Managing cereal grasses as waterfowl lure crops: investigating planting dates and waterfowl feeding ecology

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Introduction

This study examined patterns of habitat use by over-wintering waterfowl on the Lower Fraser River Delta (LFRD), with the goal of determining the efficacy of winter cover crops (specifically cereal grasses) as alternative feeding areas (AFAs) for waterfowl. Winter cover crops are important for agricultural soil management (Hermawan & Bomke 1997; Odhiambo and Bomke 2000), but also act as feeding areas for wintering and migratory waterfowl. Grazing waterfowl present many challenges to farming, aviation safety and recreation and attracting waterfowl to winter cover crops can play a role in reducing these conflicts.

Agriculture on the lower Fraser River delta is important for conserving internationally significant waterfowl populations. A range of waterfowl species use agricultural fields as foraging habitat, including the Wrangel Island Lesser Snow Goose population (the only population of Snow Geese to winter in Canada and breed in Russia), Trumpeter Swans (a previously endangered species), a diversity of dabbling ducks including the American Wigeon, Northern Pintail, Mallard, and Green-Winged Teal, and other wild goose species, including Canada Goose, Greater White-fronted Goose, and Cackling Goose (Butler and Campbell 1987). Agricultural fields contribute to the conservation of these species by providing waterfowl with food, in the form of harvested vegetable residue (e.g., potatoes), perennial forage grasses, cereal cover crops, unharvested grain crops, agricultural weeds, and invertebrates.

Conflict between waterfowl and agriculture can arise when the birds depress the yields of economically important crops, especially perennial forage grasses (hay and pasture grasses). Herbivorous waterfowl especially, Lesser Snow Geese and American Wigeon, can overgraze perennial forage grass, reducing spring yields or requiring that fields are reseeded. Data collected as part of the Delta Waterfowl Damage Mitigation and Compensation Program show that an average of 2,600 acres of forage is grazed annually (Delta Waterfowl Damage Mitigation and Compensation Program unpublished data 2009).

Waterfowl can come into conflict with other human activities as well. On the lower Fraser River delta, waterfowl pose a safety risk to the aviation industry at Vancouver International Airport (YVR), especially when large flocks of Snow Geese congregate on the foreshore marsh of Sea Island, Vancouver, directly in the flight path of approaching and departing aircraft. Snow Geese also graze recreational areas such as school playing fields in Richmond, BC.

Scaring birds away from important crops or air traffic corridors using human or mechanical scaring regimes can have some effect on the movement of birds, but it is important that alternative feeding areas are also available nearby so that waterfowl can graze undisturbed (Vickery and Summers 1992). It may be the case, as suggested by Vickery and Summers (1992), that the efficacy of bird scaring is lower when food resources become limited in supply. This may occur during periods of adverse weather conditions or when there is a lack of alternative feeding areas. Planting cereal cover crops as alternative feed in areas commonly used by waterfowl (e.g., farmland in Delta) could increase the efficacy of scaring regimes in other areas.

Cereal grasses planted as cover crops in the late summer and early fall can act as lure crops, potentially drawing waterfowl away from perennial forage fields by providing them with an alternative source of food. DF&WT's Winter Cover Crop Stewardship Program (formerly the Greenfields Project) provides a cost share to Delta farmers to plant spring cereals (barley, oats, spring wheat) and winter cereals (fall rye, winter wheat) as cover crops. Through this program, Delta farmers are paid a cost–share (per acre) to plant cereal grasses which are meant to benefit both soil fertility (by reducing winter erosion and increasing soil organic matter) and waterfowl conservation. Cereal grasses are used extensively by waterfowl and several studies show that both Snow Geese and American Wigeon will graze cereal cover crops before grazing perennial forage grasses (Bradbeer 2007; DF&WT unpublished annual report 2008).

Despite the presence of cereal cover crops on the landscape of Delta, waterfowl damage to perennial forage crops has not completely abated. Research conducted on Snow Geese shows that as potato residue, cereal cover crops and other alternative foods are depleted, the birds will begin feeding on perennial forage fields (Bradbeer 2007). Depletion of these alternative food sources usually occurs during mid winter, and it is between early March and mid April when the shortage of food appears to be most acute; Snow Geese make their most intensive use of perennial forage crops during these two months.

Managing cereal cover crops to provide greater amounts of biomass during critical periods may alleviate grazing pressure on perennial forage fields. This study will provide data that will help re-develop Winter Cover Crop Stewardship Program guidelines for planting winter wheat as a lure crop for waterfowl in spring. Snow Geese and dabbling ducks will be the focus species of the study because of their abundance in the area and their reputation for causing damage to perennial forage.

Recent evaluation of the Winter Cover Crop Stewardship Program reveals that many farmers plant barley and oats as cover crops in mid August to early September, and plant hardier winter cereals like fall rye and winter wheat from mid-September to early October. Barley and oats are preferred by farmers as early planted cover crops because they cost less than winter wheat, will frost-kill and provide organic matter for incorporation into soils during late spring. However, barley and oats desiccate on the soil surface after being killed by frost and provide little food for waterfowl in early spring. Winter cereals planted after mid-September tend to accumulate less vegetative biomass compared to earlier (August) planted crops. Because they provide less biomass, cereals planted after mid-September are completely grazed in the fall and early winter.

Winter wheat will not frost kill like barley and oats, thereby remaining a viable food source into the spring. A winter wheat lure crop that survives into spring would provide significant spring feed for waterfowl; winter wheat planted in mid August has been shown to accumulate more biomass over winter than the same crop planted in mid-September (Temple *et al.* 2001). Based on these observations, planting winter wheat instead of barley and oats in mid-August should provide waterfowl with an alternative food source to perennial forage during spring.

Study Objectives

The goal of this project was to measure waterfowl use of various cover crops in order to provide a scientific basis for updating cereal management practices on the lower Fraser River delta. With these data, it will be possible to implement practices that maximize feed for wintering waterfowl while minimizing perennial forage crop losses. We examined waterfowl field use on a variety of winter cover crops, including winter wheat, oats, and barley, as well as perennial forage grass.

With accurate waterfowl use data it is possible to quantify the carrying capacity of different cover crops. Waterfowl defecate at a fairly constant rate while feeding so accurate estimates of the number of birds supported by crops can be attained using fecal pellet counts. By using this method for evaluating waterfowl use of winter wheat and perennial forage, it is possible to calculate the acreage of cereal cover crops required to support wintering waterfowl and offset their use of perennial forage crops.

The specific objectives of this study were to:

1. Determine how the planting date of winter wheat affects the number of migratory waterfowl that a farm field can attract throughout the wintering period (fall to spring).

2. Determine how effective planting date influences the ability of winter wheat at luring waterfowl from perennial forage crops.

3. Determine how planting date influences vegetation height and ground cover provided by cereal cover crops and quantify patterns of crop depletion throughout the winter.

4. Use the data collected to calculate the waterfowl carrying capacity of cereal cover crops as well as the acreage of cereal grasses required to offset damage to perennial forage crops.

Methods

Study Site

The Fraser River Delta is the largest estuary on Canada's Pacific coast (Butler and Campbell 1987) and located such that human and non-human interests overlap. Before European settlement the landscape of the lower floodplain was predominantly herbaceous vegetation including marsh and grassland (North *et al.* 1979). Since dyking and drainage in the late 1800's, there has been an increasing human presence and influence on the region. The land has value for humans and for wildlife, in different and sometimes conflicting ways.

Agriculture currently represents approximately 41% of the land use on the lower Fraser River delta, and the majority of the area is zoned as part of the Agricultural Land Reserve (ALR) and is thus meant to remain as agricultural land (Agricultural Land Commission 2009, Fraser 2004). The region produces a variety of crops, including potatoes, beans, peas, corn, cole crops (cabbage and rutabaga), other annual field vegetables, berries, perennial forage, and grain feed for livestock (Fraser 2004). The region produces a large portion of British Columbia's total potato production, 152,343 tonnes in 2001 (British Columbia Ministry of Agriculture Fisheries and Food 2003). Currently, the growing urban population in the Metro Vancouver area is competing with agriculture for the development of land for residential, commercial, and industrial land use, as well as the associated transportation corridors.

Many of our study plots were located on Westham Island, which is situated in the Lower Fraser River Delta (LFRD) at the mouth of the Fraser River. Westham Island is an important agricultural community comprised of arable land with some small scale livestock production. The George C. Reifel Migratory Bird Sanctuary and the Alaksen National Wildlife Area are both located at the northern end of Westham Island.

Data Collection

DF&WT study fields were comprised of 3 winter wheat fields planted in late August ("Winter Wheat Late Aug" treatment), 4 winter wheat fields planted in mid-September ("Winter Wheat Mid Sept" treatment), and 3 winter wheat fields planted in late-September to early October ("Winter Wheat Late Sept" treatment). Replicates with 5 fields of perennial forage ("Perennial Forage" treatment) as well as 12 fields of oats and barley ("Spring Cereal" treatment) were also sampled.

Beginning in October 2009, waterfowl habitat use was monitored by counting the fecal pellets that accumulated in permanent plots each week. This method was ideal for monitoring waterfowl use because it is cost effective and comparably accurate to other methods (Owen 1975; Bédard and Gauthier 1986). Counting individual waterfowl requires that study fields be monitored continuously to ensure no use is missed, and visual estimates of bird numbers can be inaccurate (Boyd 2000). Using visual estimates to quantify waterfowl field use is further confounded because some species (American Wigeon and to a lesser extent, Snow Geese) will graze fields at night when counts are difficult. Generally, waterfowl defecate between every 3-4 minutes (Bédard and Gauthier 1986, Mayhew 1988, Rowcliffe *et al*. 1995), so an accurate estimate of the number of waterfowl using a field can be obtained.

Ten permanent plots, marked with small wooden stakes, were established on each field. Transects were setup at 305m from one corner of the study field to the other and 10 flags were placed at 30.5m distance from each other along the transect. From each flag a 25cm bamboo marker was placed 3m from the flag. The bamboo marker acted as the centre marker for the study plots. The position of the marker at each flag was alternated between sides of the transect. We ensured that each end of the transect (flags 1 and 10) were at least 30.5m from the corner or any edge boundary of the study fields. Fields were monitored weekly and fecal pellets were counted in a $1.03m^2$ circle at each permanent plot. The total surveyed area of each field was $10.3m^2$. Fecal pellets were identified as dabbler/goose or swan. Once counted, fecal pellets were removed from the sample plots to avoid recounting at a later date. Swan pellets were encountered so infrequently that they were excluded from the analysis.

Vegetation sward height was measured at four points in each of the ten plots. The percentage cover of all vegetation in each sample plot was estimated visually as an index of biomass depletion. Vegetation measurements were recorded every four weeks. Monitoring continued until late April 2010, when the majority of waterfowl migrate north.

Statistical Analysis

We totalled pellets per acre accumulated on each field over the entire study. We then compared pellet counts between the 5 crop types using a one-way ANOVA test, followed by a multiple comparison using Tukey's HSD test. Statistical comparisons were considered significantly different when $\alpha \leq 0.05$. We totalled all waterfowl pellets counted on each individual winter wheat field and conducted a linear regression against Julian planting date to determine how planting date affected the number of waterfowl supported.

The count data was combined with known waterfowl defecation rates to calculate waterfowl-use days. A waterfowl use day is one duck, goose, or swan using an area for one day. Waterfowl-use days can be used to express the absolute number of animals an area supports over a given time period, regardless of how variably the area is used (e.g. 1000 ducks using a field for 4 days would be the same as 4,000 ducks using a field for 1 day: 4,000 waterfowl-use days).

Waterfowl-use days were compared between treatments to determine how the planting date of winter wheat affects the carrying capacity per unit area of a cereal lure crop. The carrying capacity of the perennial forage treatments was used as an estimate of how many waterfowl use days need to be supported by lure crops. Combining this estimate with the measured carrying capacity of the cereal lure crops allows for recommendations to be made on the acreage of lure crops required to offset grazing on perennial forage crops.

Vegetation height and percent ground cover were compared across crop types to describe patterns of vegetation depletion and assess soil cover. Comparisons of vegetation height and percent ground cover were conducted for October 2009 and April 2010. A one-way ANOVA followed Tukey's HSD was used to determine which crop types differed significantly from one-another. Statistical comparisons were considered significantly different when $\alpha \leq 0.05$.

Results

Waterfowl Use of Cereals and Perennial Forage

There was a significant negative relationship between Julian day planting date and the total number of waterfowl pellets accumulated on winter wheat fields during the study ($F=29.63$; $df=1,8$; $P=0.0006$; Figure 1). There was a significant difference between mean total waterfowl pellets when compared by crop type ($F=11.34$; $df=4,22$; $P=0.0001$). No significant difference in mean waterfowl pellets was observed between Perennial Forage, Winter Wheat late Aug and Winter Wheat Mid Sept. However we did observe a significant difference in the mean foraging between Perennial Forage/Winter Wheat Late Aug and Winter Wheat Late Sept/Spring Cereal (Figure 2).

Figure 3 shows the chronology of waterfowl use of the different crop types during the study. Use of Winter Wheat Mid Sept and Winter Wheat Late Sept began in the first week of November, with use of the former accelerating in the third week of November. Waterfowl began using Winter Wheat Late Aug and Perennial Forage in the last weeks of November, and use of these fields accelerated during December. Waterfowl use of these crop types appeared to decelerate during late December and early January. In early February, waterfowl use of Perennial Forage began to accelerate and use of this crop type continued until mid April.

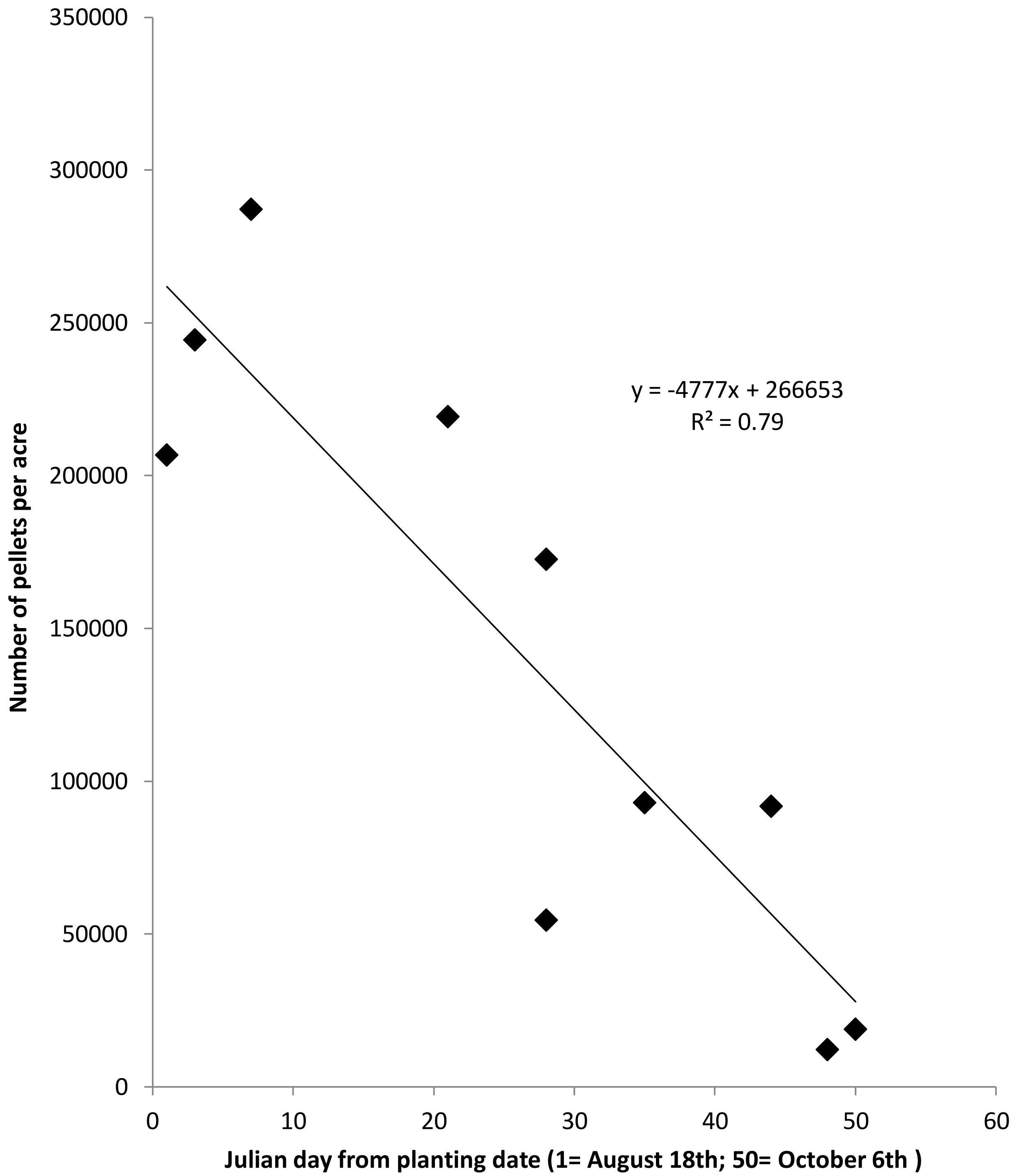

Figure 1. Waterfowl pellets per acre compared to winter wheat planting date. (F=29.63; f=1,8; P=0.0006)

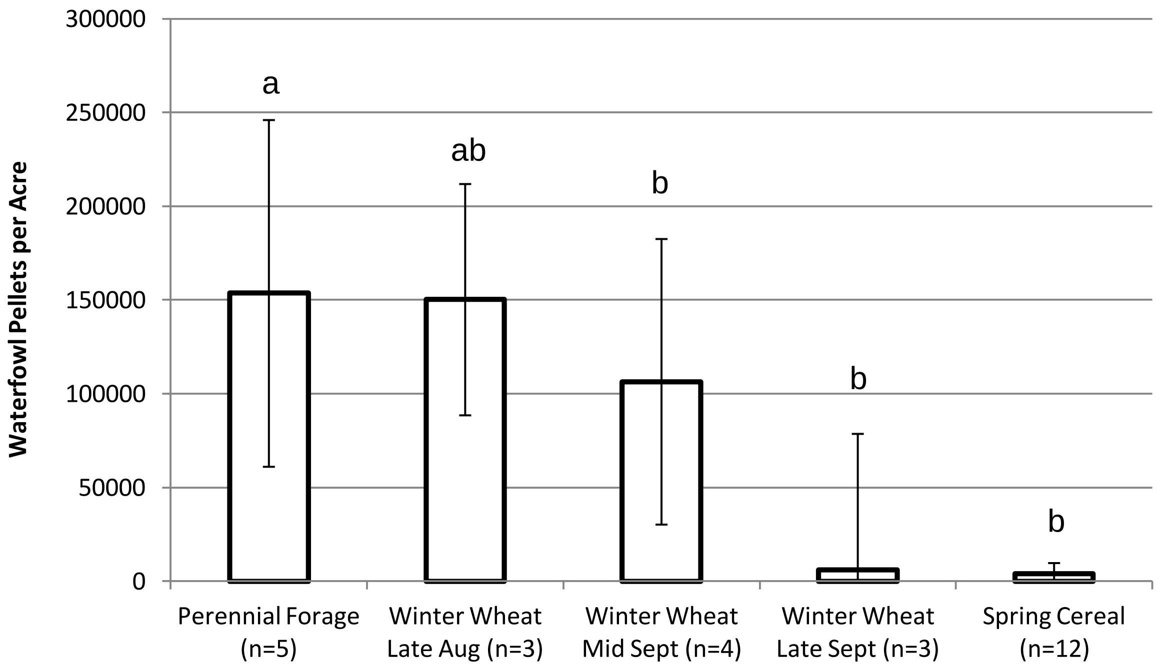

Figure 2. Total number of waterfowl fecal pellets per acre accumulated during study and averaged by crop type, including standard error bars. Columns with the same letter do not differ significantly (α=0.05).

<u>**Vegetation Characteristics**</u>

Vegetation height varied by crop type in October 2009 (F=3.21; df=4,17; p=0.039), though the multiple comparison was unable to identify significant differences between the 5 crop categories (Figure 4). Percent cover differed significantly in October 2009 (F=11.13; df=4,17; p<0.0001), with percent ground cover being lowest on Winter Wheat late Sept (Figure 5). Winter Wheat Late Aug and Spring Cereals both provided over 70% ground cover (Figure 5). In April 2010, vegetation height differed significantly between crop types (F=6.68; df=4,22; p=0.001). Perennial forage was significantly taller than all other crop types, except for Winter Wheat Late Aug. All of the cereal cover crops height was below 5 cm in April 2010 (Figure 6). Percent cover differed significantly in April 2010 (F=12.32; df=4,22; p<0.0001). Spring cereals and Winter Wheat Late Aug provided 40-50% ground cover, whereas the other winter wheat treatments provided less than 10% ground cover (Figure 7).

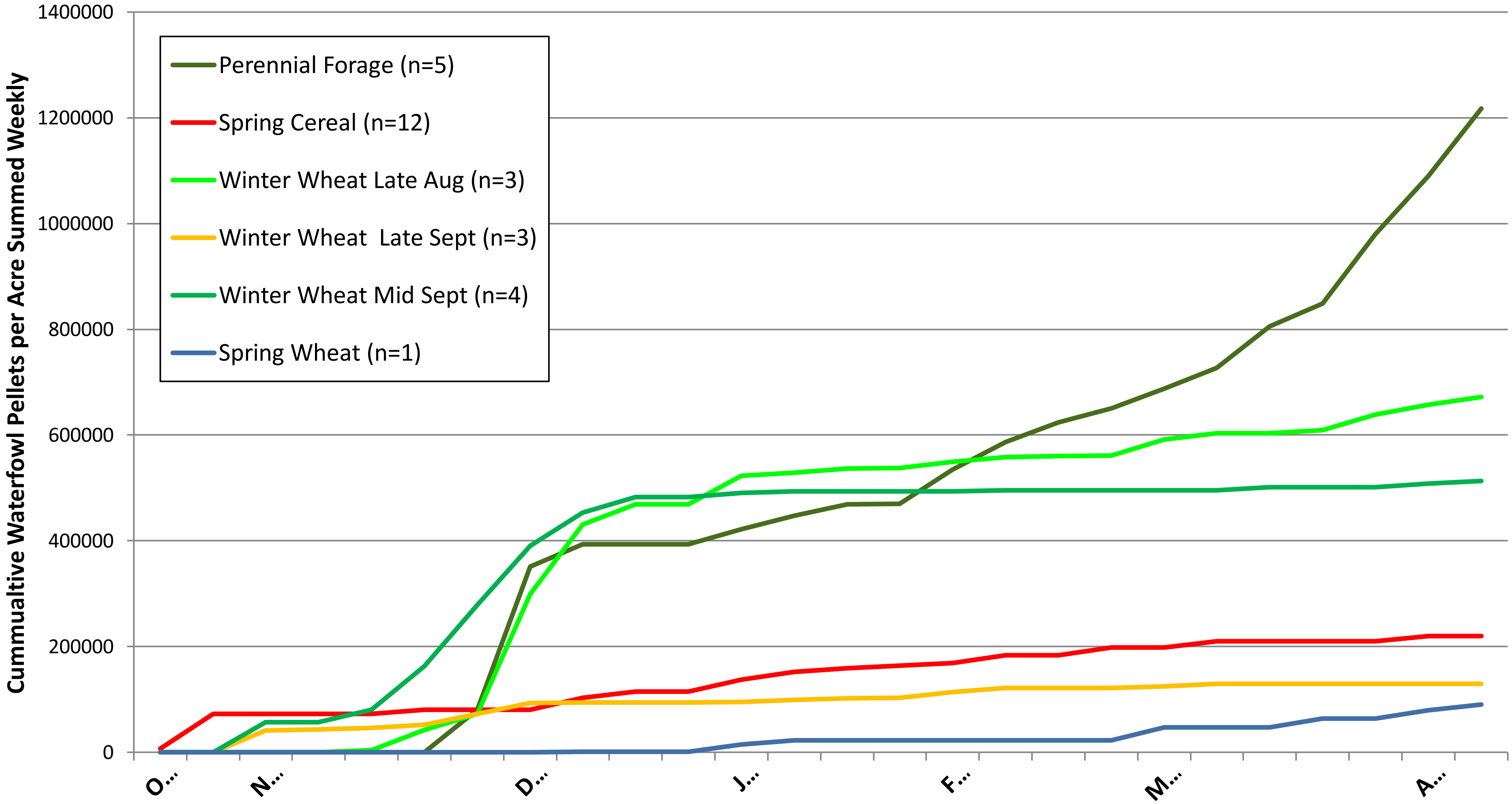

Figure 3. Weekly accumulation of waterfowl fecal pellets per acre, averaged by crop type and summed cumulatively. Weekly counts were conducted between 19 October 2009 to 14 April 2010.

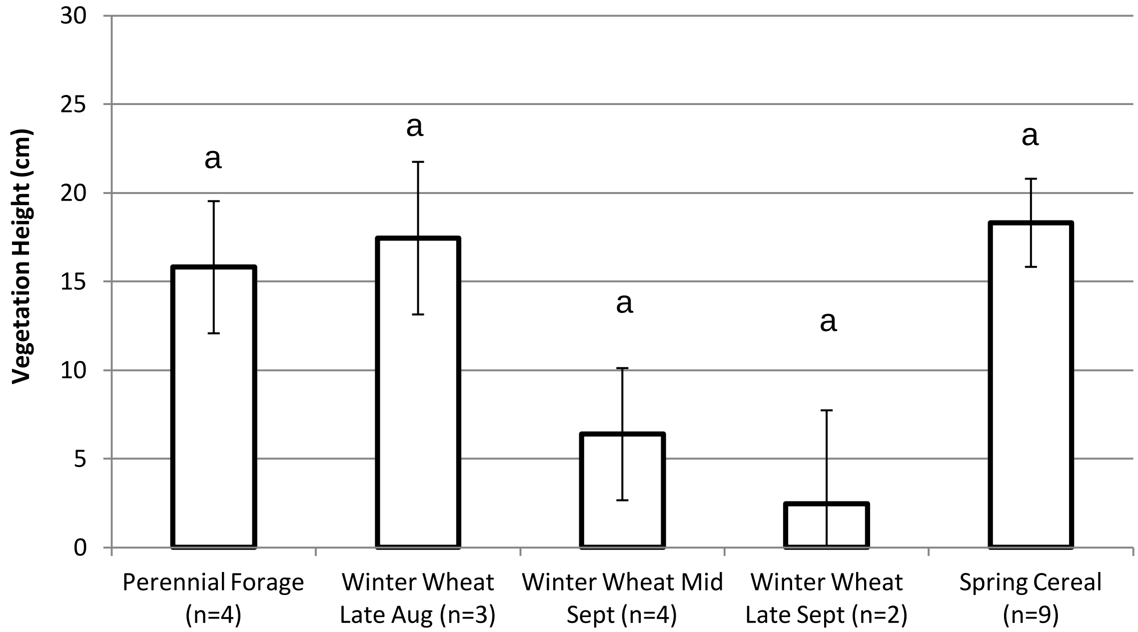

Figure 4: Comparison of mean vegetation height, with standard error bars, of perennial forage, spring cereals, winter wheat in October 2009. Columns with the same letter do not differ significantly (α=0.05).

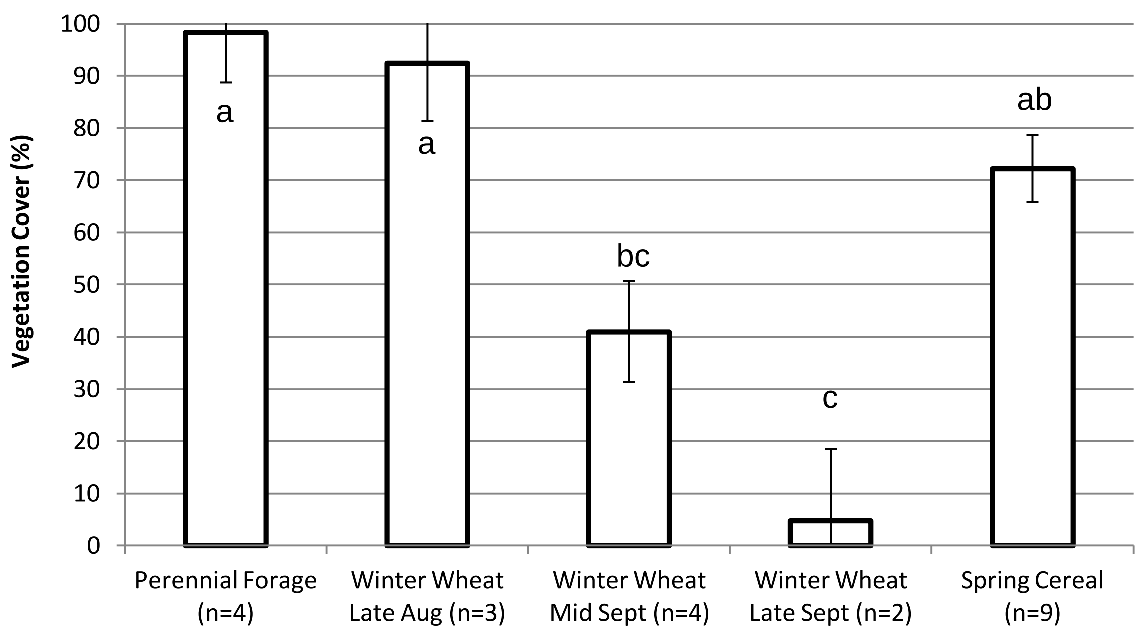

Figure 5: Comparison of percent vegetation cover, with standard error bars, of perennial forage, spring cereals, winter wheat in October 2009. Columns with the same letter do not differ significantly (α=0.05).

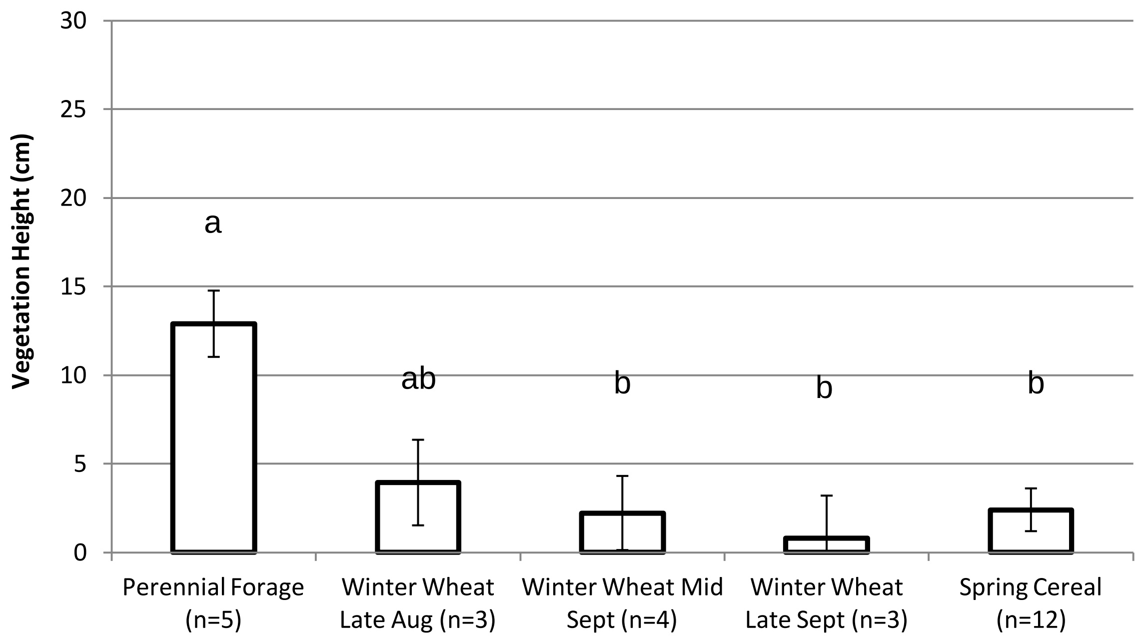

Figure 6: Comparison of mean vegetation height, with standard error bars, of perennial forage, spring cereals, winter wheat in April 2010. Columns with the same letter do not differ significantly (α=0.05).

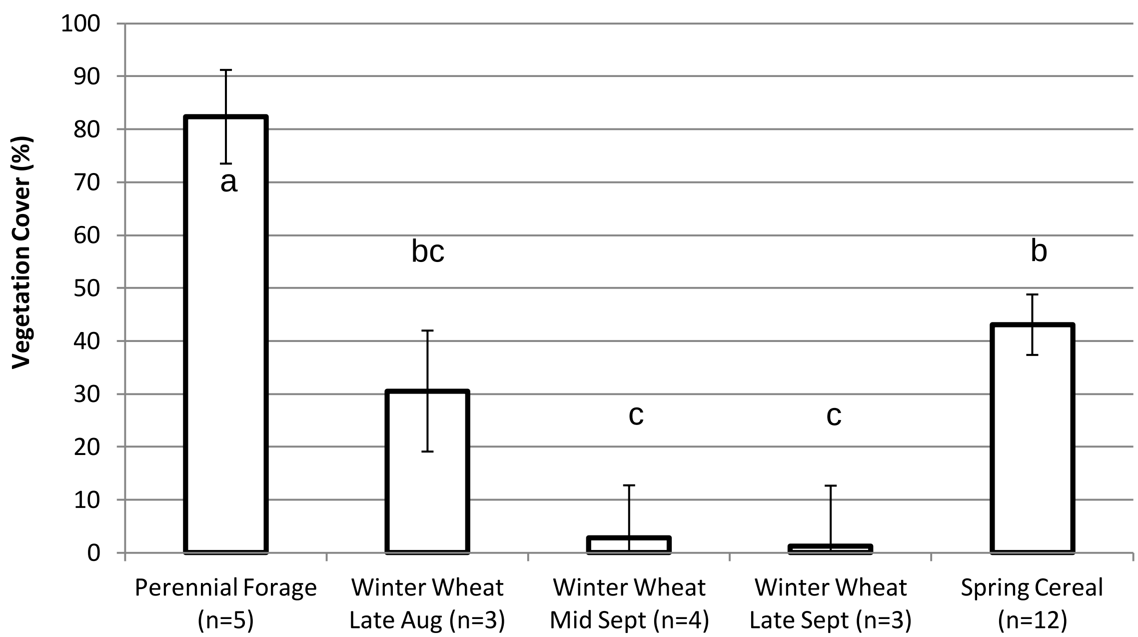

Figure 7: Comparison of percent vegetation cover, with standard error bars, of perennial forage, spring cereals, winter wheat in April 2010. Columns with the same letter do not differ significantly (α=0.05).

Discussion

Patterns of Waterfowl Field Use

The winter wheat planted in late August supported the greatest densities of waterfowl; the capacity of winter wheat to support waterfowl declined with later planting dates. There was no significant difference in the number of waterfowl supported by winter wheat planted in late August and perennial forage, but both of these crop types supported significantly more waterfowl than spring cereals and winter wheat planted in late September.

Migratory waterfowl began using farm fields in mid-October. During this time waterfowl fed on spring cereals, late-August planted winter wheat, and late-September planted winter wheat. More intense use of farm fields began in early November, when waterfowl began using mid-September planted winter wheat. A week later, use of late-August planted winter wheat increased, followed the week after by intensified use of perennial forage. Perennial forage, late-August planted winter wheat, and mid-September planted winter wheat were used concurrently by waterfowl into early December

Use of all crops declined in December when Snow Geese travelled to the Skagit River delta. This movement pattern is observed annually between late December and January (Boyd 1995). During this time, dabbling ducks continued to use late-August and mid-September winter wheat, as well as perennial forage. Perennial forage use increased in March when Snow Geese returned from the Skagit River delta. The use of early-planted winter wheat cover crops in March was marginal compared to perennial forage crops.

In contrast to a study of Snow Geese conducted in 2005 that demonstrated a shift from cover crops to perennial forage (Bradbeer 2007), winter wheat and perennial forage were used concurrently during this study. Cereal cover crops planted as lure crops during this study did not fully abate grazing to perennial forage by ducks and geese. However, cover crops likely offset a portion of the grazing. March and April remains a time when perennial forage grasses are heavily grazed by waterfowl, especially Snow Geese. Additionally, we found that winter cereals planted in late August supported significantly more waterfowl than spring cereals. Spring cereals do not appear to support large numbers of waterfowl because they winter kill; most of the spring cereal vegetation was dead by December.

Planting winter wheat in late September resulted in vegetation cover that was almost completely removed by grazing waterfowl. Winter wheat planted in late September was used significantly less than the earlier planted winter wheat. It is likely that the winter wheat planted in late September did not have enough time to grow tall enough to withstand grazing by waterfowl. Thus, winter wheat planted past late September is likely unsuitable for sustaining a full winter season of waterfowl grazing. In addition, late planted winter wheat probably has little benefit to soil conservation since most of the available vegetative cover is grazed to the ground, leaving very little plant residue to protect the soil from rain erosion.

Unfortunately all three winter wheat treatments planted in late August (WWE) did not appear to provide considerable feed for waterfowl in March and April. However, there was some use of early-planted winter wheat in March that likely offset grazing damage to perennial forage. Interestingly, we included a single replicate of spring wheat in the study and it was used in March. Spring wheat is similar to winter wheat since it is frost tolerant. This was one of the only cover crops to retain some vegetation into spring and as a result it may show promise as a cover crop that lures grazing waterfowl in March when forage is intensively grazed by Snow

Geese. However, this conclusion cannot be confirmed because there was only one spring wheat replicate.

Winter cover crops have the potential to protect the soil from rain erosion throughout the winter, provided they have enough vegetation to cover the soil. Planting winter wheat in late August can increase the amount of ground cover available to protect the soil from heavy winter rains. The cover provided by August-plated winter wheat was statistically similar to that provided by spring cereals. Winter wheat planted in mid and late September do not appear to provide abundant soil cover into April. However, the root systems of cover crops planted in September and October may provide some benefit in the form of increased soil organic matter. It is important to recognize that although the spring cereal cover crops did not providing appreciable feed to waterfowl, they did provide the greatest amount of soil cover into April. Spring cereals remain an important component of winter cover crop planting because of their ability to protect soil surface structure from rain erosion and their ability to provide dead mulch which farmers can incorporate into their soil to increase organic matter content.

Waterfowl Carrying Capacity of Cereals

Using the data collected during this project, we estimated the total number of "waterfowl use days" (1 waterfowl for 24 hours) supported by winter wheat cover crops and perennial forage fields on Westham Island during the 2009/10 study. The linear equation derived for winter wheat (which calculates the theoretical number of waterfowl pellets accumulated per acre) was used to estimate the total pellets accumulated on winter wheat of various planting dates and multiplied by 240 acres (the total area of winter wheat on Westham Island). The carrying capacity of perennial forage was estimated using the average number of waterfowl pellets accumulated during the study and multiplied by 217 acres (the total area of perennial forage on Westham Island).

We assumed that waterfowl defecate every 3.5 minutes (based on 3.1 minutes for Wigeon (Mayhew 1988) and 3-4 minutes for wild geese (Bédard and Gauthier 1986, Rowcliffe *et al*. 1995)) and multiplied pellet estimates by 3.5 to get an estimate of total waterfowl "minutes" spent on each crop type. Based on these estimations, we conclude that the 240 acres of winter wheat on Westham Island supported approximately 78,600 waterfowl use days (an average of 330 waterfowl use days/acre) and 217 acres of perennial forage supported 142,000 waterfowl use days (an average of 650 waterfowl use days/acre).

It is important to note that winter cover crops cannot be completely effective at luring waterfowl from perennial forage fields. Waterfowl are sensitive to the nutrient content of their food plants, especially nitrogen concentration (Sedinger 1997; Bos *et al.* 2005). As perennial forage grasses begin growing in late winter and early spring, they may become more profitable as feed sources than certain cover crops, and it may be impossible to completely exclude waterfowl from grazing them. Protein is highly concentrated in new spring growth and waterfowl have a physiological requirement for protein to build flight muscle and prepare for breeding (Alisauskas and Ankney 1992). However, continuing to manage cereal cover crops to be effective lures for waterfowl will ensure that a portion of the damage sustained to perennial forage crops is abated.

Management Recommendations

Our data show that winter cover crops cannot completely lure waterfowl away from perennial forage. Based on our estimates of waterfowl carrying capacity, current winter wheat acreage would need to double in order to support the same number of waterfowl as perennial forage does between October and April. However, winter wheat planted in late August and early September can support greater numbers of waterfowl than a later planted crop, reducing the acreage required to offset damage to perennial forage. For instance, 184 acres of farmland on Westham Island were planted to barley and oats. If even half of this acreage (e.g., 90 acres) were planted to winter wheat in late August, it could have supported almost 58,000 more waterfowl use days, offsetting an even greater amount of damage to perennial forage grasses.

Based on the results of this study, the Winter Cover Crop Program administered by DF&WT has been restructured to provide greater cost-share payments to farmers who plant winter wheat (or other winter cereals like fall rye) in late August. Table 1 shows the cost-shares that have been adopted for the 2010/11 program year, with 2009 cost-shares for comparison. Encouraging farmers to plant greater acreages of winter cereals planted in late August ($55/acre compared to $50/acre in 2009) and early September ($50/acre compared to $45/acre in 2009) is a way of providing greater amounts of feed for migratory waterfowl, maintaining soil cover for longer periods throughout the winter, and offsetting damage to perennial forage. Winter cereals are further encouraged by decreasing the cost-share provided for spring cereals from $45/acre to $40/acre.

DF&WT will use the results of other research projects findings to further increase the effectiveness of winter cereals as effective lure crops. The project “Eco-friendly Crop Rotations” being conducted by UBC researchers has evaluated several winter wheat varieties that have shown promise in being able to withstand grazing over conventional varieties (Photo 1, Photographic Appendix). Once these varieties have been fully evaluated by the UBC researchers, DF&WT may adopt guidelines to encourage producers to use them as winter cover crops.

Novel management practices may increase the effectiveness of DF&WT’s Winter Cover Crop Program in alleviating grazing damage to perennial forage. Further to the restructuring of the existing guidelines, DF&WT will be piloting program guidelines in 2010 that will encourage farmers to plant forage grasses and clovers into summer grain crops. Under the new guidelines, farmers can receive $45/acre (Table 3) for these plantings which essentially function as cover crops after the grain crop has been harvested. Perennial forage grasses have been proven by this study to be attractive to waterfowl in spring and clover under-seeded into a grain crop has already been trialed in small plots by the “Eco-friendly Crop Rotations” project. The clover in the trial appeared to withstand heavy spring grazing by Snow Geese and shows promise as both a cover crop and a lure crop (Photo 2, Photographic Appendix).

Table 1. DF&WT Winter Cover Crop Program cost-share structure for 2009 and new cost-share structure adopted for 2010 based on results of this study.

Cover Crop Type	Cost-share for 2009 Program	New Cost-share for 2010 Program
Frost-sensitive Spring Cereals (barley & oats)	Must be planted before September 15 $50/acre when planted before August 31 $45/acre when planted before September 15	Must be planted before September 15 $**40**/acre flat rate
Frost-tolerant Winter Cereals (winter wheat, fall rye & spring wheat)	Must be planted before October 9 $50/acre when planted before August 31 $45/acre thereafter	Can be planted up to October 9 $**55**/acre when planted before August 31; $**50**/acre when planted before September 30; $**45**/acre thereafter
Annual Ryegrass	Can be planted up to October 9 $50/acre when planted before August 31; $45/acre thereafter	Can be planted up to October 9 $50/acre when planted before August 31; $45/acre thereafter
Clover (red clover, white clover, etc.) AND/OR **Forage Grass** (timothy, fescue, orchard grass, etc.)	Must be planted before August 15 Only Timothy eligible when under seeded into grain crop	Must be planted before August 15 Clover and forage grass are eligible when under-seeded into grain crop $**45**/acre flat rate **MAXIMUM 50 acres per farm**; *call Program Coordinator to confirm acres* **Note:** new forage plantings enrolled in the Delta Forage Damage Compensation Program are not eligible for the Winter Cover Crop Program
Spring-sown grain that is not **harvested**	$50/acre (has to be planted before August 31)	$**45**/acre flat rate
Spring-sown grain that is harvested, and spilt grain germinates after harvest	Not eligible for program	Not eligible for program

Encouraging the management of forage grasses and clovers not only benefits waterfowl conservation and perennial forage protection, but also soil management. Under-seeding grass and clover into a grain crop requires less tillage than planting a cover crop in late summer/early fall and the plants have a the summer to establish strong root structures. Because they have longer to establish extensive roots systems, forage grasses and clovers seeded into a grain crop may improve soil structure more effectively than winter cover crops that are completely grazed. Clover can also fix nitrogen and can be of benefit to maintaining agricultural soil fertility. DF&WT will employ the fecal pellet counts and whole-field sampling used in this study to assess the value of forage and clover cover crops to waterfowl in 2010 and 2011, including their ability to alleviate grazing on perennial forage.

The management strategies being evaluated in this project fit well into the overall regional conservation of Snow Geese on the lower Fraser River delta. Traditionally Snow Geese wintered on foreshore marshes of Sea Island adjacent to the Vancouver International Airport (YVR) but are now hazed in the area to avoid collisions with aircraft and maintain aviation safety. It is arguable that as birds continue to be hazed around YVR and Richmond, grazing on west Delta farmlands will continue.

Snow geese still use areas adjacent to YVR, as well as residential areas in the City of Richmond where they graze turf playing fields and residential lawns. In both instances it is desirable to accommodate Snow Geese in another location, but doing so requires increasing the habitat capacity of the new location. Developing the habitat capacity of west Delta farmland using management practices like planting winter cereals in mid-August is a potential solution because geese are already using farms in the area and have done so consistently for the past 30 years. Accommodating birds may offset unnecessary damage to perennial forage crops on these farms. Adaptive management also lends itself to stakeholder participation; if measurable ecological benefit can be shown for this project (e.g. waterfowl such as Snow Geese can be attracted and accommodated by cereal lure crops), stakeholders such as YVR and the City of Richmond may express interest in funding stewardship activities on west Delta farms.

Future funding requests for the DF&WT's on-farm stewardship programs can be justified based on the measurable ecological and agricultural benefits of cereal crop management. New funding sources for adaptive stewardship programs offered by DF&WT are possible if it can be shown that waterfowl can be accommodated on west Delta farms by changing cereal crop management practices. The results provide a comprehensive understanding of how cereal crop management can influence the conservation value of agricultural lands while ameliorating the conflict that arises between farmers and waterfowl when perennial forage is grazed. This kind of information is crucial as land managers assess how to accommodate agriculture and wildlife in an increasingly urbanized and developed landscape.

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Photographic Appendix

Picture 1: Several varieties of winter wheat planted on a west Delta farm as part of another AEWF funded project, "Eco-friendly Crop Rotations." All plots were grazed by waterfowl (primarily American Wigeon) but some have re-grown. The varieties that re-grew may show promise as winter cover crops that can withstand heavy waterfowl grazing.

Picture 2: A trial plot of red clover, established as part of the "Eco-Friendly Crop Rotations" project. The clover was seeded into a summer grain crop and provided soil cover throughout the winter, as well as being grazed by Snow Geese. Clover seeded into grain will now be eligible as a cover crop through DF&WT's Winter Cover Crop Stewardship Program and will evaluated during the winter of 2010 and 2011.

Picture 3: Waterfowl completely graze cereal cover crops, removing all vegetative cover from the soil, as evidenced by this photograph of a grazing exclosure. The entire field was planted with winter wheat.

Picture 4: Lesser Snow Geese graze a winter wheat cover crop that was planted in mid-September. By the end of winter, the vegetation on this field was completely grazed off.

Picture 5: American Wigeon (and occasionally the red-headed Eurasian Wigeon) feed and roost in the marshes of the lower Fraser River delta and can significantly reduce yields of perennial forage grasses (hay and pasture).

Picture 6: Many winter cover crops are grazed by late winter and Snow Geese make extensive use of perennial forage fields in March and April.