FARM AS ECOSYSTEM:
How does spatially fragmented property ownership affect farm habitat and conservation behaviour?

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Does the geography of a farm influence how it is managed?

- For instance, are isolated or small parcels considered impractical to integrate into daily farming, so left to natural processes?
- Alternatively, are such parcels less likely to be seen as comprising an ecosystem (or a significant share of one), thus managed more intensively?

We set out to examine the differences in habitat provision and management practices between contiguous versus fragmented (a.k.a. Parcelized) farms. Habitat has been described by some as the 'engine' of ecosystem services. Some ecosystem services are public goods, benefitting those far from the producers (for instance, carbon sequestration). The services important to agricultural production, however, must largely be fostered by farmers at the site where they are needed. The organisms that provide those services thus require their habitat requirements to be locally met. Relationships have been shown to exist between ownership patterns and land cover (thus, habitat) at a landscape scale, but what does this mean for decision-making at the farm level? **How does the spatial fragmentation of farmers' holdings influence how they choose to manage that land?**
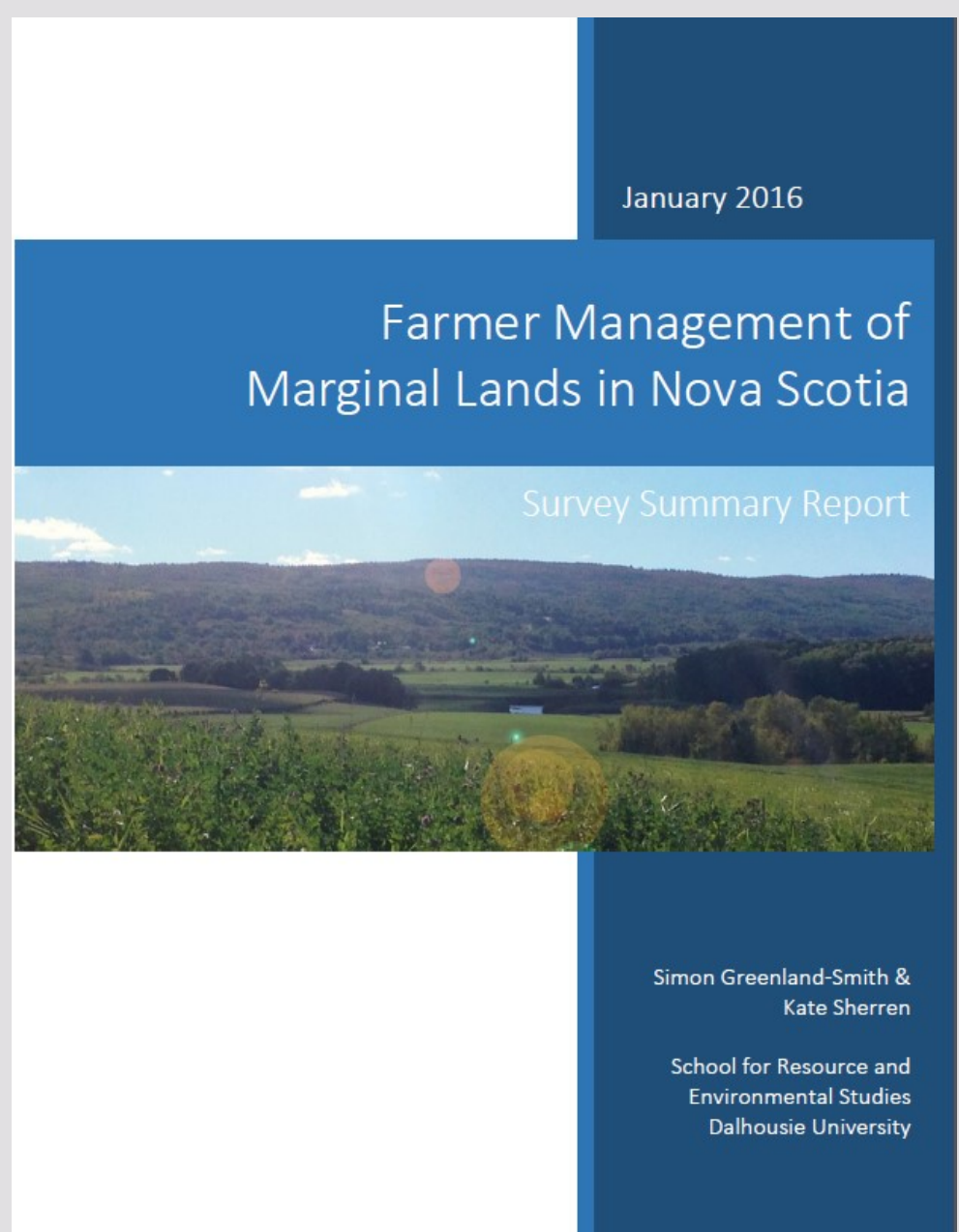
METHODS

Nova Scotia (Figure 1), in the Canadian Atlantic provinces, has been long-settled by North American standards, and thus subject to the chaos of inheritance and subdivision. It also has a finely grained variable landscape character with rolling topography and no class 1 agricultural land, and generally shallow acidic soils. It has a highly-fragmented ownership pattern.

Property datasets are difficult to mine for individual farms due to the range of names under which a single farm may be registered. We thus used a provincial **mail-out landholder survey** with multiple reminders (37% response rate, n=350) to capture information about:

- farm geography (farm area, number of parcels, size of largest and smallest, and time to drive between furthest flung parcels),
- habitat coverage (specifically woodlands, wetlands and ponds, including area, number, and size), and
- farmer values, perceptions and management practices.

We generated four farm fragmentation types using the farm geography variables (Figure 2), and used these to understand variations in habitat provision and management style at the farm scale. We cannot tell whether there is a difference between how a farmer treats near or contiguous parcels of their property and those that are more far-flung.

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Farmer Management of Marginal Lands in Nova Scotia

Survey Summary Report

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Download the full report at *ResearchGate*

1. What fragmentation types exist?
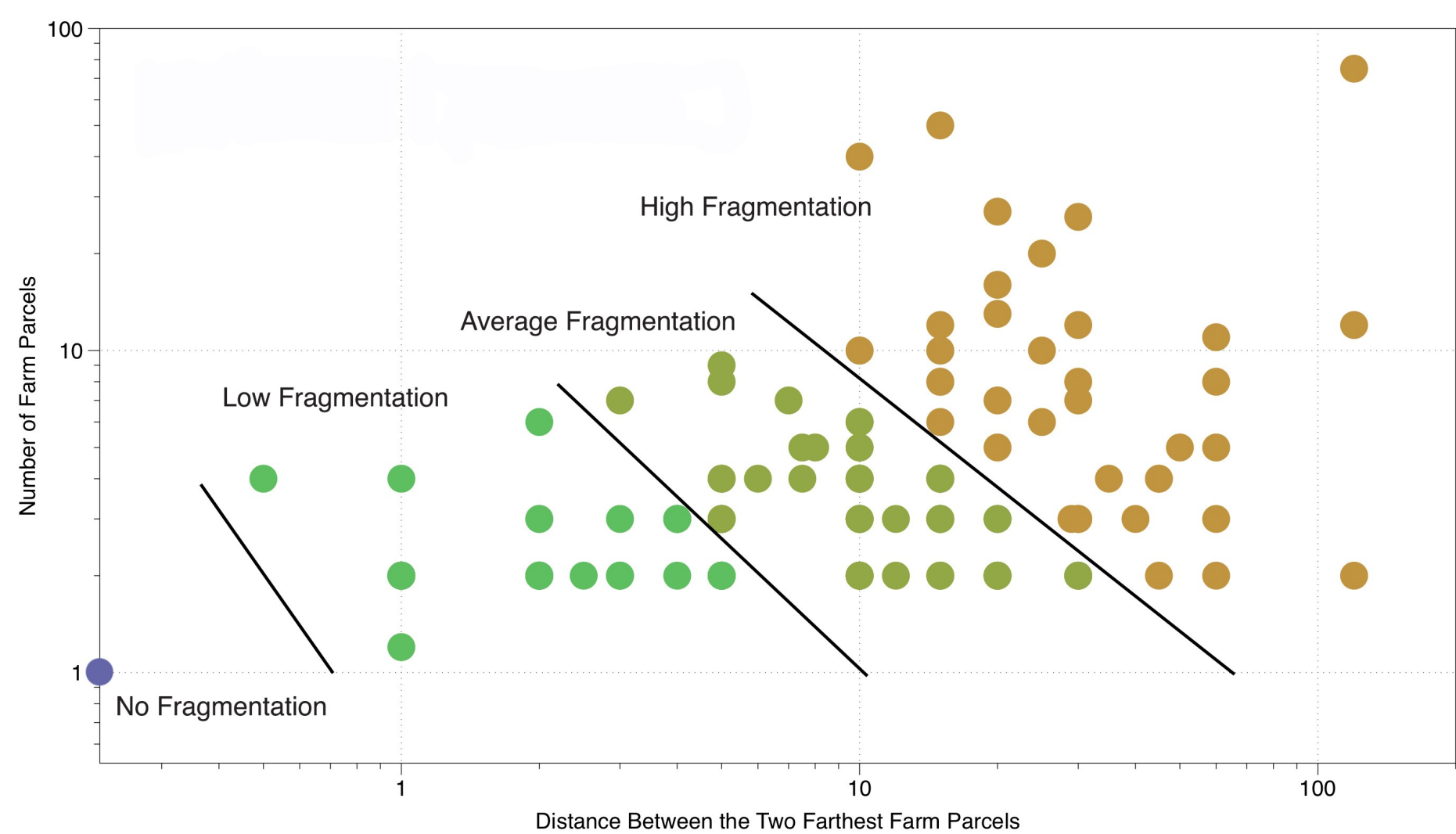
Figure 2: Scatterplot of number of parcels and distance to drive across, by type.

HIGH FRAGMENTATION
These are the oldest (63) and most **serious** farmers, earning 59% of their income from farming. Their farms are the largest (316 ha) and it takes ~37 minutes to drive across the widest part of the 12 parcels. They have the highest variation in parcel size (11 to 87 ha) and the smallest average (33 ha), but are the least diverse, specializing in commodities such as dairy and field crops (wheat, corn, soy).

NO FRAGMENTATION
This type likely includes a number of **hobby** farmers. Farms are the smallest (66 ha avg) with little income derived from farming (37%). Farmers are the youngest (58 avg), highly educated (70% above high school, equally college and university) and not concerned with keeping their farm in the family. NO farms have some of the highest diversity and are characterized by commodities well suited to small farms like grapes and vegetables.

LOW FRAGMENTATION
This type is a **smallholder** (97 ha) spread over a few parcels (2.3) with the least income derived from farming (35%). A similar proportion of this group as NO had university degrees (34%) but they were the most likely of all groups to have only high school (20%) and the least likely to have gone the college route (25%). These farms were the most likely to produce forages, beef, poultry and apples.

MID FRAGMENTATION
These farms are the closest to the Nova Scotia **average** farm size (143 ha), and derive 47% of their income from farming. These farmers are the most likely to have gone the college route (49%) instead of university (19%) and are the least likely to be female (9%). These farms have the highest diversity index but no characteristic commodities.

2. Does fragmentation affect farm habitat?

PONDS AND WETLANDS
For ponds and wetlands, the number present per unit farm area decreases with fragmentation (Figure 3). This suggests that as new land is acquired, farmers target parcels without such ecosystems. This is consistent with relatively low assessments of ecosystem goods and services (EGS; Figure 4). The number per 100 ha of NO fragmentation farms is inflated due to their small size: a quarter of those farms were smaller than 10 ha. NO fragmentation farms are a special case, being the least likely to have each of the habitat types, despite the fact that they generally assess the ecosystem goods and service (EGS) value of each higher than other groups (Figure 4). This exception is likely a factor of their small size.

WOODLANDS
Woodlands were assessed by all fragmentation types as having a high EGS value (average of 4-4.2/5), and thus we do not see the same decrease in prevalence with fragmentation. They are likely to be intentionally acquired to produce timber or Christmas trees.
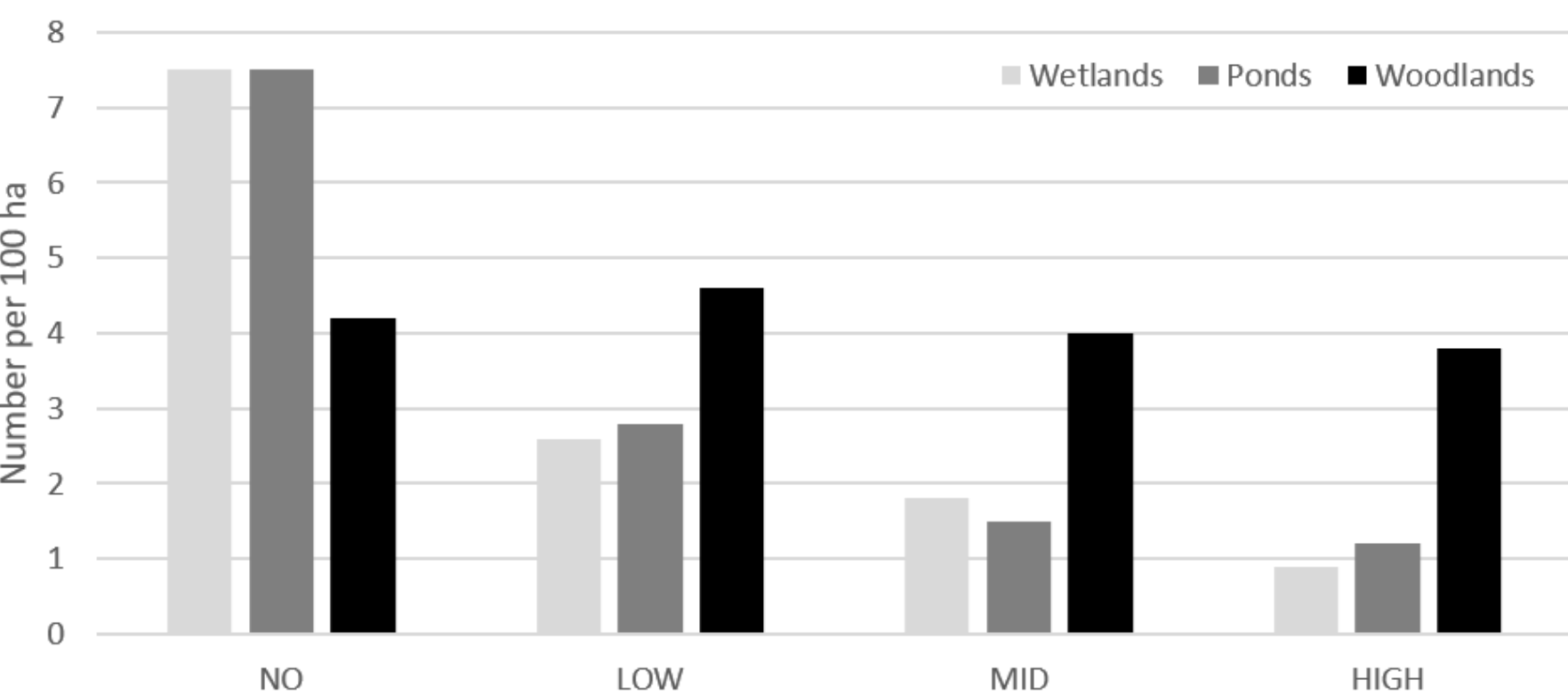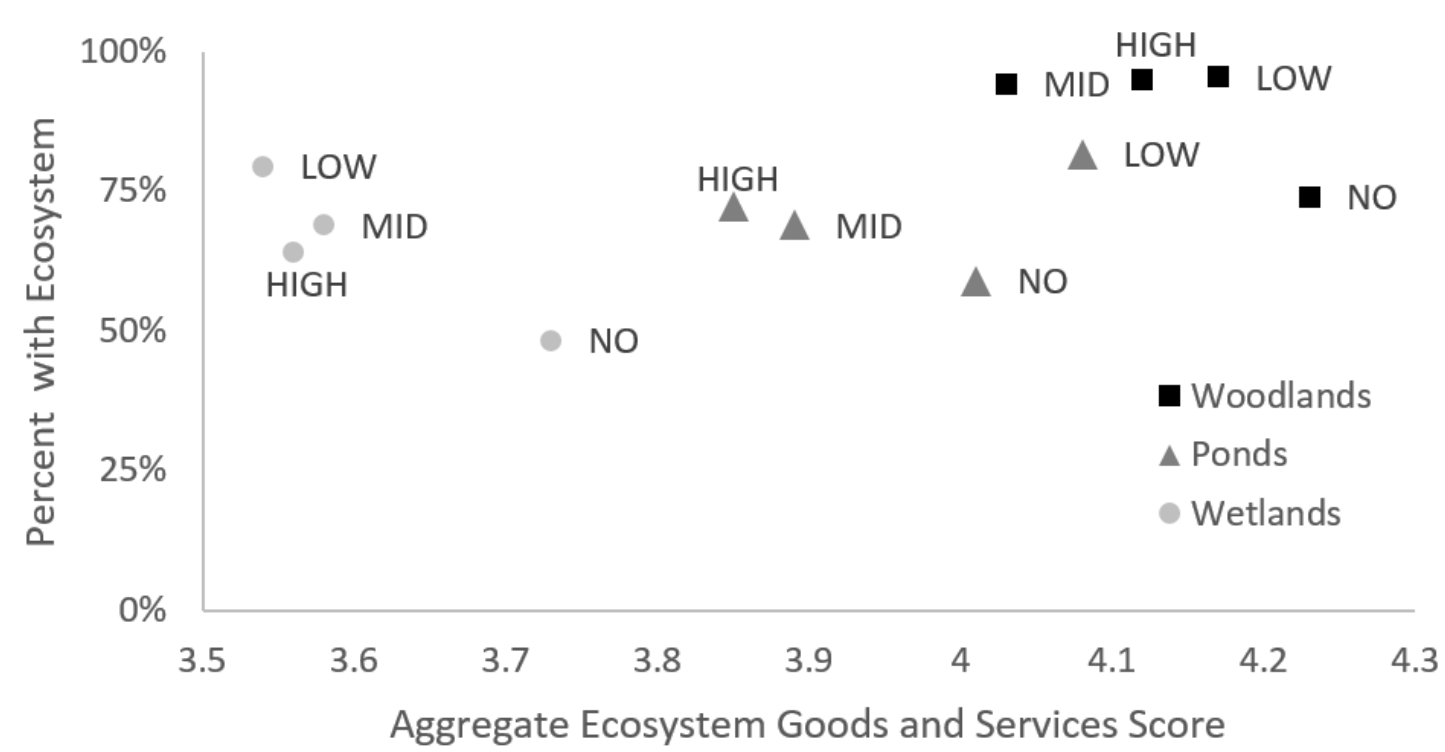

Figure 3: Habitat provision by fragmentation type

Figure 4: Aggregate EGS score and the percent of farms with each, by ecosystem and fragmentation type

Figure 1: Map showing the province of Nova Scotia within Canada (source: Mapsof.net)

3. Does fragmentation influence farm management?

We asked about their uptake of management practices associated with the grassroots Canadian ALUS (Alternative Land User Services) program, which compensates farmers for EGS stewardship (Table 1):

BUFFERS

- Riparian buffer use was similarly common across fragmentation types (77-92%), but the size of buffer used decreased with fragmentation, from 19 m for NO, to 8 m for HIGH.
- Headland buffer use (the area around crops within a field) also decreased in likelihood with fragmentation, from 71% for NO to 33% for HIGH .

LIVESTOCK FENCING

- Excluding NO fragmentation farms, the use of livestock fencing for those with beef or dairy commodities (^) decreased with fragmentation from 81% (LOW) to 61% (HIGH; similar to NO).

LAND RETIREMENT

- HIGH farms were the least likely to retire land in general (11%) but most likely to retire high-slope land.

Table 1. Uptake of stewardship practices by fragmentation type, for those with the appropriate commodity (^), which explains varying n.

Best Management Practice	Level of Fragmentation							
	NO		**LOW**		**MID**		**HIGH**	
	Mean	n	Mean	n	Mean	n	Mean	n
Riparian buffer use	80.4%	102	81.0%	42	91.3%	69	76.9%	39
Riparian buffer width (m)	19.1	65	16.1	25	16.2	55	7.9	26
Headland Buffer use^	71.4%	28	66.7%	6	44.4%	18	33.3%	9
Use of livestock exclusion^	62.5%	32	81.0%	21	71.9%	32	61.1%	18
Land Retirement	16.7%	108	19.5%	41	15.7%	70	10.8%	37
High Slope Land Retirement	7.3%	109	4.8%	42	12.9%	70	13.2%	38

In short: Farm fragmentation in Nova Scotia seems to be a conscious production decision rather than the benign result of inheritance. Habitat provision decreases with fragmentation for ecosystem types seen as less useful to production (i.e. ponds and wetlands); woodlands do not because of their monetary value. Stewardship practices generally decrease in likelihood with fragmentation (e.g. buffers, livestock exclusion, land retirement) save for those that may be more naturally associated with larger farms (e.g. high-slope land retirement). This pilot work suggests more research is necessary to understand the relationships between farmer values, geography and management decisions at a parcel rather than farm scale, including causality, to target stewardship messaging.

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