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Title: Can agri-environmental schemes be designed to meet EU habitat restoration goals for semi-natural habitats? An interdisciplinary case study

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SUPPLEMENTARY METHODS

1. Finnish semi-natural meadows and pastures

In the late 19th century, when the area of pastures and meadows peaked in Finland, semi-natural grasslands and wooded pastures covered about 10% of the total land area (Lehtomaa et al. 2018). Additionally, a much larger area of forest was grazed (Lehtomaa et al. 2018). Currently, managed semi-natural meadows and pastures cover only about 0.1% of the study area (see Figure 1). A significant portion of the remaining habitats are located in flooded or wet areas or on Baltic Sea islands.

In the Finnish red data book of habitats, 42 nationally classified habitat types are considered at least partly semi-natural and needing or benefitting from moving or grazing. These habitat types are divides into 12 groups: heaths (3 types), dry grasslands on rocky substrate (2 types), dry grasslands on mineral soil (5 types), mesic grasslands (3 types), hydrophilous grasslands (3 types), coastal meadows of the Baltic Sea (6 types), lake and river shore meadows (5 types), alluvial meadows (6 types), fen or moor meadows (1 type), wooded meadows (1 type), wooded pastures (5 types including slash-and-burn areas) and forest pastures (3 types). Finnish forest pastures have generally closed canopy and an understory of common forests species but are defined by observable effect of grazing on field layer vegetation. (Lehtomaa et al. 2018).

These habitat types include following 12 directive habitat types: 1630 Boreal Baltic coastal meadows, 4030 European dry heaths, 6210 Seminatural dry grasslands and scrubland facies on calcareous substrates, 6230 Species-rich Nardus grasslands, 6270 Fennoscandian lowland species-rich dry to mesic grasslands, 6280 Nordic alvar and precambrian calcareous flatrocks, 6410 Molinia meadows, 6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels, 6450 Northern boreal alluvial meadows, 6510 Lowland hay meadows, 6530 Fennoscandian wooded meadows, 9070 Fennoscandian wooded pastures.

The dependency of different habitat types and areas on annual mowing and grazing varies. Coastal, alluvial, and riparian meadows, wetlands, as well as lithic and sandy areas, are kept open at least partly by natural conditions. Only a small fraction of the area is managed by mowing, most of the area is grazed with cattle or sheep.

2. Farming in Finland

Farming remains relatively small-scale in Finland, with over 80% of farms being family-run. The average utilized agricultural area is less than 60 hectares per farm, and only 25% of farmer families' total income comes from combined earned and capital income from agriculture (Statistics Finland, 2024). Currently, about 20% of farms are livestock farms (Natural Resources Institute Finland, 2024). The number of farms, particularly livestock farms, has been declining, a trend likely to continue as nearly 20% of farmers are over 65 years old.

Approximately two-thirds of Finnish farms' total return comes from selling products, with one-third from subsidies, mostly area-based (EUR/ha) (Natural Resources Institute Finland, 2025). For some farmers, the proportion of return from area-based subsidies can be much higher.

Individual farmers vary significantly in how important farming income is for them and how much of their income comes from BLCs. Some farmers base their farming strategy and income on livestock grazing on semi-natural areas (mostly rented land and protected areas), some are full-time farmers with intensive farmland production (many dairy farmers), and others derive most of their income from non-farming sources.

Grazing is the predominant management method on almost all sites, but its economic role for the farmer and the livestock used also vary. A variety of native and foreign traditional sheep and cattle

breeds are commonly used, as they tolerate low-quality forage, but many sites are also grazed by improved commercial breeds or by hobby animals such as horses. Dairy farmers typically use only a portion of their herds on these sites, because fodder quality is often inadequate, locations are remote, or conditions are too harsh for dairy cows.

Finnish authorities and organizations involved in BLCs

The regional governmental authorities involved in BLCs are the Centres for Economic Development, Transport and the Environment (ELY Centres) and Metsähallitus. ELY Centres are regional government agencies in Finland responsible for various development and implementation tasks. Regarding AES, ELY Centres have two main responsibilities: 1) processing agricultural subsidy applications and monitoring the proper use of these subsidies, and 2) nature conservation. These responsibilities are internally divided into ELY-E and ELY-Y.

Metsähallitus is a state-owned enterprise that manages state-owned land, including protected areas and some privately owned protected areas. A significant proportion of the area currently under BLCs is state-owned, and Metsähallitus has leased these areas to farmers.

ELY Centres and Metsähallitus implement the policies and strategies set by the Ministry of the Environment and the Ministry of Agriculture and Forestry. Under the Ministry of Agriculture and Forestry operates the Finnish Food Authority, which is responsible for monitoring the implementation of EU and national grants, including farm subsidies.

Farmers can use advisory services provided by private organizations to make the obligatory management plan.

3. Farming subsidies eligible for agricultural semi-natural habitats

Agri-environmental scheme compensations for BLCs

Finnish farmers can commit to the BLC if they manage a site considered as 1) “high value traditional agricultural biotope” (HVTAB), 2) “traditional agricultural biotope” (TAB), or 3) “natural pasture” (NP) (Finnish Food Authority, 2022a, 2024a). NPs are for sites that do not qualify as TABs in their current condition. HVTABs and TABs include, but are not limited to, directive habitat types needing or benefiting from management.

In the CAP 2014-2022 period areas could be approved to BLC by means of a declaration of the area without site visits and ineligible areas could be defined in different ways (Ministry of agriculture and forestry of Finland, 2023). There can be some controversy between ELY-Y and ELY-E because of viewpoints and guidelines. In the STAL (ELY-Y) the interpretation is wider, and the STAL-guide, among other things, steer towards more attractive entity large areas (Kemppainen, 2017). In monitoring (ELY-E), for example, a commercial forest or unmanaged area (even if it is semi-natural meadows or pastures) cannot be included in the contract, as the payment is based on the area under management (Finnish Food Authority, 2022a, 2024a). Also, ELY-E authorities have monitoring by European commission’s certification bodies (European Commission, 2025).

The general management requirements for the different area types are the same, but the payment is two-tiered depending on the value of the area (evaluated in STAL). During the survey, the yearly payment for TABs and NPs was 450 EUR/ha, and for HVTAB 600 EUR/ha (currently 460 EUR/ha and 610 EUR/ha, respectively) (Finnish Food Authority, 2022a, 2024a).

Site management must follow a detailed management plan from the farmer, approved by ELY-E.

The management plan should implement the general contract terms:

For full compensation the area must be either mowed or grazed every year.

Mowed plant material should be removed from the parcel.

Grazing animals must not have access to fields or improved pastures, and they must not be provided with supplementary fodder. Grazing can be continuous (the growing season is around 120 days) or rotational. The stocking density should match the productivity of the specific pasture, varying depending on the length of the grazing period and the pasture's productivity. On some habitat types, the productivity can be very low. For example, a forest pasture suitable for one horse for 120 days could be as large as 2-20 hectares.

Some clearing of trees or shrubs is needed in many areas to prevent overgrowth and afforestation; however, intensive commercial forestry is prohibited. On leased areas and protected areas, the BLC holder may not have the right to cut trees. (Finnish Food Authority, 2022a, 2024a).

On state owned areas there can be additional requirements for management not related to the general BLC terms. The lease agreement of Metsähallitus outlines the tasks, responsibilities, and obligations for site management and serves as the guiding document for the preparation of the management plan. The agreement may be attached with a broader management plan or detailed management guidelines from Metsähallitus that must be followed.

Agricultural subsidies related to permanent grasslands

“Permanent grassland” is an agricultural subsidies concept referring to agricultural area used for growing grasses and/or herbaceous forage naturally (self-seeded) or cultivated (sown) and that hasn’t been included in the crop rotation of the farm at least five years (EU 2017/2393, 3 article 1 h). In Finland PGL area can’t grow any shrubs, but it can be sparsely wooded.

If a parcel under BLC qualifies as agricultural land and permanent grassland, it is eligible for several agricultural subsidies (Finnish Food Authority, 2022b). During Rural Development Programme for Mainland Finland 2014–2020 (CAP 2014-2022) these were the basic support, the greening payments, the support for young farmers, the natural constraint payment and the natural constraint payment to livestock farm (Finnish Food Authority, 2022b).

The payments are granted on the basis of the surface area of the farm or the livestock held by the farmer, provided that the eligibility criteria are fulfilled (Ministry of agriculture and forestry of Finland, 2025). The basic eligibility criteria include cross compliance and fulfilling the criteria active farmer (Ministry of agriculture and forestry of Finland, 2025). The total of payments related to PGLs can be over 500 EUR/ha (see Section 7.).

Monitoring and sanctions of BLCs and PGLs during CAP 2014-2022

During CAP 2014-2022 BLC related subsidies were monitored through on-the-spot checks and administrative audit.

Administrative audit consist of “administrative control” of the information contained in the subsidy application and automated cross-checks of information systems (Finnish Food Authority, 2024c). All BLCs (and PGL under BLC) were subject to an administrative audit. When applying the contract at the ELY Centre, among other things, the control of the area and the compulsory annexes to the application are checked. In the cross-checking the delimitation of the parcels is regularly checked using the latest aerial photographs and corrected if necessary (Finnish Food Authority, 2024c). In this case the cross-checks are related only to PGL. The cross-check compares the declared area of the parcel from the aerial photographs (mainly agricultural land) with the delimited area of the parcel and is carried out for all parcels in the aerial photograph area (Finnish Food Authority, 2024c). Small corrections are made automatically, but larger differences are dealt with by the ELY Centres (Finnish Food Authority, 2024c). The check is made twice a year and may lead to boundary corrections, field visits or the identification of overlapping parcels (Finnish Food Authority, 2024c).

In the CAP 2014-2022, at least 5% of farms applying for agricultural subsidies were monitored with on-the-spot checks (i.e., "whole farm checks") (Hentu et al., 2017). However, during the Covid-19 pandemic (2020-2022), the sample for on-the-spot checks was reduced to 3% (Finnish Government, 2020). On-the-spot checks include field inspections to verify all field subsidies applied for by the farm, as well as documentary checks (Finnish Food Authority, 2022c, 2024b).

Farms are selected for monitoring both randomly and based on weighted sampling (Finnish Food Authority, 2022c, 2024b). In weighted sampling, emphasis is placed on characteristics or attributes that have been common among premises previously subject to penalties, increasing their probability of being selected (Finnish Food Authority, 2022c, 2024b).

For minor breaches, there were no financial penalties; farmers either received a notice or had their payments reduced in proportion to the undone work. Severe breaches resulted in additional payment reductions, contract termination, and potential costs for the farmers.

The subsidy may be sanctioned if the area declared in the application exceeds the area accepted for monitoring, or if the conditions of the subsidy or cross compliance are not complied (Finnish Food Authority, 2022c). The payment may be decreased or not paid (Finnish Food Authority, 2022a). The amount of the reduction depends on the severity, extent, duration and repetition of the non-compliance (CAP-strategic plan 2014-2020).

On-the-spot checks are based on the inspector's assessment with the guidelines (Finnish Food Authority, 2022c). On-the-spot checks of measures under the terms of the contract and the management plan (specifying site-specific management measures).

The following are simple examples of four possible cases for a ten-hectare TAB-area under BLC:

1) Unmanaged Area: If the entire area is unmanaged and none of the required measures have been taken, no payment will be made for that year, and there will be a financial sanction affecting future payments.
2) Partially Managed Area: If 6 hectares are managed (4 hectares unmanaged), no payment will be made for that year, but there will be no additional financial sanction.
3) Mostly Managed Area: If 9 hectares are managed (1 hectare unmanaged), the original payment will be reduced, but there will be no additional financial sanction.
4) Minor Issues: If there are only minor issues, such as an incomplete management log, the penalty could be a notice.

The PGL areas may also be eligible for other payments, which means that any sanctions apply to them too. In addition, in the PGL area must comply with cross compliance requirements, and failure to do so may affect all payments due to the farm (including other agriculture subsidies).

Eligibility evaluation, monitoring and sanctions during CAP 2023-2027

During CAP 2023-2027, all parcels applied for BLCs will be subject to an administrative visit, i.e. a site visit (Law 1333/2022 5 §, Law 1334/2022 20 §). The site visit is not a monitoring. This may affect the economic viability of the study site, in particular through the site visit and any resulting area changes (Ministry of agriculture and forestry of Finland, 2023). If the eligible area decreases but costs remain unchanged or increase, the management of the site may become economically unviable.

The administrative audit will continue as before ("administrative control" and cross-checks), but only 2% of farms will be controlled on-the-spot checks (Finnish Food Authority, 2023a).

On-the-spot checks have been reduced because technical advancement. Automatic satellite monitoring is a new, mandatory (European Commission, 2025) way of monitoring compliance with certain payments conditions and a way of checking agricultural land requirements (Finnish Food Authority 2023b). The satellite monitoring applies only to agricultural land, i.e. PGL under BLC.

The satellite monitoring replaces traditional monitoring methods but cannot check area (Finnish Food Authority 2023b). It monitors the cultivation of agricultural land, the implementation of management measures and compliance with payment conditions (Finnish Food Authority 2023b). This may mean that areas of PGL will be monitored more closely, while BLC areas will be subject to fewer monitoring on BLC conditions as on-the-spot checks will be reduced.

In addition, during the CAP 2023-2027 will be subject to a parcel quality assessment, which is an EU Member State's way of monitoring the functioning and reliability of the support system. The European Commission selects the target parcels, which may be agricultural area or land outside agricultural area, such as BLC areas. As the quality assessment is not an actual monitoring, possible negligence, the applicant will be asked to amend his application, thus avoiding penalties. In practice, it is difficult to change BLC areas in the middle of a BLC period.

The procedure and basis of sanctions will continue as same as in CAP 2014-2022 period (Finnish Food Authority, 2022c, 2024b). The sanction system has been simplified and clarified to the CAP 2023-2027 period. If the whole area (or over half area) were unmanaged, the sanction would be applied in the same way as before. But the “intermediate” cases could lead to different sanctions between these two periods. Financial penalties may be less severe in these cases in CAP 2023-2027 period than before.

4. Survey among authorities and experts

The survey was carried out during a weekly web meeting for authorities and experts working with the STAL and BLCs. Responses were collected via the Webropol survey platform (https://webropol.co.uk/).

The survey consisted of four parts:

1. Knowledge test used in the BLC holder survey (see section 6.).

2. Self-assessment of expertise on STAL, BLC terms, and appropriate management of areas for habitats, plants, and insects.

   Please assess your knowledge and experience regarding the subject (scale 1-3):
   - *i. I do not know how grazing pressure and mowing effectiveness are assessed in STAL – I have trained surveyors to assess grazing pressure and mowing effectiveness on sites.*
   - *ii. I am not familiar with the BLC requirements concerning grazing pressure and mowing effectiveness – I have supervised or advised the implementation of BLC requirements on grazing and mowing, or I have been trained in this topic.*
   - *iii. I do not know how to assess what kind of grazing or mowing would be best for insect species – I have assessed grazing and mowing from the perspective of insects.*
   - *iv. I do not know how to assess what kind of grazing or mowing would be best for plant species – I have assessed grazing and mowing from the perspective of plants.*

3. Multiple-choice questions on the estimation of grazing and mowing intensity.
4. Interpretation of the appropriateness of grazing and mowing intensity for the contract terms, habitat types, and plant and insect species in 11 example cases presented with photographs (see Supplementary results for examples and the article for the results).

Responses from 21/26 participants used in the study based on their self-assessed expertise.

Example cases were presented with photographs and additional information, such as the management method and the date of the photograph (see Supplementary results). The similarities and differences in evaluations of mowing and grazing intensity were compared between the BLC terms and the ecological needs of the habitats, as well as between the ecological needs of the habitats and insects. The total number of evaluations used was 231 (21 participants x 11 cases).

5. Sampling of BLC holders and study sites

The sampling of BLC holders and study sites was based on comprehensive polygon data on BLCs in Mainland Finland, along with the contact information of BLC holders provided by the Finnish Food Authority to the Finnish Environmental Institute Syke for the study. To ensure confidentiality, all farmer responses were anonymized before analysis.

We found that the managed area is distributed very unevenly among individual BLC holders: less than 10% of managers are responsible for over 50% of the total managed area, while half of the contract holders manage less than 5 hectares each. Therefore, a random sample of BLC holders would have included only a few large-scale managers, while an area-based random sample would have included only a few small-scale managers. To ensure adequate representation of these different groups, stratified sampling was used.

The BLC holders were divided into four strata based on their total management area in 2021: less than 5 hectares, 5 to <20 hectares, 20 to <40 hectares, and at least 40 hectares (see Table S1). Individuals were then randomly selected from each stratum for potential study site screening. The BLC sites of these individuals were evaluated against the following criteria: i) STAL data from the site must have been collected during the CAP periods 2014-2022, ii) the sites must have been managed by grazing or mowing (some older BLC areas did not require grazing or mowing), and iii) a specific study site can be delimited and described based on its location, characteristics, and management. If a contract holder had multiple suitable sites, the study site was selected randomly.

Fig. S1. Study area and locations of the study sites. The study area covers most of Mainland Finland, primarily within the boreal zone, excluding the autonomous Åland Islands and the region of North Karelia. Åland is excluded due to a lack of ecological survey data, and North Karelia is excluded due to the interviewer's connections to local ELY Centre and farmers.

	Groups; according to their total BLC area				All
	Less than 5 ha	5 to <20 ha	20 to <40 ha	at least 40 ha	
Total area managed by the group ha (in 2021)	2 840	7 787	5 199	1 6508	32 338
BLC holders n (in 2021)	1 218	791	187	168	2 364
BLC holders screened for suitable sites	284	145	124	110	663
Approved in the sample and called	51	56	37	59	203*
Final sample n: approved respondents	22	32	24	30	108**
Rate of approved responses %	43.1	57.1	64.9	50.8	53.2
Total BLC area	64.4	331.4	714.3	4311.8	5421.9
% of total area managed by the group	2.3	4.4	13.7	26.1	16.8

Table S1. Groups and sampling. *Out of the sample of 203 people, 22 did not answer the calls. **Out of those reached by phone 113 were willing to participate in the study but 5 were excluded from the final sample (see text).

The main reasons for rejection were the lack of recent or complete STAL data, other management methods, incorrect contact information, difficulty in defining a separate study site, or the site's location in Northern Karelia.

Approximately 28% of all BLC holders during the previous CAP periods 2014-2020 and the following transitional phase (2021-2022) (a total of 2,364 managers in 2021) were screened for suitable study sites, and about 10% were approved for the study. Of those persons reached by phone, 113 were willing to participate in the study, but 5 respondents were excluded from the analysis because they were not the person in charge of the management or did not complete the survey.

The number of respondents accepted into the final sample (n=108, see fig. S1) corresponds to less than 5% of all contract holders, but their BLC area represents almost 17% of the total BLC area. Thus, although the sample size is small, it represents a significant proportion of the most relevant Finnish BLC holders. The response rate of groups varied between 43-65%.

6. Questionnaire for BLC holders

Background questions

- Year of birth
- Highest level of education
- What proportion of your household income comes from agriculture? (A small part/Less than half but a significant part/More than half/All or nearly all)
- What proportion of your household income comes from forestry? (A small part/Less than half but a significant part/More than half/All or nearly all)

- Do you have or have you applied for BLC? (Hectares)
- What is the total BLC area on your own land? (Hectares)
- Have you already received a contract decision? (Yes/No)

Knowledge test

The knowledge claims were formulated based on information materials available for managers and consisted of claims on basic management principles according to contract guidelines and habitat ecology. Such words and expressions with connotations helping select the correct response option were avoided in the claims. For example, claim: "Eutrophication is a bad thing" would be too obviously true because the word eutrophication has a strongly negative connotation. Some claims could, instead, point in the wrong direction. For example, the sixth claim: "Dead trees spoil the landscape and should therefore be removed", is not true what comes to the correct management of the sites although some might think that dead trees are ugly. We presumed that knowledge scores should be connected to either intrinsic or extrinsic motivations for goal alignment.

The set of claims presented:

1. The best management method for all meadows would be continuous grazing from the start of the growing season until autumn, whenever possible. (false)
2. The insect species of meadows would benefit if the entire meadow is not grazed or mowed at once. (true)
3. Spruce saplings should be cleared from traditional agricultural semi-natural habitats even though they provide important cover for game animals. (true)
4. Dry meadows should be allowed to become shrubby because they are otherwise too sun-exposed. (false)
5. Litter from mowing and clearing protects and nourishes the soil and should therefore be left in the less productive parts of traditional agricultural semi-natural habitats. (false)
6. Dead trees spoil the landscape and should therefore be removed. (false)
7. Grazing should not alter the undergrowth of forest pastures. (false)
8. Many plant species of traditional agricultural semi-natural habitats suffer if grass and herb vegetation is tall. (true)
9. The trees in forest pastures should be thinned evenly as it increases both light and tree growth. (false)
10. Increasing soil fertility is not a bad thing because it helps the plants of traditional agricultural habitats withstand grazing and mowing. (false)

Questions concerning the study site and its management

- Are you continuing the BLC for this area in the current support period? (Will be continued/Will likely be continued/Will likely not be continued/Will not be continued)

- Do you think the ELY Centre will reduce the eligible area of the BLC for this area compared to the previous support period? (Will remain the same/May reduce a little/May reduce significantly/I have not thought about it)
- How likely is it that you or the next generation of the farm will renew the BLC for this area in the next support period? (Very likely/Quite likely/Quite unlikely/Very unlikely)

- Is this area in your own ownership? (Entirely or mostly/Entirely or mostly leased from private landowners/Entirely or mostly leased from the state)

- If the area is managed by grazing, do you use production animals or hobby animals?
- Species and breeds used
- Do you own the grazing animals?
- Does your livestock depend on semi-natural habitats? (Yes, entirely or almost entirely/Only partially/No)

- Who/which entity has made the management plan for this area?

Likert Statements, Likert scale: agree, somewhat agree, neither agree nor disagree, somewhat disagree, disagree

1. I have invested a significant amount of capital to enable the management of this area.
2. Most of the costs of the management of this site have been compensated.
3. It is likely that we will not renew the BLC for this site because grazing animals are no longer available.
4. It is likely that we will not renew the BLC for this site because the ownership of the area changes or it is taken for other use.
5. It is likely that we will not renew the BLC for this site because it is not economically viable due to the reduction of eligible area.
6. It is likely that we will not renew the BLC for this site because it is not economically viable even if the compensation remains the same.
7. It is likely that we will not renew the BLC for this site because managing the area is too laborious.
8. It is likely that we will not renew the BLC for this site because the terms of the contract are too strict.
9. It is likely that we will not renew the BLC for this site because the management plan or lease agreement is too demanding.
10. It is likely that we will not renew the BLC for this site because protecting grazing animals from predators is too difficult or expensive.
11. It is likely that we will not renew the BLC for this site because people living or moving nearby cause problems.
12. I have other future uses for this area besides preserving the traditional semi-natural habitat.
13. I have obtained useful wood from this area for domestic use or sale during the previous contract period.
14. The BLC for this area has caused me a significant forestry income reduction during the previous contract period.
15. Continuing the BLC for this area would cause me significant forestry losses in the future.
16. One of the main reasons I have managed this area is that I have obtained significant fodder for my livestock from the area.
17. One of the main reasons I have managed this area is that it has enabled me to maintain a larger number of livestock.
18. One of the main reasons I have managed this area is that I have received compensation from the BLC for the area.

19. The BLC compensation for this area was relatively good during the previous support period.
20. I would stop managing this area if there was no BLC compensation.
21. One of the main reasons I have managed this site is that it is a beautiful place.
22. One of the main reasons I have managed this area is that I want to preserve or restore its traditional landscape.
23. One of the main reasons I have managed this area is that I feel personally responsible for the area.
24. One of the main reasons I have managed this area is that this place is very close and dear to me.
25. One of the main reasons I have managed this area is that I want to preserve it as I remember it from my childhood.
26. One of the main reasons I have managed this area is that I want to protect endangered species.
27. One of the main reasons I have managed this area is that I want to preserve its nature.
28. One of the main reasons I have managed this area is that I want to preserve the traditional semi-natural habitat it contains.
29. I have managed this area because it is important to my family or other close people.
30. My family or other close people do not understand why I have managed this area.
31. I have managed this area because farmers consider the management of traditional semi-natural habitats important.
32. Other farmers consider the management of traditional semi-natural habitats to be a pointless activity.
33. I have managed this area because I have received praise from people living or moving nearby.
34. People living or moving nearby have opposed the management measures or the keeping of grazing animals in this area.
35. I have managed this area because authorities or experts have requested it.
36. I have wanted to manage this area regardless of whether it is considered a valuable traditional semi-natural habitat by authorities.
37. I think it is unnecessary for the ELY Centre to assess the adequacy of management measures in all BLC areas.
38. I think all managers should follow the terms of BLC even if they do not always seem necessary.
39. Management plans for traditional semi-natural habitats should be drawn up according to the species of the area, even if it increases the manager's workload.
40. I have been satisfied with the management measures required for my contract sites.
41. I have actively sought information on the management of traditional semi-natural habitats.
42. I have not been very interested in the insect species of my contract sites.
43. I would like experts to monitor the plant and animal species of my contract sites so that I can get more information about them.
44. I would like experts to monitor the effects of the management of my contract sites so that I can get more information about it.

7. About used variables

Data on semi-natural habitats

Information on the distribution, habitat types and condition of seminatural meadows and pastures in Mainland Finland is collected in the Survey of Traditional Agricultural Landscapes (STAL). STAL follows a standardized information protocol and is carried out by trained personnel of ELY Centres and Metsähallitus or private consultants (Kemppainen, 2017; Forss, 2024). The first survey was conducted in the 1990s. The dataset is owned by Finnish environmental administration.

Data for BLCs, PGLs and farms animals

Data on BLC and PGL parcels and farm animals were drawn from the Farm Subsidy Database provided by the Finnish Food Authority to the Finnish Environmental Institute Syke for the study.

Estimation of payment connected to PGLs

The PGL related payment used in regression analysis were estimates based on the average values for the CAP 2014-2022 (payments can vary slightly from year to year).

Finland is divided into two support areas: the southern AB and the northern C, due to differences in cultivation conditions (e.g. Finnish government decree 5/2015). The amounts of support vary slightly between support areas, for example during CAP 2014-2022 natural constraint payment in AB-area were 217 EUR/ha and in the C-area 242 EUR/ha. On the other hand, basic income support was slightly higher in the AB-area: 122.18 EUR/ha, when C-area: 107.18 EUR/ha (average payments CAP 2014-2022). If all the criteria and conditions for PGL payments are fulfilled and the payments are added together, the average amount of payments in the C-area is about 0.2 EUR/ha higher than in the AB-area (calculated based on CAP 2014-2022 average payments).

The PGL payments mainly benefit active farmers. For example, if a farmer only applies for aid for 1 ha of BLC area, which is PGL, with the natural constraint payment (Only NCP) feature, he is only entitled to the BLC payment. On the other hand, a farmer with, for example, 7 ha of additional eligible agricultural area can also receive other payments for the same area. Thus, for the same example area in C-area, the payment differentials could be a minimum of 450 EUR/ha (TAB payment only) or a maximum of 983.54 EUR/ha (TAB payment plus all PGL payments).

The overall estimate of the amount of PGL payment is most affected by the natural constraint payment (Only NCP area), as it has the highest compensation among the PGL payments (217 or 242 EUR/ha) (Finnish Food Authority 2022b). The "Only NCP" feature was assigned in 2014 to specifically defined areas (e.g. Finnish government decree 236/2015). The designation is a feature of the parcel, and the area cannot be increased (e.g. Finnish government decree 236/2015).

This study included both livestock farms and farms with either animals for rent or with few animals of their own in relation to the eligible area. Whether a farm owns animals can affect the level of payment. The natural constraint payment to livestock farm (60 EUR/ha during the CAP 2014-2022) is reflected in a higher amount of payment for livestock holdings. The more eligibility land, the more livestock units were needed to qualify for the increase (e.g. Finnish government decree 45/2015). Just one suckler cow and 1 ha of agricultural area was sufficient to qualify for the payment. On the other hand, a farm with 50 ha of agricultural area needed at least 17.5 livestock units.

The estimated payment was calculated as follows.

The average payment of basic support was 122.19 EUR/ha in the AB-area, 107.18 EUR/ha in the C-area. The average payment was multiplied by the study sites PGL area. Unless, if farm eligible area was so low that payment falls under 100 euros, the payment was reset to zero.

The average payment of greening payment was 74.78 EUR/ha (AB-area), 65.02 EUR/ha (C-area). The average payment was multiplied by the study sites PGL area. Unless if farm eligible area was so low that payment falls under 100 euros, the payment was reset to zero.

Support for young farmers were average 59.34 EUR/ha in both areas. If manager were less than 40 years old, the average payment was multiplied by the study sites PGL area. The support can be paid up to 90 hectares, but in this study there were no study sites with more than 90 hectares of PGL.

Natural constraint payment is not only related to the PGL area, but mainly to the "Only NCP" area. The "Only NCP" area was multiplied by 217 EUR/ha (AB-area) or 242 EUR/ha (C-area). Unless, if difference between study site PGL area and “Only NCP” were negative, then the difference is taken into account. The “Only NCP” area cannot be larger than the PGL area. Also, this payment requires over 5 ha (in island-area 3 ha) eligible area by farm. If farm estimated eligible agricultural area were under 5 ha, the payment was reset to zero, because a parcel may have "NCP only" label without compensation.

If farm has animals, then farm may get “natural constraint payment to livestock farm”. This payment is related to natural constraint payment (see above), because of many same terms (e.g. 5 ha eligible agricultural area). The payment was every year 60 EUR/ha in both areas. When farm animal unit amount divided by farm estimated eligible agricultural area and the result was estimated farm animal unit. If farm animal unit was over 0.35 animal unit per hectare, then “Only NCP” area was multiplied by 60 EUR/ha (and possible negative difference between “Only NCP” and PGL areas were taken account).

Abiotic and biotic properties of study sites

Because abiotic and biotic factors could be connected to the need of higher management intensity (Tälle et al., 2018) or more demanding conditions for management, we tested the effect of conditions most likely relevant for our study sites: conditions connected to natural grasslands versus forests and forest succession habitats. Conditions connected to natural grasslands are flooding/wetness or shallow/coarse soil.

Open wetlands were defined according to SYKE’s open data: Land Cover on Wetlands. This *data describes the scope and coverage of peatbogs and wetlands (incl. reed beds). Delineation of these areas was made using Topographic Database (TDB) and Flood hazard zones (sea floods with frequency rate of 1/2a). Tree cover density was calculated with laser scanning data and Multisource National Forest Inventory (MS-NFI). Delineation of reed beds in water was made using IMAGE2017 (Sentinel 2 a+b 2017, partly 2016).* https://www.syke.fi/en-US/Open_information

Soil type, like areas of clay soil, were defined according to Geological Survey of Finland GTK’s soil database information on superficial deposits available at: https://www.avoindata.fi/data/en_GB/dataset/maapera-1-200-000-maalajit1

Finer scale outcrops and sandy areas were defined from topographic maps produced by the National Land Survey of Finland available at: https://www.maanmittauslaitos.fi/en/maps-and-spatial-data/datasets-and-interfaces/product-descriptions/topographic-database

Canopy cover was examined from recent aerial photographs, available for example at: https://earth.google.com/web

Protected areas and state-owned lands

The management goals and original conditions of protected areas often differ from those of other regions. For instance, protected areas may not be influenced by modern agriculture, and their forests are not used for forestry. These differences can impact activities such as mowing and grazing, as well as the suitability of various management regimes. To assess the potential effect of protection, we used a dichotomous category: fully protected (>90% of the area) versus not fully protected

In Finland, many protected areas are privately owned. Therefore, we separately tested whether state ownership and the involvement of Metsähallitus would influence management practices. Metsähallitus can provide guidance for proper area management, and the reputation of managers may affect their ability to renew leases or expand their BLC area. Some state-owned lands are profitable for farmers and are highly sought after, potentially reducing the likelihood of any single farmer holding a geographical monopoly. The potential effect of state ownership was tested using the dichotomous category: fully state-owned (>90%) versus not fully state-owned.

Data on Finnish protected areas on both private and state-owned lands and state-owned sites reserved for protection is available at SYKE's downloadable spatial datasets: https://www.syke.fi/en-US/Open_information/Spatial_datasets/Downloadable_spatial_dataset

Dairy cattle managers

We considered farmers utilizing industrial dairy breeds (Ayrshire and Holstein Friesian) as a relevant group due to the challenges of reconciling industrial dairy farming processes with habitat management needs. Most semi-natural pastures are unsuitable for dairy cows and suboptimal for fast-growing young animals. From a production standpoint, pregnant heifers are the most suitable group for grazing (Matosenaho 2022), but, without prior grazing experience and the presence of older animals to guide them, these heifers may not be effective grazers.

Sum variables for reliability analyses

Items related to information receptiveness included following statements: “I have actively sought information…”, “I have not been very interested in…”, and “I would like experts to monitor…”. We presumed that these items could be connected to either intrinsic or extrinsic motivations for goal alignment.

Items expressing the risk of abandoning management began with the phrase: “It is likely that we will not renew the contract for this site because…”. The reasons provided included: “it is not economically viable”, “it is too laborious”, “the contract terms are too strict”, and “the management plan or lease agreement is too demanding”. We presumed that these items might be connected to lack of intrinsic and/or extrinsic motivations for goal alignment.

SUPPLEMENTARY RESULTS

1. Evaluations of grazing and mowing intensity by expert authorities

On most example cases presented, respondents gave a mixture of the four possible STAL class options for management intensity; the only classes that were not overlapping with each other were the classes of too high and too low intensity. On average the most popular evaluate option were selected by 66% of respondents.

Following examples (Fig. S2-S5.) are presented with the of mean evaluations for the need to alter management intensity. Values >0 indicate the level of consensus for the need to increase the mowing or grazing intensity and values <0 the level of consensus for the need to decrease the intensity. If all respondents would have agreed for the need to increase the management intensity the mean value would be 1; if all respondents would have agreed for the need to decrease the management intensity the mean value would be -1.

Fig. S2. Example case with high similarity between the evaluations for BLC terms (mean 0.05) and needs of the habitats (mean 0.00) and insects (mean -0.14): management is appropriate from all perspectives. BLC area behind the fence is managed by grazing.

Fig. S3. Example case with high similarity between the evaluations for BLC terms (0.90) and needs of the habitat (0.86): management intensity is too low for them but appropriate for insects (0.14). 80% of the BLC area is moved in the first half of September, 20% of the area is still not managed.

Fig. S4. Example case with significant differences between all evaluations: the management is appropriate for BLC terms (0.05), but part of the respondent would decrease it for the habitat (-0.38), and most respondents for insects (-0.76). The BLC area is mowed at the start of July.

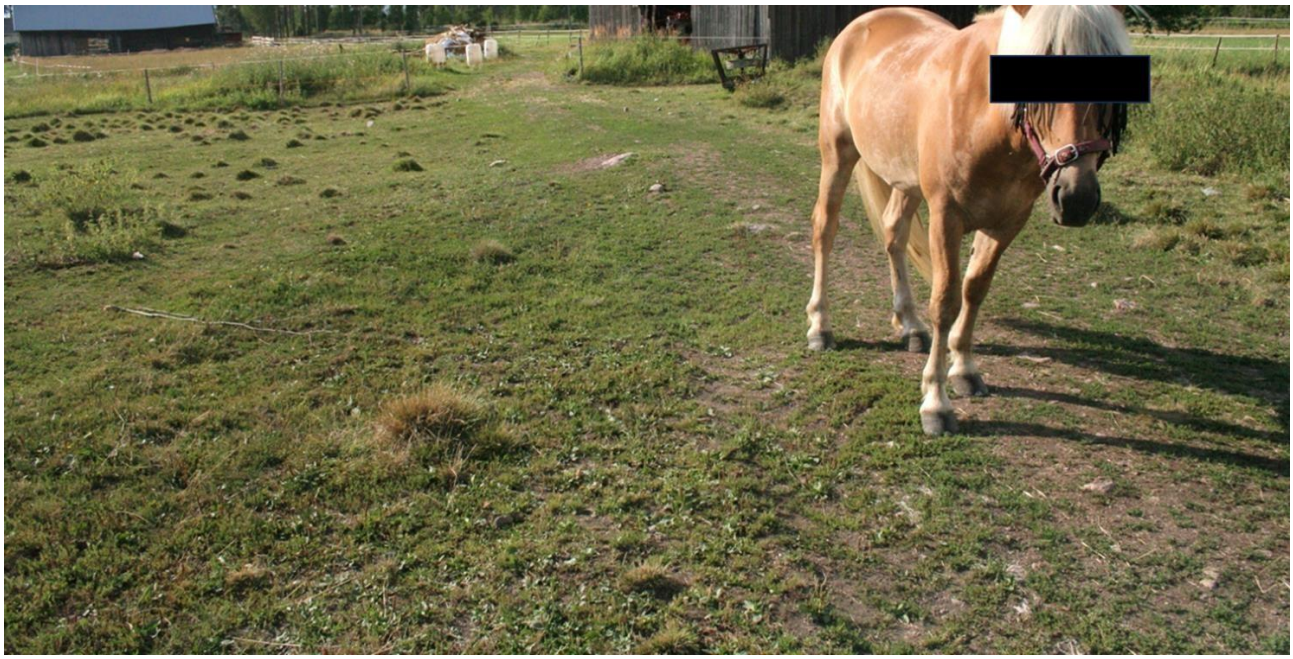


Fig. S5. Example case with significant differences between evaluations for BLC terms and ecological needs: most respondents considered the management still appropriate for BLC terms (-0.29), while thinking there is need to decrease the intensity for habitat (-0.76) and for insects (-0.90).

2. Characteristics of BLC sites and contract holders in the sample

Agricultural income was important for most of the respondents: it was the main source for the household income for 45.4 % of the respondents while only 15.7% said that only small part of household incomes comes from agriculture. Out of the respondents 18.5% were 65 years or older, oldest respondents being 80 years.

The estimated median payment for the study sites (BLC payment + subsidies related to PGL) for hectare was 600 EUR/year (mean 640; min 450; max 1 074; STD 204.4). The estimated median total payment for study site was 3447 EUR/year (mean 12 187, min 288.00, max 301 151, SD 32 030).

Less than 5% of study sites and 0,2% of the total area was managed by mowing and not grazed. Large scale managers use sheep, national or foreign traditional cattle breeds or beef cattle. Only 14% of study sites and 12% of the total area was managed by grazing them with industrial dairy cattle breeds.

Out of the 108 study sites 60 sites were either completely or mainly owned by the contract holder and 48 sites were owned by the state or by other private owners; 65 sites were fully or partially protected or reserved for protection and 43 sites were totally unprotected.

Out of the respondents 35 managed some state-owned area, but only in 13 cases the study site was state owned. These 13 respondents had significantly more BLC area but still owned less area than other respondents**.** The mean for their total BLC area was 97,6 ha while the mean for other respondents was 43.7 ha, (Mann-Whitney U = 956.0, z = 3.196, p = 0.001). The mean for their leased BLC area was 90.87 ha while the mean for other respondents was 28.4 ha. (Mann-Whitney U = 995.0, z = 3.701, p = 0.000). The mean for their owned area was 6,8 ha while the for others was 10.1 ha (Mann-Whitney U = 352.5, z = -2.519, p = 0.012).

The study sites owned by state was larger and the payments higher than for other study sites. The mean for study sites owned by state was 25,8 ha and for others 15,0 ha ((Mann-Whitney U = 884.0, z = 2.516, p = 0.012). The mean of total payments (BLC payment + subsidies related to PGL) was 19 309 EUR/year for state owned study sites and for others 11 294 EUR/year for other study sites (Mann-Whitney U = 882.0, z = 2.497, p = 0.013). State-owned study sites had somewhat different environmental conditions than other study sites: for example, the mean proportion of outcrop (exposed bedrock) was 7% while in other study sites it was only 0.5% ((Mann-Whitney U =700.5 z = 2.395, p = 0.017).

Respondents who managed some protected areas were more frequently dependent on semi-natural habitats for their livestock keeping (Chi-Square = 4.662, p = 0.031).

3. Knowledge scores for BLC holders

Many managers failed to separate true from false claims or disagreed with the formal ecological knowledge and contract terms: 34% of respondents got less than 1 test point from the maximal 10 point when incorrect answers were penalized. As the correct answer for 7 out of 10 claims was ‘the claim is false’, to select the correct answer, respondents would have to disagree with the items. Thus. the low scores indicate presence of a phenomenon called "Acquiescence": the tendency to respond to items with agreement/affirmation independent of their content.

The low mean knowledge score was in line with the responses to the statement regarding active information seeking, but the correlation between individual responses to the item and knowledge scores was only weakly positive (Pearson 0.284, p = 0.003). Reliability analysis showed internal consistency in BLC holders’ responses for the first and last five fact claims (Cronbach's Alpha 0.602). Also, some BLC holders got high scores, which indicates that the test somewhat successfully captured differences in knowledge levels between the BLC holders.

Knowledge scores did not differ between respondents who managed private but not state-owned protected areas (n =18) and respondents that managed state owned protected areas (n =35) (Mann–Whitney U 321.5, z = 0.123, p = 0.902).

4. Management quality, habitat condition and their connection to BLC payment during CAP 2023-2027

The area eligible of higher payment (HVTAB) were updated for the 2023–2027 CAP period based on STAL data. The correlation between the former area and updated area on study sites was only 0,683, indicating significant changes between CAP 2014-2022 periods and CAP 2023-2027.

After the update, the proportion HVTAB area correlated with the average habitat quality (Pearson correlation 0.423, p = 0.000) and with the proportion of directive habitats (Pearson correlation 0.334, p = 0.000). However, the proportion HVTAB area did still not differ by management intensity (Kruskal-Wallis test statistic 4.737, DF2, p = 0.094). The mean proportion of the HVTAB area was 0.36 (SD 0.47) for areas with too low management intensity; 0.62 (SD 0.47) for areas with variable management intensity; and 0.45 (SD 0.49) for areas with appropriate management intensity.

5. Exploratory factor analysis

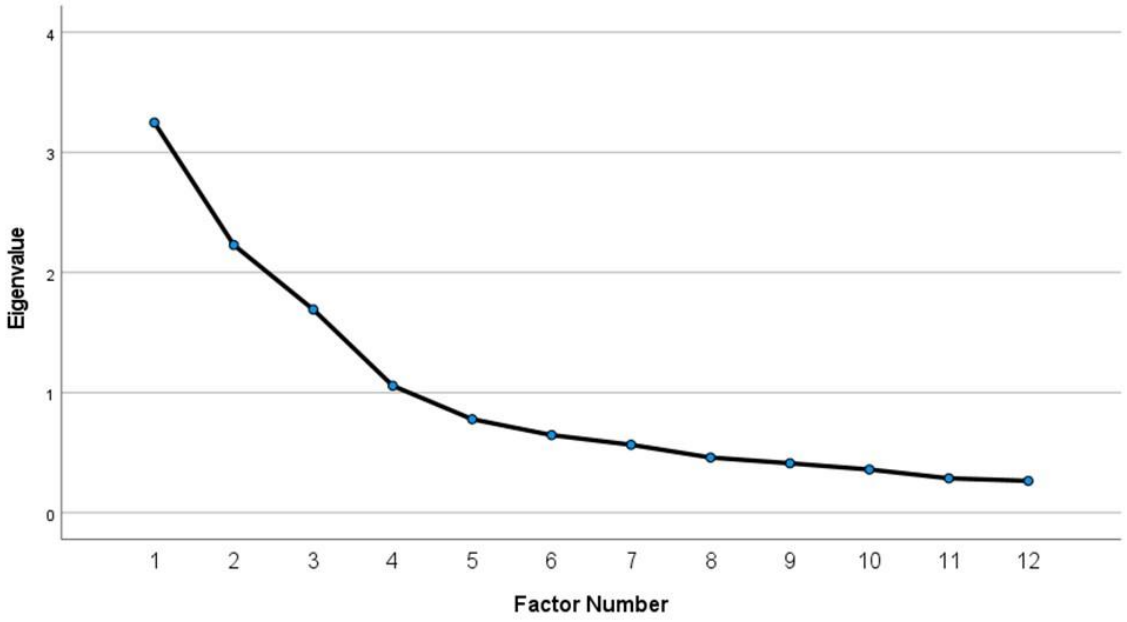
Communalities

	Initial	Extraction
... I have obtained significant fodder for my livestock from the area	0.373	0.502
… it has enabled me to maintain a larger number of livestock	0.422	0.691
… I have received compensation from the BLC for the area	0.325	0.354
… I want to preserve or restore its traditional landscape	0.537	0.595
... I feel personally responsible for the area	0.466	0.544
… this place is very near and dear to me	0.549	0.727
… I want to preserve it as I remember it from my childhood	0.377	0.369
... I want to protect endangered species	0.409	0.438
... I want to preserve its nature	0.601	0.834
… I want to preserve the traditional biotope it contains	0.355	0.375
… it is important to my family or other close people	0.338	0.382
… authorities or experts have requested it	0.383	0.719

Factor correlation matrix

	Nature	Contract	Place	Livestock
Nature	1	0.164	0.270	-0.135
Contract	0.164	1	0.046	0.371
Place	0.270	0.046	1	-0.154
Livestock	-0.135	0.371	-0.154	1

Scree plot



6. Preliminary analysis

Sum variables

The consistency of responses to the three items related to receptiveness of information were confirmed with reliability analysis (Cronbach's Alpha = 0.742) as were the consistency of responses to the four items related to the risk of abandoning management due to return-to-workload considerations (Cronbach's Alpha = 0.730). The items were thus grouped to two sum variables.

First stage logistic regressions

When the effect of perceptual variables, knowledge and survey date was tested, the resulting model for appropriate management intensity (Chi-square 10.112, df 2, p = 0.006) included the survey date, which had significant positive effect (B = 0.637, SE 0.224, p = 0.004), and the Contract orientation- factor, which has negative but insignificant effect (B = -0.363, SE 0.211, p =0.086). The model explained only small proportion of the variance in management (Nagelkerke R^2 = 0.121) but the Hosmer-Lemeshow test indicates that the model still fits the data (χ^2 = 2.988, p = 0.935).

When using the same variables to explain too low management intensity, the resulting model (Chisquare 8.869, df 1, p = 0.003) included only one variable: complete or partial livestock semi-natural habitat dependence (B = -1.349, p = 0.004) was connected to lower risk of too low management intensity. The model explained only 11.5% of the variance in management (Nagelkerke R^2 = 0.115). Furthermore, the Hosmer-Lemeshow test indicated problems in the model (χ^2 = 0.000, p = 0.000).

7. Other statistical testing

The sum variable for abandonment correlated with the risk of area loss due to compliance inspections that were done to all BLC sites during 2024 (“It is likely that we will not renew the

contract for this site because it is not economically viable due to the reduction of eligible area", Pearson 0.474, p = 0.000).

The degree of livestock semi-natural habitat dependence and importance of farming income did not correlate with each other's (Pearson correlation 0.075, p = 0.438). Importance of farming income correlated negatively with valuation of expert knowledge (-0.247, p = 0.010); with Place orientation factor (Pearson correlation -0.329, p = 0.000); and with the claim "I have wanted to manage this area regardless of whether it is considered a valuable traditional biotope by authorities or experts" (0.321, p = 0.001). The degree of livestock semi-natural habitat dependence correlated positively with Contract orientation factor (0.238, p = 0.013); livestock orientation factor (0.386, p = 0.000); and information receptiveness (0.288, p = 0.002).

Dairy cattle managers were more often completely dependent on farming income (Fisher's Exact Test p = 0.025) but less dependent from semi-natural pastures (Pearson Chi-Square p = 0.001) than other managers. Part of the dairy cattle managers did not own the animals they used and none of them based their livestock husbandry to semi-natural pastures, while ¼ of the other respondent did.

Dairy cattle managers were less receptive to information (sum variable: Mann-Whitney U = 392.0, z = -2.724, p = 0.006) and were also less willing to increase their work for the benefit of species ("Management plans for traditional biotopes should be drawn up according to the species of the area even if it increases the manager's workload": Mann-Whitney U = 480.0, z = -1.996, p = 0.046) compared to other managers, but there was no statistically significant difference in Nature Orientation-Factor scores (Mean score for Dairy cattle managers 41.10, for others 56.61, Mann-Whitney U = 875.0, z = 1.577, p = 0.081). Their sites were in most cases under grazed (11/15 sites). These sites comprised 38% of all sites with too low management intensity, even though dairy cattle pastures comprised only 13.9% of all study sites.

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