AN ANALYSIS OF WATERFOWL HABITAT MONITORING SURVEYS IN THE ASPEN PARKLAND OF SASKATCHEWAN AND MANITOBA

By

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A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of
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Abstract

This study explores the statistical compatibility of waterfowl breeding habitat survey data collected throughout the aspen parkland of Saskatchewan and Manitoba. Data collected in the 1999 air-ground waterfowl breeding habitat survey (A/G survey) and the 1999 Prairie Habitat Monitoring Program (PHMP) survey were analyzed to assess the ability of annual A/G data to supplement PHMP data. This study was undertaken to address the need for a more comprehensive and biologically informative approach to waterfowl habitat monitoring in light of habitat conservation efforts under the North American Waterfowl Management Plan (NAWMP).

Analysis of 96 quarter sections indicates that habitat areas common to both surveys, and within 200m of the right-of-way in each quarter section, accurately reflect the amount of cropland and grassland habitats within respective quarter sections. Extrapolating wooded habitat from the 200m area adjacent to the right-of-way to the quarter section is not recommended on a local level. Wooded habitat must be studied on a landscape level to eliminate localized variation. Extrapolation of natural wetland habitat is not recommended since: (1) natural wetlands are not uniformly distributed, and (2) wetlands near rights-of-way are subject to higher degrees of impact, thus wetland density within 200m of the right-of-way may under-represent availability across the broader landscape. Data for artificial wetlands and constructed cover habitats are limited, but suggest an inability of the 200m area to represent the quarter section.

Quarter section data were amalgamated to investigate landscape effects of rights-of-way. Results suggest that habitat within 200m of the right-of-way may accurately represent quarter section habitat in regards to annually tilled cropland, grasslands, woodlands and natural wetlands.

Relationships between individual wetlands were explored for 507 A/G wetlands and their associated PHMP habitat descriptions. Results indicate that the A/G and PHMP survey designs reveal complimentary and compatible information regarding available wetland and upland habitats.

Information from this study may assist in the evaluation of the long-term effectiveness of NAWMP initiatives by aiding in the development of more biologically informative habitat monitoring techniques.

Acknowledgments

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I am also indebted to Mr. David Ingstrup, Chief, Habitat Conservation and Assessment Division, Canadian Wildlife Service; Mr. Michael Watmough, Wildlife Biologist, Canadian Wildlife Service; Mr. Martin Schmoll, Landscape Analyst, Canadian Wildlife Service; and Mr. Hans Schinke, Wildlife Technician, Canadian Wildlife Service, for providing digitized versions of Prairie Habitat Monitoring Program data.

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This thesis is dedicated to my mother, for countless words of encouragement and support.

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Chapter 1: Introduction

1.1. Preamble

Waterfowl are the most prominent and economically important group of migratory birds in North America, generating direct expenditures in excess of several billions of dollars annually. For the period 1970 – 1979, continental estimates indicated a breeding duck population of approximately 62 million, which produced an average annual fall flight in excess of 100 million (North American Waterfowl Management Plan 1986). These numbers provide the benchmark on which total duck population goals for North America are currently based.

By the mid-1980's, North American waterfowl populations declined to record low numbers. Significant losses of wetland and upland habitats to agriculture (Fredrickson and Laubhan 1994) along with drought-like conditions (Klett et al. 1988), depredation (Beauchamp et al. 1996a), and over-hunting (Caswell et al. 1985) were primarily to blame. In response to declining waterfowl populations, Canada and the United States signed the North American Waterfowl Management Plan (NAWMP) in 1986, with Mexico joining in 1994. The ultimate goal of the Plan is to restore North American waterfowl populations to benchmark levels recorded in the 1970's.

Although the majority of waterfowl populations are currently close to achieving this goal, efforts must continue to monitor and preserve their critical habitats. The continuing growth of global population and the increasing demand for agricultural production, combined with an inevitable return to average or below average hydrological conditions, will likely depress waterfowl populations in the future (North American Waterfowl Management Plan 1998). Thus, if waterfowl populations are to be sustained, conservation efforts must continually be adjusted, and monitoring programs must continue to be implemented. NAWMP partners must enhance planning and program evaluation efforts by expanding current day monitoring and assessment capabilities (North American Waterfowl Management Plan 1998).

Waterfowl habitat monitoring programs currently conducted across the Canadian prairies and aspen parkland include the Waterfowl Breeding Ground Population and Habitat Surveys (hereafter referred to as Air/Ground surveys, or A/G surveys) and the Prairie Habitat Monitoring Program (hereafter referred to as the PHMP). In the effort to monitor changes in breeding population numbers, as well as changes in the availability of breeding habitat, the Canadian Wildlife Service (CWS) and the United States Fish and Wildlife Service (USFWS) have conducted annual A/G surveys since 1955 (USFWS and CWS 1987). More recently, the PHMP was implemented to address the need for a habitat monitoring program in support of Prairie Habitat Joint Venture (PHJV) programming efforts (Ingstrup and Schinke 1999). First conducted in 1986 and again in 1998 and 1999, the PHMP attempts to provide relatively quick and cost effective estimates of land cover and land use changes that have occurred within NAWMP target areas (Ingstrup and Schinke 1999). However, if waterfowl populations are to be sustained, there exists a need to establish large-scale habitat-monitoring programs which are both biologically informative and cost-effective (Williams et al. 1999). Without suitable monitoring, evaluating the long-term effectiveness of the NAWMP is difficult.

1.2. Issue Statement

The effect of habitat conservation efforts under the NAWMP in contributing to the continental recovery of waterfowl is poorly understood (Williams et al. 1999). The NAWMP has been successful in promoting conservation of waterfowl habitat, but less so in promoting the evaluation needed to guide conservation. The absence of large-scale, cost-effective, and biologically informative habitat monitoring may be the most important limiting factor that waterfowl managers face in their efforts to improve habitat management (Williams et al. 1999).

Waterfowl breeding habitats in western Canada are currently monitored under the protocols of the A/G survey and the PHMP. To varying extents, the two surveys overlap in their transect routes. To date, no efforts have been made to explore relationships between the two survey designs. PHMP data collection and analysis are time-consuming and financially costly. PHMP data are more comprehensive and biologically informative than A/G data in terms of changes in absolute areas of available habitat, however A/G surveys employ a more detailed habitat typing scheme. Statistical compatibility of the two data sets may allow annual A/G data to supplement PHMP data. This study may assist in the development of more comprehensive, cost-effective, and biologically sound methods of monitoring waterfowl habitat. This may allow for a more comprehensive evaluation of habitat change in the PHJV target areas since the inception of the NAWMP.

1.3. *Objectives*

The primary objective of this study is to explore the statistical compatibility of Air/Ground Habitat Survey data and Prairie Habitat Monitoring Program data, in the effort to determine the feasibility of amalgamating the methodologies underlying the two programs. In order to satisfy the primary objective, the following secondary objectives will be addressed:

1. Determine if the 200m area of habitat adjacent to the right-of-way in each quarter section, and common to both A/G and PHMP habitat surveys, provides an accurate representation of the habitat available in a quarter section.

2. Explore landscape effects of rights-of way on land-use, and their potential effects on survey designs.

3. Determine the feasibility of amalgamating the two survey designs by building associations between A/G habitat data and PHMP habitat data in an effort to explore the statistical compatibility of the two data sets.

4. Provide recommendations for future waterfowl habitat survey techniques.

1.4. Assumptions and Limitations

This study analyzes secondary data, with the assumption that all data were collected accurately and consistently by trained individuals adhering to standard operating procedures. It is assumed that all data are valid and provide an accurate representation of habitat conditions and impacts throughout the surveyed areas.

Habitat data are analyzed on the basis of individual quarter sections. The total area of habitat within each quarter section is restricted to 64.75 ha, which is the area of one quarter section. This limitation results in the loss of one degree of freedom in the statistical analysis of quarter section habitat data.

Chapter 2: Review of Related Literature

2.1. The Prairie Pothole Region of North America

The Prairie Pothole Region (PPR) (Figure 1) is the primary breeding ground for many species of waterfowl in North America. Approximately 80% of the region is in Canada, encompassing 480,000 km^2 in southeastern Alberta, southern Saskatchewan, and southwestern Manitoba (Greenwood et al. 1995). Although representing only 10% of the waterfowl breeding grounds in North America, the PPR yields approximately 60% of the continent's duck production (Cowardin et al. 1982, North American Waterfowl Management Plan 1994). Between 1955 – 1985, an average of 21.6 million ducks used the PPR, representing about 51.1% of the total estimated surveyed population in the continent (Greenwood et al. 1995). Prairie pothole habitat accounts for more than 50% of the breeding mallards in southern Manitoba (Manitoba NAWMP Technical Committee 1988).

Throughout the 1970's, duck populations breeding in the PPR had reached benchmark numbers. The most prominent are the dabbling ducks, which include the mallard (*Anas platyrhynchos*), northern pintail (*A. acuta*), and blue-winged teal (*A. discors*). Dabbling ducks are the most abundant and widespread group of ducks breeding in North America, and are of greatest importance to sport hunting and viewing (North American Waterfowl Management Plan 1986). Highest densities of breeding dabblers are found across the PPR of North America. By 1985, breeding populations of these 3 species had significantly declined from 1970's averages. Mallards decreased from 8.7 to 5.5 million, northern pintails from 6.3 to 2.9 million, and blue-winged teal from 5.3 to 3.8 million (North American Waterfowl Management Plan 1986).

FIGURE 1: THE PRAIRIE POTHOLE REGION (PPR) OF NORTH AMERICA (EULISS ET AL. 1999)

2.2. Historical Trends in Waterfowl Populations in the PPR

In the 1980's, dramatic declines in waterfowl breeding populations in the PPR were the result of habitat loss, drought-like conditions, and depredation. The continual loss of habitat is the most pressing waterfowl management issue in North America today. In particular, breeding and nesting habitat for ducks continues to be lost to the intensification of agricultural practices such as cultivation, clearing of vegetation, drainage of wetlands, and exploitation of marginal lands (Duebbert and Frank 1984, Carlson 1985, Bethke and Nudds 1995, Patterson 1995). It is estimated that by the mid-1950's, 72% of land in the Canadian PPR was tilled annually, with much of the remaining upland grazed by livestock (Greenwood et al. 1995). Since the 1970's, over 10 million acres (~ 4million ha) of marginal farmland and wetlands were put under cultivation in prairie Canada (Patterson 1995). By the mid-1980's, intensive agricultural land-use practices continued in the PPR, and along with periods of drought, resulted in a significant decline in wetlands and deterioration of suitable nesting habitat (Cowardin et al. 1982, 1985; Hochbaum et al. 1985). Between 1975-85, one third of the remaining grassland in the PPR was converted to cropland at an annual rate of 2% (North American Waterfowl Management Plan 1986). Currently, it is estimated that the United States has lost more than 50% of its original wetlands and continues to lose them at the rate of nearly 120,000 ha annually (Melinchuk 1995). In some regions of Canada, up to 90% of the wetlands have been altered or converted in some manner (Melinchuk 1995). In the PPR, approximately 40% of wetlands have been destroyed, and 60 – 80% of wetland margins have been degraded (Patterson 1995).

The intensification of agriculture across the PPR has interrupted the natural relationships that have evolved between ducks and their environment. Breeding dabblers require adequate upland nesting cover as well as temporary, seasonal and semi-permanent wetland complexes to successfully rear their broods. Agricultural development across the prairies has resulted in losses of upland nesting cover and small ephemeral prairie wetlands, resulting in a concentration of ducks and their predators in remaining patches of suitable habitat (North American Waterfowl Management Plan 1986). In much of the PPR, recruitment of young in recent decades has been inadequate to maintain or build certain waterfowl population levels, even in years of favorable water conditions (North American Waterfowl Management Plan 1986). Historically, the annual recruitment rate of mallards nesting in the PPR was approximately 40%. In the 1980's, this rate dropped below 15%, which is considered the minimum level necessary for a self-sustaining population (Cowardin et al. 1985, Hochbaum et al. 1988). A number of studies suggest similar trends. Hammond and Forward (1956) estimated nest success in the PPR of North Dakota to decline from as high as 70 – 80% during 1937-38, to 20 – 30% for the period 1947-51. Miller (1971) found nest success to decline from 63% in the 1930's to 29% in the 1950's across the Canadian and U.S. prairies. Beauchamp et al. (1996b) found nest success in the PPR to decrease over time from 33% in 1935 to 21% in 1955, 15% in 1970, and 10% in 1992.

Other studies hypothesize increased depredation coincident with habitat alteration as the cause of the decline in nest success of upland nesting ducks in the PPR (Cowardin et al. 1982, 1985; Beauchamp et al. 1996a). In an agricultural landscape, breeding populations of ducks are forced to concentrate their nesting efforts in islands of available habitat. Predators in turn concentrate their search effort in these isolated pockets of prime waterfowl nesting habitat, thereby increasing their search efficiency. However, Clark and Nudds (1991) suggested that nest success may not be the most important variable affecting recruitment. Brood survival (Rotella and Ratti 1992) and survival throughout the annual cycle (Hill 1984) may deserve more attention. Therefore, another approach to habitat monitoring may be to investigate the influence of broad-scale habitat patterns on population changes (Williams et al. 1999).

Changes in hydrological conditions may have also played a role in the decreased nest success of ducks in recent decades. The 1980's was one of the driest decades since the 1930's. Drought-like conditions reduced vegetation cover, resulting in reduced nest concealment. This particularly impacts early nesting species such as the mallard and northern pintail, as residual nesting cover in early spring is reduced. The end result is decreased nest success due to increased depredation rates (Beauchamp et al. 1996b). Drought-like conditions may also decrease the local abundance of small mammals and insects, which act as alternative prey for nest predators (Beauchamp et al. 1996b). If such prey becomes scarce, predators may consume a higher proportion of duck eggs (Johnson et al. 1989). It is therefore important to separate the effects of anthropogenic changes to the landscape (e.g. loss of habitat to agricultural expansion and intensification) from those caused by changes in climate (e.g. drought) (Bethke and Nudds 1995). Effective monitoring programs must therefore focus on changes in wetland availability as well as changes in availability of suitable nesting habitat.

2.3. The North American Waterfowl Management Plan

The North American Waterfowl Management Plan (NAWMP) was enacted in 1986 in response to declining continental waterfowl populations. The basis behind the Plan was the existing need for management initiatives to include habitat conservation (North American Waterfowl Management Plan 1998). Since over 85% of the duck population breeds on privately owned farmland, the traditional approach of habitat protection through nature reserves was not feasible (Patterson 1995). To achieve NAWMP goals, a myriad of habitats must be conserved, most of which exist in private, working landscapes, and thus the interests of the people who share these landscapes with wildlife must be considered (North American Waterfowl Management Plan 1998). The habitat programs under the NAWMP were designed to work with the private landowner in providing incentives for sustainable land use practices that benefited waterfowl as well as soil and water resources (Patterson 1995).

The NAWMP has been a major force in moving the wildlife conservation community toward a landscape approach, one that integrates management and stewardship of public, private and common lands (North American Waterfowl Management Plan 1998). A landscape approach to conservation strategies provides multiple benefits for soil, water, and wildlife (Melinchuk 1995). The Prairie CARE program (Conservation of Agriculture, Resources, and the Environment) is a prime example of a landscape level program, and is the major component of the NAWMP on the Canadian prairies. The whole basis of Prairie CARE is to work with farmers, the farm community, and government farm organizations to develop a menu of sustainable land use practices that benefit waterfowl and the farmer (Patterson 1995). Prairie CARE offers financial and program incentives to private landowners to adopt soil and water conservation practices that also benefit waterfowl and other species of wildlife (Melinchuk 1995). Landowners will utilize their land such that maximum profits are realized. Many factors, such as commodity prices, influence the diversification of land use. The Prairie CARE program has shown that farmers will willingly take marginal land out of grain production and put it into permanent cover for conservation purposes for $15 per acre (~$38/ha) per year if an increase in net profit is realized. In such cases, because of much reduced input costs, the farmer's net profit is increasing. Farmers who have adopted NAWMP conservation farming practices are realizing a $13 per acre (~$33/ha) net increase in annual profits (Patterson 1995). Along with the benefits to landowners, wildlife has benefited as well. In Canada, over 650,000 ha of wetland, shorelines, grassland and woodland habitat have been conserved thus far (North American Waterfowl Management Plan 1998).

In the province of Manitoba, the Manitoba Habitat Heritage Corporation (MHHC) coordinates implementation of NAWMP activities (Table 1). In Manitoba, the total land area affected by the Plan as of 1999/00 climbed to 247,416.44 ha (MHHC 2000).

Overall, NAWMP has been successful in enhancing, conserving and restoring waterfowl habitat, not only in Manitoba, but across the entire continent. However, effective monitoring programs must be established to ensure the long-term success of the Plan.

TABLE 1: NAWMP PROGRAM ACCOMPLISHMENTS SUMMARY (IN HECTARES) FOR MANITOBA AS OF 1999/00. (MODIFIED FROM MANITOBA HABITAT HERITAGE CORPORATION 2000)

	Green Acres	Prairie CARE	Potholes Plus	HELP	NAWMP Total
Secured 1999/00	642.24	615.93	474.70	0.00	1732.87
Before 1999/00	13152.00	57594.05	2698.85	4384.77	77829.67
Total Secured	13794.24	58209.98	3173.55	4384.77	79562.54
Agricultural Demonstrations 1999/00	0.00	19208.00	0.00	0.00	19208.00
Before 1999/00	8328.43	138890.14	1427.33	0.00	148645.90
Total Demonstrations	8328.43	158098.14	1427.33	0.00	167853.90
Program Totals	22122.67	216308.12	4600.88	4384.77	247416.44

2.4. *Existing Needs for Habitat Conservation and Monitoring*

Most waterfowl species have experienced a dramatic recovery under the NAWMP. Contributing to this is abundant precipitation on the breeding grounds, widespread changes in agricultural practices and policies, harvest restrictions, and habitat conservation efforts (Williams et al. 1999). Although these factors have had an obvious effect in combination, the effect of habitat conservation efforts in contributing to this recovery is poorly understood (Williams et al. 1999). As of 1999, less than 30% of the Plan's habitat goals have been attained at a cost of approximately 90% of the funding target. Based on habitat objectives currently identified in the joint venture management plans, there clearly exist large and unmet needs for habitat conservation (Williams et al. 1999).

Our understanding of the linkages between habitats and population processes remains incomplete, and our ability to predict the population consequences of conservation actions remains limited. To advance biological understanding and promote sound decision-making, there is a critical need for broad-scale habitat monitoring that focuses on biologically relevant landscape patterns (Williams et al. 1999). This information is a key element in providing a landscape context for conservation actions taken under the Plan so that landscape features can be taken into account as conservation actions are implemented and evaluated (Williams et al. 1999). It also is needed to better elucidate the species-habitat relationships on which to base conservation decisions. For example, monitoring could help in assessing habitat conditions within and across regions, with the intent to identify vulnerabilities to habitat degradation and the potential for habitat enhancement (Williams et al. 1999).

Habitat management programs need current information on the habitat available for upland nesting ducks. Knowledge of the amount and distribution of existing habitat will help to direct programs and funds into areas where greatest benefits can be expected (Sugden and Beyersbergen 1984). Although the objective of Prairie CARE is waterfowl recruitment through improved upland habitat, wetlands remain an integral part of the program. Upland nesting waterfowl require temporary and seasonal wetlands for breeding, as well as broad expanses of undisturbed cover adjacent to wetlands in which to nest. Large marshes, in turn, provide critical staging, molting and breeding habitat for waterfowl and other wetland-dependent wildlife, and offer some of the most critical habitat for migratory shore and wading birds (Melinchuk 1995). Effective monitoring programs must encompass both upland habitat and wetland habitat parameters in order to be effective at evaluating the effects of habitat conservation under the NAWMP.

With few exceptions, monitoring and assessment efforts under the NAWMP have lagged behind planning and implementation (Williams et al. 1999). Without suitable monitoring, the ability to evaluate the long-term effectiveness of the Plan is difficult. Uncertainties about the processes regulating waterfowl populations frustrate the development of useful habitat objectives. Information provided by a more holistic approach to habitat monitoring may be useful in reducing uncertainties about the consequences of management, thereby improving waterfowl conservation over the long term (Williams et al. 1999). The challenge is to design such programs for cost-effective delivery and maximum conservation benefit, while sustaining the political support needed to deliver the necessary fiscal resources (Williams et al. 1999).

Chapter 3: Research Methodology

3.1. Sources of Data

A/G Surveys have been conducted annually since 1955 (USFWS and CWS 1987). These surveys are a cooperative effort between the CWS and the USFWS, with the support of other resource management agencies in the prairie provinces. Methodology for data collection follow those described in USFWS and CWS (1987). The PHMP was first conducted in 1986 using 1985 baseline data, and again in 1998/99. General methodology for PHMP data collection follow those described in Millar (1987) and Ingstrup and Schinke (1999). This study incorporates the use of secondary data from the A/G Surveys and the PHMP. The data are provided courtesy of the Canadian Wildlife Service.

3.2. Collection of Data

3.2.1. A/G Surveys

The A/G Survey is performed annually in southern prairie Canada during the approximate period May 3rd to May 25th. The southern prairie Canada ground portion of the A/G survey focuses on the prairie and aspen parkland habitats within strata 26 - 40 (Figure 2). A stratum is defined as a specific geographic unit encompassing areas of similar waterfowl densities and is generally of a specific habitat type (USFWS and CWS 1987). Within each stratum, a systematic random sample of transects are surveyed, with each transect serving as a sampling unit. Transects are subdivided into a series of segments. Aerial crews survey waterfowl and wetland data for each individual segment. Selected segments are surveyed by the ground crew in the effort to provide visibility correction factors for the aerial crew. Segments in the prairie and aspen parkland regions of Manitoba and Saskatchewan range in length from 10 - 18 miles (16 - 28.8 km), running east to west along section lines. Waterfowl population and breeding habitat data are surveyed within 1/8 mile (200m) on either side of the east / west segment line. For the purposes of this study, data are restricted to segments within strata 34, 35, 39, and 40.

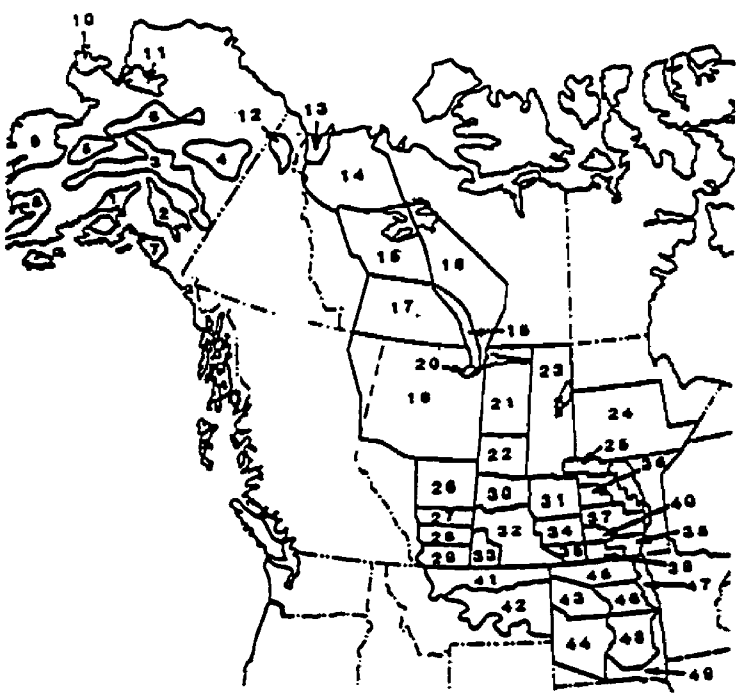
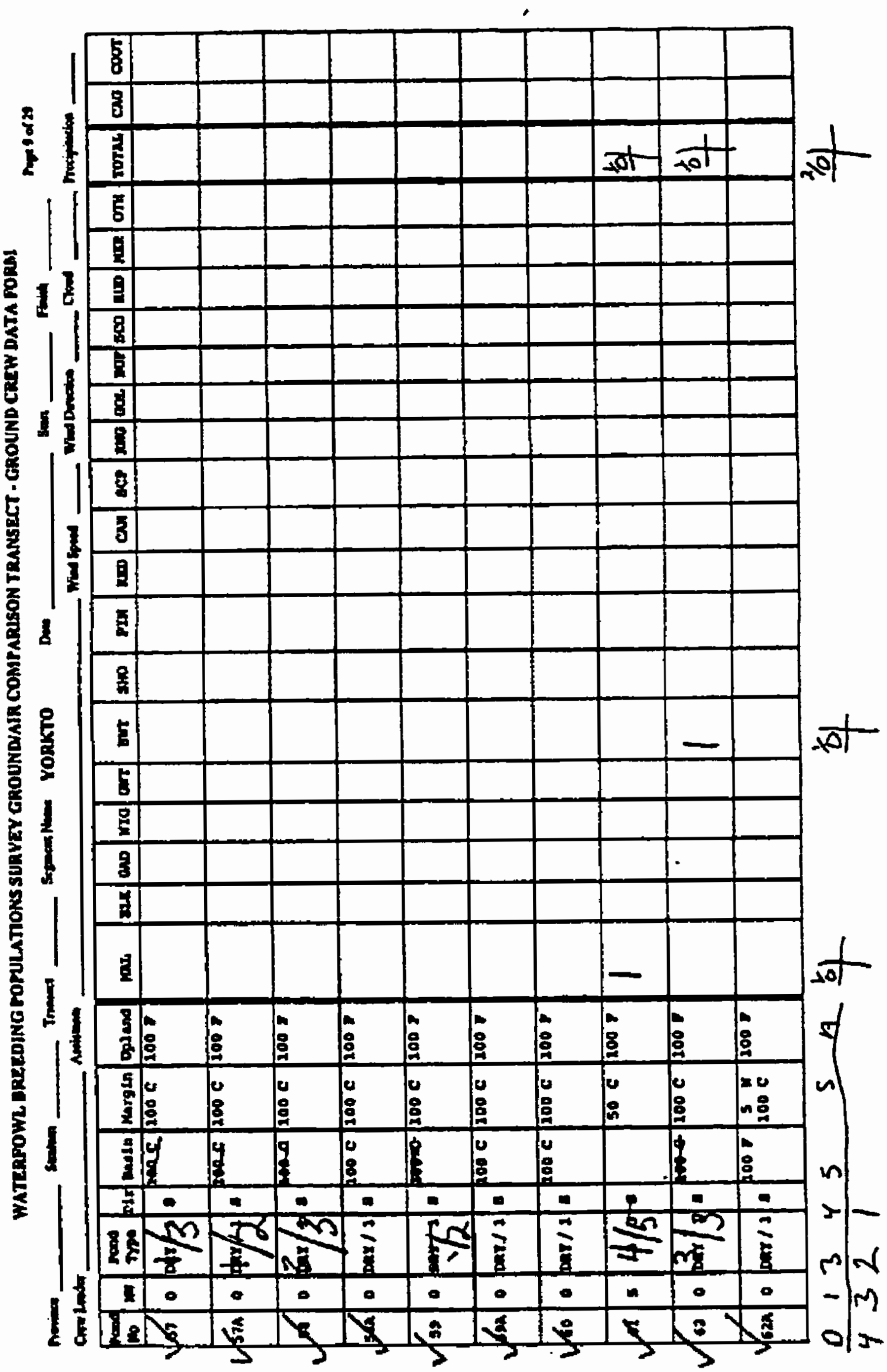


FIGURE 2: SURVEY STRATA IN A/G BREEDING POPULATION AND HABITAT SURVEYS (MODIFIED FROM JOHNSON AND GRIER 1988)

Aerial photographs of each segment (Figure 3) and data sheets from the previous year's survey (Figure 4) are updated by the ground crew throughout the course of each survey. Wetlands are individually numbered on the aerial photos, with their corresponding pond type and habitat data provided from the previous year in the effort to minimize observer bias (Schuster 1993). Ponds, which were not present in the previous year, are added onto the aerial photos and typed accordingly on the data sheets. For each wetland, impacts and conditions are recorded for the basin and margin, along with upland conditions (Figure 5). Habitat classification codes applicable to the A/G Survey are provided in Appendix A.

Waterfowl breeding population status, as well as breeding habitat impacts and conditions are analyzed following each annual survey, and compared to short-term (previous 10 years) and long-term (since 1955) trends. Results are reported in the annual Manitoba Waterfowl Status Report, an unpublished document produced by the Canadian Wildlife Service.

FIGURE 3: AERIAL PHOTOGRAPH OF A PORTION OF THE YORKTON, SK. A/G SURVEY SEGMENT (WETLANDS 54 - 62 CORRESPOND TO PHMP POLYGONS IN FIGURE 7).



WATERFOWL BREEDING POPULATIONS SURVEY GROUND/AIR COMPARISON TRANSECT - GROUND CREW DATA FORM

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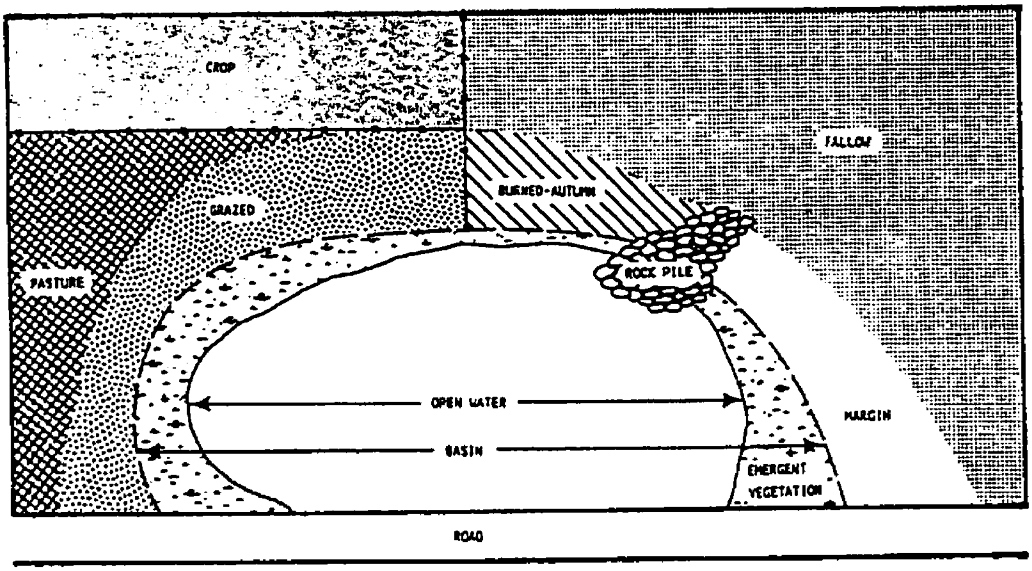
Province ______ Stratum ______ Transect ______ Segment Name YORKTO Date ______ Start ______ Finish ______

Crew Leader ______ Assistant ______ Wind Speed ______ Wind Direction ______ Cloud ______ Precipitation ______

Pond No	NW	Pond Type	Cir	Basin	Margin	Upland	MAL	BLK	GAD	WIG	GWT	BWT	SHO	PIN	RED	CAN	SCP	RNG	GOL	BUF	SCO	RUD	MER	OTH	TOTAL	CAG	COOT
67	0	DRY / 3	S	100 C	100 C	100 F																					
57A	0	DRY / 1	S	100 C	100 C	100 F																					
58	0	DRY / 3	S	100 C	100 C	100 F																					
58A	0	DRY / 3	S	100 C	100 C	100 F																					
59	0	DRY / 1	S	[illegible]	100 C	100 F																					
59A	0	DRY / 1	S	100 C	100 C	100 F																					
60	0	DRY / 1	S	100 C	100 C	100 F																					
61	S		S		50 C	100 F																					
63	0	DRY	S	[illegible]	100 C	100 F																					
62A	0	DRY / 1	S	100 F	5 W 100 C	100 F																					

FIGURE 4: SAMPLE A/G DATA SHEET FOR THE YORKTON, SK. SEGMENT CORRESPONDING TO THE AERIAL PHOTOGRAPH IN FIGURE 3.



Wetlands						
Pond No.	Pond Type	Water Level	Margin Width	Impaction (%/type)		
				Basin	Margin	Uplands
1	5	3	8	5F 20I	50G 20BA	40P 10C 50F

FIGURE 5: WETLAND IMPACTION DIAGRAM ILLUSTRATING THE HABITAT-TYPING SCHEME USED IN THE A/G HABITAT SURVEY (USFWS AND CWS 1987).

3.2.2. Prairie Habitat Monitoring Program

General methodology for Prairie Habitat Monitoring Program data collection and analysis are described in Millar (1987) and Ingstrup and Schinke (1999).

The study area for the PHMP is all lands within the boundaries of PHJV target areas (Figure 6). Within the PHJV target areas, changes in land use since 1986 have been estimated using available Census of Agriculture data. Censuses have been completed in 1986, 1991, and 1996. At the sub-provincial level, data have been aggregated within consolidated census subdivision (CCS) boundaries. All land tenure and field crop statistics for the years 1986, 1991, and 1996 were acquired for each CCS within the prairie provinces. The data have been incorporated into a GIS data management system. Average changes that have occurred within each target area boundary have been calculated.

The PHMP was first conducted in 1986, at which time 1985 baseline habitat estimates were calculated from 1:24K air photos and extensive groundtruthing. A network of 130 survey transects were established across the prairie provinces to sample habitat conditions across various ecoregions. Within each transect, baseline habitat studies were conducted on alternating quarter sections. In 1985, quarter section boundaries were identified on each aerial photo. Identifiable habitat units, or polygons, were then delineated. Field crews carried 1986 1:12K air photos in the field (Figure 7) as well as 1986 data sheets (Figure 8). The 1986 data sheets were updated in accordance to any land use changes observed. Using permanent markers, changes in land use were delineated as accurately as possible on the air photos from groundtruthing of each quarter section. Land cover classification codes, land use activity codes, and wetland data codes employed in the PHMP are provided in Appendix B. The PHMP classification scheme has primary cover classes, wetland coverage classes, land activity classes, wetland margin cover classes, upland secondary cover classes, and a wetland number for each quarter section. In 1998, 9 transects were groundtruthed to establish field techniques and data processing methodology and to determine changes that have occurred in land cover, land activity, and wetland margins since 1986. An additional 45 transects were completed in 1999.

Aerial photographs were scanned and digitized, with appropriate attribute information input for each polygon. This process was repeated using the 1998 and 1999 boundaries and field codes collected in the respective field seasons. Statistics for each transect have been extracted to portray changes in land activity, land cover, and wetland margins that have occurred between 1985 and 1998-99.

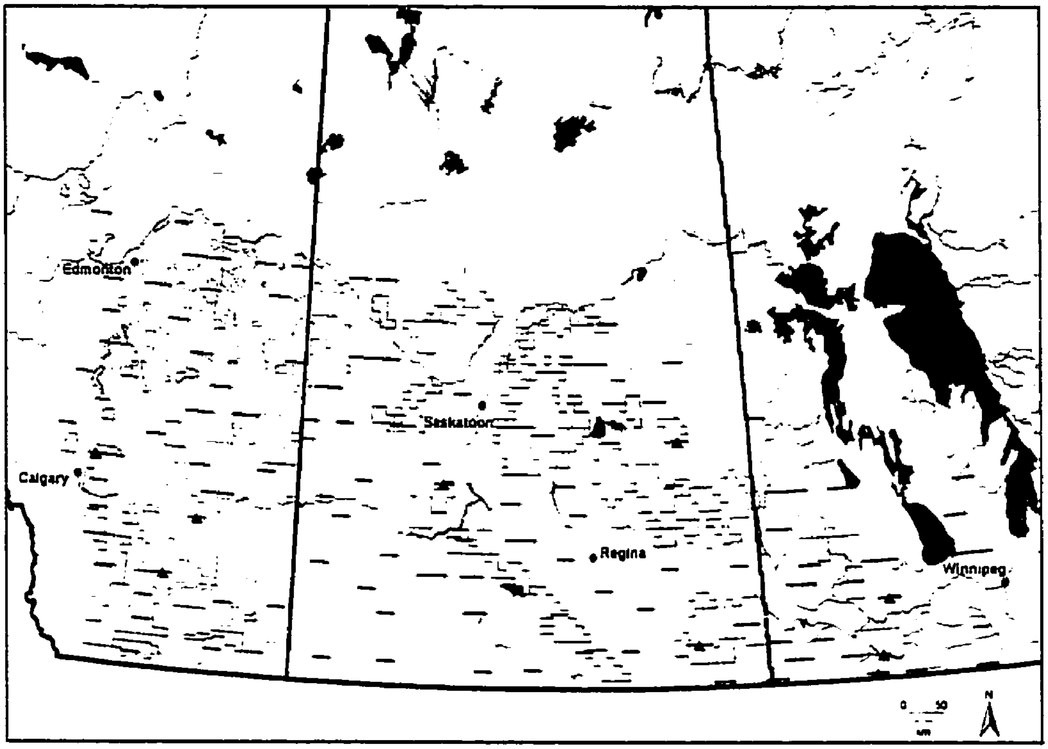


FIGURE 6: APPROXIMATE LOCATIONS OF PHMP SAMPLE TRANSECTS (RED LINES) WITHIN PHJV TARGET AREAS (BLOCKED AREAS). RED TRIANGLES DENOTE TRANSECTS GROUNDTRUTHED IN 1998, AND NOT INCLUDED IN THIS ANALYSIS. (INGSTRUP AND SCHINKE 1999).

FIGURE 7: AERIAL PHOTOGRAPH OF QUARTER SECTION # 20 IN THE YORKTON, SK. PHMP SURVEY TRANSECT (CORRESPONDS TO WETLAND #'S 54 - 62 IN FIGURE 3).

PRAIRIE HABITAT MONITORING PROJECT

1985 BASE YEAR POLYGON CLASSIFICATION DATA

Province [S] Ecoregion and Landscape Unit [450] Transect [Y]

NTS Map No. [ ] Transect Map No. [ ]

Prepared by BCD Page 1 of 2

Polygon No.	Quarter Section No.	Cover	Activity	Wetland Data: Number	Wetland Data: Margin Cover Pri.	Wetland Data: Margin Cover Sec.	Status in Quarter	Comments
19 21	22 23	24 25	26 27	28 31	32	33	34	
1	20	V1	A1					
2		Z3	N0	1 1	0	8	T	[illegible]
3		V3	N0	2 12	0	8	T	
4		W3	N0	3 13	0	8	T	Shrub?
5		V3	N0	32 14	G	8	T	20
6		V3	N0	33 15	0	8	T	
7		V3	N0	10 16	0	8	T	[illegible] 86
8		V3	N0	9 17	0	8	T	[illegible] 86
9		Z3	N0	10 18	0	8	T	[illegible]
10		Y0	A5					
11		V1	A1	4 19	0	8	T	
12		V3	N0	4 40	0	58	T	
13		V3	N0	6 41	0	8	T	
14		V3	N0	7 42	0	8	T	
15		V3	N0	17 43	0	8G	T	
16		V3	N0	8 44	0	8	T	[illegible] 86
17		V3	B0	16 45	0	8	T	
18		Z3	N0	9 46	0	8G	T	[illegible]
19		V3	N0	10 47	0	8	T	
20		V3	N0	18 18	0	68	T	[illegible] 86
21		V3	N0	19	0	8	T	
22		V3	N0	20	0	8	T	
23		V3	N0	21	0	8	T	
24		V3	N0	22	0	8	T	
~~25~~		~~V3~~	~~N0~~	~~23~~	0	8	T	
26		V3	N0	24	0	8	T	
27		V3	N0	25	0	8	T	[illegible] 86
28		V3	N0	26	0	8	T	

FIGURE 8: SAMPLE PHMP DATA SHEET FOR QUARTER SECTION # 20 OF THE YORKTON, SK. TRANSECT CORRESPONDING TO THE AERIAL PHOTOGRAPH IN FIGURE 7.

3.2.3. Comparison Between A/G and PHMP Survey Designs

Relationships between the A/G and PHMP survey designs are outlined in Table 2 in the effort to facilitate understanding of the underlying requirements for this research.

TABLE 2: COMPARISON OF A/G AND PHMP HABITAT SURVEY DESIGNS

	A/G SURVEY	PHMP SURVEY
DIFFERENCES	• conducted annually since 1955	• first conducted in 1986. Not conducted again until 1998 and 1999.
	• originally designed to serve as a population survey	• strictly designed as a habitat monitoring survey
	• restricted to habitat within 200m of the survey line	• surveys entire quarter sections
	• estimates habitat on a percentage basis with respect to wetlands	• measures absolute areas of habitat within a quarter section
	• habitat monitoring methodology unrelated to that of the PHMP	• habitat monitoring methodology unrelated to that of the A/G survey
SIMILARITIES	• A/G and PHMP surveys monitor overlapping tracts of habitat	
STRENGTHS	• employs a more detailed wetland typing scheme	• allows for the extraction of absolute areas of habitat availability
	• relatively quick and cost-effective method of habitat monitoring	• provides a more biologically informative approach to habitat monitoring

3.3. *Analysis of Data*

This study focuses on data collected in the 1999 A/G Survey and the 1999 PHMP survey. In particular, primarily for ease of data access, analysis is restricted to transects surveyed within strata 34, 35, 39, and 40. Secondary objective 1 focuses on data from 4 transects: (1) Lavinia, MB. (stratum 40), (2) Redvers, SK. (stratum 35), (3) Fairlight, SK. (stratum 35), and (4) Yorkton, SK. (stratum 34). These transects were selected for their high degree of overlap in both surveys, as well as their high variability in habitat and landscape features. Secondary objective 2 utilizes data from the Yorkton PHMP transect only. In addition to these 4 transects, secondary objective 3 includes data from 4 additional transects, namely Grayson, SK.(stratum 34), Moore Park, MB. (stratum 40), Crandall, MB. (stratum 40), and Boissevain, MB. (stratum 39). Data from the A/G Survey and from the PHMP are analyzed in accordance to this study's objectives, as outlined in section 1.3.

3.3.1. Secondary Objective (1):

Determine if the 200m area of habitat adjacent to the right-of-way in each quarter section, and common to both A/G and PHMP habitat surveys, provides an accurate representation of the habitat available in a quarter section.

In order to satisfy this objective, digitized versions of the updated PHMP transects are required. For each quarter section, all habitats within 200m of the right-of-way will be analyzed to determine the relative area composed of each differing habitat type (e.g., 2 ha natural wetland, 3 ha woodland, 1 ha grassland, and 10 ha cropland). Data for the 200m area of habitat adjacent to the right-of-way in each quarter section are compared to data in the remaining 600m of each quarter section using regression analysis.

Prior to analysis, all data will undergo the process of arcsine transformation. As all habitat data are originally expressed as proportions of habitat within a particular quarter section, these proportions must be transformed in order to be normally distributed. Arcsine square-root transformations are typically used in this situation (Abrahams 2001). Transformation ensures that the statistical techniques used to analyze the data are validly applied (Fowler et al. 1998).

Regression analysis is used to estimate or predict the value of one variable from a measurement of the other (Fowler et al. 1998). As there is no clear dependent variable in this case, Model 2, or reduced major axis regression is applied. The 200m habitat is placed on the x-axis, as this variable is used to estimate the 600m habitat. The equation derived for each regression analysis defines the mutual slope of the 2 variables (Fowler et al. 1998). In testing for significance, the null hypothesis, H_0, states that the slope of the regression line does not significantly depart from zero. Rejecting the null hypothesis indicates a statistically proven relationship between the 200m and 600m habitats. Significant results may imply that habitat in the 200m area adjacent to the right-of-way provides an accurate representation of habitat in the entire quarter section. That is, habitat composition and changes in land use over time in the 200m area may be indicative of similar trends in the entire quarter section, and possibly across an even larger scale. Achieving statistical significance may thus indicate that annual A/G data may supplement long-term PHMP data, and may in fact be indicative of trends occurring across the larger agricultural landscape.

In the effort to reduce variability in the data, all habitats classified as road allowance in the PHMP classification system are omitted from the analysis. This omission is justified, since: (1) right-of-way habitat lies beyond the quarter section boundary, and (2) right-of-way habitat is not included in A/G habitat classification.

3.3.2. Secondary Objective (2):

Explore landscape effects of rights-of way on land-use, and their potential effects on survey designs.

The Yorkton, SK transect is selected to explore this secondary objective. The habitat composition of the transect is analyzed as a function of distance from the right-of-way in each quarter section. Aerial photos for each quarter section are digitized into four partitions of equal area, with successive partitions 200m further from the right-of-way than the one previous. Habitat data is extracted from each partition to explore changes in land use as a function of distance from the right-of way. Changes in habitat composition for each strip are represented graphically, providing an indication of the broad scale effects of road allowance.

3.3.3. Secondary Objective (3):

Determine the feasibility of amalgamating the two survey designs by building associations between A/G habitat data and PHMP habitat data in an effort to explore the statistical compatibility of the two data sets.

Associations are made between PHMP polygon data and the A/G habitat survey wetland data based on 5 common criteria. In the effort to reduce variability in the results, only seasonal, semi-permanent and permanent wetlands, including streams and artificial wetlands, are considered in the analysis. Temporary wetlands, flooded basins and dry basins are excluded. Criteria used in building these associations are described in Appendix C.

3.3.4. Secondary Objective (4):

Provide recommendations for future waterfowl habitat survey techniques.

The final secondary objective explores management recommendations based on the results of this study. Recommendations are intended to facilitate steps toward improvements in current waterfowl habitat monitoring techniques, aiding in the evaluation of the long-term effectiveness of NAWMP initiatives.

Chapter 4: Results and Discussion

4.1 200m vs. 600m Habitat Comparisons

The results of this study are reported in sequence with the study objectives. The overall objective is to explore the statistical compatibility of A/G and PHMP data, in the effort to determine the feasibility of amalgamating the methodologies underlying the two survey designs. In order to determine if the A/G survey data and PHMP data are compatible, it is necessary to determine if the habitat within 200m of the right-of-way in each quarter section accurately represents the habitat composition of the entire quarter section. Habitat types and their relative areas within the 200m strip are compared to those in the remaining 600m area of each quarter section, rather than to the entire quarter section. This is necessary in the effort to achieve independence of the variables.

Data were available for four PHMP transects within the aspen parkland region of Manitoba and Saskatchewan. Each transect consists of 24 quarter sections of land, for a combined total study area of 96 quarter sections, or 6,216 ha of land. Thus, 1,554 ha of aspen parkland habitat within the 200m strip adjacent to the right-of-way are compared to the remaining 4,662 ha. Within each quarter section, 16.2 ha within each 200m strip are compared to the remaining 48.6 ha. The number of discreet habitat classes range from as many as 56 in the Redvers transect, to as few as 38 in the Fairlight transect. However, for the purposes of this study, it is possible to group a number of habitat classes, allowing each transect to be compared on the basis of 6 discreet habitat classes. Relationships between the 200m and 600m areas are explored using model 2 regression analysis, with each habitat classification analyzed independently of the others.

4.1.1 Cultivated / Cropland Habitats (V1, XO)

In the PHMP classification scheme (Appendix B), V1 habitat refers to land reserved for the production of annually cultivated crops. For the purposes of this study, the V1 group also includes XO cover, which refers to bare surfaces including summerfallow. V1 and XO are grouped together as both habitats offer minimal nesting cover for waterfowl and are subject to high degrees of agricultural disturbance. These habitats dominate the agricultural landscape across the prairies and aspen parkland regions of Manitoba and Saskatchewan, thus having a major influence on waterfowl production. Results obtained when comparing the V1, XO group in the 200m area adjacent to the right-of-way in each quarter section to that in the remaining 600m area of each quarter section are described in Figure 9.

Results for Lavinia ($F=8.66$, $df=19$, $P=0.0087$), Redvers ($F=52.27$, $df=23$, $P<0.0001$), Fairlight ($F=16.33$, $df=21$, $P=0.0006$), and Yorkton ($F=33.39$, $df=21$, $P<0.0001$) indicate high statistical significance when comparing the V1, XO category between the 200m and 600m areas. This indicates that the amount of cultivated land within the 200m area adjacent to the right-of-way provides an accurate representation of the agricultural activity in the entire quarter section.

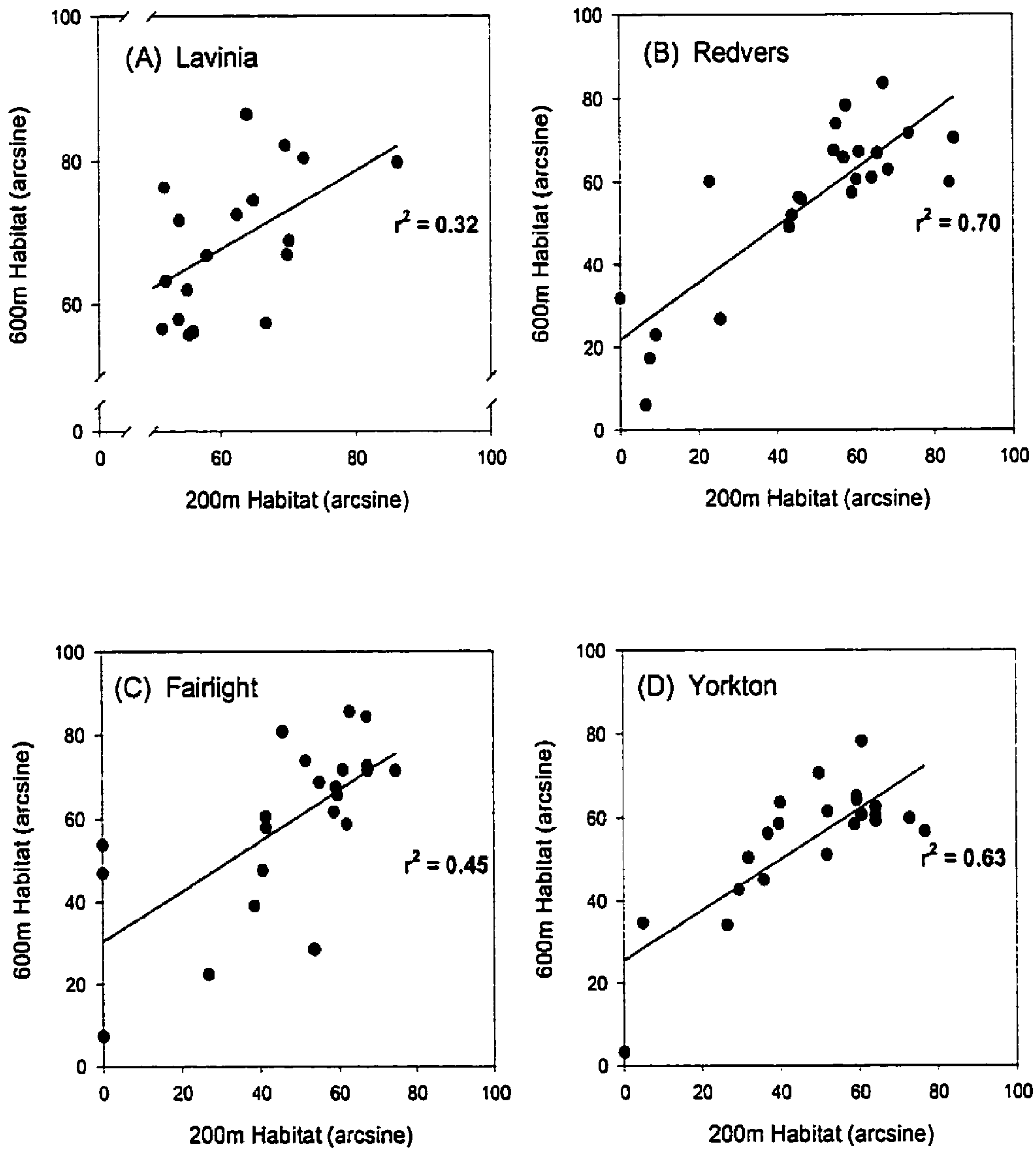


FIGURE 9: MODEL 2 REGRESSION ANALYSIS FOR CULTIVATED / CROPLAND HABITAT WITHIN THE 200M AND 600M AREAS OF THE FOUR STUDY TRANSECTS.

Although all four sample transects indicate high statistical significance, the degree of significance varies among transects. Redvers reveals the strongest relationship (r^2 = 0.70) and Lavinia the weakest (r^2 = 0.32). Regional variation in land use and agricultural practices is expected, thus influencing habitat composition on a localized scale. Amalgamating agricultural habitat data from the four study transects provides a larger sample size, as well as a more representative indication of agricultural land use across the aspen parkland region (Figure 10).

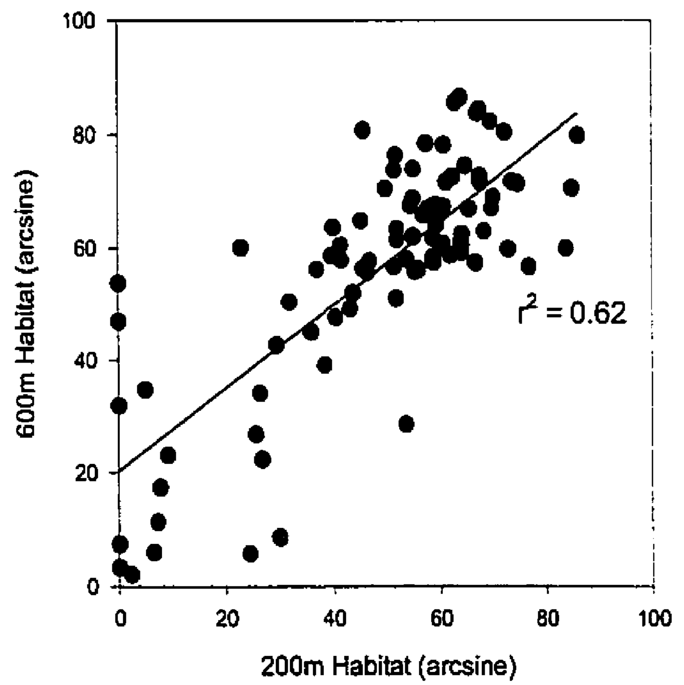


FIGURE 10: MODEL 2 REGRESSION ANALYSIS FOR AGRICULTURAL LAND USE DATA (V1, X0) OBTAINED FROM THE AMALGAMATION OF THE LAVINIA, REDVERS, FAIRLIGHT AND YORKTON STUDY TRANSECTS.

Amalgamated results ($F=143.51$, $df=90$, $P<0.0001$) provide further support for the compatibility of the A/G and PHMP programs in terms of monitoring agricultural upland land use across the aspen parkland region. Highly significant results such as these are expected, as the majority of agricultural land in the prairie pothole region is tilled annually, creating a somewhat homogeneous landscape in terms of cultivated land. Prior to the birth of the NAWMP, Sugden and Beyersbergen (1984) reported that 78% of the aspen parkland in east-central Saskatchewan was tilled annually by 1982. Conversion of uplands and wetlands to cropland is currently minimal in comparison to past agricultural practices, thus annual losses in available habitat are relatively minimal in comparison to past trends (Rakowski 2001). Conversion of marginal land to cropland poses a greater threat to waterfowl than changes on highly productive agricultural land that is already under cultivation (Boyd 1985).

Results indicate that large-scale changes in land use, such as conversion of annually tilled croplands to hayland or seeded pastures, and vice-versa, may be identified by trends observed in the 200m strip. Changes in farming practices may have significant impacts on waterfowl production, depending on the scale of the change. The amount of cover available to conceal nests is one of the most important factors influencing waterfowl production (Hochbaum et al. 1987). Considering that uplands occupy the vast majority of available habitat, changes in upland habitat will have a marked influence on the success of upland nesting waterfowl. Therefore, monitoring efforts should focus on trends in upland land use, as results indicate the possibility of detecting large-scale trends from changes in relatively small areas.

4.1.2 Grassland Habitats (V2, V3, V5)

The PHMP habitat classifications of V2, V3 and V5 are analyzed as a group, as these 3 classes can justifiably be labeled as grassland habitats (Appendix B). V3 habitats, represented by native grasslands and unimproved pastures, likely provide the best nesting habitat for waterfowl as they are subject to the least disturbance of all upland habitats. V5 habitat consists of non-woody plant species typical of previously disturbed areas. Such habitat may or may not be subject to further disturbance, thus potentially providing valuable nesting cover for waterfowl. V2 refers to improved grasslands or pastures. such as alfalfa and other tame hay. Such habitat provides nesting cover, but is subject to periodic agricultural disturbances. Although all 3 habitat classes are subject to varying degrees of disturbance, they all provide grassland cover for at least a portion of the nesting season, thus have been grouped into one habitat classification.

Results for Lavinia ($F=69.30$, $df=23$, $P<0.0001$), Redvers ($F=58.05$, $df=23$, $P<0.0001$), Fairlight ($F=40.76$, $df=23$, $P<0.0001$), and Yorkton ($F=39.40$, $df=23$, $P<0.0001$) indicate high statistical significance when comparing grassland habitats between the 200m and 600m areas of each quarter section (Figure 11). Available grassland habitat within 200m of the right-of-way provides an accurate representation of grassland habitat within the entire quarter section.

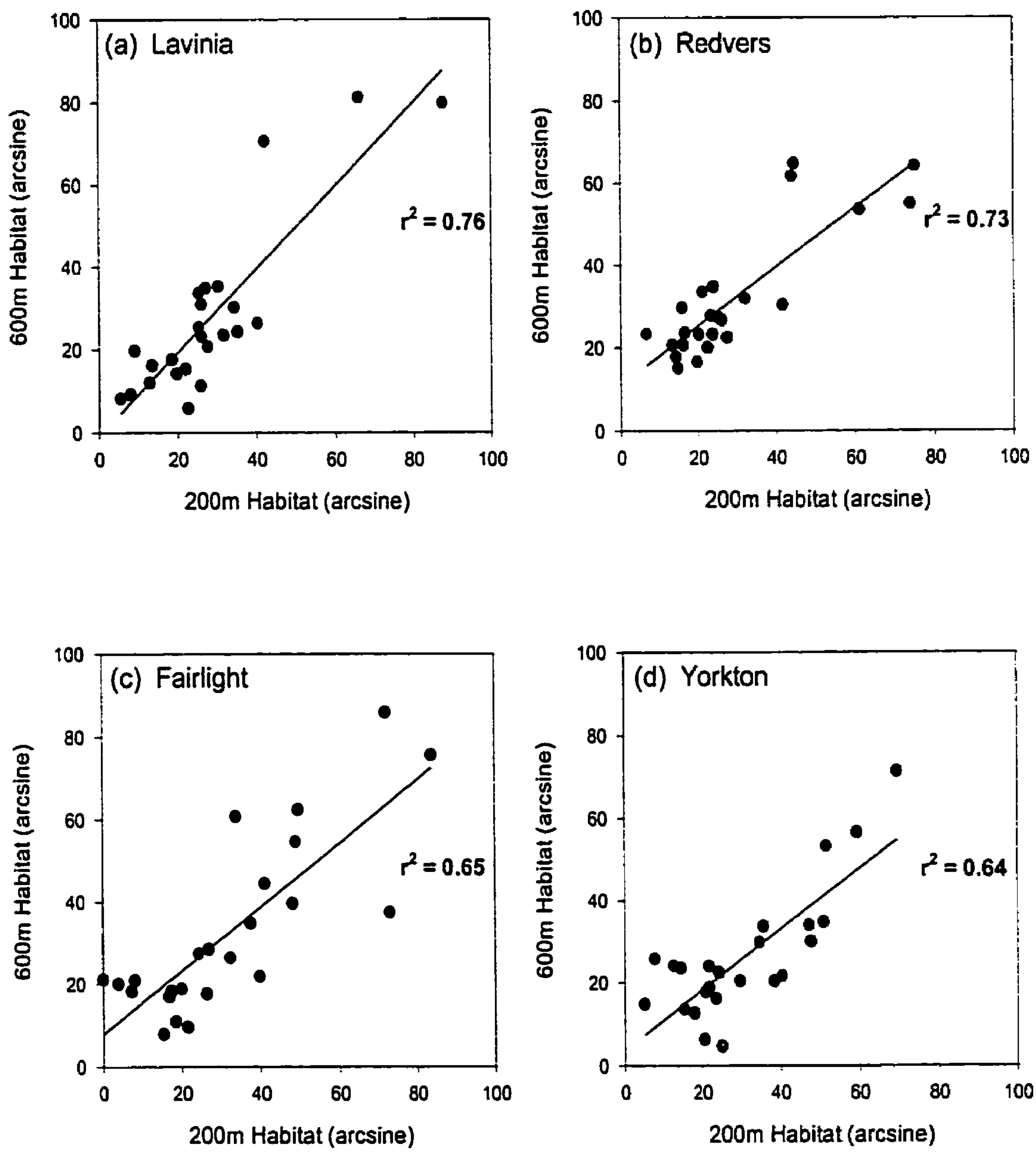


FIGURE 11: MODEL 2 REGRESSION ANALYSIS FOR GRASSLAND HABITAT WITHIN THE 200M AND 600M AREAS OF THE FOUR STUDY TRANSECTS.

Amalgamated grassland data from the four study transects further supports this relationship (F=190.89, df=95, P<0.0001), and provides a more representative indication of grassland availability across the aspen parkland region (Figure 12). Results thus indicate the ability of the 200m area of habitat adjacent to the right-of-way to accurately describe landscape level availability of grassland habitats. Based on these results, annual A/G data may supplement PHMP data in terms of annual changes in the availability of grassland habitat.

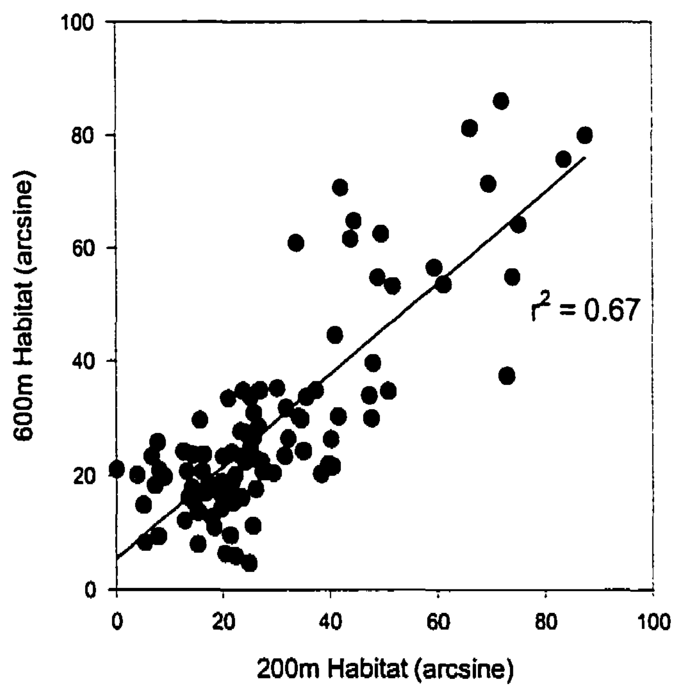


FIGURE 12: MODEL 2 REGRESSION ANALYSIS FOR GRASSLAND HABITAT DATA (V2, V3, V5) OBTAINED FROM THE AMALGAMATION OF THE LAVINIA, REDVERS, FAIRLIGHT AND YORKTON STUDY TRANSECTS.

The amount of annually tilled cropland is to some degree inversely related to the availability of grassland habitat. The vast majority of grasslands in the prairie pothole region have already been converted to cropland, with remaining grasslands primarily associated with wetlands, rights-of-way, or other marginal lands (Rakowski 2001). These marginal lands tend to remain as grasslands as they are not economically feasible to farm (Rakowski 2001).

It is unlikely that large-scale efforts to cultivate marginal grasslands will occur in the future, due to their low economic returns in conjunction with alternatives associated with conservation efforts such as Prairie CARE. As a result, monitoring efforts focused on the 200m strip of habitat are likely sufficient to provide an indication of grassland availability across the general landscape. With conservation efforts targeting marginal lands, monitoring efforts may allow for relationships to be revealed concerning available nesting habitat, nest success, and overall changes in waterfowl populations.

4.1.3 Wooded Habitats (W1 - W4)

For the purposes of this study, the PHMP wooded habitat classifications of W1, W2, W3, and W4 are grouped together into one habitat class. Wooded habitats provide valuable nesting cover for waterfowl, helping conceal nests from avian as well as mammalian predators. With the intensification of agriculture, and the conversion of grassland habitats to annually cultivated cropland, loss of wooded habitats to agriculture followed suit. In the Saskatchewan aspen parkland, the trend to convert more uncultivated upland to annual crops was prevalent in the late 1970's and early 1980's, with woodlands comprising most of the loss (Sugden and Beyersbergen 1984).

Model 2 regression analysis for wooded habitat (Figure 13) indicates significant values for the Redvers ($F=23.92$, $df=19$, $P=0.0001$), Fairlight ($F=6.77$, $df=21$, $P=0.017$), and Yorkton ($F=5.32$, $df=21$, $P=0.032$) transects, but a strong insignificant value for the Lavinia transect ($F=0.4006$, $df=21$, $P=0.5339$). Thus for Lavinia, it is not statistically valid to estimate quarter section wooded habitat from that in the 200m area. Figure 14 graphically illustrates the low association between 200m and 600m wooded habitat data for Lavinia, demonstrating no apparent relationship between these two areas of habitat.

Although significant values are observed for the Fairlight and Yorkton transects, low r^2 values of 0.25 and 0.21, respectively, indicate that other factors may influence the presence or absence of wooded habitats across the quarter sections. For example, Fairlight and Yorkton contain a relatively larger number of farmyards than Lavinia and Redvers. As farmyards typically contain wooded habitat as landscaping, local abundance and distribution of this habitat type may be influenced to varying degrees.

Another factor that may influence availability of wooded habitat is wetland availability. Discharge wetlands, in particular, tend to be associated with wooded margins, the distribution of which is largely a function of local topography. The low association observed in the Lavinia transect may be partially explained by this. However, an r^2 value near zero in the Lavinia transect indicates that a number of factors influence the distribution of wooded habitat in that transect.

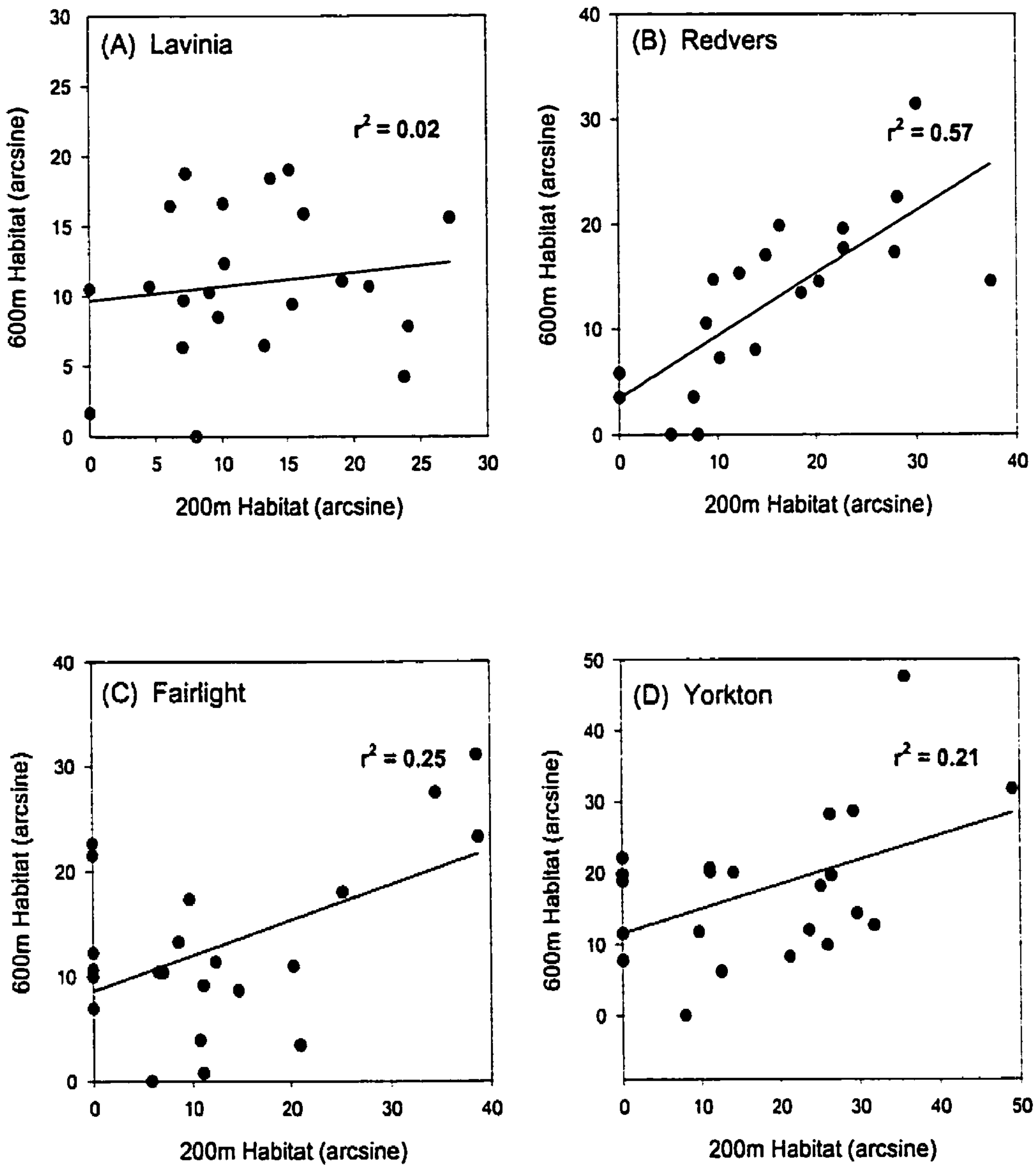


FIGURE 13: MODEL 2 REGRESSION ANALYSIS FOR WOODED HABITAT WITHIN THE 200M AND 600M AREAS OF THE FOUR STUDY TRANSECTS

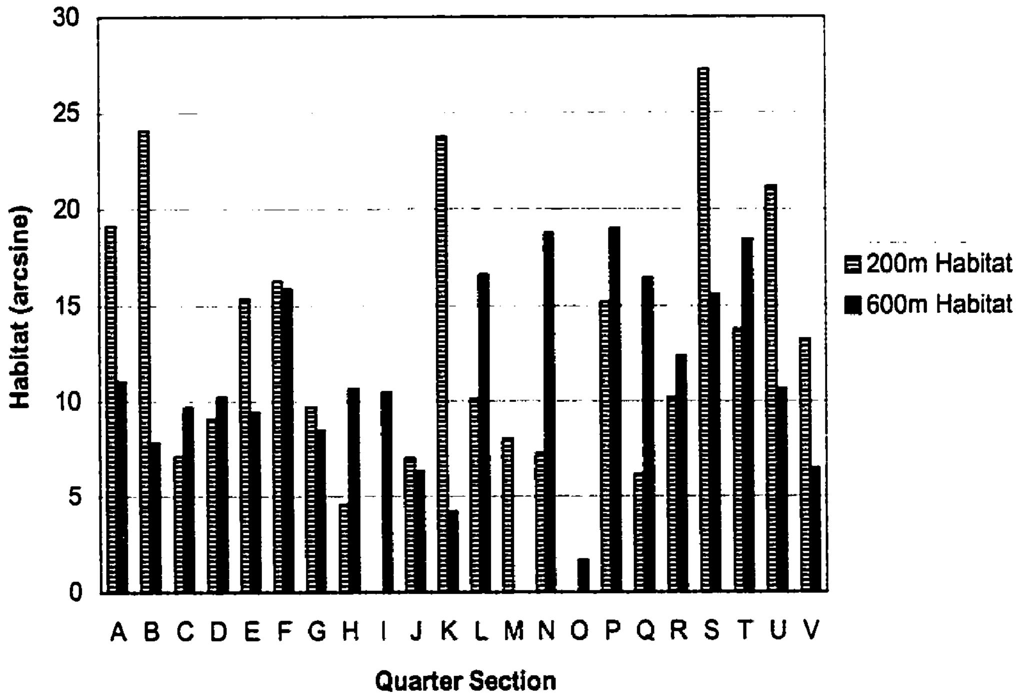


FIGURE 14: DISTRIBUTION OF WOODED HABITAT ACROSS THE 200M AND 600M AREAS OF EACH QUARTER SECTION IN THE LAVINIA TRANSECT

Overall, it would appear statistically valid to allow annual A/G wooded habitat data to supplement PHMP data for the Redvers, Fairlight and Yorkton transects, but not for the Lavinia transect. Low r^2 values indicate that caution must be exercised when extrapolating wooded habitat data from the 200m area to the quarter section, particularly on a localized level. Extrapolation of wooded habitat data from the 200m area to the

600m area and beyond, may not be valid across certain types of landscapes. As a result, prior to extrapolation of wooded habitat data, other inherent characteristics of the local landscape must be considered. However, when data is amalgamated across all landscapes (Figure 15), significant results are observed ($F=47.2033$, $df=85$, $P<0.0001$). On a landscape level, localized variations may be masked, allowing the extrapolation to be statistically valid.

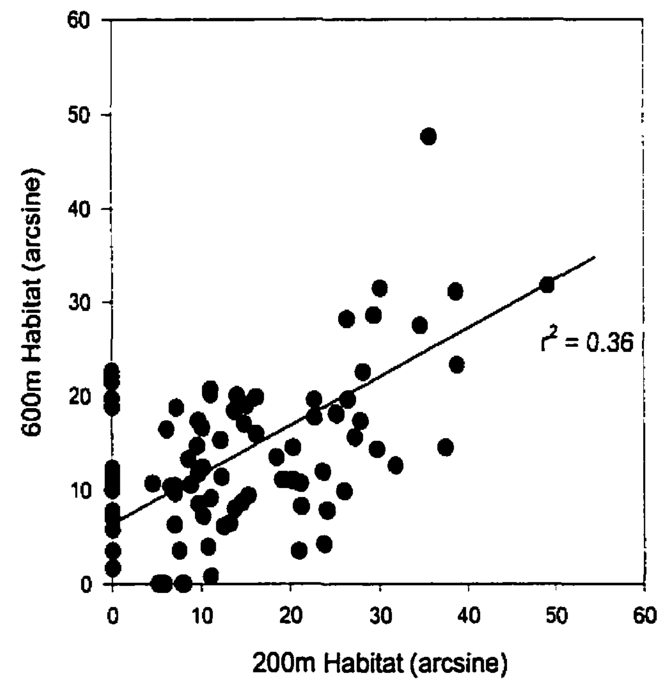


FIGURE 15: MODEL 2 REGRESSION ANALYSIS FOR WOODED HABITAT DATA (W1 - W4) OBTAINED FROM THE AMALGAMATION OF THE LAVINIA, REDVERS, FAIRLIGHT AND YORKTON STUDY TRANSECTS.

4.1.4 Natural Wetland Habitats (Z (Nat))

For the purposes of this study, natural wetlands are studied independently of artificial wetlands. The locations of artificial wetlands, unlike natural wetlands, are controlled. For example, borrow pits and gravel pits tend to be located near rights-of-way, thus over-represented within the 200m area of habitat. Locations of dugouts are under landowner control, and typically closely associated with farmyards, other infrastructure, or rights-of-way for ease of access.

Model 2 regression analysis for natural wetland data was conducted for the Redvers and Yorkton transects (Figure 16), but not for the Lavinia and Fairlight transects. Initial examination of the data for the latter two transects revealed that the direction of the slope of the regression was not obvious (Figure 17). According to Fowler et al. (1998), prior to conducting a regression analysis, data should initially be examined in the form of a scattergram. If the direction of the slope is not obvious in a scattergram of the data, then regression analysis is of no practical value for making estimations.

Model 2 regression analysis results are significant for Redvers (F=11.3014, df=23, P=0.0028) but insignificant for Yorkton (F=2.8318, df=23, P=0.1066). Both the Redvers and Yorkton transects contain quarter sections which have either natural wetlands in the 200m area or 600m area but not in both. If the 200m habitat in these two transects is used to estimate natural wetland availability in the entire quarter section, results should be interpreted with caution. Low r^2 values for these two transects indicate weak relationships between the 200m and 600m areas of habitat. As a result, the possibilities of committing Type 1 and 2 errors are present when analyzing natural wetland data, thus conclusions from these data are difficult to determine.

In the Lavinia transect (Figure18), nine quarter sections contain natural wetland habitat, of which only one quarter section contains such habitat in both 200m and 600m areas. Six of the nine quarter sections contain natural wetlands within the 600m area, but lack similar habitat in the 200m area. Similarly, in the Fairlight transect (Figure 19), only two of the ten quarter sections contain natural wetland habitat in both 200m and 600m areas. Seven out of the ten quarter sections contain natural wetlands within the 600m area, but not within the 200m area. It is apparent from Figures 18 and 19 that it is not valid to estimate relative amounts of natural wetland habitat in individual quarter sections using 200m data.

Although the sample size analyzed here is small, the results are not at all surprising. Wetlands have historically been the bane of landowners who seek to maximize the amount of arable land on their properties. Wetlands adjacent to rights-of-way were more likely subjected to drainage and filling practices than wetlands further into the quarter sections (Rakowski 2001). Even in areas where drainage has not taken place, caution must be exercised due to the nature of natural wetland distributions.

Using a small area to represent a landscape, such as the 200m area adjacent to the right-of-way in a quarter section, may result in either under- or over-representation of wetland habitats. A larger sample area which extends away from the right-of-way is required if statistics on natural wetlands are to be used to represent a landscape. It may be concluded from this data that in terms of individual quarter sections, the availability of natural wetlands in the 200m strip can not be extrapolated to the remainder of the quarter section. However, natural changes to wetlands in the 200m strip, as assessed in annual A/G surveys, may possibly reflect trends across the landscape.

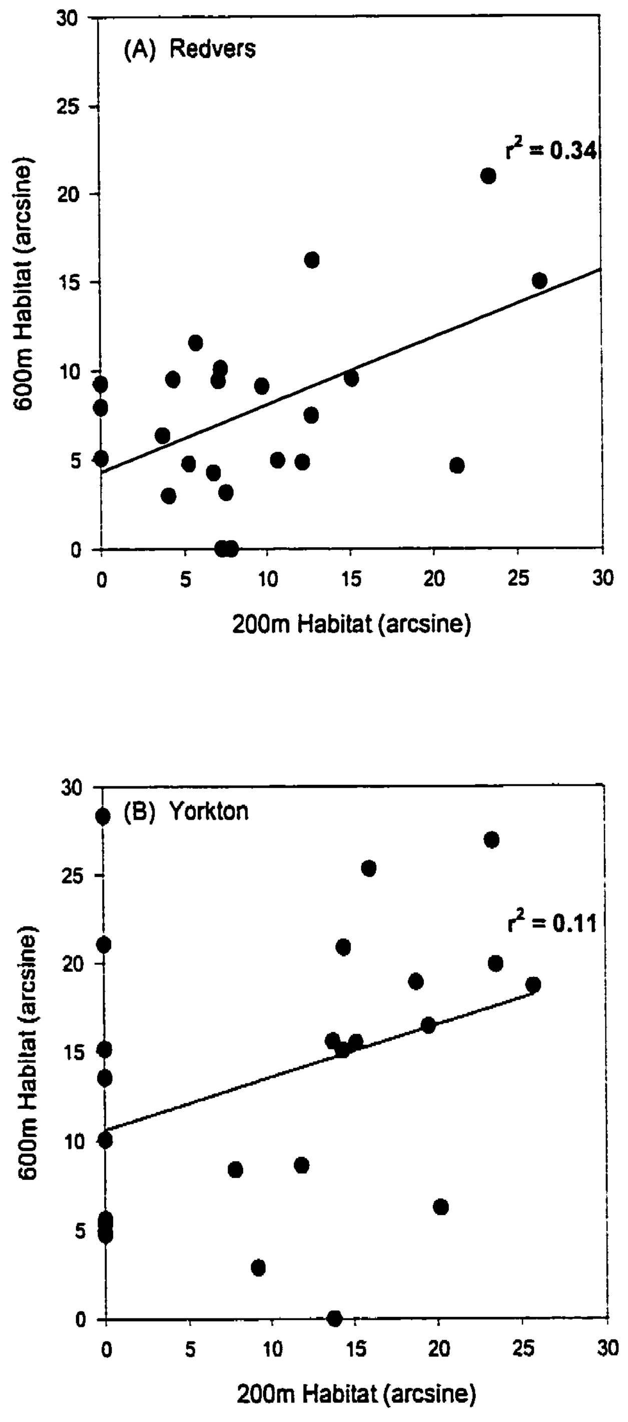


FIGURE 16: MODEL 2 REGRESSION ANALYSIS FOR NATURAL WETLAND HABITAT WITHIN THE 200M AND 600M AREAS FOR THE (A) REDVERS AND (B) YORKTON STUDY TRANSECTS

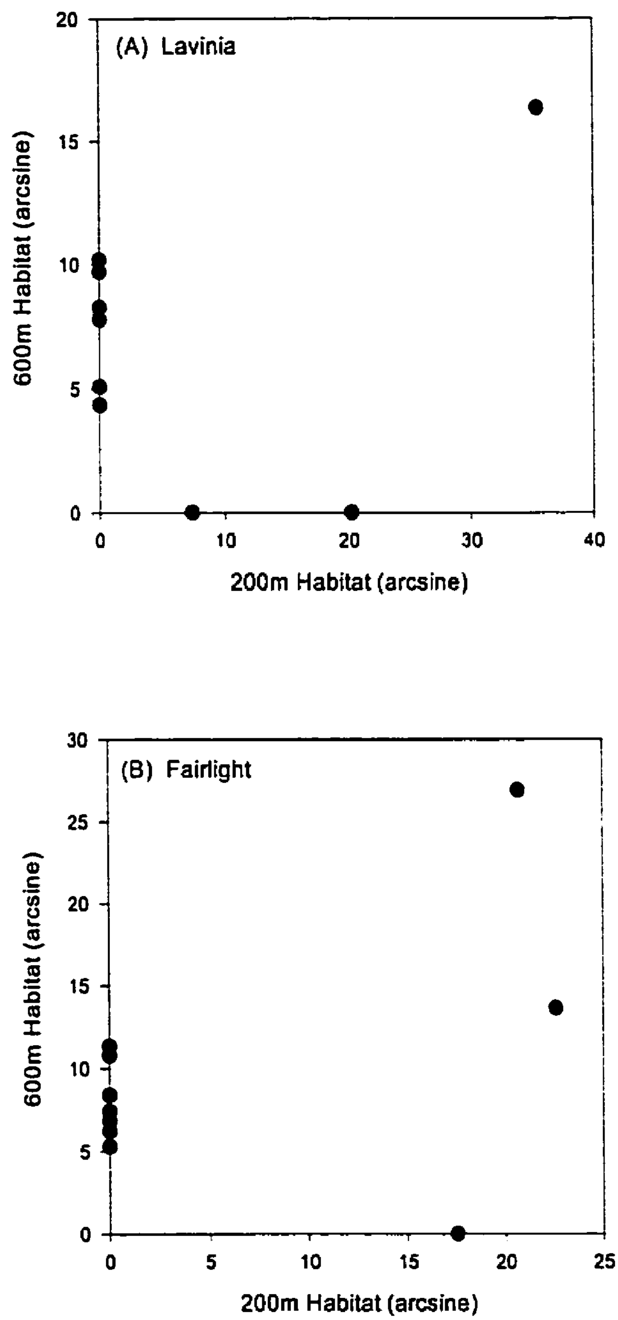


FIGURE 17: NATURAL WETLAND HABITAT DISTRIBUTION FOR THE (A) LAVINIA AND (B) FAIRLIGHT STUDY TRANSECTS. MODEL 2 REGRESSION ANALYSIS COULD NOT BE CONDUCTED AS THE DIRECTION OF THE SLOPE IN EACH INSTANCE IS NOT OBVIOUS.

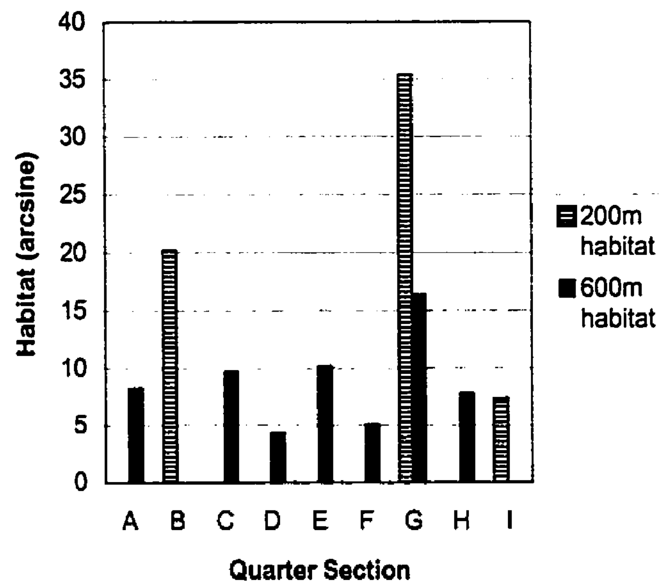


FIGURE 18: DISTRIBUTION OF NATURAL WETLANDS THROUGHOUT THE 200M AND 600M AREAS OF THE LAVINIA, MB PHMP TRANSECT

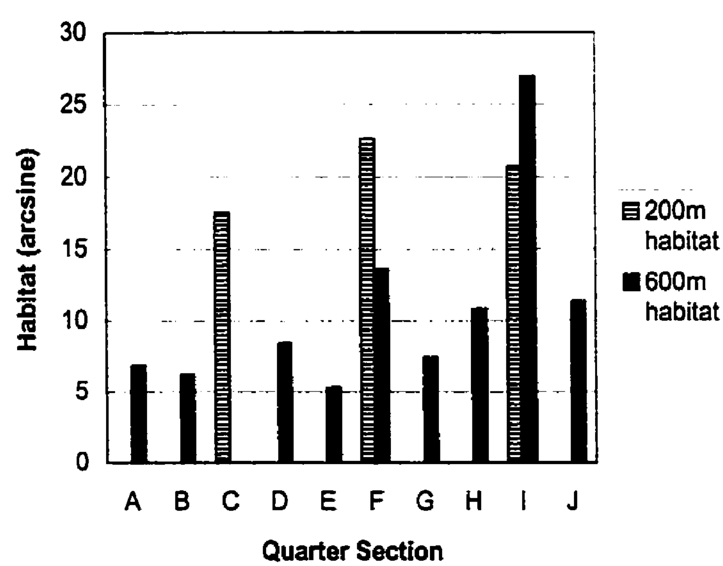


FIGURE 19: DISTRIBUTION OF NATURAL WETLANDS THROUGHOUT THE 200M AND 600M AREAS OF THE FAIRLIGHT, SK PHMP TRANSECT

4.1.5 Artificial Wetlands (Z (Art))

Artificial wetlands present an interesting case and are therefore discussed separately from natural wetlands. As expected, all four study transects contain insufficient data to conduct Model 2 regression analysis on artificial wetlands. Artificial wetlands occupy a small fraction of available land cover, and are unlikely to be found in high numbers on any given transect. The Redvers transect contains as many as ten quarter sections with artificial wetlands, whereas the Yorkton transect contains only four quarter sections with artificial wetlands. Although the data on artificial wetlands are merely demonstrative, obvious trends are apparent (Figures 20 - 23).

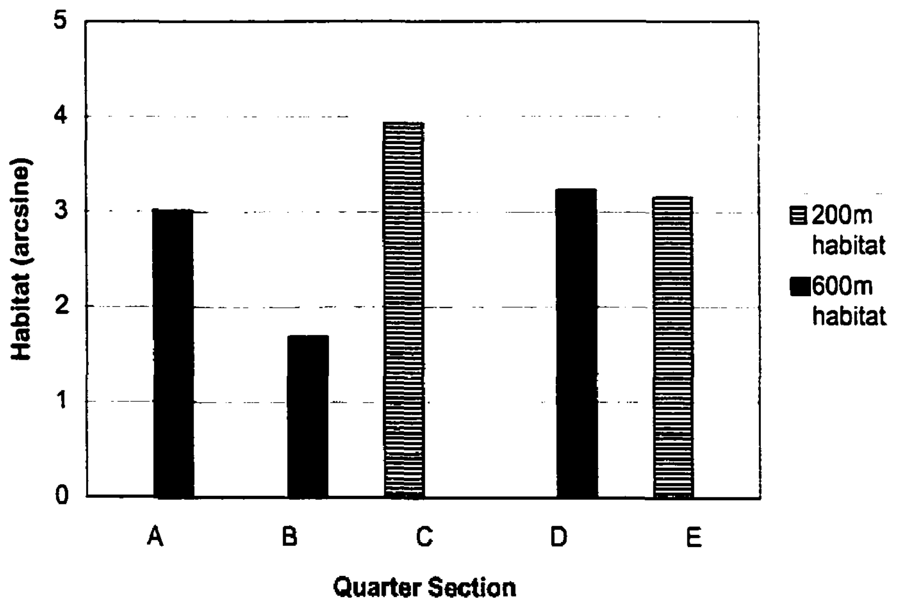


FIGURE 20: DISTRIBUTION OF ARTIFICIAL WETLANDS THROUGHOUT THE 200M AND 600M AREAS OF THE LAVINIA, MB PHMP TRANSECT

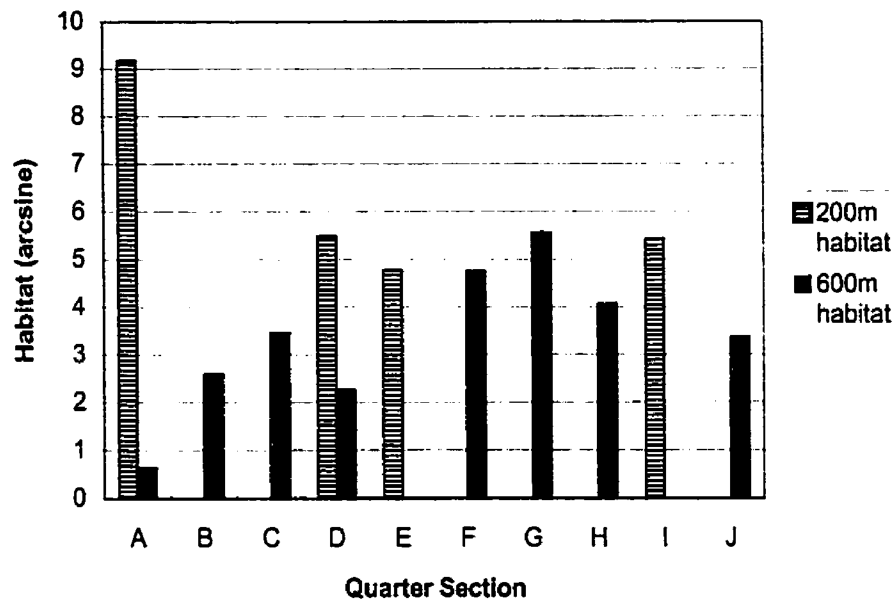


FIGURE 21: DISTRIBUTION OF ARTIFICIAL WETLANDS THROUGHOUT THE 200M AND 600M AREAS OF THE REDVERS, SK PHMP TRANSECT

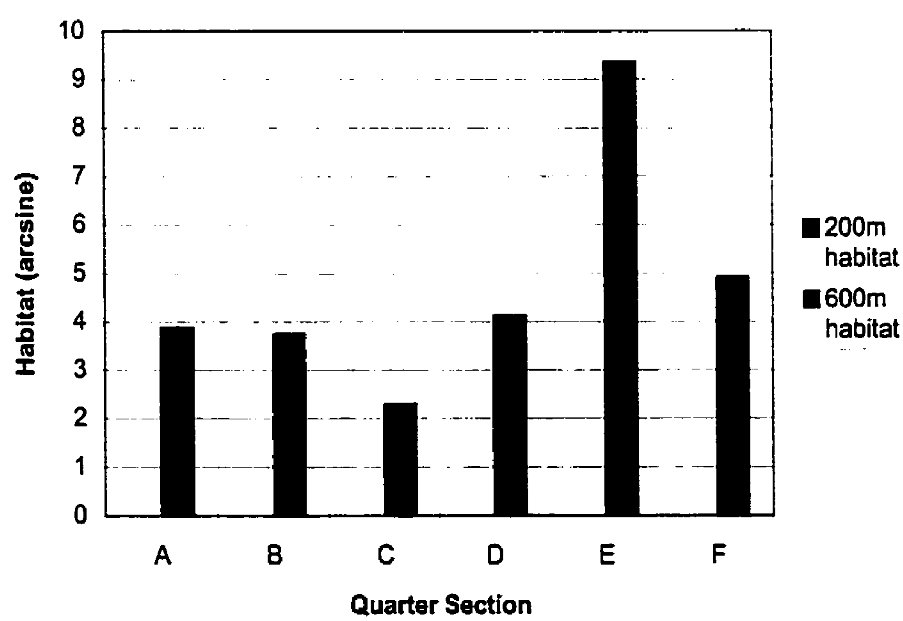


FIGURE 22: DISTRIBUTION OF ARTIFICIAL WETLANDS THROUGHOUT THE 200M AND 600M AREAS OF THE FAIRLIGHT, SK PHMP TRANSECT

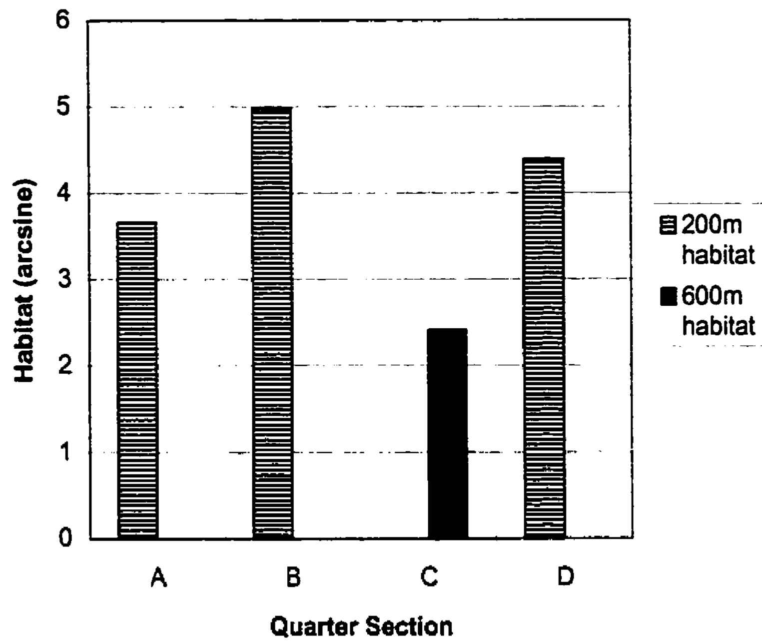


FIGURE 23: DISTRIBUTION OF ARTIFICIAL WETLANDS THROUGHOUT THE 200M AND 600M AREAS OF THE YORKTON, SK PHMP TRANSECT

From the information presented in Figures 20 - 23, it would appear statistically invalid to extrapolate the amount of artificial wetland habitat in the 200m area adjacent to the right-of-way, to the remainder of the quarter section. Figures 20 - 23 illustrate the unlikely event that artificial wetlands will be located in both the 200m and 600m areas of a particular quarter section. It is uncommon to find more than one artificial wetland within the same quarter section. Only the Redvers transect (Figure 21) reveals two quarter sections having artificial wetlands in both areas. This however is an illustration of the unlikely event that such wetlands will span the boundary separating the two areas.

The Fairlight transect (Figure 22) provides a useful illustration of the danger in extrapolating artificial wetland data. All artificial wetlands in this transect are located within the 600m area. Should the 200m data be used to estimate available artificial wetland habitat in this transect, results would suggest that no artificial wetlands were expected within this transect. Figure 22 clearly reveals that this is not the case. It may be concluded from these data that annual A/G data may be of no use in supplementing PHMP data in terms of overall changes to the availability of artificial wetlands. However, long-term PHMP data collection is likely sufficient considering that (1) artificial wetlands tend to be permanent with insignificant annual changes, and (2) new artificial wetlands or loss of existing artificial wetlands are uncommon, thus having insignificant effects across the landscape as a whole.

4.1.6 Constructed Cover (YO)

The PHMP habitat classification of YO refers to the presence of constructed cover. The majority of YO habitat is represented by homesteads and their surroundings. As was the case with artificial wetlands, YO data are limited and regression analysis is therefore not suitable. A number of similarities exist between Z (Art) and YO data. Homesteads, like artificial wetlands, tend to be limited in number, falling either entirely within the 200m or 600m areas. It is highly unlikely that more than one homestead will be located within the same quarter section, thus comparing the two areas is not valid. Figures 24 - 27 illustrate the occurrence of homesteads within the four transects, with some interesting trends being evident.

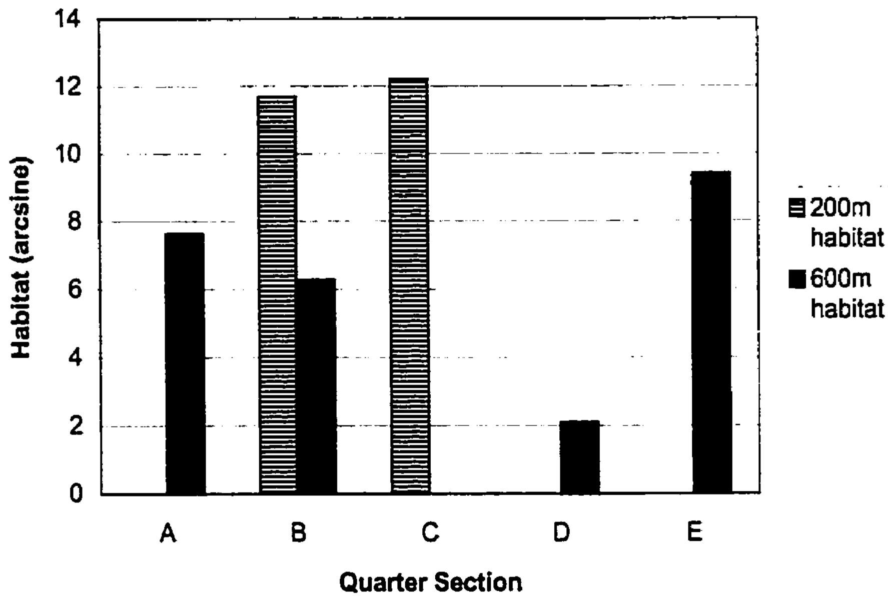


FIGURE 24: DISTRIBUTION OF CONSTRUCTED COVER HABITAT (Y0) THROUGHOUT THE 200M AND 600M AREAS OF THE LAVINIA, MB PHMP TRANSECT.

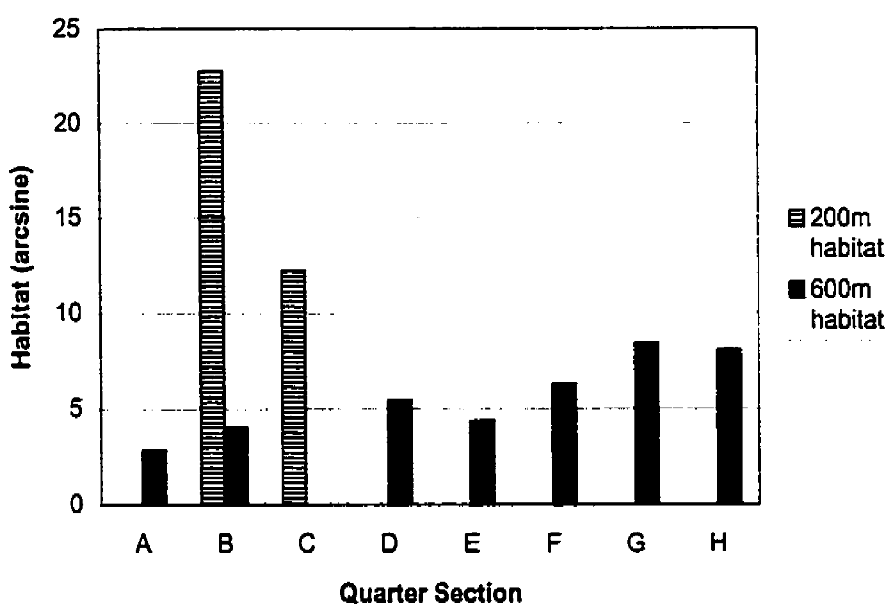


FIGURE 25: DISTRIBUTION OF CONSTRUCTED COVER HABITAT (Y0) THROUGHOUT THE 200M AND 600M AREAS OF THE REDVERS, SK PHMP TRANSECT.

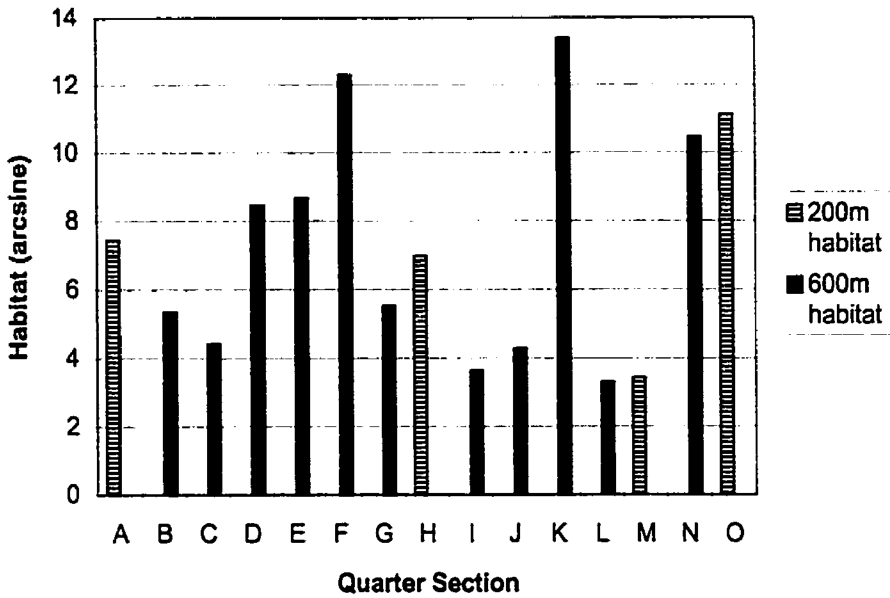


FIGURE 26: DISTRIBUTION OF CONSTRUCTED COVER HABITAT (Y0) THROUGHOUT THE 200M AND 600M AREAS OF THE FAIRLIGHT, SK PHMP TRANSECT.

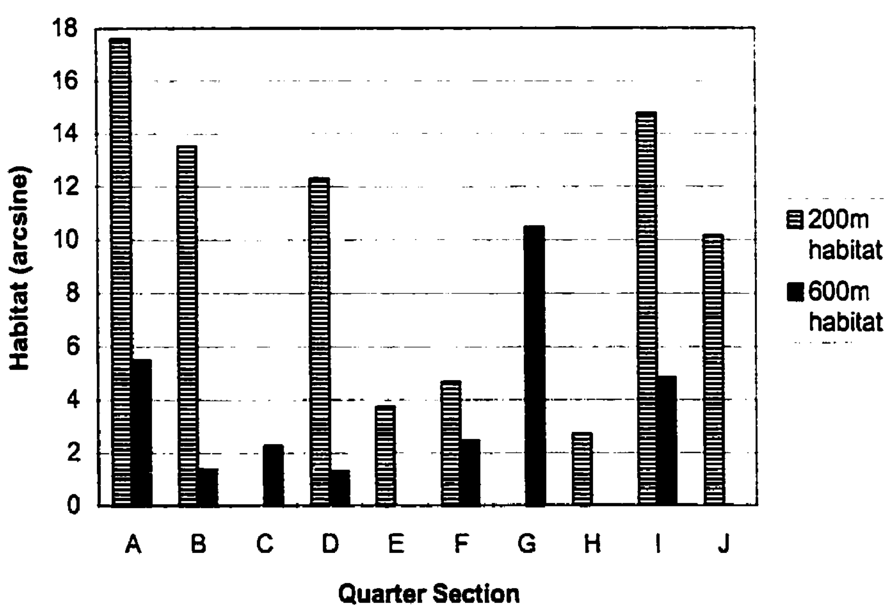


FIGURE 27: DISTRIBUTION OF CONSTRUCTED COVER HABITAT (Y0) THROUGHOUT THE 200M AND 600M AREAS OF THE YORKTON, SK PHMP TRANSECT.

Once again, quarter sections indicating YO within both the 200m and 600m areas are in most cases the result of a single homestead overlapping the boundary. The Fairlight transect (Figure 26) perhaps provides the best example of the inability to use 200m YO data to estimate 600m YO data. Of the fifteen quarter sections containing YO habitat on this transect, eleven contained YO habitat entirely within the 600m area, whereas the remaining four quarter sections contained YO habitat entirely within the 200m area. Extrapolating 200m YO data to estimate 600m YO data is clearly not possible in the examples illustrated in Figures 24 - 27. Results thus indicate that annual A/G data may not validly supplement PHMP data in terms of YO habitats.

Once again, as with artificial wetlands, the inability of A/G data to supplement PHMP data will have little effect on the overall analysis of landscape changes. Homesteads and other constructed cover are permanent, new homesteads which compromise existing waterfowl habitat are rare, and such habitats are insignificant in terms of the landscape as a whole.

4.1.7 Summary of 200m vs. 600m Analysis

Comparisons for six discrete habitat classifications were made between A/G and PHMP data. It was determined that annual A/G data may supplement PHMP data in terms of annually tilled croplands and grassland habitats. In terms of wooded habitats, results indicate that localized variation in the availability of wooded habitats make extrapolation of 200m data to the quarter section difficult. Only when landscape level data are amalgamated does wooded habitat within the 200m area represent wooded habitat within the quarter section.

The nature of natural wetland distribution makes it difficult for small tracts of land, particularly areas adjacent to rights-of-way, to accurately represent natural wetland availability across the landscape. For example, natural wetlands within 200m of the right-of-way may under-represent wetland availability across the landscape due to historical practices of draining and filling. As a result, annual A/G data should not be used to determine wetland availability or wetland density across the landscape.

Artificial wetlands and constructed cover occupy negligible space across the landscape as a whole. In both instances, habitat within 200m of the right-of-way under-represents availability of these habitats throughout the PHMP quarter sections. However, this likely has little effect on short-term or long-term waterfowl habitat management efforts.

4.2 Broad Scale Effects of Rights-of-way on Waterfowl Habitat

An exploratory analysis on the effects of rights-of-way on land-use is conducted using the Yorkton PHMP transect as an example (Figures 28 - 30). This transect was selected because of the relative complexity of its habitat composition. In comparison to the other three transects, the Yorkton transect contains the greatest amount of wooded habitat, as would be expected of typical aspen parkland habitat. The transect is digitally subdivided into four successive partitions, each one 200m further from the right-of-way than the one previous. Habitat comparisons are made as a function of distance from the right-of-way.

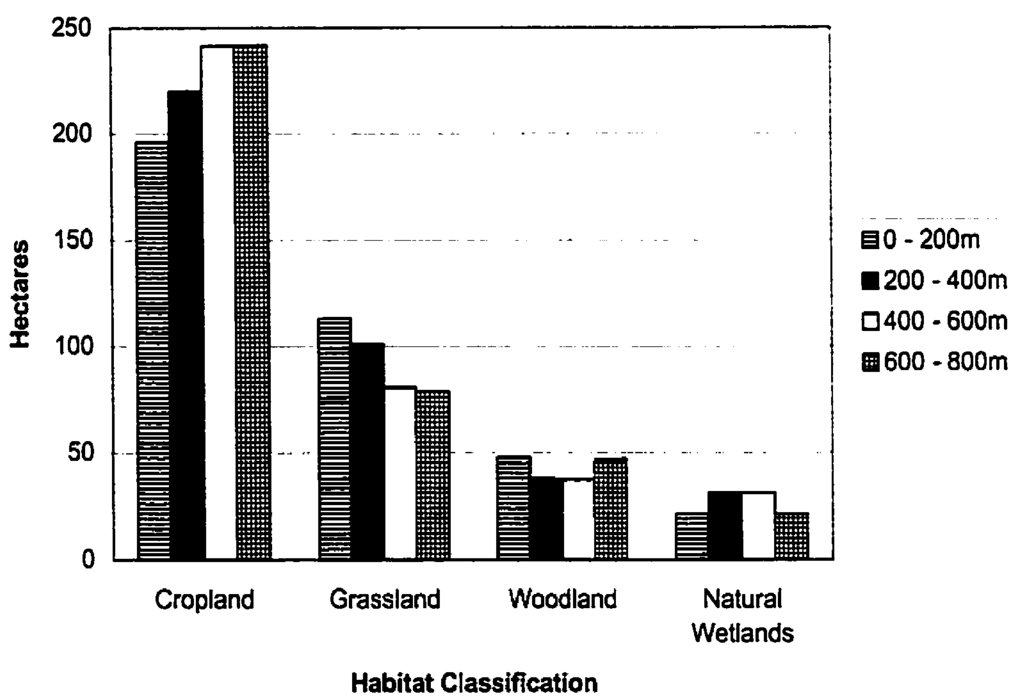


FIGURE 28: HABITAT COMPOSITION OF THE YORKTON TRANSECT AS A FUNCTION OF DISTANCE FROM THE RIGHT-OF-WAY

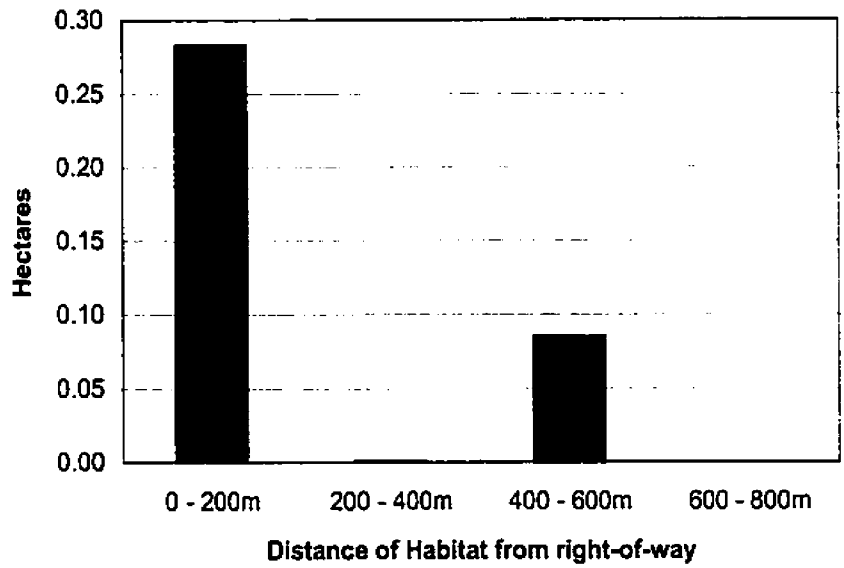


FIGURE 29: ARTIFICIAL WETLAND DISTRIBUTION THROUGHOUT THE YORKTON TRANSECT AS A FUNCTION OF DISTANCE FROM THE RIGHT-OF-WAY

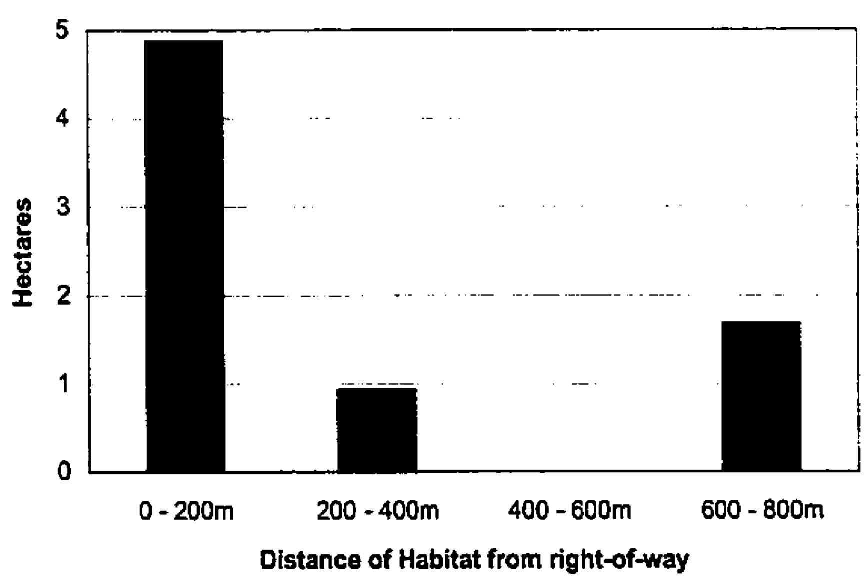


FIGURE 30: CONSTRUCTED COVER HABITAT DISTRIBUTION THROUGHOUT THE YORKTON TRANSECT AS A FUNCTION OF DISTANCE FROM THE RIGHT-OF-WAY

Analysis of the Yorkton data in terms of the four 200m wide areas of habitat, yields similar results as in the previous section. Effects of rights-of-way appear to be negligible in terms of annually tilled cropland, grassland, woodland and natural wetland habitats throughout the Yorkton transect (Figure 28). The data once again reveal the difficulty in comparing artificial wetland habitats (Figure 29) and constructed cover habitats (Figure 30) across different areas of the quarter sections. In the Yorkton transect, the majority of these two habitat types are found adjacent to rights-of-way, thus extrapolating these data across the landscape would result in an over-estimation of the availability of such habitats.

Of particular interest are the results for natural wetland habitats. In the previous section, it was concluded that it is statistically invalid to extrapolate 200m natural wetland habitat data to the remainder of the quarter section. This conclusion is based on results obtained when quarter section data are analyzed on an individual basis. However, when quarter section data are amalgamated prior to analysis (Figure 28), differences in natural wetland habitat availability across consecutive 200m areas of the Yorkton transect appear negligible. This indicates the necessity to incorporate data over larger sample areas such as entire transects, rather than using individual quarter sections to study natural wetland habitat. Using amalgamated transect data thus decreases the risks of committing Type 1 and 2 errors. Amalgamated artificial wetland data (Figure 29) and constructed cover data (Figure 30) serve to reinforce the fact that rights-of-way have an obvious influence on the distributions of these habitats.

Results indicate that annual A/G data provide an accurate representation of habitat availability across the larger landscape, except for artificial wetland and constructed cover habitats. A/G data is useful in describing annual trends in habitat, but caution must be exercised when using it to supplement PHMP data on the basis of individual quarter sections, as shown previously.

Considering results from both analyses, it is clear that the relationships will be stronger in terms of upland habitats as opposed to wetland habitats, and will be more valid across landscapes of low diversity.

4.3 A/G / PHMP Associations

In the previous analysis section, it was concluded that certain aspects of A/G data may supplement PHMP data. It is thus logical to explore the compatibility of the two survey designs in the effort to determine the ease at which data may be communicated between programs. In addition to the four transects already included in the previous analysis, data are available for four additional transects which have overlapping A/G and PHMP routes. Survey data are compared on the basis of 5 parameters common to both survey designs (Table 3).

TABLE 3: A/G / PHMP ASSOCIATION DATA

		% of Associations in Agreement				
	n	Permanency	1^0 Basin Cover	1^0 Basin Activity	1^0 Margin Cover	1^0 Upland Cover
LAVINIA	43	83.72	93.02	83.72	76.74	88.37
REDVERS	119	83.19	81.51	87.39	75.63	84.87
FAIRLIGHT	46	76.09	93.48	69.57	84.78	84.78
YORKTON	81	81.48	93.83	81.48	83.95	93.83
MOORE PARK	93	79.57	95.70	93.55	74.19	81.72
GRAYSON	91	80.22	79.12	84.62	71.43	98.90
CRANDALL	21	80.95	95.24	76.19	71.43	85.71
BOISSEVAIN	13	76.92	92.31	69.23	92.31	100.00
Total	507					
Average	63	80.27	90.53	80.72	78.81	89.77

4.3.1 Wetland Permanency

The extent to which waterfowl will exploit a wetland is largely determined by the permanency of the wetland. For example, small temporary and seasonal wetlands serve as mating territories for many species of waterfowl (Caswell 2001). These small bodies of water also tend to be shallow, thereby allowing sunlight to penetrate the water column more readily. As a result, seasonal wetlands provide a rich food source for post-migrants, and allow females to build up nutrient reserves prior to the nesting period (Caswell 2001). Large, permanent wetlands tend to have areas of dense emergent vegetation associated with them. These wetlands provide valuable nesting cover, as well as protective cover for broods. It is therefore important for habitat surveys to not only provide an index of wetland availability, but distinguish in detail the types of wetlands in existence.

The A/G survey and the PHMP both classify wetlands on the basis of permanency. A/G wetlands are assigned a specific type, which describes the permanency of the wetland, as well as a water level stage, which describes the current water level of a particular basin (Canadian Wildlife Service 1989). The PHMP labels wetlands either as intermittent/ephemeral or semi-permanent/permanent. The A/G typing scheme provides a more detailed and biologically informative approach to wetland typing than does the PHMP. In the effort to minimize variability in the data analysis, only A/G wetlands of types 3, 4, 5, streams, and artificials are considered in this study. Descriptions of A/G wetland types are provided in Appendix 1, while PHMP wetland types are described in Appendix 2.

Results obtained when comparing the A/G and PHMP survey designs are summarized in Table 3. A total of 507 wetlands are compared throughout the aspen parkland region of Manitoba and Saskatchewan. In terms of wetland permanency, the two surveys are in 80.27% agreement. Results are presented simply in percentage form, as there exists an obvious deviation from randomness. Thus no elaborate statistical analysis are deemed necessary. This result indicates that the A/G and PHMP survey designs are compatible in terms of comparing wetland permanency. However, as discovered in the previous section, caution must be exercised when extrapolating A/G wetland data from the 200m area adjacent to the right-of-way, to PHMP data across entire quarter sections.

4.3.2 Wetland Basin Cover and Activity

The characteristics of a wetland basin also play a major role in determining the extent to which a particular wetland will be utilized by waterfowl. Shallow basins, typical of intermittent or ephemeral wetlands may be subject to annual cultivation. As a result, such basins provide little or no protective cover for waterfowl from predators. Such wetlands will be used periodically for loafing or feeding purposes, but provide minimal opportunities for nesting or rearing broods (Caswell 2001). In fact, these wetlands tend to be non-existent by the onset of the annual hatch.

Wetlands which are not annually cultivated provide a vegetated basin, thus are a more valuable resource for waterfowl. Vegetated basins harbor greater food resources both in terms of plant matter as well as invertebrate matter. Depending on the size of the wetland and the height and density of vegetation, these basins may provide valuable nesting sites, both in wet and dry years, as well as protective cover for broods in wet years. Vegetated basins are especially valuable when not subjected to other agricultural disturbances such as grazing and haying.

The PHMP classifies basin cover and activity on the basis of the most dominant of each. A/G coding however classifies cover and activity on a percentage basis, with combinations not to exceed 100%. In terms of primary basin cover, the A/G and PHMP classification schemes are determined to be in agreement 90.53% of the time. In terms of primary basin activity, the two programs agree in 80.72% of cases. These results indicate that annual trends recorded in A/G data, with respect to wetland basin cover and activity, may be useful in supplementing PHMP data.

4.3.3 Wetland Margin Cover

The margin of a wetland is the remnant of native upland vegetation surrounding a wetland basin (USFWS and CWS 1987). In the prairie pothole region, wetland margins have been subject to high degrees of agricultural impacts (Schuster 1993). The extent to which a margin has been impacted, along with the types of impacts, have great influence over waterfowl production. The presence of a wetland margin is perhaps most important to dabbling ducks, such as mallard and gadwall, which select well-concealed nest site locations near water. Diving ducks, on the other hand, tend to nest over water among emergent vegetation, thus the quality and extent of the wetland margin is of secondary importance (Caswell 2001).

Margins represent a transition zone between farmland and wetland (Hochbaum and Caswell 1990, Hochbaum et al., 1988). Agricultural practices tend to cultivate as much of a wetland margin as possible in the effort to maximize arable land. In the late 1980's, as much as 78% of wetlands had been impacted by agriculture to some degree, with margins taking the brunt of the impact (Schuster 1993). Remaining margins exist as wooded or grassland vegetation, thus providing valuable nesting opportunities for waterfowl. Wooded margins, in particular, provide concealment from predators, thus serve an important role in the annual cycle of waterfowl.

Wetland margins are an invaluable resource to breeding waterfowl, but are subject to a variety of impacts due to agricultural intensification. Monitoring efforts must accurately document trends in margin impacts and conditions if conservation efforts are to be successful. A/G surveys document both margin cover and activity, however the PHMP reports only margin cover. Therefore, in comparing the two programs, only margin cover can be analyzed.

The PHMP classifies margin cover as either non-natural (cultivated or improved grass), grassland, or wooded. A/G data also documents the extent of cultivation, along with other agricultural impacts and the presence of grassland and wooded cover. In comparing the two survey designs, the focus is on the ability of the two programs to agree on the extent of margin remaining around a wetland. The two programs are in agreement in 78.81% of cases. This provides an indication of the possibility of A/G margin cover data to supplement PHMP margin cover data on an annual basis.

4.3.4 Primary Upland Cover

The habitat surrounding a wetland is important when assessing waterfowl breeding capability, as sufficient cover is necessary for success of upland nesting ducks (Talent et al. 1982, Duebbert 1974). The amount of cover available to conceal nests is one of the more important variables influencing waterfowl production (Hochbaum et al. 1987). A/G surveys assess upland conditions adjacent to the outer edge of the wetland margin in the effort to evaluate agricultural practices, and hence, nesting cover potential in the immediate vicinity of a wetland (USFWS and CWS 1987). The PHMP distinguishes habitat as either wetland or upland, thus direct comparisons of upland habitats are possible between the two programs.

A/G and PHMP data are in 89.77% agreement with respect to upland cover type. This result indicates the ability of annual A/G upland data to supplement long-term PHMP upland data. This result is of particular significance, as uplands occupy the vast majority of available habitat. Upland conditions reflect the ability of a region to support breeding duck populations, thus accurate monitoring programs are essential.

Chapter 5: Summary and Conclusions

Since its inception in 1986, the North American Waterfowl Management Plan (NAWMP) has been promoting the conservation of waterfowl habitat. With the exception of some species, such as the northern pintail and lesser scaup (Caswell et al. 2000), waterfowl populations have recovered under the Plan from record low numbers in the 1980's, approaching record high numbers similar to those of the 1970's. However, the effects of habitat conservation efforts under the NAWMP in contributing to this recovery remains poorly understood. The NAWMP was successful in promoting conservation of waterfowl habitat, but less so in promoting the evaluation and monitoring efforts needed to guide conservation (Williams et al. 1999). Monitoring efforts must distinguish between the effects which NAWMP has had on waterfowl populations, from other factors such as changes in climate and hydrological cycles. This study partly addresses these issues, attempting to improve current waterfowl habitat monitoring efforts across the aspen parkland regions of Saskatchewan and Manitoba.

The primary objective of this study was to explore relationships between two waterfowl habitat monitoring programs currently carried out across the critical waterfowl breeding regions of Canada. These two programs, the A/G survey and the PHMP, survey overlapping routes, however no prior efforts to relate the programs have been undertaken. Should the data sets be complimentary and compatible, future efforts may result in the development of more comprehensive and biologically sound habitat monitoring efforts, encompassing information from both data sets.

In order to satisfy the primary objective, a number of secondary objectives were addressed. First, the A/G survey only monitors habitat within 200m of the right-of-way survey line, whereas the PHMP surveys entire quarter sections of habitat. As a result, only the 200m area adjacent to the right-of-way is common to both surveys. Therefore, it was necessary to determine if habitat within this 200m area is representative of habitat within the quarter section as a whole. Results indicate annually cultivated cropland including summerfallow, as well as grasslands, including hayland and pasture found within the 200m area, provide an accurate representation of those habitat types for the quarter section as a whole. Extrapolation of wooded habitats from the 200m area to the quarter section is not recommended on an individual quarter section basis. Significant results for wooded habitats are observed only when quarter section data are amalgamated prior to analysis. It is apparent that a number of factors are involved in determining the amount and distribution of wooded habitat on a localized scale. Amalgamation of wooded habitat data serves to better represent conditions across the landscape, masking local variations in the process.

In terms of natural wetlands, caution must be exercised due to the nature of natural wetland distributions and their association with regional topography. Results indicate that natural wetlands within the 200m area may under-represent the amount of wetland habitat throughout the quarter section. However, annual trends in wetland permanency, for example, likely provide an accurate representation of large-scale trends.

Artificial wetland habitats, such as dugouts and borrow pits, and constructed cover habitats, such as farmyards, do not occupy sufficient areas to allow for statistical analysis of the data. However, available data suggest that those habitats within 200m adjacent to the right of way do not provide an accurate representation of available habitat within the quarter section.

Quarter section data were amalgamated to explore broad scale effects of rights-of-way on available habitat, using the Yorkton transect as an example. Results were similar to those of the previous section, with the exception that natural wetlands within the 200m area appear to be representative of the transect when quarter section data are amalgamated prior to analysis. This indicates that annual trends observed within the 200m strip may reflect trends across the landscape. However, as the previous section revealed, caution must be exercised when extrapolating data across individual quarter sections.

Finally, it was necessary to determine the compatibility of the A/G and PHMP survey designs. Results indicate that the two programs reveal complimentary and compatible information in terms of wetland permanency, primary basin cover, primary basin activity, primary margin cover, and primary upland cover.

Results of this study indicate that the A/G and PHMP survey designs are compatible, however the degree of their compatibility may vary on a localized level. The data prove more reliable for certain habitat types than others, indicating greater compatibility for upland habitats than for wetland habitats. Results of this study may contribute to the development of more comprehensive and biologically informative approaches to waterfowl habitat monitoring. Improving current habitat monitoring methodologies may increase the ability to evaluate the long-term effectiveness of NAWMP initiatives.

Chapter 6: Management Recommendations

The following management recommendations are based on the results of this study, with the intention of facilitating steps toward improvements in current waterfowl habitat monitoring techniques.

1) The annual A/G survey was originally designed as a breeding population survey, with the habitat component of secondary importance. Population data from A/G surveys, dating back to 1955, reveal long term trends and fluctuations in waterfowl populations. Although long term A/G habitat data also exist, annual reports produced following A/G surveys are heavily weighted toward population trends, with little focus on habitat change. This study recommends more attention be directed toward the habitat component of the A/G survey. Efforts must be directed to greater utilize annual habitat data, relating it to population data, in the effort to better elucidate species/habitat relationships. As this study has deemed A/G and PHMP designs compatible, efforts should be made to supplement PHMP data with A/G data. This would provide biologists with a better understanding of the association between trends in waterfowl populations and habitat availability.

2) In determining the ability of habitat in the 200m area adjacent to the right-of-way, to represent habitat in an entire quarter section, results varied according to habitat type

and geographic location of the transect. Relationships between the 200m and 600m areas vary among habitat types, with the strength of associations varying on regional scales. Similar studies need to be conducted across different ecoregions, under the assumption that the relatively homogeneous prairies will show stronger relationships than the more complex aspen parkland regions.

3) In conjunction with management recommendation #2, data should be reevaluated on a strata by strata basis to test for differences in degrees of association between the A/G and PHMP programs. Managers may then determine if population / habitat relationships should be analyzed on the basis of differing ecoregions or survey strata.

4) Present protocols of the A/G and PHMP surveys require a large number of individuals for data collection. Observer bias is currently high in data collecting procedures, often with inexperienced individuals collecting the data. Data accuracy would likely increase with fewer, and more experienced individuals involved in the data collection.

5) Compatibility of A/G and PHMP survey designs is greater for upland habitats than wetlands. Thus, under current program designs, A/G data should supplement PHMP data with reference to upland habitats only. Wetland typing is more detailed and informative under the A/G scheme than the PHMP, and should perhaps be adopted by the PHMP. This would allow for the development of stronger wetland relationships between the programs. Digitized PHMP maps could then be updated more frequently with reference to both wetlands and uplands.

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APPENDIX A

Definitions and Habitat Classification Codes

Employed in the A/G Survey

(adapted from United States Fish and Wildlife Service and Canadian Wildlife Service. 1987. Standard operating procedures for aerial waterfowl breeding ground population and habitat surveys in North America. 100p.)

l) Pond Type

For the purposes of this study, only A/G ponds of types 3, 4, 5, streams, and artificial wetlands are considered in associating A/G ponds with PHMP wetland polygons.

A/G POND TYPE	DESCRIPTION
Type 3 - Seasonal Wetlands	will retain water for at least 3 weeks after observation, but can be expected to be dry by early July. Water depth typically exceeds 6 inches.
Type 4 - Semi-permanent Wetlands	ponds of sufficient depth that water will likely persist throughout the brood season, but which may go dry during late August or early September. These wetlands will retain water during at least 7 out of 10 years.
Type 5 - Permanent Wetlands	permanent ponds, marshes or lakes of sufficient depth that water will persist year round.
Streams (ST)	a stream course containing surface water at the time of observation
Dugout (D)	a common artificial wetland characterized by an excavation with adjacent spoil banks.
Gravel Pit (GP)	an area used for excavation that can be variable in areal extent, depth, and size/shape of spoil banks.
Borrow Pit (BP)	generally a deep, rectangular area adjacent to a right-of-way, from which material was removed for road construction. Distinguished from a dugout by its lack of spoil banks.
Stock Pond (SP)	an impoundment of a natural stream course, used for the watering of cattle. Usually in the form of earthen or sand/gravel berms.
Irrigation Canal (IC)	a ditch used for the transportation of water for irrigation purposes, excluding roadside ditches.
Sewage Lagoon (SL)	large, rectangular areas, usually surrounded by well-vegetated earthen berms. Generally located near communities, and used for sewage settling purposes.
Reservoir (R)	generally large areas surrounded by an earthen berm. Used for water storage purposes, and often located near communities.

2) Water Level Stage

The water level stage is the term used for the description of the current water level of a given basin containing water. This provides an evaluation of the degree of drawdown or flooding of basins relative to a "normal" situation. Water level stage takes the form of a numerical code, from 1 to 7, and is inserted following a slash (/) after the wetland type. For example, 3 / 5 represents a type 3 wetland with a water level stage of 5. The following water level stages are used in the A/G survey:

A/G WATER LEVEL STAGES		DESCRIPTION
1	Dry	no surface water visible. Only used for artificial wetlands.
2	Vestigial	surface water appears only as small pools or puddles which can be expected to disappear in a few days
3	Recessional	water levels within the basin have receded, but still cover and extensive area. Some wetlands may have a drawdown mudflat area between the surface water and wetland vegetation.
4	Intermediate	there is some drawdown of water level represented by lack of water in the wet meadow zone.
5	Full	surface water is present to the outer edge of the wet meadow zone
6	Flooded	surface water has risen beyond the edge of the wet meadow zone and covers adjacent upland cover of the margin, if present, or adjacent cultivated land.
7	Overflowing	surface water has exceeded the full supply level of the basin

3) Definitions of Wetland Parameters

a) Basin

The basin is defined as the lower, and generally the most interior, portion of a wetland which contains surface water if present (usually in the central portion), and extending outwards to the outer edge of the wet meadow zone.

b) Wet meadow zone

The wet meadow zone is the outer portion of the basin, and is characterized by fine-stemmed grasses and sedges, and a variety of short stature herbaceous species. This zone is usually covered by surface water in the spring until late May, at which time the surface water disappears leaving the soil saturated.

c) Margin

The A/G survey defines a wetland margin as the remnant of native upland vegetation around a wetland basin. The margin width is considered to be a 10m wide band adjacent to the wet meadow zone. Evaluation of the margin width involves estimating the margin width from 0m (no remnant native upland vegetation) to 10m (full 10m margin present). The margin is of interest for its use for nesting cover by many species of ducks.

d) Upland

The upland is defined as the land cover immediately abutting the outer border of a wetland's margin, regardless of whether the full 10m wide margin is present or not. It is expressed as a percentage of the perimeter of the margin for a contiguous upland condition, and must add up to 100%. An assessment of upland conditions is used to evaluate agricultural practices, and hence, nesting cover potential, in the immediate vicinity of a wetland.

4) Basin Impacts and Conditions

Basin Impacts - Basin impacts are evaluated as a means of assessing the frequency and degree of various agricultural impacts upon wetland basins. Both permanent and transitory impacts are assessed (i.e. native vegetation cover can be established if the impact ceases). The following basin impacts are assessed by estimating the percent areal extent of each within the basin. For these impacts, the total percentage cannot exceed 100%.

BASIN IMPACT	TYPE	DESCRIPTION
(F) Fill	Permanent	Piles of rocks, brush, abandoned machinery, etc. within the basin. Brush often results from the clearing of wooded cover, and may disappear with later burning.
(BS) Spring Burning	Transitory	Burning of vegetation in the spring. Black ashes and black tips of green shoots are often indicative.
(BA) Autumn Burning	Transitory	Burning of vegetation in the previous autumn. Weathered ashes and black tips on green shoots are often indicative.
(H) Haying	Transitory	Haying in the previous year, often indicated by even cutting of basin vegetation and in some cases windrows of hay and/or bales.
(G) Grazing	Transitory	Grazing by livestock in the previous or current year.
(C) Cultivation	Transitory	Tilling of soil for crop production. Disking of the edge or entire basin, or presence of stubble from the previous year are indicative.
(Y) Farm Yard	Permanent	A basin within a farmyard in proximity to structures and activity areas.

In addition, there are three special situations for basin impacts which do not consider the above 100% maximum of areal extent. They are evaluated separately as follows:

BASIN IMPACT	TYPE	DESCRIPTION
(D) Draining	Permanent	Drainage of the surface water of a basin by creation of a drainage ditch.
(CL) Clearing	Permanent	Clearing of woody cover within the wetland basin.
(I) Impacted by Construction	Permanent	Generally in the form of a right-of-way. The percent area of the basin which has been covered by the right-of-way is estimated.

Basin Conditions - After the basin impacts are evaluated, an independent evaluation of the basin conditions is required. This addresses only one condition, the amount of woody cover within the wetland basin

BASIN CONDITION	DESCRIPTION
(W) Wooded Cover	Percent areal extent of the basin with wooded cover. This assessment is not included within the 100% maximum of the agricultural impacts described above. It is independent of the impacts and is a condition assessment.

5) Margin Impacts and Conditions

Margin Impacts - Impacts to the margin are assessed in a similar fashion as with wetland basins, with one distinct difference. If the margin width is less than 10m, then the corresponding percent cultivation must be indicated (i.e. if MW = 5m, margin impact automatically requires an entry of 50C). Loss of margin is due to cultivation of the native upland vegetation. After this step is completed, other impacts, similar to those for basin impacts, are assessed as percent areal extent on the remaining margin, with their sum not to exceed 100%. These impacts include:

F	Fill
BS	Spring Burn
BA	Autumn Burn
H	Haying
G	Grazing
Y	Farmyard

The drainage impact (D), is not applicable to margins. One special situation involves the clearing of wooded cover (CL) within the wetland margin. Clearing is evaluated as the percent of border of wooded cover removed. Another special situation involves the right-of-way road construction impact (I), which is not considered during the assessment of margin impacts. The margin present away from the road is considered only.

Margin Conditions - After the margin impacts have been evaluated, an independent assessment of a margin condition, the percent perimeter of wooded cover (W) around the basin is conducted. In contrast to the estimate of areal extent of wooded cover within the basin, the screening effect of wooded cover around the basin is involved here, regardless of width or density of stems. The percent of the perimeter of the basin which is bordered by wooded cover is estimated.

6) Upland Conditions

An assessment of upland conditions adjacent to the outer edge of the 10m margin zone is used to evaluate agricultural practices, and hence, nesting cover potential, in the immediate vicinity of the wetland. These evaluations are in the form of describing the land cover abutting the outer border of the margin at the 10m point, whether the full 10m wide margin is present or not. It is expressed as a percent of the perimeter of the margin for a contiguous upland condition. These conditions must add up to 100%, unlike basin or margin area impact assessments where presence of native cover can occur. The upland conditions for the A/G assessment include:

UPLAND CONDITION	DESCRIPTION
(C) Crop	Crop vegetation (i.e. winter wheat or fall rye)
(S) Stubble	Standing stubble from the previous year
(F) Fallow	Summerfallow characterized by bare soil
(H) Haying	Hayfields, including alfalfa, where evidence of active haying is present
(G) Grassland	Native grasses with no evidence of grazing
(W) Wooded	Tree/shrub growth with no evidence of grazing
(P) Pasture	Native or tame pastures where there is evidence of grazing, and grassland is the dominant cover
(WP) Wooded Pasture	Native pastures where there is evidence of grazing, and where wooded cover is dominant
(Y) Farmyard	Farmyard with associated structures

NOTE: When a right-of-way is near a wetland, the upland conditions are not assessed on the other side of the road.

APPENDIX B

Definitions and Habitat Classification Codes

Employed in the Prairie Habitat Monitoring Program

(adapted from Ingstrup, D. and H. Schinke. 1999. Prairie Habitat Monitoring Program Update: Preliminary Results. Draft. 23p.)

1) Primary Vegetation Cover

CODE	VEGETATION COVER	DESCRIPTION
W1	Tall Trees	Stands of tall trees (>5m)
W2	Regular spaced small trees with tall/mid shrubs	Stands of regularly spaced small trees (<5m) mixed with tall/mid shrubs (0.5 to 1.5+ m). Includes shelterbelts and hedge rows.
W3	Irregular spaced small trees with tall/mid shrubs	Stands of irregularly spaced small trees (<5m) mixed with tall/mid shrubs (0.5 to 1.5+ m)
W4	Low shrub	Stands of low shrub (<5m), includes areas with predominant buckbrush, wildrose, and sagebrush
V1	Annual Crop	Annually cultivated crop including wheat, oats, barley, mixed grains, corn, rye, canola, flaxseed, and other crops
V2	Improved Grass	Includes alfalfa and all other tame hay cut for hay or silage, other fodder crops cut for hay or silage, and improved pastures that have been seeded down for less than 5 years and are part of ordinary crop rotation
V3	Unimproved Grass	Includes native grasses, pastures containing sedges and forbes, unimproved land for grazing, and pastures seeded for more than 5 years

2) Aquatic Habitats (permanent and semi-permanent wetlands, not including intermittent/ephemeral wetlands)

CODE	COVER TYPE	DESCRIPTION
Z1	Streams and Rivers	Streams and Rivers
Z2	Irrigation Canals	Irrigation Canals
Z3	Lakes and Ponds	Permanent open water lakes and ponds that contain some emergent plants. Includes any open water marshes characterized by intermittent growth of emergents such as reeds, rushes and tall grass alternating with open water conditions.
Z4	Saline Lakes and Ponds	Permanent open water alkali wetlands. Open water of high salinity.
Z5	Artificial Water	Reservoirs and dugouts (not including irrigation canals).
Z6	Transitional Open Water	Permanent open water lakes and ponds that lack submerged, shallow, open water plants.
V4	Emergent Deep Marsh	Semi-permanent, shallow water with tall emergents such as reeds, rushes and tall grass

3) Disturbed Habitats

CODE	COVER TYPE	DESCRIPTION
V5	Disturbed Grass	Non-woody plants representing complexes of disturbed species
XO	Bare Surface	Bare ground including summerfallow. Does not include a bare field that has been seeded
YO	Constructed Cover	Includes buildings, well sites, pipeline compressor stations, etc.

4) Land Activity Codes

CODE	CLASS NAME / DESCRIPTION
A1	Crop - growing annual tillage crop
A2	Forage - growing forage crop
A3	Grazing - grazing activity
A4	Other Productivity - includes berry farms, sod farms, etc.
A5	Ag Site - includes grain bins, farm yards, etc.
F0	Forestry - forestry activities
G0	Wildlife - wildlife and fisheries activities
R0	Recreation - recreational activities
D0	Dwelling - dwelling activity
H1	Road
H2	Railway
H3	Transport - other transportation
H4	Communication - communication activity
M0	Manufacturing - manufacturing and commercial activities
M1	Wastes - treatment and disposal of wastes
E0	Extraction activity
J0	Institutional activity
P1	Conservation - research and conservation
B3	Idle land
N0	None - no perceived activity
L0	Transition - land in transition
P2	Flood - flood control and drainage
P4	Irrigation
P3	Other activity
B1	Former agricultural activity
B2	Former extraction activity
08	Unclassified

5) Intermittent wetlands

These codes are used only for any intermittent / ephemeral wetlands. This includes wet meadows composed of grasses, sedges, or willows, and are only flooded in the spring. This also includes shallow marshes that have grass, sedges and forbs of intermediate height, as well as some floating and submerged plants.

CODE	DESCRIPTION
Blank	Identifies polygons which are uplands rather than wetlands
O	Wetlands with non-natural (V1 / V2) cover as either the dominant or secondary fringe type
G	Wetlands with unimproved grass (V3) as either the dominant or secondary fringe type
S	Wetlands with tree or shrub cover (W1, W2, W3, W4) as either the dominant or secondary fringe type.
8	Only applicable in the secondary cover classification column, indicating a wetland with >75% of one fringe type

APPENDIX C

Criteria Used in Comparison of A/G / PHMP Habitat Monitoring Data

1) **Permanency**

- only consider A/G wetlands of types 3, 4, 5, streams and artificials in the analysis. A/G wetlands classified as either Dry, flooded, or type 1 are not included in the effort to reduce variability in the data.
- do not allow "leeway" in the comparisons. PHMP makes a distinction between: (a) permanent/semi-permanent, and (b) intermittent/ephemeral wetlands. Make the same distinction for A/G data.
- Type 3 wetlands must be associated with intermittent / ephemeral PHMP coding.
- Types 4 and 5 must be associated with PHMP codes of either V4, Z3, Z4, OR Z6.
- Streams must be associated with Z1
- Irrigation canals must be Z2
- Artificial wetlands other than irrigation canals must be Z5

2) **1° Basin Cover**

- PHMP cover codes include wooded cover and non-wooded cover such as annual crop (V1), improved grass (V2), unimproved grass (V3), aquatic habitats, etc.
- the PHMP provides one code for each basin cover type. This code represents the dominant cover type in each basin. This code must be reflected as a dominant A/G wetland condition, equaling or exceeding 50%

3) <u>1° Basin Activity</u>

- the PHMP provides one code for each basin activity type. This code represents the dominant activity in each basin. PHMP activity codes include crop (A1), forage (A2), grazing (A3), no activity (NO), among many others. This code must be reflected as a dominant A/G wetland activity, equaling or exceeding 50%

4) <u>Margin Cover</u>

- although A/G data reports both margin cover and activity, PHMP reports only margin cover. Therefore, only margin cover can be used as a criteria.
- the PHMP employs 3 marginal cover codes: O (non-natural cover such as V1 or V2), G (unimproved or V3 cover), and S (wooded cover). In the case where the primary margin cover exceeds 75% of one fringe type, the secondary code is assigned an 8.
- when comparing the two programs, the primary margin cover criteria will focus on the A/G margin width and the PHMP primary margin cover. MW < 5 should have O as the primary margin cover. MW > 5 should not have O as the primary cover unless V2 is associated with the margin. MW = 5 may have any cover indicated as the primary cover, but must not have an 8 associated in the secondary margin cover. In other terms, do the two programs agree on the extent of margin remaining around a wetland?

5) **1° Upland Cover**

- using the PHMP and A/G aerial photos, determine what type of upland habitat comprises >50% of the upland habitat surrounding the wetland of interest. It is this habitat which will be the primary upland cover, having the greatest influence on the associated wetland and its potential use to waterfowl.
- the primary PHMP upland polygon must be associated with complimentary A/G coding equaling or exceeding 50%.

APPENDIX D

List of Acronyms Used Throughout this Paper

ACRONYM	DEFINITION
A/G	• Air / Ground survey
PHMP	• Prairie Habitat Monitoring Program
NAWMP	• North American Waterfowl Management Plan
PPR	• Prairie Pothole Region
CWS	• Canadian Wildlife Service
USFWS	• United States Fish and Wildlife Service
PHJV	• Prairie Habitat Joint Venture
Prairie CARE	• Prairie Conservation of Agriculture, Resources, and the Environment
MHHC	• Manitoba Habitat Heritage Corporation
CCS	• Consolidated Census Subdivision
GIS	• Geographic Information System