Environment Canada's Prairie & Northern Region Habitat Monitoring Program Phase II: Recent habitat trends in the Prairie Habitat Joint Venture.

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SUMMARY

This report presents results from the Phase II Prairie Habitat Monitoring Program, which examined habitat change within the Prairie Habitat Joint Venture (PHJV) delivery area between 1985 and circa 2001. The program was designed to provide an evaluation of habitat trends throughout the PHJV delivery area and establish the foundation for a long-term habitat monitoring program.

Wetlands (Habitat Monitoring Transect Results)

Wetland habitat change was measured by comparing baseline and updated habitat change on 153 Habitat Monitoring Transects. Change detection was conducted using air photos digitized data and ground verified in 1985 to updated, ground-verified and digitized data in circa 2001. A total of 153 transects encompassing 3,556 quarter sections (235,710 ha) sampled 0.41 % of the entire PHJV study area. From 1985 to 2001, major wetlands trends on study transects were:

- Gross wetland area loss equaled -5% with the mean loss per transect equaling -5% (95% CI -7% to -4%). Net wetland area change equaled -5% with the mean net wetland area change per transect of -5% (95% CI -6% to -3%).

- Total net wetland numbers on habitat monitoring transects declined by 2,050 or -5% from 1985 to 2001, gross wetland basin losses equaled -6%.

- The mean size of lost wetland basins was 0.20 ha, (median = 0.10 ha).

- Wetland area percentage loss rates tended to be lower in PHJV-targeted lands when compared with non-targeted lands; however, it could not be concluded with certainty that wetland area losses in targeted lands were *significantly* less than in non-target lands.

- Comparisons with wetland loss studies in the PHJV from previous time periods and annual loss rates from this study indicate that annual loss rates of wetland numbers and areas has remained fairly constant.

- Results from Boreal Transition and Aspen Parkland ecoregions of the PHJV suggest that these wetland-rich ecoregions have experienced large wetland losses from 1985 to circa 2001.

Uplands (Habitat Monitoring Transect Results and Census of Agriculture)

Upland habitat change was measured on 153 Habitat Monitoring Transects. Change detection was completed by comparing habitat polygons mapped from air photos and ground-verified in 1985 to updated, ground-verified aerial photography and digitized data from circa 2001. Statistics Canada Census of Agriculture data from 1986, 1996, and 2001 was also used to evaluate upland habitat change in the PHJV study area.

Trend analysis results reported by Agricultural Census and the Habitat Monitoring Transects were similar. Agricultural census data provided a measure of total landscape change for all farms within the PHJV study area. The results of the combination of the two datasets outline the major land use and habitat trends; overall total land composition trends from 1985 to 2001 identified by combining habitat monitoring transect results and AG census results were as follows:

- Cultivated land consisting of summer fallow and annual crop decreased by approximately -6 %, so an estimated 55 % of the total PHJV land area was classified as being cultivated in 2001.

- Natural land being used for pasture decreased slightly (from 24.2 % to 23.6 % of total PHJV upland area).

- Tame or seeded pasture increased by nearly 3% from 1985 to 2001, and AG census data reports that by 2001, 7% of the total PHJV land area was classified as tame or seeded pasture.

- Tame hay increased by approximately 4% and according to AG census data increased from 5% of total PHJV land area in 1985 to 9% in 2001.

- The "all other" land category (which includes wildlife habitat) of the AG census data decreased by 1%, and in 2001 5 % of all PHJV land was designated to this category.

Habitat monitoring transects also provided the following additional habitat-specific information:

- All native habitats declined including areas of grasslands, shrubs, and trees.

- Native grassland habitats on habitat monitoring transects declined by -2,479 ha or -10 %. The mean area of native grassland lost per transect was -11 % (95 % CI = -13% to -8%). However, accurate classification of native grassland was hampered due to large amounts of tame grass on the landscape resulting in potential misclassification between baseline and update data sets. The majority of native grassland loss was attributed to "squaring the field" resulting in the removal of small remnant grassland areas within cultivation-dominated landscapes.

- Although under-sampled, large blocks of native grassland habitats area remained stable or declined only slightly.

- Overall, native grassland area losses were highest in the Aspen Parkland ecoregion which accounted for 41% of the total native grassland losses in the PHJV.

- Naturally treed habitats declined by -6% and naturally treed habitat declined in every ecoregion except the S.W. Manitoba Uplands, Cypress Uplands and Fescue Grassland ecoregions.

SOMMAIRE

Ce rapport présente les résultats de la phase II du programme de surveillance des habitats des Prairies, qui s'est penchée sur les changements des habitats dans l'aire de réalisation du Plan conjoint des habitats des Prairies (PCHP) entre 1985 et 2001 environ. Le programme a été conçu pour fournir une évaluation des tendances liées aux habitats dans l'ensemble de l'aire de réalisation du PCHP et pour établir la base d'un programme de surveillance des habitats à long terme.

Terres humides (Résultats des transects de surveillance des habitats)

Le changement des habitats de terres humides a été évalué en comparant l'état de référence des habitats et l'état mis à jour dans 153 transects de surveillance des habitats. La détection des changements a été effectuée en comparant des données numérisées de photographies aériennes et vérifiées au sol en 1985 à des données actualisées numérisées et vérifiées au sol vers 2001. Un total de 153 transects regroupant 3 556 quarts de sections (235 710 ha) ont échantillonné 0,41 % de l'ensemble de la zone d'étude du PCHP. De 1985 à 2001, les tendances principales relatives aux terres humides dans les transects d'études étaient :

- La perte brute des milieux humides était égale à -5 % avec une perte moyenne par transect de -5 % (intervalle de confiance de 95 %, de -7 % à -4 %). Le changement net de l'aire de zone de terres humides était égal à -5 % avec un changement moyen de l'aire de zone de terres humides par transect de -5 % (intervalle de confiance de 95 %, de -6 % à -3 %).

- Les nombres nets totaux de zones humides dans les transects de surveillance des habitats ont diminué de 2 050 ou -5 % de 1985 à 2001. Les pertes brutes des bassins des terres humides étaient de -6 %.

- La taille moyenne des bassins de terres humides perdus était de 0,20 ha (médiane = 0,10 ha).

- Les taux de pertes des milieux humides avaient tendance à être inférieurs dans les terres ciblées du PCHP en comparaison avec les terres non ciblées. Cependant, il a été impossible de conclure avec certitude que les pertes des milieux humides dans les terres ciblées étaient *nettement* inférieures aux pertes dans les terres non ciblées.

- Les comparaisons des études précédentes relatives aux pertes des terres humides dans le PCHP avec les taux de perte annuelle de cette étude indiquent que les taux de perte annuelle en ce qui a trait aux nombres et à la superficie des zones humides sont restés relativement constants.

- Les résultats des écorégions de transition boréale et de parcs de peupliers faux-trembles du PCHP suggèrent que ces écorégions riches en terres humides ont subi de fortes pertes de 1985 à 2001 environ.

Zones sèches (Résultats des transects de surveillance des habitats et Recensement de l'agriculture)

Le changement des habitats dans les zones sèches a été évalué dans 153 transects de surveillance des habitats. La détection des changements a été effectuée en comparant des polygones d'habitat cartographiés à l'aide de photographies aériennes et vérifiés au sol en 1985 à des données numérisées de photographies aériennes actualisées et vérifiées au sol vers 2001. Des données tirées du Recensement de l'agriculture de 1986, 1996 et 2001 ont également été utilisées pour évaluer le changement des habitats dans la zone d'étude du PCHP.

Les résultats de l'analyse des tendances rapportés par le recensement agricole et par les transects de surveillance des habitats étaient similaires. Les données du recensement agricole ont fourni une évaluation des changements dans l'ensemble du paysage pour toutes les fermes situées dans l'aire d'étude du PCHP. Les résultats de l'association des deux ensembles de données soulignent les tendances principales relatives à l'utilisation des terres et aux habitats. Les tendances générales relatives à la composition de la terre de 1985 à 2001, déterminées en associant les résultats des transects de surveillance des habitats et ceux du recensement agricole, sont les suivantes :

- La terre cultivée faisant l'objet d'une mise en jachère l'été et d'une production de cultures annuelles a diminué d'environ -6 %. On estime que 55 % de la surface totale du territoire du PCHP a été classée comme étant cultivée en 2001.

- Les terres naturelles utilisées comme pâturage ont légèrement diminué (de 24,2 % à 23,6 % de l'ensemble des terres sèches du PCHP).

- Les pâturages cultivés ou ensemencés ont augmenté d'environ 3 % de 1985 à 2001 et les données du recensement agricole indiquent qu'en 2001, 7 % de la surface totale du territoire du PCHP était classée comme étant des pâturages cultivés ou ensemencés.

- Le foin cultivé a augmenté d'environ 4 % et, selon les données du recensement agricole, il a augmenté de 5 % de la surface totale du territoire du PCHP en 1985 à 9 % en 2001.

- La catégorie « Toutes les autres terres » (qui inclut les habitats fauniques) des données du recensement agricole a diminué de 1 % et 5 % de l'ensemble des terres du PCHP ont été classé dans cette catégorie en 2001.

Les transects de surveillance des habitats ont également fourni les renseignements supplémentaires suivants, propres aux habitats :

- Tous les habitats naturels ont diminué, y compris les zones de prairies, d'arbustes et d'arbres.

- Les habitats de prairie indigène ont diminué de -2 479 ha ou -10 % dans les transects de surveillances des habitats. La perte par transect de la surface moyenne de prairie indigène était de -11 % (intervalle de confiance de 95 %, de -13 % à -8 %). Cependant, la classification exacte des prairies indigènes a été entravée en raison des grandes quantités de gazon cultivé, ce qui a pu conduire à une mauvaise classification entre les ensembles de données de référence et les ensembles de données actualisées. La plus grande partie de la perte a été attribuée à la suppression de petites zones de prairie restantes dans des paysages dominées par la culture.

- Bien qu'elles ne soient échantillonnées qu'en partie, de grandes zones d'habitats de prairie indigène sont restées stables ou ont peu diminué.

- Dans l'ensemble, les pertes de zones de prairie indigène étaient plus élevées dans l'écorégion des parcs de peupliers faux-trembles, qui a représenté 41 % des pertes totales de prairies indigènes dans le PCHP.

- Les habitats naturellement boisés ont baissé de -6 % et ils ont diminué dans toutes les écorégions à l'exception de celles des hautes terres du sud-ouest du Manitoba, des hautes terres Cypress et de la prairie à fétuque.

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INTRODUCTION

The Canadian Federal government strives to promote the conservation of Canada's wetlands resources, and to sustain the ecological and socio-economic functions of wetland resources for current and future generations. One of the goals of wetland policy in Canada is to promote "no net loss" of wetland functions. Often the most discernible measure of wetland function is the quantitative measurement of the extent of wetland area and numbers of wetland basins.

Canada does not have a national wetland inventory or a national wetland status and trends monitoring program. The status and trends of wetlands in Canada has been estimated, over time, in several independent studies, most of which provide information at local scales and occasionally at regional scales. Canada contains an estimated 127 million ha of wetlands or one-quarter of the world's total wetland area (Environment Canada, 1991). Nationally, wetland loss has been estimated at 20 million ha since the 1800's and these losses have eroded the wetland resource base in all areas of the country (Environment Canada, 1991).

Wetlands in Canada continue to be at threatened by degradation and loss. Expansion and development in the areas of agriculture, urbanization, transportation networks, resource extraction, recreational properties, and forestry pose major challenges. In many areas of Canada continued loss of wetland area has resulted in significant alterations to entire ecoregions, thus compromising the overall ecosystem function of these landscapes. One such landscape that is the current focus of extensive wetland status and trends monitoring is the Prairie Parkland Region (PPR) of Canada.

The magnitude of wetland loss on the prairies can only be surmised through piecing together small-scale studies. Most of the reported historical loss rates originate from independent and unrelated studies with varying definitions, scales, geographic locations and methods (Ignatiuk and Duncan, 1995; Rakowski and Chabot, 1984; Turner et al., 1985; Goodman and Pryor, 1972; Schick, 1972). The lack of a consistent wetland status and trends program in Canada makes it difficult for conservation planners to construct a complete understanding of the problem. Estimates of wetland loss for the Prairies, derived through consolidating results from various studies, produces estimates of wetland loss of 40 – 70% since settlement (Liton, 1997; Rubec, 1994; Government of Canada, 1996). Given the international significance of PPR wetlands to migratory bird populations of North, Central and South America, Environment Canada is striving to develop new and innovative ways to quantify and report on wetland status and trends in Canada's PPR; since 1985 the Canadian Wildlife Service has conducted a periodic wetland habitat monitoring program within this region. Results are being used to inform wetland conservation efforts of the CWS and its conservation partners.

Recent results from the habitat monitoring program reported by Watmough et al. (2002) demonstrated frequent wetland loss within the Prairie Habitat Joint Venture (PHJV; also see North American Waterfowl Management Plan [NAWMP]) program target areas

between 1985 and 1999.., 2002). This report extends this earlier work by presenting results for the monitoring of wetland and upland habitats across the entire PHJV, allowing for comparisons of targeted and non-targeted lands but, more importantly providing trend information for the NAWMP's high priority Canadian PPR. The PHJV is utilizing the results of the habitat monitoring program as part of the program planning process, and as a group have started to address the continued loss of important habitats such as wetlands. The habitat monitoring program will continue to adapt/expand to better serve the PHJV partnerships in working towards achieving renewed PHJV goals of conserving these unique and productive prairie habitats.

Objectives

1) Establish a sampling network, methods, and definitions for continued habitat status and trends monitoring in the PHJV.

2) Measure and report habitat change at the Ecoregional level for the entire PHJV study area (including both NAWMP targeted and non-targeted areas).

STUDY AREA

Field work was conducted within the Prairie Habitat Joint Venture (PHJV) delivery boundary, excluding the Grand Prairie and Peace River portions of Alberta (Figure 1). The PPR represents the most productive waterfowl habitat in North American, and is the focus of PHJV programming efforts. This study was designed to sample ecoregions within the PHJV, independent of PHJV program targeting.

Sampled landscapes are dominated by moraine type parent material with various surface forms including knob and kettle, undulating, dissected, hummocky and rolling. The sampled landscapes contain high wetland densities and are composed of diverse natural upland and wetland habitats and land use practices. The following table lists the ecoregions found within the PHJV delivery area; please refer to The National Ecological Framework for Canada (1996) for more information regarding Canada's ecological frame work (Ecoregions). The following table lists the ecoregions making up the study area.

Ecoregions
Aspen Parkland
Boreal Transition
Lake Manitoba Plain
Southwest Manitoba Uplands
Cypress Upland
Mixed Grassland
Moist Mixed Grassland
Fescue Grassland
Interlake Plain

Table 1. Ecoregions sampled in the PHJV.

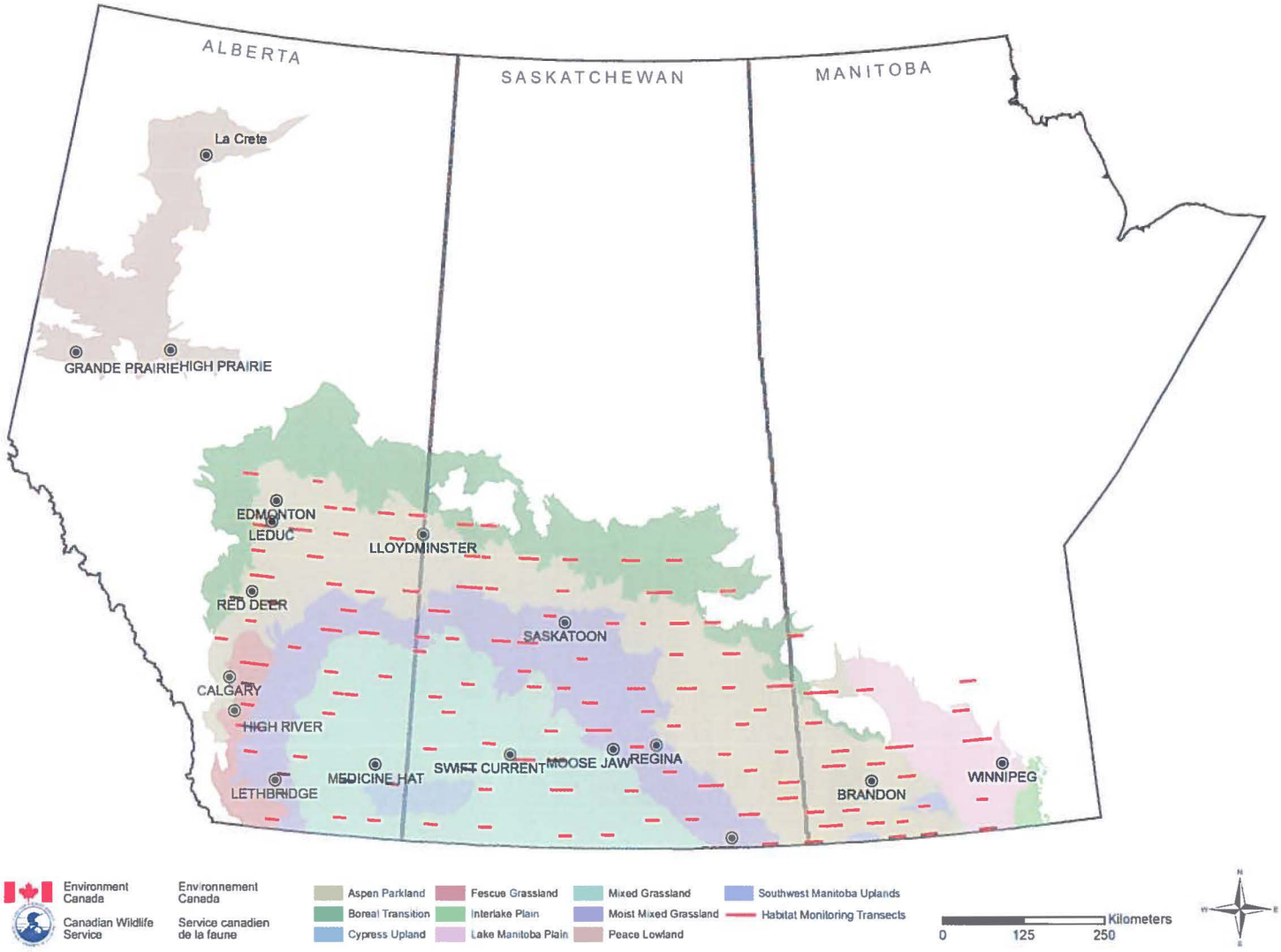


Figure 1. PHJV study area showing sampled ecoregions and the 153 habitat monitoring transects (red lines).

METHODS

Habitat Monitoring Baseline

The original purpose of this work was to establish a baseline record of habitat conditions using the previous work of Millar (1987) to which future habitat monitoring work could be compared. Millar's habitat information and products were updated using modern technologies and techniques, and formed the habitat baseline from which habitat change detection was implemented. The following section outlines the original design of the habitat monitoring sampling network as well as incorporates methods used in reproducing and updating this work.

Landscape Stratification

The original habitat monitoring program conducted by Millar was designed to sample an area slightly larger then the Prairie ecozone, which is approximately equal to the PHJV delivery area. To ensure adequate sample distribution it was necessary to stratify the landscape by units' representative of localized conditions such as soils, landform, vegetation and wetland components. The stratification unit chosen was the habitat sub-region (See Appendix I), which was considered optimal for local and regional management planning for migratory bird conservation (Adams 1988).

Sampling Network

In 1985, 153 habitat monitoring transects were established throughout the PPR (Figure 1). The core of this sampling network was composed of 65 annually surveyed CWS air/ground segments which are part of the USFWS/CWS Waterfowl Breeding Population and Habitat Survey program. Additional transects were added by a systematic, stratified random design, to sample baseline habitat conditions in as many of the larger habitat sub regions as possible.

In 1999, habitat conditions on all transect which were completely contained or had any portion of their sampled area within PHJV-targeted landscapes were updated. A total of 58 transects (32 in Alberta, 20 in Saskatchewan, and 6 in Manitoba) were selected for updating in 1999, as documented in Watmough et al. (2002).

The remainder of the transect set was updated between 2002 and 2004. This update constitutes an analysis of the complete sampling set, containing samples from both PHJV and non-PHJV- targeted landscapes. For this report, the mean date of updating for all 153 transects as calculated from ground-truth and air photo acquisition dates was set at 2001, representing a time span of 16 years between base sampling and updates.

Sampling Unit

A transect was utilized as the sampling unit for this project. The original transect design sampled every second quarter section (800m x 800m blocks developed under the Dominion Land Survey) alternating north and south of the transect mid line (often a ¼ section boundary) in a west to east direction (Figure 2). The starting quarter section was determined randomly and set the sampling pattern for the remainder of the transect. The mean length of transects was 19.2 km (12 miles) with an average area of 1536 Ha or 24 quarter sections sampled per transect. Quarter-section boundaries were mapped using a combination of Dominion Land Survey records and air photos. Overall the 153 transects sampled a total of 235,711 ha of land.

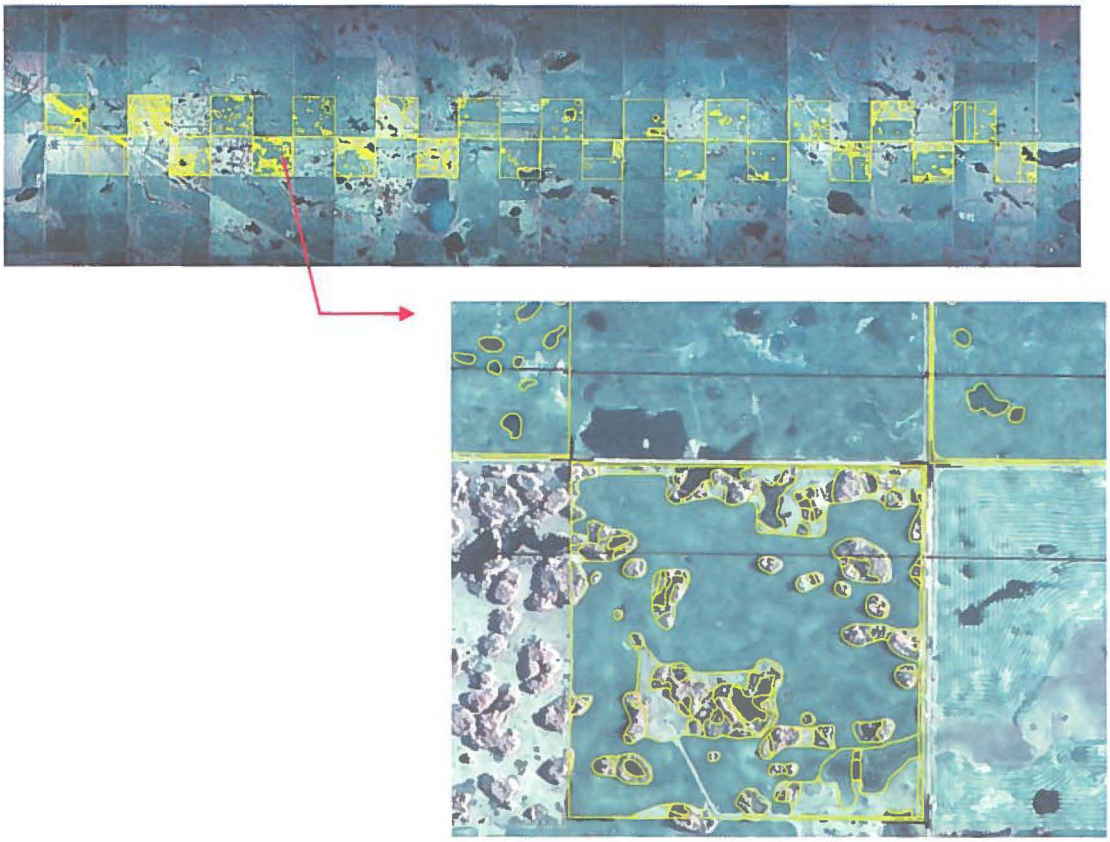


Figure 2. An example of a habitat monitoring transect (one square = 1 quarter section or 800 m x 800 m.

Baseline Habitat Mapping

Baseline Aerial Photography

Baseline habitat delineations were derived from 1:24000 false color infra-red aerial photography captured in May of 1985.

Habitat Interpretation

The initial step was to identify sampled quarter section borders on baseline air photos and delineate their boundaries. The boundary included half the width of all road allowances bordering the quarter section. Air photos were then overlaid with Mylar sheets and habitat polygons were delineated for all classified habitats within each quarter section boundary. Habitat polygons were interpreted using magnifying stereoscopes, and delineated by hand on the Mylar sheet. Effort was made to delineate the smallest habitat feature possible. Habitat polygons too small to hand draw accurately were identified with a single point. Each polygon was given a unique identifier and relevant habitat data codes. All questionable (classification or boundary was suspect) polygons were ground verified and updated as necessary.

Habitat Classification

All data were recorded on a polygon classification data form (see Appendix II). Data included polygon number, identifier codes, land cover, land activity, wetland identification, primary and secondary wetland margin cover, wetland impacts, and general comments. Wetland specific codes were only recorded for wetlands. See Appendix II for a complete list of classification types.

Habitat Polygon Delineation

A total of 18 cover classes were interpreted for the baseline data creation. Cover categories were in accordance with the Lands Directorate's Canada Land Use Monitoring Project (C.L.U.M.P.) classification. All baseline habitat polygons were intensively ground-truthed to verify the classification and establish the method for future mapping of change detection.

The targeted minimum mapping unit for wetlands was 0.025 ha (250 m^2) however, wetlands as small as 0.005 ha (50 m^2) were often mapped. Uplands were mapped to the most appropriate minimum mapping unit as determined by cover type.

Wetlands

The habitat monitoring program uses the Canadian Wetland Classification System (National Wetlands Working Group, 1997) definition of a wetland, or land that is saturated with water for sufficient time to facilitate wetland or aquatic processes as determined by the presence of poorly drained soils, hydrophytic vegetation and various types of biological activities adapted to wet environments.

Wetland basins were mapped according to their basin boundary; water presence or absence was not a major influence on the basin delineation. Basins were delineated through the mapping of the topographic depression in the land and other features such as vegetative changes and identifiable margins. Wetlands were most often delineated by one polygon, but, in multi-polygon wetlands the entire wetland was classified according to the polygon which had cover indicative of the highest level of water permanence (Millar, 1987).

Wetlands were classified by the dominant vegetative community that was representative of the wetlands ecological function. The following table summarizes the commonly occurring types of wetlands mapped during baseline habitat interpretation.

Wetland Classification	Description
Open Water Ponds and Lakes	Permanent open water type habitat, separate categories for saline lakes and ponds, streams and rivers and other open water type habitats.
Artificial Open Water Wetlands	Dugouts, irrigation, ditches cannels and reservoirs.
Emergent Deep Marsh	Dominated by deep marsh emergent vegetation such as *Scirpus sp.* and *Typha sp.*
Shallow Marsh and Wet Meadows	Grass and sedge dominated wetlands. Includes Shallow marsh, wet meadow and low prairie type wetlands.
Wooded Wetlands	Shrub or tree cover dominated basins intermixed with wet meadow type vegetation.
Cropped Wetlands	Essentially sheet water areas dominated by cropped cover or disturbance species associated with repeated cultivation.

Every mapped wetland polygon was assigned the following: a cover code which, as described above, reported the dominant cover type for the wetland; an activity code, which described the land use activity present within the wetland basin at the time of mapping, and also determined the specific use applied to a cover type (i.e. forage crop or tame pasture); a margin code describing the cover type of the wetland margin (classified as either natural grass cover, shrub cover or non-natural cover type i.e. cropland).

Wetland basin impacts such as partial filling or drainage, when present, were also recorded for every wetland mapped.

Uplands

Uplands were delineated for every sampled quarter section along the habitat monitoring transect. Upland polygons were delineated based on land cover type and natural vegetation breaks between different cover types. Upland habitat polygons were also delineated based on land use differences between like cover types, for example an unimproved pasture may have been subdivided within a sampled quarter section with one portion grazed and another portion idled. In a case like this the upland polygon would be divided based on the pasture layout, thus a uniform cover type would be divided into two separate polygons with differing activity codes. Like wetlands, the upland polygons were described by the dominant cover and activity type occurring within the delineated boundary. The following table summarizes the major upland classes. For a complete list of activity codes please refer to Appendix II.

Upland Classification	Description
Woodlands	Separate categories for trees, shelterbelts, shrubs, and low shrubs i.e. "buckbrush".
Annually Cultivated Crops	Cropland and stubble.
Summer fallow and Bare ground	Natural bare ground identified by the activity code associated with it.
Other Non-woody Plants	Complexes of disturbance species.
Constructed Cover	Man made cover, structures etc.
Improved Grass and/or Legume Cover	Tame pasture or forage crops, differentiated by the associated activity code.
Natural Grassland	Primarily native grasslands, remnant grass cover, wetland margins and uncultivated perennial cover. Uplands classified as Natural grassland did not show evidence of cultivation (present day or historical), seeding and/or plowing. Formerly known as Unimproved grassland.

Uplands and wetlands could share the same cover code as they were differentiated by the presence or absence of a wetland identifier code (wetland number). An example of this is

the unimproved grass code which is the same as the grass and sedge code; if the polygon was a wetland it would be identified by a wetland number and would also contain wetland margin information.

Change Detection and Updating

In the update year, all sampled quarter sections were revisited and ground-truthed for change detection purposes. Where available, new imagery was purchased or new aerial photography was obtained for the purpose of updating and detecting change. Existing baseline photos with accompanying polygon delineations were reproduced to enable accurate change detection (See Appendix II). Magnified copies of the 1985 imagery and polygon attribute data were updated in the field. The object of the field verification was to update polygon attributes, alter or delete polygons based on measurable habitat boundary changes, add polygons to delineate post-baseline land cover changes, and determine if new aerial photography was required to adequately detect and capture change.

Change Reporting

Measured wetland loss data represents the area of wetland removed from the landscape. Losses were considered permanent when the area was no longer considered as wetland habitat and was reclassified in the GIS as upland or totally drained wetland category (see the next section for the definition of wetland loss). Wetland loss summary statistics are divided into gross wetland losses and net wetland habitat change because there was some wetland creation (e.g. dugouts). Wetland loss was determined by the entire or partial deletion of the respective polygon. Low or high water conditions were not considered indicators of basin change (details above), and hence basin polygons were deleted or expanded only if actual measurable physical changes occurred to the basin itself. The only wetland changes recorded were those that could be reliably determined from the existing baseline comparison to conditions at the time of the update.

Habitat area gains, both wetland and upland, were measured in the field and on recent air photos; these new polygons were then delineated. Gains were only considered if they could be adequately mapped through ground-based verification and/or recent air photo interpretation. Therefore, it was not possible to record slight or minor boundary changes in upland or wetland habitats. All wetland gains were reviewed against the existing baseline data (using the original stereo pair photos) to ensure the gain occurred after 1985. Recorded wetland gains were then separated into true wetland gains and false wetland gains. False wetland gains were polygons added in the update but, through further examination, were verified to be present on the baseline (1985) imagery, but had been missed during baseline data interpretation.

Field verification of each transect required 1 – 3 person-days to complete ground-truthing. All habitat polygons delineated in 1985 were checked by either a direct field visit or use of adequate ancillary data. Field mapping was aided by the use of high power

optics, GPS and laser range finding technology, and recent aerial photography and/or satellite imagery.

Determining Wetland Loss

The determination of wetland loss can be highly subjective and variable. Here, wetland loss was defined as a measurable, anthropogenically-created wetland basin alteration sufficient in magnitude to impose permanent effects to a wetland's capacity to hold water and/or function as wetland habitat.

Wetland losses were determined through various methods including ground investigations, air photo interpretation (both stereo and/or 2 dimensional analysis), landowner interviews, satellite interpretation, and through the use of auxiliary GIS type data sources (soil maps, road networks, hydro layers etc.).

Difficulties in determining wetland loss can be related to image quality, abnormal hydrologic conditions (flooding or drought), interpretation error, cultivation, standing stubble, and land in transition. Many of these potential error sources were overcome through extensive ground-truthing and through the use of auxiliary data such as land owner interviews, multi-year air photo evaluations, and discussions with staff familiar with the area in question.

Wetland losses included a range of permanent alterations ranging from complete obliteration of a wetland basin through filling or leveling, to the construction of permanent drainage works within intact wetland basins. The following section gives examples and descriptions of the types of wetland impacts resulting in wetland loss as well as describes the difference between permanent impacts and partial impacts.

Wetland Loss Types

Below are descriptions of some of the common types of wetland loss classified during the change detection process. These types of losses could affect entire wetland basins or portions of wetland basins, thus effects on basins could be reported as entire or partial (e.g. partial filling of a wetland would result in the loss of wetland area, but not the loss of the wetland basin). The descriptions provided were created as a guide to interpreting wetland change and determining wetland loss.

Ditching

Ditching is one of the most common types of wetland loss recorded. Ditching involves the creation of a surface drainage network dug into the earth with sufficient slope to facilitate flow of water. Permanent ditches often target the deepest portions of a wetland basin and carry water to an outlet and then on to a consolidation point. Consolidations range from larger drainage ditches, creeks, rivers, road side ditches, dugouts, drainage retention ponds, lakes, or larger more permanent basins. In some cases ditches are terminal in nature and do not provide an outlet. Terminal ditches are designed to reduce the surface area of water in the basin by concentrating water in these deep water storage type ditches.

Figure 3. An example of an extensive surface drainage operation targeting a Bog type wetland in central Alberta, 2005.

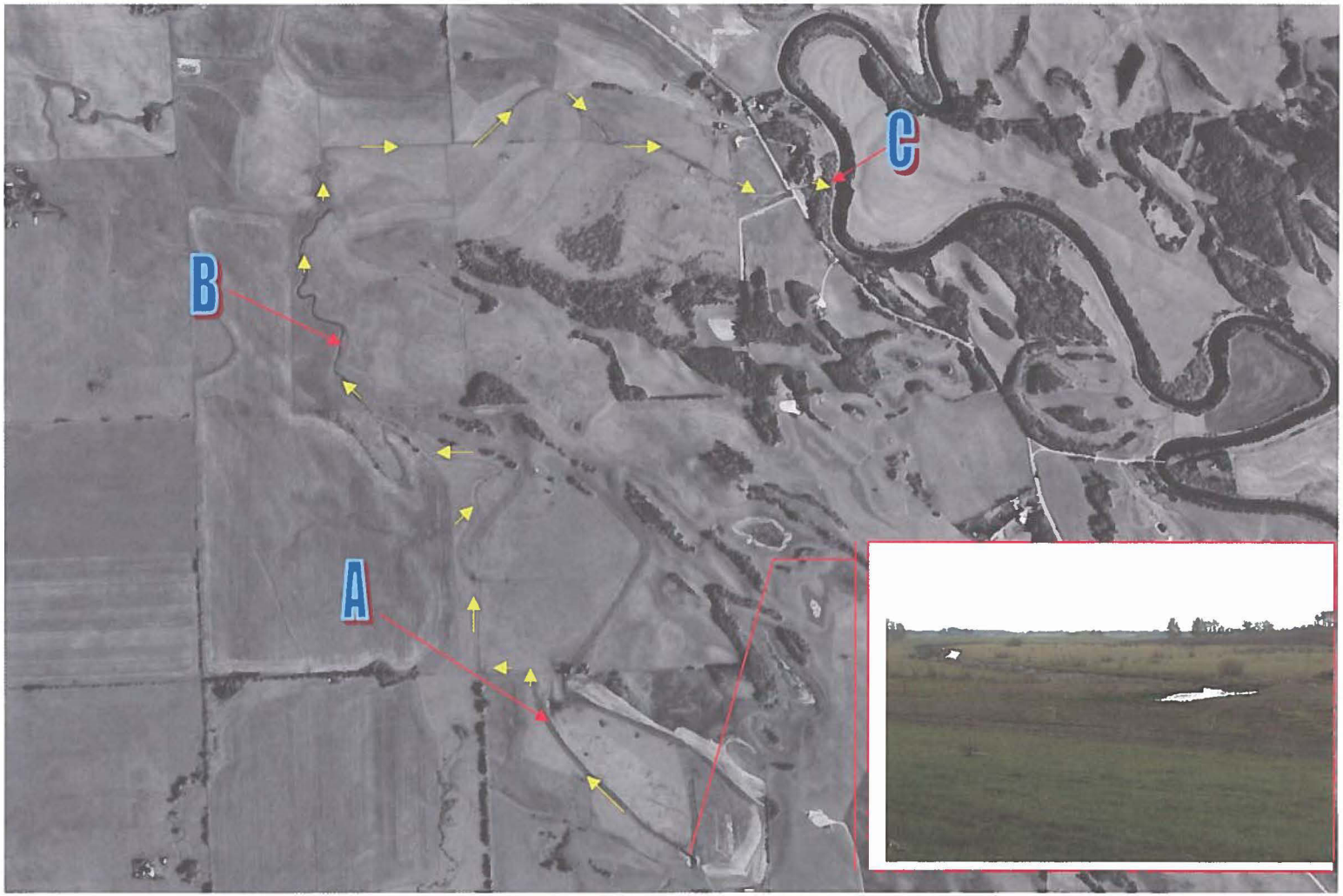


Figure 4. An example of a newly dug drainage ditch in central Alberta, 2002. The new drainage targets the deepest part of the basin (inset) and flows out of the basin at the outlet (A) and joins an existing drainage network (B) and ends up in the consolidation point (C) which in this case is a river.

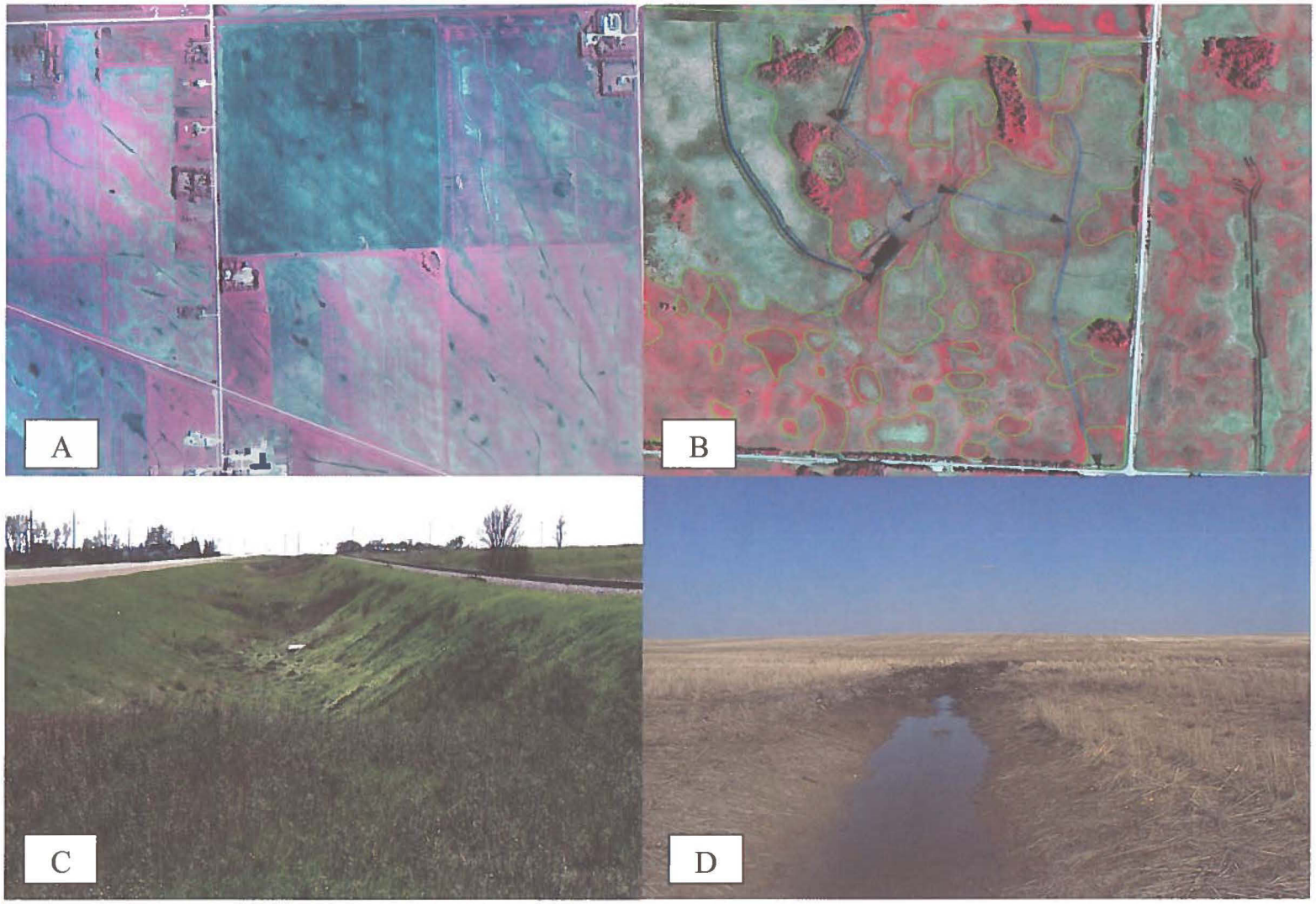


Figure 5. Examples of common ditching types encountered. (A)Extensive surface drainage (terminal and outlet types) in MB, 2004; (B) newly constructed surface ditches (note spoil piles), draining wetlands and transporting water to roadside consolidation ditches in AB, 2005; (C) roadside consolidation ditch in Saskatchewan; (D) a terminal type ditch in Manitoba.

Contour Draining

Prairie pothole wetlands often have naturally occurring drainage channels, created during high water levels which result in spill over from the basin. A commonly found alteration to this drainage pattern is the enhancement to the drainage through cultivation or earth moving techniques. Through this process the drainage is enhanced to move water out of the basin to a consolidation or outlet point. The basin is often degraded through repeated cultivation (resulting in filling and leveling) and the natural drainage channel is deepened thus enhancing the channels access to the basin (often through the removal of the basin lip closest to the natural out flow). This type of drainage appears commonly with new road construction/improvement where any wetlands intersecting the road allowance are often graded to flow into the road ditch.

Figure 6. Four examples of contour drainage activities resulting in wetland loss.

Cultivation

Annual cultivation is another impact capable of causing permanent wetland loss. The repeated cultivation of some types of basins can result in permanent loss of the wetland habitat (primarily through land leveling techniques). Cultivated wetlands included as lost wetland commonly had no measurable/detectable basin due to the repeated effects of cultivation. These basins could still have water presence but, usually only in the form of sheet water with no evidence of a basin. Often recorded losses to cultivated basins were the result of the reduction of the "footprint" of these wetlands on the surrounding land. It appears as though the reduction of this "footprint" does not require complete basin destruction but, rather a reshaping or containment of the area of the basin that is more in line with the agricultural operation in place (a portion of the basin eliminated through filling or leveling). The key feature in determining wetland loss due to cultivation was the lack of basin shape, in other words, the wetland basin area or part there of was inseparable from the cultivated upland areas surrounding it. It is important to note that the presence of cultivation in a basin was not used as a determiner of wetland loss; however, the effect of cultivation on the basin was assessed in the determination of wetland loss.

Figure 7. Examples of two wetlands lost as a result of repeated cultivation, note how the wetland basin (circled) is obliterated through land leveling and contouring effects. Saskatchewan, 2000.

Filling

Wetland filling operations varied in intensity and scope. Filling could be the result of targeted operations resulting in leveling off a basin with the surrounding uplands thus negating ponding and enhancing runoff. Other examples of filling included: waste disposal, rock piling, infrastructure creation, urbanization and general land clearing. A filled wetland was only considered as lost wetland if the basin area was dominated by filling and the deepest part of the basin was completely filled. Partial filling that was of sufficient aerial extent that it could be adequately mapped would be included as lost wetland area, as an upland polygon would be added to the impacted basin.

Figure 8. Two examples of wetland filling resulting in the loss of wetland area. Filling depicted in the top most photo resulted in the complete loss of a wetland basin, whereas, filling in the bottom photo resulted in only a partial loss of wetland area. Saskatchewan, 2001.

Tile or subsurface drainage

Tile drainage consists of a subsurface network of tile (perforated plastic tubing or "weeping tile" type material) connected to surface drains located in the deepest portions of a wetland basin. This type of drainage is difficult to detect remotely due to the small footprint created by the instillation. The wetland basin itself is largely intact with the exception of a small surface drain head. This type of drainage was found to be very uncommon, however, it was a documented method of wetland loss on some transects.

Figure 9. A 12 inch diameter drainage tile head, located in the deepest portion of what was a shallow marsh wetland. Alberta, 1999.

Channelization

Channelization is the process of converting a naturally occurring stream (ephemeral, intermittent, or permanent) to a manmade channel. The channelization is often created to accommodate increased flows created by the many wetland drainage networks that feed into the channel. Channelization can involve the deepening, widening, straightening, or redirection of a stream. Wetland area along a natural water course that has been channelized is often lost through the channel construction process. Functioning riparian areas along the stream are also often completely destroyed by the channelization process.

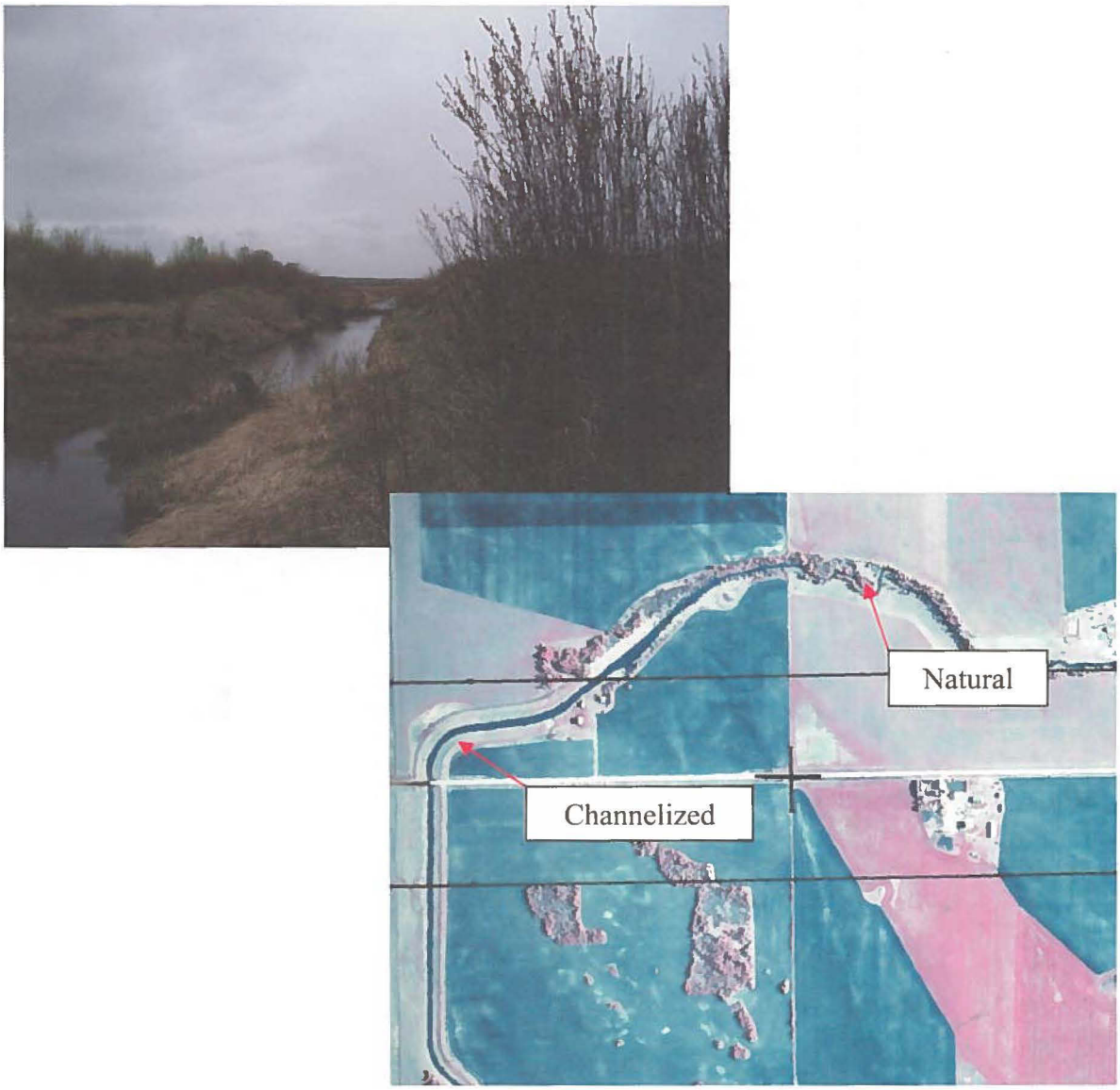


Figure 10. The top most photo shows the on the ground effects of stream channelization, note the destruction of riparian habitat (central Alberta, 2001). The bottom most photo shows how a natural stream has been deepened, straightened, and expanded as part of the channelization process, MB, 1985.

Basin Consolidation

Basin consolidation is the process of draining wetlands through various means, to a consolidated wetland. This process often results in the creation of a more permanent deep water type wetland (consolidation point) and the complete drainage of less permanent wetlands ranging from ephemeral to semi-permanent wetlands. Basin consolidation can also be achieved through damming; this method also results in the loss of wetland area in the "down stream" portion of a basin or basin network. Basin consolidations can, in some cases, result in a gain in wetland area through the permanent flooding of upland areas.

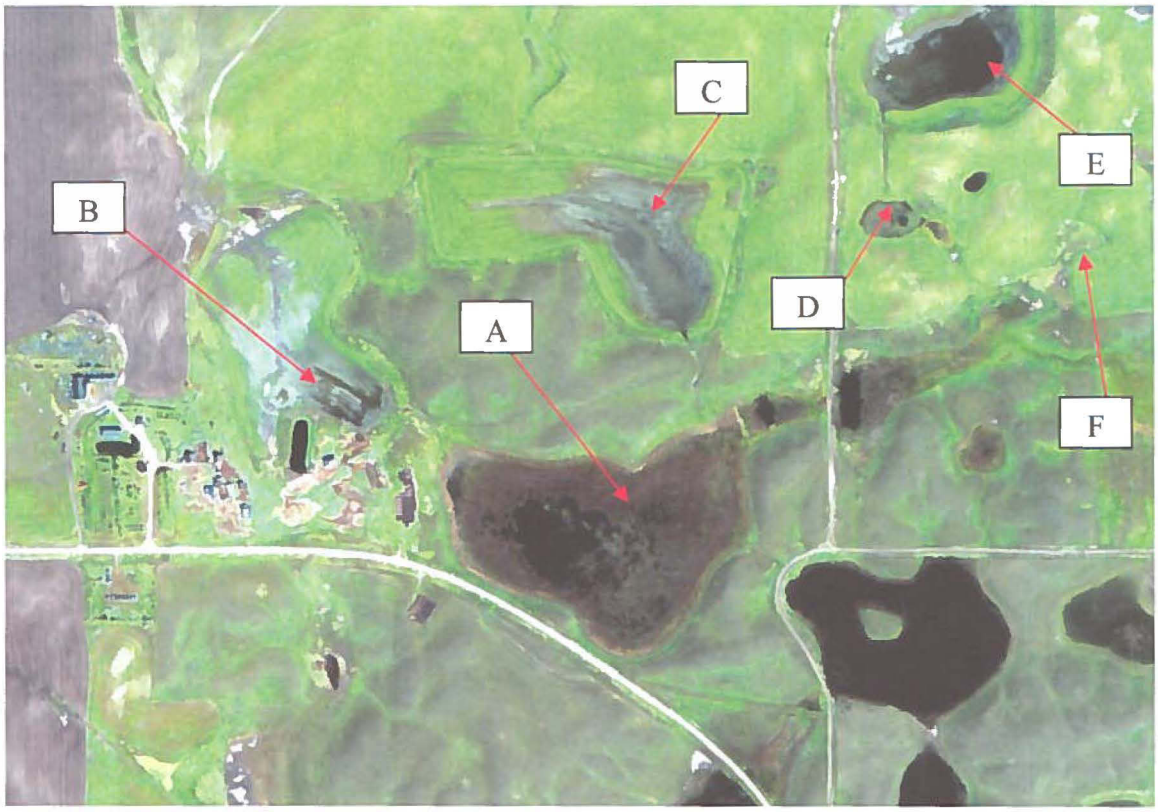


Figure 11. Wetland drainage and consolidation network. Wetland at A is the consolidation wetland, wetlands B, C, and F have been totally drained (considered as lost wetland area) and flow into the deep marsh consolidation wetland at A. Wetlands D and E are partially drained and excess water is drained out of the basin to consolidation wetland A. Saskatchewan, 2001.

Wetland Basin Impacts

A wetland impact is defined as a direct anthropogenic activity designed to alter a wetland basin through manipulation of its physical attributes but, insufficient to result in permanent loss of wetland area. Impacts recorded are often directed at reducing persistence of water in a basin, reducing water levels and/or reducing the extent of basin area with the most common activities being incomplete drainage and limited/partial filling. Incomplete drainage or limited filling were considered impacts over and above the wetland area loss, and were the result of impacts considered to degrade a wetland (functionally or physically). Incomplete drainage often consisted of permanent or seasonal type ditches which enhanced seasonal runoff, but did not result in complete basin drainage. Seasonal type ditches (Figure 12) were commonly created in the fall, and plowed over during seeding the following season. The result would be the more rapid movement of water off the field but the wetland basin would be left intact. This incomplete draining activity did not significantly physically alter the impacted basin other than the hydrology of the wetland and was such that the duration/persistence of surface water was reduced. Incomplete drainage could result in a change in the classification of a wetland e.g. temporary basin reduced to an ephemeral type wetland. Limited filling ranged from construction activities in a portion of a basin, debris piles, and small spoil piles, garbage piles, rock piles, repeated cultivation or any filling which did not meet the definition of permanent wetland loss and was thus considered as an impact. For example in Figure 12 below, the central portion of the basin has been filled and this would have been mapped as lost wetland area; in addition, however, the remainder of the wetland is incompletely/partially filled and thus would be give an impact code of LF (limited filling), although the remaining wetland area would not be considered as lost wetland area. Incomplete drainage and limited filling impacts often could not be mapped (e.g., small ditches, incomplete filling combined with leveling within a basin), and thus were recorded only as impact attributes rather than loss of area in the database.

Figure 12. Two partially impacted wetlands in Alberta, 2002.

Pre-existing Wetland Loss

Wetland losses presented here document changes from 1985 to circa 2001. Losses that occurred prior to the 1985 baseline were not measured as they were considered as upland or drained wetland area at the time of baseline classification. Pre-existing wetland loss was not always documented during the 1985 classification. In many cases, wetlands drained prior to 1985 had been completely obliterated and were indistinguishable from surrounding upland areas. However, in some cases, wetland loss due to permanent drainage was documented in 1985 (to the extent possible). An example of pre-existing wetland loss occurred at the St. Gregor Saskatchewan, transect. Based on conditions as mapped in 1985 it is estimated that before the 1985 baseline the St. Gregor transect lost an estimated 14% of total wetland area (Figure 13). Pre-existing wetland loss often resulted in significant reductions in areas and numbers of wetlands mapped in 1985. Occasionally, entire transects were "drained out" prior to 1985 and thus the wetland loss results between 1985 and 2001 were either less then expected for the area (i.e., susceptible wetlands had already been drained by 1985) or greater then expected (wetland area/numbers remaining on a transect in 1985 were so low that even few impacts between 1985 and 2001 resulted in large percentage losses).

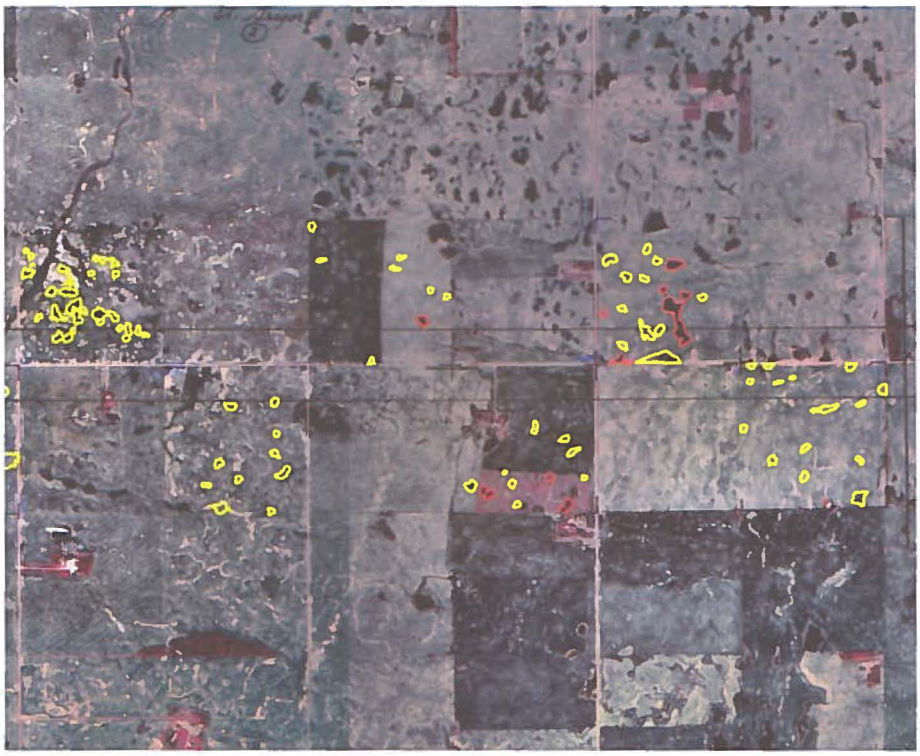


Figure 13. An example of pre-existing wetland loss in the St. Gregor area of Saskatchewan (1985). The yellow polygons indicate wetlands totally drained (red polygons are partially drained) prior to 1985 baseline mapping and thus these wetlands are considered as previously lost and not included as lost wetland area for the 1985 - 2001 comparison. Also note the signs of significant historical drainage in surrounding quarters.

Determining Native Grass Loss

During 1985 baseline data collection, native grassland was included in the unimproved grassland category. This category included some previously cultivated lands which had been seeded to grass and reverted to a near natural state over time. During the update it was necessary to review the grassland categories and further refine the natural or native grassland designations to ensure the accuracy of native type habitats classification.

Native grasslands are separated from other grassland types primarily through the activity code assigned to each grassland polygon. Any grassland polygon with evidence of past or current seeding or cultivation was not included as native grassland. Native grassland classification was conducted through air photo interpretation followed by with ground investigations. Correct baseline classification of native grassland was depended on detecting previous cultivation or seeding, the skill of the interpreter in identifying native grassland conditions, and the quality of available aerial photography.

Sources of error in determining native grassland losses included incorrect baseline classification, image quality issues, tame pasture and native grassland misclassification, over grazing, haying, limits of detection and classification from air photo and lands in transition. These challenges were more prevalent in some ecoregions than others. For example the correct classification of native grassland in the mixed grassland ecoregion was less difficult than classification in the parkland ecoregions. Separation of native from tame grasses in the mixed grassland ecoregion was simplified due to the textural, tonal, and spectral differences between native and tame grass as it appears on an air photo. In the parkland ecoregion, tame and native grasses were more difficult to separate due to similar tonal, textural and spectral characteristics as presented in the aerial photography. This confusion was dealt with through the use of auxiliary data that included ground-truthing, historical photo review, landowner interviews, soil maps, and various other data sources.

Figure 14. Breaking grassland in Alberta, 2003.

Sample distribution with regards to native grass presence on the landscape was not considered during the baseline dataset construction. The authors caution that this original sampling distribution did not adequately sample some of the larger contiguous blocks of

native grass on the landscape. Although some large areas of contiguous native grassland habitat were not sampled (e.g. Suffield in AB, Great Sand Hills in SK), other areas were (e.g. Missouri Coteau in SK, Milk River Ridge in AB). This sampling imbalance with regard to native grass and the assumption that large contiguous blocks of native grass (under sampled areas) are less prone to large area losses, could amplify relative change estimates, producing larger percentage changes. Absolute grassland losses should be used for context when interpreting native grassland loss results. Figure 15 below gives a graphic representation of how the sample was distributed in relationship to grassland dominated habitats within the PHJV.

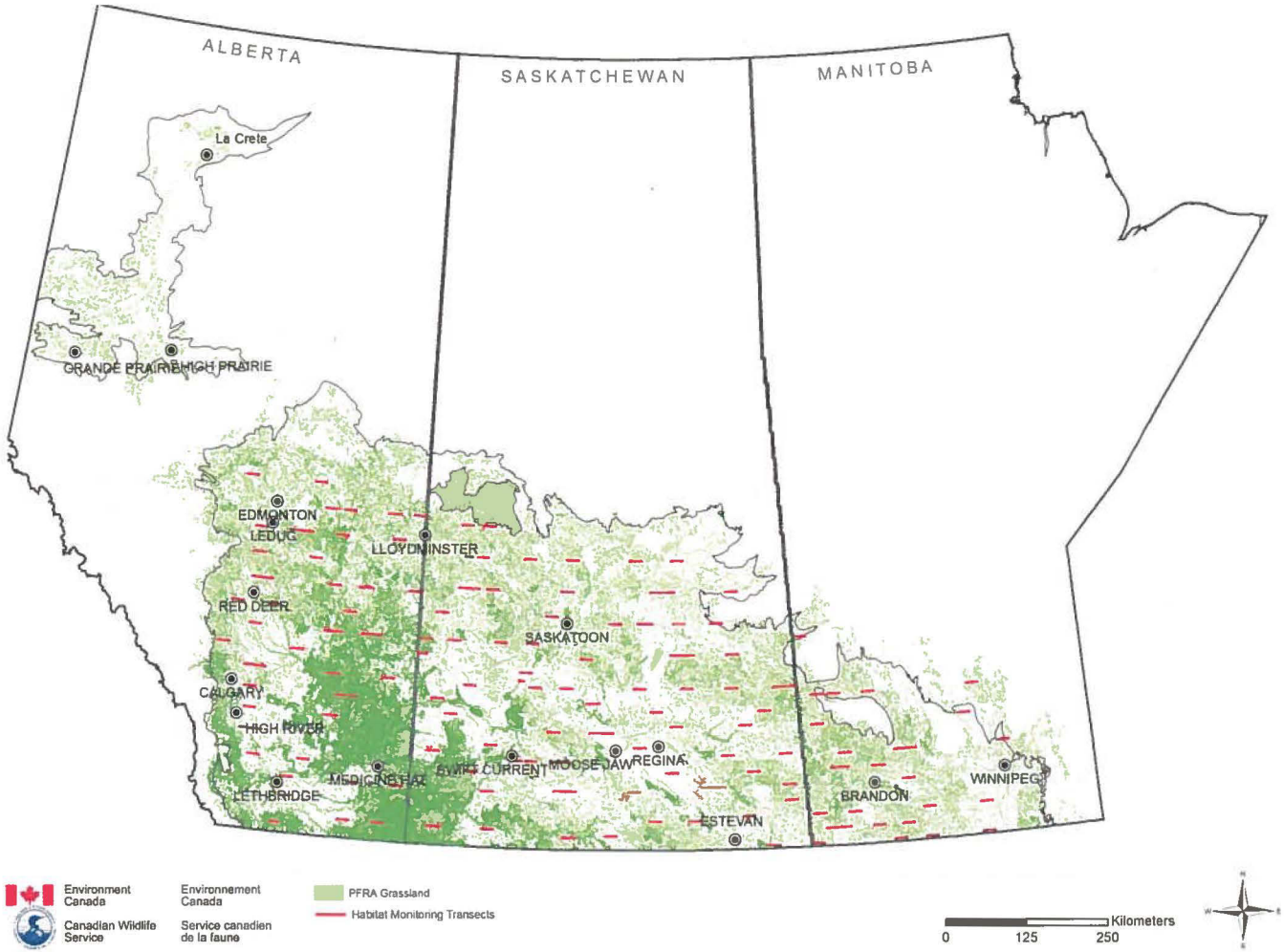


Figure 15. An overview of the location of transects in relation to broad land cover mapping of natural grassland habitats through the PFRA land cover mapping (PFRA Generalized Land cover, 2001).

Agricultural Census Data

The Census of Agriculture queries land owners with questions designed to provide agricultural information across all target areas and beyond at 5 year intervals. Each census produces a snapshot of Canadian agriculture by providing statistics at national, provincial, and sub-provincial levels on such topics as crop type and areas, numbers of livestock, soil conservation practices, natural land areas, conservation type crops and area, and land management practices. Census data from 1996 and 2001 were used for this report. At the sub-provincial level, data were typically aggregated within consolidated census subdivision (CCS) boundaries. This CCS role-up was too coarse however for use as a monitoring tool. Working with statistics Canada, we developed a method whereby dissemination areas (DAs; the smallest geographic unit currently accessible for use) were used to evaluate changes in ecodistricts within the PHJV delivery area. DA boundaries were used to rebuild ecodistrict areas, although the match to ecodistricts was not exact. The resulting geographic units were the best product possible to evaluate total landscape change within targeted areas using agricultural census data.

We acquired all agricultural statistics for the 1996 and 2001 census for the DA defined ecodistricts within the PHJV delivery boundary. These data were analyzed and incorporated into a GIS that provided information regarding changes in area, and numbers of farms reporting for specific variables (refer to Appendix III). DA boundaries have changed slightly over the years and thus Statistics Canada was contracted to perform the appropriate data assembly based on the geographies defined through DA conglomeration.

Agricultural census data presented here are intended to summarize major land use trends reported by respondents. It is recognized that census data do not mirror the transect reporting categories; nonetheless, these data do provide a coarse scale dataset from which to compare trends.

RESULTS

PHJV

This section presents results based on all 153 transects distributed across the PHJV area and summarizes major findings for the overall PHJV landscape and by ecoregions within the PHJV area.

Habitat change is reported in two ways. The first summarizes results for a group of transects as a single summed total or mean number. For example, when looking at the total wetland area for the PHJV grouping the total area of wetlands from all 153 transects is calculated as a "Grand total", in this case 18,757 ha. The second type summarizes groups of individual transects as independent samples and reports mean values with a measure of variance. For example, the mean baseline wetland area for all 153 transects contained in the PHJV was 123 ha with a standard deviation of 75.

Percentages are used to report relative and proportional change. Percent relative change between baseline and update values is calculated by the dividing the absolute change (area or counts) by the absolute baseline value. For example, assume that the baseline wetland value for a group of transects was 10 ha and the updated value for the same group of transects was 5 ha, the result is a -5 ha absolute change in wetland area. The relative change is calculated by dividing the absolute change number, -5 by 10 ha baseline value and then multiplying by 100; thus, in this example a – 50 % relative change in wetland area occurred. Caution should be used when interpreting percentage change values as they represent relative change with respect to the baseline value; absolute change must also be taken into account because it provides critical context concerning the magnitude of change.

Confidence intervals (95%) around the mean are presented where applicable. All confidence intervals presented were calculated using standard bootstrap techniques involving 10,000 iterations. The bootstrap process drew on transect results containing total wetland area in base year (1985) and total wetland area lost between 1985 and 2001. Percentage loss numbers were utilized in the bootstrap process to arrive at upper and lower limits. Confidence intervals were derived for individual ecoregions as well as PHJV specific study area components.

Unless stated otherwise, values presented here are direct measurements obtained by examining of lands mapped on habitat monitoring transects, and are not estimates of change extrapolated to the landscape scale.

Sample Size and Distribution

The 153 transects sampled a total of 3,556 quarter sections or 235,710 ha of land. The total area sampled comprised 0.41 % of the entire PHJV landscape. Sampling effort was not uniform across ecoregions as is shown in (Table 2). This sampling imbalance should be considered when interpreting results as related to a specific ecoregion.

Ecoregions	# of Transects	% of Ecoregion Area Sampled	Ecoregion composition within the PHJV
Boreal Transition	**13**	**0.20 %**	**17.66 %**
Aspen Parkland	**59**	**0.53 %**	**30.72 %**
Moist Mixed Grassland	**34**	**0.52 %**	**17.41 %**
Mixed Grassland	**31**	**0.35 %**	**23.40 %**
Fescue Grassland	**6**	**0.58 %**	**2.61 %**
Cypress Upland	**1**	**0.19 %**	**1.45 %**
Lake Manitoba Plain	**7**	**0.34 %**	**5.74 %**
SW Manitoba Uplands	**1**	**0.74 %**	**0.38 %**
Interlake Plain	**1**	**0.45 %**	**0.63 %**
Total Area PHJV	***153***	***0.41 %***	***100 %***

Table 2. Distribution of habitat monitoring transects by ecoregion within the PHJV study area.

The transects did not sample some significant landscape features, such as large water bodies (e.g. Cold Lake in Alberta, Lake Diefenbaker in Saskatchewan) and river valleys (North Saskatchewan River, Assiniboine River). These landscapes are dissimilar from the rest of the physiographic unit in which they occur and would require separate monitoring efforts. The sampling network as designed in 1985 focused on the largely privately held agricultural lands within the PHJV and did not include national parks, military lands, or major prairie cities (within city limits).

The original sampling network focused on priorities that existed in 1985. Sampling deficiencies were most evident in the Boreal Transition ecoregion, which was under sampled. The Interlake Plain ecoregion was also under sampled as the lone transect in this ecoregion fell outside the PHJV delivery boundary. For reporting purposes, this lone Interlake transect is considered representative of the Interlake Plain ecoregion within the PHJV delivery area.

Potential Roadside Bias Influence on Sample

Ecoregions	# of Transects Sampled	% of Sampled quarter sections influenced by roads	% of quarter sections in the landscape influenced by roads
Boreal Transition	**13**	**98 %**	**75 %**
Aspen Parkland	**59**	**95 %**	**85 %**
Moist Mixed Grassland	**34**	**98 %**	**83 %**
Mixed Grassland	**31**	**96 %**	**69 %**
Fescue Grassland	**6**	**93 %**	**72 %**
Cypress Upland	**1**	**100 %**	**44 %**
Lake Manitoba Plain	**7**	**99 %**	**75 %**
SW Manitoba Uplands	**1**	**100 %**	**79 %**
Interlake Plain	**1**	**100 %**	**72 %**
Total Area PHJV	***153***	***96 %***	***77 %***

Table 3. An examination of roadside influence on habitat monitoring quarter sections in comparison to all quarter sections within the PHJV study area.

Roadside sample bias was quantified by comparing sample and all quarter sections within ecoregions. All roads of any type within 32 m (buffer distance accounts for standard road width and geopositional error) of a quarter section boundary were considered as a roadside influence on that quarter section. This comparison shows that roads influenced larger numbers of quarter sections on the sample transects then is representative of the general ecoregion roadside influence (Table 3). The road side influence is a result of a focus on the settled agriculturally dominated portions of the ecoregion landscapes and the exclusion of some large grassland areas such as Military bases, National Parks, and large river valleys (areas expected to have lower road densities). However, it is also evident that roadside influence on all quarters in the PHJV landscape is high (77% of all quarters are influenced by roads), and thus the difference in roadside influence between the ecoregion and the sample was unlikely to have a strong bias to the study. Figure 16 gives a perspective of how road densities vary within the PHJV.

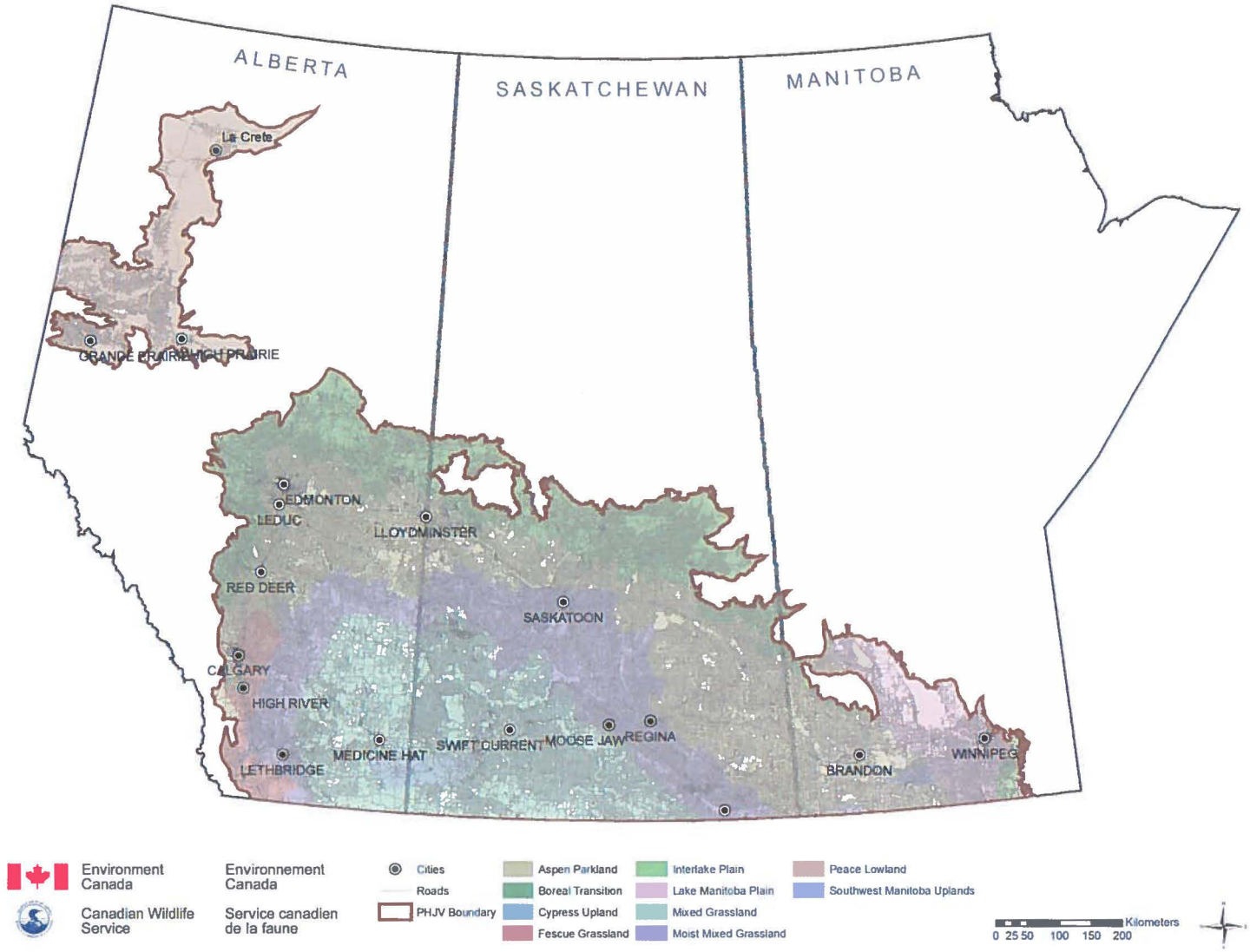


Figure 16. An overview of the road network in relation to the PHJV study area (roads are not to scale).

Wetlands

Gross Wetland Area Loss

Gross wetland losses report total lost wetland area, excluding any wetland gains (for information regarding wetland gains see page 38). Relative percent changes reported here are influenced by total wetland area, thus relative results should be taken into context with the absolute area data presented.

Gross wetland loss results are derived from all 153 transects distributed within the PHJV landscape (Table 4).

LANDSCAPE	ABSOLUTE WETLAND AREA LOST	% WETLAND AREA LOST	MEAN % GROSS WETLAND AREA LOSS BY TRANSECT		
			Mean %	Lower 95% Confidence Boundary	Upper 95% Confidence Boundary
PHJV	- 983.94 ha	- 5 %	- 5 %	- 7 %	- 4 %
Boreal Transition	- 90.26 ha	- 4 %	- 5 %	- 8 %	- 2 %
Aspen Parkland	- 443.51 ha	- 5 %	- 5 %	- 7 %	- 4 %
Moist Mixed Grassland	- 171.26 ha	- 4 %	- 4 %	- 9 %	- 2 %
Mixed Grassland	- 200.71 ha	- 8 %	- 8 %	- 13 %	- 3 %
Fescue Grassland	- 24.51 ha	- 5 %	- 5 %	- 11 %	- 2 %
Cypress Upland	- 0.40 ha	- 2 %	NA	NA	NA
Lake Manitoba Plain	- 21.43 ha	- 4 %	- 5 %	- 13 %	- 2 %
South West Manitoba Uplands	- 10.23 ha	- 11 %	NA	NA	NA
Interlake Plain	- 21.64 ha	- 24 %	NA	NA	NA

Table 4. Gross wetland area loss in the PHJV study area, 1985 - 2001.

Overall, gross wetland area loss for the PHJV between 1985 and 2001 was -5% (95% CI -7% to -4%). A total of 984 ha of wetland area was lost, reducing total wetland area on transects from 18,757 ha in 1985 to 17,893 ha in 2001.

The results for all ecoregions indicate a declining trend in wetland area. The calculated confidence intervals affirm the trend in each ecoregion showing wetland area declines and no ecoregion estimates approaching zero. In total, only 7 transects of the 153 transects had no wetland area losses.

The mean gross loss per transect was – 5% although losses by transect ranged from 0 – 61% of the total baseline area. The mean gross area lost per transect was 6 ha ranging from 0 – 77 ha (n=153 transects).

Overall the Aspen Parkland ecoregion accounted for 45% of the total lost wetland area for the PHJV study area. Transects sampling this ecoregion lost a total of 444 ha of wetland and the mean loss among transects was – 5% (95% CI -7% to -4%).

The Mixed Grassland ecoregion reported that highest relative wetland area loss at –8 %, 95% CI -13% to -3% (although SW Manitoba Uplands and Interlake Plain ecoregions of Manitoba exhibited higher losses, sample size of 1 for each of these ecoregions was considered insufficient in sample size). Samples within the Mixed Grassland ecoregion were dominated by intensive agricultural operations and thus many of the wetlands in these areas fell in the cultivated cover and activity categories. This large number of cultivated wetlands combined with dry conditions, and the large proportion of temporary type wetland basins made wetland change detection particularly difficult. The high rate of loss in this ecoregion may have been influenced by the difficulty in assessing wetland change in this area because of the relatively flat terrain and large proportions' of ephemeral wetlands. It is often not necessary to drain wetlands in this area using obvious activities such as ditching; rather land leveling, contour drainage techniques or even repeated cultivation can be used to reduce the footprint of these wetlands within cultivated fields.

The Boreal Transition ecoregion of the PHJV was not well sampled in 1985, so results for this ecoregion should be interpreted with caution. Observations during the change detection process and current work expanding the sample with in this ecoregion shows that wetland loss and general habitat change is likely higher then reported in this report. This is especially true for the Alberta portion of the Boreal Transition ecoregion, which had only one baseline 1985 sample; this ecoregion is experiencing apparent high rate of habitat changes.

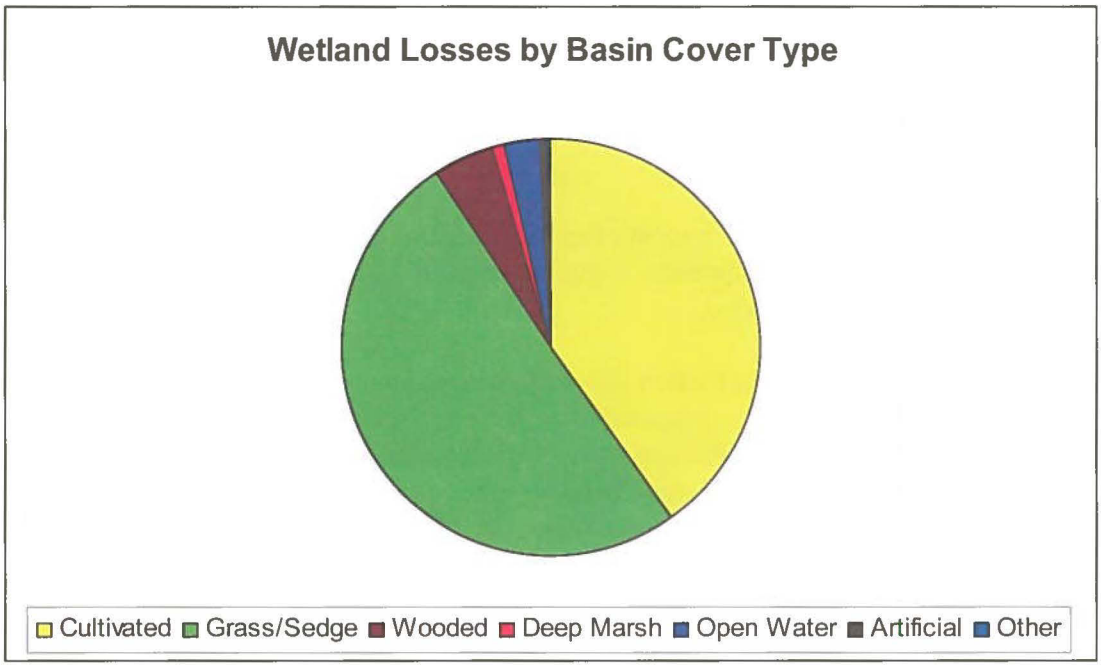


Figure 17. Wetland area losses by baseline (1985) wetland basin cover type.

Figure 17 above summarizes the cover types for total lost wetland area according to how the area was classified in the base year 1985. The grass and sedge type wetland (this category includes low prairie, wet meadow, and shallow marsh type wetlands) made up 50% of the total lost wetland area. Cultivated wetland cover represented 40% of the total lost wetland area. Wooded wetland area made up 5% of total lost wetland area. Deep marsh and open water habitats combined comprised almost 4% of lost wetland area. Artificial and all other wetland cover types combined equaled 1% of lost wetland area.

The grass and sedge cover category is the most prevalent wetland type in the sampled PHJV landscape, comprising 54% of total wetland area sampled in 1985. This shallow, temporary to seasonal wetland type is often easily drained, filled, or integrated into upland operations. This wetland cover type lost area in proportion to its expected occurrence within the sample.

Cultivated wetlands were most often grass and sedge wetlands that have been incorporated into an agricultural operation. These cultivated wetlands are often degraded through repeated cultivation and thus are a prime target for drainage or filling to some degree. Cultivated wetland cover comprised 20 % of the total wetland area sampled in 1985; however 40 % of all area lost between 1985 and 2001 was cultivated. This disproportionately high loss rate suggests that cultivated wetlands are highly susceptible to degradation and loss. However, determining the permanence of impacts to cultivated wetlands is difficult and thus there is greater potential for classification error. Cultivation alone is not a determining factor for wetland loss; many cultivated wetlands are largely intact and function as wetland habitat during wet years, and are utilized for crop production in dry years. Many cultivated wetlands appear to function as wetland habitat for brief periods in the spring and are subsequently integrated into the agricultural

operation when water recedes and the soils dry out enough to allow farming operations. In spite of these caveats, it appears that some wetlands can be seriously degraded through repeated cultivation, or due to advancements of farming equipment/techniques some wetlands are annually cultivated regardless of water levels and thus likely are never in an undisturbed state.

Losses to open water habitats were most often the result of partial filling of a portion of these more permanent basins; however, some instances of complete open water basin drainage and filling were recorded.

Wooded wetland area losses were often the result of impacts to the wet meadow zone portion of a basin that was being impacted or removed. An example would be during the loss of a shallow marsh wetland the wet meadow zone which was dominated by *Salix* sp. was also permanently removed. In some cases entire wooded basins were lost, including wetlands dominated by shrub or tree cover (e.g. Black Spruce bog).

Artificial wetland area losses were most often the result of the removal of dugouts, irrigation canals, or dams.

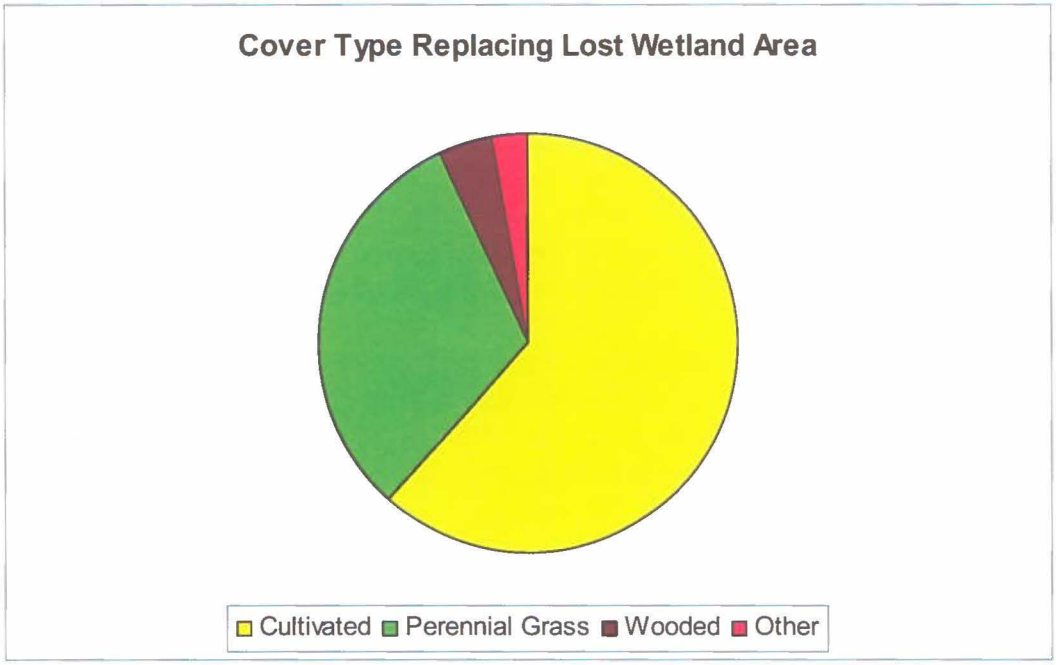


Figure 18. Upland cover type replacing lost wetland area in the PHJV study.

The most common land use activity occurring on lost wetland area was annual cultivation (Figure 18), which occurred on 62% of the total lost wetland area. Perennial grass cover was recorded on 21% of the total lost wetland area in 2001. New roads, farm infrastructure, housing developments, and extraction activities occurred on 6% of the total lost wetland area in 2001. Land use on the remaining 8% of the lost wetland area was made up of lands in transition.

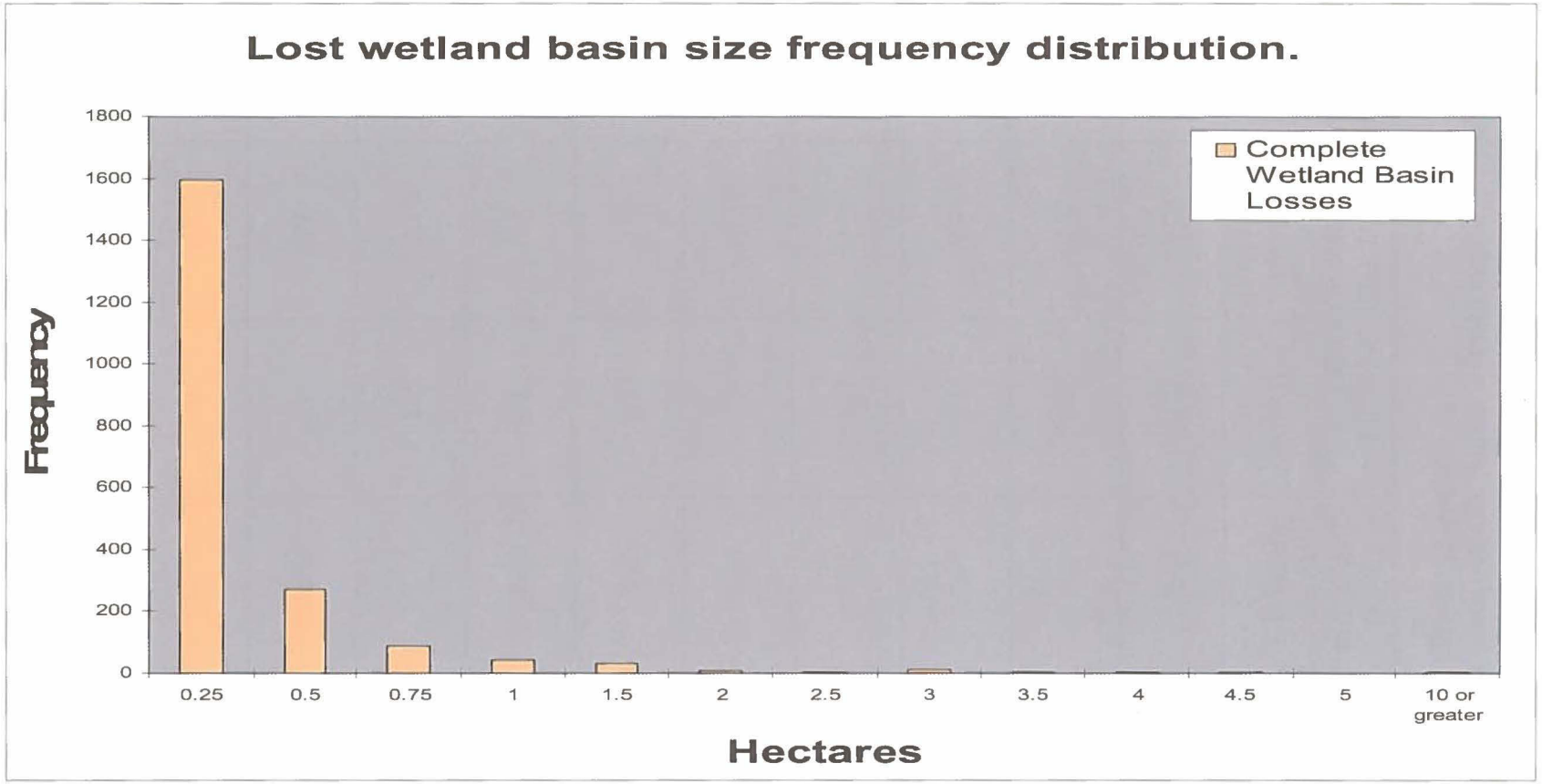


Figure 19. Basin size distribution for lost wetland basins (entire basins only does not include partial basin losses) within the PHJV study area.

In total 77% of all complete wetland basins lost from 1985 – 2001 were <0.26 ha in area. Wetland basins >0.25 ha and <1 ha in size accounted for 19% of all complete losses whereas basins >1 ha accounted for the remaining 4% of losses.

Net Wetland Area Change

Net wetland change reports the overall change in total wetland area with gains and losses combined for all 153 sampled transects (Table 5).

ECOREGION	ABSOLUTE NET WETLAND AREA CHANGE	% NET WETLAND AREA CHANGE	MEAN % NET WETLAND AREA CHANGE BY TRANSECT		
			Mean %	Lower 95% Confidence Boundary	Upper 95% Confidence Boundary
PHJV (overall)	- 864.30 ha	- 5 %	- 5 %	- 6 %	- 3 %
Boreal Transition	- 83.45 ha	- 4 %	- 4 %	- 8 %	- 2 %
Aspen Parkland	- 394.29 ha	- 4 %	- 4 %	- 6 %	- 3 %
Moist Mixed Grassland	- 144.51 ha	- 4 %	- 4 %	- 8 %	- 1 %
Mixed Grassland	- 184.42 ha	- 7 %	- 7 %	- 12 %	- 3 %
Fescue Grassland	- 18.77 ha	- 4 %	- 4 %	- 9 %	- 1 %
Cypress Upland	- 0.37 ha	- 1 %	NA	NA	NA
Lake Manitoba Plain	- 8.64 ha	- 2 %	- 2 %	- 7 %	4 %
South West Manitoba Uplands	- 9.48 ha	- 10 %	NA	NA	NA
Interlake Plain	- 20.36 ha	- 23 %	NA	NA	NA

Table 5. Net wetland area change in the PHJV study area, 1985 - 2001.

Very rarely was wetland gain the result of restoration or natural wetland area expansion. Wetland gains recorded were dominated by anthropogenic types such as dugouts, irrigation canals, drainage retention ponds, dams, basin consolidations, stream channelization, sewage treatment, and terminal type drainage ditches. These wetlands are recorded as gains; however, their quality and general value to wildlife are variable and often dubious.

The overall trend for all ecoregions is a decline in net wetland area showing that gains in wetlands have not been sufficient to offset wetland area losses. Confidence intervals for all ecoregions, with the exception of the Lake Manitoba Plain further support the widespread declining trend in wetland area. Gains in the Lake Manitoba Plain ecoregion were the result of the creation of two large sewage treatment ponds on one transect.

The most common and widespread wetland gain within the PHJV was the creation of dugouts. Dugouts result in a fundamental hydrological change to a wetland, converting what is often a seasonal type wetland to open water habitat.

Overall dugout construction accounted for ~50% of the total wetland gains recorded from 1985 to 2001. In total, dugouts accounted for 1% of the total wetland area sampled in 1985 and 2001.

Dugouts are fundamentally just holes dug in the ground that act as a collection and storage point for water. Some of the most common uses of dugouts are for providing a water source for livestock, water storage for farmsteads, and the result of borrow pit operations.

	Total Dugouts		Dugouts in Wetlands		Dugouts in Uplands	
	#	Area (ha)	#	Area (ha)	#	Area (ha)
1985	1,161	203	600	120	561	83
2001	1,359	236	694	142	665	94

Table 6. A comparison of dugout totals between 1985 and 2001 datasets.

The total number (Table 6) of dugouts increased from 1,161 in 1985 to 1,359 in 2001, a 17 % increase. Total dugout area increased by 16 % from 203 ha in 1985 to 236 ha in 2001. The mean number of dugouts per transect went from 8 in 1985 to 9 in 2001. The mean size of sampled dugouts was 0.16 ha in 1985 and 0.15 ha in 2001.

In 1985, 52 % or 600 of the total sampled dugouts were located within wetland basins, and in 2001 a total of 694 dugouts or 51 % of all sampled dugouts were located in wetland basins. Overall, dugouts constructed within wetland basins increased by 16 % from 1985 to 2001. The average size of dugouts constructed within wetland basins was 0.17 ha in 1985 and 0.16 ha in 2001. The total area of dugouts constructed in wetlands in 1985 was 120 ha and in 2001 equaled 142 ha. Dugouts constructed in wetland basins did

not result in an increase in wetland area (wetland gain) as this was simply a substitution effect, as a portion of a wetland was replaced with artificially created wetland cover.

Dugouts located in wetlands were not considered as drainage impacts, however, filling of portions of the basin with spoil piles did result in the loss of wetland area in a wetland basin. Dugouts in wetlands are often constructed in the deepest portion of the wetland basin (Figure 20) and occasionally have ditches radiating out from the dugout to draw water from other parts of the basin. It is unclear as to the ultimate impact dugout construction in a wetland has on the hydrology of the wetland. Field observations suggest that in some cases the dugout is effectively draining the majority of the wetland basin, and thus shifts in vegetative communities have been noted.

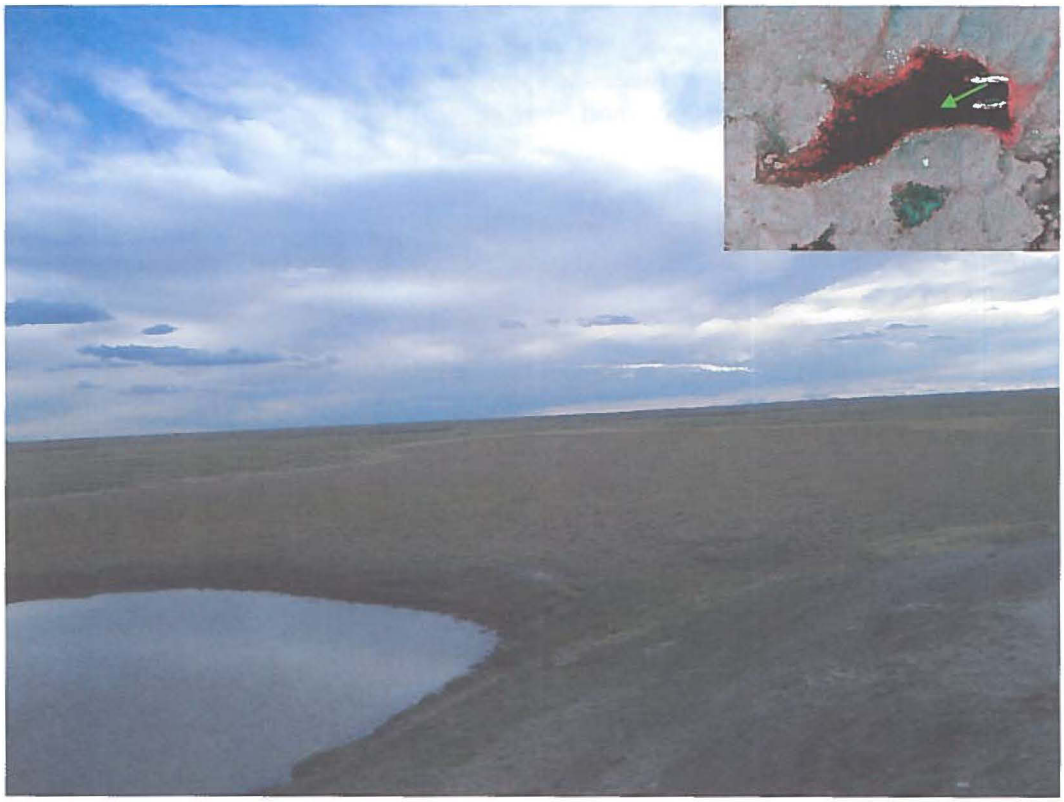


Figure 20. An example of a dugout created in a prairie wetland, Alberta, 2004 (green arrow in inset shows photo direction).

A total of 48% of dugouts sampled in 1985 were located in upland areas. The numbers of dugouts located in uplands increased by 19 % between 1985 and 2001, and 49 % of all dugouts in 2001 were located in uplands. The mean size of dugouts located in uplands was 0.15 ha in 1985 and 0.14 ha in 2001. Total area for dugouts located in uplands increased by 12 % from 1985 to 2001. Dugouts located in uplands constituted wetland gains, as wetland replaced what was previously upland area.

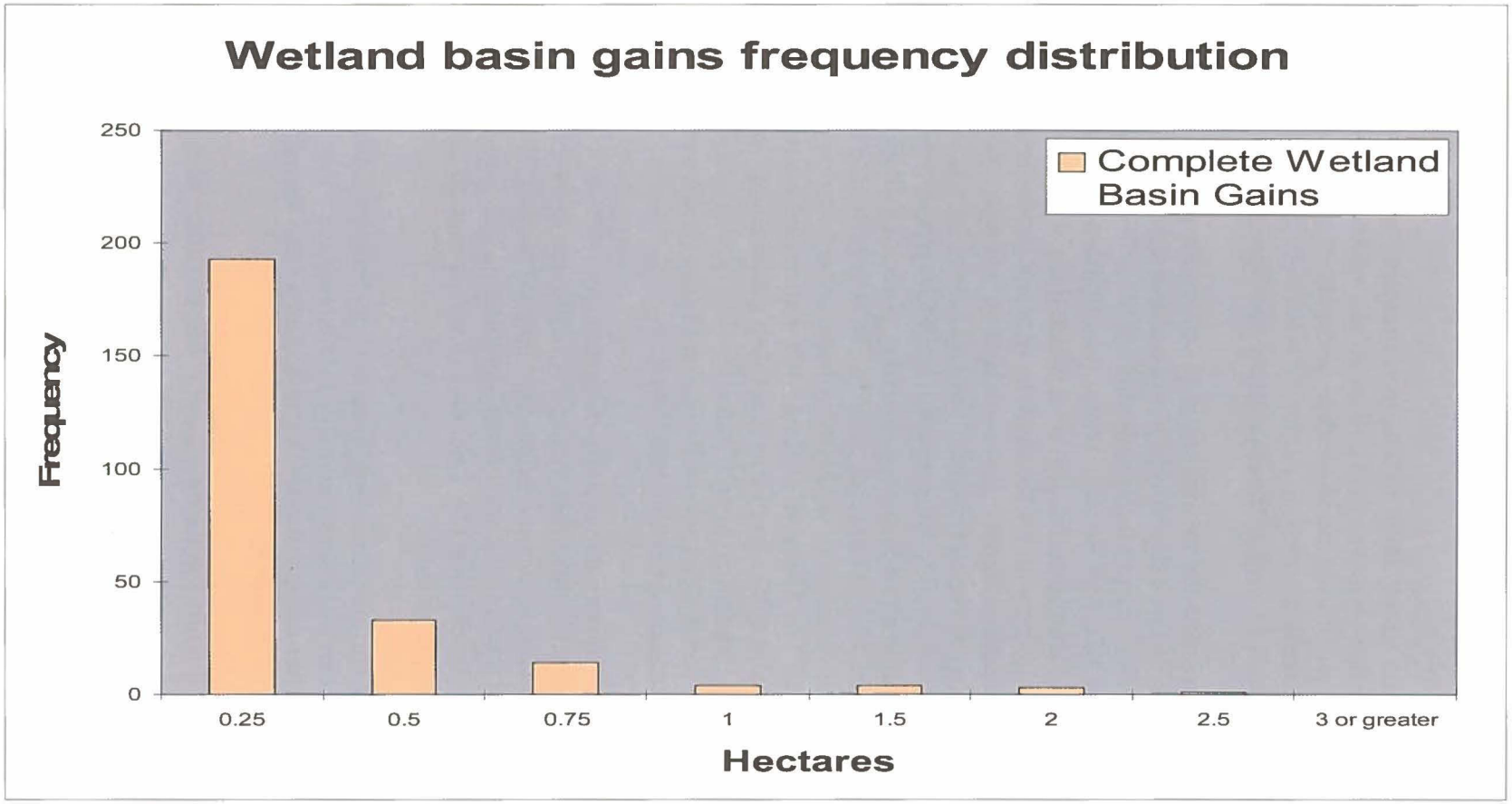


Figure 21. Size distribution of artificially created wetland basins (entire basins only does not include partial wetland area gains) within the PHJV study area.

Overall 77% of gained wetland basins were 0.25 ha or less in size (Figure 21). Wetlands larger then 0.25 ha and 1 ha or less accounted for 20% of the wetland basin gains. Wetlands 1 ha or greater made up 3% of total wetland basin gains. In absolute terms a total of 120 ha of what is considered new wetland area was added between 1985 and 2001.

Wetland Area by Land use Type

Wetland basin activity results are simply point in time measurements and record wetland area land use activities at the time of baseline data collection and update. These results give an indication as to the degree of integration of some wetlands area into any operation. For instance, once a wetland has been cultivated it is likely that it will continue to be cultivated on an annual basis so long as the appropriate conditions exist.

Annual cropping of wetlands involves the establishment of cultivation practices within a wetland basin. The wetland basin is usually entirely plowed and/or seeded and utilized for crop production; these wetlands are predominantly indiscernible from the surrounding cropped land with the exception of a depression or basin. Water presence/absence in spring is likely the determining factor as to the degree in which these wetlands can be incorporated into the annual cropping plan for the field. In very wet years these wetlands cannot be tilled and/or seeded and thus begin a reversion back to wetland. The functionality of these previously cultivated wetlands is not addressed by this monitoring program; the wetland is simply assumed to have reverted back towards an unfarmed wetland. For this reason cultivation alone is not considered a source of wetland loss. Overall, total wetland area utilized for annual cropping was 18% in 1985 and 18% in 2001 (Table 7), although annual variation in water and subsequent cultivation make a meaningful comparison difficult. The Moist Mixed and Mixed grassland ecoregions had the highest proportions of annually cultivated wetland activity within basins in both baseline and update years. This large proportion of annually cultivated wetlands in these two ecoregions made wetland change detection difficult, requiring extensive on the ground verification to discern impacts from absolute losses.

Overall, wetlands area having no observable activity increased from 48% to 49% of the total wetland area between 1985 and 2001. This increase is partly due to the effects of wetland area losses and the result of wetter conditions for some samples at the time of update. The amount of water in a basin was the primary determining factor regarding basin use activities. High water levels were not conducive to activities such as haying, cultivation, and depending on depth grazing.

Wetlands classified as drainage (primarily terminal type ditches) increased from <1% in 1985 to 1% of the total wetland area documented in 2001. Ditches have a very small linear surface area and thus do not account for much wetland area even though this type of wetland may be numerous in some areas.

The amount of wetland area being utilized for haying, grazing, and other wetland activities remained near constant between 1985 and 2001.

	1985 Wetland area land use % Composition						2001 Wetland area land use % Composition					
Ecoregion	No Use	Annual Crop	Haying	Grazing	Drainage	Other	No Use	Annual Crop	Haying	Grazing	Drainage	Other
PHJV (overall)	48 %	18 %	5 %	24 %	< 1%	4 %	49 %	18 %	5 %	24 %	1 %	4 %
Boreal Transition	61 %	11 %	5 %	18 %	< 1%	4 %	56 %	13 %	5 %	23 %	1 %	2 %
Aspen Parkland	55 %	14 %	6 %	21 %	< 1%	4 %	57 %	14 %	5 %	21 %	< 1%	4 %
Moist Mixed Grassland	38 %	29 %	4 %	24 %	< 1%	4 %	41 %	27 %	4 %	23 %	< 1%	4 %
Mixed Grassland	33 %	29 %	2 %	30 %	< 1%	5 %	33 %	28 %	4 %	31 %	< 1%	3 %
Fescue Grassland	28 %	12 %	2 %	53 %	0 %	5 %	25 %	10 %	2 %	56 %	< 1%	6 %
Cypress Upland	2 %	23 %	5 %	57 %	0 %	14 %	23 %	17 %	6 %	42 %	0 %	12 %
Lake Manitoba Plain	32 %	7 %	9 %	40 %	8 %	4 %	37 %	4 %	10 %	35 %	10 %	4 %
South West Manitoba Uplands	40 %	9 %	9 %	40 %	1 %	1%	38 %	10 %	< 1%	48 %	2 %	1 %
Interlake Plain	31 %	7 %	34 %	8 %	17 %	4 %	33 %	3 %	29 %	8 %	21 %	7 %

Table 7. Land use activities in wetland basins, a comparison between 1985 and 2001 total PHJV wetland area compositions.

Wetland Area by Cover Type

Wetland area by cover type is a point in time measurement captured at baseline (1985) and update (2001). Cover type can vary annually and is largely driven by water levels and anthropogenic use within the basin. Table 8 shows the percent composition of all surveyed wetland area in 1985 and 2001. Changes presented in Table 8 are the result of wetland area losses and shifts in cover type for wetland area between the two survey years. Cover categories include area from entire basin cover classifications, and cover categories for wetland zones associated with a wetland basin.

The Grass and Sedge type wetland cover type was the dominant wetland classification for the PHJV and each ecoregion. Grass and Sedge type wetlands comprised 54% of total wetland area for the PHJV in 1985 and 50% of total wetland area in 2001. The Grass and Sedge category encompasses a wide range of wetland types, including low prairie, wet meadow, and shallow marsh wetlands.

Within the PHJV, cultivated wetland area cover, which consists of annual crop or summer fallow cover types, increased slightly from 20% in 1985 to 21% of total wetland area in 2001. A portion of this cultivated cover was not being annually cropped at the time of survey but, was still classified as annual crop cover because the basin area did not show evidence of recovery from cultivation (only crop residue present, wetland vegetation had not returned). The Moist Mixed and Mixed grassland ecoregions had the highest proportions of annually cropped wetland cover at 30% of total wetland area sampled in 1985 and 2001.

Artificial wetland area increased from 1% in 1985 to 2% of total wetland area in 2001. Gains in artificial wetland area were primarily the result of new dugout construction.

Wooded wetlands increased from 7% of total wetland area in 1985 to 8% of the total wetland area for the PHJV study area in 2001. This increase in wooded cover was largely due to re-growth of woody vegetation in the wet meadow zone of wetland basins, and occasionally the encroachment of woody growth through-out an entire wetland basin.

Bulrush/cattail and open water cover types remained relatively stable (refer to Table 8). Changes in area for these categories were largely due to shifts between open water zones and littoral zones (driven by annual variation in water levels for these basins).

	1985 Wetland Cover Type % Composition							2001 Wetland Cover Type % Composition						
Ecoregion	Cultivated	Wooded	Grass Sedge	Bulrush Cattail	Open Water	Artificial	Other	Cultivated	Wooded	Grass Sedge	Bulrush Cattail	Open Water	Artificial	Other
PHJV (overall)	20%	7 %	54%	5 %	13%	1 %	1 %	21%	8 %	50%	6 %	12%	2 %	1 %
Boreal Transition	13%	15%	42%	6 %	22%	1 %	1 %	17%	15%	36%	8 %	22%	2 %	1 %
Aspen Parkland	15%	9 %	58%	5 %	12%	1 %	1 %	17%	10%	51%	7 %	12%	1 %	1 %
Moist Mixed Grassland	30%	4 %	50%	5 %	9 %	1 %	1 %	30%	5 %	48%	4 %	10%	2 %	1 %
Mixed Grassland	30%	1 %	52%	2 %	12%	2 %	1 %	30%	1 %	51%	4 %	10%	2 %	1 %
Fescue Grassland	12%	1 %	58%	4 %	21%	2 %	2 %	11%	<1%	57%	4 %	22%	2 %	3 %
Cypress Upland	22%	<1%	52%	1 %	<1%	16%	7%	22%	<1%	50%	1 %	2 %	17%	7 %
Lake Manitoba Plain	9 %	5 %	67%	13%	2 %	3 %	2 %	7 %	5 %	67%	12%	2 %	4 %	3 %
South West Manitoba Uplands	9 %	6 %	53%	15%	16%	1 %	1 %	11%	6 %	44%	18%	17%	1 %	3 %
Interlake Plain	11%	5 %	74%	5%	<1%	<1%	5 %	34%	5 %	46%	8 %	<1%	1 %	6 %

Table 8. Wetland area composition by cover type as a percentage of total wetland area within the PHJV study, 1985 - 2001.

Wetland Numbers

Wetland number changes reported here represent changes in complete/entire basins only and do not include partial wetland basin area losses or gains (Table 9).

Ecoregion	Gross Loss % (#'s)	Gross Gain % (#'s)	Net Change % (#'s)	Total Wetland Basins 1985
PHJV (overall)	- 6 % (-2,364)	1 % (+314)	- 5 % (-2,050)	38,781
Boreal Transition	- 9 % (-377)	1 % (33)	- 9 % (-344)	4,022
Aspen Parkland	- 6 % (-1,142)	1 % (139)	- 5 % (-1,003)	20,541
Moist Mixed Grassland	- 4 % (-308)	1 % (70)	- 3 % (- 238)	7,369
Mixed Grassland	- 8 % (-334)	1 % (29)	- 7 % (-305)	4,445
Fescue Grassland	- 9 % (-87)	2 % (18)	- 7 % (-69)	1,010
Cypress Upland	- 4 % (-8)	1 % (1)	- 4 % (-7)	195
Lake Manitoba Plain	- 8 % (-76)	2 % (22)	- 5 % (-54)	994
South West Manitoba Uplands	- 10 % (-9)	0 % (0)	- 10 % (-9)	92
Interlake Plain	- 20 % (-23)	2 % (2)	- 19 % (-21)	113

Table 9. Percent change in wetland basin numbers in the PHJV study area from 1985 - 2001.

Gross loss in wetland numbers (complete basin losses) in the PHJV equaled – 6 %, with a mean gross loss per transect of – 7 % and ranging from – 80 % to 0 % reduction in wetland numbers. Overall, the percentage of the number of entire wetlands basins lost was fairly similar to the percentage of wetland area lost.

Wetland Size

Wetland size statistics reported are for entire basins; multi-polygon wetlands have been collapsed to a single entity for measurement (Table 10). The maximum size of a wetland is limited to the size of the plot, thus the maximum size wetland would be 64 ha. Wetlands along plot boundaries had only the portions of the wetland area within the plot calculated.

ECOREGION	WETLAND BASIN SIZE 1985 (ha)		WETLAND BASIN SIZE 2001 (ha)		SIZE OF LOST WETLAND BASINS (ha)		SIZE OF GAINED WETLAND BASINS (ha)	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
PHJV (overall)	0.48	0.15	0.48	0.15	0.20	0.10	0.18	0.09
Boreal Transition	0.51	0.11	0.53	0.11	0.12	0.06	0.12	0.08
Aspen Parkland	0.43	0.15	0.43	0.15	0.20	0.11	0.16	0.08
Moist Mixed Grassland	0.52	0.17	0.51	0.17	0.23	0.09	0.20	0.09
Mixed Grassland	0.58	0.15	0.58	0.16	0.24	0.11	0.18	0.11
Fescue Grassland	0.52	0.11	0.54	0.11	0.23	0.09	0.19	0.07
Cypress Upland	0.13	0.05	0.14	0.06	0.04	0.04	0.03	0.03
Lake Manitoba Plain	0.55	0.14	0.58	0.15	0.20	0.11	0.23	0.14
South West Manitoba Uplands	1.02	0.18	1.02	0.21	0.47	0.09	NA	NA
Interlake Plain	0.78	0.15	0.73	0.15	0.38	0.15	0.40	0.39

Table 10. PHJV wetland basin size statistics.

Overall, the mean size of all sampled wetlands within the PHJV equaled 0.48 ha, and the median value for all sampled wetlands was 0.15 ha. The mean and median size of lost wetland basins was less than the mean and median size for all sampled wetlands for all ecoregions. Gained wetland basins were small in size averaging 0.18 ha (median 0.09 ha) in size.

Figure 22 shows the size distribution for all sampled wetland basins within the PHJV. The 0.25 ha or less category made up the majority of sampled wetlands representing 66% of the total wetland numbers sampled in 1985 and 65% of total wetland basins in 2001. Wetland basins 1 ha or smaller represented 91% of the total wetland basins sampled and 39% of the total wetland area sampled. Wetland basins 1 ha or larger accounted for 9% of total wetland numbers and 61% of total wetland area sampled. In absolute terms the 0.25 ha or less wetland basin category suffered the largest loss of numbers, with a reduction in the number of basins by 1263 (5% reduction from 1985).

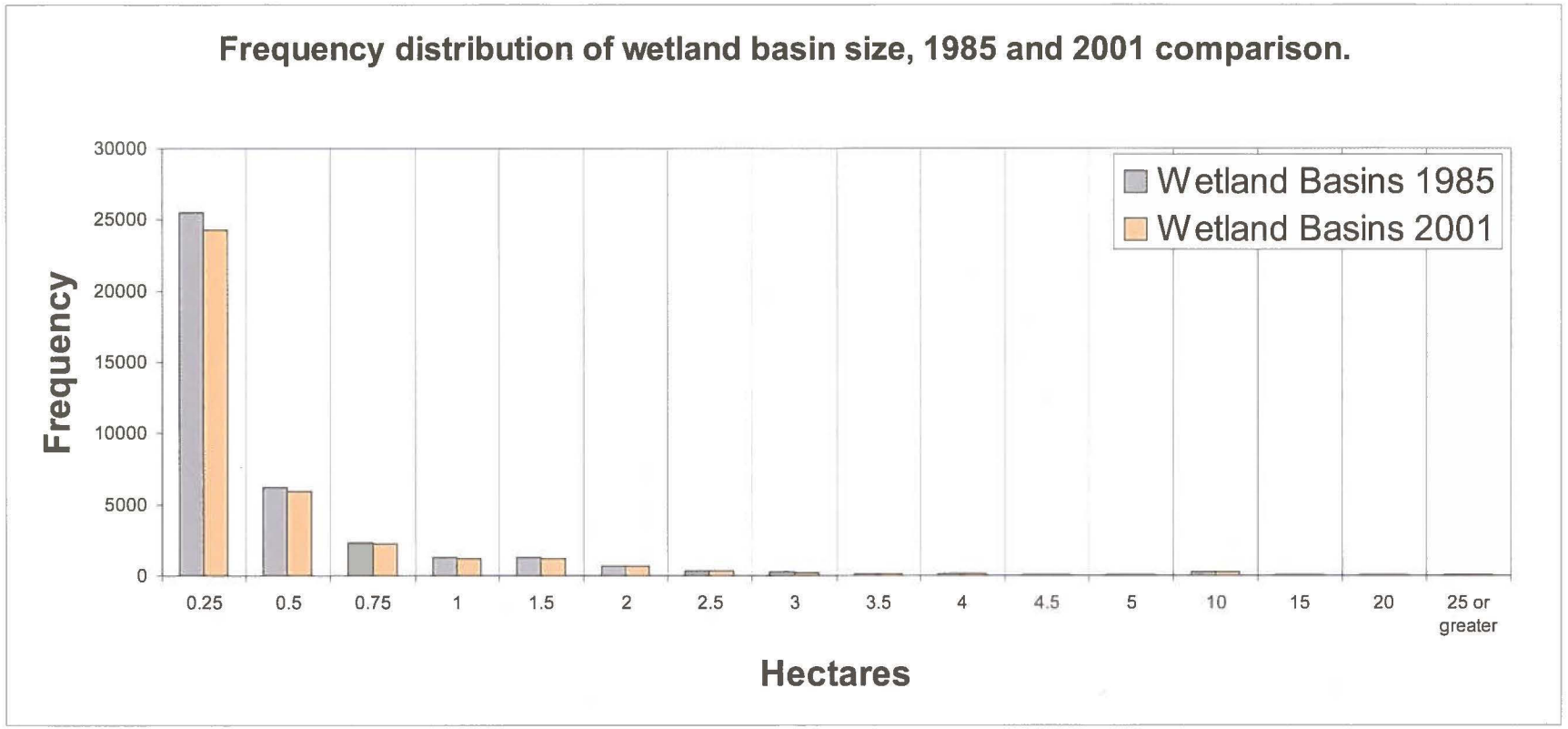


Figure 22. Overall wetland basin size distribution comparison between baseline (1985) and update (2001) datasets.

Although, wetland sizes are highly variable the data from both 1985 and 2001 demonstrate that the vast majority of wetland basins are less then 0.25 ha in size. The following figure (Figure 23) graphically displays the wide size assortment of wetland basins that were mapped and measured (in this case in a single quarter-section of land) in the sample. A regulation size hockey rink is used as a reference scale to demonstrate that although 0.16 ha can be conceived as small it is still a substantial area, in the case of the hockey rink it measures approximately 61 m x 26 m.

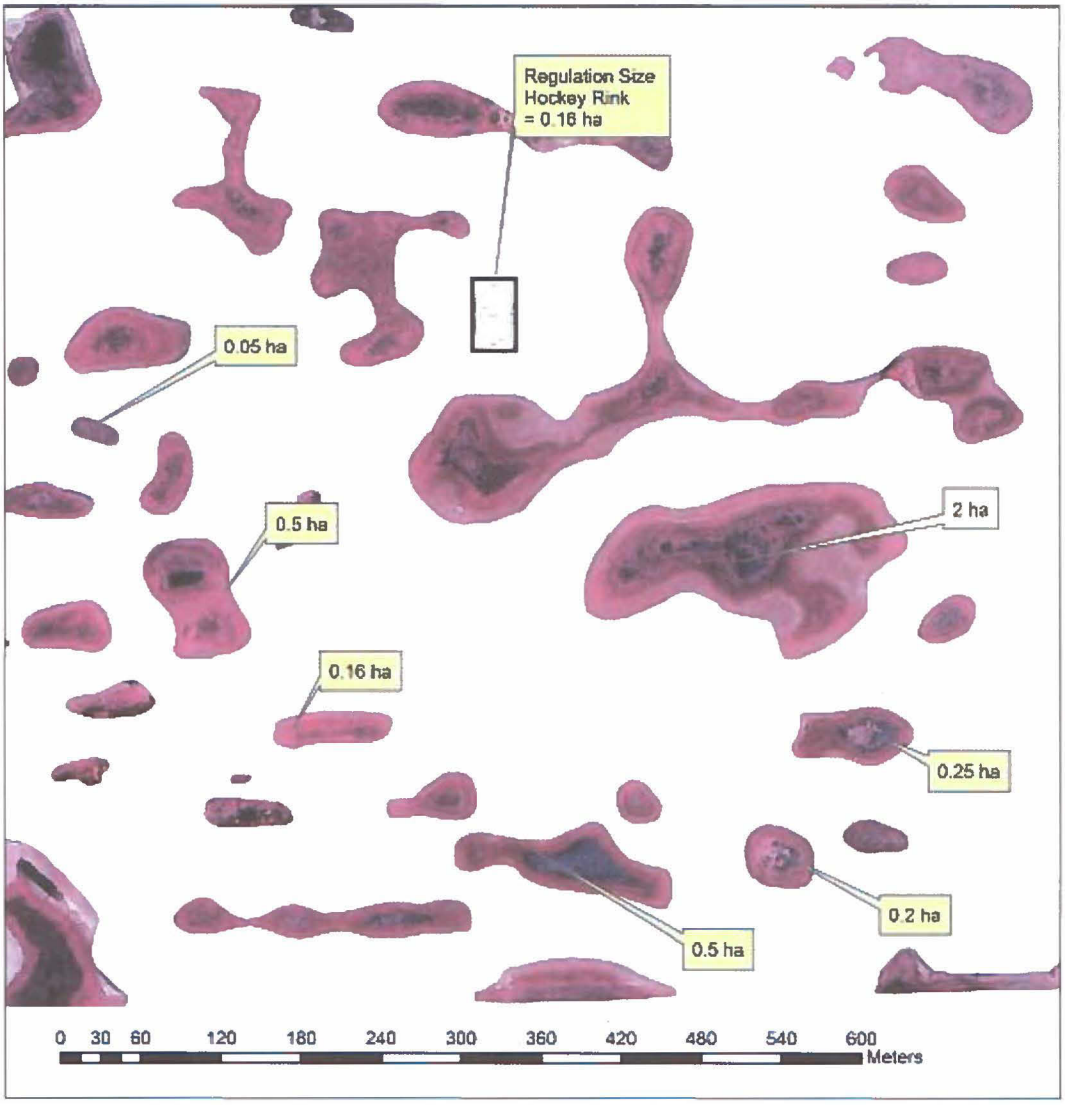


Figure 23. A comparison of various commonly occurring wetland basin sizes with a regulation size hockey rink for scale.

Wetland Impacts

Table 11 below reports total wetland area impacted by partial drainage and limited filling in the PHJV and by ecoregion within the PHJV study area. Wetland impacts recorded are simply drainage or filling activities that were considered insufficient in nature to cause permanent loss of wetland area or wetland basins. These impacted wetlands were still considered as wetland but, were attributed as being impacted by partial drainage (PD) or limited filling (LF). Impacts result in degraded wetland function, and, in some cases may be the first step in permanently removing a wetland from the landscape.

ECOREGION	% WETLAND AREA PD/LF 1985	% WETLAND AREA PD/LF 2001
PHJV (overall)	6 % (1,145 ha)	7 % (1,290 ha)
Boreal Transition	7 % (148 ha)	8 % (153 ha)
Aspen Parkland	7 % (586 ha)	8 % (655 ha)
Moist Mixed Grassland	4 % (166 ha)	6 % (216 ha)
Mixed Grassland	5 % (132 ha)	6 % (147 ha)
Fescue Grassland	10 % (51 ha)	8 % (42 ha)
Cypress Upland	1 % (0.37 ha)	3 % (1 ha)
Lake Manitoba Plain	8 % (45 ha)	11 % (62 ha)
South West Manitoba Uplands	2 % (2 ha)	1 % (1 ha)
Interlake Plain	17 % (15 ha)	21 % (14 ha)

Table 11. Total wetland area within the PHJV study area impacted by partial drainage or limited filling in 1985 and 2001.

Overall the area of wetland recorded as impacted (PD or PF) increased from 6% of the total PHJV wetland area in 1985 to 7% in 2001. In absolute terms wetlands in the Aspen Parkland ecoregion represented almost 51% of the total area of wetlands impacted in the PHJV. The area of wetlands attributed as impacted increased for all ecoregions with the exception of the Fescue Grassland and South West Manitoba Uplands ecoregions which had slight decreases. Changes in the area of impacted wetland are the result of wetland losses (of wetland area classified as impacted in the base year 1985), discontinuation of wetland impact activities, and newly constructed wetland impacts. Although cultivation is often considered as a wetland impact by many, only cultivated basins showing detectable

evidence of limited filling or partial drainage were recorded as impacted and included in the LF or PD numbers presented.

In total, 29% of the total lost wetland area (1985 – 2001) was attributed as either partially drained or filled in the original 1985 baseline survey. Between the years 1985 and 2001, these wetlands were further impacted through activities like continued filling, ditching, and land leveling. The result of these continued impacts was the progression from a partially impacted wetland to of permanent wetland loss (Figure 24).

Impacted wetlands appear to be at risk to becoming lost wetlands. Wetland function is not measured directly by this monitoring program; however, impacted wetlands show signs of degraded wetland function.

Figure 24. An example of the progression of partially impacted wetlands to lost wetlands. In 1985 basins A, B, and C were classed as PD and by 2001 these wetlands had been completely drained (through the creation of new consolidation and terminal ditches as well as new outlets).

Estimates of wetland area and wetland area loss.

The following table is an estimation of the total wetland area expected to occur within the PHJV and the ecoregions making up the PHJV landscape (Table 12). The calculation simply uses the measured mean percent wetland area by transect divided into the total landscape area. An estimate of the range is then calculated using variance measurements with 95% confidence intervals. This simple calculation of the estimated wetland area is not meant to be definitive, but rather is meant to provide some context to the measurements presented in this report. These estimates should be interpreted with caution and the study design should be considered when evaluating these results (i.e. large lakes and riverine systems are not included in these estimates because they were not sampled).

ECOREGION	MEAN % WETLAND AREA BY TRANSECT	Ecoregion Area (ha)	ESTIMATED WETLAND AREA BY ECOREGION (ha)
PHJV (overall)	8 %	57,127,038	4,570,163 +/- 442,810
Boreal Transition	10 %	10,089,259	1,008,926 +/- 97,838
Aspen Parkland	10 %	17,326,780	1,732,678 +/- 127,827
Moist Mixed Grassland	8 %	9,944,071	795,526 +/- 62,875
Mixed Grassland	6 %	13,366,259	801,976 +/- 71,968
Fescue Grassland	6 %	1,492,351	89,541 +/- 11,829
Lake Manitoba Plain	5 %	3,041,417	152,071 +/- 30,830

Table 12. Estimated wetland area, overall and by ecoregion within the PHJV.

The mean wetland area measured on transects in the PHJV was 8% of the total sampled area. Mean wetland areas were highest in the Boreal Transition and the Aspen Parkland ecoregions at 10% of the total sampled area for transects in these two ecoregions.

Overall, it is estimated that the PHJV landscape lost between 319,911 ha and 182,807 ha with a total mean area loss estimate of 228,508 ha of wetland area from 1985 to 2001 (Table 13). It is estimated that the Aspen Parkland ecoregion area of the PHJV suffered the highest loss of wetland area, losing between 121,287 ha and 69,307 ha of wetland.

ECOREGION	MEAN GROSS % WETLAND AREA LOST BY TRANSECT	Estimated Wetland Area (ha)	ESTIMATED GROSS WETLAND AREA (ha) LOSS BY ECOREGION (95% CI)
PHJV (overall)	5 %	4,570,163 +/- 442,810	228,508 (319,911 to 182,807)
Boreal Transition	5 %	1,008,926 +/- 97,838	50,446 (80,714 to 20,179)
Aspen Parkland	5 %	1,732,678 +/- 127,827	86,634 (121,287 to 69,307)
Moist Mixed Grassland	4 %	795,526 +/- 62,875	31,821 (71,597 to 15,911)
Mixed Grassland	8 %	801,976 +/- 71,968	64,158 (104,257 to 24,059)
Fescue Grassland	5 %	89,541 +/- 11,829	4,477 (9,850 to 1,791)
Lake Manitoba Plain	5 %	152,071 +/- 30,830	7,604 (19,769 to 3,041)

Table 13. Overall gross wetland area loss estimates for the PHJV and component ecoregions, 1985 - 2001.

Wetland Habitat Change Summary

It is difficult to relate this study to other studies due to differences in time periods, classification schemes, methods, localized geographic influences, and definitions of wetland loss. The following section looks at the findings of some prominent studies on the Canadian Prairies for the purposes of comparing findings, and providing some insight as to how the PHJV may have influenced wetland conservation (Table 14).

STUDY	TIME PERIOD	STUDY AREA	Annual Loss Rate Wetland #'s (%)		Annual Loss Rate Wetland Area (%)	
			Cited Study	Current Study	Cited Study	Current Study
Ignatiuk & Duncan	**1947 - 1992**	**Saskatchewan Target Areas**	-0.15	**-0.14**	NA	
Turner etal.	**1981 - 1985**	**Provincial Air Grounds**	-0.32	**-0.31**	NA	
Goodman and Pryor 1972.	**1940 - 1970**	**Black Soil Zone (Aspen Parkland Ecoregion)**	-0.15	**-0.31**	-0.43	**-0.25**
Rakowski et al., 1974	**1964 - 1974**	**Minnedosa Pothole Region, MB and SK.**	NA		- 4.00	**-0.19**
Kiel et al., 1972.	**1928 – 1964**	**Minnedosa Pothole Region, MB and SK.**	NA		-0.72	**-0.19**
Adams and Gentle, 1978.	**1964 - 1974**	**Newdale Plain, MB.**	-0.70	**-0.50**	NA	
Ritter, 1979.	**1800 - 1978**	**Battle River Basin, AB.**	NA		-0.05	**-0.29**
Schmitt, 1980.	**1800 - 1979**	**South Saskatchewan River Basin, AB.**	NA		-0.12	**-0.30**

Table 14. A comparative analysis of annual wetland loss rates between the current study and past studies within the PHJV study area (Underlined equals current study).

Ignatiuk and Duncan (1995) examined the numbers of wetlands lost in Saskatchewan's NAWMP target areas using aerial photography between 1947/1949 and 1986 – 1992. They reported a mean permanent wetland loss (in numbers of wetlands) of 6 % with high geographic variability. Although wetland numbers were not the primary focus of the current study, the 2.0 % reduction in the numbers of wetlands in Saskatchewan between the years 1985 and 1999 (Watmough et al., 2002) for the sampled NAWMP target areas is very similar to the loss rates found when the different lengths of time for the two studies are taken into account. The annual rate of wetland numbers lost over the 41 year period examined by Ignatiuk and Duncan was - 0.15% and for the PHJV transects in Saskatchewan from this study was - 0.14% over the 14 year period. This comparison shows very comparable rates of wetland loss in Saskatchewan between the two studies, and suggests loss rates have not ameliorated in recent times.

Goodman and Pryor (1972) reported a 13 % decline in wetland area and - 4.5 % decrease in wetlands numbers for the Aspen Parkland of the Prairie Provinces between the years of 1940 and 1970. The annual rate of loss calculated over the 30 year period for the Goodman and Pryor study was - 0.15% for wetland numbers, and - 0.43% for wetland area. The PHJV transects in this study had higher wetland number loss results with - 0.31 % annual loss in wetland numbers but, a significantly lower rate of - 0.25 % annual loss for wetland area. Differences in loss of wetland area could be the result of differing methods for defining wetland area, definitions of wetland loss, and changes in wetland size distribution or could be as the result of reduced wetland area loss in recent years due to PHJV activities. The difference between the wetland loss numbers may be the result of minimum mapping units, time periods, or definitions of wetland loss. This comparison does suggest that smaller wetlands of less area in the Aspen Parkland ecoregion of the Prairie Provinces are being lost at a faster rate then in previous years, but due to the different methods this can not be stated with great certainty.

Turner et al. (1987) examined drainage rates for the three Prairie Provinces and found the annual rate of loss from 1981 to 1985 to be: Saskatchewan 0.19 %, Manitoba 0.25 % and Alberta 0.53 % and a mean annual rate of 0.32 % for all three provinces. In comparing the results reported in Turner et al. 1987 with the current study wetland loss rates for each province report similar trends. The PHJV monitoring transects report annual net loss (wetland numbers) rates as follows: Saskatchewan 0.31 %, Alberta 0.38 % and Manitoba 0.44 % and a mean annual rate of 0.31 %. Considering the differences in the two methods, the annual rates of loss reported appear fairly similar and suggest a continued trend in declining wetland numbers.

Adams and Gentle looked at the loss of wetland basins in the Newdale Plain region of Manitoba and reported annual loss rates of 0.70 percent between 1964 and 1974. A comparison with transects in this area showed a decreasing rate in the loss of wetland numbers to 0.50 percent per year between 1985 and 2001.

The Ritter and Schmitt studies measured wetland area losses between 1800 and 1979 in the Battle River Basin and the South Saskatchewan river basin areas of Alberta. Comparisons with the current study show an increasing annual rate in wetland area loss for both the Battle River and South Saskatchewan basins (1985 to 2001 time period). The 179 year time period used in the Ritter and Schmitt studies, makes comparison with the current study difficult, however, the trend for these two study areas is still one of losing wetland area.

Other studies conducted in Prairie Canada have focused on small geographic areas and appear to pick up on what can be considered "Hot Spot" areas for wetland loss. The smaller study areas tend to report higher wetland loss values, whereas studies looking at broader landscapes report smaller wetland losses but significant spatial variation. An example of a "Hot Spot" type area was documented by Rakowski et al. (1974) and Kiel et al., 1972 who examined wetland loss in the Minnedosa Pothole region of Manitoba/Saskatchewan between the years of 1964 - 1974 and 1928 to 1964 respectively. Using the same samples and methods, the studies measured wetland area loss rates of - 41 % (1964 - 1974) and - 26 % (1928 - 1964). These two studies document the results of "hot spot" drainage type activities can have on a landscape. Subsequent monitoring of wetlands in this area by habitat monitoring transects (1985-2001) show an annual loss rate of 0.19 %. This large reduction in the annual rate of wetland area loss is likely the result of the heavy drainage that has occurred in this area in the past. Wetlands that could be drained in this area were largely drained prior to the 1985 baseline measurements and thus at the time of update wetland area losses were reduced because of the assumption that wetlands that could be drained had already been drained.

Previous studies regarding wetland loss for the Prairie Provinces report a range of wetland loss values. Considering findings from this study and past studies on the Canadian prairies it can be concluded that wetland loss is highly variable across the landscape and that quantities of wetlands area impacted fluctuates over time. The data in this study and other studies document a slow but continuing rate of wetland loss, emphasized by some dramatic wetland losses in localized areas. Evidence for PHJV influences regarding wetland losses is not clear. The comparison of datasets suggests there has been none to little change in the rates of wetland area and numbers loss over the last few decades. Wetland losses may be related to land operator attitudes, the capability of localized areas to support specific agricultural activities detrimental to wetlands, land ownership changes, economic shifts and attrition of small wetlands which are continually impacted by agricultural activities.

Upland Habitats

Overall, natural habitats declined from 1985 to 2001 (Table 15). Grassland habitats decreased 10% from 1985 to 2001, with the largest relative grassland losses occurring in the Aspen Parkland ecoregion. Low shrub habitats (commonly found within grassland habitats) also declined in all ecoregions except the Cypress Upland ecoregion. Tall shrub habitats increased slightly, largely as a result of establishment/re-growth of woody cover in wetland upland transitional areas and large areas of re-growth in cut block areas in the Aspen Parkland. Relative change in treed habitat area declined by 6% between 1985 and 2001. Native habitat losses were predominantly the result of "squaring the field", whereby small remnant habitat areas within cultivated settings were removed and integrated into the cropping operations. Large scale (i.e. entire quarter section) native habitat losses were rare among the transects, but this type of loss was recorded.

Annual cropland (including summer fallow) area decreased by 8 % from 1985 to 2001. A majority of previously annually cropped upland was converted to tame pasture or tame hay classification which increased by 113% and 86% respectively. Non-native tree and shrub habitats (shelter belts, farm yard plantings, tree farms etc.) decreased by 5% in the PHJV. Land conversion through rural development, resource extraction, and road networks resulted in a 33% increase in the other upland category for the PHJV.

Upland Cover Change

	Native Habitats				Non-Native Habitats				
Ecoregion	Natural Grassland	Low Shrub	Tall Shrub	Trees	Annual Crops	Tame Pasture	Tame Hay	Trees/ Shrubs	Other
PHJV (overall)	- 10 %	- 7 %	3 %	- 6 %	- 8 %	113 %	86 %	- 5 %	33 %
Boreal Transition	- 13 %	- 16 %	- 10 %	- 4 %	- 11 %	112 %	116 %	- 12 %	- 5 %
Aspen Parkland	- 15 %	- 9 %	11 %	- 8 %	- 9 %	140 %	66 %	- 12 %	41 %
Moist Mixed Grassland	- 8 %	- 7 %	9 %	- 5 %	- 7 %	130 %	100 %	3 %	33 %
Mixed Grassland	- 7 %	- 2 %	15 %	- 1 %	- 6 %	125 %	126 %	4 %	18 %
Fescue Grassland	- 13 %	- 6 %	- 1 %	17 %	- 12 %	29 %	545 %	15 %	86 %
Cypress Upland	- 5 %	12 %	- 6 %	13 %	- 19 %	8 %	714 %	10 %	47 %
Lake Manitoba Plain	- 6 %	- 19 %	- 11 %	- 2 %	- 9 %	- 8 %	64 %	0 %	39 %
South West Manitoba Uplands	- 12 %	- 9 %	- 57 %	18 %	- 2 %	95 %	- 8 %	0 %	13 %
Interlake Plain	- 39 %	- 24 %	- 18 %	- 12 %	- 24 %	714 %	29 %	110 %	37 %

Table 15. Relative percentage change (1985 - 2001) in upland cover category in the PHJV study area.

Native Grassland Change

Gross native grass land loss reports total area losses for specific landscapes. Low shrub area is included with native grassland as these shrub areas were most often complexes of shrub and grass (e.g. Symphiocarpus sp., Rosa sp.).

Total gross native grassland area losses for the PHJV equaled 10% (- 2,478 ha), with a mean loss of 11% per transect (95% CI -13% to -8%). The common trend for all ecoregions within the PHJV is decreasing areas of native grassland.

ECOREGION	GROSS NATIVE GRASS LOSS (POOLED DATA)	Mean By Transect	95 % CONFIDENCE INTERVAL	
PHJV (overall)	- 10 % - 2,478 ha	- 11 %	- 13 %	- 8 %
Boreal Transition	- 18 % - 183 ha	- 19 %	- 30 %	- 10 %
Aspen Parkland	- 17 % - 1,016 ha	- 17 %	- 20 %	-14 %
Moist Mixed Grassland	- 8 % - 426 ha	- 8 %	- 13 %	- 5 %
Mixed Grassland	- 7 % - 616 ha	- 7 %	- 13 %	- 3 %
Fescue Grassland	- 10 % - 131 ha	- 11 %	- 20 %	- 4 %
Cypress Upland	- 3 % - 8 ha	NA	NA	NA
Lake Manitoba Plain	- 9 % - 64 ha	- 11 %	- 20 %	- 6 %
South West Manitoba Uplands	- 13 % - 9 ha	NA	NA	NA
Interlake Plain	- 33 % - 26 ha	NA	NA	NA

Table 16. Gross native grassland area loss within the PHJV study area 1985 - 2001.

Natural grassland losses were largely the result of "squaring the field" and rarely were large blocks of native grassland habitat removed. The mean size of lost native grassland polygons was 2 ha and ranged from trace to 64 ha in size, and the mean grassland area loss per transect was 16 ha. The composition of total upland area replacing gross lost native grassland was made up of 48% tame grass, 37% annual crop, 4% tree or shrub, 10% constructed cover (i.e. roads, well sites, housing etc.), 1% dugouts/artificial water developments .

Native grassland area losses varied widely amongst transects, and the common trend was a reduction of natural grassland in areas sampled by transects. Transects dominated by native grassland cover (600 or more ha) showed little change with a mean gross loss rate of 2% per transect (n=5), however, losses of native grassland area in these bigger blocks did occur.

Gains in native grassland habitat were not recorded, primarily as a result of how grassland classification was determined. Any grassland habitat showing previous signs of cultivation (these indicators can last for many years) were not classed as native grassland habitat.

The large proportions of tame grass cover replacing lost native grass area are suggestive of native grassland classification error in the baseline classification, thus resulting in possible false change. As discussed in the methodology, native grassland classification in 1985 was not a priority and given the air photo classification techniques used some error in grassland classification was expected. None the less even if all of the natural grassland losses due to tame grass represented false change (which could result in an over estimation of real native grass area losses from 1985 - 2001 of approximately 50%) the trend in native grassland habitat would still be that of declining native grassland area in the area sampled by transects.

Agricultural Census

An examination of Agricultural (AG) census data confirms the trends for the dominant land uses reported on transects. Land being used for cultivation (including summer fallow) has been reduced, and tame grass/seeded pasture has increased in area from 1986 - 2001 (Table 17). The all other land category of the AG census reports a decline between the years 1996 and 2001, this may be confirmation as to the loss of natural type habitat lands (wetlands, grasslands, and treed habitat), however the All other land category of the AG census is not directly related to habitat lands and is more of a catch all category.

Transect results show similar trends to that of AG census data. The disparity in the magnitude of area composition for cultivated land and natural land for pasture is likely due to the insufficient sample in the contiguous blocks of native grassland.

Upland Habitat Summary Trends ***Total Land Area Composition Change***			
	Statistics Canada Agricultural Census Data 1986, 1996, and 2001		**Transects**
Cover Type	**PHJV 1986 to 1996**	**PHJV 1996 to 2001**	**PHJV 1985 to 2001**
Cultivated Land (Summer fallow + Annual Crop)	60.4 % to 57.6 % **- 2.8 %**	57.7 % to 55.0 % **- 2.7 %**	72.3 % to 66.0 % **- 6.3 %**
Natural Land For Pasture	24.2 % to 23.6 % **-0.6 %**	23.4 % to 23.6 % **+0.2 %**	10.7 % to 9.8 % **-0.9 %**
Tame or Seeded Pasture	4.5 % to 6.3 % **+ 1.8 %**	6.2 % to 7.2 % **+ 1 %**	2.6 % to 4.7 % **+2.2 %**
Tame Hay	4.8% to 6.5% **+1.7%**	6.7 % to 9.0 % **+2.3 %**	3.8 % to 7.0 % **+3.2 %**
All Other Land	6.1 % to 6.5 % **+0.4 %**	6.0 % to 5.2 % **-0.8 %**	NA

Table 17. Summary of land use trends with in the PHJV study area using Agricultural Census data and habitat monitoring transect results.

NAWMP Targeted & Non-targeted comparison.

Gross Wetland Loss

Gross wetland area losses for North American Waterfowl Management Plan (NAWMP) targeted areas are compared to non-targeted lands (Table 18) in order to provide insight into the possible influence of conservation program delivery and the relationship to wetland conservation. It should be noted that this study was not specifically designed to address the question of targeted and non-targeted lands. The results of targeted and non-targeted land comparison presented here are not intended to be construed as definitive but rather are meant to identify potentially meaningful differences that could be investigated further.

A total of 58 transects sampled landscapes considered as targeted by NAWMP activities, leaving 95 transects sampling areas considered as non-targeted by NAWMP. The Phase I report presented the results of the 56 transects (two additional transects in Manitoba were added for the current analysis) intersecting the NAWMP targeted landscapes, see Watmough etal. 2002. In this study, the Boreal Transition, Fescue Grassland, Cypress Uplands, Interlake Plain, Southwest Manitoba Uplands and Lake Manitoba Plain ecoregions lacked sufficient sample for comparative (targeted to non-targeted) analysis.

ECOREGION	OVERALL GROSS WETLAND AREA LOSS % (95 % CI)		OVERALL NET WETLAND AREA LOSS % (95 % CI)	
NAWMP	Targeted	Non-Targeted	Targeted	Non-Targeted
PHJV (overall)	- 4 % (-6 %, -3%) N=58	- 6 % (-9 %, -4 %) N=95	- 4 % (-5 %, -3%) N=58	- 6 % (-8 %, -3 %) N=95
Aspen Parkland	- 4 % (-6 %, -3%) N=29	- 6 % (-10 %, -3%) N=30	- 4 % (-5 %, -3 %) N=29	- 5 % (-9 %, -2 %) N=30
Moist Mixed Grassland	- 3 % (-6 %, -1%) N=10	- 6 % (-13 %, -2%) N=24	- 2 % (-5 %, +1%) N=10	- 5 % (-12 %, -1 %) N=24
Mixed Grassland	- 7 % (-16 %, - 1 %) N=11	- 8 % (-15 %, -3 %) N=20	- 7 % (-15 %, -1 %) N=11	- 8 % (-14 %, -2%) N=20

Table 18. A comparison of relative (percentage) gross wetland area losses between NAWMP targeted and non-targeted lands within the PHJV study area (1985 - 2001).

Overall, transects sampling targeted areas recorded lower mean relative wetland area losses then non-targeted lands. The Moist Mixed grassland ecoregion showed the greatest disparity between targeted and non-targeted lands with a - 3% and - 6% gross loss of wetland area for targeted and non-targeted lands respectively.

Mean gross and net wetland area losses (absolute change) were greater in targeted lands for all ecoregions with the exception of the Moist Mixed grassland ecoregion (Table 19).

LANDSCAPE	MEAN GROSS WETLAND AREA LOSS		MEAN NET WETLAND AREA LOSS	
NAWMP	Targeted	Non-Targeted	Targeted	Non-Targeted
PHJV	- 6.86 ha	- 6.43 ha	- 5.92 ha	- 5.49 ha
Aspen Parkland	- 8.66 ha	- 6.41 ha	- 7.64 ha	- 5.76 ha
Moist Mixed Grassland	- 3.73 ha	- 5.58 ha	- 2.41 ha	- 5.02 ha
Mixed Grassland	- 7.55 ha	- 5.88 ha	- 6.98 ha	- 5.38 ha

Table 19. Mean gross absolute (hectares) area loss for NAWMP targeted and non-targeted lands, 1985 - 2001.

The results of comparing gross wetland area losses for targeted to non-targeted lands (considering the standard errors for each) are largely inconclusive (Figure 25). Relative percentage loss rates are higher in non-targeted lands, and mean absolute area loss rates are higher in targeted lands.

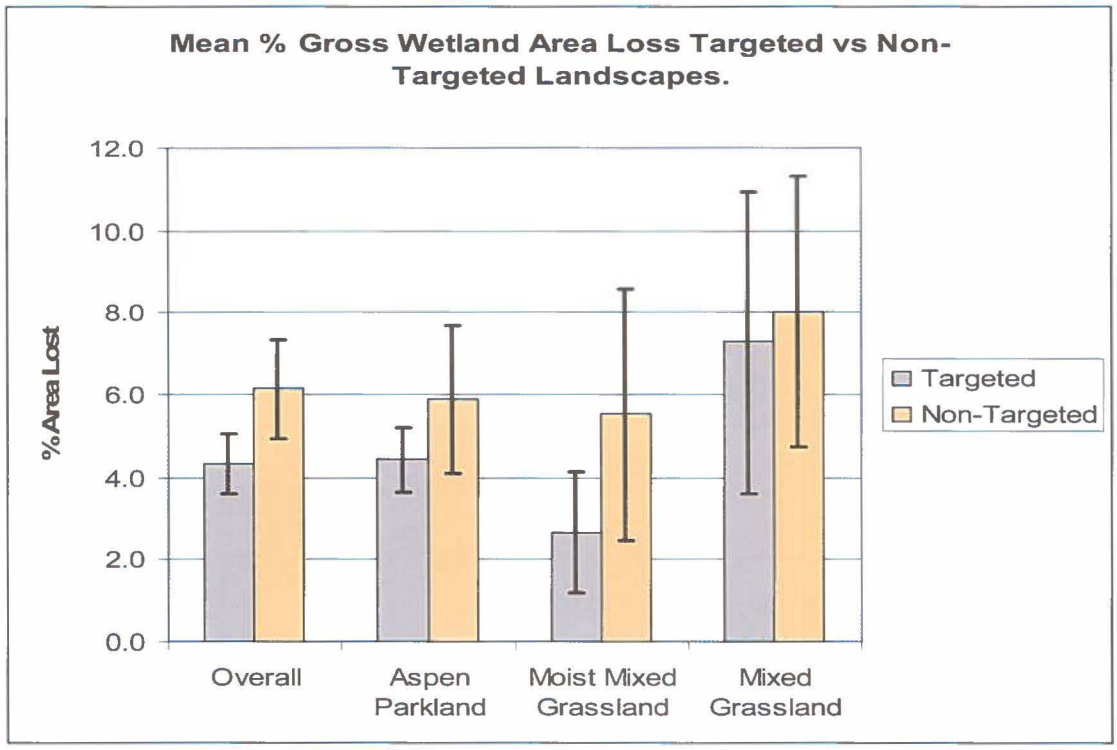


Figure 25. A comparison of relative (1985 - 2001) mean gross wetland area loss, NAWMP targeted vs. non-targeted landscapes.

Relative percentage wetland area loss rates (1985-2001) were lower in targeted areas than in non-targeted areas, however, absolute (actual hectares) net and gross area losses where higher in NAWMP targeted areas then non-targeted lands. The absolute area loss comparison between targeted and non-targeted lands suggests caution be used in interpreting the results of relative percentage change (1985-2001) between targeted areas non-targeted areas.

The reported relative percentage change differences maybe the result of the significant differences between targeted and non-targeted lands. At the inception of this program, non-targeted and targeted land comparisons were not a priority and thus sampling was not adequately designed for this purpose. Targeted lands tend to be areas of high wetland densities, wetland numbers and overall wetland area as compared to non-targeted lands which generally have lower wetland densities, numbers, and overall wetland area. Transects in the targeted lands had a mean area of wetlands per transect of 159 ha or 10 % of total sampled area, whereas transects sampling non-targeted lands had a mean area of wetlands per transect of 101 ha or 7 % of total sampled area. This difference of wetland acreage between target and non-targeted lands could influence the results of relative wetland area loss reported. Although non-targeted lands experienced smaller absolute mean wetland area loss relative to targeted areas, non-targeted areas experienced greater percentage loss of wetland area from 1985 to 2001.

While the data suggest an intriguing reduced relative (percentage) wetland area loss in targeted areas, it can not be concluded with any certainty that wetland area losses in targeted lands were significantly less then non-targeted lands. Hence, it is not clear as to if this difference may be real and a result of PHJV activities, or whether it is merely a by product due to landscape or other differences.

ALBERTA

Sample Size

Overall in Alberta a total of 48 transects sampled 1,104 quarter sections or 73,201 hectares of land. The total area sampled comprised 0.37% of the entire Alberta portion of the PHJV landscape. Sampling effort was not uniform across ecoregions as is shown in Table 20 below. This sampling imbalance should be considered when interpreting results as related to a specific ecoregion. The boreal transition and mixed grassland ecoregions of Alberta are noticeably under sampled.

Ecoregions	# of Transects	% of Ecoregion Area Sampled	Ecoregion composition within the AB PHJV
Boreal Transition	1	0.04 %	21.86 %
Aspen Parkland	21	0.56 %	29.56 %
Moist Mixed Grassland	10	0.46 %	15.82 %
Mixed Grassland	9	0.29 %	23.67 %
Fescue Grassland	6	0.58 %	7.47 %
Cypress Upland	1	0.49 %	1.63 %
Total Alberta PHJV Area	***48***	0.37 %	100.00 %

Table 20. Distribution of habitat monitoring transects by ecoregion within the Alberta portion of the PHJV study area.

The Alberta portion of the PHJV was the least sampled province with just 0.37% of the total PHJV area within the province being sampled.

Wetlands

Gross Wetland Area Loss

The mean gross wetland area loss for the Alberta portion of the PHJV study area was -6% (-365 ha) between 1985 and 2001 (Table 21). Wetland area losses in Alberta accounted for 37% of the total wetland area lost in the PHJV study area. With wetland area losses in the Alberta Aspen Parkland ecoregion representing 56% of the total wetland area losses for the entire PHJV portion of the Aspen Parkland ecoregion. The Boreal Transition ecoregion of Alberta was substantially under sampled and thus results for this ecoregion are considered as unreliable. It should be noted that during the course of current work establishing sampling transects in the Boreal Transition ecoregion of Alberta, many sampled areas were undergoing or showed evidence of large scale wetland area conversions/drainage as well as various upland habitat alterations. It is suspected that if the new transects established in 2004/05 were to be updated in the near future; they would show significant change for the Alberta portion of this ecoregion.

ALBERTA ECOREGION	ABSOLUTE WETLAND AREA LOST (HA)	% WETLAND AREA LOST (POOLED DATA)	MEAN % GROSS WETLAND AREA LOSS BY TRANSECT		
			Mean %	Lower 95% Confidence Boundary	Upper 95% Confidence Boundary
PHJV (overall)	- 365	- 6 %	- 6 %	- 9 %	- 4 %
Boreal Transition	- 13	- 4 %	NA	NA	NA
Aspen Parkland	- 249	- 8 %	- 8 %	- 11 %	- 5 %
Moist Mixed Grassland	- 27	- 3 %	- 3 %	- 4 %	- 2 %
Mixed Grassland	- 51	- 8 %	- 8 %	- 18 %	- 1 %
Fescue Grassland	-25	- 5 %	- 5 %	- 11 %	- 2 %
Cypress Upland	- 0.4	- 2 %	NA	NA	NA

Table 21. Gross wetland area loss in the Alberta portion of the PHJV study area, 1985 - 2001.

The Mixed Grassland showed the widest spread between upper and lower 95% confidence intervals (- 18 % to - 1 %), this was likely largely the result of under sampling of the Alberta portion of this ecoregion.

The Moist Mixed Grassland ecoregion had the lowest mean gross wetland area loss at - 3% (Cypress Upland was lower but contained only a single transect sample) between 1985 and 2001. Confidence intervals for this ecoregion also suggest a narrower range of expected loss rates for this ecoregion at - 4% to - 2%. These data suggest that the Moist Mixed Grassland ecoregion of Alberta suffered the fewest wetland area losses of all adequately sampled ecoregions in Alberta.

Net Wetland Area Change

Overall net wetland area change for the Alberta portion of the PHJV from 1985 to 2001 equaled - 5% or - 315 ha (Table 22). The Aspen Parkland and Mixed Grassland ecoregions of Alberta suffered the highest mean losses in net wetland area at - 7% and - 8% respectively.

The wide range in confidence interval for the Mixed Grassland ecoregion (- 18% to - 0%) is likely largely a result of under sampling of the Alberta portion of this ecoregion, and thus the true trend for this ecoregion can not be confidently determined.

ALBERTA ECOREGION	ABSOLUTE WETLAND AREA CHANGE (HA)	% WETLAND AREA CHANGE (POOLED DATA)	MEAN % NET WETLAND AREA LOSS BY TRANSECT		
			Mean %	Lower 95% Confidence Boundary	Upper 95% Confidence Boundary
PHJV (overall)	- 315	- 5 %	- 5 %	- 8 %	- 3 %
Boreal Transition	- 12	- 3 %	NA	NA	NA
Aspen Parkland	- 222	- 7 %	- 7 %	- 11 %	- 4 %
Moist Mixed Grassland	- 14	- 1 %	- 1 %	- 3 %	+ 1 %
Mixed Grassland	- 48	- 7 %	- 8 %	- 18 %	0 %
Fescue Grassland	- 19	- 4 %	- 4 %	- 9 %	- 1 %
Cypress Upland	- 0.37	- 1 %	NA	NA	NA

Table 22. Net wetland area change in the Alberta portion of the PHJV study area, 1985 - 2001.

The Moist Mixed Grassland suffered the lowest mean net wetland area loss at - 1% or -14 ha between 1985 and 2001. Confidence intervals for this ecoregion include an increase of + 1% at the upper boundary and a decrease in wetland area of - 3% at the lower boundary. This spread in data suggests that wetland area in the Moist Mixed Grassland ecoregion may be approaching a "no net loss" level to slightly declining. However, wetland gains in this ecoregion were largely the result of dugouts, and irrigation activities, the functionality of which for wildlife is uncertain but likely reduced.

Wetland Area by Land use Type

The most common land use occurring within wetland basins in Alberta in 1985 and 2001 was grazing (Table 23). The proportion of grazed wetlands area was highest of all Prairie Provinces. In 1985 the percent of grazed wetland area was highest in the Moist Mixed Grassland at 62% of total wetland area, and in 2001 the percent of grazed wetland area was highest in the Mixed Grassland ecoregion of Alberta. These shifts in grazing pressure were largely due to point in time situations such as water levels, grazing rotations, and shifts in forage or tame pasture acreages.

	1985 Wetland area land use % Composition						2001 Wetland area land use % Composition					
Alberta Ecoregion	No Use	Annual Crop	Haying	Grazing	Drainage	Other	No Use	Annual Crop	Haying	Grazing	Drainage	Other
PHJV (overall)	38 %	12 %	3 %	42 %	< 1%	3 %	40 %	12 %	4 %	40 %	1 %	4 %
Boreal Transition	69 %	1 %	3 %	25 %	1%	1 %	64 %	2 %	6 %	28 %	1 %	1 %
Aspen Parkland	47 %	11 %	4 %	35 %	< 1%	3 %	46 %	12 %	5 %	33 %	1%	2 %
Moist Mixed Grassland	22 %	10 %	1 %	62 %	< 1%	4 %	36 %	8 %	4 %	45 %	< 1%	7 %
Mixed Grassland	15 %	22 %	1 %	55 %	< 1%	6 %	14 %	20 %	1 %	57 %	< 1%	8 %
Fescue Grassland	28 %	12 %	2 %	53 %	0 %	5 %	25 %	10 %	2 %	56 %	< 1%	6 %
Cypress Upland	2 %	23 %	5 %	57 %	0 %	14 %	23 %	17 %	6 %	42 %	0 %	12 %

Table 23. Land use activities in wetland basins, a comparison between 1985 and 2001 total Alberta PHJV wetland area compositions .

Overall, the other land use category (which includes, extraction activity, rural/urban development, road development etc.) increased from 3% of total wetland area in 1985 to 4% of total wetland area in 2001, with the greatest changes occurring in the Moist Mixed and Mixed grassland ecoregions of Alberta. The increase in wetland area being classified as having Other land use is largely the result of the construction of wetlands for anthropogenic uses (sewage treatment, irrigation, dugouts etc.) and also includes wetlands area that has been impacted by other types of land use practices not specifically directed at the wetland, rather as a consequence of development (e.g. extraction activities, road construction, housing developments).

Wetland Area by Cover Type

Wetland area cover results for Alberta are similar to overall results for the PHJV (Table 24). The Grass and Sedge wetland cover type dominates wetland area composition in all ecoregions within the Alberta portion of the PHJV. Overall, wetland area cover composition remained relatively unchanged between base (1985) and update years (2001)

	1985 Wetland Cover Type % Composition							2001 Wetland Cover Type % Composition						
Alberta Ecoregion	Cultivated	Wooded	Grass Sedge	Bulrush Cattail	Open Water	Artificial	Other	Cultivated	Wooded	Grass Sedge	Bulrush Cattail	Open Water	Artificial	Other
PHJV (overall)	12%	7 %	58%	4 %	17%	2 %	1 %	13%	7 %	56%	5 %	16%	2 %	2 %
Boreal Transition	1%	16%	41%	2 %	40%	1 %	0 %	2%	15%	39%	2 %	41%	1 %	0 %
Aspen Parkland	12%	8 %	57%	3 %	19%	1 %	1 %	14%	9%	54%	6 %	15%	2 %	1 %
Moist Mixed Grassland	10%	5 %	64%	8 %	10%	2 %	2 %	9%	5 %	65%	4 %	13%	3 %	3 %
Mixed Grassland	22%	1 %	63%	2 %	4%	2 %	4 %	20%	1 %	64%	6 %	3%	3 %	4 %
Fescue Grassland	12%	1 %	58%	4 %	21%	2 %	2 %	11%	<1%	57%	4 %	22%	2 %	3 %
Cypress Upland	22%	<1%	52%	1 %	<1%	16%	7%	22%	<1%	50%	1 %	2 %	17%	7 %

Table 24. Wetland area composition by cover type as a percentage of total wetland area within the Alberta portion of the PHJV study area, 1985 - 2001 .

Wetland Numbers

In total 35% of all wetland basin numbers lost in the PHJV occurred in the Alberta portion of the PHJV (Table 25). The Aspen Parkland ecoregion of Alberta recorded losses totaling 46% of the total wetlands basins lost in the entire Aspen Parkland ecoregion of the PHJV. The majority of wetland basin losses in Alberta occurred in the Aspen Parkland ecoregion which reported a net loss of - 7% or 443 wetland basins lost.

Alberta Ecoregion	Gross Loss % (#'s)	Gross Gain % (#'s)	Net Change % (#'s)
PHJV (overall)	- 7 % (- 818)	1 % (153)	- 6 % (- 665)
Boreal Transition	- 1 % (-3)	0.4 % (2)	- 0.2 % (- 1)
Aspen Parkland	- 8 % (- 529)	1 % (86)	- 7 % (- 443)
Moist Mixed Grassland	- 5 % (- 70)	3 % (36)	- 3 % (- 34)
Mixed Grassland	- 9 % (- 121)	1 % (10)	- 8 % (-111)
Fescue Grassland	- 9 % (-87)	2 % (18)	- 7 % (-69)
Cypress Upland	- 4 % (-8)	1 % (1)	- 4 % (-7)

Table 25. Percent change in wetland basin numbers in the Alberta portion of the PHJV study area from 1985 - 2001.

Wetland Size

Wetland size statistics for Alberta (Table 26) are similar to those reported for the PHJV. The mean size of complete lost basins in Alberta was 0.19 ha with the largest mean size of lost basin occurring in the Fescue Grassland (0.23 ha) and the smallest mean size occurring in the Moist Mixed Grassland (0.11 ha).

ALBERTA ECOREGION	WETLAND BASIN SIZE 1985 (ha)		WETLAND BASIN SIZE 2001 (ha)		SIZE OF LOST WETLAND BASINS (ha)		SIZE OF GAINED WETLAND BASINS (ha)	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
PHJV (overall)	0.51	0.13	0.51	0.13	0.19	0.09	0.17	0.09
Boreal Transition	0.71	0.09	0.69	0.08	0.15	0.09	0.08	0.08
Aspen Parkland	0.48	0.13	0.47	0.13	0.20	0.10	0.15	0.09
Moist Mixed Grassland	0.72	0.14	0.72	0.14	0.11	0.05	0.24	0.09
Mixed Grassland	0.45	0.15	0.44	0.15	0.18	0.11	0.19	0.16
Fescue Grassland	0.52	0.11	0.54	0.11	0.23	0.09	0.19	0.07
Cypress Upland	0.13	0.05	0.14	0.06	0.04	0.04	0.03	0.03

Table 26. Alberta PHJV wetland basin size statistics.

Wetland Impacts

Overall, total impacted wetland area in Alberta (Table 27) accounted for 41% (1985) and 38% (2001) of the total impacted wetland area in the PHJV. Once again the Aspen Parkland ecoregion of Alberta reported large relative and absolute results, suggesting increased levels of wetland impacts in this ecoregion of Alberta. The lone transect sampling the Boreal Transition ecoregion of Alberta had the highest relative result for wetland area impacts at 15% in 1985 and 13% in 2001. This measured result supports the observations of field crews working in the Boreal Transition that wetland loss may be occurring more frequently in this area.

AB. LANDSCAPE	% TOTAL WETLAND AREA PD/PF 1985	% TOTAL WETLAND AREA PD/PF 2001
PHJV	8 % (465 ha)	9 % (485 ha)
Boreal Transition	15 % (52 ha)	13 % (44 ha)
Aspen Parkland	7 % (243 ha)	9 % (270 ha)
Moist Mixed Grassland	8 % (80 ha)	10 % (99 ha)
Mixed Grassland	6 % (40 ha)	5 % (29 ha)
Fescue Grassland	10 % (51 ha)	8 % (41 ha)
Cypress Upland	1 % (0.4 ha)	3% (1 ha)

Table 27. Total wetland area within the Alberta portion of the PHJV study area impacted by partial drainage or limited filling in 1985 and 2001.

Upland Habitats

Native habitats in Alberta have declined from 1985 to 2001 (Table 28). Grassland losses in Alberta accounted for 57% of the total grassland losses for the entire PHJV. Tall shrub habitat increased in the Aspen Parkland ecoregion of Alberta by 18% largely as a result of shrub growth in cut blocks, and within wetland margins. Treed habitats declined by 11% in Alberta, with the largest declines happening in the Aspen Parkland ecoregion which declined by 12% or 252 ha from 1985 to 2001.

Annual cropland decreased by 13% in Alberta from 1985 to 2001, this area was predominately replaced by tame grass in the form of tame pastures and tame hay.

Upland Cover Change

	Native Habitats				Non-Native Habitats				
Alberta Ecoregion	Grassland	Low Shrub	Tall Shrub	Trees	Annual Crops	Tame Pasture	Tame Hay	Trees/ Shrubs	Other
PHJV (overall)	- 11 % - 1,266 ha	- 15 % - 56 ha	14 % + 55 ha	- 11 % - 288 ha	- 13 % - 5,365 ha	88 % + 2,610 ha	84 % + 2,967 ha	- 5 % - 13 ha	44 % + 1, 671 ha
Boreal Transition	- 30 % - 38 ha	- 16 % - <1 ha	- 1 % - <1 ha	- 8 % - 31 ha	- 28 % - 40 ha	4 % + 8 ha	26 % + 75 ha	- 16 % - 2 ha	69 % + 39 ha
Aspen Parkland	- 17 % - 469 ha	- 24 % - 48 ha	18 % + 57 ha	- 12 % - 252 ha	- 12 % - 2,370 ha	104 % + 1,364 ha	60 % + 1,200 ha	- 13 % -24 ha	44 % + 764 ha
Moist Mixed Grassland	- 9 % - 210 ha	- 7 % - 5 ha	- 6 % - 2 ha	- 8 % - 7 ha	- 15 % - 1,382 ha	112 % + 616 ha	127 % + 711 ha	34 % + 10 ha	37 % + 283 ha
Mixed Grassland	- 7 % - 379 ha	- 6 % - 4 ha	0 %	0 %	- 10 % - 647 ha	98 % + 524 ha	74 % + 449 ha	3 % + < 1 ha	17 % + 105 ha
Fescue Grassland	- 13 % - 160 ha	- 6 % - 2 ha	0 %	17 % + 2 ha	- 12 % - 702 ha	29 % + 94 ha	545 % + 339 ha	15 % + 2 ha	86 % + 445 ha
Cypress Upland	- 5 % - 11 ha	12 % + 3 ha	0 %	0 %	- 19 % - 225 ha	8 % + 4 ha	714 % +193 ha	0 %	47 % + 36 ha

Table 28. Relative percentage change (1985 - 2001) in upland cover category in the Alberta portion of the PHJV study area.

Native Grassland Change

Overall, analysis of transects sampling the Alberta portion of the PHJV documented an 11% or 1,374 ha decline in native grassland area (Table 29). Native grassland losses in the Aspen Parkland ecoregion of Alberta equaled 43% of the total native grassland area losses in the province. Native grassland area losses were highly variable amongst Alberta transects. The large majority of grassland losses were the results of small remnant grassland areas within cultivated settings, being incorporated into the larger agricultural operation.

ALBERTA ECOREGION	ABSOLUTE AREA GROSS LOSS	GROSS NATIVE GRASS LOSS %	MEAN TRANSECT	95 % CONFIDENCE INTERVAL	
				LOWER	UPPER
PHJV (overall)	- 1,373.59 ha	- 11 %	- 11 %	- 17	- 8
Boreal Transition	- 47.54 ha	- 37 %	NA	NA	NA
Aspen Parkland	- 592.16 ha	- 20 %	- 20 %	- 25	- 16
Moist Mixed Grassland	- 211.08 ha	- 8 %	- 9 %	- 14	- 6
Mixed Grassland	- 383.38 ha	- 7 %	- 8 %	- 21	- 2
Fescue Grassland	- 131.08 ha	- 10 %	- 11 %	- 20	- 4
Cypress Upland	- 8.35 ha	- 3 %	NA	NA	NA

Table 29. Gross native grassland area loss within the Alberta portion of the PHJV study area 1985 - 2001.

SASKATCHEWAN

Sample Size

Overall in Saskatchewan a total of 78 transects sampled 1,824 quarter sections or 120,323 ha of land (Table 30). The total PHJV area of Saskatchewan sampled equaled 0.41% and 51% of the 153 habitat monitoring transects were located in Saskatchewan. The Boreal Transition and Mixed Grassland ecoregions were considered as under sampled and the Cypress Upland ecoregion of Saskatchewan was un-sampled.

Ecoregions	# of Transects	% of Ecoregion Area Sampled	Ecoregion composition within the SK PHJV
Boreal Transition	10	0.29 %	18.37 %
Aspen Parkland	22	0.42 %	27.66 %
Moist Mixed Grassland	24	0.55 %	23.00 %
Mixed Grassland	22	0.38 %	29.28 %
Cypress Upland	0	0 %	1.70 %
Total Saskatchewan PHJV Area	78	0.41 %	100 %

Table 30. Distribution of habitat monitoring transects by ecoregion within the Saskatchewan portion of the PHJV study area.

Wetlands

Gross Wetland Loss

Overall a total of 453 ha or 46% of the total gross lost wetland area for the PHJV occurred in Saskatchewan (Table 31). The Mixed Grassland ecoregion of Saskatchewan recorded the highest absolute and relative loss numbers at 150 ha and - 8% respectively. Wetland area losses in the Moist Mixed and Mixed Grassland ecoregions of Saskatchewan accounted for 84% and 74% (respectively) of the total PHJV gross wetland area losses for these ecoregions. The high rate of loss in the Saskatchewan portion of these ecoregions was predominantly due to the intensive annual cultivation operations in the sampled areas, thus even in the baseline classification many wetlands were considered as degraded.

SK. ECOREGION	ABSOLUTE WETLAND AREA LOST (HA)	% WETLAND AREA LOST (POOLED DATA)	MEAN % GROSS WETLAND AREA LOSS BY TRANSECT		
			Mean %	Lower 95% Confidence Boundary	Upper 95% Confidence Boundary
PHJV (overall)	453	- 5 %	- 5%	- 7 %	- 3 %
Boreal Transition	70	- 5 %	- 5 %	- 10 %	- 2 %
Aspen Parkland	89	- 3 %	- 3 %	- 5 %	- 1 %
Moist Mixed Grassland	144	- 5 %	- 5 %	- 11 %	- 1 %
Mixed Grassland	150	- 8 %	- 8 %	- 14 %	- 3 %
Cypress Upland	NA	NA	NA	NA	NA

Table 31. Gross wetland area loss in the Saskatchewan portion of the PHJV study area, 1985 - 2001.

Net Wetland Change

Overall net wetland area change for the Saskatchewan portion of the PHJV from 1985 to 2001 equaled - 4 % or - 413 ha (Table 32). The Boreal Transition, Moist Mixed and Mixed Grassland ecoregions incurred the highest net wetland area losses at - 5%, - 5% and - 7% respectively.

Although confidence intervals do approach zero for some ecoregions, zero is not within the 95% confidence, therefore if the study was repeated it is expected that the result would be declining wetland area. The data suggest that wetland area in Saskatchewan is likely declining over time.

SK. ECOREGION	ABSOLUTE WETLAND AREA CHANGE (HA)	% WETLAND AREA CHANGE (POOLED DATA)	MEAN % NET WETLAND AREA CHANGE BY TRANSECT		
			Mean %	Lower 95% Confidence Boundary	Upper 95% Confidence Boundary
PHJV (overall)	- 413	- 4 %	- 4 %	- 7 %	- 3 %
Boreal Transition	- 65	- 5 %	- 5 %	- 10 %	- 2 %
Aspen Parkland	- 81	- 2 %	- 2 %	- 4 %	- 1 %
Moist Mixed Grassland	- 130	- 5 %	- 5 %	- 11 %	- 1 %
Mixed Grassland	- 136	- 7 %	- 7 %	- 13 %	- 2 %
Cypress Upland	NA	NA	NA	NA	NA

Table 32. Net wetland area change in the Saskatchewan portion of the PHJV study area, 1985 - 2001.

Wetland Area by Land use Type

The most common land use occurring within wetland basins in Saskatchewan in 1985 and 2001 was No Observable Use (Table 33). The proportion of wetland area utilized for annual cropping was highest in Saskatchewan wetlands at 25% of the total sampled wetland area. Grazing and drainage activities in wetlands both increased from 1985 to 2001. The large proportion of wetland area classified as having no observable use in Saskatchewan was due to favorable "point in time" water conditions but, also a result of numerous deep water habitats in the Boreal Transition and Aspen Parkland ecoregions.

	1985 Wetland area land use % Composition						2001 Wetland area land use % Composition					
Saskatchewan Ecoregion	No Use	Annual Crop	Haying	Grazing	Drainage	Other	No Use	Annual Crop	Haying	Grazing	Drainage	Other
PHJV (overall)	52 %	25 %	4 %	14 %	< 1%	5 %	52 %	25 %	4 %	16 %	1 %	4 %
Boreal Transition	58 %	14 %	5 %	17 %	< 1%	5 %	52 %	17 %	4 %	23 %	1 %	3 %
Aspen Parkland	63 %	17 %	4 %	10 %	< 1%	6 %	65 %	17 %	2 %	11 %	< 1%	5 %
Moist Mixed Grassland	44 %	35 %	5 %	11 %	< 1%	4 %	44 %	34 %	4 %	15 %	< 1%	4 %
Mixed Grassland	39 %	32 %	3 %	22 %	< 1%	5 %	40 %	31 %	6 %	22 %	< 1%	2 %

Table 33. Land use activities in wetland basins, a comparison between 1985 and 2001 total Saskatchewan PHJV wetland area compositions.

Wetland Size

Wetland size statistics for Saskatchewan are similar to those reported for the PHJV (Table 36). The mean size of lost wetland basins in Saskatchewan was 0.21 ha and the mean size of gained wetland basins was 0.14 ha.

SASKATCHEWAN ECOREGION	WETLAND BASIN SIZE 1985 (ha)		WETLAND BASIN SIZE 2001 (ha)		SIZE OF LOST WETLAND BASINS (ha)		SIZE OF GAINED WETLAND BASINS (ha)	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
PHJV (overall)	0.45	0.15	0.45	0.16	0.21	0.10	0.14	0.07
Boreal Transition	0.49	0.12	0.52	0.12	0.12	0.06	0.12	0.08
Aspen Parkland	0.37	0.16	0.37	0.15	0.21	0.15	0.11	0.06
Moist Mixed Grassland	0.47	0.18	0.46	0.18	0.27	0.10	0.16	0.08
Mixed Grassland	0.65	0.16	0.64	0.16	0.28	0.10	0.18	0.10

Table 36. Saskatchewan PHJV wetland basin size statistics.

Wetland Impacts

Overall, the total wetland area impacted by either partial drainage or limited filling in Saskatchewan increased from 5% in 1985 to 6% of the total wetland area sampled in 2001 (Table 37). The Aspen Parkland ecoregion of Saskatchewan had the highest impacted wetland area at 6% or 37% of the total impacted area in Saskatchewan. Wetland area impacts in the Aspen Parkland ecoregion of Saskatchewan accounted for 30% of the total impacted wetland area in the PHJV study. The area of wetlands recorded as partially impacted increased in all ecoregions of Saskatchewan from 1985 to 2006. Impacted wetland area in Saskatchewan represented 41% of the total wetland area classified as partially impacted in the PHJV study.

SK. ECOREGION	% TOTAL WETLAND AREA PD/PF 1985	% TOTAL WETLAND AREA PD/PF 2001
PHJV (overall)	5 % (457 ha)	6 % (526 ha)
Boreal Transition	6 % (86 ha)	7 % (97 ha)
Aspen Parkland	6 % (193 ha)	6 % (195 ha)
Moist Mixed Grassland	3 % (86 ha)	4 % (116 ha)
Mixed Grassland	5 % (92 ha)	6 % (118 ha)

Table 37. Total wetland area within the Saskatchewan portion of the PHJV study area impacted by partial drainage or limited filling in 1985 and 2001.

Uplands Habitats

Native habitats in Saskatchewan declined from 1985 to 2001 (Table 38). From 1985 to 2001, annual crops decreased in area and were largely replaced by Tame Pasture and Tame Hay. The Other land category increased by 22% or 1,045 ha between 1985 and 2001, largely as a result of rural infrastructure development and resource extraction activities.

Upland Cover Change

	Native Habitats				Non-Native Habitats				
SK. Ecoregion	Grassland	Low Shrub	Tall Shrub	Trees	Annual Crops	Tame Pasture	Tame Hay	Trees/ Shrubs	Other
PHJV (overall)	- 8 % - 651 ha	- 5 % - 48 ha	- 4 % - 27 ha	- 3 % - 151 ha	- 5 % - 4,724 ha	156 % + 2,615 ha	103 % + 2,369 ha	- 4 % - 15 ha	22 % + 1,045 ha
Boreal Transition	- 12 % - 86 ha	- 17 % - 6 ha	- 12 % - 24 ha	- 2 % - 39 ha	- 12 % - 1, 127 ha	176 % + 563 ha	175 % + 933 ha	- 15 % - 12 ha	- 17 % - 137 ha
Aspen Parkland	- 10 % - 150 ha	- 8 % - 11 ha	- 5 % - 16 ha	- 5 % - 98 ha	- 5 % - 1,136 ha	149 % + 644 ha	38 % + 341 ha	0 %	38 % 507 ha
Moist Mixed Grassland	- 7 % - 181 ha	- 7 % - 25 ha	17 % + 9 ha	- 4 % - 15 ha	- 4 % - 1,078 ha	159 % + 525 ha	75 % + 449 ha	- 5 % - 6 ha	31 % + 453 ha
Mixed Grassland	- 7 % - 234 ha	- 2 % - 6 ha	19 % + 4 ha	0 %	- 5 % - 1,383 ha	150 % + 883 ha	251 % + 647 ha	4 % + 4 ha	18 % + 222 ha

Table 38. Relative percentage change (1985 - 2001) in upland cover category in the Saskatchewan portion of the PHJV study area.

Native Grassland Change

Overall, gross native grassland area losses in Saskatchewan accounted for 31% of the total native grassland area lost on all habitat monitoring transects within the PHJV. The mean area lost per transect in Saskatchewan equaled - 9% (95% CI -12% to -6%). Native grassland area losses in the Mixed Grassland ecoregion of Saskatchewan accounted for 50% of the total native grassland area losses in Saskatchewan.

SK. LANDSCAPE	ABSOLUTE AREA GROSS LOSS	GROSS NATIVE GRASS LOSS %	Mean	95 % CONFIDENCE INTERVAL	
				LOWER	UPPER
PHJV	- 772 ha	- 9 %	- 9 %	- 12 %	- 6 %
Boreal Transition	- 124 ha	- 16 %	- 17 %	- 30 %	- 8 %
Aspen Parkland	- 202 ha	- 13 %	- 13 %	- 18 %	- 8 %
Moist Mixed Grassland	- 211 ha	- 8 %	- 8 %	- 16 %	- 4 %
Mixed Grassland	- 383 ha	- 6 %	- 6 %	- 11 %	- 3 %

Table 39. Gross native grassland area loss within the Saskatchewan portion of the PHJV study area 1985 - 2001.

MANITOBA

Sample Size

A total of 27 transects sampled 42,186 ha or 0.55% of the PHJV portion of Manitoba (Table 40). The Lake Manitoba Plain ecoregion was under sampled and the Interlake Plain ecoregion was sampled but, the single monitoring transect was located outside of the PHJV delivery area (for the purposes of this report the single transect was considered representative of the PHJV portion of the Interlake Plain ecoregion).

Ecoregions	# of Transects	% of Ecoregion Area Sampled	Ecoregion composition within the MB PHJV
Boreal Transition	2	1.05 %	3.96 %
Aspen Parkland	16	0.71 %	45.49 %
Interlake Plain	1*	0.45 %	4.68 %
Lake Manitoba Plain	7	0.34 %	42.92 %
Southwest Manitoba Uplands	1	0.74 %	2.85 %
Total Manitoba PHJV Area	27	0.55 %	100 %

Table 40. Distribution of habitat monitoring transects by ecoregion within the Manitoba portion of the PHJV study area.

Wetlands

Gross Wetland Loss

Overall gross wetland area loss totals for all 27 habitat monitoring transects in Manitoba between 1985 and 2001 totaled 166 ha or a - 5% reduction in total wetland area (Table 41). The mean gross loss per transect was - 5%. Gross wetland area losses in the Aspen Parkland ecoregion of Manitoba accounted for 54% of the total gross wetland area lost in the PHJV portion of Manitoba. Many of the transects in Manitoba showed signs of significant historical drainage (pre 1985 baseline) and in some cases the sampled area was considered "drained out". In these drained out landscapes small absolute wetland area losses resulted in larger percentage (relative) changes i.e. Lake Manitoba Plain.

MANITOBA ECOREGION	ABSOLUTE WETLAND AREA LOST (HA)	% WETLAND AREA LOST (POOLED DATA)	MEAN % GROSS WETLAND AREA LOSS BY TRANSECT		
			Mean %	Lower 95% Confidence Boundary	Upper 95% Confidence Boundary
PHJV (overall)	- 166	- 5 %	- 5%	- 7 %	- 3 %
Boreal Transition	- 7	- 2 %	- 6 %	NA	NA
Aspen Parkland	- 89	- 3 %	- 3 %	- 5 %	- 1 %
Interlake Plain	- 21	- 24 %	NA	NA	NA
Lake Manitoba Plain	- 21	- 4 %	- 5 %	- 13 %	- 2 %
Southwest Manitoba Uplands	- 10	- 11 %	NA	NA	NA

Table 41. Gross wetland area loss in the Manitoba portion of the PHJV study area, 1985 - 2001.

Net Wetland Change

Net wetland area losses in Manitoba accounted for 15% of the total net wetland area lost in the entire PHJV (Table 42). The Lake Manitoba Plain ecoregion of Manitoba had the lowest net wetland area loss in the province. Wetland gains in the Lake Manitoba Plain ecoregion of Manitoba were the result of the construction of two large sewage treatment dugouts, thus offsetting wetland area losses in this ecoregion.

MANITOBA ECOREGION	ABSOLUTE WETLAND AREA CHANGE (HA)	% WETLAND AREA CHANGE (POOLED DATA)	MEAN % NET WETLAND AREA CHANGE BY TRANSECT		
			Mean %	Lower 95% Confidence Boundary	Upper 95% Confidence Boundary
PHJV (overall)	- 127	- 4 %	- 4%	- 6 %	- 2 %
Boreal Transition	- 7	- 2 %	- 6 %	NA	NA
Aspen Parkland	- 89	- 3 %	- 3 %	- 5 %	- 1 %
Interlake Plain	- 20	- 23 %	NA	NA	NA
Lake Manitoba Plain	- 9	- 2 %	- 2 %	- 7 %	+ 4 %
Southwest Manitoba Uplands	- 9	- 10 %	NA	NA	NA

Table 42. Net wetland area change in the Manitoba portion of the PHJV study area, 1985 - 2001.

Wetland Area by Land use Type

Overall, the dominant wetland area use recorded for Manitoba transects was No Use (Table 43). Grazing of wetland basins was the second most prevalent wetland area use occurring in 22% of the total wetland area in 1985 and 2001. The Lake Manitoba Plain and South West Manitoba Uplands ecoregions of Manitoba recorded the highest proportions of total wetland area being grazed both in 1985 and 2001.

	1985 Wetland area land use % Composition						2001 Wetland area land use % Composition					
Manitoba Ecoregion	No Use	Annual Crop	Haying	Grazing	Drainage	Other	No Use	Annual Crop	Haying	Grazing	Drainage	Other
PHJV (overall)	52 %	11 %	10 %	22 %	2 %	3 %	55 %	8 %	9 %	22 %	3 %	3 %
Boreal Transition	62 %	9 %	9 %	16 %	<1 %	4 %	67 %	9 %	5 %	16 %	<1 %	3 %
Aspen Parkland	56 %	12 %	10 %	18 %	<1 %	3 %	60 %	9 %	9 %	18 %	1 %	3 %
Lake Manitoba Plain	32 %	7 %	9 %	40 %	8 %	4 %	37 %	4 %	10 %	35 %	10 %	4 %
South West Manitoba Uplands	40 %	9 %	9 %	40 %	1 %	1%	38 %	10 %	< 1%	48 %	2 %	1 %
Interlake Plain	31 %	7 %	34 %	8 %	17 %	4 %	33 %	3 %	29 %	8 %	21 %	7 %

Table 43. Land use activities in wetland basins, a comparison between 1985 and 2001 total Manitoba PHJV wetland area compositions.

Wetland Area by Cover Type

The dominant cover recorded for sampled wetlands in Manitoba was Grass and Sedge (Table 44), equaling 65% (1985) and 62% (2001) of total wetland area sampled. Artificial wetland type cover increased from 1% to 2% from 1985 to 2001, largely as a result of artificial wetland creation in the Lake Manitoba Plain ecoregion. The lone transect in the Interlake Plain ecoregion had a large increase in the proportion of cultivated wetland cover, increasing from 11% to 34% (1985 - 2001) of total wetland area sampled.

	1985 Wetland Cover Type % Composition							2001 Wetland Cover Type % Composition						
Manitoba Ecoregion	Cultivated	Wooded	Grass Sedge	Bulrush Cattail	Open Water	Artificial	Other	Cultivated	Wooded	Grass Sedge	Bulrush Cattail	Open Water	Artificial	Other
PHJV (overall)	11%	8 %	65%	9 %	6 %	1 %	1 %	9%	9 %	62%	10%	8%	2 %	1 %
Boreal Transition	9%	3%	52%	9 %	26%	<1%	<1%	10%	5%	49%	9 %	27%	<1%	<1%
Aspen Parkland	12%	9%	65%	8 %	4%	1 %	<1%	10%	11%	62%	8 %	7%	1 %	<1%
Lake Manitoba Plain	9 %	5 %	67%	13%	2 %	3 %	2 %	7 %	5 %	67%	12%	2 %	4 %	3 %
South West Manitoba Uplands	9 %	6 %	53%	15%	16%	1 %	1 %	11%	6 %	44%	18%	17%	1 %	3 %
Interlake Plain	11%	5 %	74%	5%	<1%	<1%	5 %	34%	5 %	46%	8 %	<1%	1 %	6 %

Table 44. Wetland area composition by cover type as a percentage of total wetland area within the Manitoba portion of the PHJV study area, 1985 - 2001.

Wetland Numbers

Net wetland basin losses in Manitoba equaled - 479 or a net loss of - 7% from 1985 to 2001 (Table 45). Wetland basin losses in the Aspen Parkland ecoregion of Manitoba accounted for 69% of total gross wetland basin losses in the province. Overall the gross loss of 479 wetland basins in Manitoba represented 20% of the total wetland basins lost in the entire PHJV study area. Net wetland area loss was lowest in the Lake Manitoba Plain at - 5%.

MB. Ecoregion	Gross Loss % (#'s)	Gross Gain % (#'s)	Net Change % (#'s)
PHJV (overall)	- 8 % (- 479)	1 % (58)	- 7 % (- 421)
Boreal Transition	- 6 % (- 39)	0 % (0)	- 6 % (- 39)
Aspen Parkland	- 8 % (- 332)	1 % (34)	- 7 % (- 298)
Lake Manitoba Plain	- 8 % (- 76)	2 % (22)	- 5 % (- 54)
South West Manitoba Uplands	- 10 % (- 9)	0 % (0)	- 10 % (- 9)
Interlake Plain	- 20 % (-23)	2 % (2)	- 19 % (- 21)

Table 45. Percent change in wetland basin numbers in the Manitoba portion of the PHJV study area from 1985 - 2001.

Wetland Size

Wetland size statistics for Manitoba were similar to the overall PHJV size statistics (Table 46). The mean size of lost wetland basins in Manitoba was 0.20 ha and the mean size of wetland basins gained was 0.23 ha.

MANITOBA LANDSCAPE	WETLAND BASIN SIZE 1985 (ha)		WETLAND BASIN SIZE 2001 (ha)		SIZE OF LOST WETLAND BASINS (ha)		SIZE OF GAINED WETLAND BASINS (ha)	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
PHJV (overall)	0.52	0.16	0.53	0.17	0.20	0.10	0.23	0.11
Boreal Transition	0.44	0.10	0.46	0.10	0.13	0.06	NA	NA
Aspen Parkland	0.51	0.18	0.52	0.18	0.19	0.10	0.22	0.08
Lake Manitoba Plain	0.56	0.14	0.58	0.15	0.20	0.11	0.23	0.14
South West Manitoba Uplands	1.02	0.18	1.02	0.21	0.47	0.09	NA	NA
Interlake Plain	0.78	0.15	0.73	0.15	0.38	0.15	0.40	0.39

Table 46. Manitoba PHJV wetland basin size statistics.

Wetland Impacts

The area of wetlands impacted by partial drainage/filling activities increased from 7% in 1985 to 9% of all wetland area in 2001 (Table 47). Partial drainage/filling activities were highest in the Aspen Parkland ecoregion of Manitoba equaling 68% of total impacted wetland area in both 1985 and 2001.

MB. ECOREGION	% TOTAL WETLAND AREA PD/PF 1985	% TOTAL WETLAND AREA PD/PF 2001
PHJV (overall)	7 % (222 ha)	9 % (280 ha)
Boreal Transition	3 % (10 ha)	4 % (12 ha)
Aspen Parkland	7 % (151 ha)	9 % (190 ha)
Lake Manitoba Plain	8 % (45 ha)	11 % (62 ha)
South West Manitoba Uplands	2 % (2 ha)	1 % (1 ha)
Interlake Plain	17 % (15 ha)	21 % (14 ha)

Table 47. Total wetland area within the Manitoba portion of the PHJV study area impacted by partial drainage or limited filling in 1985 and 2001.

Uplands Habitats

Upland Cover Change

With the exception of native shrub habitats, native upland habitats declined in Manitoba (Table 48). The area of native treed habitats decreased in all ecoregions with the exception of the South West Manitoba Uplands. Annual crops decreased, while Tame Pasture and Tame Hay cover types increased in area from 1985 to 2001.

	Native Habitats				Non-Native Habitats				
Manitoba Ecoregion	Grassland	Low Shrub	Tall Shrub	Trees	Annual Crops	Tame Pasture	Tame Hay	Trees/ Shrubs	Other
PHJV (overall)	- 14 % - 316 ha	0 %	4 % + 16 ha	- 4 % - 107 ha	- 11 % - 3,048 ha	113 % + 1,028 ha	71 % + 1,656 ha	- 7 % - 14 ha	38 % + 921 ha
Boreal Transition	- 5 % - 4 ha	- 1 % - 16 ha	- 6 % - 4 ha	- 13 % - 34 ha	- 7 % - 137 ha	17 % + 397 ha	81 % + 128 ha	0 % 0 ha	19 % + 43 ha
Aspen Parkland	- 17 % - 240 ha	11 % + 16 ha	35 % + 47 ha	- 4 % - 37 ha	- 12 % - 2,115 ha	263 % + 902 ha	108 % + 961 ha	- 22 % - 23 ha	41 % + 580 ha
Interlake Plain	- 39 % - 23 ha	- 24 % - 24 ha	- 18 % - 5 ha	- 12 % - 21 ha	- 24 % - 183 ha	+ 714 % + 107 ha	29 % + 110 ha	+ 110 % + 9 ha	37 % + 31 ha
South West Manitoba Uplands	- 12 % - 7 ha	- 9 % - 0.1 ha	- 57 % - 7 ha	+ 18 % + 6 ha	- 2 % - 19 ha	95 % + 43 ha	- 8 % - 12 ha	0 % 0 ha	13 % + 6 ha
Lake Manitoba Plain	- 6 % - 41 ha	- 19 % - 9 ha	- 11 % - 15 ha	- 2 % - 21 ha	- 9 % - 594 ha	- 8 % - 42 ha	64 % + 468 ha	0 % 0 ha	39 % + 262 ha

Table 48. Relative percentage change (1985 - 2001) in upland cover category in the Manitoba portion of the PHJV study area .

Native Grassland Change

Native grassland area losses in Manitoba represented 13% of all gross native grassland area losses in the entire PHJV study area. The majority of gross native grassland area losses occurred in the Aspen Parkland ecoregion of Manitoba equaling 69% of the total native grassland area lost in Manitoba from 1985 to 2001 (Table 49).

MB. ECOREGION	ABSOLUTE AREA GROSS LOSS	GROSS NATIVE GRASS LOSS %	Mean	95 % CONFIDENCE INTERVAL	
				LOWER	UPPER
PHJV (overall)	- 332 ha	- 13 %	- 14 %	- 18 %	- 10 %
Boreal Transition	- 12 ha	- 12 %	- 14 %	NA	NA
Aspen Parkland	- 222 ha	- 14 %	- 15 %	- 19 %	- 11 %
Lake Manitoba Plain	- 64 ha	- 9 %	- 11 %	- 20 %	- 6 %
South West Manitoba Uplands	- 9 ha	- 13 %	NA	NA	NA
Interlake Plain	- 26 ha	- 33 %	NA	NA	NA

Table 49. Gross native grassland area loss within the Manitoba portion of the PHJV study area 1985 - 2001.

DISCUSSION

WETLANDS

Prairie wetland habitat continues to be lost and degraded in all ecoregions of the PHJV. Overall, in the PHJV study area total wetland area measured on habitat monitoring transects was reduced by 5 % from 1985 to 2001. In the same time period the total number of wetland basins monitored on transects decreased by 5 %. Wetland area classified as partially impacted (PD or LF) increased from 6 % to 7 % of total wetland area measured on transects from 1985 to 2001. Overall the data for the entire PHJV study area suggest that wetland loss continues, and there is little evidence to suggest that the rate of wetland loss has slowed over the past 50 - 70 years, except perhaps in parts of Manitoba which may be the result of areas being drained out. Wetland impact numbers and general observations suggest that wetland area/basins will continue to be lost.

To better understand the status and trends of wetlands for the various ecoregions making up the study area it is necessary to collate all aspects of wetland change into a complete picture. By evaluating wetland number loss rates, wetland area loss rates and wetland impacts in conjunction with total wetland area we can arrive at a clearer understanding as to the nature of wetland loss within the PHJV. Wetland number loss rates are an indication as to the frequency of activities targeting wetland basins for draining/removal. Wetland area loss rates provide an indication as to the area of wetland lost (includes stats for entire or partial basins) and when this loss rate is represented as a percentage (relative to baseline total area) one must take into account the total wetland area and absolute wetland area lost as these data are core to interpreting percentage results. The following section summarizes and interprets the various wetland data presented in this report for the purpose of arriving at a more complete picture of wetland status and trends by ecoregion.

Boreal Transition

The Boreal Transition ecoregion (considered as under sampled) showed a net decline in wetland area of 4% and a net decrease in wetland numbers of 9% (17% of total net wetland numbers lost in the PHJV) from 1985 to 2001. The mean wetland area per transect equaled 10% of total sampled area, and wetland estimates for this ecoregion suggest that wetlands in the PHJV portion of this ecoregion may represent approximately 22% of the total wetland area expected to occur within the PHJV. The make up of lost wetland habitat in this ecoregion was primarily of small wetlands with a mean size of 0.12 ha. Having large total amounts of wetland area in this ecoregion resulted in a reduced magnitude of percentage wetland area change. However when considering lost wetland basin totals it is likely that the occurrence of wetland loss in this ecoregion is having a greater effect on the wetland resources of this ecoregion then is suggested by the wetland area loss data. In 2001 the total area of wetland classified as partially impacted was 8 % (representing 12% of the total impacted wetland area in the PHJV) of the total wetland area further suggesting that wetlands in this ecoregion are at a potentially heightened risk of further degradation or loss. It can be concluded that wetland habitat in

the Boreal Transition area of the PHJV is declining, although percentage wetland area lost is lower in relation to other ecoregions, wetland basin loss data suggests that wetland loss in this ecoregion is likely occurring with increased frequency.

Aspen Parkland

The Aspen Parkland ecoregion had a mean percent wetland area of 10% or an estimated 38% of the total wetland area in the PHJV, making this ecoregion number one in wetland area. Overall, from 1985 - 2001, total net wetland area decreased by 4% and total net wetland numbers decreased by 5%. Wetland area losses represented 46% of all wetland area lost in the PHJV, and wetland basin (number) losses represented 49% of the total wetland basins lost in the entire PHJV study. Wetland impacts in this ecoregion represented 50% of the total wetland area classified as partially (PD or LF) impacted in the PHJV study and equaled 8% of the total wetland area sampled in the Aspen Parkland ecoregion. Overall the data suggest the Aspen Parkland ecoregion was the dominant driver of overall PHJV wetland loss data. The data suggest that substantial change in wetland habitat has occurred from 1985 to 2001 in the Aspen Parkland ecoregion of the PHJV. As it is suspected that partial impacts ultimately result in wetland loss then it is then suspected that wetland numbers and wetland area will continue to be lost in this region.

Moist Mixed Grassland

Wetland area lost in the Moist Mixed Grassland (MMG) ecoregion from 1985 - 2001 represented 17% of total lost wetland area in the PHJV study. Net change in wetland numbers in the MMG ecoregion equaled 12% of the total wetland numbers lost in the PHJV study. Overall the mean area of wetlands found on transects in the MMG equaled 8% and it is estimated that wetland area in this ecoregion represents approximately 17% of the total wetland area in the PHJV. Partially impacted wetland area in the MMG equaled 6% of total wetland area sampled in the ecoregion representing 17% of the total impacted wetland area in the entire PHJV study. Total net loss in both wetland area and basins equaled 4% thus suggesting no identifiable disparity between wetland number loss and wetland area loss. Again, partial wetland impact data for this ecoregion is suggestive of a continued threat to wetland area.

Mixed Grassland

Net wetland area losses in the Mixed Grassland ecoregion equaled 7% and total lost area represented 21% of all wetland area lost in the PHJV from 1985 - 2001. Wetland number losses for the ecoregion equaled 7% and represented 15% of total wetland numbers lost in the PHJV. Overall the mean total area of wetlands sampled per transects equaled 6% of the entire area sampled in the ecoregion. It is estimated that wetland area in the Mixed Grassland ecoregion represents approximately 18% of the total wetland area expected to occur in the PHJV study area. The lower overall wetland area totals for this ecoregion may be playing a role in the magnitude of wetland loss reported for this ecoregion,

however, the loss rate for wetland numbers is suggestive that wetland loss in this ecoregion may be at an elevated level when compared to some ecoregions. Partial drainage results for the Mixed Grassland ecoregion equal 6% of total wetland area sampled and represent 11% of total wetland area in the PHJV study classified as partially impacted. Again this 6% impacted wetland area is considered at continued risk of being lost.

Fescue Grassland

Overall wetland area losses in the Fescue Grassland represented 2% of the total net wetland area lost in the PHJV. In total 3% of all lost wetland basins in the PHJV occurred in the Fescue Grassland ecoregion. It is estimated that the total wetland area in the Fescue Grassland represents approximately 2% of the approximate total wetland area in the PHJV. Wetland area partial impacts in the Fescue grassland represent 3% of the total impacted area in the PHJV. Overall, the Fescue Grassland does not appear to be being impacted at an elevated rate in comparison with other ecoregions. However, the trend in wetland habitat is declining for this ecoregion.

Lake Manitoba Plain

Net wetland area losses in the Lake Manitoba Plain (LMP) ecoregion equaled 1% of the total wetland area lost in the PHJV. Total net wetland number loss in the LMP ecoregion equaled - 5% and represented 0.2% of all net wetland basin losses in the PHJV from 1985 to 2001. It is estimated that total wetland area in the LMP ecoregion represents 3% of the total estimated wetland area in the PHJV study area. Wetland area considered as partially impacted in the LMP equaled 11% in 2001, and represented 5% of the total wetland area classified as partially impacted in the PHJV. The overall trend for the LMP ecoregion was that of diminishing wetland area. The magnitude of loss and wetland area impacted by partial impacts is elevated largely as the result of large amounts of suspected historical wetland loss (as evidenced in the baseline aerial photography) in this ecoregion prior to the establishment of the 1985 baseline. It is clear that wetlands in this ecoregion are likely to continue to be lost due to the further development of drainage networks.

Sample sizes in the Cypress Upland, South West Manitoba Uplands, and the Interlake Plain ecoregions of the PHJV are considered as inadequate for detailed analysis. However, there is some evidence to suggest that wetland area and numbers in these ecoregions may also be declining.

Determining wetland loss is very subjective and relies heavily on the consistent adherence to the established definition of wetland loss. This project focused on the measurable anthropogenic sources of wetland loss and it is recognized that the total wetland loss issue is likely more complex involving precipitation cycles, global warming, land use change, wetland function degradation, and numerous other potential sources of wetland loss.

The permanence of any one wetland loss activity captured in this analysis varies greatly. The fundamental determinant of the permanence of most wetland area/basin losses is annual surface water conditions. It is expected that in highest water years many wetland drainages and even filling impacts would be overpowered, thus allowing for a rebound of a portion of these lost wetlands during the high water years. As an example wetlands with permanent drainage (considered as lost wetland area) could rebound from drained habitat to degraded habitat in high water years, obliterated basins within cultivated fields could reach sheet water or possibly ephemeral status in high water years. However, unless actual restoration activities take place, it is highly unlikely that wetlands classified as lost in the dataset would return to intact status, these wetlands are physically altered to the point that function and form appear permanently impaired.

The analysis did not consider the restorative potential of lost wetland area/basins. As a general guide when interpreting the data from a wetland restoration perspective it is expected that wetlands with partial impacts (PD or LF) are likely more conducive to wetland restoration efforts. However, it is expected that a proportion of lost wetland area/basins may also be good candidates for restoration.

Wetland gains are difficult to assess. Wetland gains recorded in this study were dominated by surface water management activities and included things like drainage ditches, dugouts, sewage treatment plants, drainage retention ponds and reservoirs. Very rarely was a wetland gain considered as wetland habitat expansion, and when this did occur it was predominantly the result of basin consolidation and thus wetlands were lost (drained) to achieve this. As this study did not address wetland function directly, it is unclear as to the value of measured wetland gains to wildlife. It is assumed that wetland gains presented in this report have limited functional potential as wildlife habitat.

The amount of total cultivated wetland area varied amongst ecoregions ranging from 9 % to 30 % of total wetland area sampled. As evidenced from the multiple year air photo review it is clear that many wetlands are in a perpetual state of cultivation and even in high water years a portion of these wetlands do not revert back to an uncultivated state. The relationship between cultivation and wetlands appears to be somewhat opportunistic. In dry years wetlands can easily be incorporated into the greater farmed area, however, in high water years a portion of these cultivated wetlands become no longer accessible and thus begin to revert back to potentially a functional wetland. It is important to note that cultivation alone was not a determining factor in wetland loss classification. It is suspected that cultivation of wetlands does degrade wetland function for wildlife but, this limited reduction in function does not fit with the definition of permanent wetland loss.

This study was not designed to measure wetland status and trends at localized scales rather it provides a bigger picture evaluation of status and trends at the ecoregional level. The overall intent of this program is to provide conservation managers with a picture of current status and trends for the purpose of feeding into an adaptive management strategy to wetland habitat conservation. It is important that when considering the results of this study, regional and local efforts to monitor wetlands also be considered as this would

provide conservation managers with a more complete picture of wetland status and trends within the PHJV.

The data suggests that wetland loss is occurring in every ecoregion within the PHJV. The amounts of wetland area or basins lost varies amongst transects and includes losses ranging from large scale targeted wetland destruction activities too incidental wetland loss due to various land use activities (i.e. road construction, resource extraction, urban expansion). Some transects are untouched by wetland loss showing signs of never having had targeted drainage or filling activities while other transects showed signs of significant historical drainage that has since continued resulting in the transect being largely drained out (nothing left to loose). Documented targeted wetland drainage/filling operations often occur in "Hot Spots" or areas where drainage has occurred in the past and therefore has an established drainage infrastructure that can be expanded.

Overall, the trend in wetland habitat from 1985 to 2001 was that of decreasing wetland area and wetland numbers. The magnitude of this loss is variable between ecoregions, but, the data suggest wetland habitat is not stable and is likely to continue to decline. The larger issue appears to be that of wetland function. Wetland loss is difficult to determine and thus we rely on very prominent indicators that directly impact wetland basins through physical modifications and the methods utilized are not capable of directly measuring wetland function. More work is required to better understand what constitutes a wetland loss.

This study demonstrates that wetlands continue to be lost with in the PHJV study area. However, the study also documents an interaction of land use activities with wetlands habitat that does not (under this studies definition) directly result in the loss of wetland area. It is clear that the effects of different potential wetland impacts, prairie hydrologic cycles, and targeted wetland removals need to be better understood if appropriate decisions are to be made around conserving these unique habitats.

UPLANDS

The dominant land cover within the PHJV was cultivated land equaling 55% of the total farm area reported in the 2001 AG census data analysis and 66% of the total upland area in the habitat monitoring transects in 2001. The largest shift in upland land composition was the increase in tame grass (including tame hay and tame pasture) resulting in an estimate of 16% of total upland area being utilized for tame grass production by 2001. Summer fallow continued to decline from 1985 to 2001 on both habitat monitoring transects and AG census data.

Overall, analysis of Agricultural (AG) census data and upland results on the habitat monitoring transects shows a decline in natural upland habitats from 1985 to 2001. Habitat lands in the AG census dataset are included in the All Other Land category and thus are mixed with infrastructure development, and various other activities not related to habitats. The All Other Land category in the AG census reports a decline in All Other Land category from 1986 to 2001 which could be interpreted as a decline in habitat lands, however, this category is not a direct measurement of habitat and thus the trend can not be concluded with certainty. The habitat monitoring transects show declining native habitats in all ecoregions of the PHJV. The annual loss rate of native grassland on habitat monitoring transects from 1985 to 2001 equaled 0.6% resulting in a reduction in native grassland from 10% to 9% of total upland land area surveyed.

The magnitude of native grassland area lost from 1985 to 2001 is difficult to pinpoint. Classifying native grassland is difficult for an air photo based methodology due to the definition of native grass and the variance in the signature of native grass across ecoregions. Another major potential source of error in detecting change in native grassland area is confusion with tame grass; this problem became magnified due to the substantial increase of tame grass across ecoregions between 1985 and 2001. Overall, analysis of habitat monitoring transects suggest that large blocks of native grassland remained stable to slightly declining from 1985 to 2001 and the majority native grassland losses occurred with in landscapes dominated by cultivation. It can be concluded that the majority of native grassland losses on habitat monitoring transects are the result of "squaring the field" which is essentially the removal of small remnant pieces of grassland habitat within areas dominated by cultivation.

In conclusion, native upland habitats are declining in all surveyed ecoregions. The magnitude of grassland loss can not be stated with certainty but, there is a clear trend of declining native grassland habitat in cultivation dominated landscapes from 1985 to 2001.

CURRENT WORK

In the spring of 2004 and 2005 a total of 81 new habitat monitoring transects were established across the PHJV study area, and included samples in the Peace Lowland ecoregion (Table 50). Transects were selected using the same methods as used in the original transect establishment. The intent was to complete previously unsampled habitat sub regions establishing baseline for future change detection. False color infrared aerial photography at a scale of 1:20000 was captured for all 81 transects. The aerial photography has since been digitized and classified wetland polygons captured for all 81 transects. Ground verification of classified wetland polygons and upland habitat mapping is currently underway and transects are expected to be "online" by the spring of 2009.

Ecoregions	# of Transects	% of Ecoregion Area Sampled Previous	% of Ecoregion Area Sampled Expanded Sample
Boreal Transition	**32**	**0.20 %**	**0.50 %**
Aspen Parkland	**73**	**0.53 %**	**0.66 %**
Moist Mixed Grassland	**43**	**0.52 %**	**0.66 %**
Mixed Grassland	**47**	**0.35 %**	**0.54 %**
Fescue Grassland	**6**	**0.58 %**	**0.58 %**
Cypress Upland	**2**	**0.19 %**	**0.40 %**
Lake Manitoba Plain	**10**	**0.34 %**	**0.51 %**
SW Manitoba Uplands	**1**	**0.74 %**	**0.74 %**
Interlake Plain	**2**	**0.45 %**	**0.45 %**
Peace Lowland	**18**	**0.00 %**	**0.46 %**
Total Area PHJV	***234***	***0.41 %***	***0.57 %***

Table 50. A comparison between original sample distribution and expanded sample distribution within the PHJV study area.

Overall with the addition of 81 transects to the previous 153 transects, the total number of transects equals 234 (Figure 26). This sample expansion brings the total quarter sections sampled up to 5,500 or 360,450 ha. The Peace Lowland area had 18 transects established in 2004 to form the baseline measurement for this previously unsampled area. An additional transect was established in the Interlake Plain ecoregion of Manitoba and thus takes the place of the Interlake Plain sample located outside of the PHJV boundary. In

total, the sampled area has increased from 0.41% of the PHJV (excluding the Peace Parkland) to 0.57% of the entire PHJV including the Peace Parkland ecoregion.

The additional sample was not designed as a sample expansion rather this sample establishment was meant to meet the original intended minimal sampling regime established in 1985. Depending on the needs of the PHJV partners it may be required that additional sample be established to better meet the needs of all wetland conservation partners.

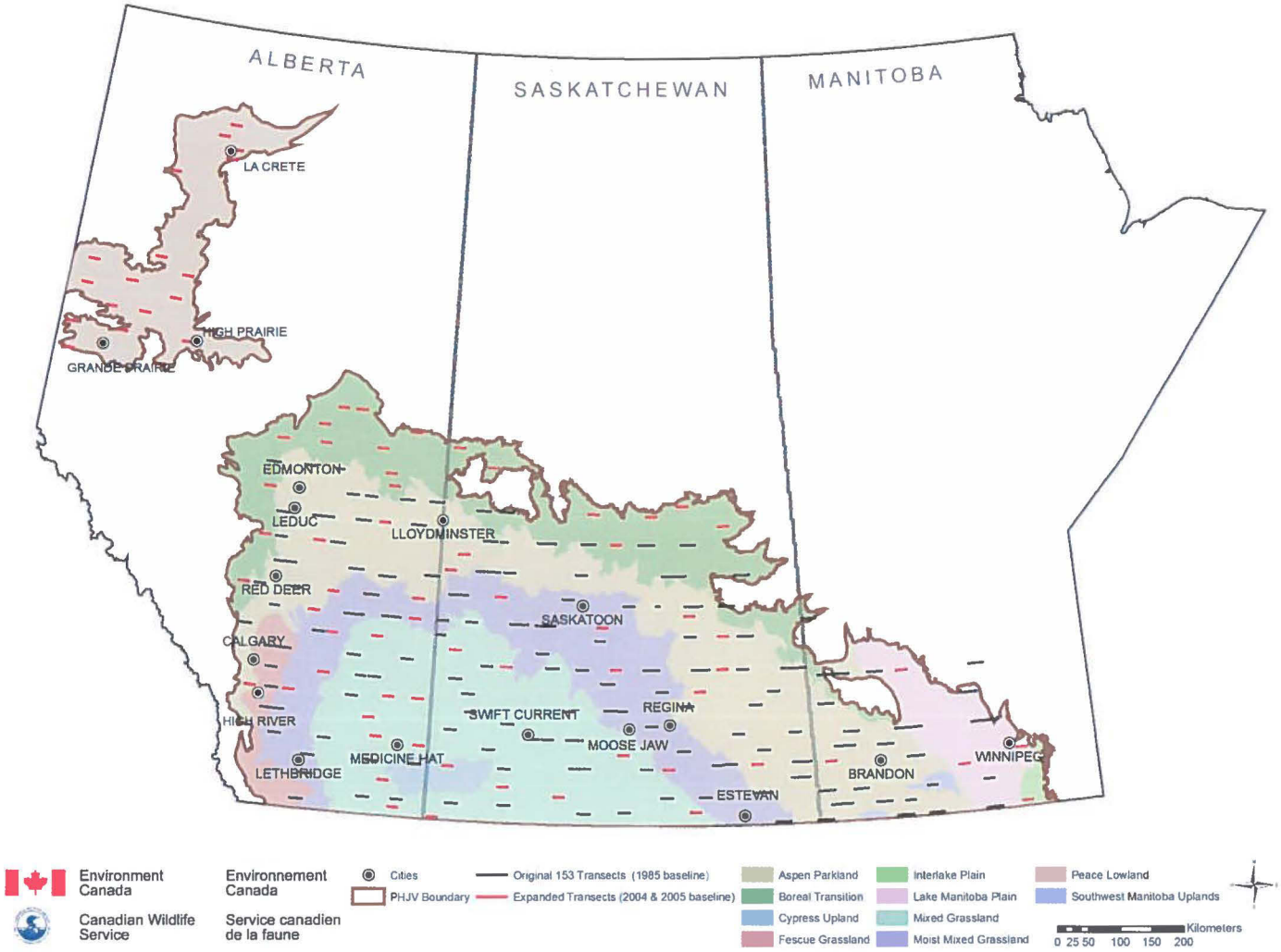


Figure 26 Overview of entire sampling network showing all 234 habitat monitoring transects.

MANAGEMENT RECOMMENDATIONS

1. Wetlands resource managers require a system to provide reliable information about wetland status, threats and trends over time. A one time "wall to wall" inventory or mapping initiative although useful for some purposes does not provide an effective tool for monitoring wetland change through time unless it can be periodically repeated at intervals useful to wetland resource managers. Environment Canada should continue to remain committed to long-term habitat monitoring.

2. The components of wetland change that are required to be targeted for change detection need to be clearly identified. The definition of what constitutes wetland loss provided in this report is suitable for the methods of change detection applied; however, the PHJV should continue to investigate the potential types of wetland loss that may be occurring, including the loss of wetland function. Utilizing the habitat monitoring dataset for sub sampling wetlands for functional assessment on an annual basis would provide a method for in-depth tracking of wetland degradation overtime. An annual sub sampling of wetlands for functional assessment could be conducted during annual waterfowl surveys. Wetland functional assessment may provide an aspect of monitoring that could begin to address climate change issues with regards to prairie wetland habitats.

3. Prairie Habitat Joint Venture's Waterfowl Working Group (WWG) Habitat sub group is currently investigating the statistical rigor of the sample. The results of this analysis will help to form the basis for the development of a habitat monitoring plan for the PHJV. It is clear that the needs of habitat managers in the PHJV vary, thus it is critical that the overall habitat monitoring plan should include options for meeting regional, provincial and even local status and trends needs. This should include options for strategic "wall to wall" mapping or expanded sampling for areas that are experiencing rapid change "hot spots" or as follow-up for areas that have experienced significant change.

4. PHJV partners require ongoing and current information regarding wetland status and trends. The WWG will recommend an appropriate update cycle for this monitoring dataset. As the habitat monitoring program and the Agricultural Census data compliment each other it is recommend that the habitat monitoring dataset be updated on the same cycle as the Agricultural Census, every five years.

5. Wetland gains are difficult to assess. This report documents some gains in wetland area and numbers, however, the actual value of these wetland gains to wildlife is suspect. The PHJV should clearly communicate what wetland gains are acceptable. No-net loss goals for wetland area or numbers could result in the creation of habitat with low habitat value as compensation for the loss of high

value habitat resulting in a net reduction in habitat value. This situation should be avoided by all partners possibly through the emphasis on wetland function assessment.

6. Results presented in this report show that wetland habitat is declining and it appears as though the annual rate of wetland loss is set to continue. Environment Canada and its PHJV partners should continue to work towards mitigating this loss of wetland resources.

7. Natural upland habitat monitoring is being partially met through this program. However, additional datasets or sampling variations maybe required to adequately estimate natural upland habitat trends in the PHJV.

8. Data presented in this report show that native grassland habitats are continuing to decline in area in the PHJV. Environment Canada and its PHJV partners should continue to work towards conserving this important wildlife habitat.

9. The PHJV partners should continue to work with land users who interact with wetlands as part of their business functions to come up with rational solutions to potential wetland loss situations. This report demonstrates that there is much to learn about the complex issue of wetland loss. The PHJV and its partners should demonstrate consistency in its understanding and communication of what wetland loss is. Fore if we convey inconsistent, unrealistic, or incomplete messages around wetland habitat change then we may damage the wetland conservation cause.

10. The current monitoring program should continue to explore methods/technologies which would allow for achieving increased sample size and sample distribution in a fiscally efficient manner. Future updates should rely primarily on stereo interpretable imagery that best captures targeted wetland change characteristics. Future baseline collections and updates should further refine efforts to accurately classify and track changes of native grassland; this will likely also require additional sampling (distribution and sample size) to achieve adequate native grassland status and trends reporting.

APPENDIX I – Classification Scheme and Field Forms

UPLANDS

Woodlands

Code	Vegetation Cover	Description
W1	TALL TREES	stands of tall trees (> 5 m)
W2	REGULAR SPACED SMALL TREES WITH TALL/MID SHRUBS	stands of regularly spaced small trees (< 5 m) 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 (< 5 m) mixed with tall/mid shrubs (0.5 to 1.5+ m)
W4	LOW SHRUB	stands of low shrub (< 5 m) includes areas with predominant buckbrush, wildrose, sagebrush

Non-woody

Code	Vegetation Cover	Description
V1	ANNUAL CROP	annually cultivated crop including wheat, oats, barley, mixed grains, corn (for grain, for silage), rye (fall, spring), canola (rapeseed), flaxseed, and other crops
V2	IMPROVED GRASS	1. alfalfa and other alfalfa mixtures cut for hay or silage 2. all other tame hay cut for hay or silage (including clovers) 3. other fodder crops cut for hay or silage 4. improved pastures that have been seeded down for less than 5 years and are part of ordinary crop rotation
V3	UNIMPROVED GRASS	1. unimproved land for grazing, "wild pastures", and pastures seeded for more than 5 years 2. pastures containing sedges and forbs 3. native grasses

WETLANDS

Code	Cover type	Description
Z1	STREAMS AND RIVERS	streams and rivers
Z3	LAKES AND PONDS	permanent open water lakes and ponds that contains some submerged plants this includes any open water marshes characterized by intermittent growth of emergent's 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
Z6	TRANSITIONAL OPEN WATER	permanent open water lakes and ponds that lacks submerged , shallow, open water plants
V4	EMERGENT DEEP MARSH	semi permanent shallow water with tall emergent's such as reeds, and rushes
Z2	IRRIGATION CANALS	irrigation canals
Z5	ARTIFICIAL WATER	reservoirs and dugouts
V3	GRASS AND SEDGE	shallow marsh to low prairie type wetlands, dominated by grass and sedge cover

DISTURBED

Code	Cover type	Description
V5	*DISTURBED GRASS*	*non-woody plants representing complexes of disturbed species*
X0	*BARE SURFACE*	*bare ground including summerfallow does not include a bare field that has been seeded (should classify this as V1 or V2).*
Y0	*CONSTUCTED COVER*	*building, well site, compressor stations*

UNCLASSIFIED

Code	Cover type	Description
08	UNCLASSIFIED	

Wetland identification column

Code		Description
S	WETLAND STATUS	wetland is a segment of a watercourse
1-999	WETLAND ID	wetland number (up to 3 digits) numbering starts at 1 for each quarter section

Marginal primary cover classification

Code	Description
Blank	identifies polygons which are uplands rather than wetlands
0	wetland with non-natural cover as dominant fringe type
G	wetland with unimproved grass (V3) as dominant fringe type
S	wetland with tree or shrub cover (W1,W2,W3,W4) as dominant fringe type

Marginal secondary cover classification

Code	Description
8	wetland with >75% of one fringe type
0	wetland with non-natural cover as secondary fringe type
G	wetland with unimproved grass (V3) as secondary fringe type
S	wetland with tree or shrub cover (W1,W2,W3,W4) as secondary fringe type

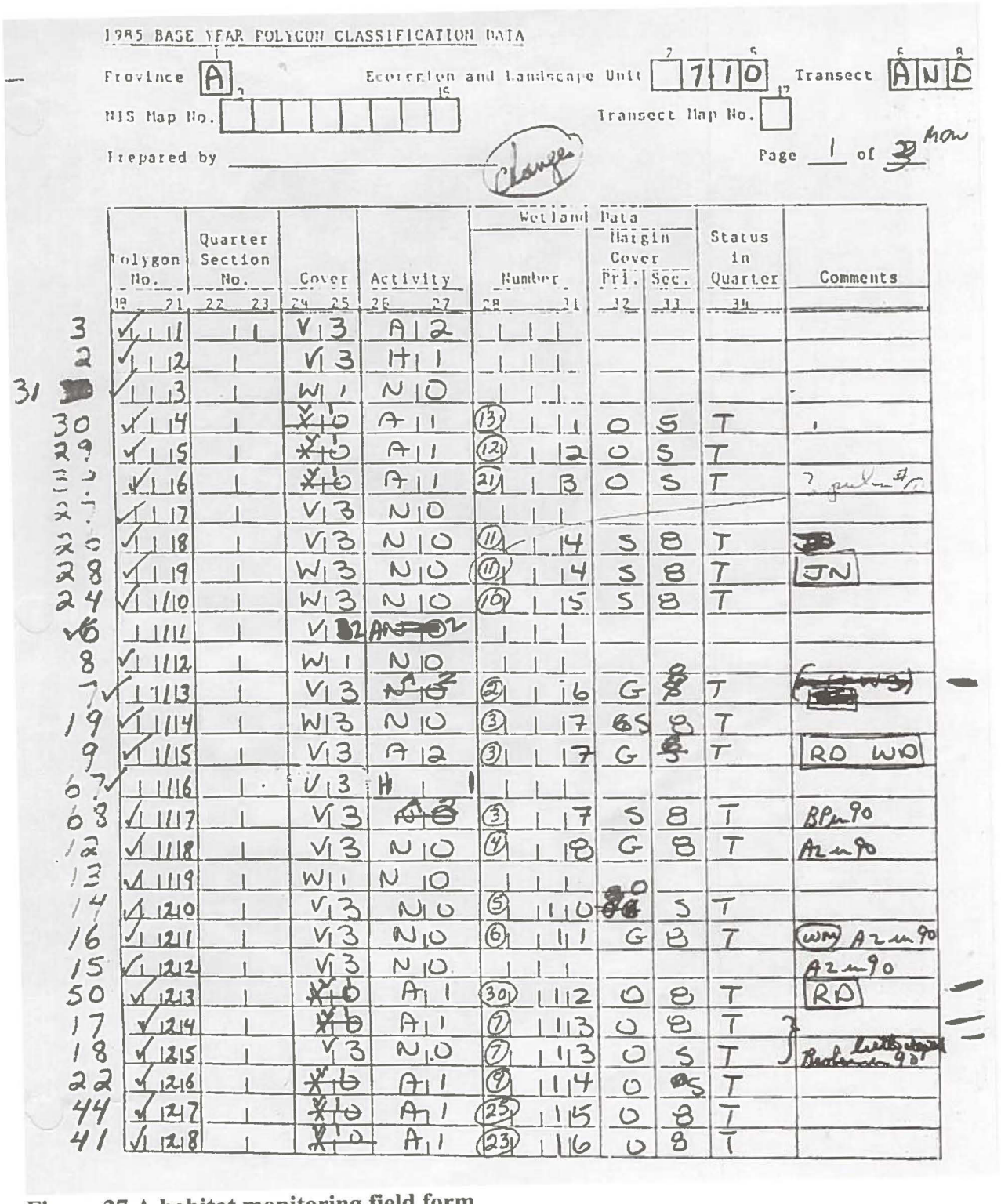
Extent to which quarter section is confined to quarter section

Code	Description
T	wetland lies totally within the quarter section
P	wetland lies only partially within quarter section

Land Activity

Code	Class name	Description
A1	CROP	growing annual tillage crop
A2	FORAGE	growing forage crop
A3	GRAZING	grazing
A4	OTHER PRODUCTIVE	other productive land (berry farm, sod farm, etc.)
A5	AG SITE	agricultural site activity including grain bins, farmyards, etc.
F0	FORESTRY	forestry activity
G0	WILDLIFE	wildlife and fisheries activity
R0	RECREATION	recreational activity
D0	DWELLING	dwelling activity
H1	ROAD	road
H2	RAIL	railway
H3	TRANSPORT	other transportation
H4	COMMUNICATION	communication activity
M0	MANUFACTURING	manufacturing and commercial activity
M1	WASTES	treating and disposal of wastes
E0	EXTRACTION	extraction activity
J0	INSTITUTIONAL	institutional activity
P1	CONSERVATION	research and conservation
B3	IDLE	idle land
N0	NONE	no perceived activity
L0	TRANSITION	land in transition
P2	FLOOD	flood control and drainage
P4	IRRIGATION	irrigation

P3	OTHER	other activity
B1	FORMER AG	former agricultural activity
B2	FORMER EXTRAC	former activity
08	UNCLASSIFIED	Unclassified



1985 BASE YEAR POLYGON CLASSIFICATION DATA

Province [A] Ecoregion and Landscape Unit [710] Transect [AND]

NIS Map No. [ ] Transect Map No. [ ]

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Polygon No.	Quarter Section No.	Cover	Activity	Wetland Data: Number	Wetland Data: Margin Cover Pri.	Wetland Data: Margin Cover Sec.	Status in Quarter	Comments
3	✓ 11	V 3	A 2					
2	✓ 12	V 3	H 1					
31	✓ 13	W 1	N 0					
30	✓ 14	~~X 0~~	A 1	(13) 1 1	O	S	T	
29	✓ 15	~~X 0~~	A 1	(12) 1 2	O	S	T	
27	✓ 16	~~X 0~~	A 1	(21) 1 8	O	S	T	
26	✓ 17	V 3	N 0					
20	✓ 18	V 3	N 0	(11) 1 4	S	8	T	
28	✓ 19	W 3	N 0	(11) 1 4	S	8	T	JN
24	✓ 1110	W 3	N 0	(10) 1 5	S	8	T	
6	1111	V 2	~~A 0~~					
8	✓ 1112	W 1	N 0					
7	✓ 1113	V 3	~~N 0~~	(2) 1 6	G	~~8~~	T	~~[redacted]~~
19	✓ 1114	W 3	N 0	(3) 1 7	~~G~~ S	8	T	
9	✓ 1115	V 3	A 2	(3) 1 7	G	~~S~~	T	RD WD
67	✓ 1116	V 3	H 1					
68	✓ 1117	V 3	~~A 0~~	(3) 1 7	S	8	T	BP m 90
12	✓ 1118	V 3	N 0	(4) 1 8	G	8	T	Az m 90
13	✓ 1119	W 1	N 0					
14	✓ 1210	V 3	N 0	(5) 1 10	~~S~~ O	S	T	
16	✓ 1211	V 3	N 0	(6) 1 11	G	8	T	WM Az m 90
15	✓ 1212	V 3	N 0					Az m 90
50	✓ 1213	~~X 0~~	A 1	(30) 1 12	O	8	T	RD
17	✓ 1214	~~X 0~~	A 1	(7) 1 13	O	8	T	
18	✓ 1215	V 3	N 0	(7) 1 13	O	S	T	Buchanan 90?
22	✓ 1216	~~X 0~~	A 1	(9) 1 14	O	~~S~~	T	
44	✓ 1217	~~X 0~~	A 1	(25) 1 15	O	8	T	
41	✓ 1218	~~X 0~~	A 1	(23) 1 16	O	8	T	

Figure 27 A habitat monitoring field form.

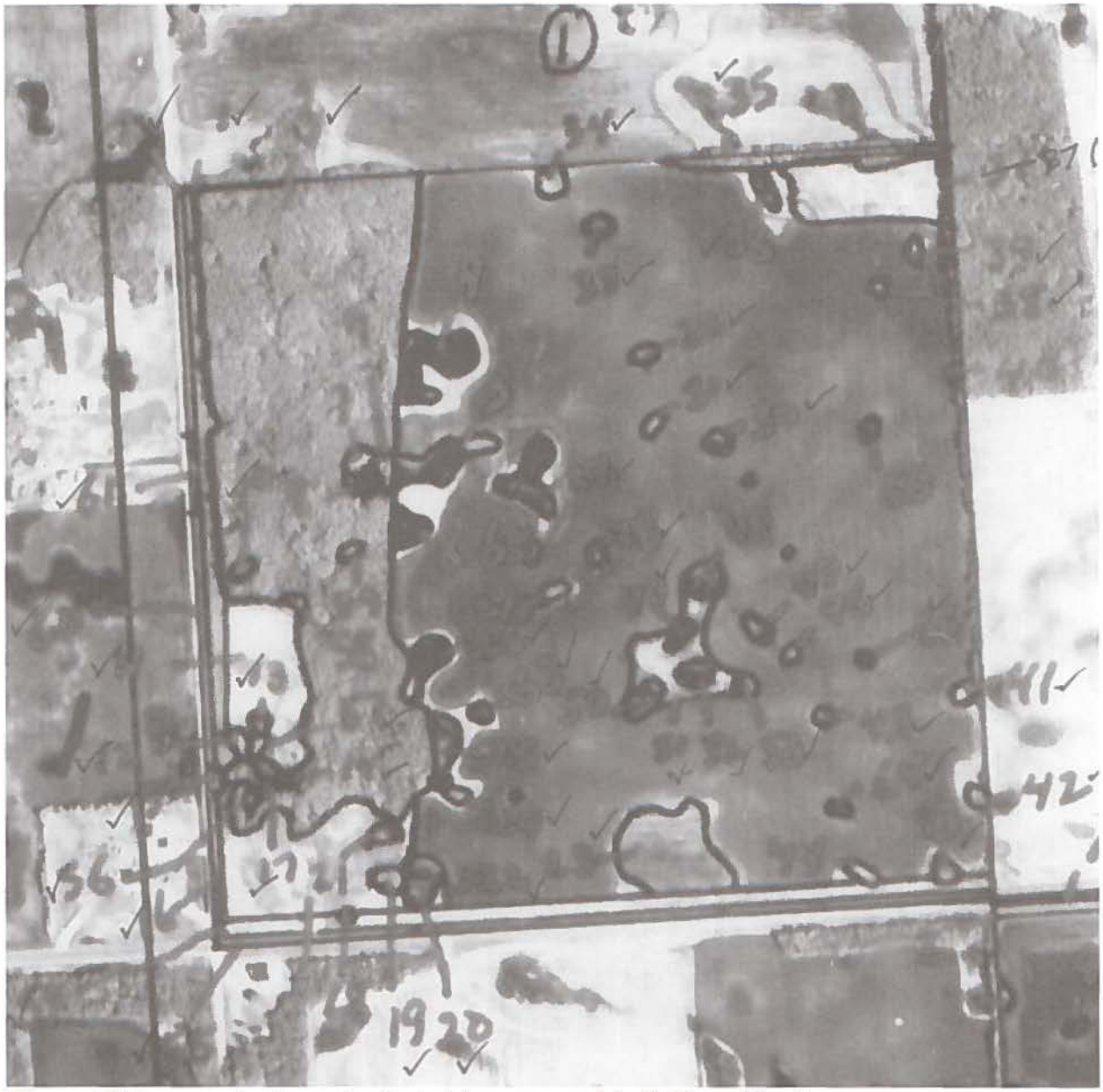

Figure 28 A example of an air photo blow-up used in field verification.

APPENDIX II – Agricultural Census Data

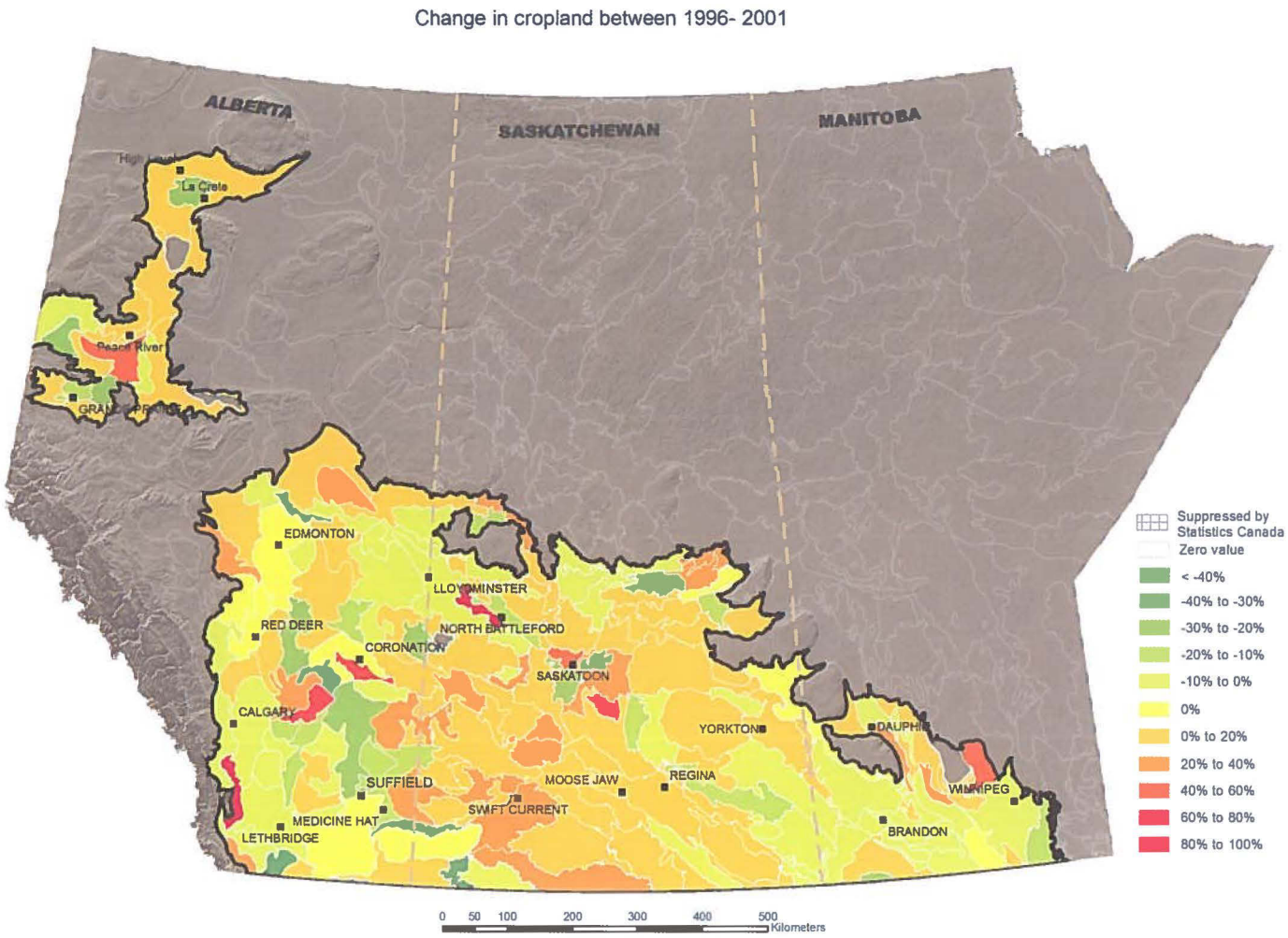

Figure 29. Relative percentage change in cropland 1996 to 2001.

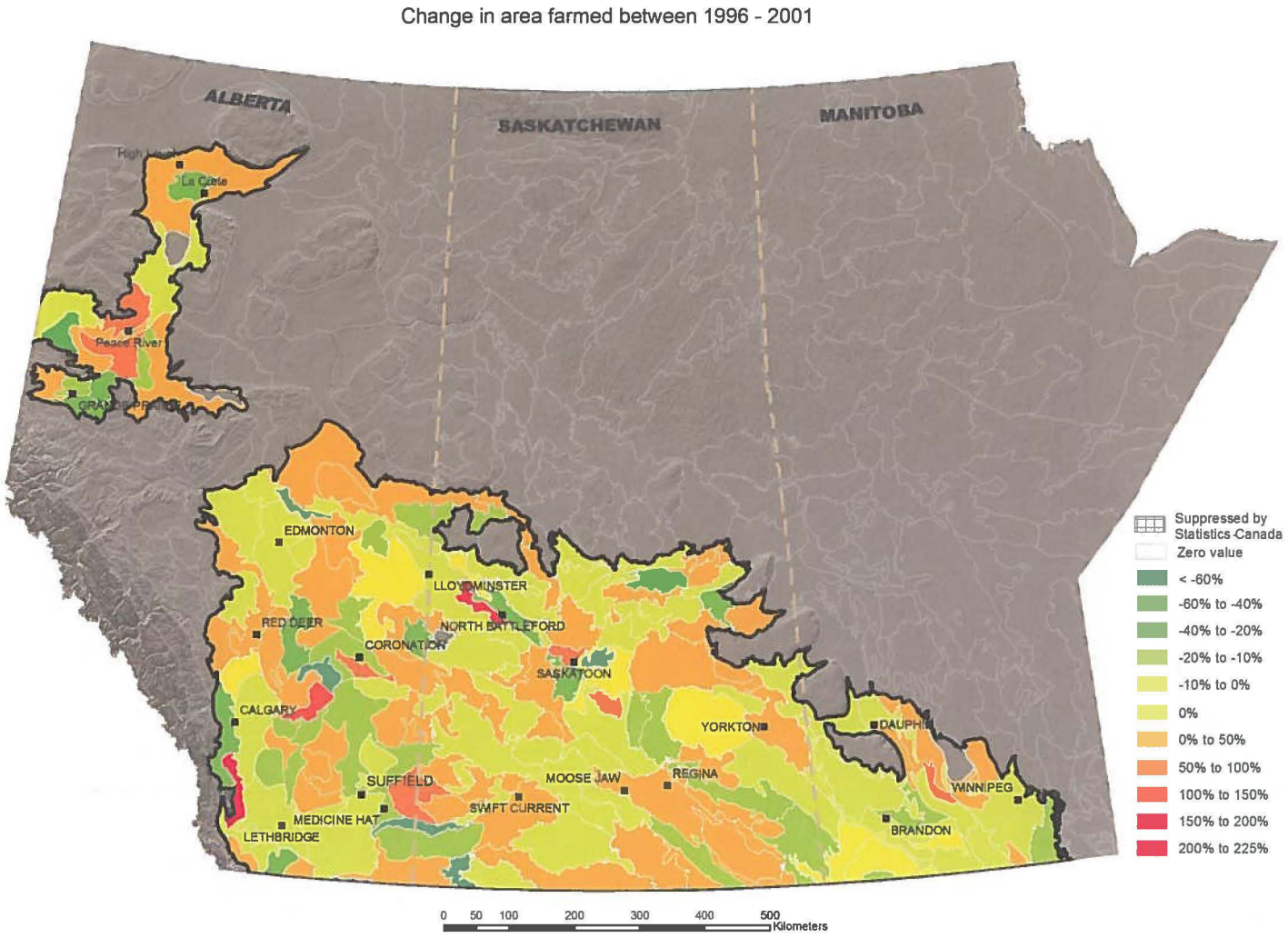

Figure 30. Relative percentage change in total farmed area 1996 to 2001.

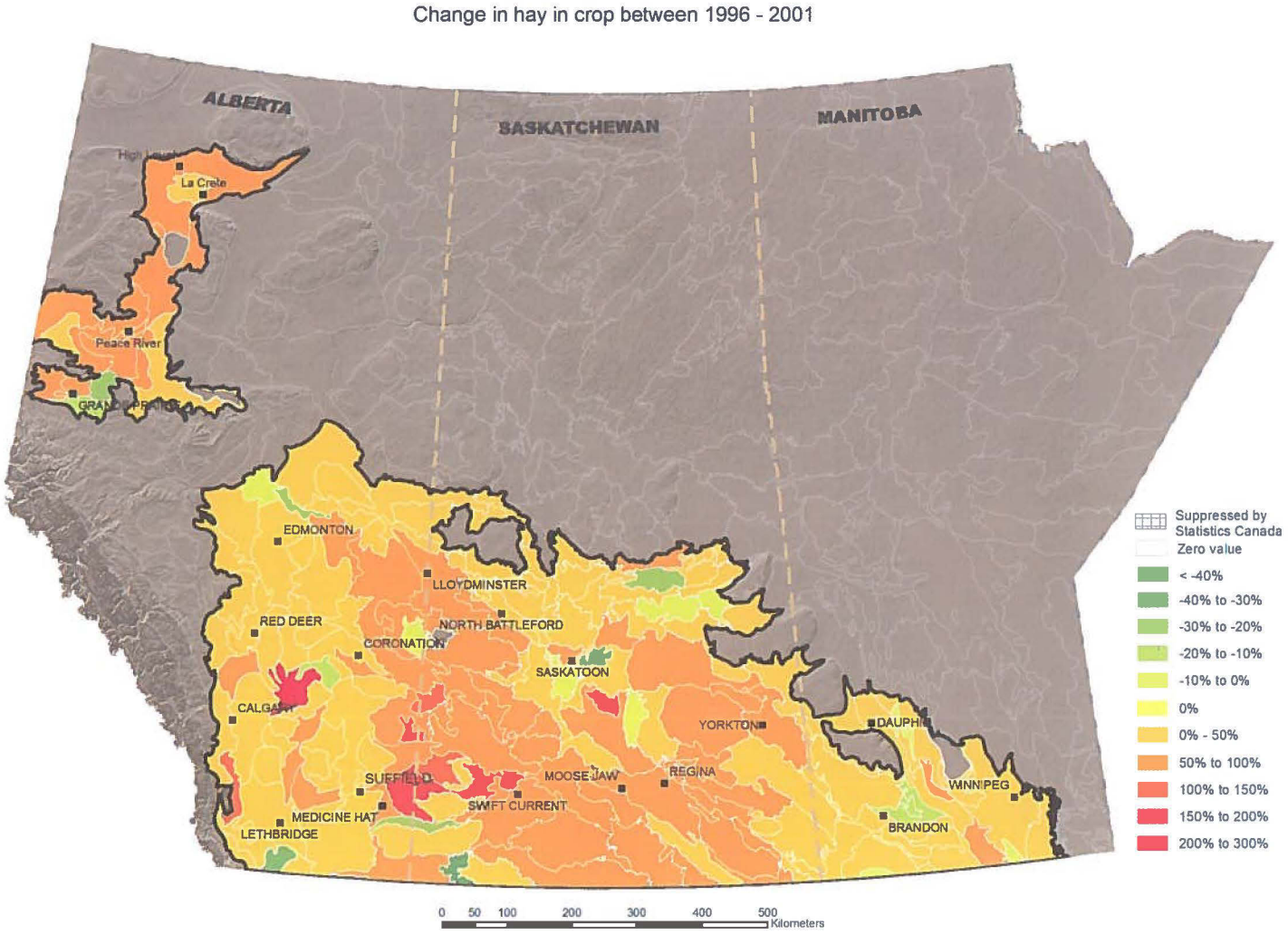

Figure 31. Relative percentage change in area of hay crop 1996 to 2001.

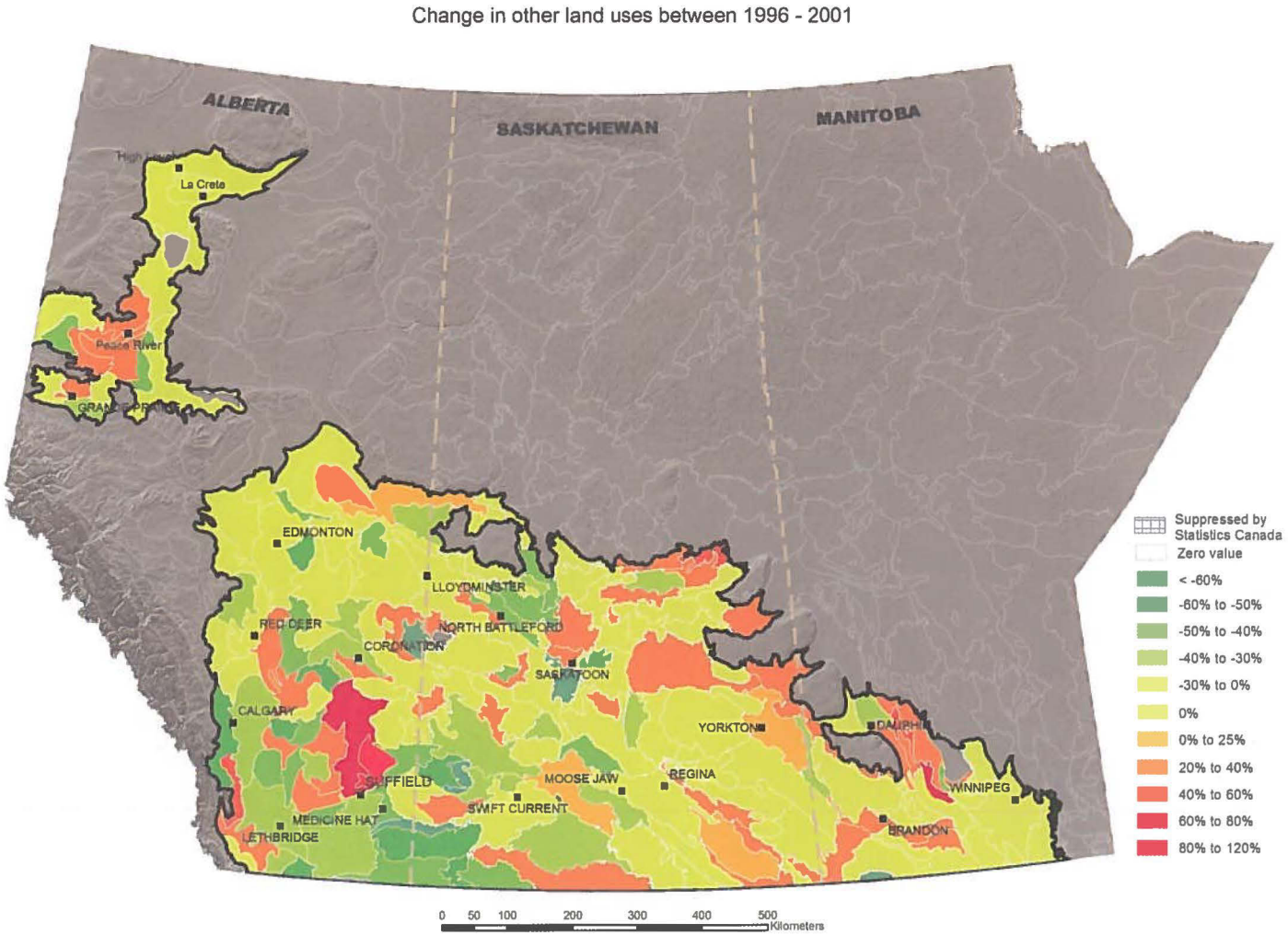

Figure 32. Relative percentage area change in the all other land category 1996 to 2001.

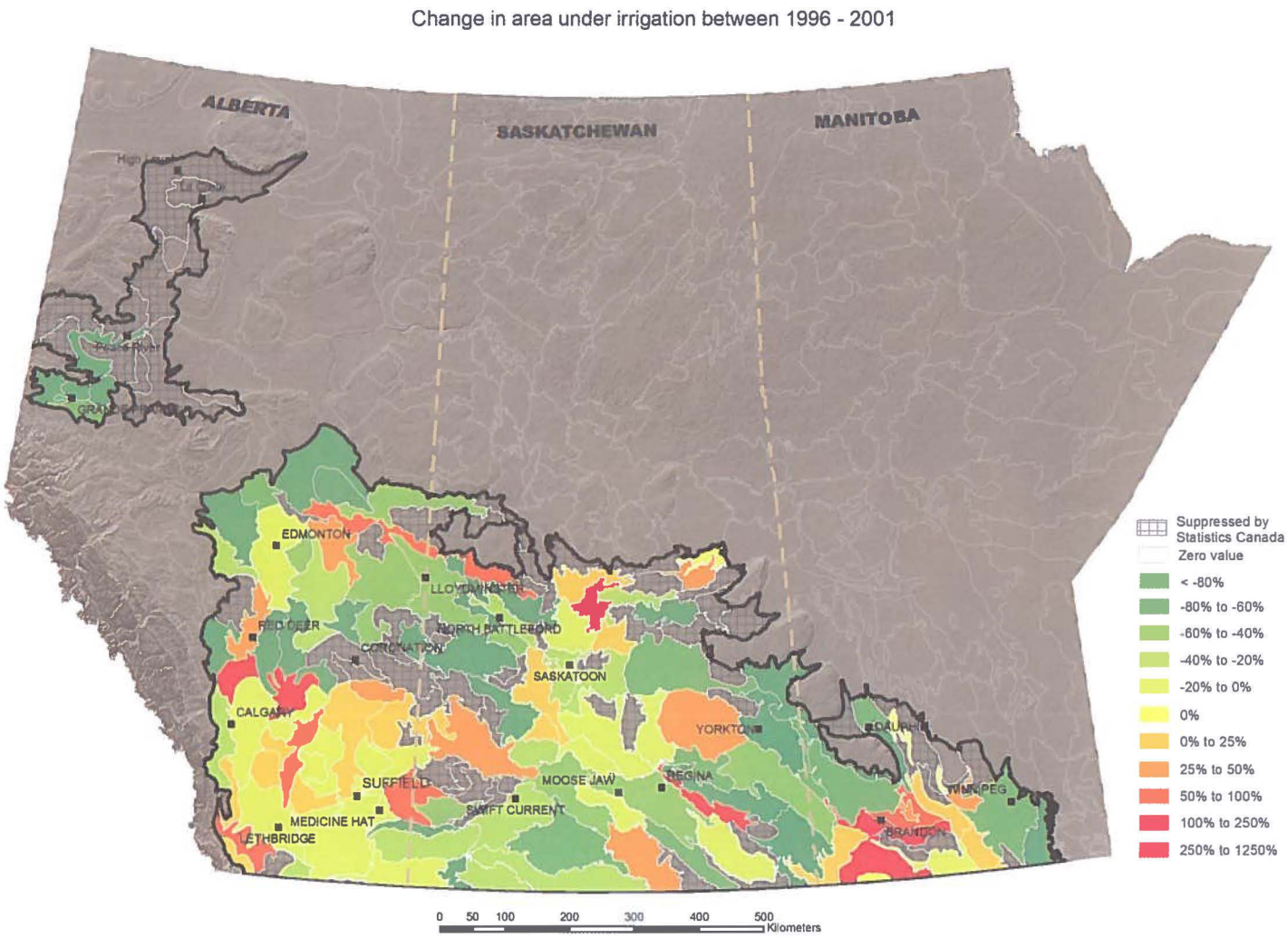

Figure 33. Relative percentage change in area under irrigation 1996 to 2001.

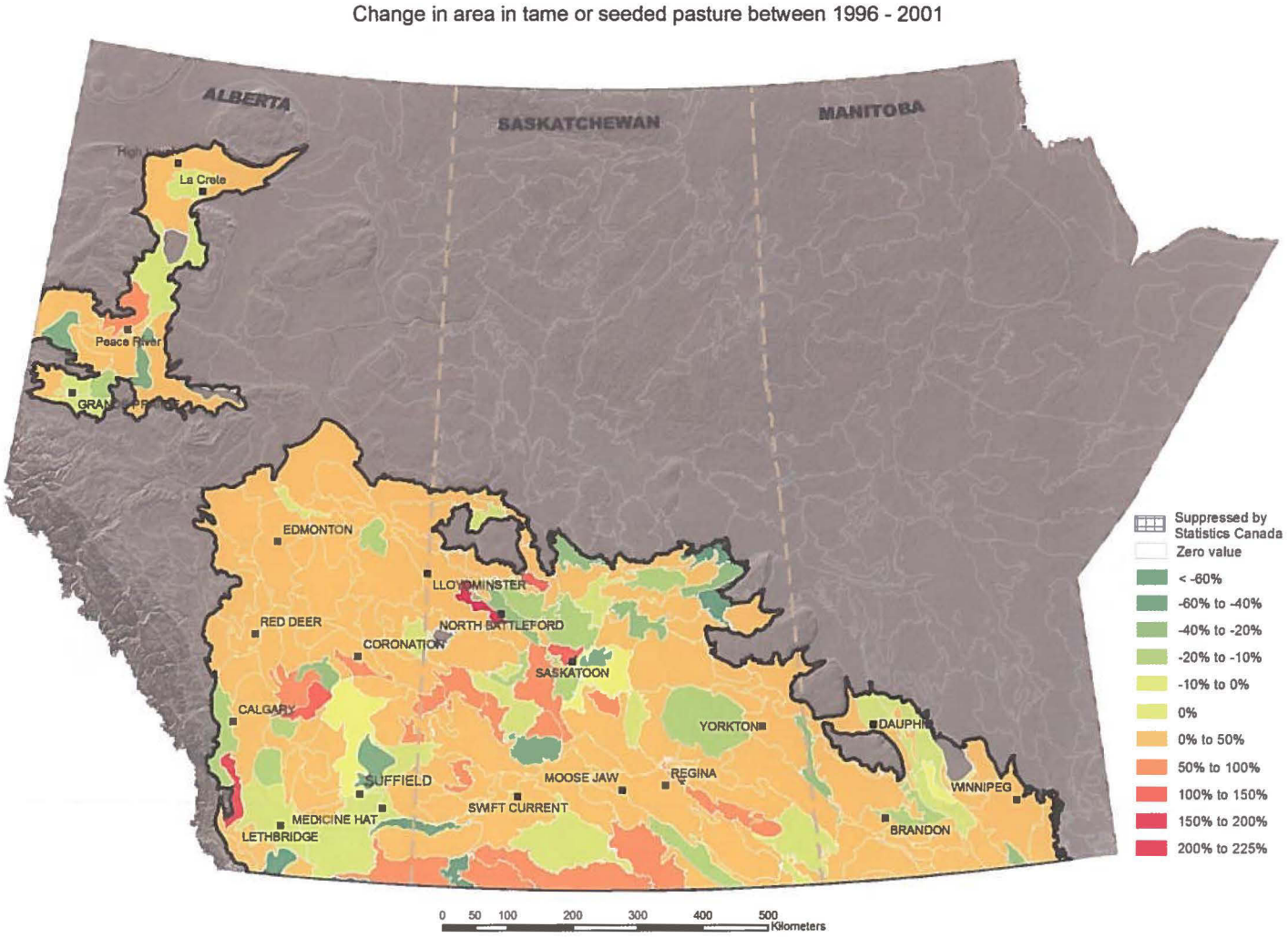

Figure 34. Relative percentage change in tame or seeded pasture 1996 to 2001.

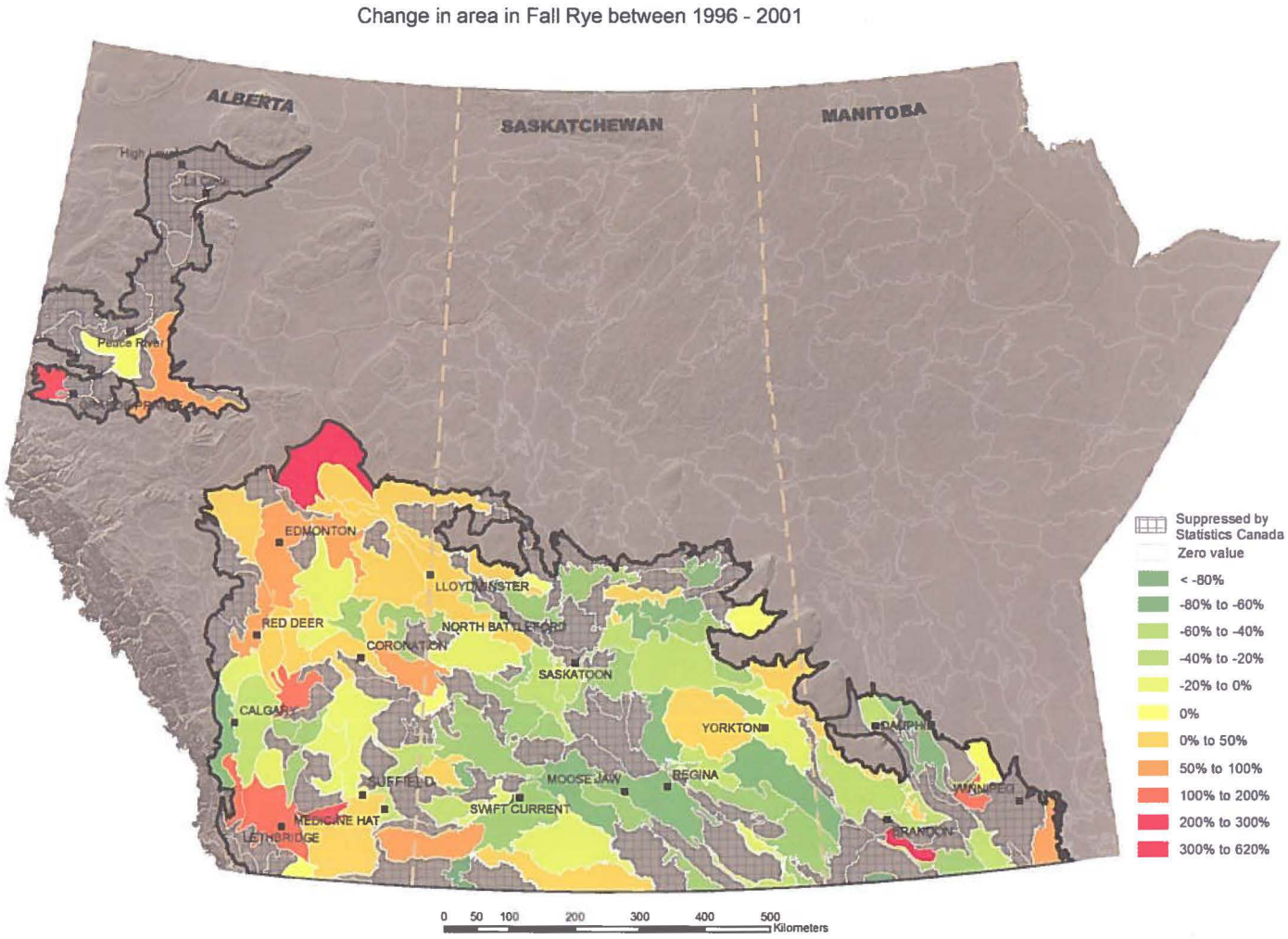

Figure 35. Relative percentage change in total fall rye area 1996 to 2001.

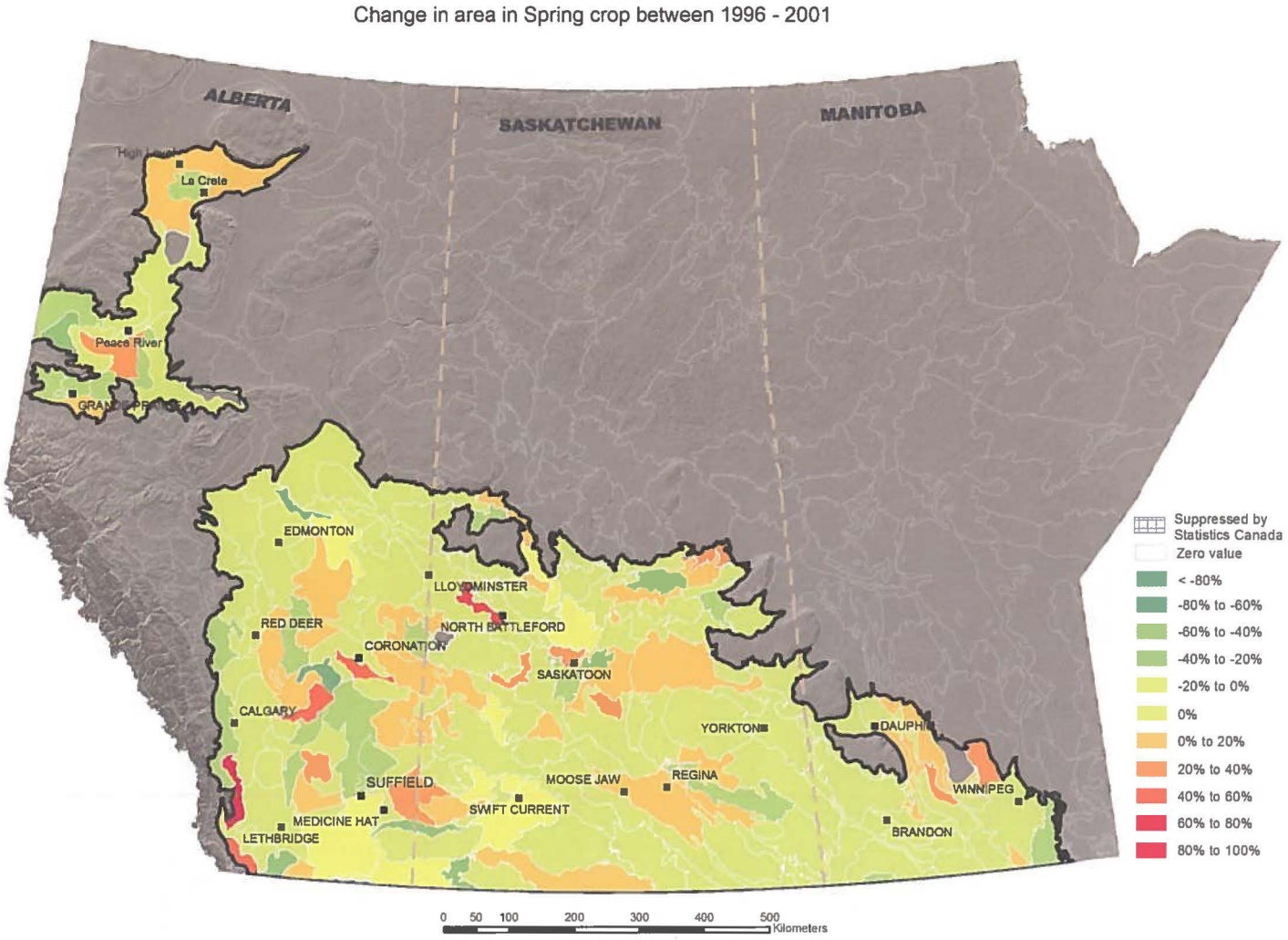

Figure 36. Relative percentage change in spring crop area 1996 to 2001.

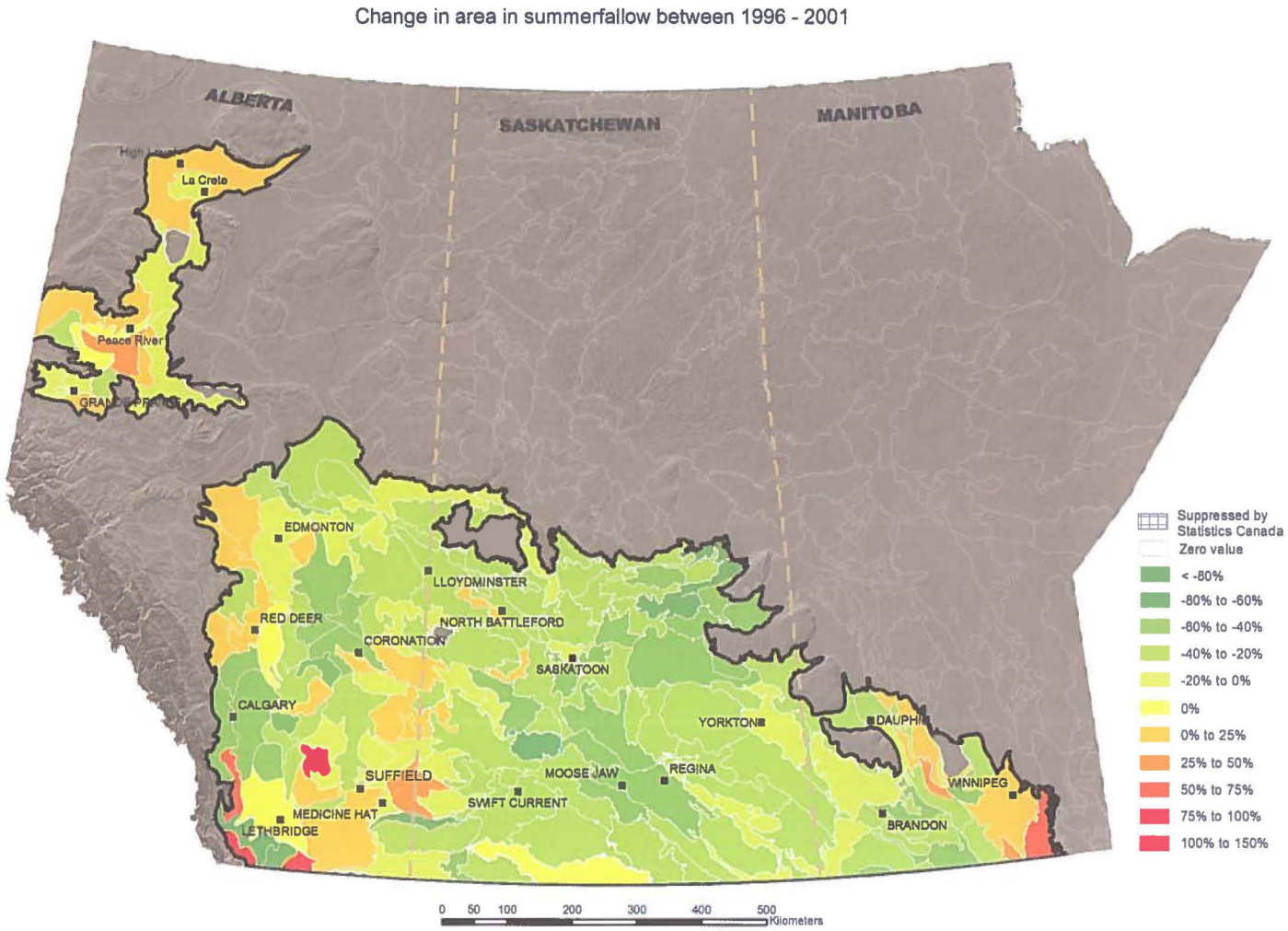

Figure 37. Relative percentage change in summer-fallow area 1996 to 2001.

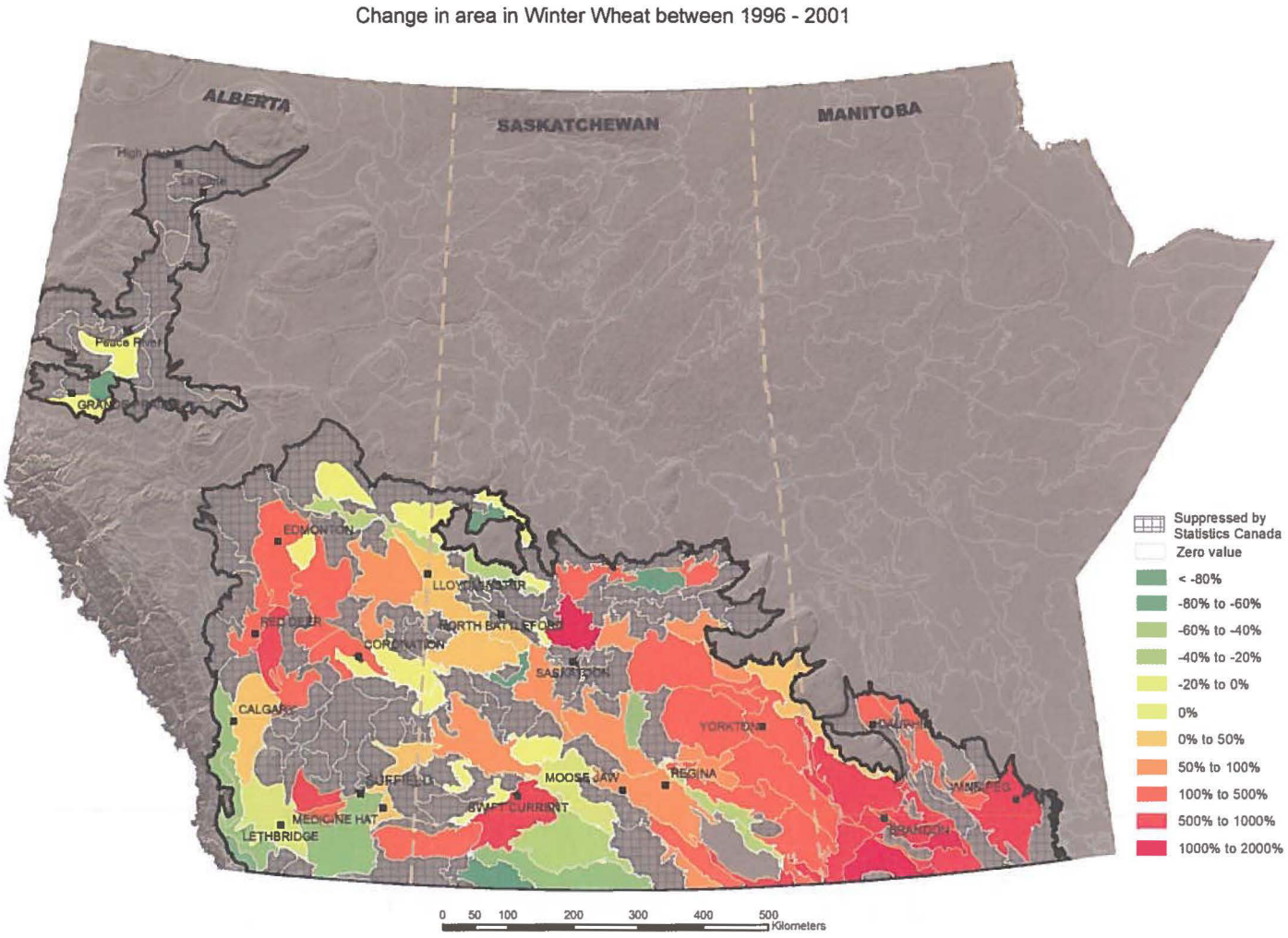

Figure 38. Relative percentage change in winter wheat area 1996 to 2001.

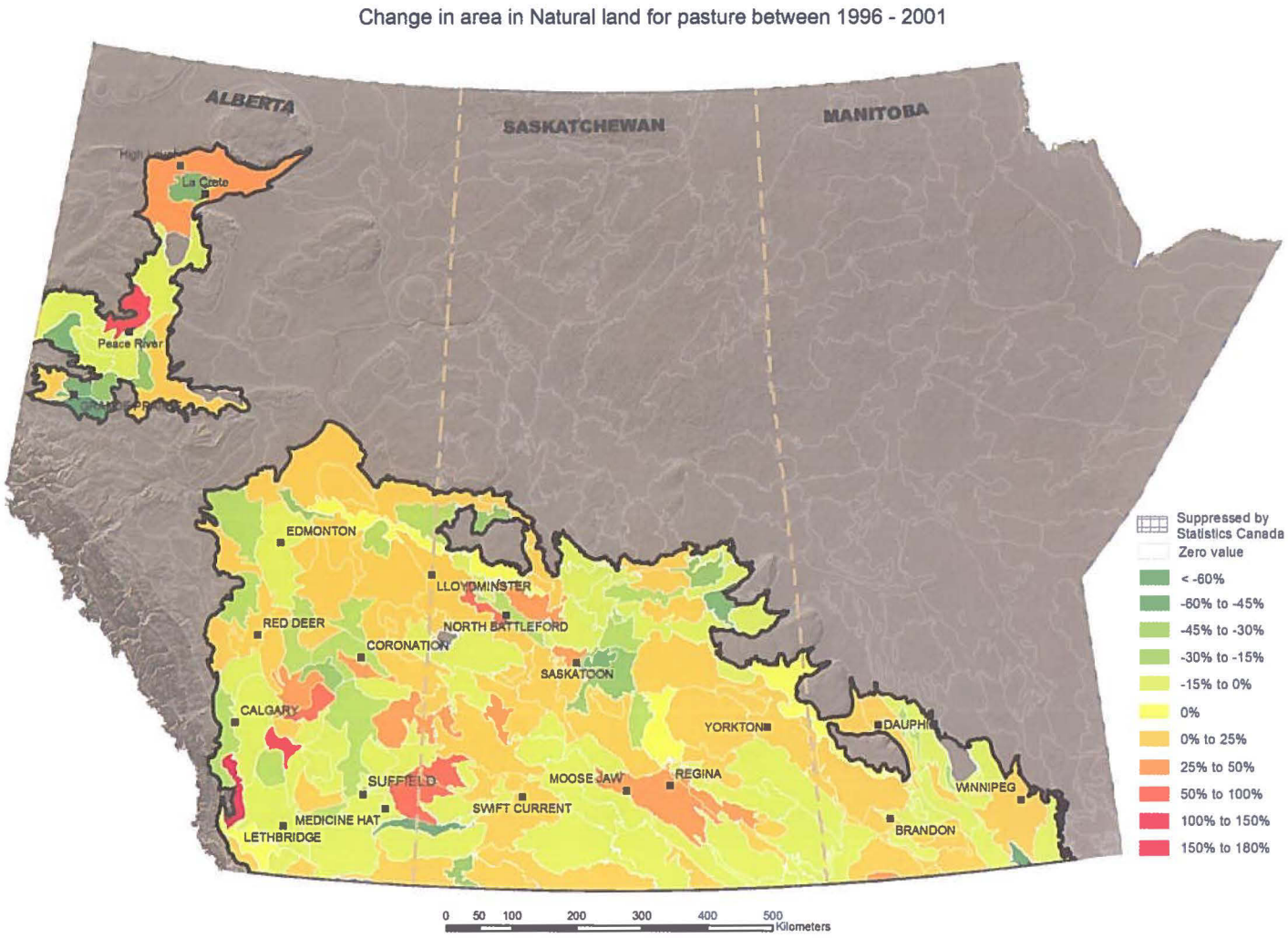

Figure 39. Relative percentage change in natural land being used for pasture 1996 to 2001.

References Cited

Adams, G. D. 1985. *A regional map base for a migratory bird habitat inventory, Prairie Provinces.* Unpublished report, Canadian Wildlife Service, Saskatoon, Canada. 11p. + Appendix and maps.

Adams, G.D. and G.C. Gentle. 1978. *Spatial Changes in Waterfowl Habitat, 1964-1974, on Two Land Types in the Manitoba Newdale Plain.* Canadian Wildlife Service Occasional Paper Number 38. 29p.

Ecological Stratification Working Group. 1995. *A National Ecological Framework for Canada.* Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull. ISBN: 0-662-24107-X

Environment Canada. 1991. *The Federal Policy on Wetland Conservation.* Ottawa, Ontario: Minister of Supply and Services. 1991. 14 p.

Goodman, A. S. and P. S. Pryor. 1972. *A preliminary study of the methods and rates of alteration of waterfowl habitat in the black soil zone of Western Canada.* Unpublished Report. Canadian Wildlife Service. 1972. 77p.

Government of Canada. 1996. *The State of Canada's Environment.* Ottawa: Government of Canada. 1996.

Ignatuik, J and Duncan, D. C. 1995. Wetland Loss in Aspen Parkland of Saskatchewan. *Blue Jay.* Vol. 53 Issue 3. pp. 29-133.

Kiel, W. H. Jr., Hawkins, A.S., and Perret, N.G. 1972. *Waterfowl habitat trends in the Aspen Parkland of Manitoba.* Report Series - Number 18 ed. Ottawa: Canadian Wildlife Service. 1972. 61 p.

Linton, J. 1997. *Beneath the Surface: The State of Water in Canada.* Canadian Wildlife Federation. 1997. 144 p.

Millar, J.B. 1987. *Baseline (1985) habitat estimates for the settled portions of the Prairie provinces. Report #1: Methods and project status.* Canadian Wildlife Service. Unpublished Report. 50 p.

National Wetlands Working Group. 1997. *The Canadian Wetland Classification System.* 1997. Wetlands Research Centre, University of Waterloo, Waterloo, Ontario. ISBN: 0-662-25857-6.

PFRA Generalized Land Cover. 2001. *Methodology PFRA Generalized Landcover. August 2001.* http://www.agr.gc.ca/pfra/gis/lcvmeth_e.pdf. Prairie Farm Rehabilitation Administration - Agriculture Agri-Food Canada.

Rakowski, P. W. and Charbot, B. P. 1984. *Changes in Land Use in the Minnedosa District of Southwestern Manitoba; an Update on the Kiel-Hawkins Transects.* Winnipeg, Manitoba. Canadian Wildlife Service. 1984.

Rakowski, P.W., Nero R.W., and Hutchison R.C. 1974. *Present Status of Waterfowl Habitat in the Prime Duck Production Area of Manitoba.* Unpublished Report prepared for the Canadian Wildlife Service. 12 p.

Ritter, A. 1980. *Wetland Reconnaissance within the Battle River Basin: 1979 Summary.* Unpublished report prepared for Ducks Unlimited Canada. 25 p.

Rubec, C. 1994. Wetland Policy Implementation in Canada. Proceedings of *National Workshop. Ottawa: North American Wetlands Conservation Council (Canada).* 1994 June 1. 127p.

Schick, C. D. 1972. *A documentation and analysis of wetland drainage in the Alberta Parkland.* Unpublished Report. Canadian Wildlife Service. 15 p.

Schmitt, K. 1980. *Wetland Reconnaissance within the South Saskatchewan River Basin.* Unpublished report prepared for Ducks Unlimited Canada. 29 p.

Turner, B. C., Hochbaum, G.S., Caswell, F.D., and Nieman, D.J. 1985. Agricultural Impacts onWetland Habitats on the Canadian Prairies, 1981-1985. *Transcripts from the 52nd North American Wildlife and Natural Resource Conference.* 1987. pp. 206-214.

Watmough, M.D., Ingstrup, D.W., Duncan, D.C., and Schinke, H.J. 2002. *Prairie Habitat Joint Venture Habitat Monitoring Program Phase 1: Recent habitat trends in NAWMP targeted landscapes.* Technical Report Series No. 391, Canadian Wildlife Service, Edmonton, Alberta, Canada. 93 p.

Additional Reference Material

Agriculture and Agri-Food Canada. Prairie Agricultural Landscapes. A Land Resource Review. Catalogue No. A98-3/4-2000E 2000

Avery, T.E. 1968 (second edition). Interpretation of Aerial Photographs. Burgess Publishing Co., Minneapolis, MN. 324 pp.

Dahl, T.E. 2000. Status and Trends of Wetlands in the Conterminous United States 1986 to 1997. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 82pp.

Federal Geographic Data Committee. 1992. Application of Satellite Data for Mapping and Monitoring Wetlands - Fact Finding Report; Technical Report 1. Wetlands Subcommittee, FGDC. Washington, D.C. 32 pp plus Appendices.

Fowler, D. Brian 1997. Winter Wheat Production Manual. Ducks Unlimited Canada, CPS Conservation Production System Ltd., Saskatoon, Saskatchewan

Hiley, J.C. and A. Richard. 1995. A comparison of estimates of agricultural land use using satellite imagery and Census of agriculture inventories. Edmonton: Agriculture and Agri-Food Canada. Centre for Land and Biological Resources Research Contribution. No. 95-72. 53 pages.

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

Lillesand, T.M. and R.W. Kiefer. 1987 (second edition) Remote Sensing and Image Interpretation. John Wiley and Sons, Inc., New York, NY. 721 pp.

Lynch Stewart, P. 1983. Land use change on wetlands in southern Canada: review and bibliography. Canada land use monitoring program. Lands Directorate. Environment Canada. Working Paper No. 26

Millar, J.B. 1984. Classification of wetlands on air/ground comparison transects in the Prairie Provinces. Part III. Waterfowl Strata 26 to 29 - Saskatchewan. Can. Wild. Serv. Unpubl. Rep. 77 pp.

Millar, J.B. 1986. Estimates of habitat distribution in the settled portions of the Prairie Provinces in 1982. Can. Wildlife. Service. Unpublished. Rep. 41 pp.

Millar, J.B. 1987a. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report #1: Methods and project status. Can. Wildl. Serv. Unpubl. Rep. 50 pp.

Millar, J.B. 1988b. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 2: Saskatchewan Parkland - Part I. Can. Wildl. Serv. Unpubl. Rep. 44 pp.

Millar, J.B. 1989c. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 3: Saskatchewan Parkland - Part II. Can. Wildl. Serv. Unpubl. Rep. 65 pp.

Millar, J.B. 1992d. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 4: Alberta Parkland. Can. Wildl. Serv. Unpubl. Rep. 72 pp.

Millar, J.B. 1992e. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 5: Alberta Mixedgrass Prairie. Can. Wildl. Serv. Unpubl. Rep. 66 pp.

Millar, J.B. 1992f. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 6: Alberta Fescue Prairie. Can. Wildl. Serv. Unpubl. Rep. 58 pp.

Millar, J.B. 1992g. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 7: Alberta Shortgrass Prairie. Can. Wildl. Serv. Unpubl. Rep. 38 pp.

Millar, J.B. 1992h. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 8: Saskatchewan Mixedgrass Prairie. Can. Wildl. Serv. Unpubl. Rep. 86 pp.

Millar, J.B. 1992i. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 9: Saskatchewan Shortgrass Prairie. Can. Wildl. Serv. Unpubl. Rep. 52 pp.

Millar, J.B. 1993j. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 10: Manitoba Parkland. Can. Wildl. Serv. Unpubl. Rep. 84 pp.

Millar, J.B. 1993k. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 11: Manitoba Mixedgrass and Tallgrass. Can. Wildl. Serv. Unpubl. Rep. 62 pp.

Millar, J.B. 1993l. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 12: Manitoba Mid-Boreal Transition. Can. Wildl. Serv. Unpubl. Rep. 66 pp.

Millar, J.B. 1993m. Baseline (1985) habitat estimates for the settled portions of the Prairie Provinces. Report # 13: Saskachewan Mid-Boreal Transition. Can. Wildl. Serv. Unpubl. Rep. 63 pp.

North American Waterfowl Management Plan. Saskatchewan Implementation. June 1989.

North American Waterfowl Management Plan. Prairie Habitat Joint Venture. Manitoba Implementation Plan. Executive Summary 1988.

North American Waterfowl Management Plan. Manitoba Implementation Plan 1997-2001. An Update to the Manitoba Implementation Plan, 1988.

Prairie Conservation Forum. January 2001. Alberta Prairie Conservation Action Plan: 2001-2005. Published by the Prairie Conservation Forum, Lethbridge, Alberta. 34 pages

Prairie Habitat Joint Venture. Implementation of the North American Waterfowl Management Plan in Alberta. 1989. Alberta Forestry, Lands and Wildlife. Canadian Wildlife Service. Ducks Unlimited Canada. Wildlife Habitat Canada. Alberta Agriculture.

Prairie Habitat Joint Venture. Prairie Habitat: A Prospectus

Research Branch. Agriculture and Agri-Food Canada. A National Ecological Framework for Canada. 1996. Cat. No. A42-65/1996E ISBN 0-24107-X.

Statistics Canada. 1997. Historical Overview of Canadian Agriculture. Catalogue No. 93-358-XPB. 253 pp.

Statistics Canada. 2001. Land tenure data from 1986, 1991, and 1996 agriculture census. Special request. Statistics Canada.

Tiner, Ralph W. 1999. Wetland Indicators: A guide to wetland Identification, Delineation, Classification, and Mapping. CRC press LLC. 392 pp

U.S. Fish and Wildlife Service. 2001. Waterfowl population status, 2001. U.S. Department of the Interior, Washington, D.C. 50 pp.

Wildlife Habitat Canada. The Status of Wildlife Habitats in Canada 2001. ISBN 0-921553-30-7