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Factors Influencing Lynx Depredation on Sheep in France: Problem Individuals and Habitat

by
Philippe Stahl, p.stahl@onc.gouv.fr
Jean Michel Vandel, rezolynx@onc.gouv.fr

In recent decades, the Eurasian lynx *Lynx lynx* has re-colonized former habitat in the Jura, east of France. The French Jura, 10,000 km², holds 36,000 ewes together with 347,000 cows and 4,000 goats. In the Jura grazing system, sheep and lambs are kept in pastures from early spring to late autumn. In these pastures which vary in size from 1 to 100 ha, sheep are always unguarded and wander freely by day and night. Livestock guard-dogs are not used in the Jura. When taking the presence of this free-access food base into account, large damage to livestock could be expected. In a recent paper, we described the distribution and trend of lynx attacks on sheep during and after the expansion of the lynx in the Jura (Stahl et al. 2001a). In France, the investigation of lynx depredation events are made by trained lynx-experts who investigate each case of domestic livestock predation. Standardized identification and reliability assessment criteria have been used as of 1989 and since then an exhaustive census of lynx attacks is available covering more than 15 years, i.e. throughout the entire sheep-lynx range. We observed that there was no general lynx-livestock problem in spite of the absence of measures to protect livestock. At the regional scale, sheep losses to lynx were low, i.e. less than 0.5 % of the available stock, many flocks were not affected and, among those suffering attacks, most (70 %) were only sporadically attacked. Nevertheless, some important lynx-livestock conflicts occurred in a few small areas. These clustered attacks are the major lynx-livestock problem. Each year, 2-6 "hot spots" were identified. These hot spots concentrated 33-69 % of the attacks on 0.3-4.5 % of the total area where attacks occurred (1835-4061 km²). Hot spots often reappeared at the same sites between 1984-1998. The reappearance of hot spots at the same sites, after years of interruption and despite the removal of lynx from some sites (Stahl et al. 2001b), suggested that the ultimate factors causing hot spots were factors inherent to these sites. In recent years, further investigations have been made (Stahl et al., submitted) to: (1) know what special set of habitat features predisposes some farms or sites to lynx depredation and (2) examine if some lynx really develop a livestock-killing behaviour on a more habitual ba-

sis than others and what factors influence this behaviour. We compared sheep availability and environmental characteristics of attacked and non-attacked pastures in a 1800-km² study area. Nine lynx were radio-tracked for a total of 21 lynx-years in the same area to estimate individual killing rates on sheep and identify possible habitual livestock killers. Depending on the individual and year, the lynx depredation rate on sheep varied between 0 and 12.4 depredation events per 100 days. There was no simple relationship between depredation rates and sheep abundance or sheep dispersion in lynx home ranges. We observed that some lynx which had access to the same flocks or had the same number of flocks in their home ranges, had very different attack rates. In particular, two individuals became habitual sheep killers during respectively their third and fourth year of monitoring. Other lynx which had access to the same flocks remained occasional sheep killers. Unlike the other lynx, these two individuals concentrated their kills on a few flocks. They could be regarded as true "problem individuals".

When comparing the characteristics of attacked and non-attacked pastures, we found no difference in sheep availability between them. This was not a surprise because sheep are not protected by shepherds or guard dogs, and there is no reason for a lynx to select large flocks rather than smaller one when entering a pasture to kill sheep. On the other hand, strong differences were found in the environmental characteristics of attacked and non-attacked pastures. Only 5.1 % of 98 pastures more than 250 m from a forest were attacked by lynx. In 228 pastures adjacent or connected to large forests by cover, 39.1 % were attacked by lynx ($P < 0.01$). For these pastures, a logistic regression showed a positive effect of their proximity to major forested areas ($P < 0.01$), absence of human dwellings ($P < 0.01$), local abundance of roe deer ($P = 0.01$) and presence of attacked pastures in their vicinity ($P = 0.03$). This last factor may express a spatial autocorrelation of lynx attacks, which could be due to the presence of a sheep-killing lynx. It then became clear that, in the Jura grazing system, frequent lynx damages in some local places are explained by a predictable set of habitat features which exposes these pastures to risk, and by an unpredictable rare event, i.e. the presence of an individual developing a regular depredation behaviour on sheep in these special circumstances. No obvious causal factor (e.g. sex-biased behaviour, reproductive status, physical debilitation) could explain the differential propensity to kill livestock among individuals or lynx-years. These facts demonstrated that in a Jura-type grazing system, i.e. where sheep are concentrated in a few sites, true problem individuals may develop. This is very different from the situation found in Norway (Linnnel et al. 1999) where sheep or cattle are distributed throughout all carnivore habitats. In that situation, most individual carnivores have similar opportunities to encounter and kill livestock, and because there are no perceptual differences between wild and domestic ungulates, "problem individuals" do not appear (Linnell et al. 2000).

From a management perspective, two very different situations must be addressed in a Jura-type grazing system. For flocks which suffer rare and unregular lynx attacks (70 % of the flocks in the Jura), the implementation of protective measures is not cost-effective, and damage compensation is probably the only available tool. In that case, sheep farmers will agree with compensation assuming that the compensation takes also the indirect costs of depredation into account, e.g. the costs induced by the regular patrol of the parks to collect the corpses of killed animals. Furthermore, we believe that compensation payments cannot justifiably be conditioned by the implementation of expensive protective measures of the flocks against irregular attacks. In hot spots, which are a sporadic but recurrent problem, the situation is quite different. The presence of habitual livestock killers among lynx strongly argues against non-selective removals to reduce depredations. Undifferentiated removals, i.e. by hunting or by any other way which aims at lowering lynx densities would be totally inefficient to limit conflicts. The "site" effect also implies that selective removals will only be beneficial for a short time. The use of guard dogs in the few local sites at risk and subsidizing sheep sheltering at night when depredation events are on the increase would be the best measures to promote.

Based on these results, the French Ministry of Environment recently devised a procedure to limit damages in hot spots. It was decided that when the number of lynx attacks on sheep within a 3-km-radius area is more than 5 during the year, guard dogs and the sheltering of sheep at night will be subsidized. When protection methods are inefficient or cannot be proposed, the selective removal of a lynx can then be authorized given that a threshold in the number of attacks is reached. Currently, the threshold is set at 10 attacks (an average of 16 sheep killed) within a 3-km-radius area. All attacked pastures within this area must be located in the same continuous forested area, i.e. not be separated by valleys or open areas. The

removal can only be attempted by trapping around sheep killed by lynx or by shooting them in the most-attacked pastures. A few sites are at risk in the Jura mountains, and we expect that by this procedure very few individuals will be removed in the next years while the conflicts will be definitively solved.

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Procedure to Selectively Remove Stock Raiding Lynx in Switzerland

by
Christof Angst, ch.angst@kora.ch

In 1997, the Swiss Agency for the Environment, Forest and Landscape (SAEFL) mandated the KORA to define criteria to selectively remove lynx specialising on livestock. The condition was that the criteria should be easily applicable for the wildlife services of the cantons authorities and yet not arbitrary.

A time series and geographic analysis of the 954 approved lynx kills from 1973–1997 revealed some clusters of lynx kills. As in the French Jura Mts. (see article above), there were some "hot spot" regions, containing the majority of damages (Angst et al. 2000). A lynx core area in Switzerland may be about 80–100 km^2. Such an area can very simply be described by a circle with a radius of 5 km. When we were overlaying all clusters of attacks with such circles, we found that a few cases contained 20 or more kills, but all the other ones less than 10. The basic idea was to remove any lynx that was merely feeding on livestock. The average kill rate for wild ungulates is one animal (roe deer or chamois) per week. As lynx often did not consume sheep entirely, we assumed that they would kill somewhat more than one sheep per week. During the average aestivation period of 15 weeks, a lynx feeding only on livestock would therefore kill about 20 animals. We concluded that we had indeed seen a few "specialists" in the past, and that the "random" attacks had never lead to more than 10 kills in the same area.

Based on the temporal and geographical analyse and the behavioural considerations we proposed the following criteria that were included into the *Swiss Lynx Concept* implemented by the SAEFL in August 2000:

- A permission to remove a lynx will be given if at least 15 animals are killed during a season of aestivation or a calendar year within a circle of 5 km radius around any killed livestock.
- If any lynx attacks occurred in the same region during the previous year, the threshold is reduced to 12 animals.
- The permission will only be given if prevention measures were applied on these pastures.
- The permission will not be given if any barrier cuts the circle in a way that it is very unlikely that the same lynx was responsible for the kills on each side of the barrier.
- Only a state game warden or a person mandated by the cantonal authority is allowed to shoot a lynx.
- A lynx can only be shot or trapped in flagranti, so at a domestic animal killed or in the pasture where the damage occurred.

From 1997-2001, eight shooting permissions have been given according to these criteria. Three lynx have officially been shot so far.

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