białowieża that in Vadim's mind sprouted a seed of interest in deeply exploring the biology of the lynx, thanks to which we can now read and admire his wonderful book about the lynx?

As this book proves, nobody before Vadim has been able to get so close, so deep, into the secret life of a lynx! Aspects of lynx biology that I could only imagine from the telemetry virtual locations of individuals with radio collars or tracks in the snow, he was able to register in the wild and show us! He did so owing to an immense effort and dedicating days, months and years to first learning lynxes, where they can be found, how they move, how to approach them, and then successfully documenting their life in the forest. As Vadim wrote, the method he adopted was just "to be smart to notice and read the species activity signs through a lot of efforts and hard work in the wild, despite

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rain, blood-sucking insects, frost, deep and sticky snow cover, frozen fingers, cold and wet crossings of swamps and streams, having dirty clothes all the time and other rough conditions". And this, indeed does require outstanding intuition, determination and hard work.

I think, most valuable in the book are the pictures. They do not need much explanations. They speak for themselves. It's hard to believe that they show the lynx and other wild animals photographed in the wild, especially since many of them captured the most intimate moments of their lives. Vadim's approach with his "smart camera trapping" paved the way to uncover the missing information about the biology of lynx, which was so far unavailable to commonly used methods. For example, while telemetry primarily distinguishes between "moving" and "stationary" activities, this book shows us what telemetry could not recognize – and guides us through the rich array of behaviors when lynx do not travel long distances and stay at their resting sites. This is a real big value of the data collected this way, as Vadim went deep into the lynx life unraveling what has been previously unrecordable. I would actually recommend that while reading this book it is highly advantageous to follow video-recorded behavior of lynx available at Professor Sidorovich blog and YouTube channel. This may allow you to fully understand and appreciate the strength of his observations.

Interestingly, the existence of some facts about lynx presented by Vadim I have already suspected by conducting the research in the Białowieża Forest using telemetry, for example those that suggest more complex social interactions among them as opposed to commonly accepted, solitary way of their life. My attention was drawn to the large overlapping of their home ranges and a number of encounters that occurred outside of the mating season. However, since my study was directed at a different, more population-based approach than at the individual level, detailed, long-lasting observations of interactions between individuals were not achievable at the time. So, we had to wait almost three decades for Vadim's persistence (and the availability of technical capabilities in the form of camera traps) to get to know the details of relationships between the lynx individuals.

The book contains many very interesting observations documented with camera-trapping method, such as interactions between lynx and wolves, the interspecific interactions related to scent marking or adult males supporting the females with kittens. And what is most striking, something I have always doubted - lynx climbing vertical trees, now seems to be undeniably confirmed by Vadim's photographic documentation. However, being a scientist, doubt is a perfectly natural and desirable character trait. It was precisely this trait that certainly inspired Vadim's

desire to test and challenge the previous knowledge of the species.

For the same reason, readers of this book are likely to deeply consider and contest various claims and interpretations of animal behavior presented here based on visual or tracking material. It is the reader's right to take out of the book what is most valuable to him. We don't have to agree on every point. Myself, being a scientist too, I approach with caution and find quite a lot of room for a different interpretation of some of the observations presented in the book. Since the facts about lynx are almost entirely based on typically observational research, there is a great temptation to subjectively interpret the observed facts. This is why statistics should help scientists see what the researcher's eye cannot perceive.

First of all, while the "snow-tracking combined with camera-trapping" provides interesting, reliable data on the animal behavior, the data obtained this way are not directly comparable with the telemetry data. While such data perfectly complement the white spots in animal biology that cannot be filled by telemetry, they cannot replace it, as, for example, when studying the space use, data recorded by camera traps are strongly biased by the choice of researchers. Snow tracking, on the other hand, is generally limited by the ability to track an individual for only a very short time making it impossible to estimate the year-round home ranges. Moreover, observations made with camera-trapping or snow-tracking are inherently discontinuous in time and space, which makes them prone to over-interpretation of what happened in between. Therefore, I think, for instance, that the support for "hunt-watching" behavior of lynx, which the Author suggests as the main hunting strategy of these cats is not really based on strong evidence. I would like to point out that the record of the sequence of events may be difficult to read from tracks, especially when the lynx stayed near to its prey. To distinguish the sequence of events: whether the lynx actually watched the prey for a long time and then killed it, or first killed and then simply rested nearby for the duration of its use in a well-hidden resting place in most cases can be extremely difficult. Furthermore, I believe that if the "hunt-watching" strategy was to evolve in lynx, the strong effectiveness of their hunting would be clearly noticeable in the field. In contrast, only a few kills have actually been found near the "ambuscade" of the lynx.

Many findings presented in the book are really intriguing, including the idea of patchy home ranges with distinguished "house areas", the individual dietary specialization, as well as the dynamic interactions between lynx numbers and the pack composition and migration of wolves. While the uneven use of the home range with "activity centers" have previously emerged from telemetry data, indeed the concept of "house areas" is new and could have even help to explain

some inconsistencies in the lynx censuses. It is a pity, however, that this has not been documented more systematically, so that other researchers may have better insight into the spatial and temporal distribution of raw data. When it comes to individualizing the lynx diet, while I realize this would be costly, it would be more convincing to use molecular methods to separate materials from different individuals. The same would apply to the history of wolf population turn-over recorded by the Author using the enigmatically described snow tracking combined with camera-trapping. While I am very impressed with the details of the lynx-wolf interactions captured by Vadim's camera traps, I believe that without extensive telemetry and genetic monitoring, it is difficult to imagine acquiring such accurate information about wolf pack migration and relatedness with the details presented in his book. It is especially so, considering that "wolves are not easily recognizable by camera-trapping", as Vadim himself admitted. But this is only my opinion, as the reader of this book. And …. because I have known Vadim for years, I know that if something seems impossible to me, there are no limits to the possibilities for him!

The last but not least, in addition to Vadim's exceptional intuition and research inquisitiveness, which allowed him to gather so huge amount of data on various aspects of the lynx biology, he is also an excellent storyteller. The book guides you through the complexity of the lynx behaviors and its interactions with environment and other wildlife in an exceptionally interesting and engaging manner, so that it is not read as a boring scientific report, but as a record of a research passion that made it possible to learn the unknown secrets of the everyday life of a large, elusive and beautiful carnivore.

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Chapter 1. Introduction: story of the study on the Eurasian lynx in Belarus, challenges of the standard research way, collaboration and acknowledgement, new findings and structure of the monograph

This scientific book gives the results of the long-term studies on the Eurasian lynx *Lynx lynx* in Belarus. Mainly these studies were fulfilled in Naliboki Forest (central-western region) and Paazierre Forest (northern region). Population structure, breeding, diet and prey supply as well as the variety of behavioural traits were considered. Among behavioural questions there were investigated sociality, hunting modes, mating and denning behaviour, territorial marking, sheltering and interspecific interference. The monograph presents not only the regional aspects of lynx biology, but also includes many new findings for the Eurasian lynx overall.

Despite that, the initial goal of the fulfilled studies on the Eurasian lynx was just to get regional knowledge on the species' population dynamics and ecology in Belarus, because there was a little known about lynxes in Belarus. That was in the mid-1990s, when it looked like it would be impossible in Belarus to learn something generally new about lynxes as a species. In western and northern Europe (*e.g.* Switzerland, Poland and Scandinavia), lynxes were studied within high budget research projects including telemetry studies, whereas in Belarus, my initial study on lynx ecology and behaviour was performed by private efforts without any financial or practical support from other parties.

At that time, I mainly applied snowtracking, track-based census, scat analysis and some other methods (Sidorovich, 2011). Some common, basic ecological questions were investigated, such as population number and habitat carrying capacity, home range size and structure, prey supply and foraging, temporal changes in diet (between years and seasons), reproduction rate and mortality causes, lynx predation impact on the prey populations and population structure. These zoological questions, perhaps, were raised by any other lynx researcher in any other country. The questions are hard to investigate entirely, but anyway they are initial and basic questions for all lynx researchers.

In my initial study on lynxes, I did not answer entirely on all these questions, although at that time substantial progress for the topic for the region of Belarus was achieved. Here it is worthwhile to notice that even after much further studies on lynxes together with quite many collaborators, it looks like the initially raised basic questions were not fully investigated still. However, we got to know the species better.

In the early 2000s, I realized that the Eurasian lynx as a species was not sufficiently investigated across its range. At that time, by studying the Eurasian lynx, I tried to pay more attention to several poorly

Photo 1.1. Eurasian lynx in forest habitat.

known questions to acquire original knowledge on the species level. Those questions were denning behaviour and timing of parturition, raising of kittens up to 3 months old, home range structure and its usage particularly during summer, individual specificity of diets in the conditions of relatively poor supply with lynx-relevant prey (roe deer, hares and tetraonids), hunting modes, mating behaviour and the role of trees in the life of lynxes. Another quite distinct and poorly studied, but very important question was about competition between lynxes and wolves, particularly interference between these two large carnivores. At that time, Irina Rotenko started assisting me in the lynx research. Also, Irina Solovej helped in the studies. We were still carrying out this study on lynxes without any funded project until 2006.

Only in 2006-2008, we got two projects financed by state budgets in the Institute of Zoology of National Academy of Sciences of Belarus: one for telemetry study on lynxes, and another one for elaboration of the National action plan for the lynx population in Belarus. Working for these two projects on lynxes, Irina Rotenko assisted me a lot. Also, she was the main my assistant in all further studies on the species.

In 2012-2015, we had another big project on lynxes: a telemetry study in Krasny Bor, Paazierre Forest in northern Belarus. This telemetry project had excellent equipment (including GPS-GSM telemetry) and many helpers; it was financed by the "Krasny Bor" game husbandry and "Interservice" company. The lynx telemetry project was carried out thanks for much care and efforts of Nikolaj Vorobej, who is a businessman and top-director of the mentioned sponsor companies. Irina Solovej and Ihar Bashkiraw helped a lot in those telemetry studies on lynxes in Krasny Bor terrain.

Within these three lynx projects, we continued investigating the main ecological traits of the lynx in Belarus. Moreover, we advanced a lot in studying of the above poorly studied questions. Also, the fulfilled telemetry study raised many useful new questions and showed evident problems and artefacts of the method. As we think afterwards, the main problem of any telemetry study on lynxes is that the species often use long-lasting hunt-watching (i.e. watching for an opportunity to hunt) without moving that is registered as inactivity. Registering this highly active behaviour (i.e. hunt-watching) as inactivity is a horrible artefact of telemetry, and that in my opinion nullifies all other evident merits of the method. Another plausible problem is the high stress that the radiotagged lynxes were evidently being exposed to, while researchers captured, handled and radiotagged them.

Despite the fact that we used the softest techniques available of catching and radiotagging lynxes, we were unsure how much time it would take for such stressed lynxes to recover and start behaving fully natural again. A study of the effect of live-capturing on the space use of lynxes has demonstrated that it took lynxes significantly longer to return to the area of their capture compared to other home range patches (Moa *et al.*, 2001). Even though some reservations can be made regarding these results, at least, they underline the fact that we don't know much about the effect of live-capturing on

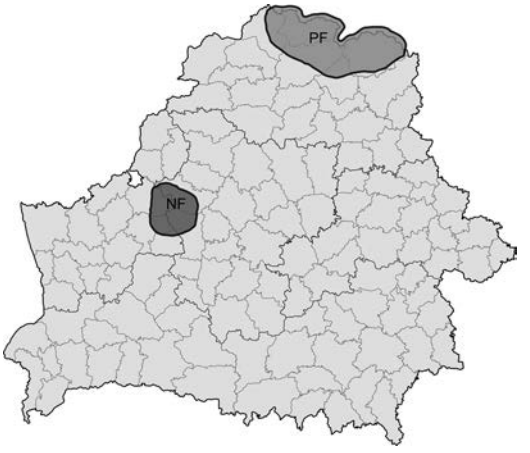
Photo 1.2. Main author Prof.Dr. Vadim Sidorovich working with a camera-trap in a lynx spot.

stands, spruce-prevailed forest occurs the most.

In the Lovats' terrain as well as in the whole Paazierre Forest there are many treefalls, and some of them are fairly large - up to ten hectares. Small treefalls as well as groups of several fallen or inclined trees stay untouched for longer periods and are gradually overgrown with young forest.

There are many clearcuts with reforestations of various ages; during the period of study clearcuts up to 7 years old covered 2-4% of the area. Usually a lot of wood materials (logging remains etc.) and even rotten log piles are present on the clearcuts. Around clearcuts there are usually many fallen trees.

Extended bogs largely overgrown with suppressed pines occur in this study area as well. Stream density in the Lovats' upper reaches is about 0.7 km/km² and there are also small and medium-sized glacial lakes (0.3-2 km²). Open grassy marshes occupy about 11% of the area and are common in the valleys of rivers and glacial lakes. Remote patches of open grassy marshes are mostly small and scattered. Man-made landscape elements (fields, hay meadows, villages, roads etc.) make up about 8% of the territory. Both agricultural lands and villages are getting deserted and natural habitats expand to the rural areas.



Map 2.1. Paazierre Forest (PF) and Naliboki Forest (NF) on the map of Belarus.

We have got quite a lot of data on the prey supply of lynxes in the Lovat terrain, Paazierre Forest as well as for its other two parts, where we studied lynxes (Palata terrain and Krasny Bor terrain). The gained data relate to the main possible prey species of lynxes: the roe deer *Capreolus capreolus*, hares (mountain hare *Lepus timidus*, European or brown hare *Lepus europaeus*), grouses (capercaillie *Tetrao urogallus*, black grouse *Lyrurus tetrix*, hazel grouse *Bonasa bonasia*), wild boar *Sus scrofa* and Eurasian beaver *Castor fiber*. These data on prey stock for lynxes have distinctive characters. One of them is an abundance index on a multiannual scale estimated for the whole Paazierre Forest and suggests the prey population trends. Another set of data provides the prey species population density for each of the three model terrains in Paazierre Forest.

The population dynamics of the prey species that are most relevant for lynxes *i.e.* the roe deer, hares and grouses were assessed by means of the species abundance index in the entire Paazierre Forest during 1984-2010. We tried to get the mean-weighed estimates for all three model terrains in Paazierre Forest (the Lovats', Palata and Krasny Bor terrains,

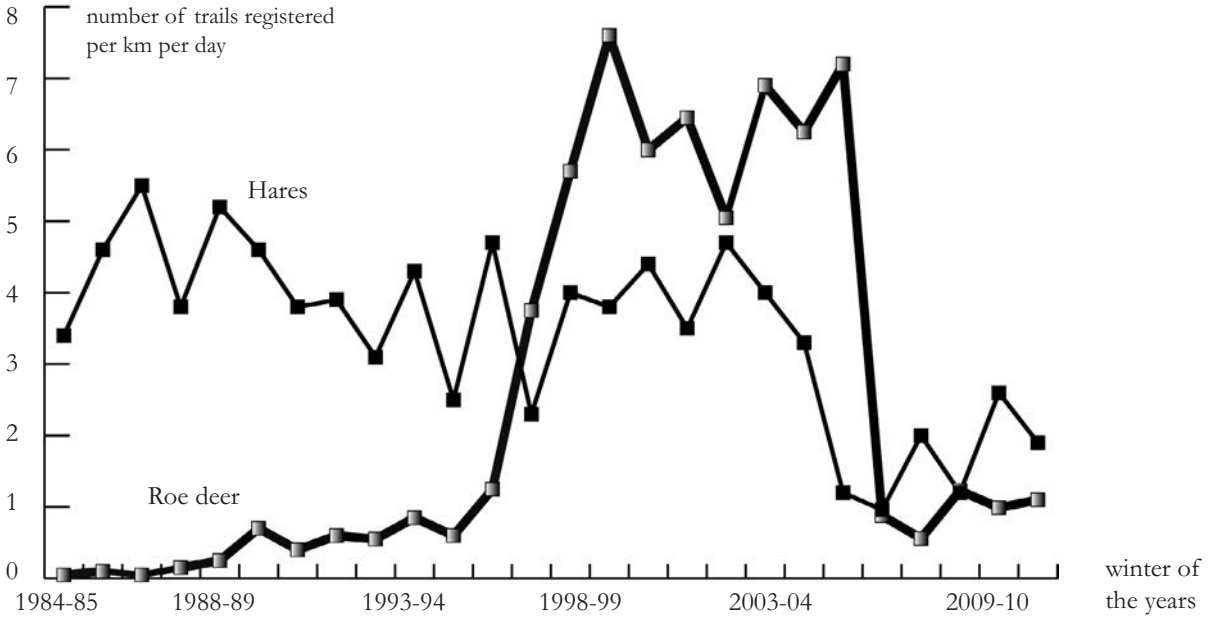
Map 2.2. Paazierre Forest on the map of northern Belarus, locations of the Lovats' terrain (LT, 35 km by 40km), Palata terrain (PT, 15 km by 20 km) and Krasny Bor terrain (KBT, 20 km by 30 km) in Paazierre Forest. The total area of Paazierre Forest in Belarus about 5 thousands km².

see further). Until 2004 hare numbers were generally stable on a multiannual scale (Graph 2.1). The variation of the hare abundance index (number of track trails registered per km per day) between years was rather low (CV=20.9%) and there was no trend of its dynamic with time (r_s=-0.18, P=0.44). Then, we registered about 4-fold decline in the abundance index of hares, and this prey species became much less common.

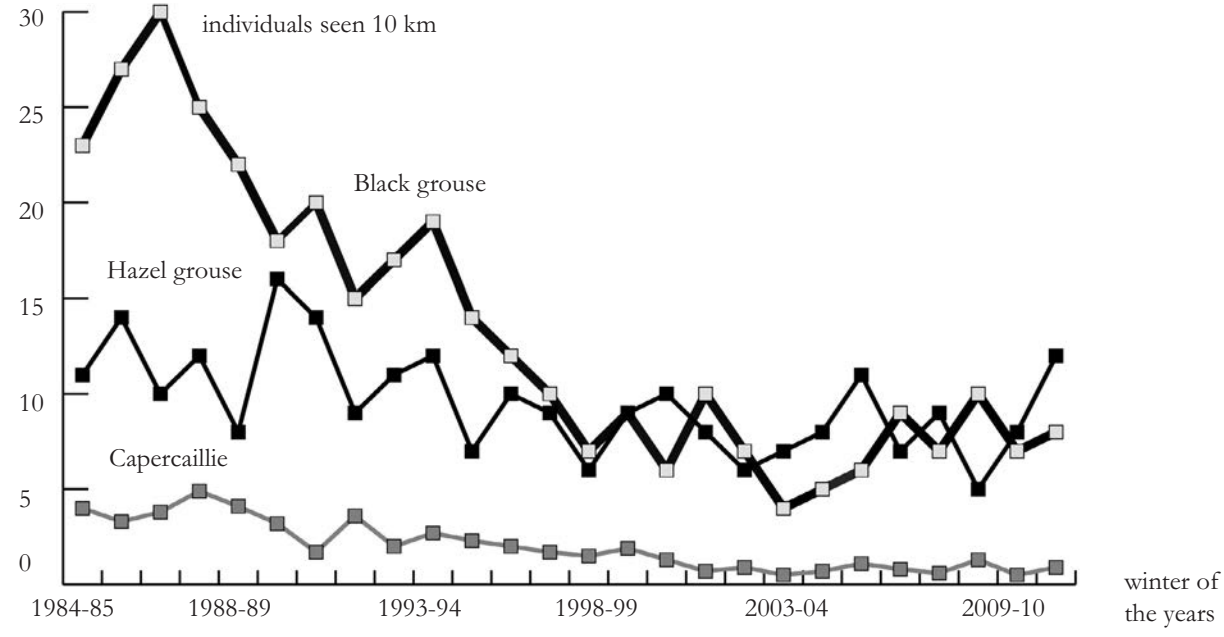
The index of roe deer population abundance (number of track trails registered per km per day) increased manifold at first (Graph 2.1, r_s=0.94, P<0.001). Mean abundance of roe deer between the periods of 1985-1996 and 1997-2005 grew about 12-fold (U=96.0, P<0.001). After 2005 the roe deer numbers decreased 7-fold.

Populations of tetraonids (grouses) declined gradually (Graph 2.2): data was pooled for all species – r_s=-0.89, P<0.001; black grouse – r_s=-0.96, P<0.001; capercaillie – r_s=-0.91, P<0.001; hazel grouse – r_s=-0.67, P=0.001. When the two periods were compared (1985-1996 versus 1997-2010) the decrease of abundance was more pronounced for black grouse – about 2.7-fold (U=96.0, P<0.001) and for capercaillie – about 3.2-fold (U= 94.5, P<0.001).

As to more precise data on lynx prey species, wolf and brown bear in the Lovats' terrain, we have got the following. In the early 2000s the roe deer population density was about 0.4 to 2 inds per one km². The wild boar, always a dominating species in the wild ungulate community, declined more than ten times from 1990



Graph 2.1. Population dynamics of hares (mostly mountain hare) and roe deer in Paazierre Forest, northern Belarus, 1985-2010. Average numbers of the species trails recorded on transects divided by the number of kilometers inspected and the number of days since the last snowfall was used as an index of the species abundance.



Graph 2.2. Dynamics of the grouse populations in Paazierre Forest, northern Belarus, 1985-2010. Average numbers of the species individuals seen per 10 km of transects inspected was used as an index of the species abundance.

Photos 2.19-2.22. ↓↑ Broadleaved deciduous forest with fallen huge trees. Lynxes on fallen oaks. Naliboki Forest, Navahradak and Iwje districts of Harodnja region. In such habitats there are many roe deer, red deer and hares as well as many comfortable shelters, so, these favourable conditions attract lynxes there year-round.

Photos 2.23 and 2.24↓↑ Lynx family is grooming on fallen big oak. Naliboki Forest, Iwje district, the Harodnja region.