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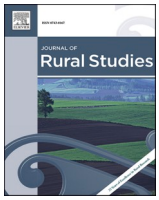

Psychological health among livestock owners, the potential effect of large carnivores

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ABSTRACT

Sustainable wildlife management should, amongst others, safeguard human health. This study concerns rural residents' perceived quality of life and the potential effect of large carnivores (LCs) on psychological health outcomes (life satisfaction, anxiety symptoms, and exhaustion). One group of rural residents that appears to be especially vulnerable when the number and range of LCs increase is sheep owners. 279 participants (rural residents without livestock n = 114, livestock owners without sheep n = 103, and sheep owners n = 62) completed a survey on rural living also including established instruments to assess psychological health outcomes. Rural residents without livestock were mainly positive while sheep owners were mainly negative towards presence of LCs. Sheep owners reported lower life satisfaction, more anxiety symptoms, and more exhaustion symptoms as compared to other livestock owners and rural residents as a group. However elevated stress and anxiety symptoms among sheep owners seem to be an outcome of accumulated stress due not only to the presence of LCs, but also due to problems to reach the break even point economically. The results are discussed in terms of the overall situation for livestock owner.

The Convention on Biological Diversity (CBD, United Nations, 2018) states that sustainable wildlife management should consider the socio-economic needs of human populations (p. 5) and safeguard human and environmental health. Land-sharing between people and large carnivores (LCs) may sometimes bring negative effects on local livelihood and lifestyle, and may generate social conflicts regarding their presence and management (for a recent review see Eklund et al., 2024). Both effects and conflicts evoke negative feelings and experience of stress, due to perceived threat and a feeling of being vulnerable to injury to people, dogs and other domestic animals (e.g. Johansson et al., 2012). Furthermore, it is limiting local practices such as free-ranging livestock husbandry (Strand et al., 2019), hunting with dogs (Eklund et al., 2020a), and are potentially undermining the psychological benefits of time spent in natural settings, for example recreational walks, mushroom and berry-picking (Johansson et al. 2024a,b). In Sweden, the number of LCs and livestock attacks by LCs has increased over the past 20 years (Eklund et al., 2024), Also, the number of people who state that they fear encountering LCs is on the rise (Dressel et al., 2021). In areas with local presence of LCs, fear of attacks on livestock and pets are generally stronger than fear of attacks on humans (Frank et al., 2015).

1. Rural living, livestock husbandry and LCs in Sweden

Rural living is often appreciated for aspects such as access to nature and clean air, important to perceived life quality (Poortinga et al., 2004). Residential relocation trends show that access to natural settings and greenery has become important after the COVID 19, and households tend to shift towards rural areas with the advent of possibility of remote working (Ilham et al., 2024). Furthermore, there has been a trend over several years in Sweden that people are buying smaller, often abandoned, farms with the vision of becoming more or less self-sustainable (Sandström, 2022). However, despite such opportunities, rural living could bring its own sources of daily hassles; longer commuting distances to work, school and childcare, limited access to services, public transport and so forth, which can add to stress.

In Sweden, livestock husbandry is an important part of the rural economy and is in line with political intentions to increase locally produced food, supporting a prosperous rural community (Wretling-Clarin, 2010). Grazing livestock also keeps the agricultural landscapes and wetlands open, which thereby enhances biodiversity in the landscape and maintains a cultural heritage (Lindborg et al., 2008).

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In this context the four LCs, brown bears (Ursus arctos), golden eagles (Aquila chrysaetos), lynx (Lynx lynx), and wolves (Canis lupus), present a specific source of (Frank et al., 2015). Even though some of the LCs occur mainly in some parts of the country, all these species have the capacity for long-range dispersal (Wabakken et al., 2007). Thus, sporadic occurrence of, for example, wolves can be expected in the entire country. In 2023 there were 454 documented attacks on livestock by wolves, 134 attacks by lynx, 23 attacks by brown bears and one sheep attacked by an eagle, resulting in 526 sheep and 9 cattle verified to have been killed or injured by LCs (Frank et al., 2024). According to the Swedish Board of Agriculture there were 454,540 sheep and 1,410,229 cattle in Sweden in 2024 (The Swedish Board of Agriculture, 2024). Thus, killed sheep are about 180 times as frequent as killed cattle in Sweden. Livestock farming occurs with the highest intensity in the southern and coastal parts of the country and becomes gradually less common along the south-north gradient (see Ewerlöf et al., 2025, for cattle; Rosander et al., 2023, for sheep). ***LCs and psychological health among livestock owners.***

Livestock owners more than others hold negative attitudes and emotions towards large carnivores (Røskaft et al., 2007), even before LCs have been reintroduced (e.g. Tan et al., 2024). They also express less trust in management (Barmoen et al., 2021). In a meta-analysis, Dressel et al. (2015) showed that while attitudes towards brown bears had become more positive (that might be due to different samplings in different studies or to the possibility to hunt bears), attitudes towards wolves had grown more negative over time, especially among livestock owners and hunters. Livestock owners also rate the perceived danger of brown bears and wolves as relatively high (Johansson and Karlsson, 2011) and seem prone to have negative emotions towards LCs and stress in general, as compared to other groups in society (e.g. Sjölander-Lindqvist et al., 2021). Livestock owners express fear, anger and frustration both towards the presence of LCs per se, as well as having the additional burden of interventions needed to protect their animals from attacks, e.g. increased demands for guarding and fencing (Eklund et al., 2020b). In areas with LCs in Norway, the number of sheep farms have decreased over time (Hansen et al., 2019).

Zahl-Thanem et al. (2020) found that Norwegian farmers who kept sheep in a wolf area and/or had sheep killed by wolves reported higher levels of stress than other sheep owners. In Norway, sheep are mostly kept free ranging and are therefore more vulnerable to LCs than sheep are in Sweden, where they are mostly kept in enclosures. Still, in a qualitative study among Swedish sheep farmers, Flykt et al. (2022) identified expressions of several stress indicators, including various cognitive, somatic and behavioural responses.

2. Theoretical background: "A landscape of fear" and human stress

Flykt et al. (2022) proposed the concept of "landscape of stress" to describe the situation of sheep owners in LC areas. The concept was derived from the "landscape of fear" used in wildlife research (Laundré et al., 2001). In ecology, the concept describes how the presence of a predator will alter the behavior of the prey (see e.g. Brown et al., 1999; Fanselow and Lester, 1988; Davis, 1996; Fernandes et al., 2013). As the prey allocates resources to be vigilant to the potential occurrence of the predator, the prey thus also sustains costs beyond those of the direct predation (Zanette and Clinchy, 2019). This also seems to be the case for humans as the mere thought of having LCs around livestock may induce feelings of fear and other negative emotions, or in other words stress or, in its clinical form, anxiety. This implies that among humans the presence of LCs is also associated with "costs" in terms of stress.

Human fear/stress reactions to perceived threats are considered functional when they are elicited in situations where they increase the likelihood of survival (Darwin, 1872) of the individual, or in the present case when it increases the likelihood of survival of the livestock the individual cares for (as well as securing the income from sheep farming). That is, fear reactions are adaptive in the sense that they help the individual to handle a situation that is perceived as threatening. When fear reactions are elicited in situations where the reactions do not increase the likelihood of survival or the reduction of harm, they could instead result in anxiety symptoms and exhaustion (see e.g. Beckers et al., 2023; Öhman, 2008). A more or less chronically heightened arousal due to perceived potential threat, for example the mere existence of LCs in the area, will be dysfunctional and will potentially result in psychological health effects. What is regarded as a threat and result in stress is based on the individual's appraisal, and can thus differ greatly between persons. Moreover, several different perceived stressors with low intensity could together add up to a stress response corresponding to a threat of higher intensity (Evans and Cohen, 2004).

3. Psychological health consequences due to (prolonged) stress

The literature identifies different indicators of negative psychological health consequences due to (prolonged) stress (O'Connor et al., 2021). In general, stress or anxiety reduces life quality. This has been shown by Padmanabhanunni et al. (2023), who used the "Satisfaction with life scale" (Diener et al., 1985) which is one way to operationalize life quality. Moreover, memory capacity will be reduced (McEwen and Sapolsky, 1995) and there will be an increase in muscle tension (e.g. Lundberg et al., 1999). If the muscle tension is accumulated over time, this may result in muscles being sore (e.g. McNulty et al., 1994). These indicators may be more or less pronounced in different individuals, but over a prolonged time of stress reaction they can result in exhaustion symptoms such as tiredness, muscle tensions, sleep problems, chest pain, stomach problems, dizziness, memory and concentration problems (Swedish National Board of Health and Welfare/Socialstyrelsen, 2003).

In the study by Flykt et al. (2022) sheep owners stress response was divided into cognitive, somatic and behavioral responses. Some of these responses were identified in the interview data (intrusive thoughts – cognitive dwelling, attention to sheep movements during sleep - cognitive, and stomach pain - somatic) while others were never mentioned (e.g. effects on memory and learning - cognitive). These interviews did not specifically target fear/stress responses and some aspects may simply not have been triggered in the interviews. Zahl-Thanem et al. (2020) successfully used an established and validated instrument to assess stress among sheep owners; the total score of Hopkins five item symptom check list (SCL-5).

However, a more fine-grained understanding of psychological health consequences could be obtained by further differentiating between symptoms in the assessment. That would be valuable as it may generate insight into whether the symptoms would be biased either towards somatic consequences or cognitive consequences in sheep owners. One validated instrument that differentiates between cognitive and somatic symptoms in the assessment of psychological health consequences associated with stress and anxiety is the State-Trait Inventory of Cognitive and Somatic Anxiety (STICSA, Ree et al., 2008; van Dam et al., 2013). STICSA has a clear-cut division between cognitive and somatic symptoms of anxiety, despite the fact that these components are often correlated. Risk for clinical levels of exhaustion could be measured with the Karolinska Exhaustion Disorder Scale (KEDS; Besèr et al., 2014). Preferably, these instruments assessing clinical symptoms should also be combined with more overall assessments of life quality (e.g. the life satisfaction scale, Diener et al., 1985).

4. Aim and research questions

In this study we assess the potential effect of LCs on psychological health outcomes (life satisfaction, anxiety symptoms, and exhaustion) in Swedish rural areas. We focus on sheep livestock owners - a group that appears to be especially vulnerable when the number and range of LCs increase.

The aim was to assess any measurable differences in psychological

health between rural residents with **no** livestock, rural residents **with other livestock** than sheep**,** and rural residents **with sheep.**

Moreover, the study investigated whether livestock owners' psychological health (quality of life, cognitive and somatic anxiety symptoms, and exhaustion symptoms) is associated with concerns about the presence of LCs. Considering the fact that sheep owners seem to be the group of livestock owners (outside the reindeer husbandry area) most likely to suffer attacks from LCs in Sweden, we hypothesized that sheep owners' ratings of LCs is likely to be a more frequently occurring and negative aspect of rural living, and thus sheep owners are more likely to be more vulnerable to psychological health issues compared to other livestock owners, who in turn would be more likely to be vulnerable than rural residents as a group. It is hypothesized that the higher vulnerability would be expressed as:

Hypotheses, that will be referred to with the abbreviations H1-H8 in the text.

H1). Lower quality of life

H2). More cognitive anxiety symptoms

H3). More somatic anxiety symptoms

H4). More exhaustion related symptoms

One reason for why sheep owners would be more affected by large carnivores than other rural residents is that, apart from the above mentioned risks of attacks and feelings of fear, sheep owners may be subject to additional sources of stress with consequences to perceived quality of life. We predicted that ratings of quality of life and/or ratings of LC's effects on quality of life are correlated with.

H5). Rules and laws for keeping livestock in general,

H6). Rules and laws for keeping livestock in relation to LCs,

H7). Costs related to keeping the livestock, and

H8). The distance from the farmers house to where the livestock is grazing

5. Method

5.1. Participants

The study included 279 participants: 114 rural residents with no livestock (average age 64 years, range 32–84, stdv = 11.36, 77 women, 44 men), 103 rural residents with livestock that did not include sheep (average age 66 years, range 24–86, stdv = 12.16, 66 women, 37 men), and 62 rural residents with sheep (average age 56 years, range 25–75, stdv = 12.38, 46 women, 16 men). Participants were recruited in collaboration with the National Sheep Farmers' Organisation (Svenska fåravelsförbundet) and the Swedish Local Heritage Federation (Sveriges hembygdsförbund), that provided their members with the web address to the questionnaire. Rural residency was verified by manually checking postal numbers. The participants become fewer along the south-north gradient (Fig. 1). There are more participants in the south and fewer in the north. Livestock farming is also less common the further north you get in Sweden. No compensation were given to the participants.

5.2. Materials

An internet-based questionnaire was constructed with Qualtrics ™. After providing information and informed consent, participants were directed to the questionnaire and were asked to write their; postal number, age and gender. The questionnaire covered the following topics:

Quality of life: was assessed in three different ways.

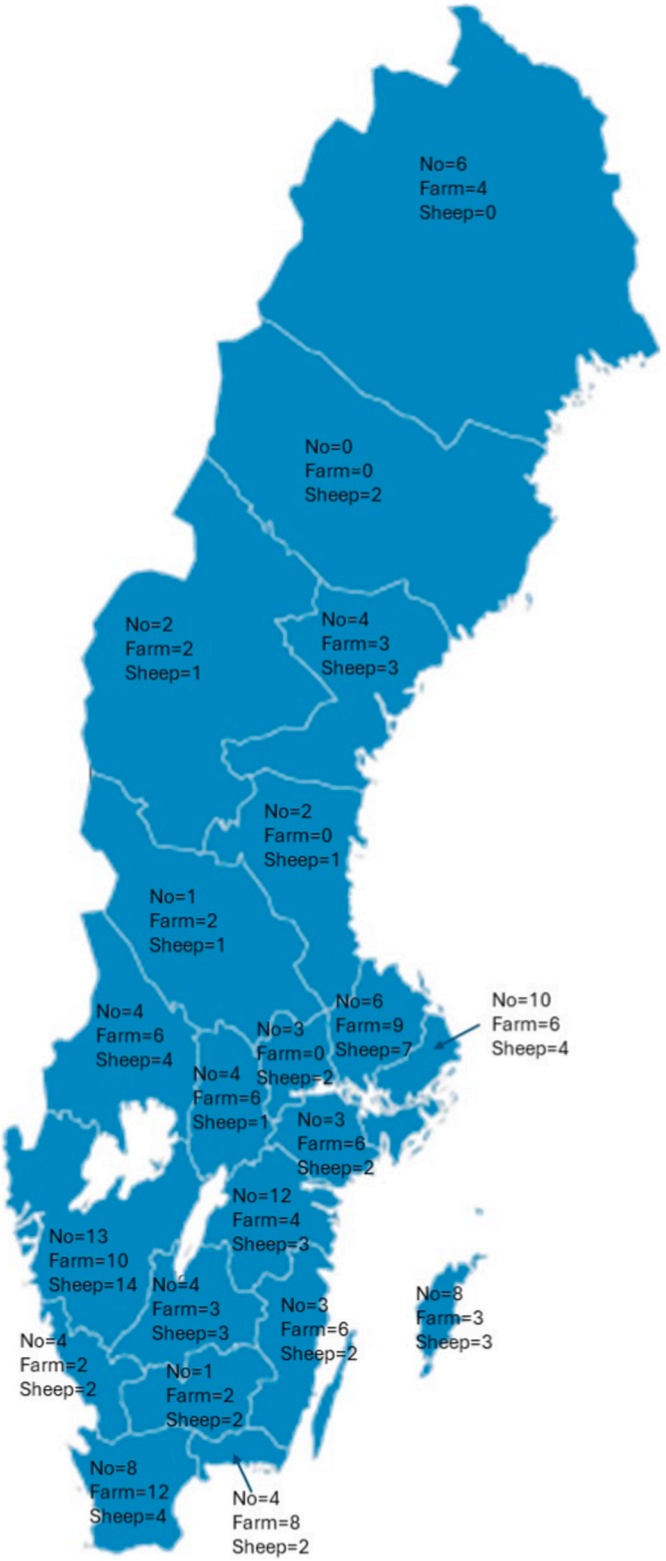

Fig. 1. Schematic map showing the distribution of the different groups of participants over the different Swedish counties. No - indicate participants without livestock, Farm - indicate participants with livestock without sheep and Sheep - indicate participants with livestock with sheep.

1) Participants were in two open-ended questions asked to write in their own words what it is about rural living that they feel has the most positive respectively negative effect on their lives.

2) Participants were asked to rate different listed aspects of living on the Swedish countryside on the scale as very negative, negative, neither positive nor negative, and positive to very positive. The aspects to be rated were a) the possibility to do outdoor activities, b) possibility to do gardening, c) number of lines and departures for public transport, d) fuel costs, e) access to health care and service, f) relation to neighbours, g) village and hamlet communities, h) postal service, i) large carnivores, j) air quality, k) closeness to nature, l) accessibility to different public administrations, m) availability to do leisure time activities, n) commuting distance to work, o) secure income, p) distances to schools. The ratings of all different listed aspects of living in rural areas except the ratings for LCs was averaged and used as an index in the following analyses.
3) The participants completed the Satisfaction with life scale (SWLS, Diener et al., 1985), in which the participants indicated how much they agree or disagree with five items (In most ways my life is close to my ideal. The conditions of my life are excellent. I am satisfied with my life. So far I have gotten the important things I want in life. If I could live my life over, I would change almost nothing), using a 7-point scale (From 1 strongly disagree to 7 strongly agree. For this scale the ratings of the five items were averaged for each participant for the analyses.

Cognitive and Somatic Anxiety symptoms: Participants were presented with the 21 statements of STISCA (Ree et al., 2008) where they were asked to indicate to what extent they agree or disagree with each item using a 4-point scale (from 1 is not correct to 4 absolutely correct). These items were for cognitive anxiety symptoms: I feel agony over my problems, I think that others won't approve of me, I feel like I'm missing out on things because I can't make up my mind, I picture some future misfortune, I can't get some thought out of my mind, I have trouble remembering things, I think the worst will happen, I keep busy to avoid uncomfortable thoughts, I cannot concentrate without irrelevant thoughts intruding, and I worry that I cannot control my thoughts as well as I would like to. For somatic anxiety symptoms the items were: My heart beats fast, My muscles are tense, My muscles feel weak, I feel trembly and shaky, I feel dizzy, My face feels hot, My arms and legs feel stiff, My throat feels dry, My breathing is fast and shallow, I have butterflies in my stomach, My palms feel clammy. For the analyses of the STICSA scores the ratings for the cognitive and the somatic items were summarised separately, for each participant.

Exhaustion symptoms: were assessed by KEDS (Besér et al., 2014), in which participants were asked to check what best corresponds to their ability in nine different areas (concentration, memory, bodily exhaustion, persistence, restoration, sleep, hypersensitivity to input from senses, experience of demands, and irritation & anger. All items were answered using 7-point scales from 0 = this is not an issue for me, to 6 = this is huge problem for me. The ratings of the items in KEDS were summed for each participant for the analyses.

Sheep owner issues: Sheep owners were asked to answer a set of additional questions specifically related to their farming practice, experience of LC attacks, and regulations.

Questions about farming practice covered a) number of sheep, b) distance from home to area of grazing, c) enclosure type, d) if they had applied for subsidies to install large carnivore repelling fences during the last 15 years, and e) if the application was approved or not.

Experience of LC attacks: sheep owners were asked if they have had attacks by LCs on their sheep, and if they knew someone in the neighbourhood that had experienced attacks by large carnivores. Both questions were to be answered with "yes" or "no". Next, they were asked if they thought that they would still have sheep five years from now and, if yes, they were asked if the number of sheep would be less, the same or more, and in an open-ended follow-up question provide a motivation.

Regulations: concerning livestock husbandry, large carnivores, and costs for livestock husbandry was assessed on separate 5-graded scales 1 = very negative, 5 = very positive.

This was followed by an open question where the sheep owners could state if there was something else that affected their quality of life.

6. Data treatment and statistics

One-way ANOVAs with animal ownership as independent variable with the levels

rural residents with **no** livestock, rural residents with livestock but **not sheep**, and rural residents with **sheep** were made for 1) the average of all other rated possible advantages/disadvantages, 2) the perceived advantages of LC, 3) the score on the Satisfaction with Life scale, 4) the score of the cognitive items on the STICSA, 5) the scores of the somatic items on STICSA, and 6) the score of the KEDS. Welch correction was used. To further investigate any effect, deviation contrasts were made, where the mean for the categories rural resident with life stock but not sheep and rural residents with sheep were compared with the mean for the total sample. Moreover, an analysis of covariance (ANCOVA) with sex and age as covariates was made for each one of the dependent variables to account for somewhat differing sub-sample characteristics. For sheep owners, correlations were calculated between the number of sheep, the distance from their home to where the sheep were grazing, and how much they rated that the laws and regulations concerning keeping livestock, large carnivores, and costs for livestock husbandry effected their life quality based on their ratings, and the scores on the Satisfaction with life scale.

7. Ethics

Participants were informed about the study and provided with informed consent in writing before entering the online questionnaire. This research received ethical clearance from the Swedish Ethical Review Agency (2022-02602-01).

8. Results

Quality of Life: The participants perceived the rural living environment as having a positive influence on their life quality with regard to the possibility to do outdoor activities, gardening, relationships with neighbours, village and hamlet communities, air quality, closeness to nature, possibility to do leisure time activities, secure income and (close) distance to schools (see Fig. 2). The number of routes and departures for public transport, fuel costs, access to health care and service, postal service, large carnivores, accessibility to different public administrations, and commuting distance to work were on average rated as having a negative influence on the participants quality of life (see Fig. 2). The closer to the Neither nor level one gets in Fig. 2 the more heterogeneous the ratings become. For example, some experience that accessibility to different public administrations contributes negatively to their quality of life, while others, that have reasonably good accessibility, find that accessibility contributes positively to their quality of life.

When splitting the ratings between rural residents without livestock, residents with livestock without sheep, and residents with sheep, no difference was found for these different aspects except for how they rated the influence of LCs (Table 1). The sheep owners rated the LCs as more negative to their quality of life than the total group of participants. The ratings on the Satisfaction with life scale showed that sheep owners were less satisfied with life than the sample at large (see Table 1). Hypothesis 1 could thus not be rejected.

The hypothesis that sheep owners as a group would be less positive to LCs than other rural residents was also supported by the free-text answers. LCs were reported as being the most negative aspects of living in rural Sweden by nine sheep owners, by one with livestock without sheep, while none of those without livestock regarded LCs as having a negative effect on living in rural Sweden (see Fig. 3). Another aspect that separated the sheep owners from the two other groups was that the sheep owners more frequently stated that freedom is the most positive

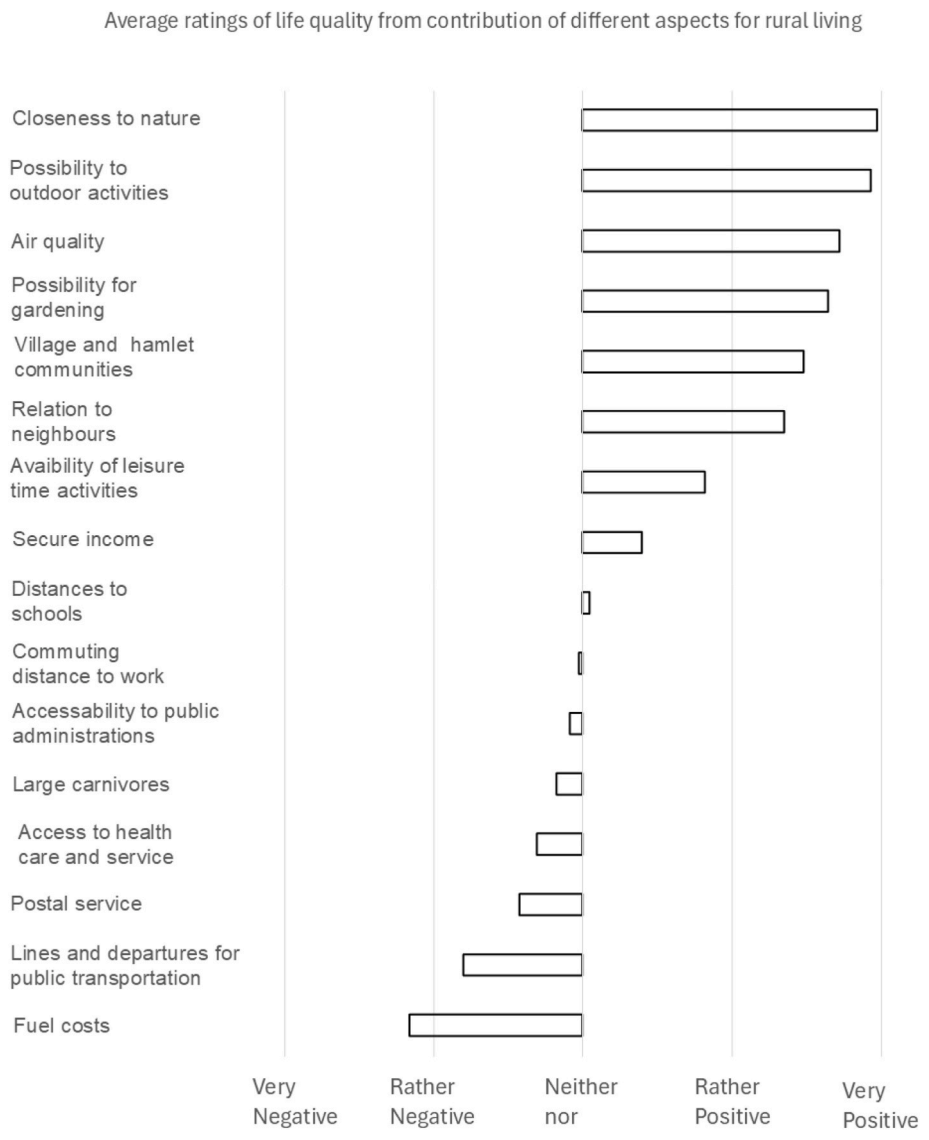

Fig. 2. The average ratings of the 16 different listed aspects were rated with respect to their perceived contribution to the quality of life for persons living in Swedish rural areas. The aspects rated as positive (to the right in the Figure) above the level Rather Positive were rated as positive by the vast majority of the respondents. The same is valid for the negative contribution of fuel costs (to the left in the Figure).

aspect of rural life.

Anxiety symptoms: The analyses of the STICSA (Ree et al., 2008) showed that sheep owners had more self-rated cognitive and somatic symptoms of anxiety compared to the total group. This was not true for the participants with livestock without sheep (see Table 1). Hypotheses 2 and 3 could not be rejected. The cut-off scores for clinical anxiety are 22–23 for the cognitive symptoms and 17–18 for the somatic symptoms (van Dam et al., 2013). Thus, the average scores (all below 15) of the three groups in this study do not reach a clinical level, even if the score does so for some individuals.

Exhaustion related symptoms: The score on KEDS showed that the sheep owners rated themselves higher on exhaustion symptoms than the total sample. This finding prevents Hypothesis 4 from being rejected. The cut off in KEDS for clinical exhaustion is 18.5–19.0 points (ref). All three groups reach averages scores on clinical exhaustion, however the average score is higher among sheep owners. (see Table 1).

Sheep owners – life quality associated with the livestock: Correlations showed that sheep owners that rated life satisfaction as low also rated rules and laws for livestock husbandry as negative to their life quality (see Table 2, I). Moreover, those who rated their life satisfaction as low saw the cost of keeping sheep as a negative aspect of their life quality (see Tables 2 and II), thus hypotheses 5 and 7 could not be rejected. Other significant correlations were: The further away from the house the sheep were grazing the more negative influence the LCs were rated to have on life quality (see Tables 2 and III). Hypotheses 6 and 8 were rejected.

Among participants who found that LCs contribute to a lower life quality, the laws concerning LCs were also regarded as contributing to a lower life quality (See Table 2 IV). Furthermore, for participants who regarded the cost for keeping livestock as a negative aspect of living in a rural area, LCs were also considered a more negative aspect (see Table 2 V). Finally, the further away from the house the sheep were grazing the more the sheep owners found rules and laws concerning LCs to be a negative aspect of life quality (see Table 2 VI).

9. Discussion

Living in rural areas in Sweden seems to be motivated by several aspects that benefit life quality (Sandström, 2022). In our study, rural residents reported air quality, closeness to nature, freedom, peacefulness, social aspects and opportunity for various outdoor activities to be positive aspects. Unsurprisingly, these benefits are for many

Table 1
One-way between subject ANOVAs with independent variable: Livestock (rural residents **without livestock**, rural residents with **livestock without sheep**, and residents with **sheep**) for different Dependent measures. All results are Welch corrected. Ordinary degrees of freedom are kept for readability. Deviation contrasts are used to identify which group/s was/were higher or lower than the mean for the total sample. The No livestock group will be part of the baseline. The column for each of the three groups display the average, the 95 % confidence interval of the average, and the number of respondents for the different measures.

	ANOVA				No Livestock	Livestock Without sheep	Sheep	Deviation contrasts
Dependent variable	*df*	*F*	*p*	η2	Mean 95 % CI N	Mean 95 % CI N	Mean 95 % CI N	$p < .05$
Average ratings of LC	2, 261	29.42	<.01	.19	.09 −.09-.27 N = 99	−.11 −.29-.72 N = 103	−1.02 −1.25–−.79 N = 62	> Without sheep < Sheep
Average of all ratings - LC	2, 261	2.12	.12	.02	.57 .49–.65 N = 99	.61 .53–.69 N = 102	.48 .38–.58 N = 61	= Without sheep = Sheep
Life satisfaction	2, 259	7.14	<.01	.06	5.65 5.46–5.84 N = 99	5.85 5.66–6.04 N = 102	5.24 4.99–5.48 N = 61	> Without sheep < Sheep
STICSA Cognition[a]	2, 259	2.73	.07	.03	12.93 12.23–13.63 N = 99	13.03 12.34–13.72 N = 102	14.48 13.59–15.36 N = 61	= Without sheep > Sheep
STICSA Soma[b]	2, 259	2.03	.14	.02	13.48 12.88–14.07 N = 99	13.35 12.77–13.94 N = 102	14.39 13.64–15.15 N = 61	= Without sheep > Sheep
KEDS	2, 256	2.34	.10	.02	19.04 17.44–20.64 N = 99	19.35 17.75–20.96 N = 99	21.91 19.88–23.96 N = 61	= Without sheep > Sheep

Note.
[a] An ANCOVA with age and gender as covariates showed that the effect with higher ratings on STICSA Cognition in the Sheep owner group is mainly due to the lower age in that group.
[b] An ANCOVA with age and gender as covariates showed that the effect with higher ratings on STICSA Soma in the Sheep owner group is mainly due to more women in that group. The ANOCOVAs for other dependent variables no effect of age or gender was shown. The sign > indicate that the value is significantly higher, < indicate that the value is significantly lower, while = indicate that there is no difference with the mean of the total sample.

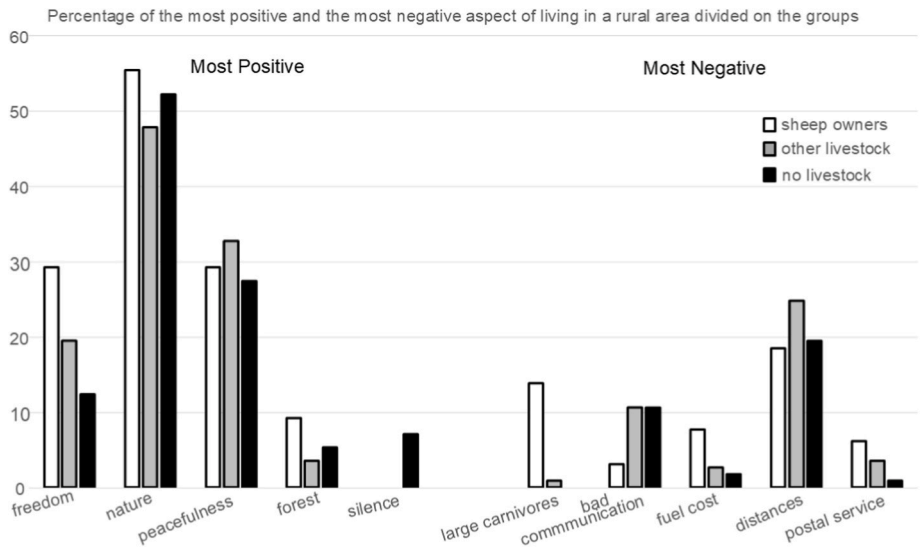

Fig. 3. The free-text answers from the open-ended questions: What do you find is the most positive aspect of living a rural area? and In your experience, what is the most negative aspect of living in a rural area? The bars represent the percentage of participants in the different groups (not the absolute number). That is, how central are the different aspects for the different groups.?.

accompanied with drawbacks and costs. As an example, commuting distances could be long and in Sweden the fuel cost has increased with about 77 % from year 2000–2022 (The National Institute of Economic Research, NIER, 2023). Our results suggest that while some aspects seem to negatively influence life quality across groups of rural residents (e.g. fuel costs), sheep owners seem to be relatively more affected by the presence of LCs.

On average, sheep owners rated LCs as having a more negative effect on their life quality than the other groups did. More than 10 % of the sheep owners spontaneously mentioned LCs as having the most negative effect on life quality in the free-text answers. Only one respondent in the group rural residents with livestock without sheep also mentioned LCs. One reasonable explanation could be that sheep owners are substantially more at risk for attacks from LCs than other livestock owners and rural residents in Sweden (see Frank et al., 2024). Previous research suggests that it is not only LCs per se, but also LC policy and management (e.g. Eklund et al., 2020a; Eriksson, 2017; Strand et al., 2019) that may have a negative effect on quality of life. Eklund et al. (2020a) showed that animal owners make separate appraisals of the LC and the management measures. In the present study none of the respondents explicitly or

Table 2
Pearsons correlation between ratings on the life satisfaction scale and ratings of the contribution of LCs to the life quality and measures related to having sheep.

Pearson's r								
variable		Satisfaction with life	Large Carnivores	Number of sheep	Distance to sheep	Laws and rules livestock	Laws and rules large carnivores	Cost keeping sheep
Number of sheep	n	61	62					
	r	−.179	−.154					
	p	.167	.231					
Distance to sheep	n	61	62	62				
	r	.118	−.305* III	.154				
	p	.365	.016	.232				
Laws and rules livestock	n	61	62	62	62			
	r	.272* I	.082	−.015	−.057			
	p	.034	.524	.907	.658			
Laws and rules large carnivores	n	61	62	62	62	62		
	r	.091	.679*** IV	−.125	−.253* VI	.159		
	p	.485	<.001	.333	.047	.216		
Cost keeping sheep	n	61	62	62	62	62	62	
	r	.334** II	.331**V	−.142	−.072	.123	.201	
	p	.009	.009	.272	.579	.342	.117	

*p < .05, **p < .01, ***p < .001.

implicitly referred to LC policy and management in the free-text responses.

Sheep owners also had lower average scores on the Satisfaction with life scale (Diener et al., 1985) than the other two groups did. Sheep owners also reported a slightly higher number of anxiety symptoms when compared to the two other groups in our sample. This was the case both for the average ratings on somatic anxiety symptoms as well as for cognitive anxiety symptoms as assessed by the STICSA (Ree et al., 2008). The average scores were, however, below 15 for both sub-scales. This means that on average our participants did not reach clinical levels, i.e. scores of 17–18 or above on the somatic anxiety symptoms and scores of 22–23 on the cognitive anxiety symptoms variable, which would indicate clinical issues (van Dam et al., 2013). A study containing 330 students from a public university in the USA showed an average score for cognitive symptoms of anxiety of 15.18 and for somatic symptoms a score of 14.62. At the time of completing the questionnaires, rural residents with sheep in Sweden had experienced anxiety symptoms comparable to regular university student (in the USA).

Sheep owners on average reported a stronger indication of clinical exhaustion when compared to the other study participants. Sheep owners reported an average KEDS score of 22 (the cut-off for clinical levels are scores over 18.5 to 19, Besèr et al., 2014).

Sheep owners are more stressed than the other two groups in our study. They also perceive that LCs negatively affect them in a way and magnitude that is not reported in the other two groups. To what extent the stress is a direct or indirect result of the presence of LC is not possible to conclude from our data. There are many significant correlations and they may be intricate. One example a significant correlation is the distance between the sheep owners home and grazing areas. Long distances indicate that the nature in the area is not continuous fertile farmland, but instead the grazing opportunities are dispatched, thus making the distance to the sheep far. The distance causes the surveillance of the sheep harder, not only in relation to possible visits from LCs, but also in terms of other aspects such as sheep inside enclosures escaping, resulting in free ranging sheep grazing less nutritional plants, which reduces growth and thereby also profit.

One should take into account the fact that domestic animals have the potential of promoting wellbeing and life satisfaction in their owners, although perhaps not in the same way that pets such as dogs and cats do (see Hardie et al., 2023). Instead, sheep can bring life satisfaction through a feeling of making a contribution to the maintenance of an open landscape and the preservation of cultural expressions and self-sustainability (Eklund et al., 2019). If sheep are perceived as "more than livestock", for example as contributing to the neighboring society and bringing life satisfaction to neighbours and visitors, this could result in a complex exchange between health benefits and health costs since the sheep affect stress in different ways. Sheep owners may in that way increase the pressure they put on themselves to persist in their efforts to keep the sheep safe. In the present study, we found, in the free-text answers, that freedom was mentioned by sheep owner as the most positive contribution to their life quality with much higher frequency than by the other groups. Thus, there could be an intricate interaction between a feeling of freedom associated with living in a rural area, keeping sheep, thereby contributing to the cultural landscape and exhaustion.

Zahl-Thanem et al. (2020) showed that the more economically stable Norwegian sheep farmers were, the less prone they were to anxiety and depression. Swedish sheep farms are often comparably small. In Sweden, 83 % of sheep farmers have 1 to 49 sheep, while in Norway only 18 % of sheep farmers have 1 to 49 sheep. (Statistics Norway, 2024; The Swedish Board of Agriculture, 2024). Despite the fact that sheep farming in Sweden is more at a hobby level than industry as in Norway, economic aspects seem to be associated with stress independently of the number of sheep.

Landscape of stress: Our data suggest that sheep owners more than other livestock owners experience stress in their daily life. To what degree this is a result of sheep owners being more vulnerable to the "Landscape of stress" (Flykt et al., 2022) than other rural residents with or without livestock requires further attention in future studies. Our results indicate that it would be worthwhile to further consider how several perceived threats of different significance add up and accumulate stress rather than searching for one source of stress (Evans and Cohen, 2004). The sheep owners experienced a negative influence on life quality as a result of LCs, but this also coincided with a perceived negative effect brought on by other aspects associated with animal keeping, such as costs and rules and laws (, as well as more general aspects of rural living like long distances and high fuel costs that negatively influence life quality. In an interview study by Young et al. (2015) all 23 ranchers (from wolf areas in the west of USA) spoke about the need for policies for supporting their way of life and the economic problems. These findings could support the idea of an accumulation of daily life struggles resulting in higher average scoring on STICSA and KEDS among sheep owners. Although a large carnivore attack on sheep per se is an acute stressor, the presence of LCs seems rather to be the tip of an iceberg of the daily struggles sheep owners appear to face (Frank et al., 2023).

10. Conclusion

Initially we referred to The Convention on Biological Diversity (CBD,

2018) with its statement that sustainable wildlife management should consider the socioeconomic needs of human populations (p. 5) and safeguard human and environmental health. In this study it is clear that there is no single factor (the LCs per se) that seems to threaten life quality for sheep owners. Instead, a multitude of different related, as well as unrelated, aspects of rural living and animal keeping influence the life quality of sheep owners. We found support for our hypotheses 1–4 (Lower quality of life, More cognitive anxiety symptoms, More somatic anxiety symptoms, More exhaustion related symptoms) in sheep owners than in the other groups. However, the anxiety symptoms effects were caused by age and gender imbalance between the groups. The hypotheses 5 and 7, that Rules and laws for keeping livestock in general, and Costs related to keeping the livestock, are associated with ratings of quality of life and/or ratings of LC's effects on quality of life were supported. Thus, it seems insufficient to singularily consider the management of LCs to safeguard human health among sheep owners.

Study limitations: One limitation is that it is reasonable to believe that those answering the questionnaire are individuals that are most engaged in questions about rural living in general and those involved in issues associated with keeping sheep. However, this potential bias would probably not change the relations between the different groups in our sample. Moreover, it is also likely that those that would score higher on exhaustion would initially dismiss the questionnaire. Another possible limitation is that variables that could have an effect on life quality might been overlooked. We did try to overcome this potential issue by starting the questionnaire with open-ended questions concerning the strongest contribution to their life satisfaction, positively as well as negatively. However, it is possible that some aspects were not reported since they might not been viewed as the most important contribution by anyone of the participants.

CRediT authorship contribution statement

Anders Flykt: Writing – review & editing, Writing – original draft, Visualization, Project administration, Formal analysis, Data curation, Conceptualization. **Jens Frank:** Writing – review & editing, Conceptualization. **Maria Johansson:** Writing – review & editing, Writing – original draft, Conceptualization.

Declaration of competing interest

There is no known conflict of interests. This research has been supported by Formas grant 2019-000709.

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Data availability

Data will be made available on request.

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