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FIRST PUBLIC INVOLVEMENT IN EURASIAN LYNX DISTRIBUTION REGISTRATION IN LITHUANIA FROM 2009

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From 2009 the Lithuanian hunter's forum (www.hunter.lt) requested information about the activities of Eurasian lynx (*Lynx lynx* L., 1758). The volunteers provided precise information on their observation of lynx and included such information as number of individuals, time, location and any other important facts. During a six year period 160 reports, suitable for analyses (i.e. fulfilled observational requirements), were received. In 2009, 34 reports were received, in 2010 – 23, in 2011 – 39, in 2012 only 9 reports were received, but in 2013 and 2014 the number of reports received increased to 23 and 32 reports per year.

The Lithuanian hunter's forum is an open access forum, where any visitor is able to register their lynx observations. Therefore, it can be assumed the records were randomly distributed and that the results reflect real lynx distribution throughout Lithuania. Importantly long-term research, such as this study, where data is collected over successive years can increases the reliability and accuracy of both the data and results.

According to data received during the six year period (2009–2014), lynx activity was observed in 80.8% of Lithuanian municipalities (excluding the municipalities of towns). The majority of the records were received from districts of Panevėžys (18 records), Ukmergė (12) and Biržai (11).

The most registered observations of lynx were visual sighting. Single individual observations were registered the most (83% of records). There were 4 registered cases, when 4 lynx were observed simultaneously and 2 registered cases where lynx were involved with vehicle accidents in 2009 and 2010.

A land cover analysis indicated that the territories with the lynx observations contained 49.9% forest cover. This exceeds the average forest cover in Lithuania (33.3 %). The young stands prevailed in forests occupied by lynx comparing with control plots.

Key words: lynx, distribution, Lithuania, public observations.

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INTRODUCTION

From 1979 hunting lynxes in Lithuania is prohibited. Official recordings from 1990 showed a decrease in the population. In 1990 a population of 170 individuals was estimated, 1995 – 100, 2000 – 87 (Balčiauskas & Balčiauskienė 2012). In 1995, the hunting experts in all forest enterprises and national parks of the country filled special questionnaires. The distribution of the lynx under investigation was irregular. Accidental lynxes were registered in 49 forest districts, while permanent ones – in 35 (total number of forest districts was 505) (Bluzma 1999). In 2000 the lynx was listed in the Red Data Book of Lithuania. The results of census in 2004 year revealed, lynx survived only in Northern and Western parts of Lithuania (Bukelskis et al. 2004). In the 2007 year edition of the Red Data Book of Lithuania it was stated, that Lithuania's lynx population consists of 30-40 lynxes (Rašomavičius 2007). There was also a lack of research about lynx habitation in Lithuania.

Considering the arisen situation, in 2009 a public internet survey was started. The goal of the survey was to collect and to summarize the data about the population of lynxes that live in Lithuania's territory

During the time the internet survey was taking place, the population of lynxes in Lithuania increased. In February of 2012, during the survey, conducted by the General Forest Enterprise, a bigger population was estimated – around 60 individuals. In 2015 during the survey it was estimated that no less than 97 lynxes live in the forests of Lithuania (http://www.am...). Also in 2011-2012 the project of setting free captive lynxes was carried out, during which after the adaptation process 9 captive bred lynx were released and replenished the wild lynx population (Gintaras 2013). Next year 9 lynxes additionally were released.

MATERIAL AND METHODS

From 2009 the Lithuanian hunter's forum (www.hunter.lt) requested information about the activities of Eurasian lynx (*Lynx lynx* L., 1758). The volunteers provided precise information on their observation of lynx and included such information as number of individuals, time, location and any other important facts.

The Lithuanian hunter's forum is an open access forum, where any visitor is able to register their lynx observations. Therefore, it can be assumed the records were randomly distributed and that the results reflect real lynx distribution throughout Lithuania. Importantly long-term research, such as this study, where data is collected over successive years can increases the reliability and accuracy of both the data and results.

The distribution of lynx in the landscape was examined on the basis of survey data during the period of years 2009-2014.

In analyzing the influence of the landscape on lynx distribution, a 5.9 km radius buffer zone was drawn around each spot (n = 156) where a lynx activity had been observed. The area of the buffer was equivalent to 75% of the average territory occupied by lynx, as estimated during radio-telemetry in neighbouring countries, Poland and Latvia (Schmidt et al. 1997, Ozoliņš et al. 2007). Territories, where the lynx activity had been observed, were compared to the whole territory of Lithuania covered by control plots (n = 165), which were systematically arranged across the entire territory of the country. Control plots that happened to correspond to the biggest cities of the country or partially cross the borders of the republic were eliminated. The control plots used for this check could not overlap.

16 environmental factors were analysed in all plots: indicators of forest stands (5 factors), humidity of habitats (4), layers of anthropogenic origin (7). Environmental factors were analysed with ArcGIS, Microsoft Excel and Statistica programs.

To determine the significance of the measured factors on lynx, an Ivlev selectivity index was calculated (Ivlev 1961). Even though

the primary goal of creating the index was evaluating food source selectivity, the algorithm is also successfully applied while measuring the habitation selectivity (Van Dyke 2008).

$$SI = (U - A)/(U + A)$$

Here SI – Ivlev selectivity index, U – the animal habitat's part among all the habitats that were used, A – the same habitat's part among all the habitats that could be used.

When the selectivity index SI = -1 – high evasion (considering the habitat's frequency in the researched landscape, it is used especially rarely), when SI = 0 – random selection (the habitat is used proportionally to its frequency) and when SI = 1 – strong priority to the habitat.

RESULTS AND DISCUSSION

During a six year period 160 reports, suitable for analyse (i.e. fulfilled observational requirements), were received. In 2009, 34 reports were received, in 2010 – 23, in 2011 – 39, in 2012 only 9 reports were received, but in 2013 and 2014 the number of reports received increased to 23 and 32 reports per year.

According to data received during the six year period, lynx activity was observed in 80.8% of Lithuanian municipalities (excluding the municipalities of towns) (Fig. 1). There are 60 municipalities in Lithuania (including 7 municipalities of towns). The majority of the records were received from districts of Panevėžys (18 records), Ukmergė (12) and Biržai (11).

The most registered observations of lynx were visual sighting. Single individual observations were registered the most (83% of records). There were 4 registered cases, when 4 lynx were observed simultaneously and 2 registered cases where lynx were involved with vehicle accidents

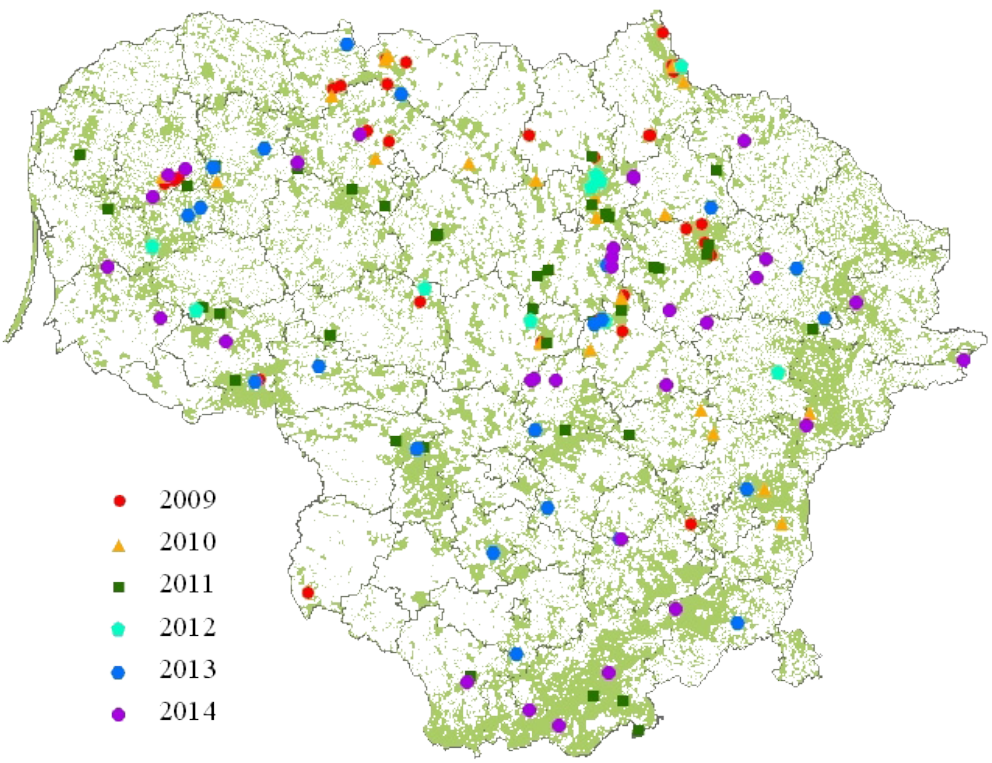

Fig. 1. Places where during 2009–2014 lynx activity signs were registered.

in 2009 and 2010.

Taking all six years examined in general, spatial autocorrelation showed that the locations of the lynx were in clusters. The Moran's I Index was equal to 0.23, and the calculated value of Z score showed 2.04 standard deviation. The probability ($p = 0.05$) that the clusters were obtained randomly was less than 5%. The dot concentration shows, that lynxes were observed mostly in the territories of Telšiai, Panevėžys, Ukmergė, Joniškis, Biržai Forests Enterprises (Fig. 2).

Lynx strongly prefers forest habitats (Prūsaitė 1988, Jędrzejewska & Jędrzejewski 1998, Jędrzejewski et al. 2002, Ozoliņš et al. 2007 Männil & Kont 2012). A land cover analysis indicated that the territories with the lynx observations contained 49.9% (SD = 17.19) forest cover. This exceeds ($p = 0.000$) the average forest cover in Lithuania (33.3 %). The forest cover of lynx inhabited territories varied from 16.6% to 98.4% (Fig. 3), while in control sample plots - from 0.5% to 94.2% (Fig.4). It is worth mentioning, that in all cases lynxes or their activity signs were observed in forest areas. Ivlev index (0.50) shows, that considering the frequency of the habitat (forest) in the landscape, it is used apparently more often than random.

Lynxes hunt at the edge of the forest, regrowing clearcuts, where the prey concentrates (Prūsaitė 1988). Anova one-factor forest stand age analysis by their maturity groups showed, that young stands was the only maturity group, which dominated the lynx selected areas (50.85%) compared with the sampled plots (17.68%) ($p = 0.000$) (Fig. 5). Lynxes obviously give priority to forests that have plenty of young stands (Ivlev index was 0.48). And the other way around, mature, premature or middle-aged forest stands part in the lynx habitated forests was smaller than in the control sample plots.

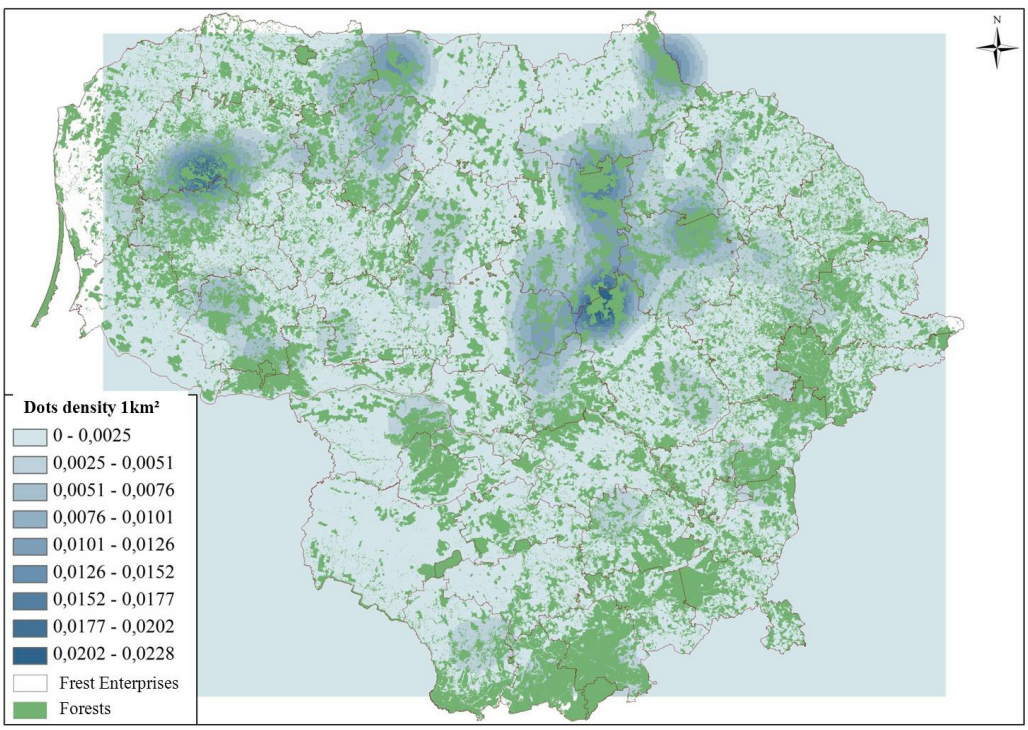

Fig. 2. During 2009-2014 lynxes were mostly observed in Telšiai, Panevėžys, Ukmergė, Joniškis, Biržai Forest Enterprises' territories.

Wetlands possess a specific microclimate, usually are visited less by people. Bogs are not inhabited by lynx permanently, however, lynx often occur at the edges of the bogs, and readily use inaccessible islands in the bogs as resting sites, they also cross wetlands using roads and paths (Ozoliņš et al. 2007). It is possible that these factors influence lynx priorities when choosing territories. In the territories, where lynx activities were observed, upland bogs and intermediateland bogs were a little bit more common (on average 5.23%, SD = 6.06) than in the sample plots (on average 5.07%, SD = 9.02), even though no difference in preference was found (p = 0.854). Ivlev index (0.02) showed, that the habitat is used proportionally to the frequency it was found in the environment. Analogical data was found, while calculating lowland bogs part of the lynx habitated forests (on average 12.88%, SD = 2.81) and in sample plots (on average 12.66%, SD = 3.89) p = 0.559. Ivlev index (0.01) showed random selection. Though waterlogged fertile and very fertile soils in the forests, where lynxes were observed, made up 7.71% (min–max = 0.21–18.85%, SD = 4.48) compared to the sample plots 6.15%, (min–max = 0.20–24.30%, SD = 4.11). In this way a statistically reliable difference is set p = 0.001. Ivlev index was 0.11. Also waterlogged fertile and very fertile soils in the landscape, where lynxes were observed, made up 3.80% (min–max = 0.08–12.19%, SD = 2.66) compared to the control sample plots 1.86%, (min–max = 0.05–10.72%, SD = 1.68) p = 0.000. A stronger priority to this habitat was also shown by the Ivlev index (0.34).

The roads are a constant anthropogenic disturbance in the animal habitated territories. The crucial factor can be their traffic load and the density of the roads in the territory. There should be less of these anthropogenic surfaces than there are on average in Lithuania. The main roads (highways and national roads that are wider than 14 meters) in the recorded sample plots with lynxes made up 0.19 km/km^2, and in control sample plots 0.27 km/km^2 (Table 1). The main road length in the whole sample plots and in the forest territory statistically significantly differed between lynx habitated areas and control areas. Medium roads (national, municipality and forest enterprise roads with the surface of 5–14 (18) meters wide) in the recorded sample plots

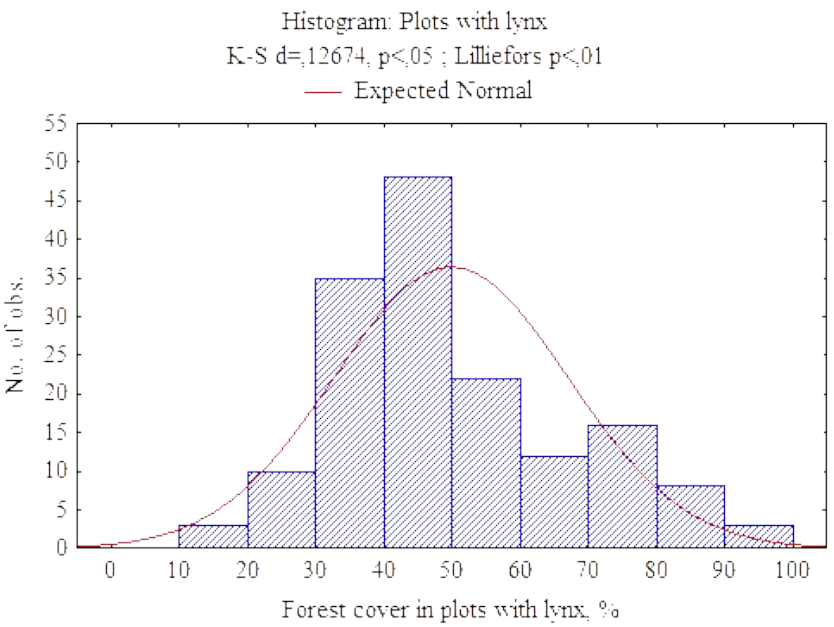

Fig. 3. A histogram of the density of forests in the sample plots, where lynx activity signs were observed.

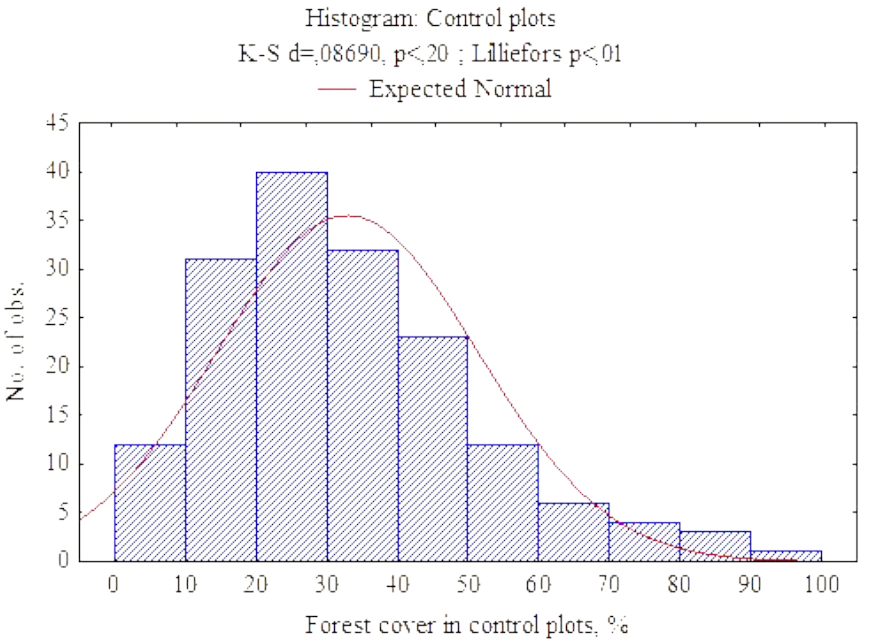

Fig. 4. A histogram of the density of forests in the control sample plots.

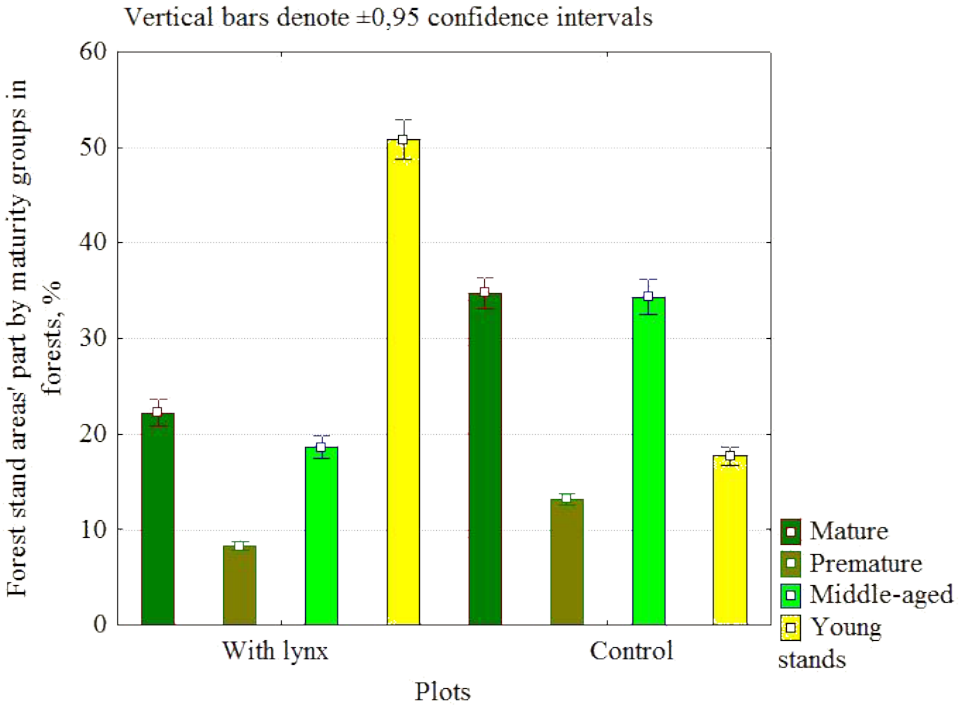

Fig. 5. Forest stands age (by maturity groups) comparison in sample plots, where lynx activity signs were observed, and in control sample plots.

Table 1. Length of roads in the lynx territory and territory of Lithuania depending on the roads' traffic load

Roads	Length of roads in sample plots, km/km²						p	Ivlev index
	Plots with lynx			Control plots				
	$\bar{x}$	Min-Max	SD	$\bar{x}$	Min-Max	SD		
Main roads in sample plots	0.19	0.00-0.55	0.11	0.27	0.00-2.37	0.21	0.000	-0,17
Main roads in forest area of sample plots	0.06	0.00-0.35	0.08	0.11	0.00-1.82	0.18	0.004	-0.29
Medium roads in sample plots	3.29	0.35-17.57	3.13	2.68	0.04-10.28	2.36	0.047	0.10
Medium roads in forest area of sample plots	0.22	0.00-0.70	0.16	0.18	0.00-2.81	0.27	0.161	0.10
Natural primer roads in sample plots	1.03	0.03-3.65	0.75	0.94	0.13-3.42	0.65	0,25	0.04
Natural primer roads in forest area of sample plots	1.29	0.08-4.33	0.94	1.34	0.14-4.10	0.97	0.68	-0,02

Note: $\bar{x}$ – average of the data in plots, SD – standard deviation, (Min-Max) – highest and lowest value; p – statistically significant differences comparing the plots with lynx and control plots.

with lynxes in the forests made up 0.22 km/km², and in control sample plots – 0.18 km/km². Even though the road length in the lynx habitated sample plots was bigger than the average length in the control sample plots, however the difference was statistically insignificant, p = 0.161. Natural primer roads (roads without surface 3–6 meters wide) in the recorded sample plots with lynxes in the forests made up 1.29 km/km², and in control sample plots 1.34 km/km², p = 0.68. The lynxes mainly avoided the main roads both in the landscape and in the forest territory (Ivlev index was respectively-0.17 and -0.29).

The average resident density in lynx territories, counting in 2.5 x 2.5 km pieces was 146.02 people (SD = 602.46), and in all Lithuania's territory – 341.15 people in a 2.5 x 2.5 km square (SD = 2297.21). The resident density in the lynx territories greatly differed from the overall density of Lithuania. p = 0.000. Ivlev index (-0.40) showed quite a high avoidance degree.

CONCLUSIONS

In all of the cases of observing lynxes or their activity signs, the observations were made in forest territory. A land cover analysis indicated that the territories with the lynx observations contained 49.9% forest cover.

It was determined, that young stands were the only maturity group, where forest stand amount dominated in the lynx selected areas (50.85%) compared to the control sample plots (17.68%) (p = 0,000). Lynxes were obviously giving the priority to the forests that had enough young stands (Ivlev index 0.48). And the other way around, mature, premature or middle-age stands part in the lynx habitated forests was smaller than in the control sample plots.

Wetlands were not lynx priority habitats (Ivlev index was 0.01, 0.02), even though waterlogged fertile soils were surely more common (p = 0.001) compared to the control sample plots.

The roads, despite the traffic load, were a disturbance to the lynxes, however the lynxes mainly avoided the main roads both in the landscape and in the forest territory (Ivlev index was respectively-0.17 and -0.29).

The resident density in the lynx territories greatly differed from the overall density of Lithuania. p = 0.000. Ivlev index (-0.40) showed quite a high avoidance degree.

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