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Farmer Management of Marginal Lands in Nova Scotia

Survey Summary Report

Simon Greenland-Smith &
Kate Sherren

School for Resource and
Environmental Studies
Dalhousie University

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Executive Summary

We implemented a multi-purpose landholder survey in mid-2015 to explore landholder perspectives and use of marginal land on their farms, with an eye towards policy and outreach on biodiversity

The survey garnered a good response rate of 37%. Our participant pool was mostly male with an average age that was slightly higher than the last census of agriculture. Participants were mixed in education, but held more university degrees than the average NS farmer. Commodities were mixed, which is characteristics of the region. Farms ranged widely in size and spatial arrangement.

Economically, the survey revealed three general types of farmers in Nova Scotia: 1) production farmers, who make the majority of their incomes from agricultural production; 2) multiple income farmers, whose income comes from a combination of agricultural production and off-farm employment; and 3) casual farmers, who make the majority of their income off-farm. Incomes from value-added products and tourism were rare within the population.

Practices and perceptions were mixed among the participants but some patterns can be gleaned:

- Woodlands are very common on farms and represent a large area. They are managed more intensively than other marginal land and they are perceived as assets on the farm. Farmers own and manage large amounts of woodland in NS, often firewood for personal use. Those who belong to woodlot owner associations, however, tend to be more professionalized, selling for firewood, saw logs or pulp fibre.
- Ponds are quite common and are considered ecosystem service assets on farms, particularly for habitat and provisioning (i.e. water) services. Ponds are managed less than woodlands and in a more hands-off way. Buffer use is common around ponds, mainly to improve natural conditions.
- Wetlands are the least common marginal land type and farmers would prefer that they are confined to certain areas rather than mixed throughout the farm. Farmers prefer to manage wetlands in a hands-off manner. Buffer use around wetlands is common and is implemented to improve natural conditions. Regulation and habitat services are most important wetland services for farmers.
- In other areas of the farm such as riparian and headland buffer zones, passive management is much more common than active management. Mowing is the most common active management practice in such areas.

Farmers feel strong control over their farmland. Further questions reveal:

- To make farming workloads more manageable farmers sacrifice spatially (neglecting marginal lands) more than they consciously turn to short-term thinking.
- Farmers' 'production' legacy is more important to them than their 'natural' legacy, though both are important.
- Keeping farms in the family is important to farmers and most do not plan to sell outside the family when they retire.
- Farmers strongly believe it would be negative to see a decline in provincial agriculture.

Questions on hunting reveal a divided population about the topic of hunting and its capacity to co-exist with farming, even in the face of nuisance animal populations.

1.0 Introduction

Nova Scotia, in the Canadian Maritime provinces, is an isthmus with highly variable terrain and shallow soils. It has no Class 1 agricultural land according to the Canadian Land Inventory, and the acceptable farmland that does exist is interspersed with woodlands, wetlands and ponds. These 'marginal' lands hold tremendous value for biodiversity, and thus it is important to know how owners perceive and manage these lands. This is particularly critical as most of the province is under private ownership. Investigating the *practices* of farmers on these lands provides valuable baseline insight into the threats and opportunities facing biodiversity conservation in the agricultural context. Inviting farmers to share their *perceptions* of marginal lands helps better cater extension programs to the unique (and sometimes divergent) attitudes and needs of the farming community.

Farmers, in Nova Scotia as elsewhere, are an over-surveyed population. This has led to reduced response rates, particularly for single mail-out surveys. As such, Dalhousie University's School for Resource and Environmental Studies (SRES) partnered with the Nova Scotia Federation of Agriculture (NSFA), Environment Canada (EC), and the Nova Scotia Department of Natural Resources (DNR) to design a single survey that would meet multiple purposes. That single survey would be heavily promoted through reminders to improve response rates. The objectives included a range of interests related to marginal land management:

- How do farmers perceive and manage woodlands, wetlands and ponds and other marginal lands?
- How do farmers perceive their land overall, and the agricultural industry?
- How do farmers perceive hunting on their property?
- How variable is the geography of Nova Scotia farms and their constituent ecosystems?

2.0 Methods

In July 2015 a mail-out survey was initiated with a target sample of 1000 Nova Scotia farmers. A random sample of 1005 farmers was selected from the Nova Scotia Federation of Agriculture's contact list. The contact list contains about 2400 farmers in total; about two-thirds of all Nova Scotia farmers.

A multiple reminder format was used. First, selected farmers were sent an initial postcard to alert them that they would be receiving a survey. In roughly two-week intervals (with some adjustment to target delivery during times of poor weather) farmers were then sent a copy of the survey, followed by a reminder postcard, a second copy of the survey and finally another reminder postcard (Figure 1).

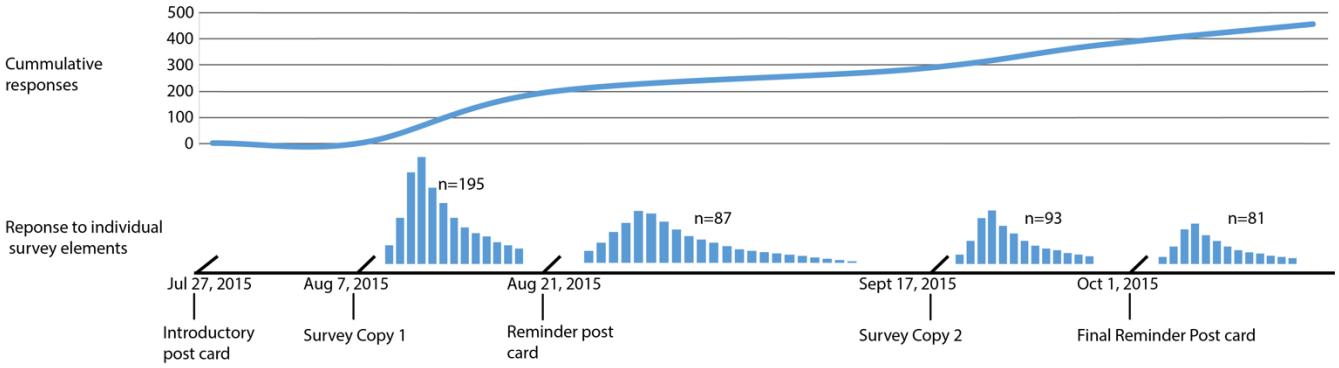

Figure 1 Response rates to individual survey elements as well as cumulative response rate including ineligible farmers and survey refusals. Cumulative response rate is based on actual number of responses from each survey phase. Response patterns within individual survey elements is simulated.

The survey was a 12-page booklet. Half of the booklet was comprised of two-page spreads on each of woodlands, wetlands and farm ponds, including: how much of the farm comprised these features, in area and number; how they manage each one; how they perceive them in terms of ecosystem goods and services; and, finally, a question set for each to establish whether farmers preferred them interspersed around the farm or kept separate, and whether they managed them hands-on or hands-off. Subsequent question sets explored: (1) involvement in a range of practices advocated by grassroots Alternative Land Use Services (ALUS) programs in other provinces; (2) perceptions of the land; (3) perceptions of farming; (4) farm geography; and, (5) respondent demographics. One page included questions about communications preferences with the NSFA (not analyzed here).

Only farmers who were currently farming were considered eligible respondents. On the front page farmers could indicate if they were uninterested in participating or if they thought they were ineligible (not currently farming). Fifty-four surveys were returned because they were undeliverable or the farmers were ineligible, and these farmers were subtracted from the denominator yielding an actual maximum possible 951 surveys. A further 52 farmers returned surveys saying that they did not want to participate in the study. Three hundred fifty surveys were returned completed giving a final response rate of 36.9% (Figure 1).

3.0 Respondent demographics

Farmers were asked a series of demographic questions to allow us to contextualize their responses to other questions, and check whether sample farmers sample were representative of the broader Nova Scotia farming community.

3.1 Gender

Farmers were asked "what is your gender". The majority of respondents (85%) identified as male, while 15% identified as female (Table 1). Respondents reported no other genders on the survey.

Table 1 Farmer genders

Farmer gender	Frequency	Percent
Male	273	84.8
Female	48	14.9
Total	**322**	**100**

3.2 Age

Farmers within the sample had a mean and median age of 59 and 60 years respectively (sd=12.4). The youngest farmer in the sample was 23 years of age while the oldest was 91 years old.

Within the sample of farmers, the mean farming experience was 27.6 years (sd=17.0), the median was 30 years. The sum of farming experience included in the survey sample was 9011 person-years.

3.3 Commodities

Farmers could choose multiple commodities from a provided list and responses varied widely (Table 2). Farmers were also given the opportunity to include "other" products, which were coded and included in the list below. Some farms produced only one or two products while others were highly diversified with many crops and several types of livestock. The most common farm products were forages (129) and beef (124) which were often reported together. Other very common products were field vegetables (64) which encompassed many different products, and blueberries (54) which were commonly produced in conjunction with maple products (14).

3.4 Education

Respondents were asked to indicate their highest level of educational attainment. The most common level of highest educational attainment was the 'college diploma' level (Table 3). Farmers were represented in all categorical educational attainment categories.

3.5 Income

Farmers were asked to report their relative incomes from four different sources; non-farm income (e.g. off farm employment), agricultural production (e.g. the growing and selling of vegetables, meat), value-adding (e.g. production of jams or pies from berries) and tourism (e.g. tourism income from a corn maze or U-pick). Responses were gathered in percentages of each to avoid the discomfort some people feel about disclosing their income.

Table 2 Products produced on respondent farms in Nova Scotia.

Farm product	Number of farms reporting	Farm product	Number of farms reporting
Forages	129	**Christmas Trees**	11
Beef	124	**Pork**	11
Field vegetables	64	**Lamb**	9
Blueberries	54	**Honey**	8
Poultry	49	**Nursery plants & sod**	7
Wheat, corn and soy	44	**Eggs**	7
Dairy	32	**Pollinators**	6
Apples	32	**Haskap berries**	4
Greenhouse vegetables	25	**Goats**	3
Grapes	24	**Raspberries**	3
Sheep	16	**Strawberries**	3
Maple Products	14	**Cranberries**	2
Furbearers	13	**Horses**	2
Stone fruits	12	**Total**	**343**

Table 3 Farmer education levels.

Highest education level	Number	Percent
Grade nine or less	22	6.6
Some high school	35	10.4
High school graduate	57	17.0
Some university or college	54	16.1
College diploma	72	21.4
Undergraduate degree	59	17.6
Postgraduate degree	37	11.0
Total	**336**	**100.0**

The most common yet not the largest source of income was agricultural production comprising a median 40% of income for 264 farmers out of 295. Comprising the largest median percentage of income was off-farm income which made up about 80% of income for 222 farmers. Value-adding and tourism income were only present for 30 and seven farmers respectively and typically made up less than half of farmers' incomes.

From these responses it is possible to group the majority of farmers into one of three groups; 1) Non-farm-dependent farmers, who rely mainly on income generated off-farm, 2) Farm-dependent farmers, who generate most of their income on-farm and , 3) Mixed-dependency farmers, who rely equally on farm and non-farm income (Figure 2). Non-farm-dependent farmers were the most common (145) followed by farm-dependent farmers (93). Mixed dependency farmers were the least common

identifiable group of farmers (38), but many farmers (47) did not fit into the three main categories (Figure 2).

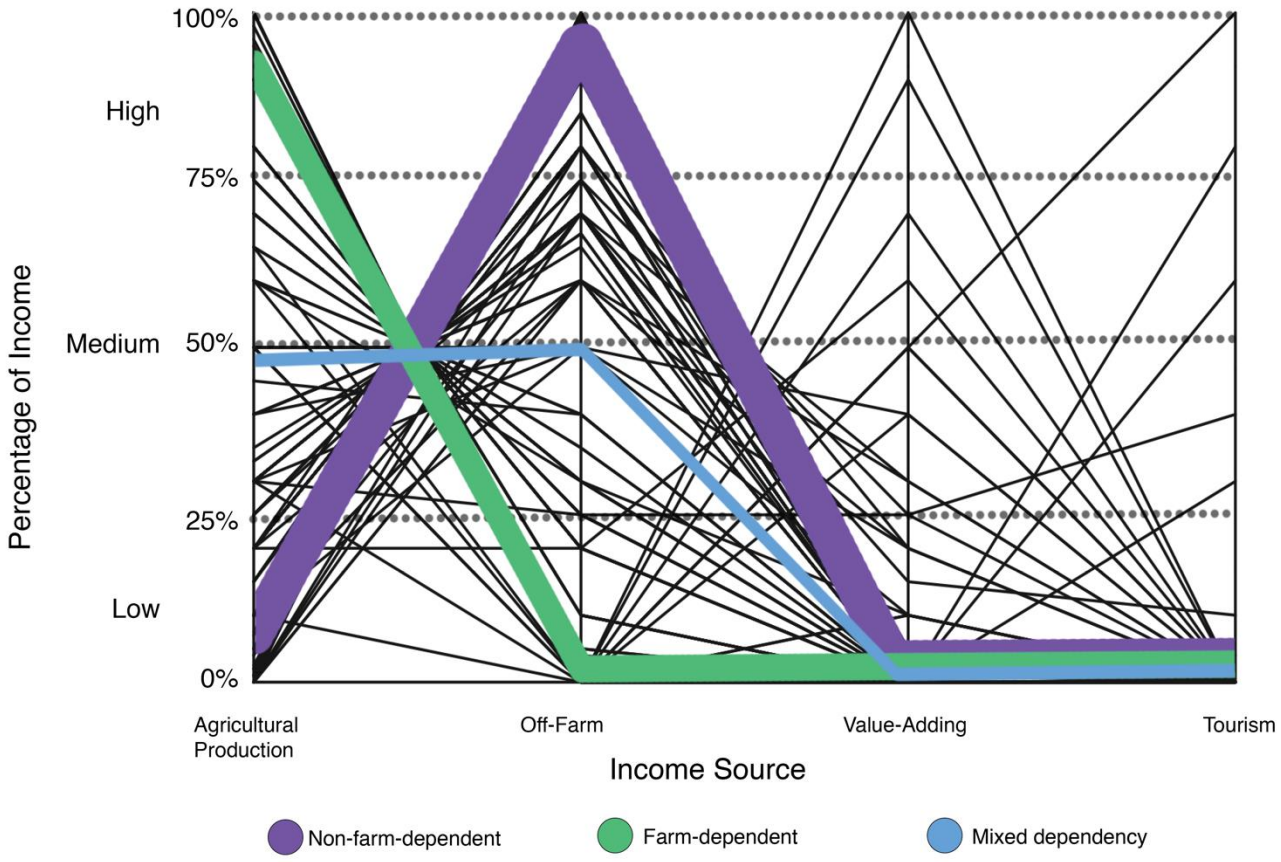

Figure 2 Typology of farmers based on relative income sources reported by farmers. Coloured line thicknesses indicate the number of farmers fitting each category. Black lines indicate actual responses.

4.0 Perceptions of the land and its future

Survey participants were asked a series of questions to gauge attitudes surrounding farming in general. Survey statements were not explicitly about marginal areas of the farm, but general attitudes and values that impact on-farm practices and farmer perceptions. Farmers were asked to rate their agreement with each statement on a Likert scale. Statements were designed to test informal working hypotheses that have been informed by expert opinion as well as previous research with farmers (see, Sherren & Verstraten, 2013; Goodale, Yoshida, Beazley & Sherren, 2015; Greenland-Smith & Sherren, in press). Concepts investigated here include; control, limitations and sacrifice, farmers' legacy, tenure planning, provincial farming culture, landscape level stewardship and visual land quality cues.

Perceived control is an important aspect of frameworks such as the Theory of Planned Behaviour. About 50% of farmers either "strongly disagreed" or "disagreed" that the "quality of [their] undeveloped or natural areas [is] out of [their] hands". Almost 30% were ambivalent and only 22% "agreed" or "strongly agreed" (Table 4). This suggests that most farmers feel agency over the quality of their land and that if they make the right decisions they can maintain and improve the quality of their land, including the natural areas of their farm where most biodiversity conservation will occur.

Time is limited on farms and there is generally more to do than can be done in any given season. Farmers were asked two questions to identify whether farmers dealt with constraints by limiting the work they do over space or time (focus efforts on short-term gains rather than long-term gains). Farmers agreed slightly that they prioritize spatially, but were ambivalent about temporal prioritization (Table 4). An independent-samples t-test was conducted to compare agreement for temporal and spatial sacrifices. There was a significant difference between the "spatial sacrifices" ($\bar{x}$= 3.56, sd=0.97) and "temporal sacrifices" ($\bar{x}$=2.99, sd=1.12); t (303)= -7.03, p <0.001. These results suggest that farmers make spatial sacrifices like neglecting natural areas, more readily than they make temporal sacrifices, like doing short-term rather than long-term planning.

On average, farmers agreed more with statements about the legacy of their productive land than their legacy associated with natural areas of the farm. While both statements garnered general agreement there was a significant difference in mean agreement between the "production legacy" statements ($\bar{x}$=4.42, sd=0.68) and "natural legacy" statements ($\bar{x}$=3.92, sd=0.78); t (309)= 18.30, p <0.001 (Table 4). Perhaps not surprisingly, farmers are more concerned about their legacy in terms of productive land than natural areas. In many cases the legacy of productive land – passing on fertile, good quality land – will mean a livelihood for another generation within the family. However, natural legacies are clearly important to farmers as well.

For many farmers, financial security during retirement would not be possible without selling their farms and liquidating the value in the land itself. However, many farmers also want to pass on their farms within their families which does not always allow for the maximum price to be withdrawn from the farm upon retirement. These competing realities, and which one dominates, have a profound effect on land tenure in Nova Scotia and in turn the farming culture that has developed over many decades. Farmers agreed that "family tenure" - "keeping the farm in the family is really important…" ($\bar{x}$=3.96, sd=0.89). Farmers disagreed that their "retirement plans" were based on the selling the farm outside the family ($\bar{x}$=2.28, sd=0.99) (Table 4), suggesting that farmers are intent on keeping their farms within the family when possible.

Table 4 Summarized farmer agreement with statements related to temporal and spatial sacrifice due to the busy nature of farming.

Variable	Statement	Obs	Mean	SD	95% CI
Control	*The quality of the undeveloped or natural areas of my farm is largely out of my hands*	325	2.70	0.91	2.60-2.79
Spatial Sacrifice	*The busy nature of farming doesn't allow me to care for the undeveloped or natural areas of my farm as much as I would like.*	325	3.56	0.97	3.46 - 3.67
Temporal Sacrifice	*I'm trying to make my farm work for now; I am not able to plan very far into the future.*	336	2.99	1.12	2.87 - 3.11
Production Legacy	*Leaving my productive land in good condition for the future is important to me.*	343	4.42	0.68	4.35 - 4.50
Natural Legacy	*The health of my undeveloped and natural land is a significant part of my legacy as a farmer.*	330	3.92	0.78	3.83 – 4.00
Family tenure	*Keeping my farm in the family is really important to me*	337	3.96	0.89	3.86 – 4.05
Retirement plan	*My retirement plan is based on selling my farm to someone outside my family*	314	2.28	0.99	2.17 – 2.39
Farm loss	*A decline in the number of farms in NS would be a real loss to the province*	341	4.52	0.70	4.44 – 4.59
Farm conversion to forest	*Seeing some agricultural land return to forest would be a good thing*	323	2.72	1.03	2.61 – 2.84
Effect of practices on landscape level	*It is nice to have neighbours that are good farmers because it helps to maintain the quality of my farmland as well*	330	3.99	0.70	3.92 – 4.07
Visual best practice identification	*I can look at a farm and know if the person is a 'good' farmer by the condition of their farmland*	330	3.72	0.86	3.63 – 3.81

Farmers were also presented with questions about the future of Nova Scotia agriculture. Respondents agreed strongly ($\bar{x}$=4.52, sd=0.70) that “farm loss” in the province would be a real loss. Farmers disagreed slightly that some “farm conversion to forest” would be a good thing ($\bar{x}$=2.72, sd=1.03) (Table 4). Accompanying several returned surveys were notes from farmers sharing a similar sentiment and saying that crown land should be open to farming activities like it is open to forestry activities. Farmers want to see agricultural land use protected in Nova Scotia.

A statement about the effects of neighbours' practices on farmers' own farms garnered mostly agreement. Only 6 farmers "disagreed" or "strongly disagreed" while 202 farmers "agreed" and 67 farmers "strongly agreed ($\bar{x}$=3.99, sd=0.70) (Table 4). This indicates a landscape-scale conceptualization of land health; farmers recognize that practices implemented on farms can have a positive effect outside the bounds of that individual farm.

Farmers agreed ($\bar{x}$=3.72, sd= 0.86) (Table 4) that they could identify "good farmers" by the look of their farmland. Farmers who believe that other farmers will be able to judge their worth as a farmer visually may be more likely to take up practices associated with 'good looking' farms. While best management practices for biodiversity do not always fit with the aesthetic most preferred by farmers, the agreement among farmers suggests that visual cues may be a motivating factor for behaviour change.

5.0 Farm geography

Farms can be a single contiguous property or a series of properties operated under a single owner/farmer. The effects of special dynamics on the management is largely unknown. Farmers were asked a series of questions about the size and distribution of the parcels of land that make up their farm. Parcels are defined here as areas of a farm that are not connected with or directly adjacent to another area of the farm. A single parcel may have multiple property IDs.

The mean and median farm sizes reported by farmers were 123 and 79 hectares respectively. Some farms were large, including two over 1,000 ha (omitted from Figure 3 for clarity). Ninety percent of farms were smaller than 263 ha (Figure 3).

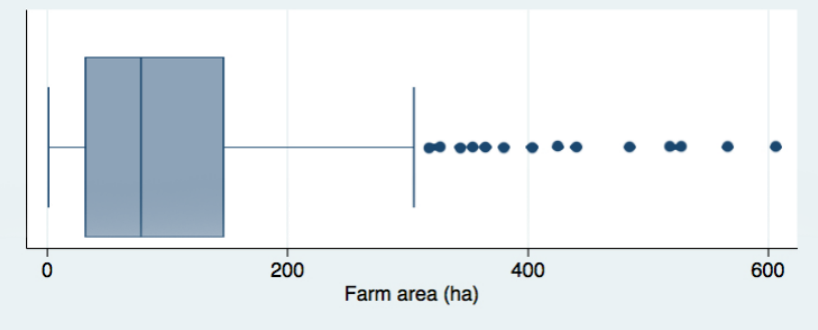

Figure 3 Horizontal boxplot of farm sizes reported by farmers (n=337)

The median number of parcels that made up the sample farms was two (Table 5), but some farms contained as many as 75 individual unconnected parcels of land. Out of the sample of 302, 103 farms contained a single parcel of land. The mean smallest parcel size was 13.5 ha, while the largest parcels averaged 70.5 ha. The average parcel size on Nova Scotia farms was 50.3 ha.

Table 5 Descriptive statistics of farm geographic attributes

Farm attribute	Mean	Median	SD	Number of farmers responding
Overall farm area	123	79	247	**337**
Smallest farm parcel	13.5	8.9	14.2	**190**
Average farm parcel	50.3	32.1	57.5	**298**
Largest farm parcel	70.5	52.3	73.3	**190**
Number of farm parcels	3.4	2.0	6.4	**302**

Most farm parcels were close together; the median distance reported between the most-distant two parcels was only 10 minutes driving. One farmer reported a driving distance of two hours between their two most distant farm plots but this was an exception, ninety percent of farms had their most distant parcels within 30 minutes of each other. Many farmers reported zero distance between plots and these were considered to be connecting and therefore not included in the above analysis.

6.0 Woodlands

Woodlands dominate Nova Scotia and host much of its biodiversity. Conservation practices on woodlands can help contribute to resilient populations of species at risk, species that are hunted for sport and species that are appreciated by citizens seeking recreational opportunities.

6.1 Woodland ownership

Out of 347 farmers, about 84% reported having some woodland on their farms. The number of parcels of woodland found on each farm varied widely with some farms reporting as many as 50 distinct woodland parcels. The average number of parcels was 2.8 and 90% of farms had fewer than 4 parcels of woodland (Figure 4).

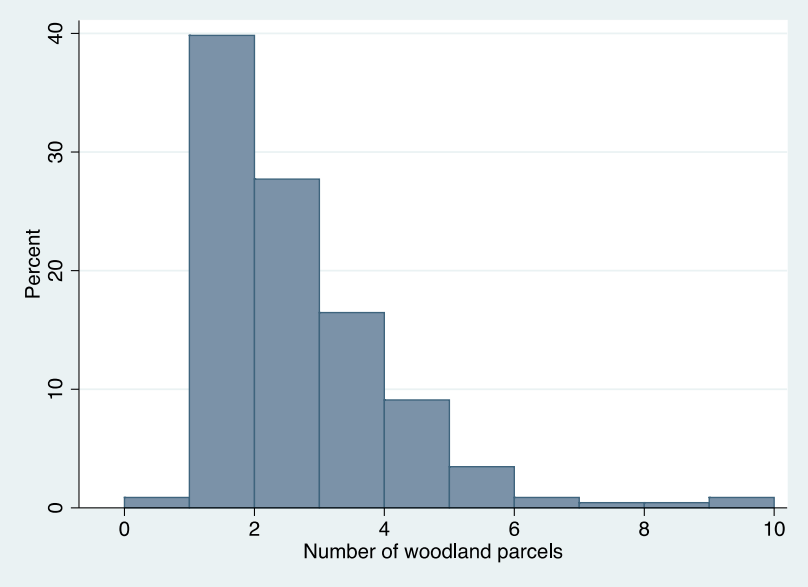

Figure 4 Histogram of the occurrences (in percent) of the number of woodland parcels found on sample farms (n=238). Outliers above 11 are omitted.

The smallest woodland parcel on farms had an average area of 11.2 ha. The largest parcels of woodland on farms were about 48 ha and the average parcel was 28.3 ha in size. Woodland coverage as reported by farmers had a mean of 52.6% and a median of 50%, showing that woodlands make up a large portion of farms by area. Multiplying the average size of parcels by the average number of parcels results in a larger area than the estimated woodland coverage of the average farm size, suggesting there may be some misreporting of woodland parcel areas.

Woodlands were 'bought' (36%) more frequently that they were 'inherited' (64%) (Table 6). Woodlands may simply be a natural by-product of purchasing farmland in a diverse landscape, however, they may also be directly purchased for production of woodland products. Depending on farmers' motivations, both scenarios are likely true.

Table 6 Farmer-reported mode of acquisition of woodland parcels.

	Number of responding farmers	Percentage
Bought	198	63.9
Inherited	112	36.1
Total	**272**	**100**

Management for preservation often seeks different goals than management for production. Intensive production can lead to even-aged stands that leave little room for biodiversity. Management to foster a healthy mixed-age forest creates much better conditions for biodiversity and is not exclusive of some production benefits. Only about 11% of farmers reported they managed solely for production. Farm woodlands were managed for a combination of preservation and production 59% of the time. About 22% of the time, woodlands were not managed at all (Table 7).

Table 7 Woodland management styles as reported by respondent farmers.

Woodland management	Number	Percent
Mix of preservation and production	161	59.0
Neither preservation nor production	61	22.3
Production	31	11.4
Preservation	20	7.3
Total	**273**	**100.0**

Membership in woodland associations was low; only 24.4% of respondents reported being members (Table 8). A similar proportion of respondents had a management plan in place (25.8%) and most of these plans (90%) were created by forestry professionals. The presence of a woodland management plan was positively correlated with membership in a woodland association (r=202, 0.54, p<0.001). About 80% of these plans were reportedly created to "guide future activities on woodland" (Table 9).

Table 8 Presence of woodland management plan by farmer reported membership in a woodland association.

		Woodland Management Plan		
		No	Yes	Total
Woodland Association Membership	**No**	133	18	**151**
	Yes	18	35	**53**
	Total	**151**	**53**	**204**

Table 9 Farmer motivations for having a woodland management plan.

Motivations for Management Plan	Number	Percent
Planning future activities	51	79.7
Requirement for certification program	7	10.9
Tax purposes	3	4.7
Estate planning	3	4.7
Total	**64**	**100**

Four times as many farmers harvested products (165) from their woodlands than didn't (39), and the most common products harvested were firewood for personal use (45.6%) and saw logs (29%) (Figure 5). Membership in a woodland association was a weak but significant predictor of the products that farmers harvested from their land. Spearman's correlation showed that members of woodland associations were less likely to harvest firewood for their own use (r=162, -0.1972, p<0.05) and more likely to harvest firewood for sale (r=162, 0.1875, p<0.05). Pulpwood and saw log production were both positively associated with woodland association membership (r=162, 0.2392, p<0.05; r=162, 0.3200, p<0.05).

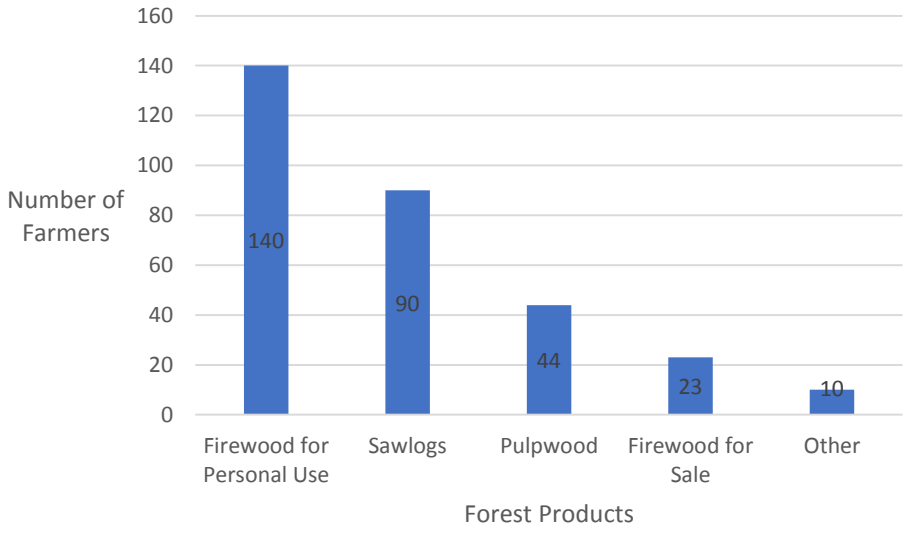

Figure 5 Forest products harvested from farms, as reported by farmers (n=165).

6.2 Woodland information and assistance needs

The respondent population was split between those who wanted further information and resources (151 of 284) and those who did not (133). Farmers reported a desire for information on a number of topics including boundary marking (65.1% of respondents), dealing with insects and disease (55.9% of respondents), and supporting wildlife habitat (40.8% of respondents) (Table 10). Less popular topics included tree harvesting and contacting forestry professionals.

Farmers most desired face-to-face (45%) information delivery about woodlands and least wanted social media sources (11.3%) (Table 11).

Table 10 Woodland assistance categories, by frequency (n=151).

Assistance Categories	Number	Percentage
Boundary marking/surveys	99	65.1
Dealing with insects and disease	85	55.9
Supporting wildlife habitat	62	40.8
Management / stewardship planning	57	37.5
Improving stream crossings	55	36.2
Road building & maintenance	53	34.9
Cleaning up blowdown	48	31.6
Site regeneration	34	22.4
Contacting professional foresters	14	9.2
Tree harvesting	8	5.3

Table 11 Woodland assistance information sources, by frequency (n=222).

Information Sources	Number	Percentage
Face-to-face	100	45.0
Website	50	22.5
Day courses	38	17.1
Social media	25	11.3

6.3 Woodland economics

Economic factors are often cited as primary drivers of management. In the survey, farmers were presented with several statements about the economic value of woodlands and asked to respond on a Likert scale: that is, to indicate whether they strongly disagreed (1), disagreed (2), neither disagreed nor agreed (3), agreed (4) or strongly agreed (5), a scale that was used throughout the survey. Most farmers agreed that woodlands were important to the rural economy ($\bar{x}$=4.35), even in farming communities (S2, Table 12). They also disagreed somewhat that "without [their] woodland, [their] farm would not be profitable" ($\bar{x}$=2.65). While the standard deviation is large it is normally distributed, and fully half of the respondent farmers indicated that they strongly disagreed or disagreed (S3,Table 12).

Table 12 Farmer's Likert scale position on three woodland economics-related statements.

Question	Mean ($\bar{x}$)	Standard Deviation	Median	N
S1. My woodland is not important to my income as a farmer	2.93	1.33	3	278
S2. Woodlands are an important part of the rural economy, even in farming communities	4.35	0.75	4	285
S3. Without my woodland, my farm would not be profitable	2.65	1.24	2	280

Farmers were overall ambivalent but individually more divergent about a statement that suggested woodlands are not important to personal income ($\bar{x}$=2.93) (S1, Table 12). Farmers' agreement with the three economic statements were normally distributed around the means with the exception of S1 which showed a slight bimodal distribution with peaks at 2 – "disagree" and 4 – "agree". This suggests that there may be two distinct groups, some of whom rely on woodlands for personal income and some who do not rely on this income.

6.4 Woodland ecosystem goods & services

Similarly, in section 4.3, we presented farmers with a range of statements about the benefits they might associate with woodlands, and asked them to judge their agreement using a Likert scale. The statements that garnered the most agreement from farmers discussed woodlands as areas that provide materials like firewood, lumber and pulpwood ($\bar{x}$=4.46), and habitat for wildlife ($\bar{x}$=4.46) (Table 13). Statements about cultural services like recreation with the family and the tranquility of woodlands also garnered much agreement from farmers ($\bar{x}$=4.22; $\bar{x}$=4.21, respectively). Farmers were least likely to agree that their woodlands provide wild food ($\bar{x}$=3.61) and micro-climate regulation ($\bar{x}$=3.83), the latter of which is surprising because global climate regulation attracted the third highest agreement ($\bar{x}$=4.40). The term micro-climate may simply not have been familiar to the respondents.

Table 13 Farmer Likert-scale agreement with woodland ecosystem service related statements (n=338).

Category	Service	Statement - Woodlands…	Mean ($\bar{x}$)	SD
Provisioning	Materials	…provide products like lumber, pulp and firewood	4.46	0.59
Habitat	Animal habitat	…provide habitat to many species of animals	4.46	0.62
Regulating	Global climate regulation	…trap carbon and help regulate the global climate	4.40	0.64
Habitat	Refugium services	…are good places for animals to get away from threats or to reproduce	4.24	0.69
Cultural	Family recreation	…are great places for farmers and their families to enjoy a walk of other outdoor activity	4.22	0.72
Cultural	Tranquillity	…are special places on the farm to take in the surroundings and appreciate the tranquility	4.21	0.74
Regulating	Pest control	…help prevent pest outbreak by providing habitat for predators	3.97	0.76
Regulating	Micro-climate regulation	…can create micro-climates that improve the growing conditions for crops on my farm	3.83	0.87
Provisioning	Wild food	…provide an area to collect wild foods like mushrooms, fiddleheads, wild leeks and others	3.61	0.94

Many of the services were correlated, often significantly so. Correlations between services within a single service category were generally weak, and thus were seen very differently by respondents, for instance materials and wild food (both provisioning services) were hardly correlated at all (r=0.06, p=0.26). Cultural services were the exception to this rule and were correlated strongly (r=0.06, p<0.05). As such there is no benefit to grouping the services into categories.

That said, taken together, farmer responses on all nine statements had internal reliability, meaning that any given farmer rated all the different services in a similar way. This is evidenced by Cronbach's alpha between all service categories for unstandardized, non-zero responses (α=0.79) showing a high level of internal consistency.

6.5 Woodland management style

The survey section on management style is echoed in the sections on wetlands and ponds, and in each instance was designed to categorize farmers based on their philosophies and approaches: in the case of woodlands (1) whether they would rather have them integrated throughout the farm, "sharing" with farmland or "sparing" woodland from production to keep them separate (sharing vs sparing axis); and (2) whether they prefer a hands-on approach that favours human action when maximizing natural conditions, or believe that nature is best left alone (hands-on or hands-off axis). Two positively phrased statements were presented per axis, one representing agreement with each pole, and a single metric derived by taking the difference of each pair of responses, except for zeroes indicating that respondents "don't know".

The results show that when it comes to woodlands, farmers prefer a mixed, hands-on approach (Figure 6), indicated by a positive value ($\bar{x}$=1.41, 95% CI = 1.26, 1.57) on the sharing/sparing scale (-4 = total preference for land sparing; 4 = total preference for land sharing). Hands-on preferences also outweighed hands-off management styles on average ($\bar{x}$= -1.57, 95% CI = -1.73, -1.41) (-4 = total preference for hands-on; 4 = total preference for hands-off). Interestingly, not a single farmer held land sparing attitudes *and* a preference for hands-off management.

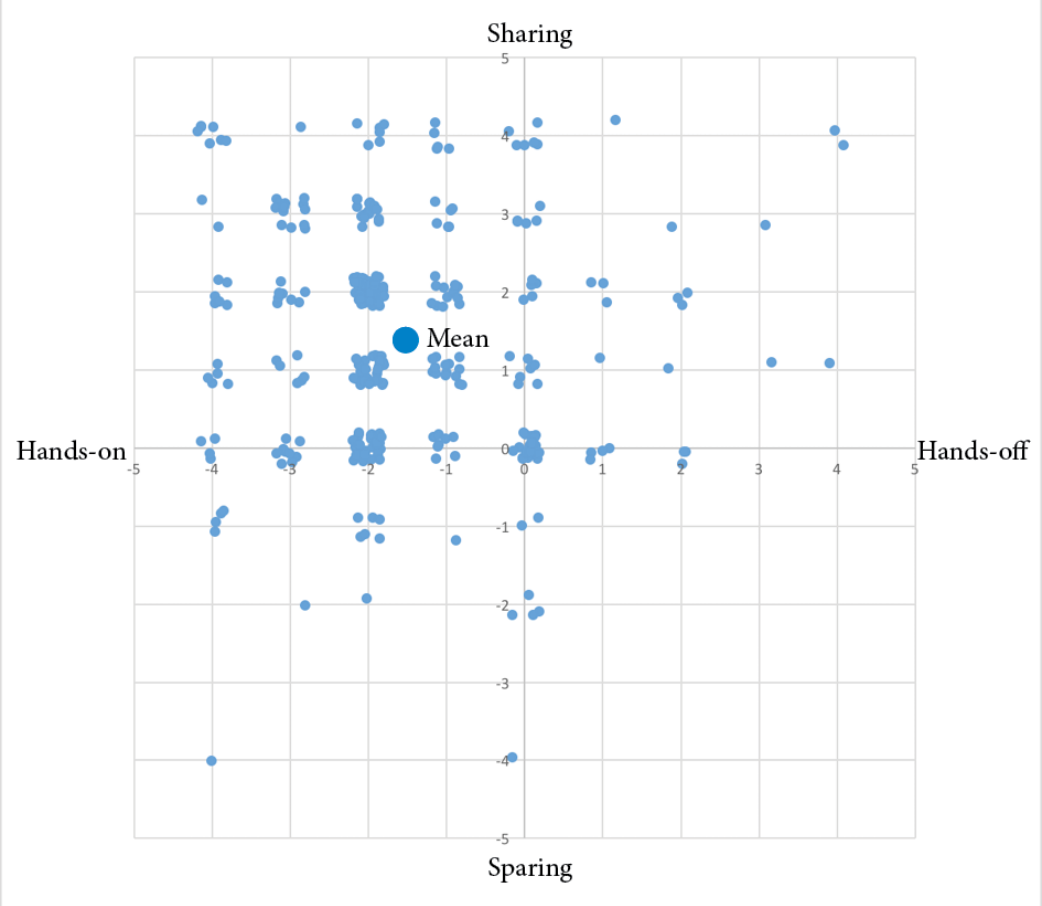

Figure 6 Farmer preferences for 'sparing' vs. 'sharing' and 'hands on' vs. 'hand off' management for woodlands. Random 'jitter' has been added to the integer (x and y) data to show overlapping data points. The mean plot position is indicated by a larger dot (n=335).

Farmers preferences for land sharing over land sparing was not significantly correlated (at $p<0.05$) to any of the woodland characteristic metrics including woodland cover, number of woodland parcels, parcel sizes or membership in woodland associations. The number of woodland parcels held by farmers was weakly, but significantly correlated (r=233, -0.2086, $p<0.05$) with farmers' preferences for hands-on over hands-off management. That is, farmers with more woodland parcels are more likely to be active woodland managers.

7.0 Ponds

Ponds are ubiquitous on the farm landscape. They have diverse purposes in terms of farm operations, but also benefit wildlife and biodiversity in general. Ponds play a role in the hydrological cycle and create aquatic habitat in areas where it can be rare (i.e. upland agricultural areas). Understanding how farmers perceive and manage their ponds can guide conservation extension activities.

7.1 Pond ownership

Sixty-five percent of the 348 farmers in the sample reported having ponds on their farms. Of the farmers reporting to have ponds, they reported an average of 2.2 ponds per farm. Ninety percent of farmers had four or fewer ponds. Only one out of every seven ponds are reportedly natural in origin (14%).

The average construction year for the most recently constructed artificial pond per farm was 1991. Only 10% of ponds were constructed before 1970 and 90% of ponds had been constructed by 2013 (Figure 7).

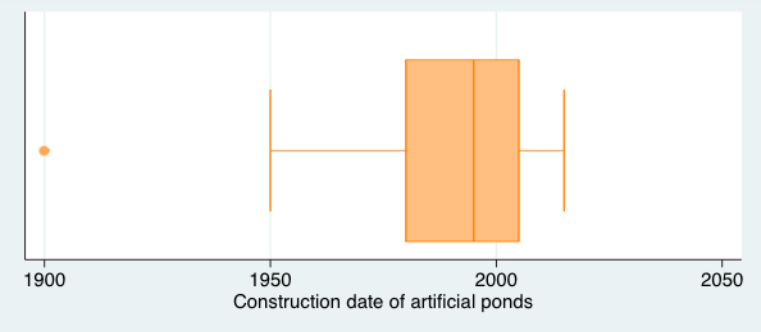

Figure 7 Boxplot of farmer reported construction dates of artificial ponds (n=144).

Farm ponds were most-often created by the respondent farmers themselves (93), but former farm owners (49) and family members (37) were also relatively common (Figure 8). Ten ponds within the sample had been created by Ducks Unlimited Canada.

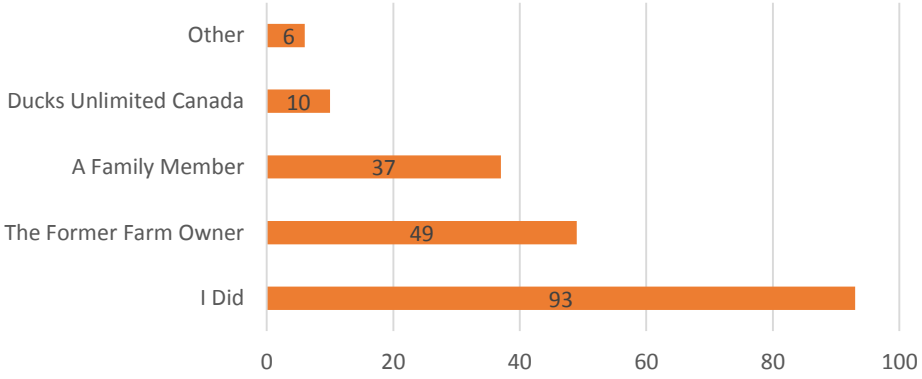

Figure 8 Creator of artificial ponds as reported by farmers (n=197).

Farmers implemented several different practices around their ponds (Figure 9), and for the most-part their motivation was to improve natural conditions rather than production potential. Buffer use was

very common among farmers (103 farmers utilizing the practice to improve natural conditions). Other practices indicated by farmers were less common but were driven by similar motivations as buffer use. Occasional dredging did not fit the same trend; more farmers used dredging to improve production than natural conditions. Certainly dredging a pond is likely to disturb aquatic soils and is unlikely to improve the natural conditions of the pond, with the exception of creating deeper water for trout populations.

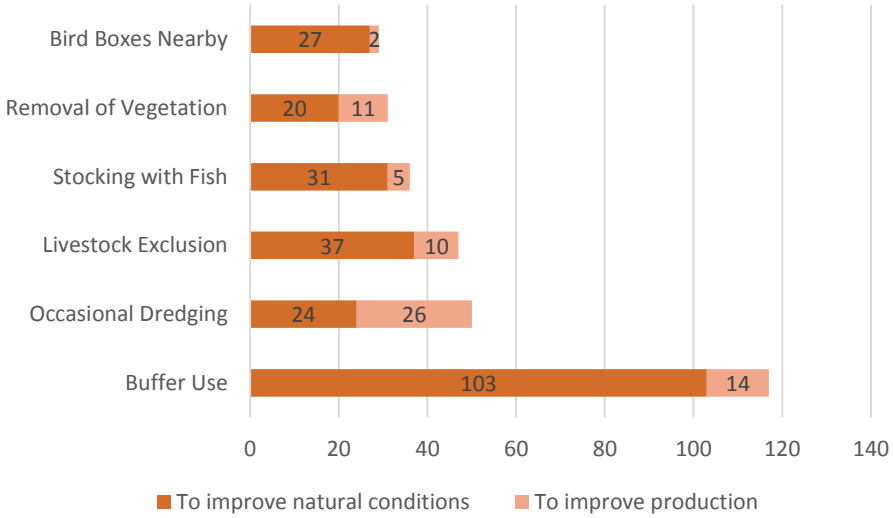

Figure 9 Management practices by motivation around farm ponds (n=218).

7.2 Pond ecosystem goods & services

Farmers generally agreed that ponds produced various ecosystem services, however agreement with similar statements was higher for woodlands than it was for ponds (Table 14). The most agreed-upon statements were in regards to water provision ($\bar{x}$=4.17, sd=0.69), habitat services ($\bar{x}$=4.04, sd= 0.68) and refugium habitat services ($\bar{x}$=4.23, sd=0.61). Similar to the case of woodlands, the statement that earned the least amount of agreement was regarding micro-climate effects of ponds ($\bar{x}$=3.67, sd=0.78). The recreational services also garnered a high level of agreement among farmers.

Cronbach's alpha test of internal reliability was suggestive that farmers considered pond services in the same service category similarly (Table 15). Average correlation between intra-categorical services (at p<0.001) was r=0.65, while the average correlation between inter-categorical services (at p<0.001) was r=0.44. Cronbach's alpha between all service categories for unstandardized, non-zero responses (α=0.83) showed the highest level of internal consistency. This suggests that any given farmer rated their agreement with all service related statements about ponds similarly. The mean agreement with all service-related statements was 3.97 (Std. dev. =0.53).

Table 14 Farmer agreement with pond-related ecosystem service statements (n=326).

Service Category	Service	Statement - Ponds…	Mean ($\bar{x}$)	Standard Deviation
Habitat	Refugium	…are home to animals that reproduce in the spring like frogs, ducks and other birds	4.23	0.61
Provision	Water Provision	…are a source of freshwater for livestock and irrigating crops	4.17	0.69
Habitat	Habitat	…are great habitat for plants and animals that I enjoy seeing	4.04	0.68
Cultural	Tranquility	….create a tranquil space on the farm that is enjoyable	3.94	0.70
Cultural	Aesthetics	…provide a nice addition to the farm landscape making it more beautiful	3.92	0.73
Cultural	Recreation	…are a great place for farmers and their families to enjoy the outdoors, watch birds or skate in the winter	3.90	0.68
Regulating	Pest Control	…help balance the surrounding ecosystem and prevent pests by providing habitat to predators of pests	3.84	0.76
Regulating	Micro-climate Regulation	…create micro-climates that improve the growing conditions for crops around the ponds	3.67	0.78

Table 15 Cronbach's alpha coefficients of internal reliability for farmer agreement to statements about ecosystem services within service categories.

Service Category	Number of items in scale	Cronbach's Alpha (α)
Regulating	2	0.68
Provision	1	N/A
Habitat	2	0.79
Cultural	3	0.80
All services	**8**	**0.83**

7.3 Pond management style

Farmers slightly favoured 'hands-on' management over 'hands-off' management of ponds as indicated by a negative value ($\bar{x}$=-0.60, 95% CI = -0.79, -.42) on the management style preference scale (-4=total preference for hands-on management; 4=total preference for hands-off management) (Figure 10). Farmers favoured land sharing over land sparing in reference to ponds, as indicated by a positive value ($\bar{x}$=0.69, 95% CI = 0.53, 0.86) on the land sharing/ land sparing scale (-4 = total preference for land sparing; 4 = total preference for land sharing). Farmers share preferences with all quadrants of the graph unlike in the case of woodland.

A farmer's placement on the pond management scale (hands-on vs. hands-off) was not significantly correlated with any pond attributes including the number of ponds and the proportion of artificial ponds. The number of ponds farmers reported having was weakly positively correlated with the land sharing / land sparing scale (r=194, 0.27, p<0.001). This suggests that farmers with more ponds are more likely to see benefits from their presence throughout the farm landscape, though the direction of causality is unclear.

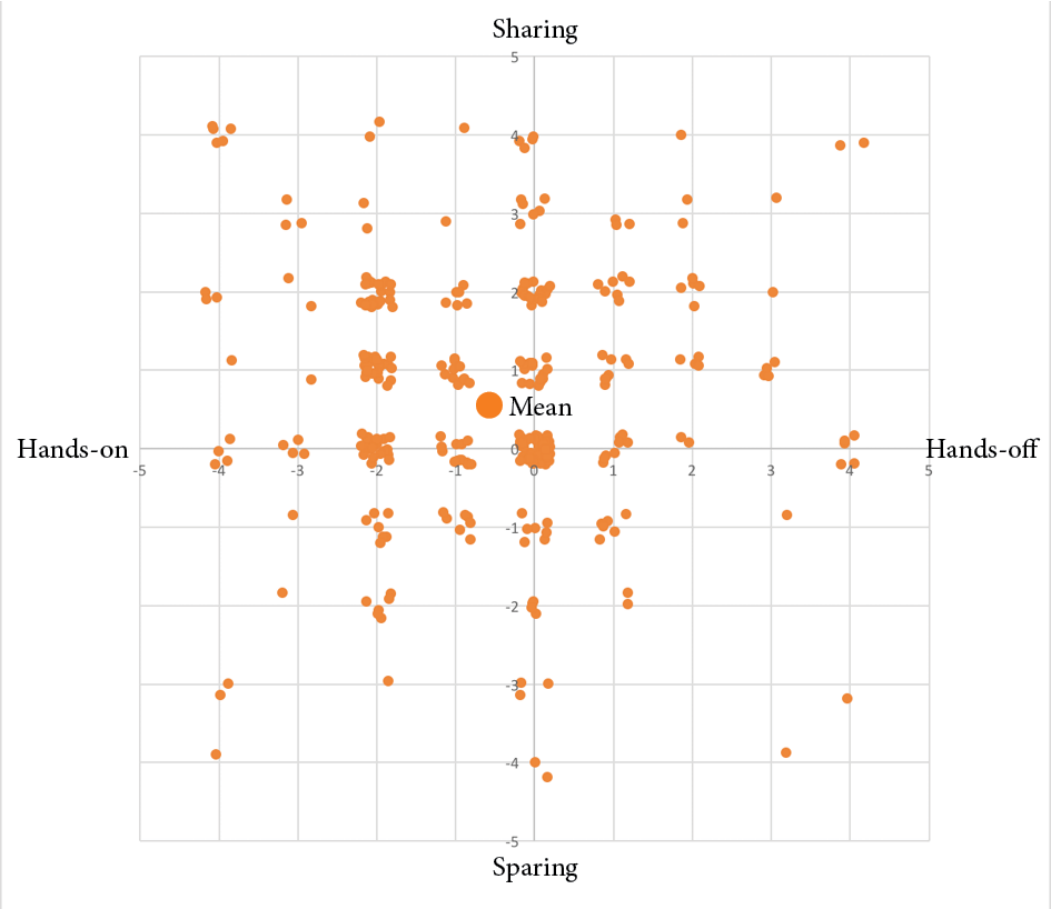

Figure 10 Farmer preferences for 'land sparing' vs. 'land sharing' and 'hands on' vs. 'hands off' management of ponds. Random jitter has been added to the discrete (x and y) data to show overlapping data points (n=326).

8.0 Wetlands

Wetlands were the third and last target landform featured in the survey. Learning about the perceptions and practices of farmers around wetlands is useful in promoting their conservation, by being able to better direct outreach materials (e.g. catering to already held perceptions) and promote less commonly reported best management practices.

8.1 Wetland ownership

About 60% of farmers reported wetlands on their farms. Out of the sample of 346, 139 farmers did not have any wetlands on their farm.

On average, the farms that had wetlands on them had 2.3 wetlands and 90% of those farms had 4 or fewer wetlands. Some farmers within the sample reported as many as 20 wetlands on their premises. Only 12 percent of wetlands were reportedly 'artificial' the rest were deemed 'natural'. Constructed wetlands were built sporadically throughout the 20th century with a median construction date of 1998 (Figure 11)

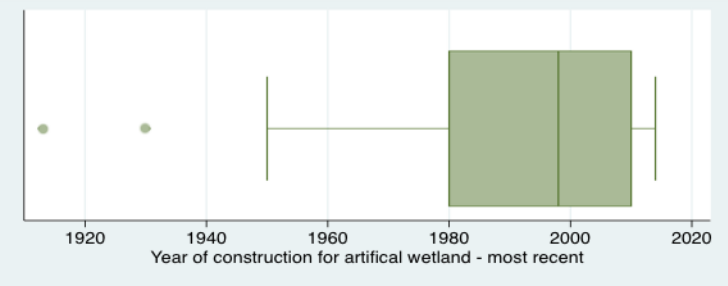

Figure 11 Boxplot of artificial wetland construction dates (n=23).

Buffer use was the most commonly reported practice around wetlands, and the majority of farmers did so to improve natural condition rather than to boost production (Figure 12). Livestock exclusion was less popular but for similar reasons. The least common practices included installing bird boxes, removing vegetation and occasional dredging.

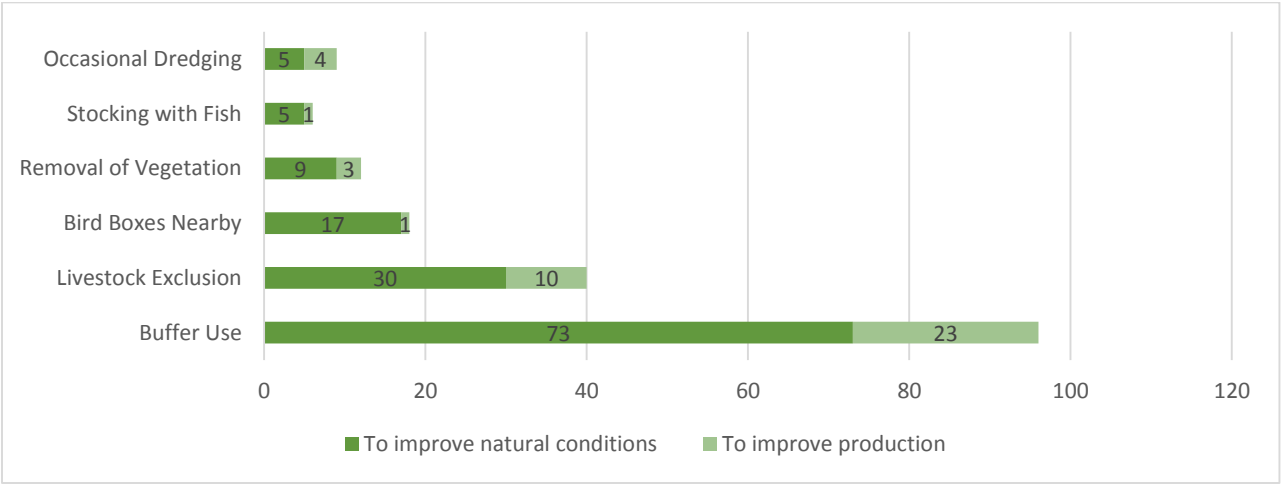

Figure 12 Management practices, by motivation, around wetlands (n=178).

8.2 Wetland ecosystem goods & services

Wetland ecosystem service statements garner less agreement from farmers than similar statements for either woodlands or ponds. No single service averaged over 4 ("agree"). However, similar patterns were seen: the top services by mean farmer agreement include habitat services and global climate regulation ($\bar{x}$=3.94, sd=0.65). Differences appear when in regards to provisioning services ($\bar{x}$=3.38, sd=0.93) and some recreational services ($\bar{x}$=3.21, sd=0.93) (Table 16).

Table 16 Farmer agreement with wetland related ecosystem service statements (n=326).

Service Category	Service	Statement - Wetlands…	Mean ($\bar{x}$)	Standard Deviation
Regulation	Global Climate Regulation	…trap carbon and help regulate the global climate	3.94	0.65
Regulation	Pest Regulation	…help balance the surrounding ecosystem and prevent pests by providing habitat to predators of pests	3.88	0.70
Habitat	Animal and Plant Habitat	…serve as an important habitat to plants and animals that I enjoy seeing	3.88	0.71
Habitat	Refugium	…are an important place for animals to seek safety from predators and reproduce	3.81	0.77
Cultural	Tranquility	…are special places to take in the surroundings and appreciate the tranquility of the landscape	3.64	0.79
Cultural	Aesthetics	…add to the farm landscape and make it more beautiful	3.54	0.86
Regulating	Micro-climate Regulation	…create a micro-climate that improves the growing conditions for crops around the wetland	3.52	0.80
Provision	Water Provision	…are a source of freshwater for livestock or for irrigating crops	3.38	0.93
Cultural	Recreation	…provide a recreational space for outdoor activities for me and my family	3.21	0.85

Cronbach's alpha coefficients were high for farmer agreement with statements representing the same service category (Table 17). Farmers' agreement among all the statements showed high internal reliability (scale items= 9, α= 0.8864).

Table 17 Cronbach's Alpha measure of internal reliability between farmer agreement with wetland-related ecosystem service statements, including means and 95% CI (n=326).

Service Category	Number of items in scale	Cronbach's Alpha (α)	Mean ($\bar{x}$)	95% Confidence interval
Habitat	2	0.81	3.86	3.78 - 3.93
Regulating	3	0.76	3.79	3.72 - 3.85
Cultural	3	0.85	3.46	3.37 - 3.54
Provisioning	1	N/A	3.33	3.22 - 3.43
All services	**9**	**0.89**		

Agreement with the different service categories were slight but significant (Table 17). Farmers had the highest mean agreement with statements that were part of the 'habitat' service category ($\bar{x}$=3.86), followed in order by regulating services ($\bar{x}$=3.79), cultural services ($\bar{x}$=3.46) and provisioning services ($\bar{x}$=3.33) (**Error! Reference source not found.**). All results were significantly different at =0.05.

8.3 Management style

Farmers displayed no overall preference for hands-on over hands-off management of wetlands (Figure 13). Farmer preferences were normally distributed and centered on a neutral position ($\bar{x}$=0.13, 95% CI = -0.052, 0.321) (-4=total preference for hands-on; 4=total preference for hands-off management). A slight preference for land sparing was indicated by farmers ($\bar{x}$= -0.62, 95% CI = -0.806, -0.431) (-4 = total preference for land sparing; 4 = total preference for land sharing), suggesting that they may be more willing to segregate wetlands than have them scattered throughout the farm.

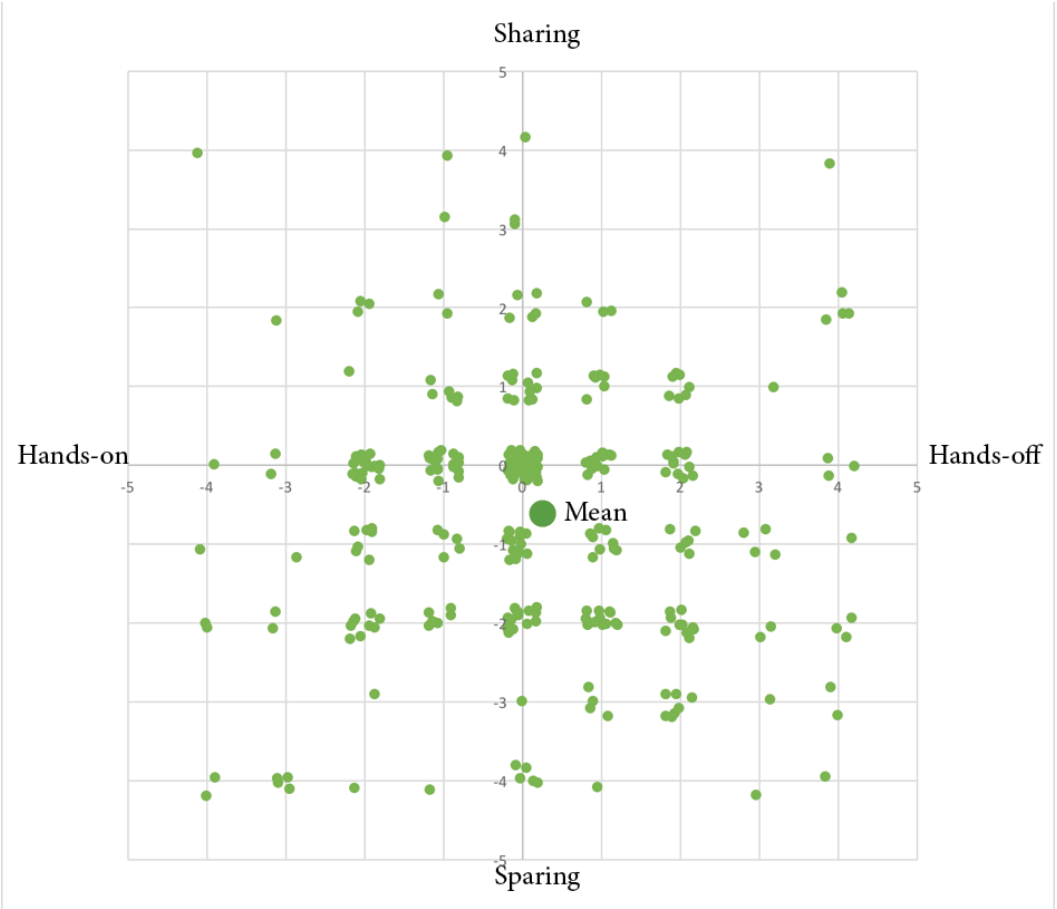

Figure 13 Farmer preferences for 'land sparing' vs. 'land sharing' and 'hands on' vs. hands off' management of wetlands. Random jitter has been added to the discreet (x and y) data to show overlapping data points (n=326).

Farmers preference for hands-off management was moderately correlated (r=22, 0.627, p<0.01) with the construction date of their artificial wetlands. Farmers' aggregated agreement to EGS statements related to regulating services (r=263, -0.363, p<0.01), habitat services (r=303, -0.310, p<0.01) and cultural services (r=292, -0.276, p<0.01) were all significantly negatively correlated with farmer

positions on the land sharing / land sparing scale. That is, a higher perception of services is associated with land sparing.

9.0 Other Areas of the Farm

Sample farmers were asked about their implementation of several best management practices on areas of the farm *not* covered by woodlands, ponds or wetlands. These practices include; leaving buffers around riparian areas, leaving headland buffers around fields, land retirement and livestock fencing. These practices were chosen because they have potential to improve conditions for biodiversity and to maintain farmland quality. In addition, elsewhere in Canada these best management practices are incentivised through the Alternative Land Use Services (ALUS 2) program which pays farmers to implement the practices on a yearly basis.

9.1 Buffers

Seventy percent of farmers reportedly used buffer strips around wetlands, ponds and watercourses, while another 13% used them "sometimes" (Table 18).

Table 18 Buffer use among farmers.

Buffer use	Freq.	Percent
No	55	17.4
Yes	221	69.9
Sometimes	40	12.7
Total	**316**	**100**

Buffers implemented by farmers around riparian areas varied in size. The mean size was 15.5m, but most were far smaller than that, with a median value of 6m (Figure 14).

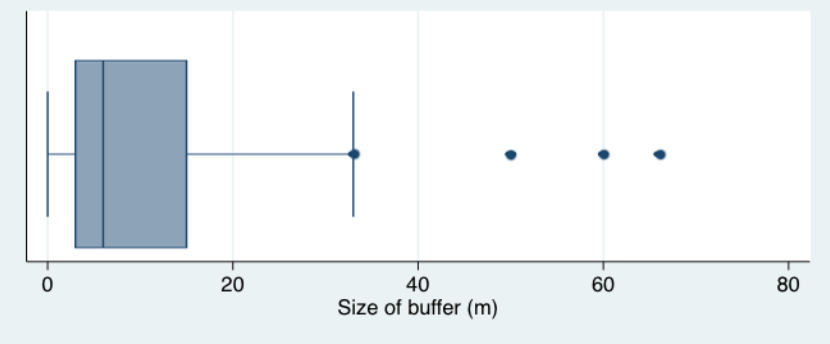

Figure 14 Boxplot of farmer reported buffer sizes (m). Graph exclude data points greater than 100m to increase detail presented in graph (n=212).

Management practice in riparian buffer zones are primarily passive in nature. The most common were allowing shrub and tree growth and doing nothing at all (Figure 15). Less common practices included active management like mowing and using fencing to exclude livestock. Mowing in riparian areas is not recommended and may be counteractive to other biodiversity conservation practices.

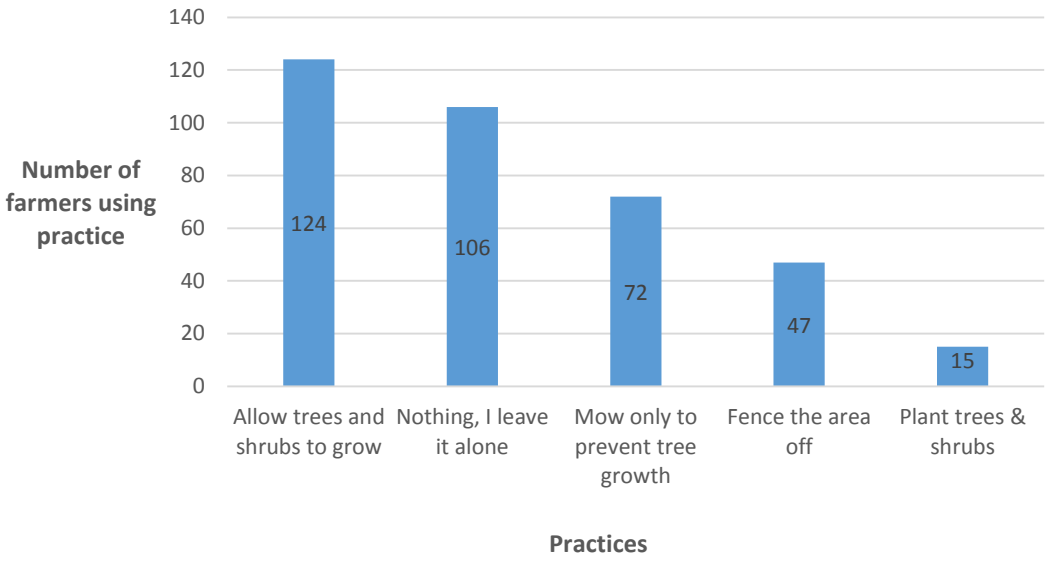

Figure 15 Practices on riparian buffers (n=262).

Buffer strips were most commonly used for soil-loss control (133), and wildlife habitat (113) (Figure 16). Water quality maintenance (65) and flood protection (42) were less commonly reported than no use at all (99). Soil loss control may be a significant motivator for farmer to implement buffer strips in riparian areas. Soil loss control may be valued by farmers because it avoids the loss of a valuable asset (soil) while helping maintain healthy waterways by reducing sediment pollution. Buffer strips for soil-loss control is thus a win-win situation for both farmers and advocates of biodiversity conservation.

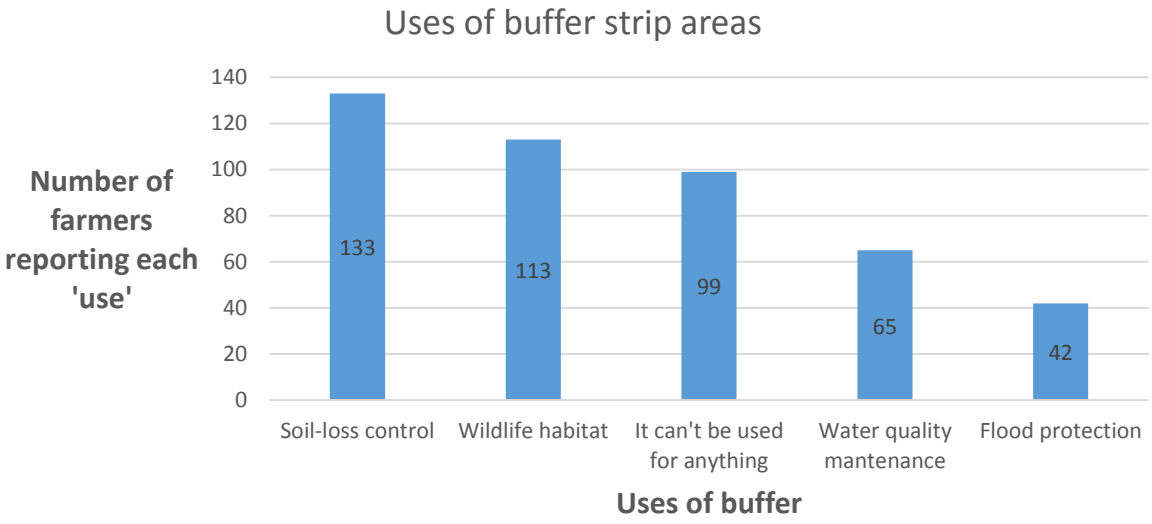

Figure 16 Use of land in riparian buffer zones as reported by farmers (n=261).

9.2 Headlands

The reported use of headland buffers (between fields and non-riparian natural areas) was less common than reported use of riparian buffers. The number of farmers who used headland buffers

was slightly outnumbered by those who did not use headland buffers (Table 19), suggesting that the practice is not a mainstream but not uncommon. Most respondents said they did not have row crops.

Table 19 Farmer reported use of headland buffers.

Headland buffer use	Freq.	Percent
No	69	21.8
Yes	83	26.3
I don't have row crops	164	51.7
Total	**316**	**100**

The most common management practice in headland buffers was to mow periodically (62), while the next three most common practices were all passive; avoiding tillage, avoiding pesticide use and doing nothing (Figure 17). While fewer farmers are engaging in headland buffering (83) than riparian buffering (261), active management is relatively more common among those who use headland buffers. Few farmers were utilizing headland buffer areas for the production of forage (9).

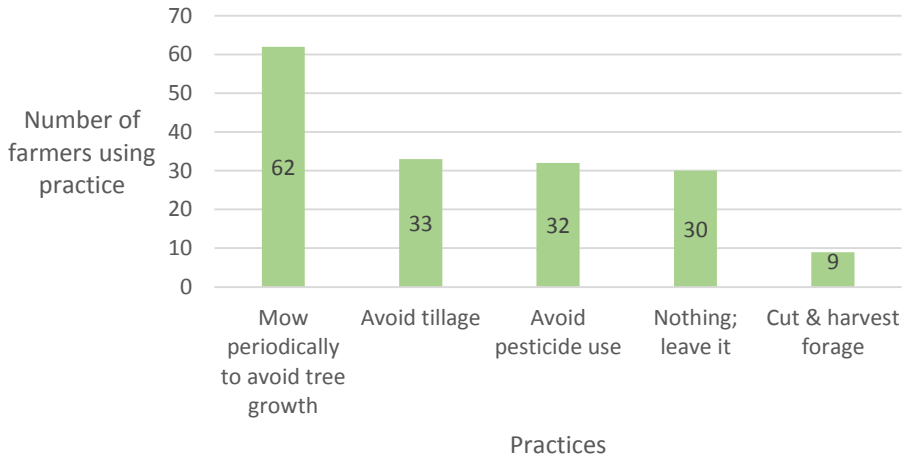

Figure 17 Practices in use on headland buffer areas (n=103).

The most common use for headland buffers is transportation around the farm (50) (Figure 18). The second-most common response was that farmers had no define use for the areas (36), but importantly some farmers were also using headland buffers to provide soil-loss control (29) and to improve pollination (15), both of which can benefit production.

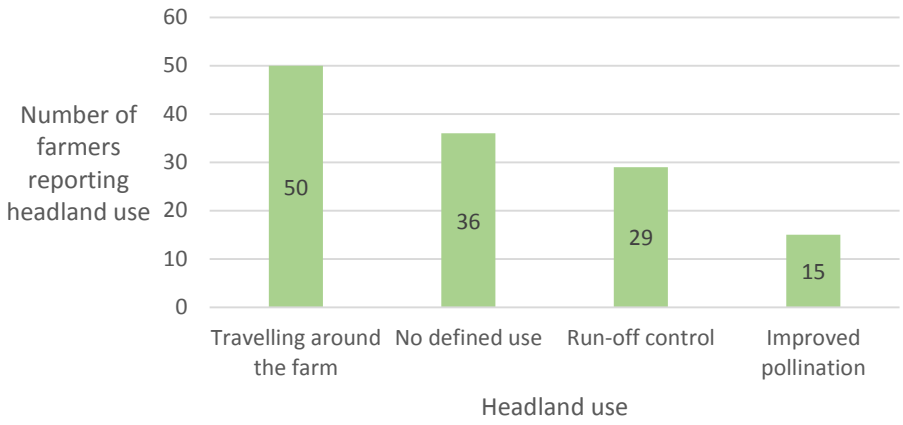

Figure 18 Farmer reported uses of headland buffer areas (n=103).

9.3 Land retirement

Land retirement near wetlands, ponds and watercourses can give these areas added protection from degradation by agricultural activities; sixteen percent of farmers reported retiring land for this reason (Table 20). The vast majority had not retired any land.

Table 20 Land retirement among farmers.

Land retirement	Freq.	Percent
Yes	53	16.4
No	270	83.6
Total	**323**	**100**

Management practices on retired land were mostly passive, with doing nothing as the most common response followed by avoiding several practices (Figure 19). Some farmers mowed their land to prevent the growth of trees while others actively planted trees and shrubs.

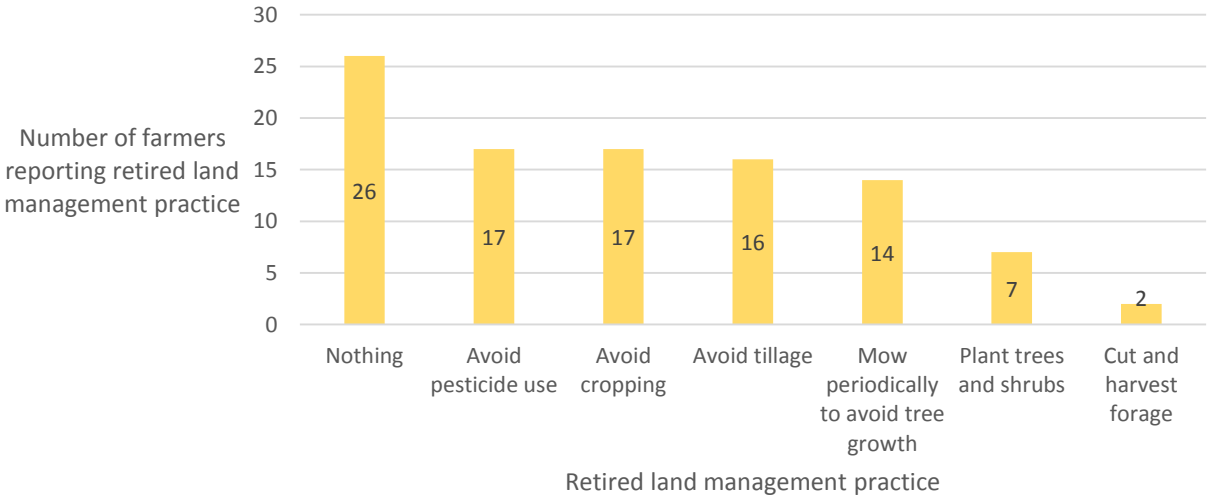

Figure 19 Management practices on retired land (n=54).

The most common use for retired land was to create wildlife habitat (Figure 20). The second most common response was that the land cannot be used for anything which may suggest land retirement out of convenience rather than a specific motivation.

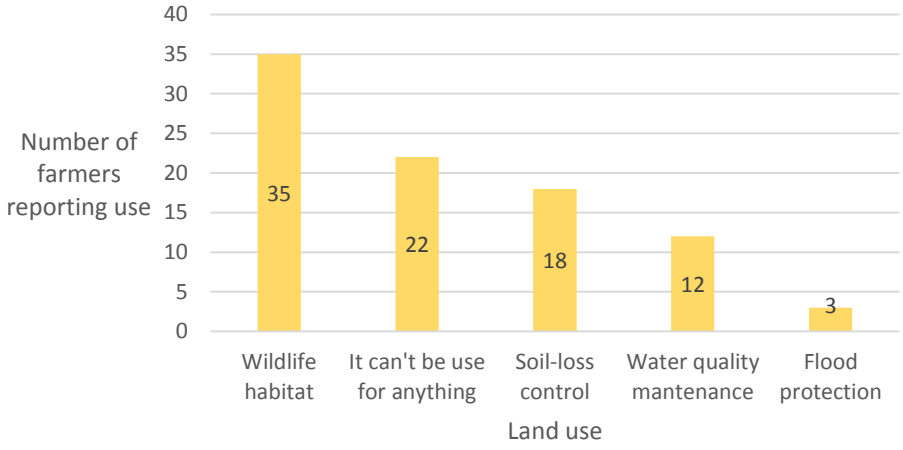

Figure 20 Farmer reported uses of retired land (n=53).

9.4 Retirement of high slope land

Retirement of high slope land was uncommon among farmers (10%) (Table 21). High slope land may not be in production to begin with, however it is clear that this type of land retirement is not a mainstream practice among farmers.

Table 21 Farmer reported retirement of high slope land.

Retirement of high slope land	Freq.	Percent
No	293	90.2
Yes	32	9.9
Total	**325**	**100**

Management practices on high slope land are difficult to gauge due to the rarity of retiring high slope land among farmers. The most commonly reported practice was mowing to prevent the growth of trees(13) (Figure 21). Other active management practices were less common than passive practices like leaving the area alone (9) and allowing trees and shrubs to grow (10).

Figure 21 Farmer reported management practices on retired high slope land (n=32).

9.5 Livestock fencing

Livestock fencing can protect sensitive water bodies as well as streams and brooks. Similarly, limiting livestock access can also benefit the livestock. Of the 71% of respondents who reported having livestock, about 43% did not use any livestock fencing. The balance were somewhat evenly split between those who use it everywhere, and just in some places (Table 22).

Table 22 Farmer reported use of exclusionary livestock fencing.

Use of livestock fencing	Freq.	Percent
No	99	30.46
Yes	61	18.77
Yes, but not everywhere	71	21.85
I don't have livestock	94	28.92
Total	**325**	**100**

The top reasons reported for not using livestock fencing was that it is expensive (44%) and time consuming (30%) suggesting a tangible limitation rather than a doubts about its efficacy (23%) (Figure 22).

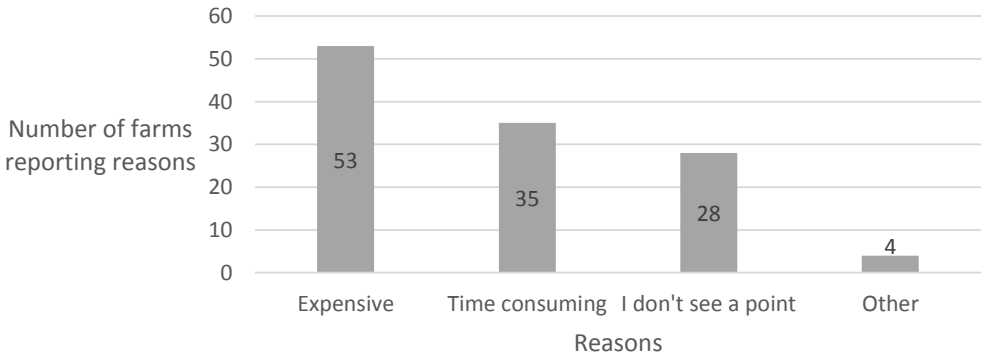

Figure 22 Farmer reported reasons for not using livestock fencing (n=84).

10.0 Hunting

Farms can provide habitat to species like deer and also attract migratory species that are all targets for hunters. Hunting is an acceptable way to deal with some nuisance species on farms, but is not always used (Goodale et al, 2014; Goodale & Sherren, 2014). Finally, unwanted hunting activity on farms can pose a safety risk as well as a nuisance for farmers. None of this is well understood in Nova Scotia. Understanding the relationship between hunters and farmers has the potential benefit of improving relationship between the two group and better using hunting as means of nuisance wildlife control.

10.1 Hunting practices

Hunting was common on farms in the sample. About 73% of respondents reported hunting occurring on their farms (Table 23). Hunting was most often performed by people that the farmers didn't know, without permission, followed by the farmers themselves. Friends and neighbours also made up a substantial proportion of hunters on farms, farmers' family members made up the smallest proportion followed by people unknown to the farmers, but with permission (Table 23).

Table 23 Hunter types in relation to farmers.

Hunters on farms	Frequency	Percent
People that I don't know, without permission	81	32.3
Respondent farmer	70	27.9
Non family members (friends & neighbours)	53	21.1
People that I don't know, with permission	29	11.6
Respondent farmer's family	18	7.2
Total	**251**	**100**

Deer were the most common animals hunted on farms according to respondents (Figure 23). Other bird species were also frequently hunted, both deer and other birds were primarily hunted for food. Bears were hunted primarily to eliminate them as a nuisance. Ducks were hunted as a food source but also commonly hunted for sport and to eliminate them as a nuisance (Figure 23).

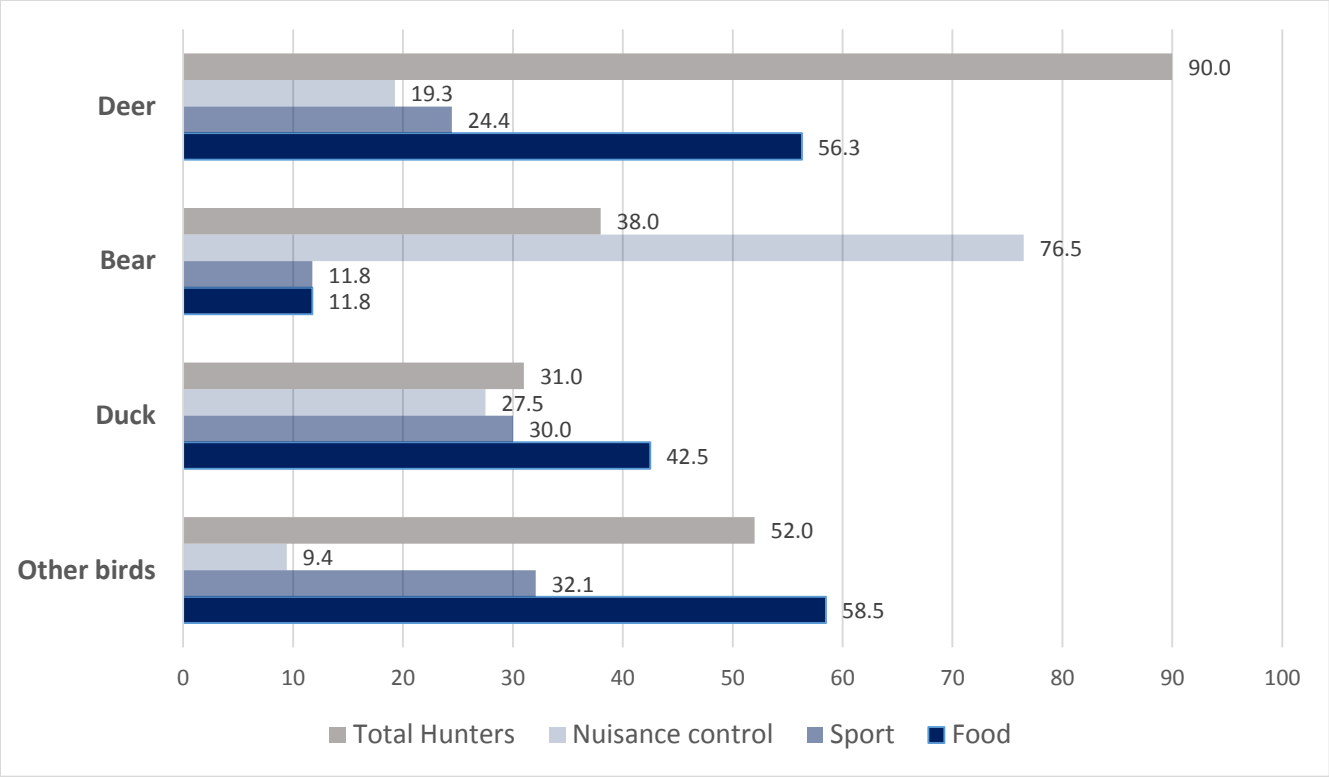

Figure 23 Number of hunters (absolute values) of animal species and relative motivations (percentage of all motivations).

10.2 Perceptions of hunting

Farmers' attitudes towards hunting were mixed and varied by who hunted on the farm. Statements that garnered the most agreement were those that portrayed hunting and hunters as respectful and co-existing well with farming. However, farmers also agreed that hunting posed a safety risk and was sometimes a nuisance (Table 24). Negative statements about safety concerns, hunters as a nuisance and the incompatibility of farming and hunting were agreed with most by those who had hunters coming on their farms without permission.

In general farmers agree more with positive statements when they, their families or friends and neighbours hunt on the farm and agree with negative statements more when stranger hunt on the farm with but especially without permission (Table 24).

Table 24 Mean agreement with six hunting-related statements based on who hunts on the farm.

Hunting attitude	Statement	Farmer	Family	Friends and Neighbours	Stranger w permission	Stranger wo permission	All farmers
Respect	*Hunters are generally respectful and responsible*	3.67	3.75	3.68	3.56	3.29	**3.45**
Compatibility	*Hunters and farmers work well together; there is a mutual benefit*	3.63	3.64	3.59	3.47	3.20	**3.29**
Safety concerns	*I prefer not to have hunters because they pose a safety risk for farmers and rural residents*	2.65	2.73	2.89	2.98	3.23	**3.29**
Nuisance	*I prefer not to have hunters because they damage fields, leave gates open or block access to place I need to go*	3.10	3.01	2.99	3.00	3.25	**3.27**
Incompatible - general	*Hunting should be kept away from farms*	2.47	2.58	2.72	2.77	2.96	**3.08**
Incompatible - personal farm	*There is no risk to having hunters, I just prefer that they stay off my farm*	2.67	2.72	2.59	2.55	2.79	**2.88**

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