Prairie Habitat Monitoring Program

CANADIAN PRAIRIE WETLAND AND UPLAND STATUS AND TRENDS 2001-2011

PRAIRIE HABITAT JOINT VENTURE

prairie habitat
joint venture

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GLOSSARY

Abbreviations

Abbreviation	Description
AAFC	Agriculture and Agri-Food Canada
CWS	Canadian Wildlife Service
ECCC	Environment and Climate Change Canada
NAWMP	North American Waterfowl Management Plan
PHJV	Prairie Habitat Joint-Venture
PHMP	Prairie Habitat Monitoring Program
PHMP SDI	Prairie Habitat Monitoring Program Surface Ditching Index
PPR	Prairie Pothole Region
WBPHS	Waterfowl Breeding Ground Population and Habitat Survey

Statistics, Definitions, and Calculations

Statistic	Description
Habitat Change Summaries	Results summarized for a group of transects as a single summed total or mean. Results summarized for groups of individual independent transect samples as mean values with a measure of variance.
Absolute Change	Absolute change reports raw totals (area or numbers) of habitat measured against the baseline sum for the specific habitat grouping.
Relative Change (%)	Change at time of update measured against the baseline value for specific habitat grouping.
Compositional Change (%)	Examines changes in the proportions of specific habitat types between baseline and update, i.e., summarizes shifts in the compositional makeup of a sample or group of samples.
Net Change	Change (area or numbers) inclusive of gains and losses. Informs wetland cover type shifts over time.
Estimated Change	Estimations of total areas for the entire PHJV landscape, or other reporting unit, are extrapolations based on mean measures from grouped transect results in conjunction with the 95% confidence interval.
Gross Habitat Loss	Gross loss (area or numbers) from the total baseline habitat provides a detailed investigation into habitat loss independent from wetland changes not falling within the definition of habitat loss, i.e., excluding any wetland gains.
Gross Wetland Loss	Gross habitat loss but specific to wetland habitats.
Relative Mean Gross Wetland Loss (%)	Mean gross loss (area or numbers) is relative to baseline totals for the specific habitat grouping.
Absolute Wetland Loss	Summary of total gross wetland area lost in hectares.
95% Confidence Interval	95% confidence intervals (CI) are presented along with means for transect summaries. Generated statistical estimates include CI's as a measure of the reliability of the estimate. Confidence intervals are not provided where the transect sample size was ≤ 3: Manitoba Boreal Transition, Cypress Upland, Southwest Manitoba Uplands, and Interlake Plain Ecoregions.

Wetland and Upland Habitat Cover Types

Classification	Description
Wetland	
Open Water Ponds and Lakes	Semi-permanent to permanent, open water pond type habitat. Can be found as an open water zone in a multi-zoned wetland or wetland complex. Separate categories for saline ponds, streams and rivers, and transitional open water habitat types.
Artificial Open Water	Dugouts, stock ponds, borrow pits, drainage retention ponds, irrigation, ditches, canals, dams, and reservoirs.
Deep Marsh	Dominated by deep marsh emergent vegetation such as *Scirpus* sp. and *Typha* sp. Often an open water zone present in the central or deepest portion of the wetland basin. Considered a semi-permanent wetland habitat type.
Grass/Sedge Marsh	Graminoid dominated wetlands includes shallow marsh, wet meadow, low prairie type wetlands, open fen, and open bog. Contains the ephemeral, temporary, and seasonal type wetland habitats. Also inclusive of shallow basins seeded to tame grass.
Wooded Wetlands	Habitat polygon is dominated by shrub or tree cover. Inclusive of treed bog and fen cover types. Can include wooded low prairie to shallow marsh zones.
Cultivated Wetlands	Also referred to as annually cropped wetlands. Classified based on activity in the wetland basin and signs of current or previous cultivation; cultivated basins include crop, stubble, or summer fallow cover types.
Upland	
Wooded	Includes tree, shelter belt/planted trees, shrubs, and scrub land cover types.
Annual Crop	Annually cultivated crops inclusive of standing stubble, summer-fallow, hay/forage stubble, and bare soil associated with recent tillage.
Anthropogenic	Includes development, man-made cover, structures, roads, and resource extraction.
Tame Pasture/ Hay/ Forage	Improved grass such as tame pasture, forage crops, roadside ditch planted grass cover, disturbed site cover, lawns, farm yard grass cover, and grass cover with evidence of recent (less than 5 years) seeding or plowing.
Natural Grassland	Primarily natural grasslands, remnant grass cover, wetland margins, uncultivated perennials, low-density shrub, forb, and grass complexes. Natural grasslands do not show evidence of cultivation (in past 5 years), seeding, and/or plowing. Includes seeded pastures and forage plantings estimated to be older than 5 years.

SUMMARY

The Prairie Habitat Monitoring Program (PHMP) examined habitat changes for both uplands and wetlands in the Prairie Habitat Joint-Venture (PHJV) delivery area (comprised of the Canadian portion of the Prairie Pothole Region and includes the Boreal Transition Ecoregion of Canada) between circa 2001 and 2011. The purpose of this analysis was to provide wetland and upland habitat status and trends for that period. Change detection methods included the use of high resolution aerial and satellite images in conjunction with 3D heads-up stereo interpretation techniques and limited on-the-ground field verification. The net product was the updating of the Prairie Habitat Monitoring Geodatabase to support PHJV implementation planning and evaluation (*PHJV 2014*).

In total, 221 habitat monitoring transects, averaging 19.2 km in length, sampled 5,198 quarter-sections containing 350,000 ha of land. The transect sampling network was utilized as sampling plots in a systematic stratified random sample. Transects sample 0.6% of the entire PHJV delivery area, with a mean distance between transect samples of 20 km.

Change detection was completed using GIS techniques to compare habitats between the circa 2001 baseline and the circa 2011 update year. The results of this status and trends update of the Prairie Habitat Monitoring Program are summarized here.

Wetlands

Overall, 56,586 wetland basins comprising 30,500 ha of wetland habitat area across 221 transects were evaluated for change between 2001 and 2011. Unless otherwise specified, the numbers presented here summarize transect sample results, and are not extrapolated to the greater PHJV landscape.

- ***Wetland Change***
    - Gross mean wetland habitat area loss (i.e., excluding any wetland gains) on habitat monitoring transects equaled 2.6% (95% CI [1.9, 3.3]) with 653 ha lost for the transect sample. The PHJV mean net (includes wetland area gains and losses) wetland habitat area change was -2.2% (95% CI [-3.2,-1.5]) for the 221 sampled transects.
    - Gross mean wetland habitat area loss as an annual rate was 0.31% per year (95% CI [0.22, 0.40]). The mean net annual wetland habitat change rate for the PHJV equaled -0.26% (95% CI [-0.35,-0.18]).
    - Overall in the PHJV it is estimated that wetland area declined by 108,195 ha (95% CI [-104,522; -111,867]). Based on extrapolations for the transect sample results, it is estimated that the PHJV in circa 2011 contained approximately 4,958,697 ha (95% CI [4,542,956; 5,374,439]) of wetland area, down from the estimate of 5,066,892 ha (95% CI [4,647,478; 5,486,306]) in circa 2001.
    - Gross wetland basin loss (i.e., excluding wetland basin gains) for the PHJV averaged 3.7% (95% CI [2.8, 4.6]) for an estimated mean annual gross wetland basin loss rate of 0.45% (95% CI [0.35, 0.56]).

- Net wetland basin change (includes gains in number of wetland basins) in the PHJV sample equaled -3.1 (95% CI [-4.0,-2.2]), resulting in a calculated net annual wetland basin number change of -0.37% (95% CI [-0.48,-0.27]).
- The composition of the total gross lost wetland habitat area in the PHJV was dominated by annually cropped wetland basins, making up 57% of the absolute total gross lost wetland habitat area, followed by the grass/sedge marsh (34%), wooded (5%), and other, open water, artificial, and deep marsh, each of which contributed to ≤ 4%.
- Of all the cover types, annually cropped wetlands had the highest mean area gross loss: 8.8% (95% CI [6.8, 10.7]).
- The dominant upland replacing gross lost wetland habitat area was annual crop, which replaced 70% (95% CI [66.1, 74.0]) of the gross lost wetland area in the PHJV.
- The mean size of lost wetland basins in the PHJV equaled 0.3 ha. The mean sampled basin size equaled 0.5 ha in both the baseline 2001 and 2011 datasets. Overall, wetland basin losses of less than or equal to 1 ha in size accounted for 95% of the total lost basins and 67% of the total wetland area lost.
- Wetland densities generated for the PHJV from the circa 2011 update samples range from 0.82 to 64.28 basins per km^2 for an estimated total number of basins in the PHJV of 9,156,787 (95% CI [8,298,458; 10,015,117]).

- ***Relative Cumulative Gross Wetland Area Loss Estimates***
  - Cumulative wetland habitat area losses include losses from the current study, any losses recorded in the 1985–2001 study, as well as any detectable pre-1985 baseline losses on the transect samples. Cumulative loss reporting is an attempt to capture the more prominent wetland losses on transects prior to the 1985 baseline; however, this did not involve a historic evaluation of loss for transect samples and, thus, is considered a conservative measure of pre-1985 losses due to the limited evaluation of pre-1985 historical loss information.
  - The cumulative area loss measured on transect samples averaged 8.7% (95% CI [6.9, 10.5]) and ranged from 0–80% relative cumulative wetland habitat area losses. It is expected that these averages are conservative, none the less demonstrating the large variance in wetland habitat area losses across the PHJV landscape.
  - The cumulative loss analysis, along with the current 2001–2011 analysis, suggests wetland loss to be non-uniformly distributed, with "hot spots" of intense drainage and large areas where drainage does not occur and some areas of very limited impacts to wetland area, a conclusion that is further supported by the Surface Ditching Index presented in this report.

Uplands

A total of 96,281 upland habitat monitoring polygons on 221 transects, comprising 312,253 ha of upland habitat area were evaluated for change between 2001 and 2011.

- ***Net Upland Habitat Area Change – Mean Relative Change***
  - Natural grassland cover declined by a mean of 4.2% (95% CI [-5.5, -2.9]).
  - Tame pasture/forage/hay cover increased in all Ecoregions in the PHJV study by an average of 20.6% (95% CI [12.4, 28.8]). The Mixed Grassland Ecoregion had the largest mean relative increase in tame pasture/forage/hay type habitats of 29.1% (95% CI [-0.2, 58.3]).
  - Wooded cover declined by a mean of 3.9% (95% CI [-4.8, -3.1]), with the Aspen Parkland Ecoregion recording the highest mean loss: (5.4% (95% CI [-7.1, -3.8]).
  - Annual crop cover declined by a mean of 4.4% (95% CI [-6.5, -2.3]).
  - Resource extraction cover increased for all Ecoregions by an average of 42.3% (95% CI [19.4, 65.1]).
- ***Upland Composition Change***
  - Overall, the percentage of uplands composed of natural grasslands changed from 11.9% (95% CI [9.6, 14.2]) to 11.4% (95% CI [9.1, 13.7]) of the total upland area sampled.
  - Tame pasture/forage/hay type habitats changed from 17.2% (95% CI [15.5, 18.9]) to 20.7% (95% CI [18.8, 22.6]) of the sampled upland area.
  - Total grassland cover (tame pasture/forage/hay + natural grasslands) changed from 29.1% (95% CI [26.3, 32.0]) to 32.1% (95% CI [29.1, 35.1]) of the total upland area sampled; increase in total grassland cover was a result of increases in the area of tame pasture/forage/hay upland habitat type. The Mixed Grassland and Cypress Upland Ecoregions had the highest composition of grassland at 42.2% and 58.3% of total upland area sampled in these Ecoregions.
  - The composition of wooded habitat as a percentage of total upland area sampled in the PHJV remained relatively unchanged at 7.6% (95% CI [6.2, 9.1]) in 2011.
  - Annual crop cover changed from 56.5% (95% CI [52.9, 60.1]) to 53.9% (95% CI [50.2, 57.6]) of the total upland area sampled.
- ***Natural Grasslands Conversion***
  - Relative mean area loss to non-grassland anthropogenic cover types in the PHJV equalled 2.3% (95% CI [1.5, 3.1]).
  - Of the grassland dominated-Ecoregions the Moist Mixed Grassland saw a mean relative decline in natural grassland area equalling 2.1% (95% CI [-0.5, 4.8]); natural grassland loss related to anthropogenic conversion equaled 2.0% (95% CI [0.6, 3.4]) in the Mixed Grasslands and 0.9% (95% CI [0.0, 1.8]) in the Fescue Grassland Ecoregions.

INTRODUCTION

The Prairie Habitat Joint Venture (PHJV) directs the conservation of wetland and upland habitats in the Prairie Pothole Region (PPR) of Canada through the implementation of the North American Waterfowl Management Plan (NAWMP). Conservation implementation planning in the PHJV is focused on grassland and wetland habitats that support important North American bird populations. A major requirement of PHJV implementation planning is the tracking of wetland and grassland habitats status and trends through time. The loss and degradation of wetlands and the upland habitats surrounding them remain a priority conservation issue for PHJV.

As a major partner in the PHJV, Environment and Climate Change Canada's (ECCC) Canadian Wildlife Service (CWS) provides relevant data on wetland status and trends to the partnership to aid with conservation implementation planning. The CWS has been monitoring wetland and upland habitats in conjunction with migratory bird population monitoring since the 1950s. Since 1985, the CWS has conducted a periodic wetland- and grassland-focused Prairie Habitat Monitoring Program (PHMP) targeting the PHJV delivery area.

Wetland loss, inclusive of drainage, is influenced by climate, economics, politics, and attitudes. The decision to drain has, for the most part, been the sole decision of the landowner and is guided by individual attitudes toward drainage, but is also a function of market pressures, weather, high land prices, and the nuisance component wetlands play on operations *(Leitch 1983)*. The PHJV agricultural landscape is dominated by individual agricultural operations on private lands. This multitude of individual operator decisions around wetland drainage makes the tracking of wetland status and trends throughout the PHJV a difficult task.

Historically, the magnitude of wetland loss on the Prairies could 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 *(Goodman and Pryor 1972, Schick 1972, Rakowski and Chabot 1984, Turner et al. 1987, and Ignatiuk and Duncan 1995)*. Recently, the United States Fish and Wildlife Service (USFWS) undertook an intensive prairie-wide wetland status and trends analysis for the US portion of the PPR, concluding that in the United States, between 1997 and 2009, total net wetland area declined by an estimated 1.1% *(Dahl 2014)*.

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, range from 40–70% since settlement *(Rubec 1994, Environment Canada 1996, and Linton 1997)*. The PHMP dataset is the first PPR-wide sample of wetland status and trends in Canada. The tracking of wetland status and trends with consistent definitions and methods across the PPR remains a priority for the PHJV and related implementation plans.

The purpose of this report is to provide supporting information to the 2013–2020 PHJV implementation planning and delivery process *(PHJV 2014)*. Results from the first iteration of Wetland Status and Trends Update documented continued wetland loss, equalling an estimated 5% decline in wetland area across the PPR of Canada between 1985 and 2001 *(Watmough and Schmoll 2007)*. This current report presents results for the monitoring of wetland and upland habitats across the entire PPR between circa 2001 and 2011. This program continues to provide information in support of the innovative decision support tools utilized for conservation planning and evaluation within the PHJV. The PHJV continues to utilize the results of the PHMP as part of the implementation planning process and, as a group, continues to address the ongoing loss/degradation of important habitats, such as wetlands. The PHMP will continue to adapt, expand, and serve the PHJV partnership in working towards achieving renewed PHJV goals of conserving these unique and productive prairie habitats.

STUDY AREA

This study focused on the glaciated prairie region, or PPR, of the western Canadian Prairies, which is also the focus of the PHJV for the delivery of NAWMP conservation efforts. The PHJV delivery boundary, excluding the Grand Prairie and Peace River portions (Peace Lowland Ecoregion) of Alberta, is shown in **Figure 1**. For summary purposes the Canadian PPR combined with the Boreal Transition Ecoregion is referred to as the PHJV landscape.

The PPR contains some of the most productive waterfowl habitat in North America *(Greenwood et al. 1995)*. This study was designed to sample Ecoregions within the PHJV, independent of PHJV program targets. The study focused on sampling the privately-held lands in the intensive agriculturally-productive Ecoregions within the PHJV delivery area.

Although land use within the PPR is currently dominated by agriculture, many other land uses, such as resource extraction, urbanization, and transportation are prevalent.

Sampled landscapes are dominated by moraine-type parent material with various surface terrain forms including knob and kettle, undulating, dissected, hummocky, and rolling. These landscapes also contain high wetland densities, and are composed of diverse natural upland and wetland habitats. For more information on the Ecoregions related to this study please refer to *the National Ecological Framework for Canada (1996)* for more information regarding Canada's ecological framework *(Ecological Stratification Working Group 1995).*

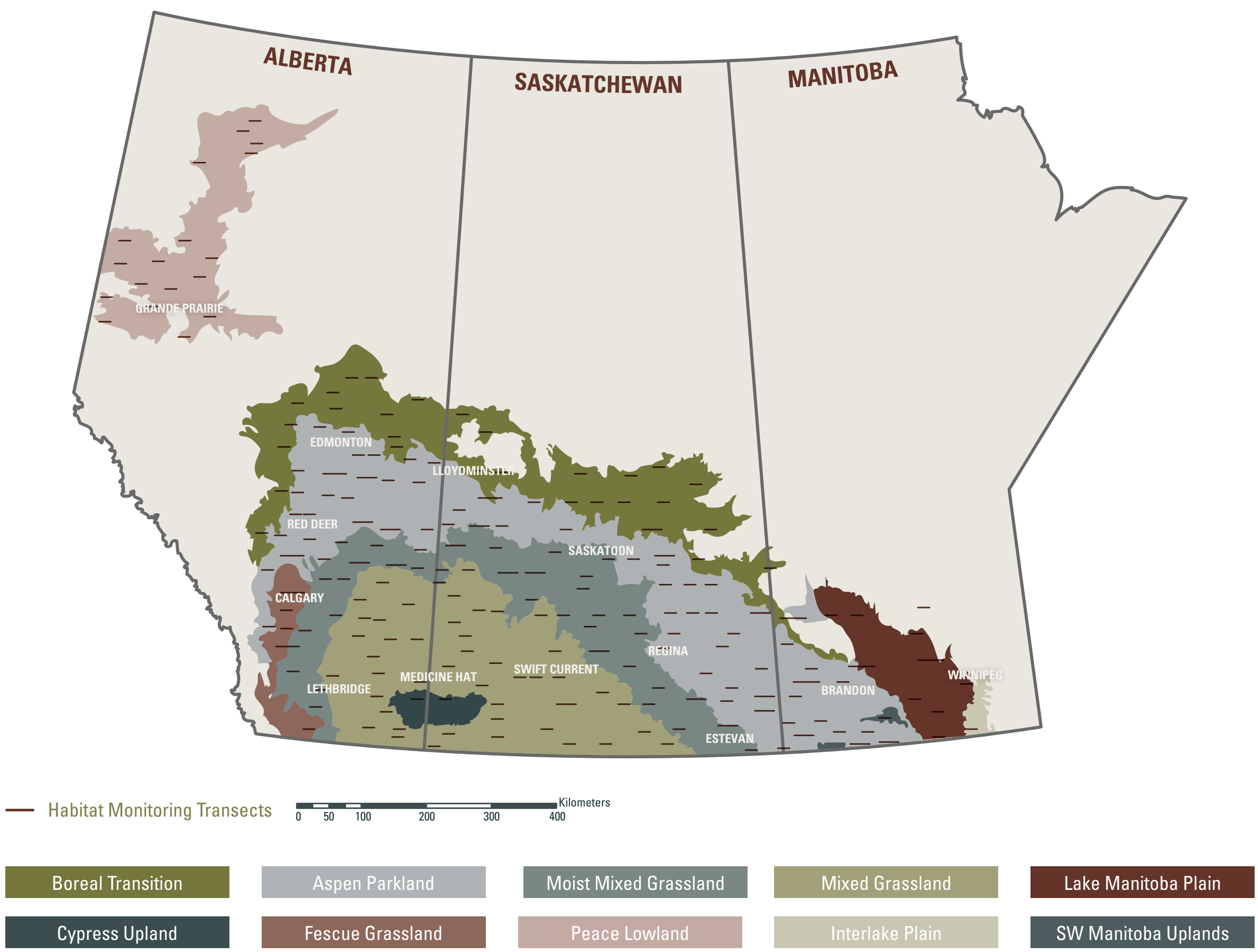


Figure 1. Ecoregions making up the PHJV delivery area and the PHMP transect sampling network. Note that results for the Peace Lowland Ecoregion transect samples were not included in this report.

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. The habitat information and products of *Millar (1987)* were updated using modern technologies and techniques (additional detailed methodological information can be found in *Watmough and Schmoll (2007*) and formed the habitat baseline from which habitat change detection was implemented.

Landscape Stratification

The original habitat monitoring program was designed to sample an area slightly larger then the Prairie Ecozone (included the Boreal Transition Ecoregion), so as to represent 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, land-form, vegetation, and wetland components. The stratification unit chosen was the habitat sub-region, which was considered optimal for local and regional management planning for migratory bird conservation *(Adams 1988)*. Habitat sub-regions are similar to Ecodistricts under the *National Ecological Framework for Canada (1996)*.

Sampling Unit

The original design sampled every second quarter-section (800 m x 800 m blocks) alternating north and south of the transect mid-line (often a 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 transects. The mean length of transects was 19.2 km with a mean area of 1,536 ha, or 24 quarter-sections sampled per transect. Mean distance between transects was 21 km. Quarter-section boundaries were mapped using a combination of Dominion Land Survey records and air photos.

Sampling Network

The core of the sampling network was established in 1985 *(Millar 1987)* and updated in 2001 (153 transects; see *Watmough and Schmoll (2007)*). Sixty-eight new transects were mapped and added to the overall sampling network as new baseline in 2004/2005 to account for under-sampled Ecoregions. For this reporting period, a total of 221 habitat monitoring transects were sampled throughout the PHJV delivery area: 86 in Alberta, 103 in Saskatchewan, and 32 in Manitoba **(Figure 1)**.

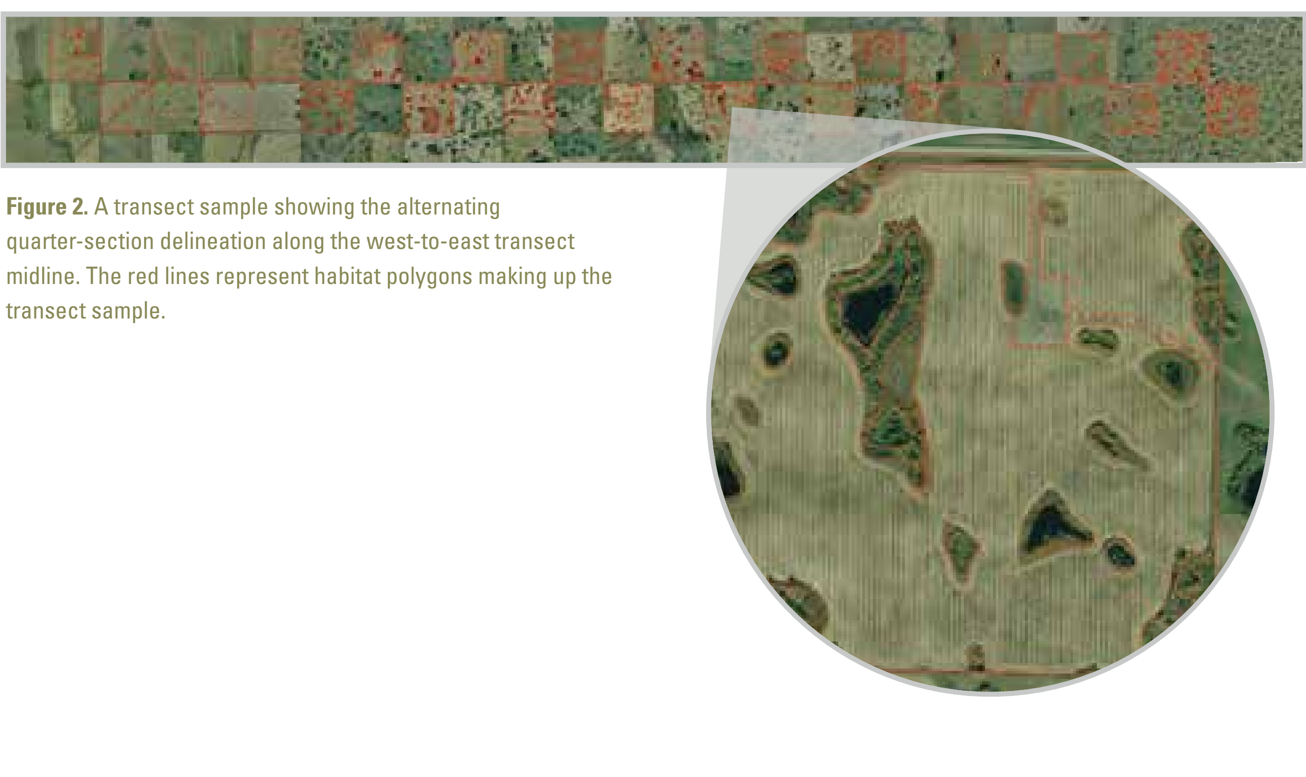


Figure 2. A transect sample showing the alternating quarter-section delineation along the west-to-east transect midline. The red lines represent habitat polygons making up the transect sample.

Sample Size and Distribution

Overall, the 221 transects sampled 5,198 quarter-sections (350,000 ha) within the PHJV composed of 30,500 ha of wetlands and nearly 60,000 distinct wetland basins. The total area sampled comprised 0.6% of the entire targeted PHJV landscape. Sampling effort was not uniform across Ecoregions, as is shown in **Table 1**. Transects that crossed Ecoregion boundaries were included in both the intersected Ecoregions; therefore, it is important to note that some PHJV transect number totals are greater than the sum of their constituents.

The sampling network focuses on the largely privately-held agricultural lands within the PHJV, and did not include national parks (i.e., Grasslands National Park), military lands (i.e., Suffield Military Range), major prairie cities (within city limits), large water bodies (i.e., Cold Lake in Alberta and Lake Diefenbaker in Saskatchewan), and river valleys (i.e., North Saskatchewan and Assiniboine Rivers). These landscapes are dissimilar from the rest of the physiographic unit in which they occur, and would require separate monitoring efforts.

Ecoregion[1]	Proportion (%)	Number of Transects				% of Total Ecoregion Area Sampled
		AB	SK	MB	Total	
PHJV (Overall)	100.0	86	103	32	221	0.6
Boreal Transition	17.8	17	16	2	35	0.5
Aspen Parkland	30.7	22	32	18	83	0.7
Moist Mixed Grassland	17.7	19	30	NA	49	0.7
Mixed Grassland	23.3	20	32	NA	52	0.6
Fescue Grassland	2.7	7	NA	NA	7	0.6
Cypress Upland	1.5	1	1	NA	2	0.4
Lake Manitoba Plain	5.3	NA	NA	10	10	0.5
SW Manitoba Uplands	0.4	NA	NA	1	1	0.7
Interlake Plain	0.6	NA	NA	3	3	0.5

Table 1. PHMP transect sample distribution within the PHJV study area.

1 *For detailed Ecoregion descriptions see the National Ecological Framework for Canada (Ecological Stratification Working Group 1995)*

HABITAT CLASSIFICATION

Wetlands Classification

The habitat monitoring program uses the Canadian Wetland Classification System *(National Wetlands Working Group 1997)* definition of a wetland: land that is saturated with water for sufficient time to facilitate wetland or aquatic processes as determined by the presence of poorly drained soils, hydrophytes, and various types of biological activities adapted to wet environments. The classification of wetland presence or absence is dependent upon those indicators that can be determined from 3D air photo interpretation and, when possible, supporting ground verification.

Wetland basins were mapped according to their basin boundary; water presence or absence was not a sole indicator for basin delineation. Basins were delineated through the mapping of the topographic basin depression. The minimum depression size mapped varied, and was dependent upon interpretable air photo evidence and the skill of the interpreter. No minimal mapping unit was determined for this dataset; rather, efforts were made to delineate all wetland basins that showed visual evidence of wetland characteristics identifiable from 3D air-photo interpretation. Additional features used for wetland delineation included vegetative transitions (between vegetative wetland zones and upland transitional areas) and identifiable margins or dominant wetland cover zones (see glossary for detailed information regarding wetland cover types). Water presence in wetland basins was considered an optimal condition for basin delineation, and when combined with depressional and vegetative features resulted in detailed wetland basin delineations. Wetlands were most often delineated by one polygon, but in multi-polygon wetlands, the entire wetland was classified according to the polygon that had cover indicative of the highest level of water permanence *(Millar 1987)* and/or dominated the central zone *(Millar 1987)*. Wetland margins were classified according to the dominant cover type along the wetland basin perimeter.

Wetlands polygons were classified by the dominant vegetative community that was representative of the wetlands ecological function. The classification of wetland polygons was achieved through air photo interpretation and, thus, was constrained to those indicators reliably interpretable from the available air photo. Wetland classes reported are a point-in-time classification derived in combination with historical classification type and other supporting information, such as multi-temporal imagery where available. As with all prairie classification, it is necessary to evaluate wetland classes in context with annual to decadal cycles of wetness on the Prairies in consideration of the subsequent unique hydrological influences on wetland classification (*van der Kamp et al. 2016 and Hayashi et al. 2016*). It is recognized that remote classification of wetland basin types in this study was highly influenced by seasonal influences on standing water and the effects on subsequent vegetative cover type.

Every mapped wetland polygon was assigned the following attributes:

- A cover code indicating the dominant cover for the wetland polygon
- An activity code describing the dominant land use activity present within the wetland basin
- A margin code describing the dominant cover type of the wetland margin
- Ancillary wetland basin impacts, such as partial filling or drainage, when present

Wetland habitat polygon cover types were assigned according to the following categories:

- ***Open Water Ponds and Lakes:*** Semi-permanent to permanent, open water pond type habitat which can be found as an open water zone in a wetland complex. There are separate categories for saline ponds, streams and rivers, and transitional open water habitat types.
- ***Artificial Open Water:*** Dugouts, stock ponds, borrow pits, drainage retention ponds, irrigation, ditches, canals, and reservoirs.
- ***Emergent Deep Marsh:*** A semi-permanent wetland habitat type, dominated by deep marsh emergent vegetation such as *Scirpus* sp. and *Typha* sp. Often, these include an open water zone present in the central or deepest portion of the wetland basin.

- ***Grass/Sedge Marsh:*** Graminoid-dominated wetlands including shallow marsh, wet meadow, low prairie wetland zones, and shallow basins seeded to tame grass. These contain the ephemeral, temporary, and seasonal wetland types.
- ***Wooded Wetlands:*** Dominated by shrub or tree cover, including treed bog, fen cover types. These can also include wooded low prairie to shallow marsh zones.
- ***Cultivated Wetlands:*** Classified based on activity in the wetland basin and signs of current or previous cultivation; these include cultivated basins in crop, stubble, or summer fallow.

Uplands Classification

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, as well as land use differences between like cover types. Similar to wetlands, the upland polygons were described by the dominant cover and activity type.

A major focal point of upland change detection was the grassland habitats of the PHJV. The accurate classification of various grassland habitats through the use of aerial photography is challenging. Tame pastures/and tame hay fields are often easily confusable with natural grassland habitats and the accurate separation of these types of grassland habitats, are dependent on factors such as image timing, precipitation, and grazing impacts. Efforts were made to separate tame or planted grasses and forages from more natural grassland type habitats; these efforts included limited roadside ground verification and the use of additional imagery types to make the best classification determination possible. Grassland classifications were not based on species types but, were an evaluation of evidence of anthropogenic modifications i.e., previous cultivation, seeding, rock piles, or other indicators indicative of non-natural grassland conditions.

Upland habitat cover types were assigned according to the following categories:

- ***Wooded:*** Includes tree, shelter belt/planted trees, shrubs, and scrub land cover types.
- ***Annual Crop:*** Annually cultivated crops inclusive of standing stubble (including hay/forage stubble), summer-fallow, and bare soil associated with recent tillage.
- ***Anthropogenic:*** Includes development, man-made cover, structures, roads, and resource extraction.
- ***Tame Pasture/Hay/Forage:*** Improved grass such as tame pasture, forage crops, roadside ditch planted grass cover, disturbed site cover, lawns, farm yard grass cover, and grass cover with evidence of recent (less than 5 years) seeding or plowing.
- ***Natural Grassland:*** Primarily natural grasslands, remnant grass cover, wetland margins, uncultivated perennials, low-density shrub, forb, and grass complexes. These can include seeded pastures and forage plantings estimated to be older than 5 years. Natural grasslands lacks remotely detectable evidence of cultivation (in past 5 years), seeding and/or plowing.

Change Detection and Updating

The first change detection iteration of the PHMP occurred in 2001 and reported on habitat changes over the 16-year period from 1985; results were reported in *Watmough and Schmoll (2007)*. This current study evaluates change between the circa 2001 dataset and the updated circa 2011 dataset. This iteration included the expanded sampling transects established in 2004/2005. Update year varied based on the most recent year of imagery available at the time the work was completed. For ease of reporting, update year is reported as circa 2011, but may include imagery from 2008 to 2014. In the update year, changes in all sampled quarter-sections were determined through various methods including roadside ground investigations (ground-truthing), air photo interpretation (3D stereo and/ or 2D analysis), satellite interpretation, landowner interviews, and auxiliary GIS type data sources (soil maps, road networks, hydro layers, etc.). Existing baseline photos (circa 2001 for 153 transects and circa 2004/2005 for 68 transects) with accompanying polygon delineations were reproduced to enable accurate change detection. All change detection was completed using GIS techniques to map changes to the landscape either through changing attributes or by adding/ modifying habitat polygons **(Figure 3)**.

Change detection was completed for both upland and wetland habitats for all quarter-sections making up a transect.

Figure 3. An example of change detection within a sampled quarter-section in (A) the 2004 baseline condition and (B) the 2011 update year. Note the extensive ditch construction resulting in several wetland basins (delineated in yellow) being classified as lost (encircled in red). The red circle shows an area of extensive surface ditching targeting several monitored wetland basins.

CHANGE REPORTING

Habitat Gain

Habitat area gains, both wetland and upland, were measured on recent air photos, and when required, confirmed in the field; these new polygons were then delineated. Gains were only considered if they could be adequately mapped through air photo interpretation. Therefore, it was not operationally possible to record slight or minor boundary changes in upland or wetland habitats.

Wetland Gain

All wetland gains were reviewed against existing baseline data (using the original stereo pair photos or 2D digital photography) to ensure the gain occurred after baseline. Wetland gains were only considered if they were the result of direct anthropogenic creation, for example, dugouts, dams, diversions, reservoirs, terminal drainage ditches, borrow pits, drainage retention ponds, basin consolidations, or wetland restorations. Recorded wetland gains were then separated into *true* or *false* wetland gains. False gains refer to polygons added in the update and, through further examination, were verified to be present in the baseline imagery, but had been missed during interpretation (primarily due to seasonal/decadal variability effects on image interpretation). These new/missed wetland basins were then added into both the baseline and update dataset to ensure accurate reporting of wetland gains and losses. Surface water accumulations can result in numerous small, difficult-to-detect wetland habitats that are virtually invisible during dry years, thus the mapping of those basins was only possible when adequate characteristics were available to the photo interpreter.

Wetland Habitat Loss

The determination of wetland habitat loss can be highly subjective and variable over time and is further complicated by the wet and dry cycles common to the prairies.

Here, wetland loss was defined as a measurable, anthropogenically created wetland basin alteration sufficient in magnitude and duration to impose permanent effects to a wetland's capacity to hold water and/or function as wetland habitat.

Measured wetland loss data therefore represents the area of wetland removed/drained/filled or, in some cases, severely degraded (e.g., **Figure 4**). Losses were determined when the area was no longer considered as wetland habitat and was reclassified as upland or a drained/ filled wetland. Loss was determined by the entire or partial deletion of the respective wetland polygon(s), or the modification of wetland polygon attributes. High or low water conditions alone were not considered indicators of wetland habitat loss, and hence basin polygons were classified as lost only if actual measurable constructed impacts 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.

Figure 4. Semi-permanent wetland basins being drained through permanent surface ditch construction. Notice the large ditch construction and the subsequent substantial water level draw down in the basin.

Wetland losses reported here included various permanent alterations ranging from complete obliteration of a wetland basin through filling and/or leveling **(Figure 10)**, to the construction of permanent drainage works within intact wetland basins, or the repeated annual practice of fall/winter ditching of wetland basins with non-permanent surface ditches. For complete detailed descriptions of the types of wetland impacts resulting in wetland loss refer to *Watmough and Schmoll (2007*).

Difficulties in determining wetland loss and wetland habitat change in general can be related to image quality, abnormal hydrologic conditions (flood or drought), interpretation error, cultivation, standing stubble, land-in-transition, and the practice of intermittent seasonal ditching. Many of these potential error sources were overcome through limited ground-truthing and with auxiliary data such as landowner interviews, multi-year air photo evaluations, and discussions with staff familiar with the area. None the less, the determination of wetland habitat loss remains highly subjective and is a point-in-time measurement focusing on key factors present at the time of dataset updating.

While the magnitude of the ditching or filling impact on a wetlands hydrology can vary through time and by wet and dry cycles, the fundamental assumption in wetland loss determination is that all the recorded loss impacts have a net negative impact on wetland habitats. The magnitude of impact on a wetlands hydrology was not directly measured as part of the habitat loss determination; rather the presence of a ditch or fill was the primary determinant of wetland habitat loss.

Wetland habitat loss summary statistics are divided into gross losses and net change:

- ***Gross wetland habitat loss:*** data on losses (area and numbers) from both the total baseline wetland habitat and details of wetland habitat loss, independent from wetland gains.
- ***Net wetland habitat change:*** wetland changes (area or numbers) over time inclusive of wetland habitat loss and gains. Net wetland habitat change may relate to constructed/restored wetland area, abandoned or failed wetland drainages, basin consolidation, etc.

There is much variability among wetland loss types and the impacts they impose on wetland habitats. Some wetland losses are considered transient, whereas others are permanent. Some impacts from wetland loss can be equivalent to habitat loss, even if the area remains a wetland by definition.

It should be noted that from the perspective of wildlife, impacts from wetland loss can vary among species. Conversion of wetland cover types, margins, and surrounding upland cover and land use impacts may be equivalent to loss of habitat for some wildlife species. Thus, wetland cover summaries for both baseline and update are provided to describe wetland impacts and wetland cover conversions/shifts that did not result in wetland loss, but which may represent a degradation of wetland habitat depending upon the species being considered. Conversely, reversions from impacted wetland habitat in some wetland cover types may represent an improvement in wetland habitat for a species.

Drained wetland complex in a recently seeded agricultural field.

Study Limitations and Scientific Reviews

The original study design was completed in 1985 (see *Millar 1985*) with a focus on generating estimates of the then current distribution of a variety of important habitat types for the various strata in the settled portions of the three Prairie Provinces. The initial and current work was completed through heavy reliance on aerial photography with manual interpretation techniques common to this type of work. Methods developed for updating, modernizing, and change detection were based on commonly used practices related to aerial photograph based change detection in wetlands and other habitats. Wetland and upland change detection methods and subsequent analysis techniques were evaluated with the help of leading experts in parallel types of work in the USFWS (*Dahl 2011, Dahl and Bergenson 2009),* and Ducks Unlimited Canada *(Lyle Boychuk with Ducks Unlimited Canada*). Throughout the life cycle of the PHMP, there has been considerable effort to share methods, report results, and target program objectives. At its inception, the PHMP involved cooperative efforts between the CWS, USFWS, and the Canada Lands Directorate in all areas from sample design to air photo acquisitions. The sample-based approach to monitoring habitats was developed with guidance and cooperation with the Canada Lands Directorate *(Bryant and Russwurm 1983*) and incorporated components of the Canada Land Use Monitoring Program (CLUMP). To this day, the CWS continues to lead the PHMP and is guided through science based reviews via the PHJV Science Committee and methodological review through PHJV partners, as well as the sharing of experiences with the USFWS Wetland Status and Trends program (*Dahl and Watmough 2007*).

Operational realities and initial program priorities (1985) have resulted in some significant scientific reporting limitations. The high cost of aerial photography and subsequent manual image interpretation resulted in sampling limitations that are recognized through out the report. Original sample distribution was also limited due to costs.

As this programs' methods are based on remotely-sensed information combined with manual image interpretation, there are limitations as to the accuracy of wetland delineations, determination of wetland types, and wetland impact detections. The determination of the cumulative impacts of the combined individual impacts on a wetland over time are highly subjective and, thus, are considered as point-in-time assessments of wetland habitat loss. Every effort is made to validate change data where required; however, resources are limited with regards to additional technological applications and ground-truthing. The reader is reminded that the primary focus of this program is wetland and upland habitats and this data should not be construed as a hydrological study of wetlands or wetland loss.

Priorities have changed somewhat with regards to prairie habitats, the PHMP continues to adapt and report on habitat types that were not the primary focus of the original program design. Natural grassland is an example of a recent priority shift; PHMP efforts are currently underway to refine original (1985) baseline information to allow for more robust and reliable assessments in future updates.

RESULTS & DISCUSSION

Overview

This section summarizes the results of the 2001–2011 change detection analysis for both wetlands and uplands. Results reported as PHJV totals summarize data from all 221 transects. Ecoregion results summarize totals for all transects samples intersecting the identified Ecoregion reporting unit. Provincial results include all transects contained within provincial boundaries, and Ecoregional inter-province results include all transects intersected by the specific Ecoregion and within the specified province.

Change analysis measurements are reported for wetland habitat polygons. Some habitat categories were combined to simplify reporting.

Change was summarized as either relative or compositional change (see glossary Statistics, Definitions, and Calculations). Relative change is a measure of change with respect to the absolute baseline value. The transect composition or percentage refers only to specific habitat type for the specified period; compositional change is simply a comparison of the baseline 2001 and the update 2011 compositions. Estimates of total areas are extrapolations based on mean measures from transect results in conjunction with the 95% CI.

Unless otherwise stated, results presented here are measurements for transect samples and are not extrapolated to the entire PHJV.

Wetlands

Wetness Cycle

Many land-uses and wetland cover types within wetland basins are driven by annual to decadal variation in water levels within wetland basins and wetland catchments. The overall water balance of prairie wetlands is highly influenced by annual variations in precipitation (*Hayashi et al. 2016*).

When interpreting changes in PPR wetland habitat types, decadal-scale measures of wetness should be referenced to better interpret changes in vegetative zones and overall wetland duration (van der Kamp et al. 2016).

Consideration to wetness should be made when evaluating the ultimate impacts of wetland drainage on availability of surface-water habitat. For example, in periods of high wetness, drained wetlands may persist in a drawn-down state with a reduced overall wetland footprint area, but may still provide some limited — although likely severely impaired — wetland habitat functions. Flooded conditions can also result in back-flooding of drained wetlands, overfilled wetland ditches, basin conglomeration, etc. Conversely, in periods of average to dry conditions the impacts of drainage likely completely impair wetland habitat functions and allow for complete shifts in land use within drained wetland basins.

The PPR of Canada has incredible wetland habitat diversity ranging from small ephemeral wetlands of short temporal duration to deeply entrenched catchments providing open water habitats and related emergent vegetation. Prairie wetlands and related catchments form an integrated hydrological unit, in which runoff from the catchment and exchange of water between the central pond and moist margin drive overall wetland hydrology. Thus, the effects of evaporation and precipitation strongly influence the prairie wetlands water balance (*Hayashi et al. 2016*). Furthermore, drought and wet period extremes drive key ecological prairie wetland processes and wetland habitat cover cycles (*Johnson et al. 2004*).

To contextualize wetness through ponded areas, we provide the annual pond estimates generated from the Spring Waterfowl Breeding Ground Population and Habitat Survey (WBPHS) in North America (*USFWS and CWS 1987*). The WBPHS annual transects geographically overlap the habitat monitoring transects throughout the PHJV study area and, thus, that data set was selected as the measure of annual surface water availability over the various study iterations. The annual pond counts provide an index as to the degree of wetness on the landscape (as indicated by surface water pond counts) for both annual and decadal reference in relation to the circa 2001 baseline and 2011 update datasets. It is important to note that the WBPHS annual pond counts only count ponds holding water, and thus are only a measure of annually ponded water counts and not a comprehensive count of wetland basins both wet and dry. Once again these wetness cycle data should be considered when interpreting the wetland change data presented in this report.

PHJV Pond Number Estimates

The initial 1985 baseline dataset was created during a low to average annual pond count period **(Figure 5a)**. The first 153 monitoring transects established were mapped using spring 1985 aerial photography. Dry conditions required the use of 3D stereoscopic image interpretation techniques to ensure accurate detection of wetland basins to the extent possible, in both the dry and wet conditions.

The circa 2001 update portion of the initial 1985 – 2001 study relied heavily on ground-truthing, with limited availability of aerial photography. The 2001 update was completed from 1998 – 2003, a period which included drought conditions on the prairies in 2002 and 2003. The generally dry conditions at the time of that update heavily influenced wetland classification and drainage determinations. The cultivation cover category, in particular, was more extensive due to many basins being cultivated or hayed (including the more permanent deep marsh habitat types).

The transect sampling network was expanded in 2004 within an average- to slightly above- average period of wetness.

Generally, and for all provinces, the 2011 study period was considered wetter (from a ponded water perspective) than the 2001 baseline, resulting in average-to-high annual pond counts **(Figure 5a)**. With wetter conditions, basins fill up, cover types change, and land uses within undrained basins are more restricted, resulting in shifts in cover type (e.g., from cultivated basins back to an open water pond). This iteration of the monitoring program relied heavily on aerial photography captured in spring, summer, and/or fall, in combination with spring and fall ground-truthing efforts.

Provincially, pond estimates for the circa 2011 period were greatest in Saskatchewan, slightly above average in Alberta, and average in Manitoba **(Figures 5b, 5c, 5d)**. The high pond count in Saskatchewan over the 2011 period was indicative of a wet cycle, with many basins having been inundated throughout the season and the expansion of basins flooding out through shallower wetland zones, and in some cases, the complete inundation of catchments **(Figure 5c)**.

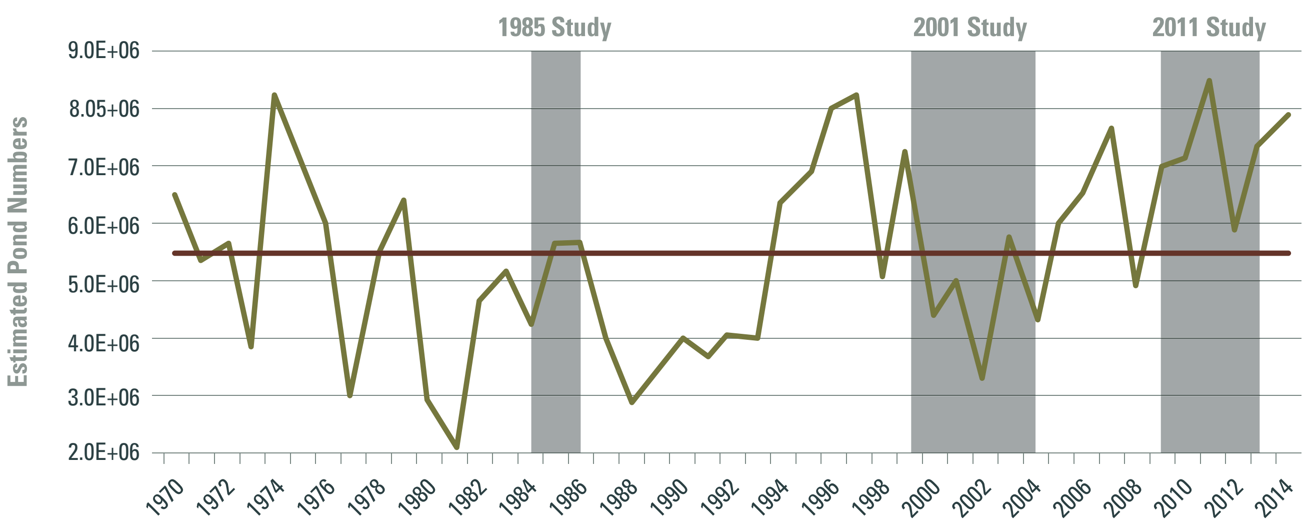


FIGURE 5A PHJV

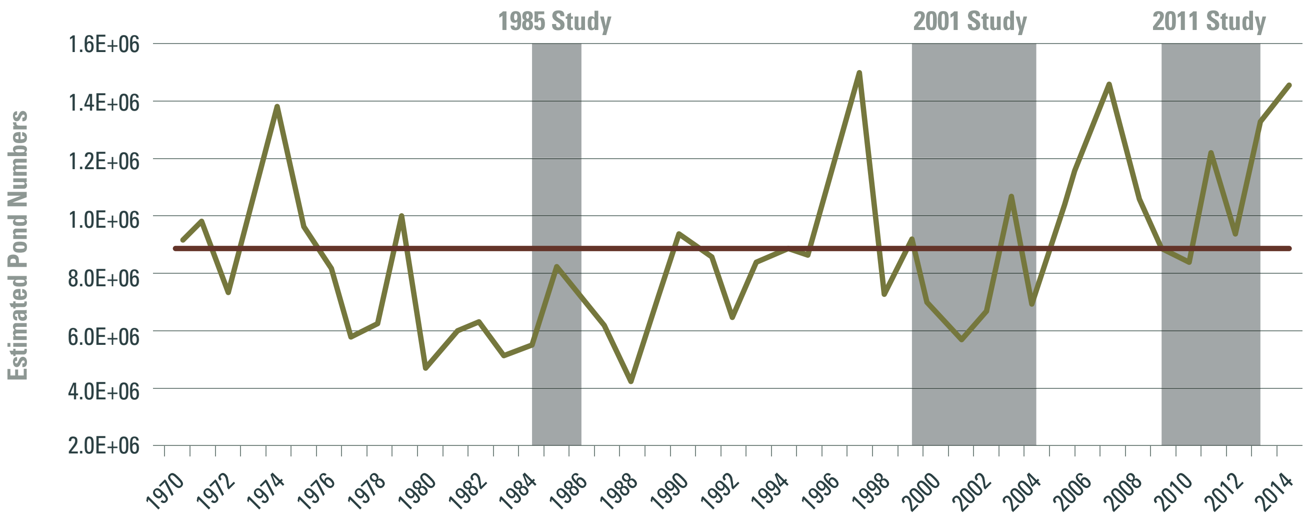


FIGURE 5B **ALBERTA**

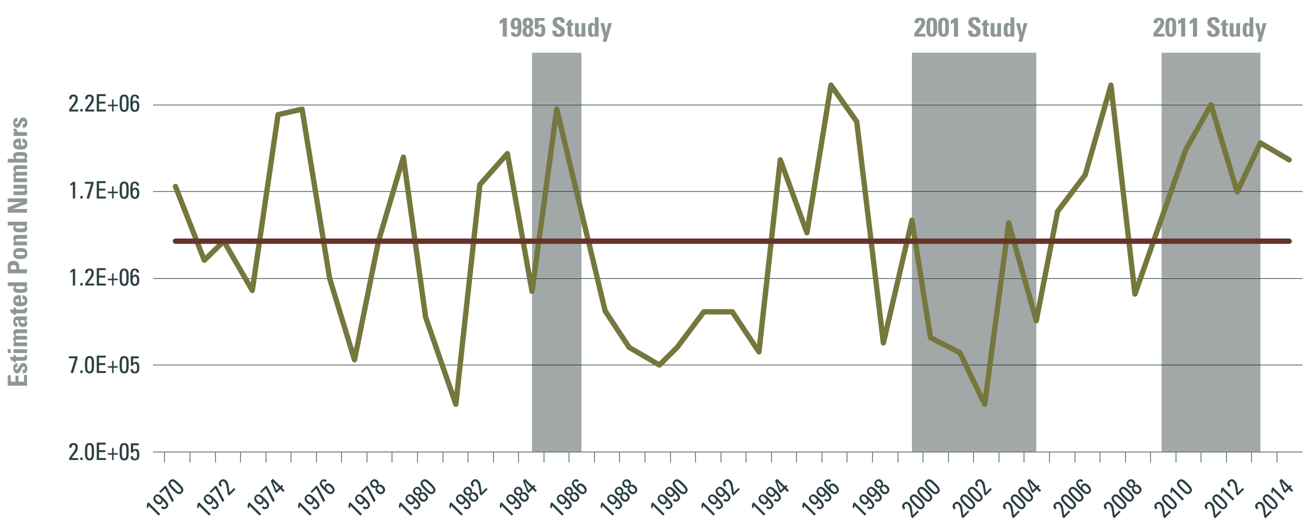


FIGURE 5C **SASKATCHEWAN**

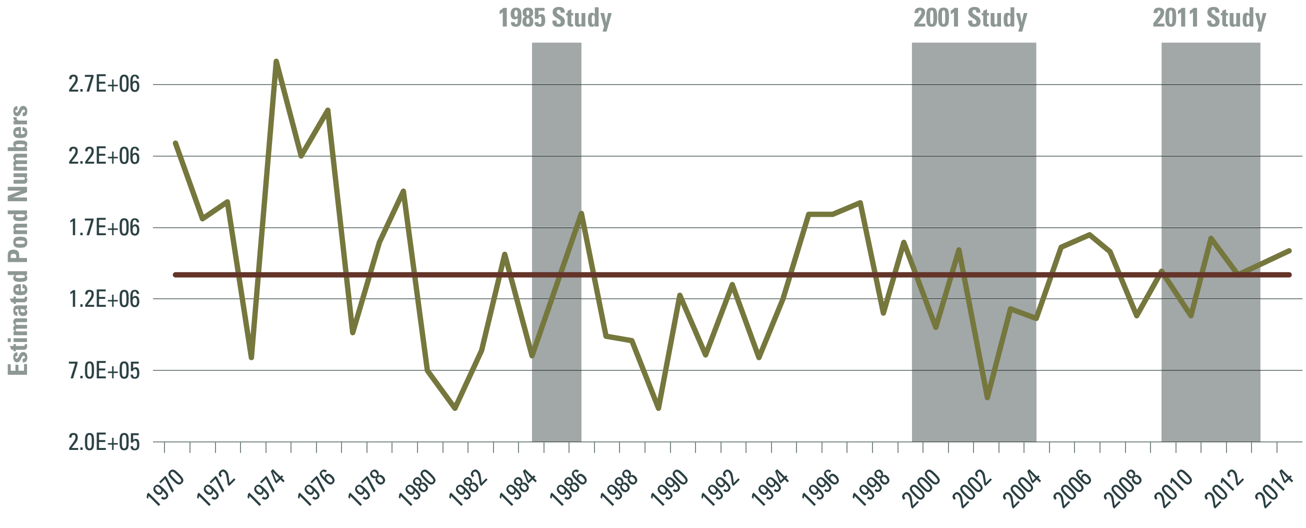


FIGURE 5D MANITOBA

Figure 5. Estimated annual pond numbers (a measure of ponds holding water during spring counts and not a measure of total basin numbers, wet and dry) in (A) PHJV (Overall), (B) Alberta, (C) Saskatchewan, and (D) Manitoba study areas derived from the North American WBPHS. Shaded areas indicate the three different study periods. The red trend line indicates the long-term average from 1970 to 2014.

CHANGES IN WETLAND HABITATS, 2001–2011

This section provides results for both wetland area and wetland number changes. Wetland habitat changes are summarized as gross and net results, cover composition, basin size, estimates of total wetland area, margin area, and cumulative (1985 to 2011) wetland habitat loss. Relative and absolute habitat measures are provided as applicable.

Gross Wetland Area Loss

Gross wetland losses report total lost wetland habitat area, excluding any wetland gains on monitoring transects (**Table 2**). Mean relative gross area losses are relative to baseline (2001) area totals for the specific sample group or category. Absolute wetland area loss totals present a summary of total gross wetland area that has been identified as lost wetland habitat area for the specific transect grouping.

Overall, 653.3 ha of wetland habitat area were classified as lost between 2001 and 2011, with a mean gross wetland area loss of 2.6% (95% CI [1.9, 3.3]).

It is worth noting that there is considerable range in loss measurements over the entire sample, with the minimum equalling 0% and maximum over 60% loss in wetland area relative to the baseline wetland area **(Table 2)**. The Aspen Parkland Ecoregion experienced the greatest gross wetland area loss, with a mean loss of 3.5% (95% CI [2.3, 4.6]) and an absolute loss of 306.3 ha, accounting for the largest percentage (47%) of the absolute total wetland habitat area lost across the PHJV sample. The Aspen Parkland Ecoregion contains some of the highest wetland basin number densities in the PHJV study area. This prevalence of wetland basins, combined with wetter conditions circa 2011, appears to have been a primary driver for increased wetland area loss in this Ecoregion in comparison to other Ecoregions in the PHJV. This combination of wet conditions and higher wetland densities is suspected of increasing potential for negative implications to agricultural operations. It was observed that under wetter conditions the footprint of individual wetlands expanded considerably resulting in the loss of access to previously farm-able area. Thus some form of anthropogenic intervention was required in-order to access these now flooded basins for agricultural production.

Among the provinces, absolute total gross wetland area loss was greatest in Saskatchewan at 56% of total wetland area loss in the overall PHJV sample **(Table 2)**. The Saskatchewan portion of the PHJV contained the largest proportion of overall PHJV land area, and also accounted for the largest area of Aspen Parkland in the PHJV. Saskatchewan also contained some of the highest estimated wetland pond densities in the PHJV. All of these factors combined likely resulted in heightened potential for wetland habitat to be impacted in Saskatchewan as compared to the other provinces. When Ecoregions are compared by province, the absolute wetland area losses in the Aspen Parkland represented the greatest percentage in each of Alberta (62%), Saskatchewan (35%), and Manitoba (62%) **(Figure 6)**.

Mean gross wetland habitat area loss was greatest in Manitoba 4.3% (95% CI [2.8, 5.7]) and lowest in Alberta 1.3% (95% CI [0.8, 1.8]).

Overall, the dominant impact resulting in the loss of wetland area was the creation of surface ditches. A wide range of ditch construction types were observed over the sample **(Figure 7)**. Drainage is often required as part of agricultural production to remove excess surface water in wetter regions, as well as to manage salt and water balances in the root zone of drier irrigated regions. Water table and drainage management are crucial to agricultural production (*Madramootoo et al. 2007*).

Table 2. Relative gross wetland habitat area loss by Ecoregion and province; 2001–2011.

Ecoregion by Province		Absolute Gross Wetland Area Lost (ha)	Proportion of Lost Area (%)	Mean Gross Loss (%) [95% CI]	Min (%)	Max (%)
PHJV (Overall)	AB	147.4	22	1.3 [0.8,1.8]	0.0	15.7
	SK	363.9	56	3.2 [1.9,4.6]	0.0	60.4
	MB	142.0	22	4.3 [2.8,5.7]	0.1	19.6
	PHJV Totals	653.3	100	2.6 [1.9,3.3]	0.0	60.4
Boreal Transition	AB	35.8	32	1.1 [-0.2,2.4]	0.0	15.7
	SK	72.5	65	3.0 [-0.6,6.5]	0.0	41.7
	MB	3.8	3	1.6 [NA]	1.5	2.3
	PHJV Totals	112.1	100	1.8 [0.3,3.3]	0.0	41.7
Aspen Parkland	AB	91.1	30	1.9 [1.0,2.8]	0.0	15.7
	SK	126.7	41	4.1 [1.6,6.7]	0.0	37.2
	MB	88.5	29	5.4 [3.3,7.5]	0.1	15.8
	PHJV Totals	306.3	100	3.5 [2.3,4.6]	0.0	37.2
Moist Mixed Grassland	AB	24.2	20	1.0 [0.0,2.0]	0.0	10.0
	SK	95.5	80	2.5 [-0.6,5.5]	0.0	60.4
	PHJV Totals	119.7	100	1.9 [0.1,3.7]	0.0	60.4
Mixed Grassland	AB	13.8	16	0.5 [-0.2,1.2]	0.0	5.8
	SK	72.9	84	2.3 [1.0,3.6]	0.0	19.9
	PHJV Totals	86.8	100	1.6 [0.7,2.4]	0.0	19.9
Fescue Grassland	AB	3.7	100	0.7 [0.4,1.0]	0.0	1.1
	PHJV Totals	3.7	100	0.7 [0.4,1.0]	0.0	1.1
Cypress Upland	AB	0.4	12	0.4 [NA]	0.4	0.4
	SK	2.9	88	2.8 [NA]	2.8	2.8
	PHJV Totals	3.3	100	1.7 [NA]	0.4	2.8
Lake MB Plain	MB	49.5	100	3.4 [0.4,6.4]	0.2	19.6
	PHJV Totals	49.5	100	3.4 [0.4,6.4]	0.2	19.6
SW MB Uplands	MB	0.1	100	0.1 [NA]	0.1	0.1
	PHJV Totals	0.1	100	0.1 [NA]	0.1	0.1
Interlake Plain	MB	23.9	100	3.9 [NA]	1.5	19.6
	PHJV Totals	23.9	100	3.9 [NA]	1.5	19.6

Figure 6. Proportion of absolute gross wetland habitat area losses by Ecoregion in (A) PHJV (Overall), (B) Alberta, (C) Saskatchewan, and (D) Manitoba; 2001–2011.

Figure 7. An example of a large, recently constructed drainage ditch targeting semi-permanent wetlands.

Gross Wetland Area Loss – Annual Loss Rates

Annual loss rates of both wetland area and number are calculated for individual transects based on baseline and update imagery dates and/or the date of related ground verification **(Table 3)**. Wetland loss rates are provided for summary purposes only; it is not expected that the loss of wetland basins occurs at a constant rate through time.

Mean annual gross wetland area loss rates for the PHJV equaled 0.31%, and were greatest in the Lake Manitoba Plain (0.48%) and Aspen Parkland Ecoregions (0.38%). Provincially, annual gross wetland area loss rates were highest in Manitoba (0.51%), and the Manitoba Aspen Parkland average annual gross wetland area loss rate equalled 0.61%. The maximum annual gross wetland area loss rate for a single transect occurred in the Moist Mixed Grassland Ecoregion of Saskatchewan (8.6%).

Table 3. Relative annual gross wetland area loss by Ecoregion and province; 2001–2011.

Ecoregion by Province		Mean Annual Gross Loss (%) [95% CI]	Min (%)	Max (%)
PHJV (Overall)	AB	0.16 [0.10,0.22]	0.0	2.0
	SK	0.39 [0.22,0.55]	0.0	8.6
	MB	0.51 [0.34,0.67]	0.01	2.4
	PHJV Totals	0.31 [0.22,0.40]	0.0	8.6
Boreal Transition	AB	0.15 [0.00,0.29]	0.0	1.7
	SK	0.34 [-0.14,0.82]	0.0	6.0
	MB	0.20 [NA]	0.2	0.3
	PHJV Totals	0.22 [0.02,0.41]	0.0	6.0
Aspen Parkland	AB	0.22 [0.11,0.33]	0.0	2.0
	SK	0.44 [0.19,0.70]	0.0	3.7
	MB	0.61 [0.39,0.83]	0.01	1.6
	PHJV Totals	0.38 [0.26,0.51]	0.0	3.7
Moist Mixed Grassland	AB	0.13 [-0.01,0.28]	0.0	1.4
	SK	0.34 [-0.09,0.78]	0.0	8.6
	PHJV Totals	0.26 [0.00,0.51]	0.0	8.6
Mixed Grassland	AB	0.05 [-0.01,0.11]	0.0	0.6
	SK	0.31 [0.14,0.48]	0.0	2.5
	PHJV Totals	0.20 [0.09,0.31]	0.0	2.5
Fescue Grassland	AB	0.07 [0.04,0.10]	0.0	0.1
	PHJV Totals	0.07 [0.04,0.10]	0.0	0.1
Cypress Upland	AB	0.04 [NA]	0.0	0.0
	SK	0.47 [NA]	0.5	0.5
	PHJV Totals	0.27 [NA]	0.0	0.5
Lake Manitoba Plain	MB	0.48 [0.05,0.90]	0.0	2.4
	PHJV Totals	0.48 [0.05,0.90]	0.0	2.4
SW MB Uplands	MB	0.01 [NA]	0.0	0.0
	PHJV Totals	0.01 [NA]	0.0	0.0
Interlake Plain	MB	0.51 [NA]	0.2	2.4
	PHJV Totals	0.51 [NA]	0.2	2.4

Figure 8. An example of intensive ditching construction targeting multiple wetland basins in a cultivated field.

Composition Summary of Lost Wetland Area

Prairie wetlands are commonly considered to be dominated by three *Stewart and Kantrud (1971)* wetland cover types: temporary, seasonal, and semi-permanent *(Hubbard 1988)*. Furthermore, the majority of all prairie wetlands can be classified as palustrine as defined by *Cowardin et al. (1979)* and dominated by the emergent marsh category *(Dahl 2014)*. Wetland classification in the PHMP focused on dominant wetland cover types at the habitat polygon level. These wetland cover polygons are equivalent to wetland vegetative zones in *Stewart and Kantrud (1971)*. Wetland cover types included in this study also included wetlands considered to be ephemeral, inclusive of remotely detectable, low prairie basin types.

Composition summary information presented here reports the types of wetlands lost, as categorized according to baseline conditions (2001 classification; **Table 4**). Partial wetland basin losses are also included in this composition summary.

Overall, in the PHJV sample, 57% of the absolute wetland habitat area lost between 2001 and 2011 was classified as cultivated in the 2001 baseline **(Figure 9)**. Dry conditions in 2001 resulted in an increased opportunity for cultivation within wetland basins without the need for drainage. When water levels are low or absent, agricultural operations can incorporate wetland area into the overall production area. The dryer conditions in 2001 resulted in many wetlands being converted to agricultural production which, in the absence of drainage, is not considered a wetland loss. In circa 2011, many wetlands that had been converted to cropland in 2001 were classified as lost due to evidence of drainage/filling in the basin. The dominant proportion of previously cultivated wetland basin area making up the total wetland habitat area lost (57% of absolute gross wetland area lost was classified as cultivated in 2001) is suggestive of a preference for targeting wetland basins suitable for crop production **(Figure 9)**. It is suspected that once wetland area has been accessible to production activities, it may be considered as flooded agricultural land when wetter conditions return and, thus, possibly be targeted for drainage or other measures to ensure the land is kept in production to the extent possible.

Agricultural producers, land owners, and users of the land are generally not able to capture compensation for the various functions wetlands provide to the public (*Leitch 1983*). Rising crop prices, higher input costs, and high land prices continue to make wetland drainage/filling/conversion a potentially cost effective alternative to new land purchases and, thus, wetland basin types that lend themselves to easy conversion to annual crop production through limited drainage/filling/manipulation appear to be primary targets for wetland loss or degradation.

Annually cropped basin area lost as a percentage of total lost wetland area was greatest in the Moist Mixed Grassland Ecoregion, equalling 71%. Provincially, the highest percentage of lost wetland habitat area classified as cultivated occurred in Saskatchewan, equalling 69% of total wetland area lost in the province. Except for Alberta, the cultivated wetland basin type accounted for the majority of wetland habitat area losses. It is important to note that the conversion of a wetland basin to cultivation without evidence of drainage or filling did not result in classification as lost wetland area and, instead, was captured as a change in wetland cover and activity type within the basin.

The grass/sedge marsh habitat cover type made up 34% of all wetland habitat area lost in the PHJV sample, where the greatest loss (54%) occurred in Alberta. As the majority of grass/sedge wetland habitats are shallow, range from ephemeral to seasonal with regards to permanence, and require minimal resources to fill or drain, these wetland areas make good candidates for conversion to crop production or other uses.

The grass and sedge wetland cover type accounts for more than half the total wetland area sampled and is thus the most abundant basin classification by wetland area in PHJV. The prevalence of the grass/sedge type wetland results in an increased potential for the targeted land use conversion for this wetland habitat type.

Instances of grass/sedge wetlands drainage for the purpose of increased grazing access, hay production, and land development/resource extraction were also recorded.

Wooded wetland habitat types represented only 5% of total absolute wetland area lost in the PHJV **(Table 4)**. Losses of wooded wetland area were greatest in Alberta, equalling 7% of the total provincial wetland area lost. Wooded wetland area losses were mostly the result of the drainage/filling of entire wetland basins. Wooded area losses were predominantly made up of cleared wooded wetland zones as part of a larger basin drainage/filling and clearing operation. Wooded wetland area losses also included the conversion of some wooded bog habitats in the Boreal Transition Ecoregion.

The combination of deep marsh and open water pond habitat accounted for 2% of the total wetland area lost in the PHJV sample. Losses to open water pond habitat were highest in the Boreal Transition Ecoregion accounting for 2% of the total wetland habitat area losses for the Ecoregion. The majority of lost area for these two wetland cover types was the result of partial wetland basin impacts primarily as the result of filling. Deep marsh and open water pond habitats often hold large volumes of water, which require large scale ditching operations to remove. It is suspected that the smaller area of deep marsh and open water pond habitats recorded as loss is a result of the expected larger costs and complexity of draining or filling these basin types.

Losses classified as either artificial or 'other' (drainage, streams, riparian areas, alkali mudflats, etc.) each represented 1% of absolute wetland area lost. In total, 8% of all lost wetland area in the Fescue Grassland Ecoregion was classified as artificial, the highest proportion of lost artificial wetland area for all Ecoregions in the PHJV. Loss of artificial wetland area was due to the filling of dugouts, drainage retention ponds, and general gravel pit operations.

Table 4. Percent composition of absolute wetland area losses by Ecoregion, province, and basin cover type; 2001–2011.

Ecoregion by Province		Annual Crop	Grass/ Sedge Marsh	Wooded	Deep Marsh	Open Water	Artificial	Other
PHJV (Overall)	AB	30	54	7	1	2	2	3
	SK	69	22	4	1	1	<1	2
	MB	51	42	5	1	0	<1	<1
PHJV Totals		57	34	5	1	1	1	1
Boreal Transition	AB	17	51	15	<1	5	4	7
	SK	69	13	8	<1	0	1	<1
	MB	14	10	76	0	0	0	0
PHJV Totals		47	27	14	<1	2	2	3
Aspen Parkland	AB	32	56	5	1	1	3	1
	SK	65	27	4	1	1	<1	1
	MB	51	43	3	2	0	1	0
PHJV Totals		53	39	4	1	1	1	1
Moist Mixed Grassland	AB	44	46	4	0	0	2	4
	SK	78	13	1	<1	1	1	6
PHJV Totals		71	21	1	<1	1	1	5
Mixed Grassland	AB	25	65	<1	3	0	2	0
	SK	69	29	1	<1	0	<1	<1
PHJV Totals		63	34	1	1	0	1	<1
Fescue Grassland	AB	4	77	10	0	0	8	0
PHJV Totals		4	77	10	0	0	8	0
Cypress Upland	AB	41	59	0	0	0	0	0
	SK	0	100	0	0	0	0	0
PHJV Totals		5	95	0	0	0	0	0
Lake MB Plain	MB	55	44	<1	0	0	0	<1
PHJV Totals		55	44	<1	0	0	0	<1
SW MB Uplands	MB	0	0	30	0	0	0	70
PHJV Totals		0	0	30	0	0	0	70
Interlake Plain	MB	65	35	0	0	0	0	0
PHJV Totals		65	35	0	0	0	0	0

Figure 9. Gross wetland habitat area losses by basin cover type in (A) PHJV (Overall), (B) Alberta, (C) Saskatchewan, and (D) Manitoba; 2001–2011.

Gross Wetland Area Loss by Cover Type

Mean gross wetland area loss by wetland cover type summarizes results within specific wetland cover categories relative to baseline data for that specific wetland category **(Table 5)**. This summary provides information as to the magnitude of wetland area losses by cover type for comparison among wetland habitat types, exclusive of any wetland gains or cover type shifts. Gross wetland area loss by cover type is calculated in the same manner as overall gross wetland area loss, but is computed by individual wetland cover type as opposed to all wetlands combined.

Overall, the mean gross area loss for the annually cropped wetland cover equalled 8.8% (95% CI [6.8, 10.7]) in the PHJV. Provincially, this was greatest in Manitoba, equalling 16.9% (95 % CI [10.4, 23.4]), and by Ecoregion, this was greatest in the Interlake Plain, equalling 41.2% (95% CI [NA]). Once again these data are suggestive of a preference for targeting previously cropped wetland basin areas for conversion through drainage and/or filling activities.

The grass/sedge marsh wetland habitat cover had a mean gross loss in area of 1.7% (95% CI [1.3, 2.1]) between 2001 and 2011. Again, this loss was greatest in Manitoba, equalling 3.0% (95% CI [1.5, 4.6]). By Ecoregion, the Cypress Upland also had the highest mean gross grass/sedge marsh wetland area loss, equalling 2.6% (95% CI [NA]). The shallow nature of the grass/sedge wetland category likely makes the drainage and/or filling of these types of wetland habitats more feasible and less cost restrictive. The shallow nature of these basin depressions also makes the wetlands more suitable for conversion to other land uses with limited requirements for filling or leveling **(Figure 10)**.

Figure 10. An example of a shallow grass and sedge (seasonal) wetland basin being filled and leveled.

Mean gross wetland area losses for the deep marsh cover in the entire PHJV study area equalled 0.4% (95% CI [0.2, 0.6]), and by Ecoregion, were greatest in the Aspen Parkland (0.7% (95% CI [0.2, 1.1])) **(Table 5)**.

Mean gross wetland area losses for the wooded wetland cover in the entire PHJV study area equalled 1.4% (95% CI [0.9, 1.9]) **(Table 5)**. Wooded wetland cover types were most prevalent as components of larger wetland basin complexes. The loss of wooded cover type was predominantly the result of clearing following drainage and prior to any filling (if required) of the basin. The majority of wooded wetland area losses occurred within the wet meadow zones of wetland basins.

Open water pond habitats remained relatively stable with a mean gross wetland area loss of 0.2% (95% CI [0.1, 0.4]).

Open water pond habitats appear to require significant costs and planning if conversions through drainage/filling are to take place. For the most part, this appears to be a barrier to the loss of this wetland habitat type; however, losses of open water habitat as a component of wetland basins and the loss of open water pond dominated basins were recorded in this update.

Table 5. Relative mean gross percent wetland area loss by Ecoregion, province, and cover type; 2001–2011.

Ecoregion by Province		Annual Crop	Grass/ Sedge Marsh	Wooded	Deep Marsh	Open Water
PHJV (Overall)	AB	3.6 [2.2,5.1]	1.3 [0.8,1.9]	0.8 [0.3,1.3]	0.3 [-0.1,0.6]	0.2 [0.0,0.5]
	SK	9.5 [6.4,12.6]	1.5 [1.0,2.0]	1.8 [0.8,2.7]	0.3 [0.1,0.6]	0.3 [0.1,0.5]
	MB	16.9 [10.4,23.4]	3.0 [1.5,4.6]	2.5 [1.2,3.8]	0.8 [0.3,1.3]	0.0 [0.0,0.0]
	PHJV Totals	8.8 [6.8,10.7]	1.7 [1.3,2.1]	1.4 [0.9,1.9]	0.4 [0.2,0.6]	0.2 [0.1,0.4]
Boreal Transition	AB	4.4 [0.4,8.5]	1.4 [-0.4,3.1]	0.7 [-0.3,1.7]	0.0 [0.0,0.0]	0.2 [-0.6,1.0]
	SK	10.8 [1.3,20.4]	0.8 [0.0,1.7]	1.7 [-0.5,3.9]	0.2 [-0.1,0.5]	0.0 [0.0,0.0]
	MB	1.6 [NA]	0.4 [NA]	6.4 [NA]	0.0 [NA]	0.0 [NA]
	PHJV Totals	8.4 [3.2,13.6]	1.1 [0.2,2.0]	1.3 [0.3,2.3]	0.1 [0.0,0.2]	0.2 [-0.3,0.6]
Aspen Parkland	AB	5.6 [2.9,8.3]	2.0 [1.0,3.0]	0.9 [0.0,1.8]	0.4 [-0.4,1.2]	0.2 [0.0,0.4]
	SK	14.2 [7.5,20.8]	2.2 [0.9,3.5]	2.0 [0.5,3.6]	0.6 [-0.1,1.2]	0.4 [-0.1,1.0]
	MB	18.8 [10.3,27.2]	4.0 [1.4,6.6]	1.7 [0.0,3.4]	1.2 [0.3,2.1]	0.0 [0.0,0.0]
	PHJV Totals	12.5 [8.8,16.1]	2.5 [1.7,3.4]	1.5 [0.7,2.2]	0.7 [0.2,1.1]	0.3 [0.0,0.5]
Moist Mixed Grassland	AB	3.9 [0.2,7.5]	0.7 [-0.1,1.5]	1.8 [0.3,3.4]	0.0 [0.0,0.0]	0.0 [0.0,0.0]
	SK	5.8 [0.8,10.8]	0.7 [0.3,1.1]	0.3 [-0.4,1.0]	0.1 [-0.1,0.4]	0.5 [0.3,0.8]
	PHJV Totals	5.4 [1.9,8.9]	0.7 [0.3,1.1]	0.7 [0.1,1.4]	0.1 [-0.1,0.3]	0.3 [0.1,0.5]
Mixed Grassland	AB	0.8 [-0.1,1.8]	0.4 [-0.3,1.2]	0.2 [0.2,0.3]	0.3 [-0.2,0.8]	0.0 [0.0,0.0]
	SK	6.7 [3.5,9.9]	1.4 [0.7,2.1]	2.9 [-2.7,8.4]	0.2 [-0.2,0.5]	0.0 [0.0,0.0]
	PHJV Totals	5.0 [2.7,7.2]	0.9 [0.4,1.4]	2.4 [-1.6,6.4]	0.2 [-0.1,0.5]	0.0 [0.0,0.0]
Fescue Grassland	AB	0.2 [-0.1,0.4]	1.0 [0.2,1.7]	14.7 [-14.6,43.9]	0.0 [0.0,0.0]	0.0 [0.0,0.0]
	PHJV Totals	0.2 [-0.1,0.4]	1.0 [0.2,1.7]	14.7 [-14.6,43.9]	0.0 [0.0,0.0]	0.0 [0.0,0.0]
Cypress Upland	AB	0.9 [NA]	0.5 [NA]	0.0 [NA]	0.0 [NA]	0.0 [NA]
	SK	0.0 [NA]	4.1 [NA]	0.0 [NA]	0.0 [NA]	0.0 [NA]
	PHJV Totals	0.7 [NA]	2.6 [NA]	0.0 [NA]	0.0 [NA]	0.0 [NA]
Lake MB Plain	MB	16.8 [-0.9,34.5]	2.3 [0.1,4.6]	0.3 [0.0,0.7]	0.0 [0.0,0.0]	0.0 [0.0,0.0]
	PHJV Totals	16.8 [-0.9,34.5]	2.3 [0.1,4.6]	0.3 [0.0,0.7]	0.0 [0.0,0.0]	0.0 [0.0,0.0]
SW MB Uplands	MB	0.0 [NA]	0.0 [NA]	0.2 [NA]	0.0 [NA]	0.0 [NA]
	PHJV Totals	0.0 [NA]	0.0 [NA]	0.2 [NA]	0.0 [NA]	0.0 [NA]
Interlake Plain	MB	41.2 [NA]	1.6 [NA]	0.0 [NA]	0.0 [NA]	0.0 [NA]
	PHJV Totals	41.2 [NA]	1.6 [NA]	0.0 [NA]	0.0 [NA]	0.0 [NA]

Upland Cover Type Replacing Lost Wetland Habitat Area

Evaluating the upland cover type and land use replacing lost basin habitat provides a means of attributing drivers of such loss. These resultant land cover and land use conversions include direct-targeted wetland area conversion as well as partial loss of area to portions of wetland basins. This section summarizes (mean area with associated 95% CI) land cover in conjunction with land use replacing lost wetland area. The replacing cover type was determined from the classification of the lost wetland area in the 2011 period **(Table 6)**.

Across the PHJV, the dominant upland cover type replacing lost wetland area was annual crop, which made up 70.0% (95% CI [66.1, 74.0]) of the absolute total upland area replacing lost wetland basin area.

Cultivated basins replacing lost wetland area were often the result of drainage or filling of basins for incorporation into annual crop production, and a portion was a result of repeated seasonal ditching/blading impacts (i.e., non-permanent ditch construction).

Tame pasture/hay/forage was the second largest cover type replacing lost wetland area, accounting for 22.4% (95% CI [19.1, 25.8]) of the total lost wetland area. Tame pasture/hay/forage cover replacing lost wetland area was largely a function of draining grass/sedge marshes for the purpose of haying, grazing, or forage production.

Resource extraction replacing lost wetland area (primarily oil and gas and gravel pit operations) was most prevalent in the Alberta portion of the PHJV, making up 2.9% (95% CI [1.4, 4.5]) of cover totals replacing lost wetland habitat area. Losses to resource extraction were largely due to construction activities and related filling within wetland basins **(Figure 11)**.

The development cover category (buildings, roads, farmsteads, etc.) made up 5.1% (95% CI [3.6, 6.7]) of the total area of lost wetland habitat. These losses were largely the result of wetland habitat area being filled as part of construction activities. This estimate included partial and complete basin area losses.

Mean wooded area replacing lost wetland area equaled 1.4% (95% CI [0.2, 2.5]) over the PHJV sample. Wooded cover replacing lost wetland area was the result of woody encroachment into drained basins, or in some cases plantings associated with developed areas (new farmsteads, urban expansion, or similar). Often, wooded cover in drained basins was the result of incomplete wetland conversion, where clearing had not taken place at the time of update, but drainage infrastructure was completed, resulting in the basin being classified as drained.

Figure 11. An example of an extraction activity impact on a monitored wetland basin (indicated by arrow). Polygons in blue represent baseline 2001 wetlands, the imagery in the background is from 2012. Note the recently constructed resource extraction activity in the monitored wetland basin.

The dominant anthropogenic impact utilized for wetland conversion was surface ditching either permanent or seasonal constructions (see *the focus on seasonal wetland drainage* on pg. 45). New (i.e., post-2001 baseline) installations of subsurface tile were not detected or recorded on any transects for the period 2001 to 2011. Filling was the second most dominant anthropogenic activity related to wetland area loss. Filling was often only detectable if recorded during the filling activity or as a result of subsequent additional construction on the site. Drained wetland basins were often converted to a new land use such as annual crop production. Instances of non-targeted or indirect wetland drainage or filling were also recorded. Culvert construction or replacement resulted in the incidental drainage of wetland areas, as did the construction or maintenance of new roads and road allowances, primarily through the construction of deep roadside ditches that intersected previously undrained wetlands.

Road-side ditches were often utilized as consolidation points for water from drained wetlands, and small drainage networks often terminated at the roadside ditch (**Figure 12*****). A large portion of wetland drainage found in this study utilized the roadside ditch for ultimate water storage, transport, or both.***

A similar drainage impact by road networks was reported by *Smith et al. (1989),* which reported that a 1975 USFWS study estimated over 40,000 ha of wetlands had been drained, either directly from road construction or indirectly from drainage into adjacent rights-of-way in western Minnesota. *Watmough and Schmoll (2007*) estimated that 77% of all quarter-sections in the PHJV study area have roadside influence, suggestive of extensive available ditch infrastructure for water storage or transport.

Gross losses of wetland habitat area in Saskatchewan and Manitoba were dominated by annually cropped cover replacing lost wetland area, equalling 81.4% (95% CI [76.9, 85.8]) and 65.5% (95% CI [55.5, 75.4]) of the total lost wetland area respectively **(Figure 13)**. Alberta saw a more even split of replacement cover types, with 44.8% (95% CI [38.1, 51.5]) annually cropped and 40.5% (95% CI [34.3, 46.7]) tame pasture/hay/forage cover replacing lost wetland area.

Figure 12. An example of a roadside ditch being utilized for consolidation and transport of drainage water.

Table 6. Mean percent composition of upland cover type replacing lost wetland area. These are the same data as illustrated in **Figure 13.**

Ecoregion by Province		Annual Crop	Tame Pasture/ Hay/Forage	Wooded	Resource Extraction	Development
PHJV (Overall)	AB	44.8 [38.1, 51.5]	40.5 [34.3, 46.7]	2.4 [0.3, 4.5]	2.9 [1.4, 4.5]	8.7 [5.2, 12.2]
	SK	81.4 [76.9, 85.8]	13.0 [9.6, 16.4]	0.4 [0.0, 0.8]	0.3 [-0.2, 0.8]	4.8 [2.6, 7.0]
	MB	65.5 [55.5, 75.4]	28.7 [19.4, 37.9]	2.7 [-2.5, 7.9]	0.3 [-0.4, 1.0]	2.8 [0.2, 5.4]
PHJV Totals		70.0 [66.1, 74.0]	22.4 [19.1, 25.8]	1.4 [0.2, 2.5]	0.9 [0.3, 1.4]	5.1 [3.6, 6.7]
Boreal Transition	AB	36.4 [19.2, 53.5]	44.7 [27.3, 62.0]	0.5 [0.1, 0.9]	4.7 [0.5, 9.0]	13.5 [-0.3, 27.3]
	SK	71.4 [52.9, 90.0]	11.0 [1.6, 20.3]	0.9 [-0.2, 2.0]	0.1 [-0.7, 1.0]	16.2 [4.7, 27.7]
	MB	19.8 [NA]	0.0 [NA]	75.9 [NA]	0.0 [NA]	4.3 [NA]
PHJV Totals		55.9 [43.1, 68.8]	22.4 [12.6, 32.2]	5.0 [-1.3, 11.4]	1.8 [-0.1, 3.6]	14.6 [6.8, 22.3]
Aspen Parkland	AB	45.2 [35.2, 55.2]	41.4 [31.9, 50.9]	3.4 [-0.5, 7.3]	2.5 [1.3, 3.7]	7.2 [2.5, 11.8]
	SK	82.3 [76.8, 87.7]	13.5 [8.6, 18.3]	0.1 [-0.1, 0.4]	0.6 [-0.6, 1.8]	3.5 [1.2, 5.7]
	MB	70.0 [57.8, 82.2]	26.2 [14.8, 37.6]	0.1 [0.0, 0.2]	0.2 [-0.1, 0.6]	3.3 [-0.4, 7.1]
PHJV Totals		70.1 [64.4, 75.8]	23.7 [18.7, 28.8]	0.9 [-0.4, 2.1]	0.9 [0.3, 1.6]	4.3 [2.3, 6.2]
Moist Mixed Grassland	AB	68.6 [56.7, 80.4]	26.1 [17.4, 34.8]	1.1 [-2.6, 4.9]	0.0 [0.0, 0.0]	4.2 [-1.7, 10.1]
	SK	89.9 [82.6, 97.1]	6.6 [1.8, 11.5]	0.5 [-0.3, 1.3]	1.2 [-0.4, 2.8]	1.7 [-1.1, 4.5]
PHJV Totals		85.2 [78.9, 91.5]	10.9 [6.3, 15.5]	0.7 [-0.5, 1.8]	1.0 [-0.1, 2.0]	2.2 [-0.3, 4.7]
Mixed Grassland	AB	24.0 [10.2, 37.8]	52.2 [36.5, 67.8]	0.0 [0.0, 0.0]	4.7 [-4.0, 13.5]	17.2 [8.6, 25.7]
	SK	74.7 [64.9, 84.5]	21.3 [12.2, 30.5]	0.6 [-0.7, 2.0]	0.0 [0.0, 0.1]	3.3 [0.1, 6.5]
PHJV Totals		68.3 [59.3, 77.3]	25.2 [17.3, 33.2]	0.6 [-0.4, 1.5]	0.6 [-1.2, 2.5]	5.0 [1.8, 8.2]
Fescue Grassland	AB	57.7 [17.6, 97.7]	20.1 [-1.1, 41.3]	0.0 [0.0, 0.0]	3.5 [-3.3, 10.4]	8.5 [-4.0, 21.1]
PHJV Totals		57.7 [17.6, 97.7]	20.1 [-1.1, 41.3]	0.0 [0.0, 0.0]	3.5 [-3.3, 10.4]	8.5 [-4.0, 21.1]
Cypress Upland	AB	40.9 [NA]	59.1 [NA]	0.0 [NA]	0.0 [NA]	0.0 [NA]
	SK	100.0 [NA]	0.0 [NA]	0.0 [NA]	0.0 [NA]	0.0 [NA]
PHJV Totals		92.5 [NA]	7.5 [NA]	0.0 [NA]	0.0 [NA]	0.0 [NA]
Lake MB Plain	MB	53.0 [29.2, 76.9]	45.8 [22.3, 69.2]	0.3 [-0.2, 0.7]	0.6 [-2.5, 3.8]	0.3 [-3.6, 4.2]
PHJV Totals		53.0 [29.2, 76.9]	45.8 [22.3, 69.2]	0.3 [-0.2, 0.7]	0.6 [-2.5, 3.8]	0.3 [-3.6, 4.2]
SW MB Uplands	MB	0.0 [NA]	29.7 [NA]	0.0 [NA]	0.0 [NA]	70.3 [NA]
PHJV Totals		0.0 [NA]	29.7 [NA]	0.0 [NA]	0.0 [NA]	70.3 [NA]
Interlake Plain	MB	73.6 [NA]	26.4 [NA]	0.0 [NA]	0.0 [NA]	0.0 [NA]
PHJV Totals		73.6 [NA]	26.4 [NA]	0.0 [NA]	0.0 [NA]	0.0 [NA]

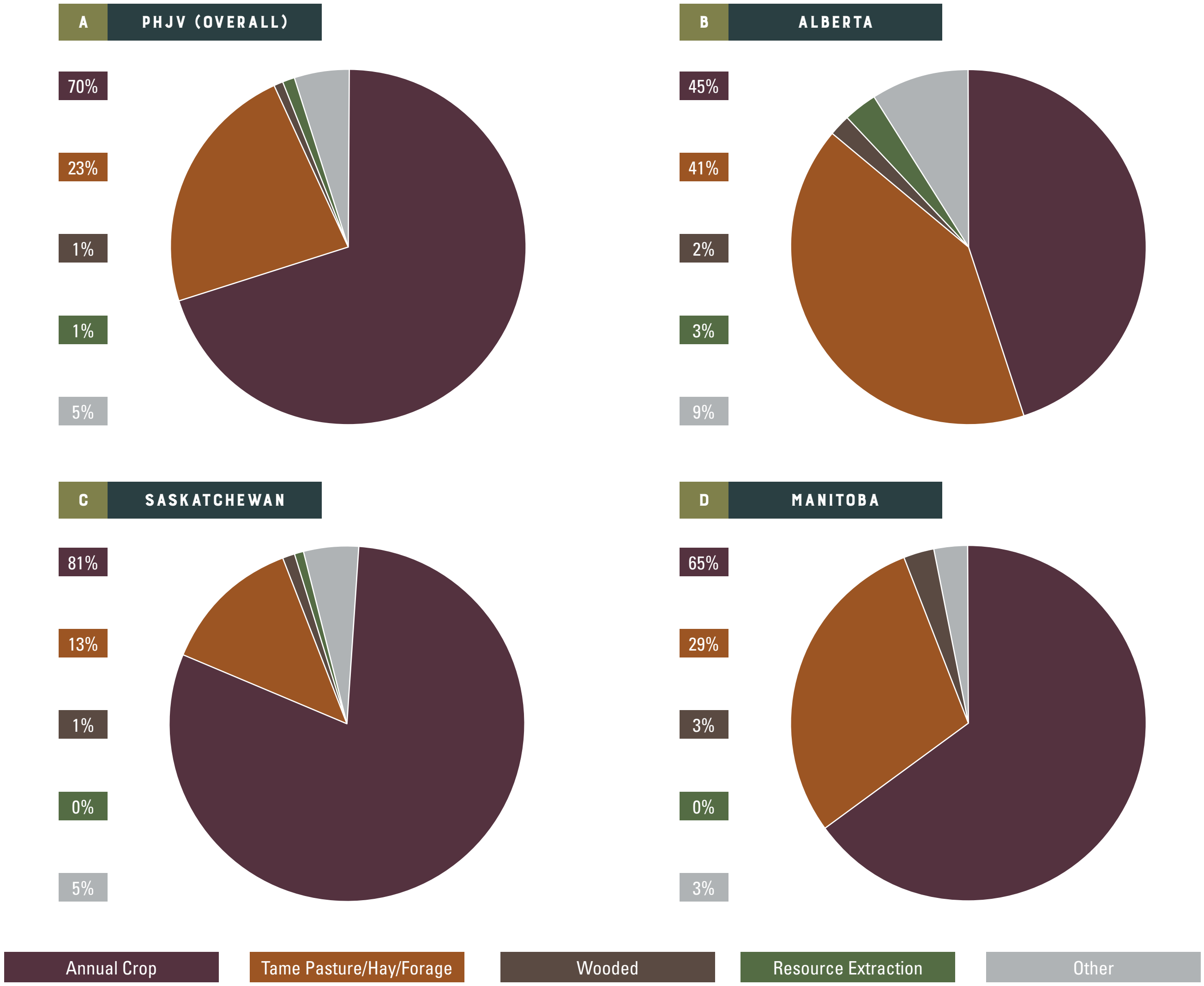


Figure 13. Upland cover replacing gross lost wetland habitat area in (A) PHJV (Overall), (B) Alberta, (C) Saskatchewan, and (D) Manitoba. These are the same data as in **Table 6**.

Relative Cumulative Gross Wetland Area Loss

Relative cumulative wetland area loss estimates were calculated by totaling all gross lost wetland area from the current and previous studies (1985–2011), as well as historically drained wetlands delineated at the time of the 1985 baseline sample construction. Cumulative wetland loss numbers provide an estimate of mean wetland area losses through time, based on detectable evidence remaining on the landscape. Cumulative loss estimates were not derived through an examination of wetland habitats prior to the 1985 baseline, but rather were based on evidence of loss from the 1985 dataset and included losses since the 1985 baseline. Historically-drained wetlands were, in some instances, identifiable from baseline 1985 air photo stereo interpretation of sampled areas; however, the date at which the loss occurred was not identifiable.

Overall, the mean estimated cumulative loss of wetland area by transects was 8.7% (95% CI [6.9, 10.5]) **(Table 7)**, with a maximum recorded loss of 80.3% of wetland area. Mean estimates of cumulative wetland area loss were highest in the Interlake and Lake Manitoba Plain Ecoregions at 19.8% (95% CI [NA]) and 16.7% (95% CI [3.5, 29.9]), respectively. Provincially, mean estimates of cumulative wetland loss were highest in Manitoba at 12.5% (95% CI [8.2, 16.8]), and the range of cumulative wetland area loss measurements was greatest in Saskatchewan ranging from 0.0–80.3% wetland area losses.

Table 7. Estimated relative cumulative gross wetland area loss by Ecoregion and province; 1985–2011.

Ecoregion by Province		Mean % [95% CI]	Min (%)	Max (%)
PHJV (Overall)	AB	7.2 [4.7,9.7]	0.0	53.2
	SK	8.7 [5.8,11.7]	0.0	80.3
	MB	12.5 [8.2,16.8]	0.2	60.0
	PHJV Totals	8.7 [6.9,10.5]	0.0	80.3
Boreal Transition	AB	9.8 [1.6,18.1]	0.0	53.2
	SK	10.1 [0.1,20.2]	0.0	76.7
	MB	9.7 [NA]	1.8	17.7
	PHJV Totals	10.0 [4.4,15.6]	0.0	76.7
Aspen Parkland	AB	9.7 [5.4,14.0]	0.0	46.7
	SK	7.1 [3.0,11.2]	0.0	52.1
	MB	11.1 [6.4,15.8]	0.4	29.1
	PHJV Totals	9.0 [6.5,11.5]	0.0	52.1
Moist Mixed Grassland	AB	5.2 [0.9,9.5]	0.0	38.0
	SK	7.8 [2.1,13.6]	0.2	80.3
	PHJV Totals	6.8 [3.1,10.5]	0.0	80.3
Mixed Grassland	AB	3.4 [-1.0,7.8]	0.0	42.1
	SK	8.7 [3.1,14.2]	0.0	72.7
	PHJV Totals	6.7 [2.9,10.4]	0.0	72.7
Fescue Grassland	AB	6.7 [-0.2,13.7]	0.6	18.4
	PHJV Totals	6.7 [-0.2,13.7]	0.6	18.4
Cypress Upland	AB	5.4 [NA]	5.4	5.4
	SK	11.8 [NA]	11.8	11.8
	PHJV Totals	8.6 [NA]	5.4	11.8
Lake MB Plain	MB	16.7 [3.5,29.9]	0.2	60.0
	PHJV Totals	16.7 [3.5,29.9]	0.2	60.0
SW MB Uplands	MB	12.6 [NA]	12.6	12.6
	PHJV Totals	12.6 [NA]	12.6	12.6
Interlake Plain	MB	19.8 [NA]	9.7	29.8
	PHJV Totals	19.8 [NA]	9.7	29.8

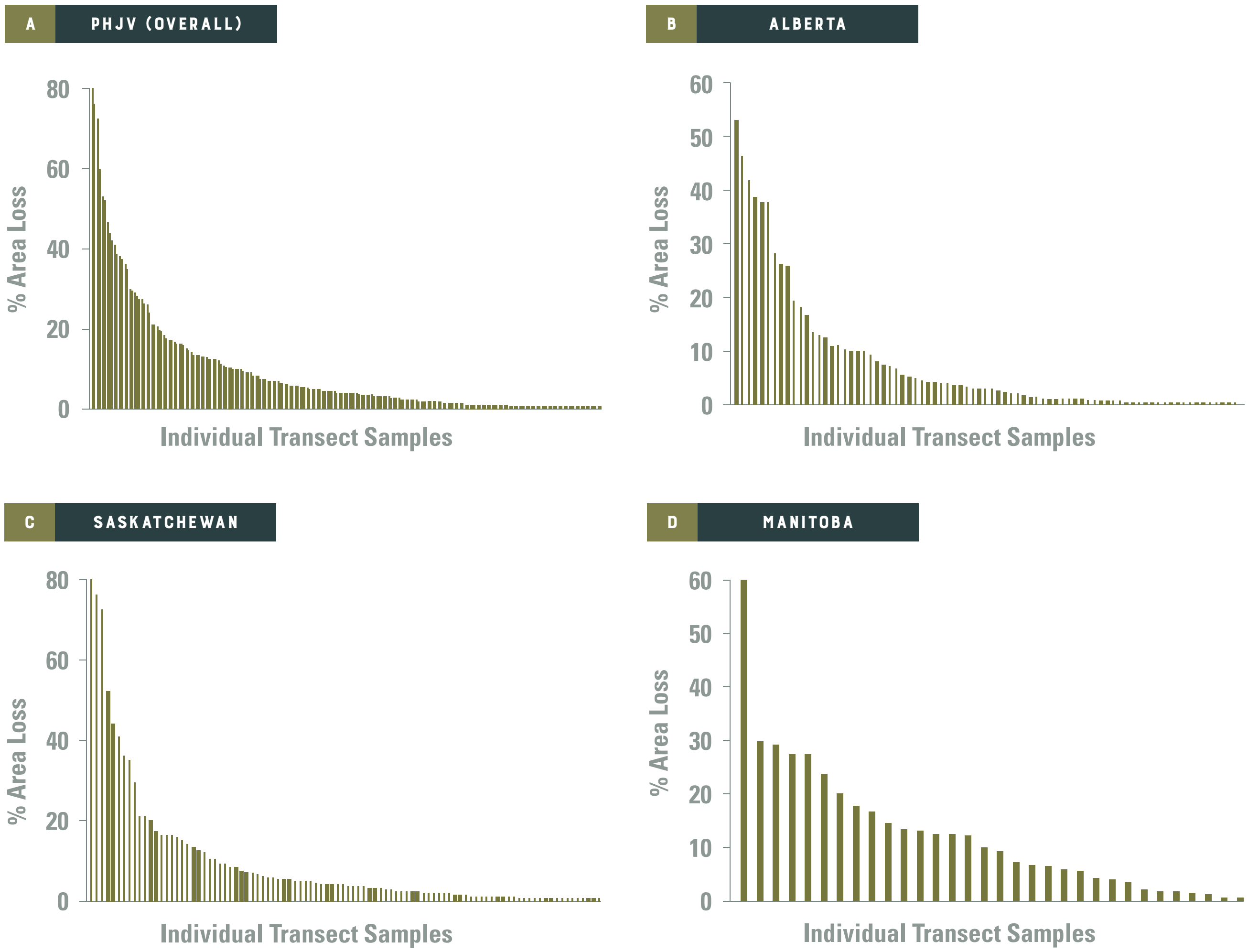


Figure 14. Cumulative gross percent wetland area loss for each individual transect in (A) PHJV (Overall, n = 221), (B) Alberta (n = 86), (C) Saskatchewan (n = 103), and (D) Manitoba (n = 32).

The cumulative loss data in Figure 14 demonstrate that wetland loss is not uniform across the PHJV delivery area; rather, wetland loss occurs in hot spots (areas with intensive targeted drainage/filling), with small-scale geographically-dispersed wetland losses related to small scale drainage operations and infrastructure impacts.

These should be considered conservative estimates of cumulative historical wetland area losses that occurred earlier than the original 1985 baseline PHJV transect sample, because it is likely that not all historical losses on transects were completely captured through this method of historical wetland area loss estimation.

FOCUS ON SEASONAL DRAINAGE

Seasonal ditching is the process of cutting, scraping, or plowing a small (often > 1 m wide and > 1 m deep) non-permanent ditch through wetlands or low areas to expedite water runoff during spring melt. Seasonal ditches predominantly target ephemeral, temporary, and seasonal wetlands, and appear to be an inadequate solution to draining more permanent wetland types due to the volume of water to be moved.

Seasonal ditches are often constructed in late fall/early winter, or even throughout the winter, and are subsequently plowed over and filled in early spring following the runoff period, negating the need for a permanent ditch construction (see **Figure 15** and **Figure 16** for examples).

By constructing ditches in fall and filling them prior to seeding operations the producer can avoid issues such as ditch maintenance and the need to farm around a permanent ditch, which can result in lost time and added cost. Seasonal ditches are often constructed along natural drainage contours. Networks of these ditches intercept shallow wetland basins, moving water off the land to road-side ditches **(Figure 15)**, consolidation wetlands, or, if available, an outlet to a stream, river, or lake.

Evidence of seasonal ditching of wetlands continues to be a challenge to capture through the monitoring program. During the 2001–2011 update process, efforts were made to account for those types of drainage to the extent possible; areas where drainage activities were common were evaluated in detail and with increased frequency by the habitat monitoring program. Late fall (post-harvest) surveys over several years in these areas were conducted along with the acquisition of late fall aerial photography to map the various seasonal ditching impacts. Field verification was also conducted to detect and collect presence/absence information regarding seasonal impacts.

During the update, if a basin was determined to be impacted by seasonal type drainage, then the basin was categorized as a drained basin habitat type. Seasonal impacts that targeted/diverted overland flow, but which could not be determined to be directly draining a wetland basin did not result in the designation of a drained basin. Seasonal impacts that targeted wetland edges (often wet meadow or shallow marsh zones) and were designed to draw down water to reduce the footprint of a wetland were considered as drainage impacts and not "wetland habitat loss", as defined in this project. Thus, those situations did not result in a loss of wetland area/number.

The transient nature of these seasonal drainage techniques make detection and determination of wetland loss difficult. The habitat monitoring program often relies on readily available aerial or satellite photography, which is often not captured during the optimal period for the detection of these seasonal drainage works. Products such as Lidar or detailed DEM/DTM models were determined to be too costly and too limited (due to no existing Lidar or high-resolution DTM for baseline 1985) to be feasible. The PHMP continues to develop methods for better estimation of seasonal drainage impacts. It is evident that seasonal drainage impacts vary annually and, thus, previously drained wetland basins could revert to un-drained status if the practice is discontinued. It has been determined that fall and late winter field surveys related to the change detection process are ideal for the determination of active seasonal drainage impacts on transects.

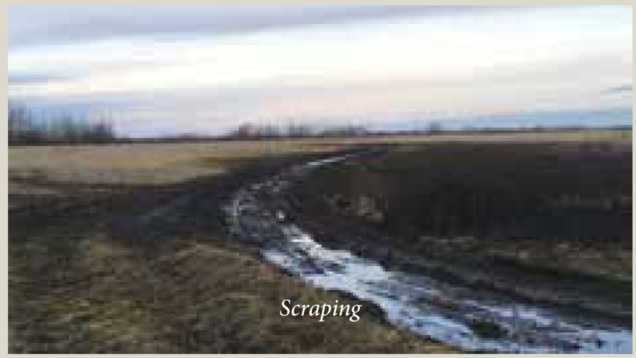
Figure 15. An example of a fall constructed ditch draining a seasonal type wetland and consolidating drained water in the roadside ditch.

Seasonal Blading/Scraping and Land Contouring

Seasonal blading consists of using various plow or scraper type implements to construct shallow soil scrapes to remove surface water from the land and/or drain targeted wetlands. Like seasonal ditching, this process occurs in late fall and/or early winter. Blading often follows natural or previously enhanced land drainage contours, and often removes the edges of shallower type basins to enhance drainage.

These subtle drainage works are very difficult to detect and to distinguish from natural drainages on the landscape. Once again, the window to document this type of impact is narrow and not at an optimal time of year for capture of other information such as wetland water level or vegetation type. Sometimes, if the seasonal blading is not detected during construction or maintenance, it may not be possible to distinguish natural drainage contours from enhanced drainage contours.

Contouring can result in the accumulation of runoff water in depressions that were not previously captured as wetlands. Contour and seasonal ditching types often move water to consolidation basins or other drainage corridors such as roadside ditches, streams, or drainage networks. Some scrape contouring or seasonal drainage ditches are designed to simply distribute water in a field and avoid accumulations that could delay or complicate production operations. Observations suggest that scraper operations can occur annually to semi-annually and as with seasonal ditches, require maintenance to maintain effectiveness.


Scraping


Contouring

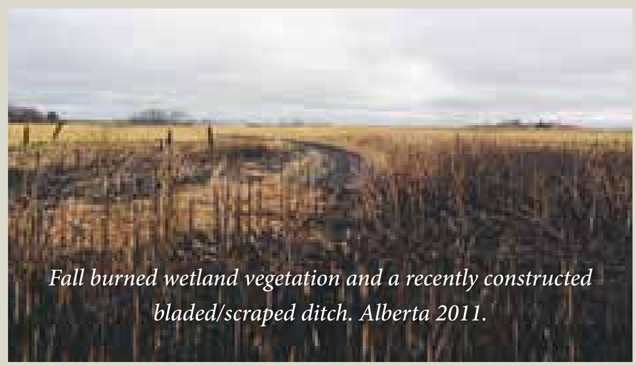

Fall burned wetland vegetation and a recently constructed bladed/scraped ditch. Alberta 2011.

Figure 16A (left) & 16B (right). (A) Shows a fall constructed ditch targeting multiple wetland areas draining early spring melt water. (B) The same area as shown in image (A) later in the spring of the same area during seeding. Note how the ditch has been removed from the landscape and all the spring runoff has been drained from the field. This seasonal drainage technique can thus be very difficult to quantify and detect.

Spring Pumping

Spring pumping of water out of wetlands for the purpose of wetland drainage is also a seasonal type of impact undertaken at various times. Due to the short duration of pumping activities, this monitoring program was not capable of quantifying or identifying this type of impact on monitored wetlands.

Figure 17. An example of a motorized pumping system being utilized to draw down a spring flooded emergent deep marsh habitat.

Fall Ditching

Figure 18. (A) A Ducks Unlimited Canada wetland restoration project in (B) 1985, and (C) 2011. Note the large drainage ditch (at location denoted by the arrow) in the baseline 1985 photo. The ditch is submerged, but still visible in the 2011 air photo; however, a drain plug/ control has been installed and the wetland has been restored. This restoration resulted in an increase in wetland habitat area on sampled PHMP transect quarter-sections.

Net Wetland Area Change – Mean Net Gains and Losses

Net wetland habitat area change reports the results of all wetland area changes, inclusive of gains and losses **(Table 8)**. Sampling error, methodological error, and sample size limitations all combine to make the statistical determination of "no net loss" of wetland area difficult to report with any statistical significance. Confidence intervals are provided with mean measures of net wetland change in an attempt to provide confidence to the measure of wetland change.

The PHJV mean net wetland habitat area change was -2.2% (95% CI [-3.2,-1.5]) for the 221 sampled transects **(Table 8)**. The greatest negative mean net wetland area change occurred in the Interlake Plain Ecoregion equalling -3.9% (95% CI [NA]); two Ecoregions saw net gains in wetland area: Fescue Grassland at 2.7% (95% CI [-4.4, 9.2]) and Cypress Upland at 3.2% (95% CI [NA]). Gains in net wetland area were largely attributable to reservoir construction, dugouts/borrow pits, gravel pit excavations, and some flooding or basin expansion due to basin consolidation.

A portion of wetland gains were the result of the abandonment of seasonal drainage impacts or the failure/abandonment of permanent drainage works, resulting in the re-establishment of wetland habitat in previously drained wetland basins. As discussed earlier (see the seasonal wetland drainage focus piece on pg. 45), seasonal drainage impacts are transient in nature and are not permanent constructions; however, wetland habitats repeatedly impacted by these seasonal drainage works were classified as drained habitats.

Transects in the Alberta portion of the PHJV saw the highest measured gain in wetland area (offsetting gross losses) on monitoring transects, primarily as a result of large borrow pits, gravel pit ponds, and the restoration of a large wetland area. Definitive evidence (i.e., determined by on-the-ground investigations) of wetland restoration activities were measured on a few transects. The most significant impact of wetland restoration was identified in Alberta. Weed Lake wetland complex restoration **(Figure 18)** in Southern Alberta contributed to a near 3% mean increase in wetland area on the transect sample in the Fescue Grassland Ecoregion by returning previously drained wetland area, which, in turn, compensated for past and present wetland area losses. This type of wetland restorative gain is beneficial to waterfowl and other water associated birds (*Galatowitsch 1998*) and is considered more desirable habitat than other human made incidental/ isolated wetland creations (dugouts/borrow pits, gravel pits, drainage retention ponds, etc.).

Overall, in the PHJV, wetland gains due to artificial wetland constructions, basin expansion due to consolidation, drainage abandonments, and discontinuation of seasonal drainage or wetland restorations were not sufficient to offset area losses in wetland habitats. However, mean net wetland area change results from the Fescue Grassland, Mixed Grassland, and Moist Mixed Grassland Ecoregions of Alberta suggest statistical uncertainty as to the overall net change of wetland area **(Table 8)** for these Ecoregions.

Table 8. Relative net wetland habitat area change by Ecoregion and province; 2001-2011.

Ecoregion by Province		Absolute Net Area Change (ha)	Mean % Change [95% CI]	Min (%)	Max (%)
PHJV (Overall)	AB	-71.5	-0.7 [-1.6,-0.1]	-10.0	19.7
	SK	-323.1	-3.0 [-4.8,-1.5]	-57.3	6.3
	MB	-130.03	-4.0 [-5.7,-2.4]	-19.1	0.3
	PHJV Totals	-524.6	-2.2 [-3.2,-1.5]	-57.3	19.7
Boreal Transition	AB	-23.8	-0.8 [-2.7,-0.1]	-9.9	0.2
	SK	-69.9	-2.8 [-9.9,1.2]	-41.7	0.8
	MB	-3.4	-1.5 [NA]	-2.1	-1.4
	PHJV Totals	-97.1	-1.5 [-5.2,-0.4]	-41.7	0.8
Aspen Parkland	AB	-60.6	-1.3 [-3.0,-0.6]	-10.04	10.6
	SK	-116.3	-3.9 [-6.4,-0.9]	-36.8	2.1
	MB	-81.05	-5.1 [-6.7,-2.3]	-15.3	0.01
	PHJV Totals	-257.9	-3.1 [-4.4,-1.9]	-36.8	10.6
Moist Mixed Grassland	AB	-16.4	-0.7 [-2.0,0.2]	-9.1	2.3
	SK	-80.6	-2.0 [-6.6,1.2]	-57.3	1.8
	PHJV Totals	-97.0	-1.5 [-4.3,0.3]	-57.3	2.3
Mixed Grassland	AB	-8.8	-0.3 [-1.0,0.1]	-4.1	0.3
	SK	-62.2	-2.1 [-3.5,-0.4]	-19.9	6.3
	PHJV Totals	-71.0	-1.4 [-2.3,-0.4]	-19.9	6.3
Fescue Grassland	AB	16.9	2.7 [-4.4,9.2]	-1.0	19.7
	PHJV Totals	16.9	2.7 [-4.4,9.2]	-1.0	19.7
Cypress Upland	AB	6.04	6.0 [NA]	6.04	6.04
	SK	0.5	0.5 [NA]	0.5	0.5
	PHJV Totals	6.6	3.2 [NA]	0.5	6.0
Lake MB Plain	MB	-44.7	-2.9 [-8.7,-0.2]	-19.1	0.3
	PHJV Totals	-44.7	-2.9 [-8.7,-0.2]	-19.1	0.3
SW MB Uplands	MB	-0.06	-0.1 [NA]	-0.1	-0.1
	PHJV Totals	-0.06	-0.1 [NA]	-0.1	-0.1
Interlake Plain	MB	-23.4	-3.9 [NA]	-19.1	-1.5
	PHJV Totals	-23.4	-3.9 [NA]	-19.1	-1.5

Net Wetland Area Change – Annual Rates

Net annual wetland change rates were calculated at the transect unit and means were derived for specific reporting units. The mean net annual wetland habitat change rate for the PHJV equaled -0.26% (95% CI [-0.35,-0.18]) **(Table 9)**. The Lake Manitoba Plain, Interlake Plain, and Aspen Parkland had the highest negative mean annual net habitat change rates, while the Fescue Grassland and Cypress Upland Ecoregions both had net positive mean annual wetland area change rates. The maximum annual loss rate recorded on PHJV transects equaled 8.19% and occurred in the Moist Mixed Grassland Ecoregion of Saskatchewan.

Provincially, Manitoba had the highest mean annual net wetland habitat area loss rate (0.47%), while Alberta had the lowest (0.10%).

Table 9. Relative annual net wetland habitat area change by Ecoregion and province; 2001–2011.

Ecoregion by Province		Mean % [95% CI]	Min (%)	Max (%)
PHJV (Overall)	AB	-0.10 [-0.16,-0.03]	-1.4	2.0
	SK	-0.35 [-0.51,-0.18]	-8.2	1.1
	MB	-0.47 [-0.64,-0.30]	-2.4	0.0
	PHJV Totals	-0.26 [-0.35,-0.18]	-8.2	2.0
Boreal Transition	AB	-0.11 [-0.20,-0.01]	-1.1	0.0
	SK	-0.31 [-0.79,0.18]	-6.0	0.1
	MB	-0.18 [NA]	-0.3	-0.2
	PHJV Totals	-0.18 [-0.37,0.01]	-6.0	0.1
Aspen Parkland	AB	-0.16 [-0.26,-0.06]	-1.4	0.9
	SK	-0.42 [-0.67,-0.16]	-3.7	0.3
	MB	-0.58 [-0.80,-0.36]	-1.5	0.0
	PHJV Totals	-0.34 [-0.46,-0.22]	-3.7	0.9
Moist Mixed Grassland	AB	-0.10 [-0.24,0.04]	-1.3	0.2
	SK	-0.28 [-0.69,0.14]	-8.2	0.3
	PHJV Totals	-0.21 [-0.45,0.04]	-8.2	0.3
Mixed Grassland	AB	-0.03 [-0.07,0.01]	-0.4	0.0
	SK	-0.29 [-0.46,-0.12]	-2.5	1.1
	PHJV Totals	-0.19 [-0.30,-0.08]	-2.5	1.1
Fescue Grassland	AB	0.27 [-0.41,0.95]	-0.1	2.0
	PHJV Totals	0.27 [-0.41,0.95]	-0.1	2.0
Cypress Upland	AB	0.60 [NA]	0.6	0.6
	SK	0.09 [NA]	0.1	0.1
	PHJV Totals	0.34 [NA]	0.1	0.6
Lake MB Plain	MB	-0.41 [-0.84,0.03]	-2.4	0.0
	PHJV Totals	-0.41 [-0.84,0.03]	-2.4	0.0
SW MB Uplands	MB	-0.01 [NA]	0.0	0.0
	PHJV Totals	-0.01 [NA]	0.0	0.0
Interlake Plain	MB	-0.50 [NA]	-2.4	-0.2
	PHJV Totals	-0.50 [NA]	-2.4	-0.2

Wetland Basin Numbers

Overall, 56,586 wetland basins were monitored and evaluated for change. Wetland basin polygons included all components of wetland habitat polygons sharing boundaries, resulting in a single count per basin. Changes in basin number reflect losses, gains, and splitting of basins by various partial basin impacts (i.e., bisecting by road, creating multiple separated basins).

Gross wetland basin number losses are a summary of complete wetland basin losses excluding any gains or partial basin losses. Gross wetland basin loss for the PHJV over the 2001–2011 period averaged 3.7% (95% CI [2.8, 4.6]) **(Table 10)** for an estimated mean annual gross wetland basin loss rate of 0.45% (95% CI [0.35, 0.56]) **(Table 11)**. Net wetland basin change in the PHJV equalled -3.1 (95% CI [-4.0,-2.2]) **(Table 10)** resulting in a calculated net annual wetland basin number change equalling -0.37% (95% CI [-0.48,-0.27]) **(Table 12)**. Results for both gross and net wetland area infer a decline in the total number of undrained, or unfilled wetland basins in the PHJV.

Gross wetland basin losses in Saskatchewan represented 56% of the total basins lost on monitoring transects. Manitoba had the highest estimated PHJV mean annual gross loss rate at 0.72% (95% CI [0.50, 0.95]) basins per year; however, the highest mean annual gross loss rate of 0.85% (95% CI [-0.21, 1.90]) basins per year occurred in the Boreal Transition Ecoregion of Saskatchewan **(Table 11)**; however, the confidence intervals for this estimate suggests statistical uncertainty.

Overall, absolute wetland basin number losses were greatest in the Aspen Parkland Ecoregion of all three provinces, representing 49% of all basin numbers lost in the PHJV. Basin number losses as a percentage of all basins lost were highest in the Aspen Parkland Ecoregion of Alberta (68%) and Manitoba (63%). Wetland basin losses in Saskatchewan were more evenly distributed among Ecoregions with 38% in the Aspen Parkland, 24% in the Moist Mixed Grassland, 21% in the Mixed Grassland, and 20% in the Boreal Transition.

The Cypress Upland was the only Ecoregion in the PHJV that had a mean net increase in wetland basin numbers, equaling 0.6% (95% CI [NA]) **(Table 10)**. Similar to other Ecoregions, wetland gains were anthropologically driven, primarily made up of dugouts, borrow pits, etc.

Provincially, mean net increases (albeit with low statistical confidence) in wetland basin numbers were recorded in the Manitoba Boreal Transition 0.7% (95% CI [NA]), Alberta Mixed Grassland 0.3% (95% CI [-0.1, 0.6]), and the Alberta Cypress Upland 1.9% (95% CI [NA]) Ecoregions **(Table 10)**. Again, recorded gains were dominated by anthropological constructions such as dugouts and borrow pits.

Mean annual net wetland basin number losses were greatest in the Boreal Transition Ecoregion of Saskatchewan equaling 0.82% **(Table 12)**. The highest annual mean net loss rate in both Alberta and Manitoba occurred in the Aspen Parkland Ecoregion (0.19% and 0.75%, respectively) of each province.

Table 10. Wetland basin change statistics by Ecoregion and province; 2001–2011.

Ecoregion by Province		Number of Wetland Basins: Total 2001	Total 2011	Mean per Transect [95% CI] 2001	Mean per Transect [95% CI] 2011	Gross Loss Mean (%) [95% CI]	Net Change Mean (%) [95% CI]
PHJV (Overall)	AB	20,986	20,797	243.9 [210.7,277.1]	241.7 [208.9,274.5]	1.8 [1.2,2.4]	-0.9 [-1.5,-0.3]
	SK	28,619	27,414	277.7 [238.7,316.8]	266.0 [228.0,304.0]	4.5 [2.7,6.2]	-4.2 [-5.9,-2.6]
	MB	6,981	6,624	218.1 [161.7,274.5]	206.8 [152.8,260.7]	6.0 [4.2,8.2]	-5.2 [-7.2,-3.2]
PHJV Totals		56,586	54,835	255.9 [232.1,279.8]	248.0 [224.7,271.2]	3.7 [2.8,4.6]	-3.1 [-4.0,-2.2]
Boreal Transition	AB	4,158	4,142	244.6 [184.5,304.6]	243.6 [183.7,303.6]	1.5 [0.6,2.5]	-0.4 [-0.9,0.1]
	SK	4,191	3,908	261.9 [169.4,354.3]	244.2 [155.1,333.3]	7.0 [-1.3,12.9]	-6.8 [-14.2,0.7]
	MB	588	592	294.0 [NA]	296.0 [NA]	0.3 [NA]	0.7 [NA]
PHJV Totals		8,937	8,642	255.3 [206.4,304.3]	246.9 [199.0,294.8]	4.0 [0.4,6.6]	-3.3 [-6.7,0.1]
Aspen Parkland	AB	11,323	11,138	343.1 [280.0,406.1]	337.5 [274.5,400.4]	2.6 [2.0,4.4]	-1.6 [-2.7,-0.6]
	SK	13,249	12,557	413.9 [332.0,495.8]	392.2 [311.9,472.5]	5.6 [2.3,8.5]	-5.2 [-8.1,-2.4]
	MB	4,548	4,253	252.7 [170.8,334.5]	235.9 [159.2,312.6]	7.3 [4.2,9.7]	-6.6 [-9.6,-3.7]
PHJV Totals		29,120	27,948	350.8 [305.7,395.8]	336.6 [292.5,380.6]	4.7 [3.4,6.3]	-4.0 [-5.5,-2.6]
Moist Mixed Grassland	AB	3,850	3,837	202.5 [126.7,278.4]	201.8 [126.8,276.9]	0.9 [0.2,2.2]	-0.3 [-1.5,0.8]
	SK	7,559	7,411	252.0 [199.9,304.0]	247.0 [194.6,299.4]	2.4 [0.5,6.8]	-2.0 [-3.7,-0.3]
PHJV Totals		11,409	11,248	232.8 [191.5,274.1]	229.5 [188.3,270.6]	1.9 [0.8,4.6]	-1.4 [-2.5,-0.3]
Mixed Grassland	AB	3,905	3,915	195.0 [152.0,238.0]	195.5 [152.5,238.5]	0.3 [-0.1,1.0]	0.3 [-0.1,0.6]
	SK	4,804	4,708	150.0 [110.0,190.0]	146.9 [107.0,186.8]	2.4 [1.3,4.7]	-2.0 [-3.5,-0.6]
PHJV Totals		8,709	8,623	167.3 [137.8,196.8]	165.6 [136.1,195.1]	1.5 [0.9,3.1]	-1.0 [-1.9,-0.1]
Fescue Grassland	AB	1,055	1,046	150.4 [74.4,226.5]	149.1 [73.6,224.6]	0.9 [-0.1,1.9]	-0.9 [-1.6,-0.1]
PHJV Totals		1,055	1,046	150.4 [74.4,226.5]	149.1 [73.6,224.6]	0.9 [-0.1,1.9]	-0.9 [-1.6,-0.1]
Cypress Upland	AB	207	211	207.0 [NA]	211.0 [NA]	1.0 [NA]	1.9 [NA]
	SK	129	127	128.0 [NA]	126.0 [NA]	0.8 [NA]	-1.6 [NA]
PHJV Totals		336	338	167.5 [NA]	168.5 [NA]	0.9 [NA]	0.6 [NA]
Lake MB Plain	MB	1,569	1,521	156.8 [51.0,262.6]	152.0 [47.6,256.4]	4.5 [1.3,10.9]	-3.1 [-6.4,0.2]
PHJV Totals		1,569	1,521	156.8 [51.0,262.6]	152.0 [47.6,256.4]	4.5 [1.3,10.9]	-3.1 [-6.4,0.2]
SW MB Uplands	MB	77	76	77.0 [NA]	76.0 [NA]	1.3 [NA]	-1.3 [NA]
PHJV Totals		77	76	77.0 [NA]	76.0 [NA]	1.3 [NA]	-1.3 [NA]
Interlake Plain	MB	422	399	140.7 [NA]	133.0 [NA]	5.9 [NA]	-5.5 [NA]
PHJV Totals		422	399	140.7 [NA]	133.0 [NA]	5.9 [NA]	-5.5 [NA]

Table 11. Relative annual gross wetland basin number loss by Ecoregion and province; 2001–2011.

Ecoregion by Province		Mean % [95% CI]	Min (%)	Max (%)
PHJV (Overall)	AB	0.21 [0.14,0.28]	0.0	2.0
	SK	0.55 [0.35,0.76]	0.0	7.8
	MB	0.72 [0.50,0.95]	0.0	2.9
	PHJV Totals	0.45 [0.35,0.56]	0.0	7.8
Boreal Transition	AB	0.20 [0.09,0.31]	0.0	0.9
	SK	0.85 [-0.21,1.90]	0.0	7.8
	MB	0.04 [NA]	0.0	0.2
	PHJV Totals	0.49 [0.02,0.96]	0.0	7.8
Aspen Parkland	AB	0.30 [0.17,0.43]	0.0	2.0
	SK	0.63 [0.33,0.92]	0.0	4.2
	MB	0.84 [0.52,1.17]	0.1	2.5
	PHJV Totals	0.53 [0.38,0.69]	0.0	4.2
Moist Mixed Grassland	AB	0.13 [0.01,0.24]	0.0	0.9
	SK	0.35 [0.08,0.62]	0.0	6.5
	PHJV Totals	0.27 [0.10,0.44]	0.0	6.5
Mixed Grassland	AB	0.03 [-0.01,0.08]	0.0	0.4
	SK	0.36 [0.14,0.58]	0.0	3.3
	PHJV Totals	0.21 [0.08,0.35]	0.0	3.3
Fescue Grassland	AB	0.11 [0.03,0.18]	0.0	0.3
	PHJV Totals	0.11 [0.03,0.18]	0.0	0.3
Cypress Upland	AB	0.10 [NA]	0.1	0.1
	SK	0.13 [NA]	0.1	0.1
	PHJV Totals	0.11 [NA]	0.1	0.1
Lake MB Plain	MB	0.64 [0.19,1.10]	0.1	2.9
	PHJV Totals	0.64 [0.19,1.10]	0.1	2.9
SW MB Uplands	MB	0.16 [NA]	0.2	0.2
	PHJV Totals	0.16 [NA]	0.2	0.2
Interlake Plain	MB	0.77 [NA]	0.4	1.3
	PHJV Totals	0.77 [NA]	0.4	1.3

Table 12. Relative annual net wetland basin number change by Ecoregion and province; 2001–2011.

Ecoregion by Province		Mean % [95% CI]	Min (%)	Max (%)
PHJV (Overall)	AB	-0.11 [-0.18,-0.04]	-1.8	1.5
	SK	-0.51 [-0.72,-0.31]	-7.8	1.4
	MB	-0.61 [-0.84,-0.38]	-2.9	0.4
	PHJV Totals	-0.37 [-0.48,-0.27]	-7.8	1.5
Boreal Transition	AB	-0.05 [-0.13,0.02]	-0.4	0.3
	SK	-0.82 [-1.88,0.24]	-7.8	0.2
	MB	0.09 [NA]	-0.1	0.1
	PHJV Totals	-0.40 [-0.88,0.07]	-7.8	0.3
Aspen Parkland	AB	-0.19 [-0.32,-0.06]	-1.8	0.9
	SK	-0.59 [-0.88,-0.30]	-4.1	0.3
	MB	-0.75 [-1.08,-0.42]	-2.4	0.4
	PHJV Totals	-0.46 [-0.61,-0.31]	-4.1	0.9
Moist Mixed Grassland	AB	-0.06 [-0.20,0.08]	-0.8	1.5
	SK	-0.29 [-0.53,-0.05]	-5.6	0.2
	PHJV Totals	-0.21 [-0.37,-0.06]	-5.6	1.5
Mixed Grassland	AB	0.03 [-0.01,0.07]	-0.1	0.3
	SK	-0.30 [-0.52,-0.09]	-3.2	1.4
	PHJV Totals	-0.15 [-0.29,-0.02]	-3.2	1.4
Fescue Grassland	AB	-0.10 [-0.18,-0.01]	-0.3	0.0
	PHJV Totals	-0.10 [-0.18,-0.01]	-0.3	0.0
Cypress Upland	AB	0.19 [NA]	0.2	0.2
	SK	-0.26 [NA]	-0.3	-0.3
	PHJV Totals	0.02 [NA]	-0.3	0.2
Lake MB Plain	MB	-0.43 [-0.84,-0.01]	-2.9	0.3
	PHJV Totals	-0.43 [-0.84,-0.01]	-2.9	0.3
SW MB Uplands	MB	-0.16 [NA]	-0.2	-0.2
	PHJV Totals	-0.16 [NA]	-0.2	-0.2
Interlake Plain	MB	-0.71 [NA]	-1.0	-0.4
	PHJV Totals	-0.71 [NA]	-1.0	-0.4

Wetland basin densities are predominantly driven by land forms ranging from areas of hummocky moraines pitted with depressions of various sizes *(Coupland 1961)* to landscapes of mostly lacustrine and fluvial materials, which average fewer wetlands per square kilometer than hummocky terrain *(Adams and Hutchison 1976)*. The retention of minimum wetland densities in anthropogenically dominated landscapes is considered fundamental to the conservation of many wetland dependent species, as higher wetland densities generally equate to reduced isolation among wetlands *(Gibbs 2000)*, which is important for maintaining natural levels of connectivity across the landscape.

Wetland densities generated for the PHJV, from the circa 2011 update samples **(Figure 19)** range from 0.82 to 64.28 basins per square kilometer for an estimated total number of basins in the PHJV equaling 9,156,787 (95% CI [8,298,458; 10,015,117]) **(Table 13)**. The highest wetland densities predominantly occur in the Aspen Parkland Ecoregion and the lowest occurring in the dry Mixed Grassland Ecoregion. Densities of wetlands are expected to vary regionally according to local surface form, glacial materials and relief *(Adams 1988)*. This reduction in mean wetland basins per transect is inconclusive at the landscape scale. It is clear that on some transect samples wetland densities have been reduced substantially, however, the effects of this local decrease on wetland density at the landscape level cannot be determined with certainty **(Table 13)**. Further analysis is required to evaluate wetland density change in more detail.

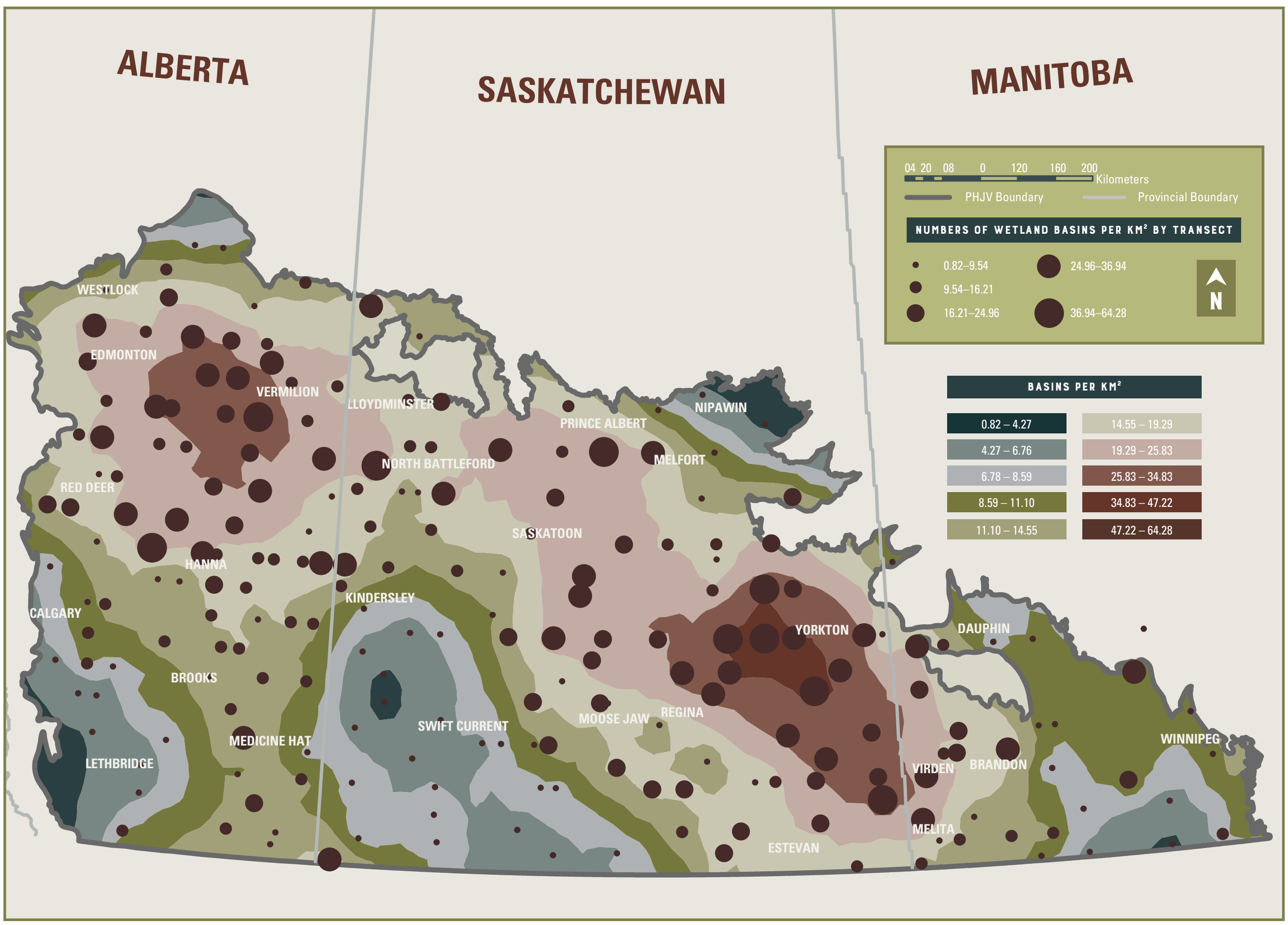


Figure 19. Wetland basins per km² in the PHJV extrapolated from 2011 transect wetland basin counts.

Table 13. Wetland basin density and extrapolated total wetland basins in the PHJV; 2001 and 2011.

Ecoregion	Mean Wetland Basin Density on Transect Samples (Basins / km²)		Estimated Total Number of Wetland Basins in the Entire PHJV [95% CI]	
	2001	2011	2001	2011
PHJV (Overall)	16.5 [15.0, 18.1]	16.0 [14.5, 17.5]	9,450,858 [8,569,945; 10,331,771]	9,156,787 [8,298,458; 10,015,117]
Boreal Transition	15.9 [12.8, 18.9]	15.4 [12.4, 18.4]	1,588,736 [1,284,169; 1,893,304]	1,536,288 [1,238,145; 1,834,431]
Aspen Parkland	22.2 [19.4, 25.1]	21.3 [18.5, 24.1]	3,883,372 [3,384,759; 4,381,984]	3,726,105 [3,238,031; 4,214,179]
Moist Mixed Grasslands	15.2 [12.5, 17.9]	15.0 [12.3, 17.6]	1,508,366 [1,241,036; 1,775,696]	1,486,812 [1,220,342; 1,753,283]
Mixed Grasslands	11.0 [9.0, 12.9]	10.9 [8.9, 12.8]	1,462,640 [1,204,841; 1,720,440]	1,447,844 [1,189,678; 1,706,011]
Fescue Grassland	10.3 [5.1, 15.5]	10.2 [5.0, 15.4]	151,833 [75,087; 228,579]	150,535 [74,325; 226,745]
Cypress Upland	10.7 [NA]	10.7 [NA]	91,047 [NA]	91,590 [NA]
Lake Manitoba Plain	10.0 [3.2, 16.7]	9.7 [3.0, 16.3]	324,710 [105,620; 543,800]	314,770 [98,531; 531,009]
SW Manitoba Uplands	4.8 [NA]	4.7 [NA]	10,245 [NA]	10,112 [NA]
Interlake Plain	8.8 [NA]	8.3 [NA]	33,322 [NA]	31,506 [NA]

Wetland Cover Type Composition

Prairie wetlands are commonly considered to be dominated by three *Stewart and Kantrud (1971)* wetland cover types: temporary, seasonal, and semi-permanent *(Hubbard 1988)*. Furthermore, the majority of all prairie wetlands can be classified as palustrine as defined by *Cowardin et al. (1979)* and dominated by the emergent marsh category *(Dahl 2014)*. Wetland classification in the PHMP focused on dominant wetland cover types at the habitat polygon level. These wetland cover polygons are equivalent to wetland vegetative zones in *Stewart and Kantrud (1971)*. Wetland cover types included in this study also included wetlands considered to be ephemeral, inclusive of remotely detectable, low prairie basin types. Cover type classifications are point in time determinations.

The dominant wetland cover type surveyed was the grass/sedge marsh, which made up 52% of the total wetland area sampled in both the baseline and update **(Table 14, Figure 20)**. It is worth reminding the reader that the grass/sedge marsh has the largest spread of wetland classification types in the classification structure, including Low Prairie, Wet Meadow, and Shallow Marsh type wetland zones (as defined in *Stewart and Kantrud 1971*).

Cultivated basins were predominantly made up of ephemeral, temporary, and seasonal *Stewart and Kanturde (1971)* wetland types that were in a cultivated state at the time of the 2001 baseline. Cultivated (farmed wetland basins with cropland cover types) wetland basin cover was most prevalent in the Moist Mixed Grassland Ecoregion at 24.5% (95% CI [18.2, 30.8]) in the baseline and 19.2% (95% CI [13.4, 25.0]) of the total wetland area for that Ecoregion sample in the update **(Table 14)**.

The largest wetland shift occurred in the cultivated wetland cover category with a composition decrease in proportion equalling 5% **(Figure 20)** on the monitoring transects. The reduction in annually cropped wetland area was consistent across Ecoregions, with the exception of the Cypress Upland of Alberta and Saskatchewan. Reduction in annually cropped wetland area was largely a result of targeted wetland drainage activities and the return to wetter conditions in the 2011 update year. Wet conditions were limiting to cultivation activities within wetland basins and, thus, many previously cultivated wetlands returned to a different wetland cover type, often grass/sedge marsh, once cultivation activities within the basin had ceased. Frequently cultivated wetland basins are likely less attractive nesting habitats as the tall robust wetland vegetation is often replaced with short stands of weak-stemmed annuals or bare soil *(Kantrud and Stewart 1984)*.

***The transition of cultivated to grass/sedge marsh cover types is driven by annual variation in moisture and surface water. Drier years allow for access to wetland basins for annual crop production (without the need for drainage), and in wetter years, without the aid of drainage, operators are unable to incorporate these basins into crop production. The result is to have previously cultivated basins return to non-cultivated wetland cover types* (Figure 21).**

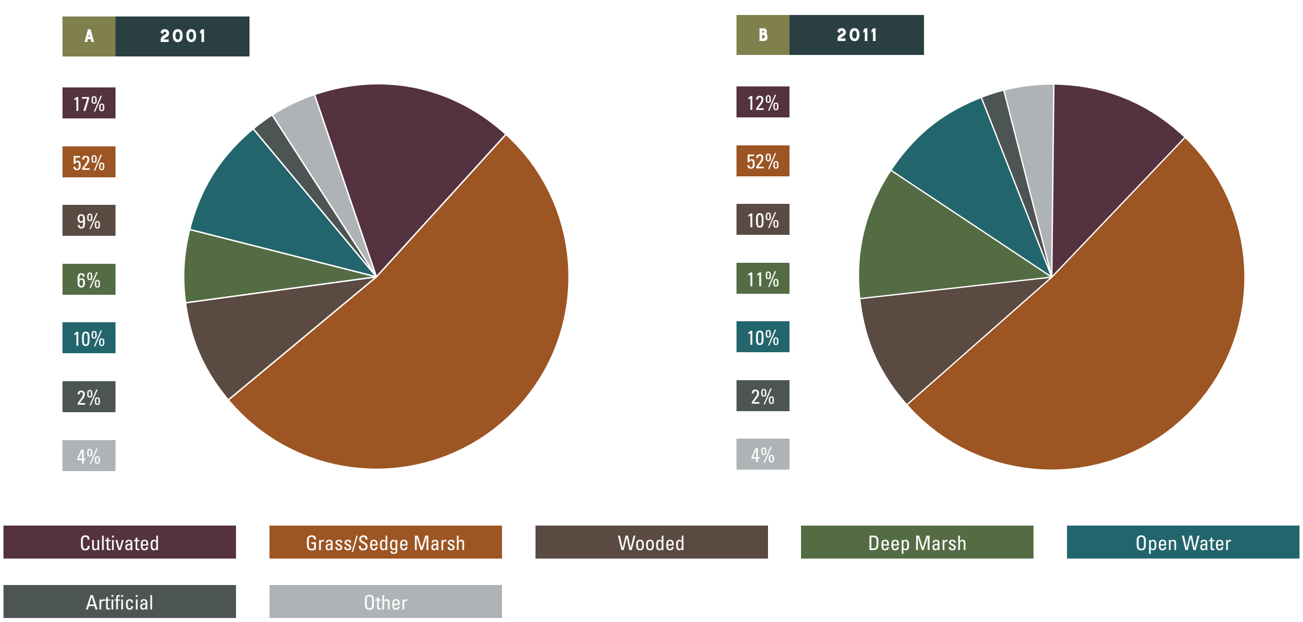


Figure 20. Comparison of baseline (2001) and update (2011) wetland area cover composition.

Figure 21. A previously cultivated wetland basin returning to a grass/sedge marsh dominated cover type.

A portion of reverted (i.e., classified as cultivated in baseline and grass/sedge marsh in update) basins appeared to be dominated by invasive species with limited vegetative diversity and may not resemble pre-disturbance conditions or function. *Mullhouse and Galatowitsch (2002)* provided measured observations, suggesting that many restored wetlands are dominated by invasive species, and that significant planting, seeding, and aftercare would likely be required to return disturbed wetlands to a closer representation of what existed historically. These reverted basins have not been restored, however, do to a return of surface water, vegetation shifts have been observed.

Deep marsh cover type increased from 6.7% (95% CI [5.5, 7.9]) to 12.8% (95% CI [10.8, 14.7]) of the total wetland area sampled in the Aspen Parkland Ecoregion **(Table 14).** Deep marsh cover type increases were the result of wetter conditions on the prairies in comparison to circa 2001, resulting in the re-establishment of deeper water habitats.

Across the overall PHJV area, mean wooded wetland area changed from 8.7% (95% CI [7.1, 10.4]) to 9.6% (95% CI [7.9, 11.2]) of total wetland area between 2001 and 2011 **(Table 14)**. Wooded cover was most often made up of *Salix* sp. and either dominated entire shallow wetland basins or made up the cover type present in the wet meadow zone of a multi-polygon wetland basin. Again, the prevalence of this cover type was largely a function of wetter conditions on the Prairies around the time of the update years. These wetter conditions resulted in shifts in vegetative communities and changes in land use practices within wetland basins, primarily as a function of soil wetness limiting potential land uses in this wetland zone.

Wooded wetland increases were greatest in Alberta and Saskatchewan, largely as a function of woody growth within shallower zones of wetland basins. Wooded wetland areas in Manitoba declined largely as a function of drier conditions allowing for clearing activities within basins, or in some cases natural die-off of woody vegetation. Clearing of wooded wetlands was sometimes done in combination with wetland drainage activities.

The other wetland cover category included wetlands in transition, mud flats, and riparian stream habitats. The composition for this cover type remained relatively unchanged at 4.4% (95% CI [2.7, 6.1]) of the total wetland area sampled in the update **(Table 14)**. Changes in the other category were also attributable to wet/dry cycles (for example graminoid regrowth in what was previously a mudflat dominated basin, the cultivation of portions of an alkali mudflat wetland, or the expansion of an open water area within an alkali basin) and general land use shifts.

The overall total area composition of the remaining wetland types (open water and artificial) remained essentially unchanged between base and update years. Measured increases in the area of artificial wetland cover types were the results of new constructions and not simply cover shifts related to wet and dry cycles.

Table 14. Wetland composition by cover type, as a percentage of total wetland area by PHJV, Ecoregion and province; 2001 and 2011.

Ecoregion by Province		Composition % (change from 2001)													
		Annual Crop		Grass/Sedge Marsh		Wooded		Deep Marsh		Open Water		Artificial		Other	
		2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
PHJV (Overall)	AB	11.0 [7.8, 14.1]	8.0 [5.4, 10.5] (-3.0)	53.7 [49.1, 58.4]	54.8 [50.0, 59.5] (1.0)	10.9 [7.5, 14.3]	11.6 [8.2, 15.0] (0.7)	5.4 [4.1, 6.7]	7.5 [6.0, 9.0] (2.1)	12.7 [9.1, 16.3]	11.6 [8.4, 14.8] (-1.1)	1.4 [1.1, 1.8]	1.8 [1.3, 2.3] (0.4)	4.8 [2.1, 7.4]	4.7 [2.1, 7.3] (-0.1)
	SK	23.6 [19.6, 27.7]	17.1 [13.5, 20.7] (-6.5)	48.9 [45.5, 52.3]	47.4 [44.2, 50.6] (-1.5)	6.7 [5.1, 8.3]	8.3 [6.4, 10.1] (1.5)	6.5 [5.0, 8.0]	12.2 [10.4, 14.1] (5.7)	7.9 [6.0, 9.8]	8.6 [6.6, 10.5] (0.6)	1.4 [1.0, 1.9]	1.5 [1.1, 1.9] (0.1)	4.6 [2.1, 7.1]	4.9 [2.2, 7.5] (0.3)
	MB	12.8 [8.0, 17.6]	9.0 [4.2, 13.9] (-3.7)	59.5 [52.8, 66.1]	55.4 [48.1, 62.8] (-4.0)	8.8 [5.4, 12.2]	7.7 [4.6, 10.7] (-1.1)	7.9 [6.2, 9.6]	14.2 [11.0, 17.4] (6.3)	7.2 [3.8, 10.6]	9.6 [5.9, 13.4] (2.5)	1.9 [0.1, 3.7]	2.1 [0.4, 3.9] (0.2)	2.0 [-0.4, 4.4]	1.9 [-0.6, 4.4] (-0.1)
PHJV Totals		16.9 [14.4, 19.3]	12.1 [10.0, 14.3] (-4.7)	52.4 [49.8, 55.1]	51.6 [49.0, 54.3] (-0.8)	8.7 [7.1, 10.4]	9.6 [7.9, 11.2] (0.8)	6.3 [5.4, 7.1]	10.5 [9.4, 11.7] (4.3)	9.8 [8.0, 11.5]	10.0 [8.3, 11.7] (0.2)	1.5 [1.2, 1.9]	1.7 [1.3, 2.1] (0.2)	4.3 [2.6, 6.0]	4.4 [2.7, 6.1] (0.1)
Boreal Transition	AB	4.2 [1.7, 6.7]	3.2 [0.3, 6.0] (-1.0)	41.2 [31.0, 51.4]	40.3 [31.1, 49.5] (-0.9)	23.7 [14.2, 33.3]	24.8 [15.1, 34.4] (1.0)	5.6 [3.2, 8.1]	7.2 [4.6, 9.9] (1.6)	23.1 [13.1, 33.1]	22.4 [12.7, 32.1] (-0.7)	0.7 [0.5, 0.9]	0.9 [0.2, 1.5] (0.1)	1.4 [0.4, 2.4]	1.2 [0.2, 2.1] (-0.2)
	SK	18.8 [10.5, 27.1]	10.6 [6.2, 15.0] (-8.2)	48.2 [41.4, 55.1]	47.4 [41.0, 53.9] (-0.8)	14.0 [7.8, 20.2]	15.2 [8.8, 21.6] (1.2)	6.5 [1.8, 11.2]	12.9 [7.6, 18.2] (6.4)	8.2 [3.3, 13.1]	9.7 [4.9, 14.5] (1.5)	1.0 [-0.1, 2.0]	1.1 [0.0, 2.1] (0.1)	2.4 [-1.0, 5.7]	2.9 [-1.3, 7.1] (0.5)
	MB	14.0 [NA]	11.5 [NA]	39.1 [NA]	31.8 [NA] (-7.3)	18.8 [NA]	15.1 [NA] (-3.7)	6.9 [NA]	13.6 [NA] (6.7)	20.1 [NA]	27.5 [NA] (7.3)	0.4 [NA]	0.3 [NA] (0.0)	0.7 [NA]	0.3 [NA] (-0.4)
PHJV Totals		10.0 [5.9, 14.1]	6.3 [3.8, 8.8] (-3.7)	43.6 [37.7, 49.4]	42.3 [36.9, 47.6] (-1.3)	20.0 [14.5, 25.5]	20.8 [15.2, 26.4] (0.8)	6.0 [3.9, 8.2]	9.6 [7.1, 12.2] (3.6)	17.6 [11.9, 23.4]	18.3 [12.7, 23.9] (0.7)	0.8 [0.4, 1.2]	0.9 [0.4, 1.4] (0.1)	1.7 [0.3, 3.1]	1.7 [0.1, 3.4] (0.0)
Aspen Parkland	AB	10.9 [7.0, 14.9]	8.7 [4.7, 12.8] (-2.2)	52.6 [46.2, 58.9]	52.6 [46.2, 59.0] (0.0)	10.6 [6.3, 14.9]	11.9 [7.5, 16.3] (1.3)	5.7 [4.0, 7.3]	8.7 [6.7, 10.7] (3.1)	12.8 [7.4, 18.3]	10.4 [6.2, 14.7] (-2.4)	1.2 [0.8, 1.6]	1.8 [0.9, 2.7] (0.6)	6.1 [1.4, 10.8]	5.7 [1.1, 10.3] (-0.3)
	SK	18.9 [14.1, 23.6]	12.1 [8.2, 16.0] (-6.8)	51.3 [46.8, 55.8]	48.6 [43.8, 53.4] (-2.6)	9.0 [6.5, 11.6]	10.7 [7.9, 13.5] (1.7)	6.9 [4.6, 9.3]	14.9 [11.5, 18.2] (7.9)	11.1 [7.4, 14.7]	10.7 [7.0, 14.5] (-0.3)	1.2 [0.6, 1.8]	1.3 [0.8, 1.9] (0.1)	1.6 [-1.2, 4.5]	1.7 [-1.2, 4.5] (0.1)
	MB	14.7 [7.2, 22.3]	10.4 [2.3, 18.6] (-4.3)	57.6 [50.2, 65.0]	51.2 [43.8, 58.6] (-6.4)	9.9 [4.8, 15.1]	8.7 [3.8, 13.6] (-1.2)	8.5 [6.3, 10.7]	17.3 [12.7, 21.9] (8.8)	6.6 [2.3, 11.0]	9.3 [5.2, 13.4] (2.7)	0.9 [0.6, 1.3]	1.2 [0.6, 1.7] (0.2)	1.6 [-0.4, 3.6]	1.8 [-0.6, 4.2] (0.2)
PHJV Totals		14.8 [11.9, 17.8]	10.4 [7.6, 13.1] (-4.4)	53.1 [49.6, 56.5]	50.8 [47.3, 54.3] (-2.3)	9.8 [7.6, 12.1]	10.8 [8.5, 13.1] (1.0)	6.7 [5.5, 7.9]	12.8 [10.8, 14.7] (6.1)	10.9 [8.1, 13.7]	10.3 [7.9, 12.7] (-0.6)	1.1 [0.8, 1.4]	1.5 [1.0, 1.9] (0.3)	3.4 [1.1, 5.8]	3.4 [1.0, 5.8] (0.0)

Table 14. Continued.

Ecoregion by Province		Composition % (change from 2001)													
		Cropland		Grass/Sedge Marsh		Wooded		Deep Marsh		Open Water		Artificial		Other	
		2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Moist Mixed Grassland	AB	11.5 [6.1, 16.9]	7.2 [1.9, 12.6] (-4.3)	65.0 [58.3, 71.7]	68.6 [60.8, 76.4] (3.6)	2.3 [0.5, 4.1]	2.8 [0.7, 4.8] (0.5)	3.5 [0.4, 6.6]	5.4 [1.9, 8.9] (1.9)	4.1 [0.0, 8.1]	2.5 [-0.8, 5.9] (-1.5)	1.9 [0.8, 2.9]	2.2 [1.0, 3.3] (0.3)	11.7 [4.5, 19.0]	11.3 [4.3, 18.3] (-0.5)
	SK	33.5 [24.6, 42.3]	27.5 [19.4, 35.6] (-5.9)	45.5 [38.8, 52.2]	42.5 [37.1, 47.9] (-3.1)	4.4 [2.4, 6.5]	7.2 [4.1, 10.3] (2.8)	5.1 [3.6, 6.6]	9.2 [6.8, 11.7] (4.2)	3.4 [1.5, 5.2]	5.3 [2.9, 7.7] (1.9)	1.6 [0.7, 2.5]	1.7 [0.8, 2.6] (0.1)	6.5 [1.8, 11.2]	6.6 [1.8, 11.3] (0.1)
PHJV Totals		24.5 [18.2, 30.8]	19.2 [13.4, 25.0] (-5.3)	53.5 [48.1, 58.8]	53.2 [47.6, 58.8] (-0.3)	3.6 [2.2, 5.0]	5.4 [3.4, 7.4] (1.8)	4.4 [3.0, 5.9]	7.6 [5.7, 9.6] (3.2)	3.7 [1.8, 5.5]	4.2 [2.2, 6.1] (0.5)	1.7 [1.1, 2.4]	1.9 [1.2, 2.6] (0.2)	8.6 [4.7, 12.6]	8.5 [4.6, 12.4] (-0.1)
Mixed Grassland	AB	14.6 [3.6, 25.7]	8.8 [2.2, 15.4] (-5.8)	72.1 [61.4, 82.7]	75.2 [65.0, 85.5] (3.2)	0.2 [-0.1, 0.5]	0.2 [-0.1, 0.5] (0.0)	5.2 [1.4, 9.0]	6.6 [2.3, 10.9] (1.4)	2.1 [0.1, 4.1]	3.4 [0.4, 6.4] (1.3)	1.8 [1.1, 2.5]	1.9 [1.2, 2.7] (0.1)	3.8 [-1.1, 8.7]	3.8 [-1.2, 8.7] (0.0)
	SK	23.4 [14.7, 32.1]	20.2 [11.9, 28.5] (-3.2)	48.8 [40.3, 57.4]	49.4 [41.5, 57.2] (0.5)	0.7 [0.1, 1.4]	0.8 [0.1, 1.4] (0.0)	7.1 [3.8, 10.4]	9.7 [6.2, 13.1] (2.6)	7.8 [3.7, 11.9]	7.6 [3.4, 11.8] (-0.3)	1.8 [1.0, 2.7]	1.6 [1.0, 2.2] (-0.2)	10.3 [5.0, 15.5]	10.7 [5.2, 16.2] (0.5)
PHJV Totals		19.9 [13.1, 26.7]	15.6 [9.8, 21.4] (-4.3)	58.1 [50.9, 65.3]	59.8 [52.8, 66.8] (1.7)	0.5 [0.1, 0.9]	0.5 [0.1, 1.0] (0.0)	6.3 [3.9, 8.8]	8.4 [5.8, 11.1] (2.1)	5.6 [2.8, 8.3]	5.9 [3.0, 8.7] (0.3)	1.8 [1.3, 2.4]	1.7 [1.3, 2.2] (-0.1)	7.7 [3.5, 11.8]	7.9 [3.6, 12.2] (0.2)
Fescue Grassland	AB	18.8 [0.4, 37.3]	14.3 [1.6, 27.0] (-4.6)	54.1 [43.1, 65.1]	54.6 [45.0, 64.3] (0.5)	0.5 [0.1, 0.8]	0.5 [0.1, 0.9] (0.1)	3.2 [0.4, 5.9]	5.9 [0.7, 11.1] (2.7)	16.9 [2.7, 31.1]	16.4 [8.0, 24.8] (-0.5)	2.3 [0.5, 4.1]	2.4 [0.6, 4.1] (0.1)	4.0 [0.4, 7.7]	5.7 [0.9, 10.5] (1.6)
PHJV Totals		18.8 [0.4, 37.3]	14.3 [1.6, 27.0] (-4.6)	54.1 [43.1, 65.1]	54.6 [45.0, 64.3] (0.5)	0.5 [0.1, 0.8]	0.5 [0.1, 0.9] (0.1)	3.2 [0.4, 5.9]	5.9 [0.7, 11.1] (2.7)	16.9 [2.7, 31.1]	16.4 [8.0, 24.8] (-0.5)	2.3 [0.5, 4.1]	2.4 [0.6, 4.1] (0.1)	4.0 [0.4, 7.7]	5.7 [0.9, 10.5] (1.6)
Cypress Upland	AB	20.6 [NA]	19.6 [NA]	53.1 [NA]	49.5 [NA] (-3.6)	0.4 [NA]	0.3 [NA] (-0.1)	1.4 [NA]	1.3 [NA] (-0.1)	2.0 [NA]	1.9 [NA] (-0.1)	15.9 [NA]	21.3 [NA] (5.3)	6.6 [NA]	6.3 [NA] (-0.4)
	SK	3.6 [NA]	3.6 [NA] (0.0)	69.9 [NA]	61.0 [NA] (-8.8)	0.0 [NA]	0.0 [NA] (0.0)	7.5 [NA]	8.2 [NA] (0.8)	11.3 [NA]	11.2 [NA] (-0.1)	7.1 [NA]	14.7 [NA] (7.6)	0.7 [NA]	1.2 [NA] (0.5)
PHJV Totals		11.9 [NA]	11.6 [NA] (-0.3)	61.7 [NA]	55.3 [NA] (-6.4)	0.2 [NA]	0.1 [NA] (-0.1)	4.5 [NA]	4.8 [NA] (0.3)	6.8 [NA]	6.5 [NA] (-0.2)	11.4 [NA]	18.0 [NA] (6.6)	3.6 [NA]	3.7 [NA] (0.2)
Lake MB Plain	MB	11.1 [2.8, 19.4]	7.1 [0.5, 13.7] (-4.0)	64.1 [48.2, 80.1]	67.0 [50.9, 83.1] (2.8)	3.1 [0.4, 5.7]	3.3 [0.5, 6.2] (0.3)	8.2 [3.7, 12.6]	9.1 [4.7, 13.5] (1.0)	4.3 [-2.9, 11.5]	4.6 [-3.3, 12.4] (0.3)	5.4 [-1.5, 12.3]	5.7 [-0.9, 12.4] (0.3)	3.8 [-4.3, 11.9]	3.1 [-4.2, 10.4] (-0.6)
PHJV Totals		11.1 [2.8, 19.4]	7.1 [0.5, 13.7] (-4.0)	64.1 [48.2, 80.1]	67.0 [50.9, 83.1] (2.8)	3.1 [0.4, 5.7]	3.3 [0.5, 6.2] (0.3)	8.2 [3.7, 12.6]	9.1 [4.7, 13.5] (1.0)	4.3 [-2.9, 11.5]	4.6 [-3.3, 12.4] (0.3)	5.4 [-1.5, 12.3]	5.7 [-0.9, 12.4] (0.3)	3.8 [-4.3, 11.9]	3.1 [-4.2, 10.4] (-0.6)

Table 14. Continued.

Ecoregion by Province		Composition % (change from 2001)													
		Cropland		Grass/Sedge Marsh		Wooded		Deep Marsh		Open Water		Artificial		Other	
		2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
SW MB Uplands	MB	3.8 [NA]	1.4 [NA] (-2.4)	46.2 [NA]	46.9 [NA] (0.7)	15.3 [NA]	10.0 [NA] (-5.3)	16.3 [NA]	22.2 [NA] (5.9)	14.9 [NA]	15.5 [NA] (0.6)	0.7 [NA]	1.6 [NA] (0.9)	2.9 [NA]	2.4 [NA] (-0.5)
PHJV Totals		3.8 [NA]	1.4 [NA] (-2.4)	46.2 [NA]	46.9 [NA] (0.7)	15.3 [NA]	10.0 [NA] (-5.3)	16.3 [NA]	22.2 [NA] (5.9)	14.9 [NA]	15.5 [NA] (0.6)	0.7 [NA]	1.6 [NA] (0.9)	2.9 [NA]	2.4 [NA] (-0.5)
Interlake Plain	MB	6.2 [NA]	2.2 [NA] (-3.9)	85.7 [NA]	89.2 [NA] (3.6)	1.4 [NA]	1.3 [NA] (-0.1)	2.6 [NA]	2.7 [NA] (0.1)	0.4 [NA]	0.5 [NA] (0.1)	1.6 [NA]	1.8 [NA] (0.2)	2.0 [NA]	2.0 [NA] (0.0)
PHJV Totals		6.2 [NA]	2.2 [NA] (-3.9)	85.7 [NA]	89.2 [NA] (3.6)	1.4 [NA]	1.3 [NA] (-0.1)	2.6 [NA]	2.7 [NA] (0.1)	0.4 [NA]	0.5 [NA] (0.1)	1.6 [NA]	1.8 [NA] (0.2)	2.0 [NA]	2.0 [NA] (0.0)

Estimates of Total Wetland Area

Total wetland area estimates are derived through analysis of mean wetland composition over the sampled landscape **(Figure 22)**. Mean percent wetland area estimates from transect samples were then used to generate estimates of total wetland area based on the overall area for each Ecoregion. These estimates are simplistic summaries intended to provide some context to the wetland habitat change information presented in this report. Some portions of the PHJV landscape were excluded from these estimates, as they were not sampled for the dataset (national parks, major rivers, military bases, large lakes).

***Overall in the PHJV it is estimated that wetland area declined by 108,195 ha (95% CI [104,522; 111,867]) between 2001 and 2011* (Table 15).**

The 2004 baseline wetland area estimate generated for this report increased from the 2001 baseline estimate (*Watmough and Schmoll 2007*), largely as a function of under-sampling in some of the Ecoregions in 2001, which was improved for this round of updates with the additional sampling efforts established in 2004.

Based on transect analysis, it is estimated that the PHJV in circa 2011 contained approximately 4,958,697 ha (95% CI [4,542,956; 5,374,439]) of wetland area, changed from the estimate of 5,066,892 ha (95% CI [4,647,478; 5,486,306]) in circa 2001 **(Table 15)**. The Aspen Parkland Ecoregion is estimated to contain the largest amount of wetland area equalling 1,774,613 ha (95% CI [1,562,663; 1,986,563]) or 36% of the total PHJV estimated wetland area in 2011.

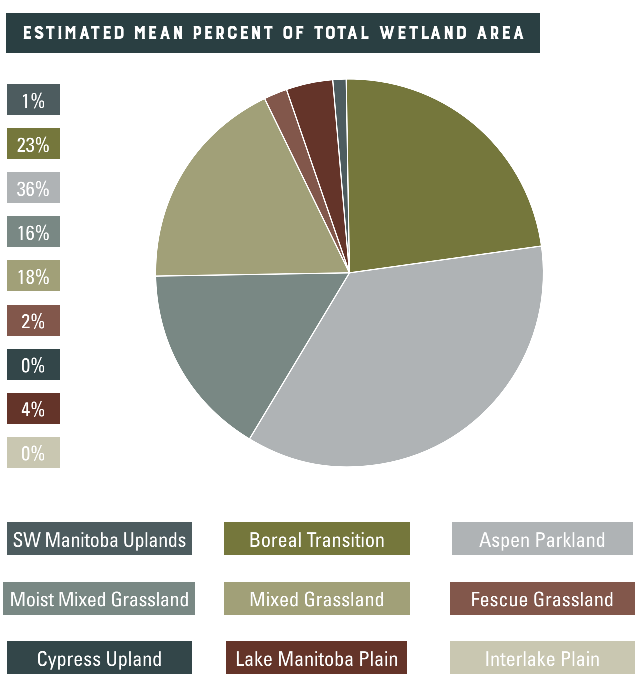


Figure 22. Estimated mean percent total wetland area by Ecoregion in 2011.

The overall mean estimated proportion of wetlands in the PHJV landscape area is estimated to have declined by 0.2% from 8.9% (95% CI [8.1, 9.6])–8.7% (95% CI [9.0, 9.4]) of the total PHJV study area as calculated from the change in area, as reported in **Table 15.** The largest estimated change in mean proportion wetland area occurred in the Aspen Parkland (10.5% (95% CI [9.2, 11.7])–10.2% (95% CI [8.9, 11.4]). In contrast, the mean proportion of wetland area in the Fescue Grassland Ecoregion changed from 6.5% (95% CI [1.3, 11.7])–6.7% (95% CI [1.5, 11.8]) **(Table 15)**, an increase in wetland area due to restoration of a few large wetlands, dugout and reservoir constructions on monitoring transects. The Boreal Transition Ecoregion is estimated to have the greatest proportion of wetland area overall at 11.3% (95% CI [9.2, 13.5]) of the total area for the Ecoregion (derived from **Table 15**).

The composition of total wetland area in a specific habitat cover type varies through time. Wet and dry cycles drive wetland cover-types; these temporal variations in wetness alone, or in combination with land-use practices, can result in shifts in wetland habitat/cover. The dominant wetland habitat type in the PHJV is the grass/sedge marsh; in 2011, estimates equaled 2,559,287 ha (95% CI [2,298,049; 2,820,475]) across all Ecoregions, changed by an -3.7% from the 2,656,667 ha (95% CI [2,387,866; 2,925,407]) estimate in 2001 **(Table 15)**. It is estimated that the largest net relative decrease in wetland area occurred in the annually cropped wetland habitat type (-29.5%), decreasing from 854,578 ha (95% CI [738,444; 970,656]) across all Ecoregions in 2001 to 602,329 ha (95% CI [509,971; 694,643]) in 2011.

The largest increase in wetland habitat type occurred in the deep marsh cover category, increasing from 316,881 ha (95% CI [257,626; 376,094]) to 522,251 ha (95% CI [432,531; 611,922]) across all Ecoregions between 2001 and 2011. Shifts to deep marsh habitat type are estimated to be greatest in the Aspen Parkland Ecoregion, which increased by 84.4% from 122,872 ha (95% CI [95,181; 150,563]) in 2001 to 226,617 ha (95% CI [173,614; 279,627]) in circa 2011. Once again, this shift in cover type is largely a function of wetter conditions in the circa 2011 update. An increase was reported both for wooded wetland and artificial wetland areas of the PHJV. The area of wooded wetland habitat types changed by 30,617 ha, increasing from an estimated area of 443,289 ha (95% CI [318,649; 567,821]) in 2001 to 473,906 ha (95% CI [347,191; 600,528]) in 2011, a net relative increase of 6.9%. Wooded wetland habitat type increases were greatest in the Aspen Parkland Ecoregion, increasing by 6.5%. Artificial wetland area changed from 76, 501 ha (95% CI [63,927; 89,067]) to an estimated 85,313 ha (95% CI [72,250; 98,370]) between 2001 and 2011. Open water and other wetland habitat categories are estimated to have remained near unchanged.

Table 15. Estimated wetland area change by Ecoregion and cover type; 2001–2011.

Ecoregion by Cover Type	Area (ha) [95% CI]		Change in Area (ha)	Net Relative Change (%)
	2001	2011		
PHJV (Overall)				
Cultivated	854,578 [738,444; 970,656]	602,329 [509,971; 694,643]	-252,249	-29.5
Grass/Sedge Marsh	2,656,667 [2,387,866; 2,925,407]	2,559,287 [2,298,049; 2,820,475]	-97,380	-3.7
Wooded	443,289 [318,649; 567,821]	473,906 [347,191; 600,528]	30,617	6.9
Deep Marsh	316,881 [257,626; 376,094]	522,251 [432,531; 611,922]	205,370	64.8
Open Water	494,982 [361,554; 628,294]	495,408 [374,608; 616,124]	426	0.1
Artificial	76,501 [63,927; 89,067]	85,313 [72,250; 98,370]	8,812	11.5
Other	217,662 [125,055; 310,177]	217,444 [126,222; 308,587]	-218	-0.1
PHJV Totals	5,066,892 [4,647,478; 5,486,306]	4,958,697 [4,542,956; 5,374,439]	-108,195	-2.2
Boreal Transition				
Cultivated	114,813 [70,134; 159,456]	71,127 [49,004; 93,238]	-43,686	-38.0
Grass/Sedge Marsh	500,701 [402,709; 598,685]	478,676 [385,894; 571,457]	-22,025	-4.4
Wooded	229,740 [129,712; 329,677]	235,688 [135,203; 336,103]	5,948	2.6
Deep Marsh	69,319 [41,877; 96,739]	108,994 [73,321; 144,648]	39,675	57.2
Open Water	202,888 [103,025; 302,652]	207,476 [110,189; 304,690]	4,588	2.3
Artificial	8,902 [6,058; 11,745]	10,065 [6,721; 13,407]	1,163	13.1
Other	19,240 [7,582; 30,884]	19,470 [7,189; 31,741]	230	1.2
PHJV Totals	1,149,713 [935,783; 1,363,643]	1,132,805 [917,283; 1,348,328]	-16,908	-1.5
Aspen Parkland				
Cultivated	271,007 [218,265; 323,747]	183,927 [141,341; 226,518]	-87,080	-32.1
Grass/Sedge Marsh	971,102 [826,916; 1,115,286]	901,049 [761,320; 1,040,788]	-70,053	-7.2
Wooded	180,180 [126,816; 233,540]	191,938 [137,310; 246,575]	11,758	6.5
Deep Marsh	122,872 [95,181; 150,563]	226,617 [173,614; 279,627]	103,745	84.4
Open Water	199,394 [130,711; 268,073]	183,491 [128,178; 238,813]	-15,903	-8.0
Artificial	21,008 [16,711; 25,304]	26,548 [19,894; 33,202]	5,540	26.4
Other	62,953 [12,367; 113,536]	60,266 [12,162; 108,382]	-2,687	-4.3
PHJV Totals	1,829,918 [1,615,274; 2,044,561]	1,774,613 [1,562,663; 1,986,563]	-55,305	-3.1
Moist Mixed Grassland				
Cultivated	198,444 [149,275; 247,531]	153,111 [110,276; 195,851]	-45,333	-22.8
Grass/Sedge Marsh	432,913 [323,027; 542,599]	424,605 [309,549; 539,421]	-8,308	-1.9
Wooded	28,901 [18,318; 39,448]	42,978 [24,139; 61,740]	14,077	48.7
Deep Marsh	35,828 [22,303; 49,305]	61,042 [39,600; 82,415]	25,214	70.4
Open Water	29,591 [10,010; 49,073]	33,139 [13,151; 53,029]	3,548	12.0
Artificial	13,854 [10,512; 17,192]	15,043 [11,551; 18,531]	1,189	8.6
Other	69,816 [22,501; 116,890]	67,911 [23,458; 112,140]	-1,905	-2.7
PHJV Totals	809,551 [656,715; 962,387]	797,955 [644,332; 951,578]	-11,596	-1.5

Table 15. Continued.

Ecoregion by Cover Type	Area (ha) [95% CI] 2001	Area (ha) [95% CI] 2011	Change in Area (ha)	Net Relative Change (%)
Mixed Grassland				
Cultivated	182,063 [123,189; 240,700]	140,902 [90,758; 190,828]	-41,161	-22.6
Grass/Sedge Marsh	531,406 [410,469; 652,083]	539,294 [417,003; 661,332]	7,888	1.5
Wooded	4,798 [179; 9,384]	4,869 [225; 9,481]	71	1.5
Deep Marsh	58,045 [23,367; 92,515]	76,129 [39,789; 112,274]	18,084	31.2
Open Water	50,760 [15,909; 85,390]	53,055 [25,275; 80,680]	2,295	4.5
Artificial	16,805 [10,849; 22,735]	15,688 [11,754; 19,611]	-1,117	-6.6
Other	70,226 [21,993; 118,154]	71,377 [22,801; 119,650]	1,151	1.6
PHJV Totals	914,572 [759,948; 1,069,195]	901,630 [747,944; 1,055,316]	-12,942	-1.4
Fescue Grassland				
Cultivated	18,113 [1,374; 35,842]	14,045 [1,787; 26,792]	-4,068	-22.5
Grass/Sedge Marsh	51,974 [15,184; 86,806]	53,704 [18,826; 86,223]	1,730	3.3
Wooded	455 [-212; 1,253]	525 [-266; 1,451]	70	15.4
Deep Marsh	3,039 [-2,006; 9,203]	5,807 [-4,189; 17,742]	2,768	91.1
Open Water	16,239 [-10,736; 49,208]	16,151 [-4,646; 39,873]	-88	-0.5
Artificial	2,210 [128; 4,430]	2,321 [323; 4,390]	111	5.0
Other	3,887 [-1,940; 10,879]	5,596 [-2,517; 15,041]	1,709	44.0
PHJV Totals	96,117 [19,597; 172,636]	98,346 [22,222; 174,470]	2,229	2.4
Cypress Upland				
Cultivated	1,806 [NA]	1,815 [NA]	9	0.5
Grass/Sedge Marsh	9,396 [NA]	8,683 [NA]	-713	-7.6
Wooded	30 [NA]	22 [NA]	-8	-26.7
Deep Marsh	687 [NA]	751 [NA]	64	9.3
Open Water	1,029 [NA]	1,028 [NA]	-1	-0.1
Artificial	1,733 [NA]	2,824 [NA]	1,091	63.0
Other	546 [NA]	587 [NA]	41	7.5
PHJV Totals	15,227 [NA]	15,709 [NA]	482	3.2
Lake Manitoba Plain				
Cultivated	22,885 [4,637; 40,964]	14,216 [-452; 28,595]	-8,669	-37.9
Grass/Sedge Marsh	131,877 [11,081; 250,881]	133,800 [13,655; 252,250]	1,923	1.5
Wooded	6,303 [1,409; 11,157]	6,640 [1,817; 11,444]	337	5.3
Deep Marsh	16,766 [-3,067; 36,135]	18,248 [-1,627; 37,693]	1,482	8.8
Open Water	8,843 [-5,890; 23,108]	9,134 [-6,824; 24,535]	291	3.3
Artificial	11,106 [-219; 22,219]	11,425 [1,393; 21,326]	319	2.9
Other	7,732 [-2,931; 18,101]	6,214 [-934; 13,194]	-1,518	-19.6
PHJV Totals	205,602 [70,312; 340,891]	199,747 [64,836; 334,658]	-5,855	-2.9

Table 15. Continued.

Ecoregion by Cover Type	Area (ha) [95% CI]		Change in Area (ha)	Net Relative Change (%)
	2001	2011		
Southwest Manitoba Upland				
Cultivated	489 [NA]	177 [NA]	-312	-63.8
Grass/Sedge Marsh	5,962 [NA]	6,053 [NA]	91	1.5
Wooded	1,977 [NA]	1,294 [NA]	-683	-34.5
Deep Marsh	2,100 [NA]	2,862 [NA]	762	36.3
Open Water	1,923 [NA]	1,997 [NA]	74	3.8
Artificial	89 [NA]	211 [NA]	122	137.1
Other	372 [NA]	311 [NA]	-61	-16.4
PHJV Totals	12,913 [NA]	12,904 [NA]	-9	-0.1
Interlake Plain				
Cultivated	1,620 [NA]	566 [NA]	-1,054	-65.1
Grass/Sedge Marsh	22,470 [NA]	22,501 [NA]	31	0.1
Wooded	363 [NA]	327 [NA]	-36	-9.9
Deep Marsh	678 [NA]	678 [NA]	0	0.0
Open Water	112 [NA]	133 [NA]	21	18.8
Artificial	407 [NA]	446 [NA]	39	9.6
Other	514 [NA]	503 [NA]	-11	-2.1
PHJV Totals	26,233 [NA]	25,223 [NA]	-1,010	-3.9

Wetland Margins

Wetland margin reports the area of wetland according to the dominant margin cover type measured along the perimeter of the wetland basin **(Table 16)**. The margin information therefore provides a measure of the habitat conditions in the transition zone from wetland to upland. The margin information presented here is supporting information to the wetland monitoring component of the program. Margin cover types can vary annually, driven by basin inundation/draw-down and the resultant impacts on surrounding land use.

The percent cover of dominant species in the wetland margin areas changed slightly from the 2001 baseline to the 2011 update. In the PHJV, the 2001 baseline wetland margin area was dominated by cultivated cover type (35%), followed by grassland cover (29%) **(Figure 23, Table 16)**. Slight declines were observed for both those cover types in 2011, although the difference may not be significant. The proportion of the total wetland area in both annually cropped (35–32%) and grassland (29–28%) margins show some evidence of decline, while tame pasture/hay/forage type margins increased (15–19%), and wooded and anthropogenic (roads, buildings, etc.) margins remained approximately constant (19% and 1.8%, respectively).

Wooded margin types can be found in all Ecoregions, however, are generally more prevalent in the more forested upland Ecoregion areas. The percent of wetland area with wooded margin type was highest in the Boreal Transition at 44.4% of total wetland area in the Ecoregion in 2001 and falling to 43.5% in 2011.

Wetlands with wooded margin type as a percentage of total wetland area was highest in Alberta in 2001 (24.7%) and 2011 (24.9%). The largest decrease of wetland area with wooded margin occurred in Saskatchewan, declining by 0.5% between base and update years.

Cultivated wetland margin types are a result of farming practices that incorporated transitional areas between wetland and upland into agricultural production. Generally, cultivated wetland margin areas are highest in highly modified agricultural producing Ecoregions. Wetland area with cultivated margin type was greatest in the Moist Mixed Ecoregion, equaling 44.6% of wetland area in 2001 and dropping to 40.5% in 2011 **(Table 16)**. The Fescue Grassland and Southwest Manitoba Uplands Ecoregions saw the largest decline in percentage of wetland area with cultivated margins at 5.2% and 18.5% in 2001 and 2011, respectively. Wetland margin shifts were largely the result of wetter conditions and resulting shifts in land use practices.

Provincially, some margin cover types were particularly prevalent. Overall, in the PHJV, the anthropogenic (i.e., roads, buildings, extraction activities) margin type basin area was greatest in Alberta at 3.5% of the total wetland margin area in 2011 **(Table 16)**. Within Alberta, the highest percentage of wetland area with anthropogenic margin type occurred in the Moist Mixed Grassland Ecoregion at 13.5% of the total wetland area in this Ecoregion. Cultivated margin type was most prevalent in the Saskatchewan portion of the PHJV equaling 45.2% in 2011, down from 50.4% in 2001 **(Table 16)**.

Overall, increases in wetland area with tame pasture/hay/forage margin types had the greatest increase in the Saskatchewan portion of the PHJV, increasing from 11.5–17.4% of total wetland between the baseline and update years.

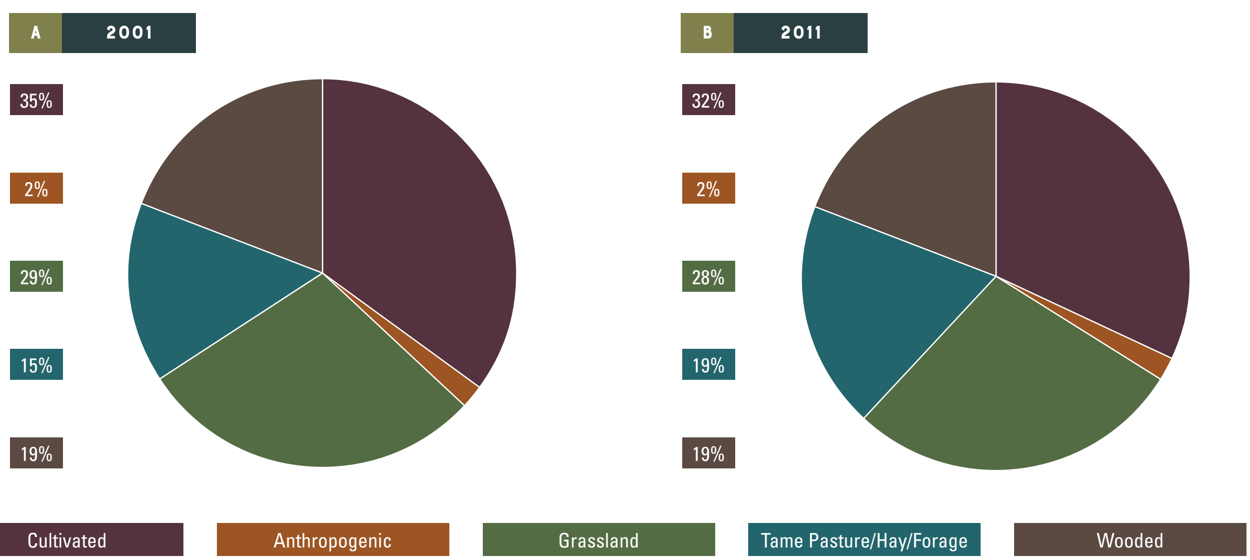


Figure 23. Comparison of wetland basin areas in the PHJV by margin type in (A) 2001 baseline and (B) 2011 update years. These data are the same as those represented in **Table 16.**

Table 16. Wetland basin margin percent area composition (change) by Ecoregion and province; 2001 and 2011.

Ecoregion by Province		Annual Crop		Grassland		Tame Pasture/ Hay/Forage		Wooded		Anthropogenic	
		2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
PHJV (Overall)	AB	17.8	17.1 (-0.7)	35.6	34.3 (-1.3)	18.3	20.1 (1.8)	24.7	24.9 (0.2)	3.6	3.5 (-0.1)
	SK	50.4	45.2 (-5.1)	24.3	23.9 (-0.3)	11.5	17.4 (5.9)	13.6	13.1 (-0.5)	0.3	0.4 (0.1)
	MB	35.8	31.6 (-4.1)	25.3	25.8 (0.5)	18.3	22.1 (3.8)	19.7	19.5 (-0.2)	1.0	1.0 (0.0)
PHJV Totals		34.9	31.6 (-3.3)	29.1	28.5 (-0.6)	15.3	19.2 (3.9)	19.0	18.9 (-0.1)	1.7	1.8 (0.0)
Boreal Transition	AB	8.7	7.9 (-0.7)	16.1	14.8 (-1.3)	21.5	23.9 (2.3)	51.1	51.3 (0.1)	2.5	2.1 (-0.4)
	SK	37.0	36.7 (-0.3)	15.5	13.4 (-2.1)	16.9	22.1 (5.2)	30.1	27.2 (-3.0)	0.5	0.6 (0.1)
	MB	24.5	19.6 (-4.9)	8.8	8.7 (-0.1)	5.3	10.8 (5.5)	61.2	60.7 (-0.5)	0.2	0.2 (0.0)
PHJV Totals		19.7	18.7 (-1.0)	15.4	13.9 (-1.5)	18.9	22.4 (3.5)	44.4	43.5 (-0.9)	1.6	1.5 (-0.2)
Aspen Parkland	AB	20.7	21.5 (0.8)	24.2	22.0 (-2.2)	21.2	22.0 (0.8)	27.6	28.2 (0.6)	6.2	6.2 (0.0)
	SK	52.2	45.9 (-6.3)	18.8	18.9 (0.0)	11.9	18.1 (6.2)	16.7	16.8 (0.1)	0.3	0.3 (0.0)
	MB	46.4	43.1 (-3.4)	23.6	23.5 (-0.1)	16.0	20.1 (4.1)	13.7	13.0 (-0.7)	0.3	0.3 (0.0)
PHJV Totals		38.2	35.2 (-3.0)	22.0	21.1 (-0.9)	16.6	20.1 (3.6)	20.6	20.8 (0.2)	2.7	2.8 (0.1)
Moist Mixed Grassland	AB	16.2	15.4 (-0.7)	43.7	43.4 (-0.3)	19.1	20.1 (1.0)	7.7	7.6 (-0.1)	13.4	13.5 (0.2)
	SK	64.0	57.9 (-6.2)	21.2	20.6 (-0.6)	9.0	15.7 (6.7)	5.6	5.5 (-0.1)	0.2	0.4 (0.2)
PHJV Totals		44.6	40.5 (-4.1)	30.3	29.9 (-0.4)	13.1	17.5 (4.4)	6.4	6.4 (-0.1)	5.6	5.8 (0.2)
Mixed Grassland	AB	17.9	16.4 (-1.5)	68.7	68.2 (-0.5)	11.9	13.9 (2.0)	1.4	1.3 (0.0)	0.1	0.2 (0.1)
	SK	40.6	36.3 (-4.3)	43.6	43.6 (0.0)	9.3	13.6 (4.3)	6.2	6.1 (-0.1)	0.3	0.5 (0.2)
PHJV Totals		31.6	28.3 (-3.3)	53.6	53.5 (-0.1)	10.3	13.7 (3.4)	4.3	4.2 (-0.1)	0.2	0.4 (0.2)
Fescue Grassland	AB	33.7	28.4 (-5.2)	56.7	56.4 (-0.3)	7.2	12.8 (5.6)	2.2	2.0 (-0.2)	0.2	0.3 (0.2)
PHJV Totals		33.7	28.4 (-5.2)	56.7	56.4 (-0.3)	7.2	12.8 (5.6)	2.2	2.0 (-0.2)	0.2	0.3 (0.2)
Cypress Upland	AB	25.2	26.9 (1.7)	50.9	47.2 (-3.7)	16.9	19.1 (2.2)	7.0	6.9 (-0.2)	0.0	0.0 (0.0)
	SK	3.6	3.6 (0.0)	79.5	79.6 (0.1)	3.6	3.6 (0.0)	13.2	13.2 (-0.1)	0.0	0.0 (0.0)
PHJV Totals		14.1	15.2 (1.1)	65.6	63.4 (-2.2)	10.1	11.3 (1.3)	10.2	10.0 (-0.2)	0.0	0.0 (0.0)

Table 16. Continued.

Ecoregion by Province		Annual Crop		Grassland		Tame Pasture/ Hay/Forage		Wooded		Anthropogenic	
		2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Lake MB Plain	MB	19.9	15.3 (-4.6)	32.0	33.8 (1.8)	22.3	24.5 (2.2)	22.3	22.8 (0.4)	3.5	3.6 (0.1)
PHJV Totals		19.9	15.3 (-4.6)	32.0	33.8 (1.8)	22.3	24.5 (2.2)	22.3	22.8 (0.4)	3.5	3.6 (0.1)
SW MB Uplands	MB	41.2	22.7 (-18.5)	25.9	25.8 (-0.1)	9.5	28.1 (18.6)	23.4	23.1 (-0.3)	0.0	0.3 (0.3)
PHJV Totals		41.2	22.7 (-18.5)	25.9	25.8 (-0.1)	9.5	28.1 (18.6)	23.4	23.1 (-0.3)	0.0	0.3 (0.3)
Interlake Plain	MB	7.1	3.5 (-3.6)	35.6	35.8 (0.2)	43.2	45.8 (2.7)	14.1	14.8 (0.7)	0.0	0.0 (0.0)
PHJV Totals		7.1	3.5 (-3.6)	35.6	35.8 (0.2)	43.2	45.8 (2.7)	14.1	14.8 (0.7)	0.0	0.0 (0.0)

Individual Wetland Basin Size

Wetland size statistics were measured for entire wetland basins (multi-polygon wetland basins were combined for reporting purposes) **(Table 17)**. The mean and median wetland basin sizes in the PHJV study area were 0.5 ha and 0.1 ha, respectively, in both the 2001 and 2011 periods. Overall, 91% of all sampled basins were ≤1 ha in size **(Figure 24)**, and these basins accounted for 33% and 32% of the total wetland area surveyed in 2001 and 2011, respectively **(Figure 24)**.

The mean lost wetland basin size (entire basin losses only) equaled 0.3 ha (median 0.1 ha) **(Table 17)**. Wetland basin losses ≤ 1 ha in size accounted for 95% of the total number of lost basins and these basins accounted for 67% of total wetland area lost from 2001–2011 **(Figure 24)**. Wetland basins < 1 ha in size difficult to track through time and are often ephemeral in nature.

Lost wetland basin size statistics suggests that smaller wetlands are more frequently targeted and/or impacted by activities that can result in wetland habitat losses.

Wetland basins ≥ 2 ha in size accounted for 9% of the total wetland numbers and 67% and 68% of the total wetland area sampled in 2001 and 2011 respectively **(Figure 24)**. It is important to note that the maximum measurable size of basin was limited by the quarter-section boundary of the transect sample (i.e., the largest wetland size could not be larger than a single quarter-section); portions of wetlands basins falling outside of the quarter-section boundary were not included in the size statistics. The largest wetland basin loss recorded equaled 14 ha. Wetland basin losses greater than 2 ha in size accounted 5% of total basin number losses and 33% of the total wetland area lost (complete basin area losses only).

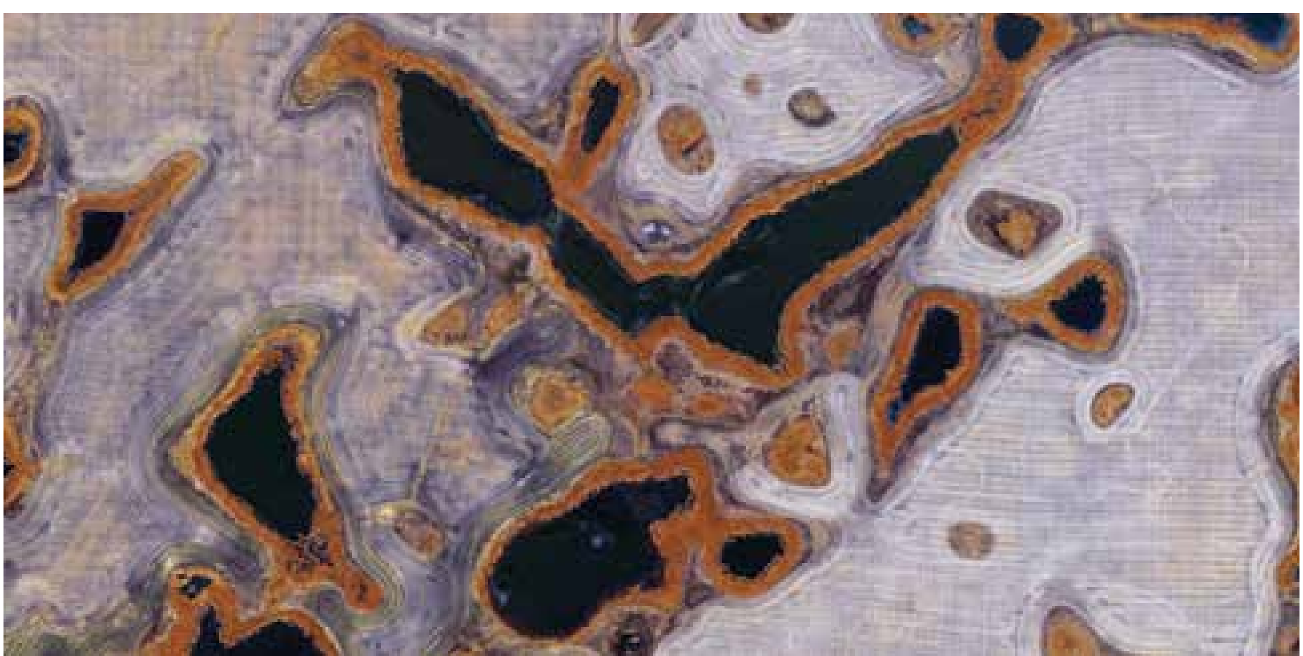


Table 17. Individual wetland basin size (ha); 2001–2011.

Ecoregion	2001		2011		Lost		Gained	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
PHJV (Overall)	0.5	0.1	0.5	0.1	0.3	0.1	0.2	0.1
Boreal Transition	0.7	0.1	0.7	0.1	0.2	0.1	0.2	0.1
Aspen Parkland	0.5	0.1	0.5	0.1	0.3	0.1	0.3	0.1
Moist Mixed Grasslands	0.5	0.2	0.5	0.1	0.4	0.2	0.1	0.1
Mixed Grasslands	0.6	0.1	0.6	0.1	0.5	0.2	0.1	0.1
Fescue Grassland	0.6	0.1	0.6	0.1	0.4	0.1	0.3	0.2
Cypress Upland	0.2	0.1	0.2	0.1	0.3	0.1	0.3	0.2
Lake Manitoba Plain	0.6	0.1	0.6	0.1	0.4	0.2	0.1	0.1
SW Manitoba Uplands	1.3	0.2	1.3	0.2	0.1	0.1	NA	NA
Interlake Plain	0.8	0.2	0.8	0.2	0.5	0.2	0.1	0.1

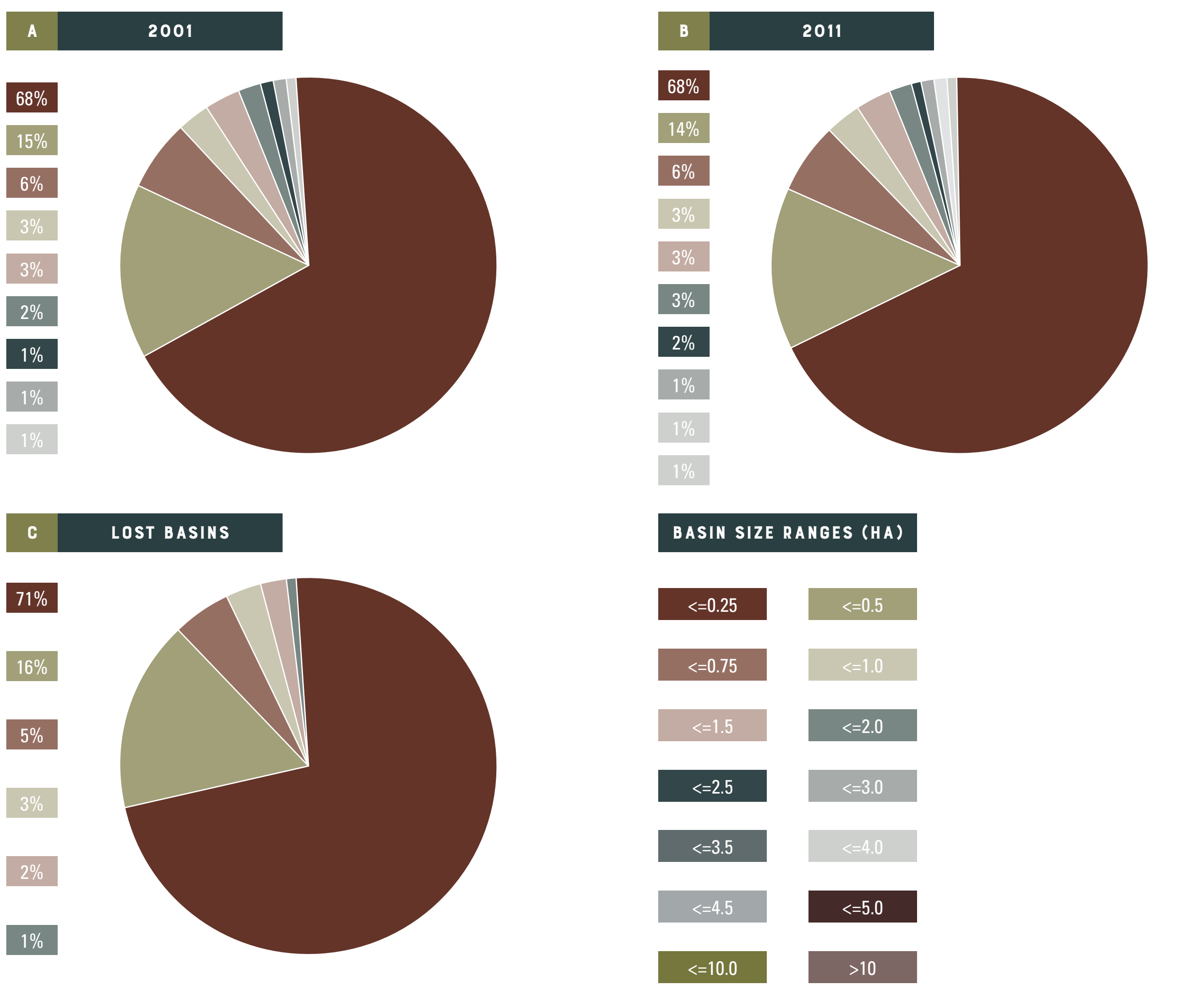


Figure 24. Individual wetland basin size composition of the overall PHJV study area. Percentages reflect proportion of wetlands of each size range.

PRAIRIE HABITAT MONITORING PROGRAM SURFACE DITCHING INDEX

The Prairie Habitat Monitoring Program Surface Ditching Index (PHMP SDI) was developed to better understand the geographic distribution of land use activities related to wetland habitat loss/degradation **(Figure 25).**

This mapping product is the result of a section-based classification that measured the intensity of surface ditching in relation to wetland habitats across the PHJV delivery area. The intent of this mapping product is to aid in the identification of geographic areas that have been and/or are subject to wetland habitat loss or degradation. The surface ditching index is used in combination with the PHMP change detection results to gain a more complete picture of wetland habitat loss related pressures within the PHJV delivery area. Surface drains (e.g., ditches, canals, and to some degree contour-type drainage works) can be readily detected through aerial photography and high-resolution satellite imagery. The interaction of these surface ditches with wetland basins can also often be detected. The mapping product presented here was designed to provide a geographic distribution map of identifiable ditching intensity from a wetland habitat conservation perspective.

Methods

Aerial photography and high resolution satellite imagery (provided by PHJV partners) of varying dates (AB 2004–2012, SK 2008–2013, MB 2007–2011) were used as the base of assessment for this map. Image resolution varied from sub meter to 2.5 m, and images were snow-free. Images were evaluated through a "heads-up" process of interpretation at an average viewing scale of 1:7000. Every section of land within the PHJV delivery area was manually photo interpreted and sorted into three classes according to the intensity of surface ditching present: None to Low ditching (Class 1), Low to Medium ditching (Class 2), and Medium to High ditching (Class 3).

Class 1: None to Low ditching intensity is reserved for sections in which there is minimal evidence of anthropogenic drainage and/or natural drainage alteration. These areas show no direct evidence of wetland drainage but may show indications of limited natural drainage disturbance impacts.

Class 2: Low to Medium ditching intensity is reserved for sections in which strong evidence exists that there is currently or has been definable ditching activities with some evidence of wetland drainage (ditches intersecting wetland basins). These sections often have permanent ditching works in place or significant natural drainage pattern alterations. There may often be definable drained basins and supporting drainage infrastructure (arrow identifies ditch in wetland).

Class 3: Medium to High is reserved for sections in which extensive ditching and related drainage works are present or sections with evidence of large wetland area impacted by ditching. Multiple drained/impacted basins are very apparent throughout the section. Extensive ditching webs/networks are apparent and there is evidence of ditches in wetland basins (arrows indicate ditches that are part of a ditching network).

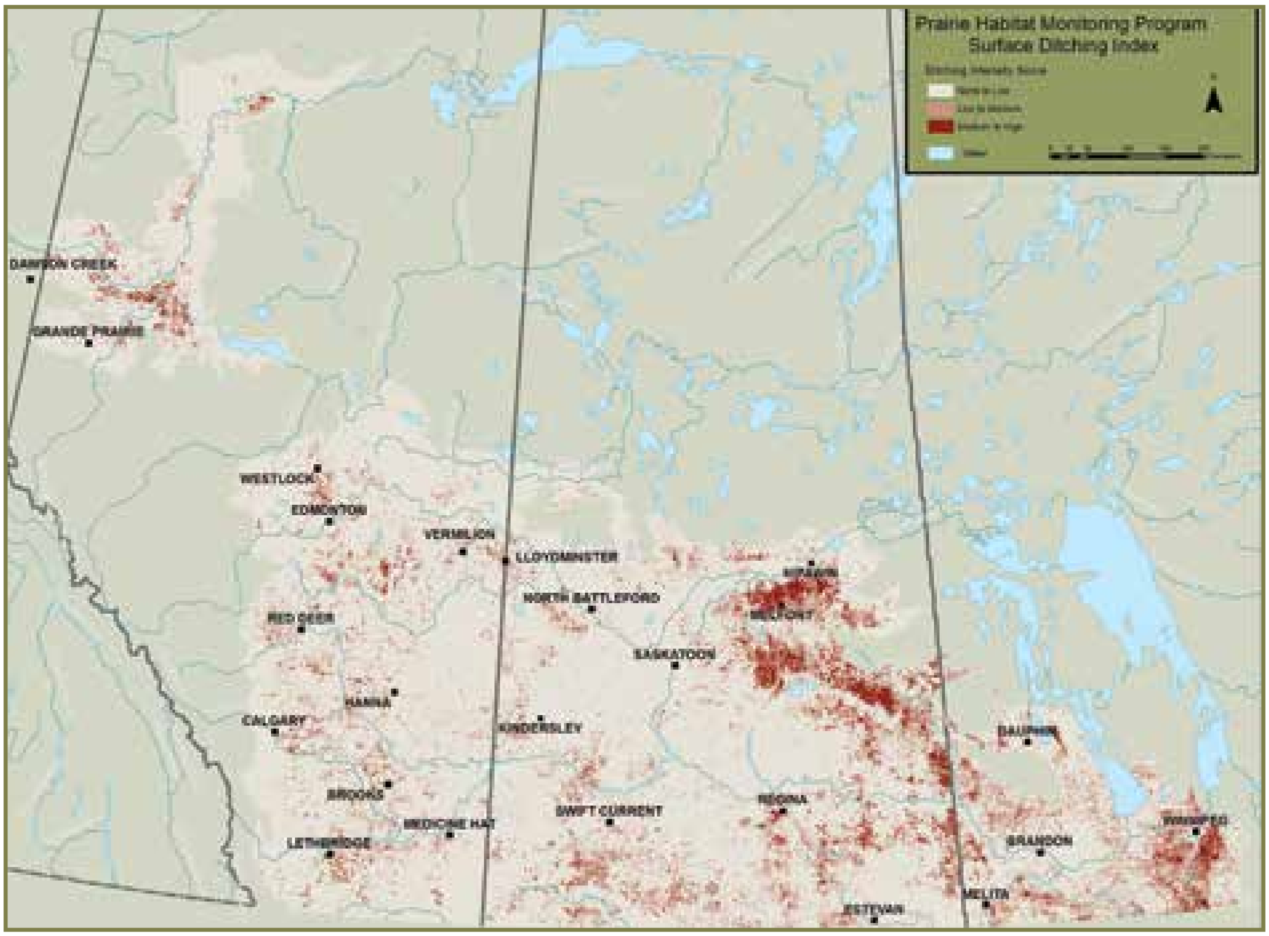


Figure 25. Prairie Habitat Monitoring Program Surface Ditching Index. This map shows the locations of the various drainage intensities across the PHJV delivery landscape.

Limitations of data

Ditching classifications presented here should be interpreted with caution and with consideration of local land use practices. This product is not a direct representation of wetland loss but rather a measurement of ditching intensity that, in some areas can be directly related to wetland drainage and/or degradation. Historical drainage that shows little remaining evidence of wetland basin or related ditching works would likely not have been identified through this manually interpreted mapping process.

All ditching works were considered for classification purposes, thus ditches related to irrigation would also have been included. Common sources of error include misclassification between natural drainage patterns and anthropogenic ditching, linear land workings similar in appearance to ditch construction, and issues related to season of image capture. Wetland losses related to non-ditching type activities (e.g., filling, land re-contouring, and other non-ditching type wetland impacts) are not captured through this inventory.

UPLANDS

Net Upland Habitat Area Change

Relative upland habitat changes presented in **Table 18** represent mean net change from baseline area expressed as a percentage. These relative change values indicate the trend and magnitude of change between the 2001 baseline and 2011 update for specific habitat groupings. Change presented here is a function of shifts from one upland cover category to another. This information summarizes results for sampled transects and has not been extrapolated to the entire PHJV landscape.

Overall, mean relative net change in natural grassland habitats was estimated to be -4.2% (95% CI [-5.5, -2.9]) while tame pasture/hay/forage land increased by 20.6% (95% CI [12.4, 28.8]) **(Table 18).** Wooded cover had a mean relative area decline of 3.9% (95% CI [-4.8, -3.1]). Annual crop, including summer-fallow, declined by a mean of 4.4% (95% CI [-6.5, -2.3]). Resource extraction including oil and gas, gravel pits, mining, etc. increased by an average of 42.3% (95% CI [19.4, 65.1]).

Annual crop declined in all Ecoregions with the exception of the Cypress Upland which saw a 2.0% increase **(Table 18)**. Declines in annual crop area on transects were largely due to conversion to tame pasture/hay/forage cover and due to wetter conditions in the majority of the PHJV study area, thus resulting in the expansion of grassy margins around wetlands and remnant habitats. Resource extraction increased in all Ecoregions.

Mean relative upland changes in the other category were largely the result of a decrease in the area of lands considered in transition (i.e., lands that were undergoing active change at the time of classification and the ultimate end land cover/use could not be determined). Overall, the PHJV transects saw a net relative average change in the other upland category of -2.7% (95% [-7.8, 2.3]), this was predominantly the result of the conversion of cover components such as brush piles, rock piles, and to some degree old farmsteads or components of farmsteads.

Table 18. Relative mean net percent change in upland habitat cover types by Ecoregion and province; 2001–2011.

Ecoregion by Province		Annual Crop	Natural Grassland	Tame Pasture/ Hay/Forage	Wooded	Resource Extraction	Other
PHJV (Overall)	AB	-3.6 [-7.9, 0.7]	-4.5 [-6.6, -2.3]	11.4 [1.6, 21.2]	-4.5 [-6.1, -3.0]	56.9 [22.5, 91.2]	0.3 [-7.3, 7.9]
	SK	-5.3 [-8.1, -2.5]	-3.6 [-5.3, -2.0]	37.0 [20.6, 53.4]	-3.2 [-4.3, -2.1]	10.8 [-18.2, 39.9]	-4.2 [-12.3, 3.8]
	MB	-3.0 [-6.4, 0.4]	-5.1 [-8.8, -1.5]	15.9 [2.8, 28.9]	-4.1 [-6.1, -2.1]	40.7 [-72.4, 153.9]	-3.5 [-13.0, 6.1]
PHJV Totals		-4.4 [-6.5, -2.3]	-4.2 [-5.5, -2.9]	20.6 [12.4, 28.8]	-3.9 [-4.8, -3.1]	42.3 [19.4, 65.1]	-2.7 [-7.8, 2.3]
Boreal Transition	AB	-8.8 [-27.2, 9.7]	-14.5 [-24.9, -4.0]	12.6 [-3.1, 28.3]	-2.2 [-3.6, -0.9]	25.6 [-28.2, 79.4]	-3.0 [-28.0,21.9]
	SK	-0.4 [-14.1,13.4]	-12.0 [-17.8, -6.3]	11.2 [-1.3, 23.6]	-1.9 [-4.7, 0.9]	1192.5 [-239.1, 624.0]	-6.8 [-25.1,11.6]
	MB	-9.7 [NA]	1.0 [NA]	47.5 [NA]	-13.8 [NA]	0.0 [NA]	41.8 [NA]
PHJV Totals		-4.4 [-14.2, 5.4]	-12.8 [-18.4, -7.2]	13.2 [3.2, 23.2]	-2.4 [-3.9, -1.0]	29.4 [-37.9, 96.8]	-4.9 [-17.8, 8.0]
Aspen Parkland	AB	0.1 [-5.9, 6.2]	-15.1 [-20.5, -9.7]	5.5 [-7.7, 18.7]	-6.5 [-9.8, -3.3]	82.3 [46.0, 118.6]	7.0 [-4.3, 18.3]
	SK	-6.4 [-10.3,-2.5]	-6.9 [-11.1, -2.7]	40.1 [18.1, 62.2]	-4.3 [-6.0, -2.5]	74.8 [2.4, 147.1]	-3.4 [-13.9, 7.1]
	MB	-2.1 [-6.8, 2.5]	-9.9 [-16.1, -3.7]	16.7 [0.5, 32.9]	-5.7 [-9.1,-2.4]	19.1 [1.5, 36.7]	-4.7 [-22.6,13.2]
PHJV Totals		-3.1 [-6.1, -0.2]	-11.6 [-14.7, -8.4]	17.1 [6.7, 27.4]	-5.4 [-7.1, -3.8]	72.3 [45.6, 98.9]	-0.1 [-7.1, 7.0]
Moist Mixed Grassland	AB	-3.5 [-10.6, 3.6]	-3.2 [-6.5, 0.0]	12.0 [-4.1, 28.1]	-3.9 [-6.0, -1.7]	58.3 [16.8, 99.8]	-5.3 [-26.2,15.6]
	SK	-4.2 [-8.7, 0.4]	-6.5 [-10.4, -2.6]	41.9 [17.6, 66.2]	-2.2 [-4.1, -0.2]	-5.2 [-37.2, 26.8]	-2.7 [-17.8,12.4]
PHJV Totals		-4.0 [-7.6, -0.3]	-4.3 [-6.6, -2.0]	24.6 [10.2, 39.0]	-3.1 [-4.5, -1.7]	17.9 [-7.7, 43.4]	-3.2 [-14.7, 8.3]
Mixed Grassland	AB	-4.8 [-15.9, 6.3]	-1.2 [-2.7, 0.3]	12.2 [-24.0, 48.4]	-5.1 [-10.4,0.2]	46.7 [-62.9, 156.2]	-3.3 [-16.0, 9.4]
	SK	-6.9 [-11.0,-2.8]	-1.0 [-1.9, -0.1]	45.3 [0.9, 89.6]	-1.2 [-4.6, 2.1]	4.0 [-3.6, 11.6]	-2.8 [-31.9,26.3]
PHJV Totals		-6.4 [-10.6,-2.2]	-1.1 [-1.9, -0.3]	29.1 [-0.2, 58.3]	-1.7 [-4.4, 1.0]	29.2 [-20.4, 78.8]	-3.2 [-16.4,10.1]
Fescue Grassland	AB	-1.9 [-7.8, 4.1]	-2.2 [-4.0, -0.3]	8.4 [-25.6, 42.4]	-1.6 [-5.3, 2.0]	4.6 [-30.0, 39.1]	-2.2 [-30.9,26.6]
PHJV Totals		-1.9 [-7.8, 4.1]	-2.2 [-4.0, -0.3]	8.4 [-25.6, 42.4]	-1.6 [-5.3, 2.0]	4.6 [-30.0, 39.1]	-2.2 [-30.9,26.6]
Cypress Upland	AB	4.2 [NA]	-4.3 [NA]	-12.3 [NA]	-6.6 [NA]	0.0 [NA]	17.1 [NA]
	SK	-15.8 [NA]	-1.2 [NA]	16.6 [NA]	0.0 [NA]	0.0 [NA]	12.6 [NA]
PHJV Totals		2.0 [NA]	-1.7 [NA]	-2.7 [NA]	-0.3 [NA]	0.0 [NA]	16.3 [NA]
Lake MB Plain	MB	-4.4 [-11.6, 2.7]	-0.7 [-3.3, 1.9]	17.0 [-15.3, 49.2]	-0.8 [-1.6, 0.0]	533.4 [-926.9, 993.7]	-11.1 [-26.0, 3.8]
PHJV Totals		-4.4 [-11.6, 2.7]	-0.7 [-3.3, 1.9]	17.0 [-15.3, 49.2]	-0.8 [-1.6, 0.0]	533.4 [-926.9, 993.7]	-11.1 [-26.0, 3.8]
SW MB Uplands	MB	-5.6 [NA]	-5.2 [NA]	21.0 [NA]	0.1 [NA]	0.0 [NA]	90.6 [NA]
PHJV Totals		-5.6 [NA]	-5.2 [NA]	21.0 [NA]	0.1 [NA]	0.0 [NA]	90.6 [NA]
Interlake Plain	MB	-12.3 [NA]	1.0 [NA]	19.9 [NA]	-4.4 [NA]	85.5 [NA]	-2.3 [NA]
PHJV Totals		-12.3 [NA]	1.0 [NA]	19.9 [NA]	-4.4 [NA]	85.5 [NA]	-2.3 [NA]

Upland Composition Change

Composition changes in upland habitats are predominantly the result of land use impacts and, to a lesser degree, natural shifts in vegetation communities. For instance, shrubby encroachment on natural grassland-dominated polygons would result in an updated classification, thus, a reduction in natural grassland and an increase in shrub land; whereas, the construction of a well site and access road in a natural grassland polygon would result in the loss of natural grassland cover and an increase in the resource extraction cover type. Natural vegetation shifts were not a primary focus of this program and limited effort was applied to the delineation of natural habitat boundary shifts.

Upland composition data summarizes all upland area, by major habitat cover as a percentage of total upland area (wetland area is excluded from total upland area) for base and update survey years **(Table 19)**.

Overall, in the PHJV, the mean natural grassland habitat composition changed from 11.9% (95% CI [9.6, 14.2]) to 11.4% (95% CI [9.1, 13.7]) of total upland area sampled **(Table 19)**. Tame pasture/hay/forage increased from 17.2% (95% CI [15.5, 18.9]) to 20.7% (95% CI [18.8, 22.6]) of total upland area between 2001 and 2011. Mean annual crop area equalled 56.5% (95% CI [52.9, 60.1]) in 2001 and in 2011 equaled 53.9% (95% CI [50.2, 57.6]) of total upland area in the sample. All other upland categories summarized at the PHJV reporting unit remained relatively unchanged from a landscape composition perspective.

The Interlake Plain, Aspen Parkland, and Mixed Grassland Ecoregions saw the largest change in percentage of tame pasture/hay/forage crops at 5%, 4%, and 4%, respectively. Proportions of tame pasture/hay/forage habitats increased in all Ecoregions with the exception of the Cypress Upland, which remained unchanged at 16% of the total upland area sampled. The overall proportion of natural grassland habitats remained unchanged in all but the Aspen Parkland, Moist Mixed Grassland, and Cypress Upland Ecoregions.

Provincially, the Saskatchewan portion of the PHJV had the greatest decline in annual crop, from 64.4% (95% CI [59.1, 69.6]) to 60.8% (95% CI [55.5, 66.1]) of total upland area sampled **(Table 19)**. The mean area of natural grassland habitats in Alberta samples declined (slightly, and not a statistically significant decline) by 0.9% (18.2–17.3%) of total upland area sampled in the province. The largest annual crop habitat decrease and tame pasture/hay/forage habitat increase occurred in the Boreal Transition Ecoregion (-7% and 7% respectively).

Total grassland habitats (natural grassland + tame pasture/hay/forage) changed by +3% in the PHJV sample between 2001 and 2011, rising from an estimated 29% (95% CI [26.3, 32.0]) to 32% (95% CI [29.1, 35.1]) of the total upland area sampled **(Table 19, Figure 26)**. The largest increase in the proportion of grassland to total uplands on the transects sampled occurred in the Interlake Plain, increasing from 33% (95% CI [NA]) to 38% (95% CI [NA]). Transects sampling the Cypress Upland Ecoregion saw the only decline of total grassland proportion dropping from 59% (95% CI [NA]) to 58% (95% CI [NA]) of the total upland area sampled (again this is a slight decline and is not statistically significant). Gains in total grassland habitat were driven by the increase in the tame pasture/hay/forage habitats. In some areas, the conversions of croplands to haylands (with delayed haying) can have beneficial impacts to some grassland species of high conservation priority in the PHJV; however, grassland bird species of concern nested more frequently in native grasslands than in haylands *(McMaster et al. 2005)*.

Table 19. Upland mean % composition (change) by Overall, Ecoregion and province; 2001 and 2011.

Ecoregion By Province		Annual Crop		Natural Grassland		Tame Pasture/ Hay/Forage		Grassland Total		Wooded		Other	
		2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
PHJV (Overall)	AB	45.1 [39.7, 50.6]	43.4 [37.6, 49.3] (-1.7)	18.2 [13.6, 22.7]	17.3 [12.8, 21.9] (-0.8)	22.8 [19.8, 25.7]	25.4 [22.1, 28.6] (2.6)	41.0 [36.1, 45.8]	42.7 [37.5, 47.9] (1.7)	8.5 [6.2, 10.9]	8.2 [6.0, 10.5] (-0.3)	5.0 [2.6, 7.4]	5.0 [2.6, 7.4] (0.0)
	SK	64.4 [59.1, 69.6]	60.8 [55.5, 66.1] (-3.6)	8.8 [6.2,11.5]	8.5 [5.8, 11.2] (-0.3)	12.1 [10.2, 14.0]	16.6 [14.2, 19.0] (4.4)	21.0 [17.6, 24.4]	25.1 [21.3, 28.9] (4.1)	7.3 [5.1, 9.5]	7.1 [4.9, 9.3] (-0.2)	7.2 [3.5, 11.0]	6.9 [3.2, 10.6] (-0.3)
	MB	61.1 [53.2, 69.1]	59.1 [51.0, 67.1] (-2.0)	5.4 [3.2, 7.5]	5.1 [2.9, 7.2] (-0.3)	18.8 [14.8, 22.8]	21.7 [17.2, 26.1] (2.9)	24.1 [19.6, 28.7]	26.8 [21.7, 31.8] (2.6)	8.2 [5.0, 11.3]	7.8 [4.7, 10.9] (-0.4)	6.5 [2.0, 11.0]	6.3 [1.9, 10.6] (-0.2)
PHJV Totals		56.5 [52.9, 60.1]	53.9 [50.2, 57.6] (-2.6)	11.9 [9.6, 14.2]	11.4 [9.1, 13.7] (-0.5)	17.2 [15.5, 18.9]	20.7 [18.8, 22.6] (3.5)	29.1 [26.3, 32.0]	32.1 [29.1, 35.1] (3.0)	7.9 [6.4, 9.3]	7.6 [6.2, 9.1] (-0.3)	6.3 [4.2, 8.4]	6.1 [4.0, 8.2] (-0.2)
Boreal Transition	AB	33.9 [23.2, 44.5]	30.8 [17.9, 43.8] (-3.0)	3.6 [2.2, 5.0]	3.1 [1.7, 4.5] (-0.5)	33.1 [27.4, 38.7]	37.2 [28.9, 45.4] (4.1)	36.7 [31.2, 42.1]	40.3 [32.6, 47.9] (3.6)	24.7 [17.8, 31.7]	24.2 [17.5, 30.9] (-0.5)	4.3 [3.0, 5.7]	4.2 [3.1, 5.3] (-0.1)
	SK	48.1 [34.2, 62.0]	47.8 [33.7, 61.9] (-0.3)	2.7 [1.0, 4.5]	2.4 [0.9, 3.9] (-0.3)	18.5 [12.6, 24.4]	20.5 [13.5, 27.5] (2.0)	21.3 [14.3, 28.2]	22.9 [15.3, 30.6] (1.7)	15.5 [10.5, 20.4]	15.1 [10.2, 20.0] (-0.3)	15.2 [-0.4, 30.8]	14.1 [-1.4, 29.6] (-1.1)
	MB	70.6 [NA]	63.8 [NA] (-6.8)	2.6 [NA]	2.6 [NA] (0.0)	13.2 [NA]	19.5 [NA] (6.3)	15.8 [NA]	22.1 [NA] (6.3)	10.1 [NA]	9.1 [NA] (-1.0)	3.5 [NA]	5.0 [NA] (1.5)
PHJV Totals		42.7 [34.3, 51.0]	40.7 [31.6, 49.8] (-2.0)	3.1 [2.1, 4.1]	2.7 [1.8, 3.6] (-0.4)	25.1 [20.7, 29.5]	28.3 [22.8, 33.9] (3.2)	28.2 [23.5, 32.9]	31.1 [25.5, 36.7] (2.8)	19.5 [15.3, 23.7]	19.1 [15.0, 23.1] (-0.5)	9.4 [2.4, 16.3]	8.9 [2.0, 15.8] (-0.5)
Aspen Parkland	AB	51.4 [44.8, 58.0]	51.3 [44.1, 58.6] (-0.1)	8.3 [5.8, 10.8]	7.0 [4.8, 9.2] (-1.3)	25.5 [21.1, 30.0]	26.9 [21.8, 31.9] (1.3)	33.9 [28.7, 39.0]	33.9 [28.0, 39.8] (0.1)	10.4 [8.0, 12.8]	9.8 [7.6, 12.1] (-0.5)	4.0 [2.9, 5.1]	4.3 [3.3, 5.3] (0.3)
	SK	64.5 [56.4, 72.7]	60.1 [51.7, 68.5] (-4.4)	5.6 [3.4, 7.8]	5.2 [3.1, 7.3] (-0.4)	13.6 [10.4, 16.7]	18.9 [15.2, 22.6] (5.4)	19.2 [14.9, 23.5]	24.1 [19.2, 29.0] (4.9)	10.3 [6.7, 13.9]	9.9 [6.4, 13.5] (-0.4)	5.9 [0.2, 11.6]	5.7 [0.0, 11.4] (-0.2)
	MB	66.7 [59.0, 74.4]	64.9 [56.0, 73.9] (-1.8)	5.0 [3.5, 6.5]	4.4 [3.0, 5.9] (-0.5)	18.1 [13.3, 22.8]	21.0 [14.7, 27.2] (2.9)	23.0 [17.2, 28.8]	25.4 [18.0, 32.8] (2.4)	6.2 [3.2, 9.1]	5.7 [2.9, 8.6] (-0.4)	4.0 [2.7, 5.3]	3.8 [2.7, 4.8] (-0.2)
PHJV Totals		59.8 [55.2, 64.4]	57.7 [52.8, 62.5] (-2.1)	6.5 [5.2, 7.9]	5.8 [4.5, 7.0] (-0.8)	19.3 [16.7, 21.9]	22.5 [19.7, 25.4] (3.2)	25.9 [22.6, 29.1]	28.3 [24.8, 31.8] (2.4)	9.4 [7.6, 11.3]	9.0 [7.2, 10.8] (-0.4)	4.7 [2.5, 7.0]	4.7 [2.5, 7.0] (0.0)

Table 19. Continued.

Ecoregion By Province		Annual Crop		Natural Grassland		Tame Pasture/ Hay/Forage		Grassland Total		Wooded		Other	
		2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Moist Mixed Grassland	**AB**	49.4 [36.8, 62.0]	47.7 [34.4, 60.9] (-1.8)	21.7 [12.6, 30.8]	21.0 [11.9, 30.1] (-0.7)	21.4 [15.0, 27.9]	24.0 [17.6, 30.4] (2.6)	43.1 [32.1, 54.2]	45.0 [33.0, 57.0] (1.8)	3.8 [1.4, 6.1]	3.8 [1.4, 6.1] (0.0)	3.5 [2.3, 4.7]	3.3 [2.3, 4.4] (-0.2)
	SK	73.2 [63.3, 83.1]	70.0 [60.0, 80.1] (-3.2)	6.0 [2.1, 9.9]	5.6 [1.8, 9.4] (-0.4)	9.4 [6.1, 12.7]	13.3 [8.7, 17.9] (3.9)	15.4 [9.7, 21.1]	18.9 [12.4, 25.4] (3.5)	2.3 [1.3, 3.3]	2.2 [1.2, 3.2] (-0.1)	8.9 [0.6, 17.2]	8.7 [0.4, 16.9] (-0.3)
PHJV Totals		64.3 [56.2, 72.4]	61.6 [53.4, 69.9] (-2.6)	11.9 [7.4, 16.4]	11.4 [6.9, 15.9] (-0.5)	13.9 [10.5, 17.3]	17.3 [13.5, 21.1] (3.4)	25.8 [19.4, 32.2]	28.7 [21.9, 35.4] (2.9)	2.9 [1.8, 3.9]	2.8 [1.8, 3.8] (-0.1)	6.9 [1.9, 11.9]	6.7 [1.7, 11.6] (-0.2)
Mixed Grassland	**AB**	31.6 [17.4, 45.9]	30.1 [15.6, 44.6] (-1.5)	42.1 [29.5, 54.7]	41.6 [29.1, 54.1] (-0.5)	16.8 [9.4, 24.2]	18.8 [12.0, 25.6] (2.0)	58.9 [44.3, 73.5]	60.4 [45.4, 75.4] (1.5)	0.9 [0.4, 1.4]	0.9 [0.4, 1.4] (0.0)	8.0 [-2.3, 18.3]	7.7 [-2.6, 18.1] (-0.3)
	SK	67.4 [58.7, 76.1]	62.7 [53.5, 71.8] (-4.7)	14.7 [9.0, 20.5]	14.6 [8.9, 20.3] (-0.2)	11.1 [7.6, 14.6]	16.1 [11.4, 20.8] (5.0)	25.8 [18.8, 32.9]	30.7 [22.6, 38.7] (4.8)	4.7 [-0.3, 9.8]	4.7 [-0.4, 9.8] (0.0)	1.8 [1.2, 2.3]	1.7 [1.2, 2.3] (-0.1)
PHJV Totals		53.5 [44.7, 62.3]	50.0 [41.2, 58.9] (-3.5)	25.4 [18.6, 32.2]	25.1 [18.3, 31.8] (-0.3)	13.3 [9.8, 16.8]	17.1 [13.3, 21.0] (3.8)	38.7 [30.5, 46.8]	42.2 [33.9, 50.6] (3.5)	3.3 [0.1, 6.4]	3.2 [0.1, 6.4] (0.0)	4.2 [0.3, 8.1]	4.1 [0.2, 7.9] (-0.1)
Fescue Grassland	**AB**	63.9 [46.1, 81.8]	62.9 [45.6, 80.1] (-1.1)	12.5 [3.3, 21.6]	12.2 [3.1, 21.3] (-0.2)	16.5 [8.5, 24.5]	17.9 [10.5, 25.3] (1.4)	28.9 [14.8, 43.1]	30.1 [16.1, 44.1] (1.2)	0.9 [-0.5, 2.2]	0.9 [-0.5, 2.2] (0.0)	5.9 [2.4, 9.4]	5.8 [1.4, 10.1] (-0.1)
PHJV Totals		63.9 [46.1, 81.8]	62.9 [45.6, 80.1] (-1.1)	12.5 [3.3, 21.6]	12.2 [3.1, 21.3] (-0.2)	16.5 [8.5, 24.5]	17.9 [10.5, 25.3] (1.4)	28.9 [14.8, 43.1]	30.1 [16.1, 44.1] (1.2)	0.9 [-0.5, 2.2]	0.9 [-0.5, 2.2] (0.0)	5.9 [2.4, 9.4]	5.8 [1.4, 10.1] (-0.1)
Cypress Upland	**AB**	60.4 [NA]	63.0 [NA] (2.6)	12.9 [NA]	12.3 [NA] (-0.5)	21.6 [NA]	19.0 [NA] (-2.6)	34.5 [NA]	31.3 [NA] (-3.2)	1.8 [NA]	1.8 [NA] (0.0)	3.2 [NA]	3.8 [NA] (0.6)
	SK	7.9 [NA]	6.7 [NA] (-1.3)	73.9 [NA]	73.0 [NA] (-0.9)	11.0 [NA]	12.9 [NA] (1.8)	84.9 [NA]	85.9 [NA] (1.0)	6.4 [NA]	6.4 [NA] (0.0)	0.8 [NA]	0.9 [NA] (0.1)
PHJV Totals		34.5 [NA]	35.2 [NA] (0.7)	43.0 [NA]	42.3 [NA] (-0.7)	16.4 [NA]	16.0 [NA] (-0.4)	59.4 [NA]	58.3 [NA] (-1.1)	4.1 [NA]	4.1 [NA] (0.0)	2.0 [NA]	2.4 [NA] (0.3)
Lake MB Plain	**MB**	56.5 [38.3, 74.7]	53.9 [37.1, 70.7] (-2.6)	5.8 [-0.7, 12.3]	5.8 [-0.8, 12.3] (0.0)	19.9 [11.2, 28.7]	23.3 [14.6, 31.9] (3.3)	25.8 [15.0, 36.5]	29.0 [18.8, 39.3] (3.3)	12.2 [3.9, 20.5]	12.1 [3.8, 20.4] (-0.1)	5.5 [3.3, 7.7]	4.9 [2.6, 7.2] (-0.6)
PHJV Totals		56.5 [38.3, 74.7]	53.9 [37.1, 70.7] (-2.6)	5.8 [-0.7, 12.3]	5.8 [-0.8, 12.3] (0.0)	19.9 [11.2, 28.7]	23.3 [14.6, 31.9] (3.3)	25.8 [15.0, 36.5]	29.0 [18.8, 39.3] (3.3)	12.2 [3.9, 20.5]	12.1 [3.8, 20.4] (-0.1)	5.5 [3.3, 7.7]	4.9 [2.6, 7.2] (-0.6)

Table 19. Continued.

Ecoregion By Province		Annual Crop		Natural Grassland		Tame Pasture/ Hay/Forage		Grassland Total		Wooded		Other	
		2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
SW MB Uplands	**MB**	75.7 [NA]	71.5 [NA] (-4.2)	4.0 [NA]	3.8 [NA] (-0.2)	16.5 [NA]	20.0 [NA] (3.5)	20.6 [NA]	23.8 [NA] (3.3)	2.8 [NA]	2.8 [NA] (0.1)	1 [NA]	1.9 [NA] (0.9)
PHJV Totals		75.7 [NA]	71.5 [NA] (-4.2)	4.0 [NA]	3.8 [NA] (-0.2)	16.5 [NA]	20.0 [NA] (3.5)	20.6 [NA]	23.8 [NA] (3.3)	2.8 [NA]	2.8 [NA] (0.1)	1 [NA]	1.9 [NA] (0.9)
Interlake Plain	**MB**	33.3 [NA]	29.2 [NA] (-4.2)	6.8 [NA]	6.8 [NA]	25.8 [NA]	30.8 [NA] (5.0)	32.5 [NA]	37.6 [NA] (5.1)	8.1 [NA]	7.8 [NA] (-0.3)	25.9 [NA]	25.2 [NA] (-0.7)
PHJV Totals		33.3 [NA]	29.2 [NA] (-4.2)	6.8 [NA]	6.8 [NA]	25.8 [NA]	30.8 [NA] (5.0)	32.5 [NA]	37.6 [NA] (5.1)	8.1 [NA]	7.8 [NA] (-0.3)	25.9 [NA]	25.2 [NA] (-0.7)

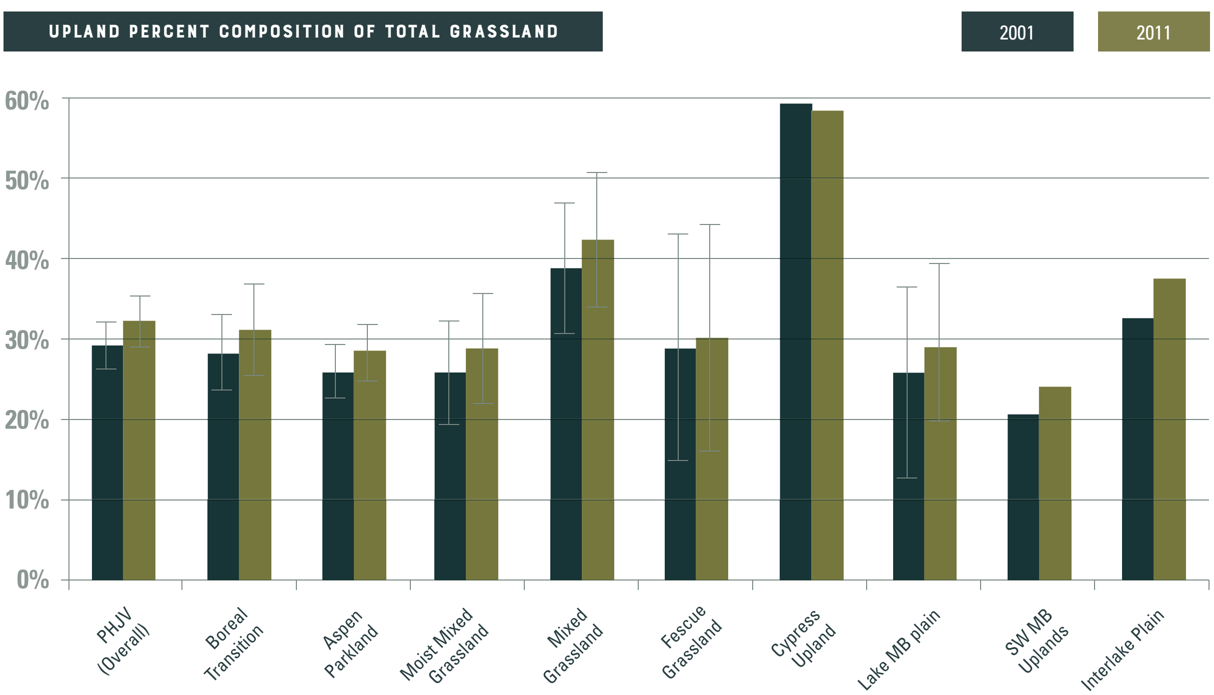


Figure 26. Upland percent composition of total grassland habitat (natural and tame) in 2001 and 2011. Due to insufficient sample size confidence intervals are not provided for the Cypress Upland, Lake Manitoba Plain, or SW Manitoba Uplands Ecoregions.

Figure 27. An example of natural grassland loss as a result of conversion to cultivated cover type.

Natural Grasslands Conversion

Natural grasslands are important habitats to many different species and thus it is important to track the types and quantity of impacts to these habitat types. Although historical estimates of grassland habitats are limited, there are some detailed studies that provide estimates as to the vast extent of grassland habitats available within the PPR. For example, *Archibold and Wilson (1980)* estimated that over half of the townships surveyed in the 1880s (in an area roughly equivalent to a large portion of the Saskatchewan PHJV delivery area) were comprised of greater than 80% grass cover, and a mean grass cover for the area of 65%. It is studies like this which, in comparison to the current extent of grassland cover estimated here, suggest the availability of grassland habitat has been diminished over time and the current extent of these important wildlife habitats is limited. This continued grassland conversion to cultivation reduces safe upland nesting habitats for species such as pintail ducks (*Miller and Duncan 1999*) as well as many other grassland specific wildlife species.

In this context, natural grasslands are defined based on identifiable characteristics that can be consistently determined through aerial photo interpretation. The primary identifiable characteristic is the lack of evidence of recent anthropogenic modification such as cultivation, haying, seeding, or other classifiable alteration to the natural cover type **(Figure 27)**. There is always the potential for misclassification of natural grasslands change to tame pasture, tame seeding, or other grassland modification. Natural grasslands are often subjected to land uses that can mimic change (as observed from aerial photography), such as overgrazing, haying, mowing, burning, and various other impacts.

The inventory, change detection, and classification of natural grassland changes on the prairies presents a difficult problem. It is recognized that the classification of natural grasslands in the baseline and update years in this dataset may have some confusion between tame and natural grasses (errors of commission or omission). Definitions of native or natural grasslands are often based on reference to plant community types, which is not conducive to the classification from aerial photography used here.

In an attempt to account for possible natural grassland change misclassifications (confusions with tame grass plantings, overgrazing etc.), **Table 20** reports mean relative losses to this habitat type, with a focus on clearly identifiable anthropogenically-caused loss to natural grassland habitats (i.e., changed to cultivation, extraction, construction, or other human-caused natural grassland loss) **(Figure 27)**. Changes in natural grassland area related to natural changes (such as flooding, shrub or tree growth, natural bare soil) or as a result of apparent conversion to tame grass/forage/hay cover type, are not included in the mean relative change reported in **Table 20**, but are included in the overall relative mean change results for natural grassland area reported in **Table 19**.

***Overall, relative mean loss of natural grassland habitats directly attributable to anthropogenic alteration (excluding tame pasture/hay/forage conversions) between circa 2001 and 2011 equalled 2.3% (95% CI [1.5,3.1]) in the PHJV* (Table 20).**

The largest anthropogenic conversion of natural grassland by transect equalled 67%, occurring on a transect sample in the Moist Mixed Grassland Ecoregion of Alberta.

Of the grassland-dominated Ecoregions, the Moist Mixed Grassland Ecoregion saw a mean relative decline in natural grassland area equaling 2.1% (95% CI [-0.5, 4.8]); natural grassland loss related to anthropogenic conversion equaled 2.0% (95% CI [0.6, 3.4]) in the Mixed Grassland and 0.9% (95% CI [0.0, 1.8]) in the Fescue Grassland Ecoregions **(Table 20)**.

Provincially, there was an even wider range of values reflecting mean relative natural grassland losses to anthropogenic activities and tame grass cover types. In Alberta, mean relative natural grassland losses to anthropogenic activities (excluding tame pasture/hay/forage conversions) equalled 3.4% (95% CI[1.5,5.3]) **(Table 20)**. In Saskatchewan, mean relative natural grassland losses to anthropogenic cover-types were greatest in the Aspen Parkland (1.7% (95% CI[0.5,2.9])). In Manitoba, mean relative natural grassland losses to anthropogenic conversion were highest in the Aspen Parkland (4.9% (95% CI[1.5,8.3])) **(Table 20)**.

Table 20. Anthropogenic (i.e., excluding conversions to tame grass, tame pasture, and forage) upland cover replacing lost natural grassland area by Ecoregion and province; 2001–2011.

Ecoregion by Province		Mean % Relative Cover Change [95% CI]	Min (%)	Max (%)
PHJV (Overall)	AB	3.4 [1.5,5.3]	0.0	66.7
	SK	1.2 [0.7,1.7]	0.0	18.8
	MB	2.9 [1.0,4.8]	0.0	28.4
	PHJV Totals	2.3 [1.5,3.1]	0.0	66.7
Boreal Transition	AB	1.1 [0.1,2.1]	0.0	7.4
	SK	1.3 [-0.5,3.1]	0.0	13.6
	MB	0.4 [NA]	0.4	0.4
	PHJV Totals	1.2 [0.3,2.0]	0.0	13.6
Aspen Parkland	AB	3.6 [1.6,5.6]	0.0	28.6
	SK	1.7 [0.5,2.9]	0.0	18.8
	MB	4.9 [1.5,8.3]	0.0	28.4
	PHJV Totals	3.2 [2.0,4.3]	0.0	28.6
Moist Mixed Grassland	AB	4.3 [-2.9,11.6]	0.0	66.7
	SK	0.7 [0.2,1.2]	0.0	4.8
	PHJV Totals	2.1 [-0.5,4.8]	0.0	66.7
Mixed Grassland	AB	3.6 [0.0,7.3]	0.0	33.6
	SK	1.0 [0.4,1.5]	0.0	7.0
	PHJV Totals	2.0 [0.6,3.4]	0.0	33.6
Fescue Grassland	AB	0.9 [0.0,1.8]	0.0	2.9
	PHJV Totals	0.9 [0.0,1.8]	0.0	2.9
Cypress Upland	AB	4.2 [NA]	4.2	4.2
	SK	2.3 [NA]	2.3	2.3
	PHJV Totals	3.3 [-0.9,7.5]	2.3	4.2
Lake Manitoba Plain	MB	0.3 [-0.2,0.8]	0.0	2.2
	PHJV Totals	0.3 [-0.2,0.8]	0.0	2.2
SW Manitoba Uplands	MB	2.9 [NA]	2.9	2.9
	PHJV Totals	2.9 [NA]	2.9	2.9
Interlake Plain	MB	0.2 [NA]	0.0	0.5
	PHJV Totals	0.2 [NA]	0.0	0.5

Much of the lost grassland area recorded was the result of “cleaner” farming practices or “squaring of the field” **(Figure 28)**. These more thorough modern farming techniques maximize productive acreages through removal of grass margins and associated habitats that impede the movements of large machinery (*Higgins et al. 2002*) and likely raise the cost of inputs due to the manipulations required to avoid these obstacles.

The wetter conditions at the time of the update did allow for some reversion to grassland habitats as equipment could not reach as far, likely due to extended soil saturation. The result was the regrowth of larger grassland margin areas, which, when feasible, were measured as natural grassland upland habitats, although the species composition of these areas was not evaluated.

Figure 28. Abandoned farmsteads and other remnant habitats are often removed from the landscape to increase cultivatable area. This incorporation of remnant habitat fragments into the larger agricultural operation results in a "squaring of the field" or the reduction in the amount of habitat diversity in the field.

Natural grassland change estimates remain elusive with current methods. The magnitudes of change are relative to baseline habitat amounts, which for most transect samples were small. The transect sample is focused on the primarily privately held lands in the PHJV and large tracts of publicly held lands were not included (as discussed in the methods). The sample has some bias towards the crop producing areas of the PHJV; however, the 2004 sample expansion attempted to alleviate this to the extent possible.

AAFC Uplands - Comparison of Land Cover Composition

Agriculture and Agri Food Canada's (AAFC) annual crop mapping products were included in the upland land cover analysis to present a more comprehensive estimate of land cover in the PHJV and to provide a brief evaluation of AAFC products for potential utilization in future monitoring updates.

The AAFC data presented here is for two purposes: (1) to compare land cover composition measurements at the transects level, and (2) to provide an inventory based summary of overall land cover composition as captured through the AAFC annual crop dataset within the PHJV.

AAFC's annual crop mapping products are satellite based classifications of crop and general land cover type. Map products are based on a 30 m pixel size and the classification system is focused on annual crop identification and classification. For detailed information on AAFC's annual crop products please refer to *AAFC (2013)*.

The 2009 annual cropland-mapping data was utilized for land cover composition measurements, as the data from that year was deemed to be the best fit for most of the image classifications completed for the upland portion of the monitoring transect survey. For comparison to land cover measures interpreted from air photos circa 2011 ("PHMP Transect"), AAFC data were clipped (referred to as "AAFC Transect") to the transect sample boundaries and extracted in summarized tabular format. The purpose of this comparison was not to compare change detection, but to compare land cover estimation based on the two mapping approaches at the transect level.

In order to provide conservation planners with a more complete picture of the land cover composition within the PHJV, a complete wall-to-wall classification of the AAFC was summarized ("AAFC PHJV"). This summary allowed for comparison of the complete AAFC inventory within the PHJV to that of the AAFC transect sample. This analysis provided a method for evaluating AAFC products with the more detailed investigations of land cover composition via the monitoring transect (update years only).

Classifications between the AAFC dataset and the transect dataset were aligned as required to provide the best cross-walking of classifications as possible, and then summarized in like categories for complimentary comparison and subsequent reporting.

To provide a summary of land cover composition that is aligned between the two datasets, the AAFC transect data focused on the land cover composition estimate for the PHJV, with the utilization of comparative data in a complementary approach. A thorough comparative analysis of the two different methods is not within the scope of this report.

Overall, in the PHJV landscape the two datasets reported similar composition values for the major land cover classes. However, at the transect level the AAFC data reported a higher estimated percentage of annual crop (58.1%) than the PHMP (54.0%), although these are likely not statistically different from each other (**Table 21, Figure 29a**). It should be noted that the AAFC inventory data includes lands excluded from the transect study area, which likely accounts for some of the differences in composition. These excluded lands include large water bodies, river valleys, and other habitat areas within parks and military ranges, such as the large tracts of native grassland habitats present in the Suffield Military Range and Grasslands National Park.

Comparison of wetland area captured between the two methods reported some distinct differences **(Table 21, Figure 29)**. The circa 2011 transects reported the proportion of wetlands in the PHJV landscape as 8.7%, whereas the AAFC 2009 transect reported wetlands as 4.3% of the clipped AAFC annual crop inventory data **(Figure 29a)**. Wetland proportion for the 2009 complete PHJV AAFC annual crop inventory equalled 5.9% **(Table 21)**. This under-reporting of wetland area by the AAFC is to be expected, as the 30 m pixel classification method and timing would likely be limiting in the accurate detection and classification of many wetland basins. The comparative analysis suggests that the AAFC inventory most likely under reports wetland area within the PHJV.

Comparison of tame pasture/hay/forage and natural grassland also showed differing proportional composition values **(Table 21)**. The circa 2011 transects reported natural grassland proportion as 11.0% and tame pasture/hay/forage as 21.0%. AAFC Transect data reported natural grassland proportion as 12.4% and tame pasture/hay/forage as 17.0%. The wall-to-wall PHJV study area AAFC annual crop inventory reported a natural grassland proportion of 16.0% and tame pasture/hay/forage as 14.7%. Based on this limited comparative investigation it may be possible that the AAFC dataset slightly overestimates the proportion of natural grassland on the landscape while under estimating the proportion of tame pasture/hay/forage. It is likely that the AAFC annual crop inventory suffers from the same classification challenges as the PHMP transects, in that the separation of natural from tame grasslands can prove challenging. This discrepancy in the natural grassland proportion between AAFC inventory and monitoring transects is also suggestive of transect samples possibly under representing larger tracts of natural grassland habitats (for example Suffield Military Range, Grasslands National Park). A more detailed investigation of the AAFC products and the PHMP products would be required to determine the significance in differences between the two datasets.

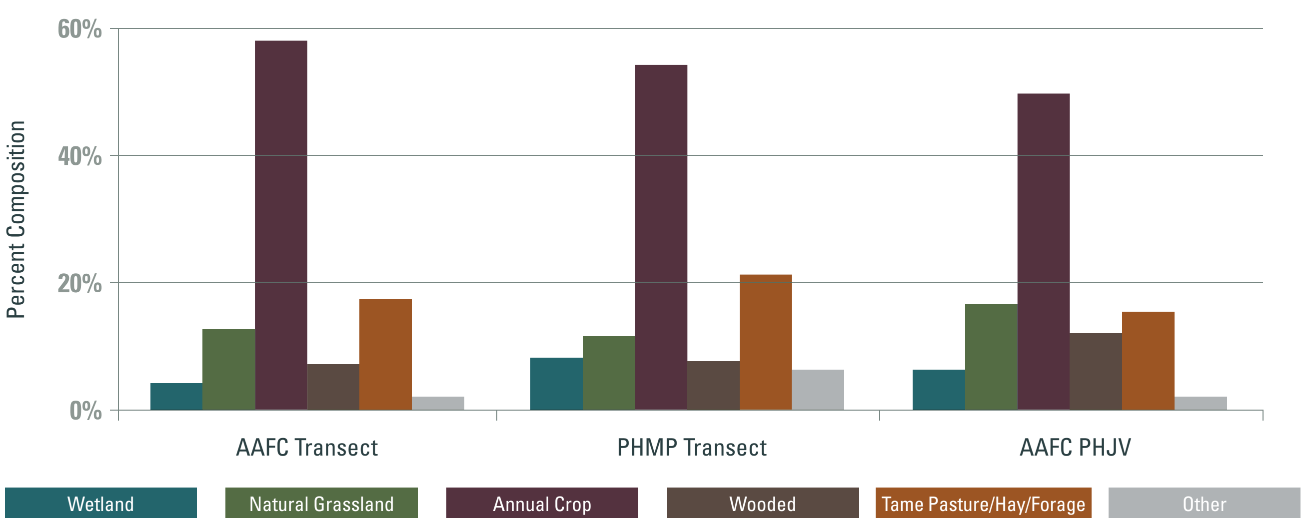
AAFC Uplands - Grasslands

Similar to the methods outlined in the Upland Composition Change section, grassland totals were compared between the AAFC and the 2011 PHMP transects. This comparison again focused on a complementary approach to provide the best possible estimate of the composition of total grassland area as a proportion of total landscape area for the circa 2011 period.

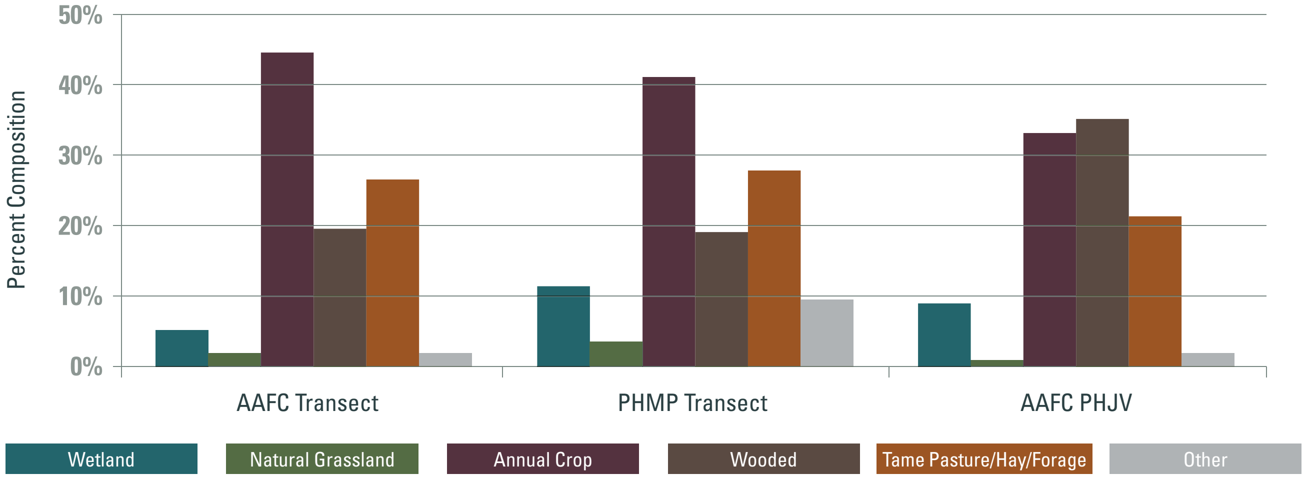
Overall, total grassland habitat composition on PHMP transects equalled 32.0% while the 2009 clipped AAFC grassland total equalled 29.4%, and the AAFC wall-to-wall inventory clipped to the entire PHJV area had a grassland total proportion of 30.8%.

Overall, comparison of the two datasets suggests that the PHJV, Aspen Parkland, Moist Mixed Grasslands, and Fescue Grassland Ecoregions have similar estimates of total grassland area. However, a more detailed comparative investigation of grassland habitat mapping is required to better understand discrepancies between the AAFC and PHMP datasets. This further evaluation could help to improve estimation of grassland trends and refine methods for use of both complementary datasets for grassland habitat reporting.

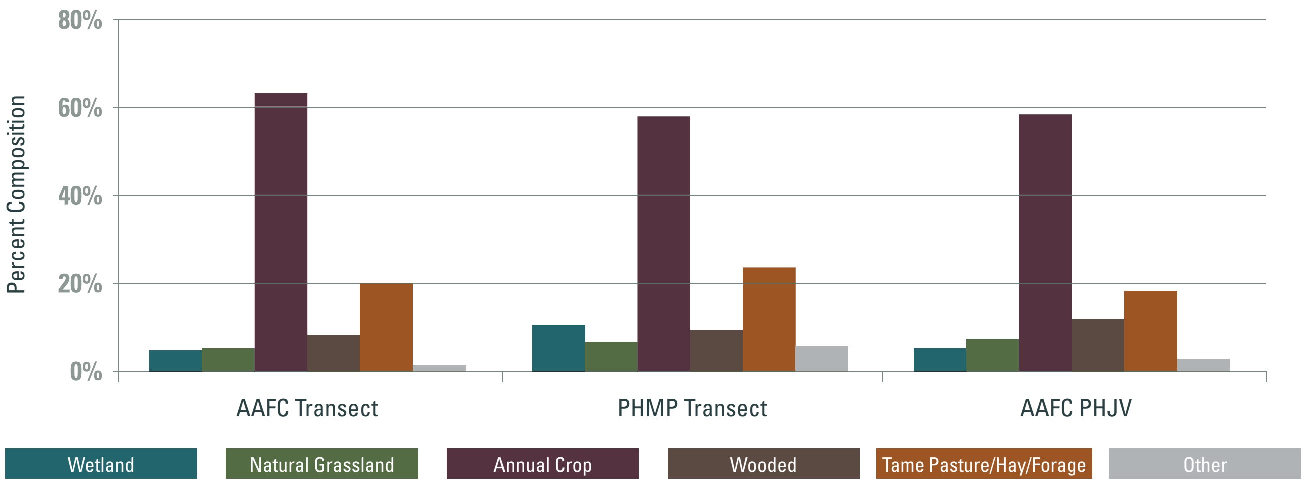
A PHJV (OVERALL)



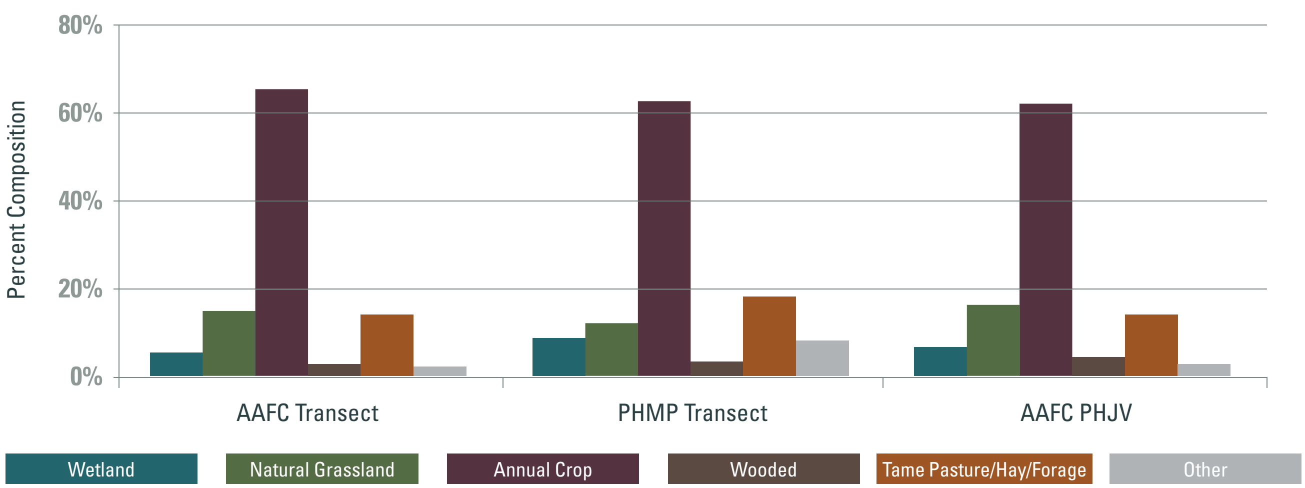
B **BOREAL TRANSITION**



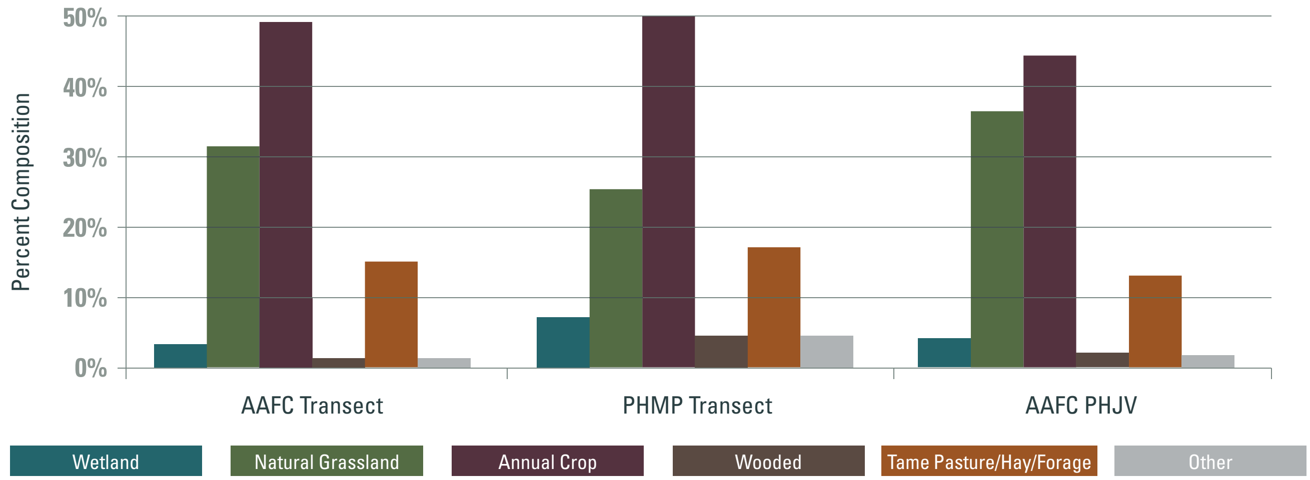
C **ASPEN PARKLAND**



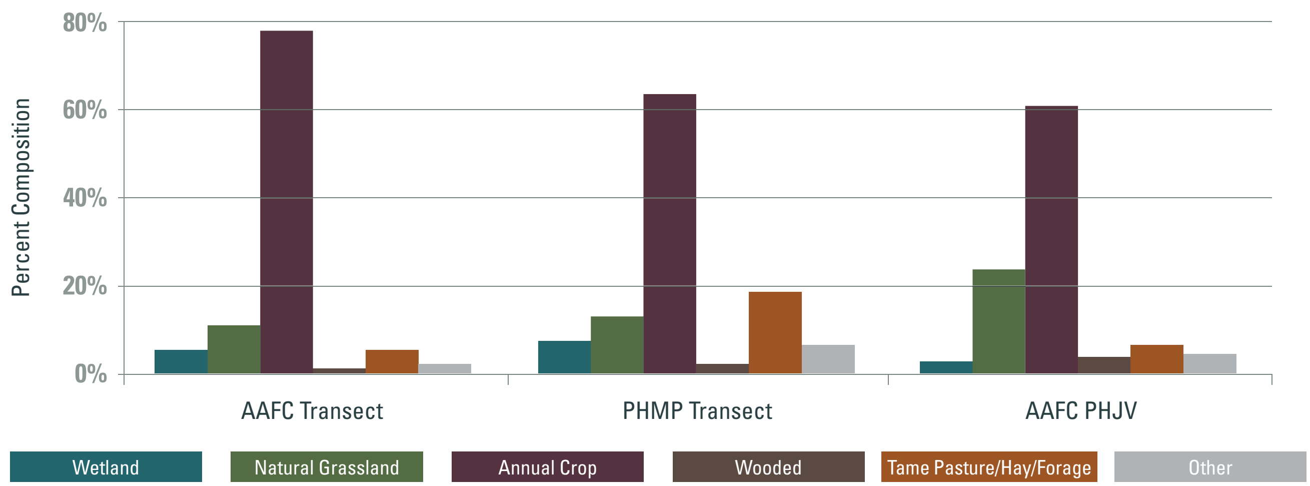
D **MOIST MIXED GRASSLAND**



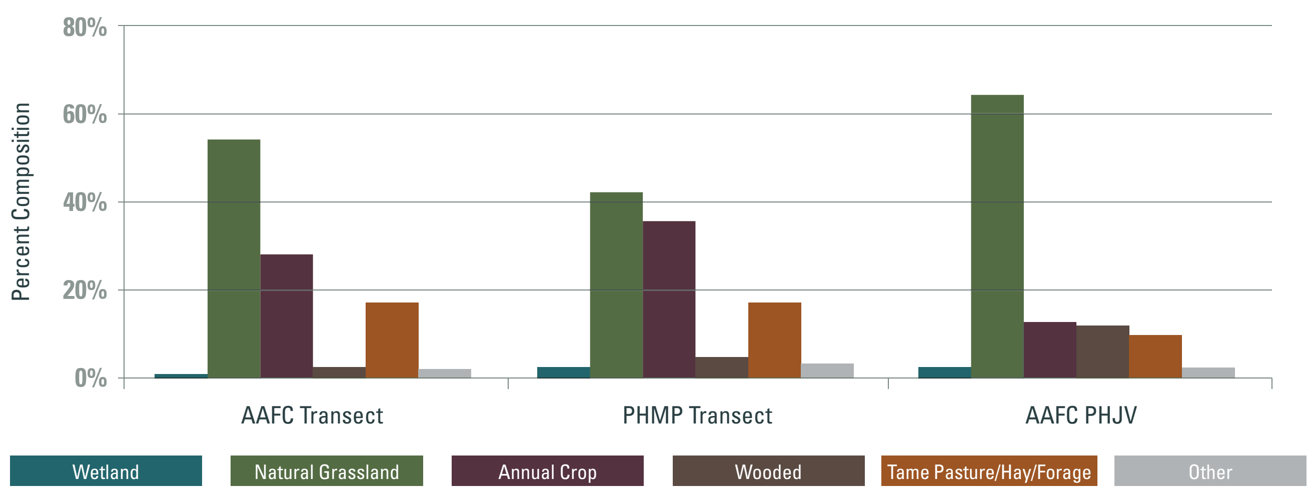
E MIXED GRASSLAND



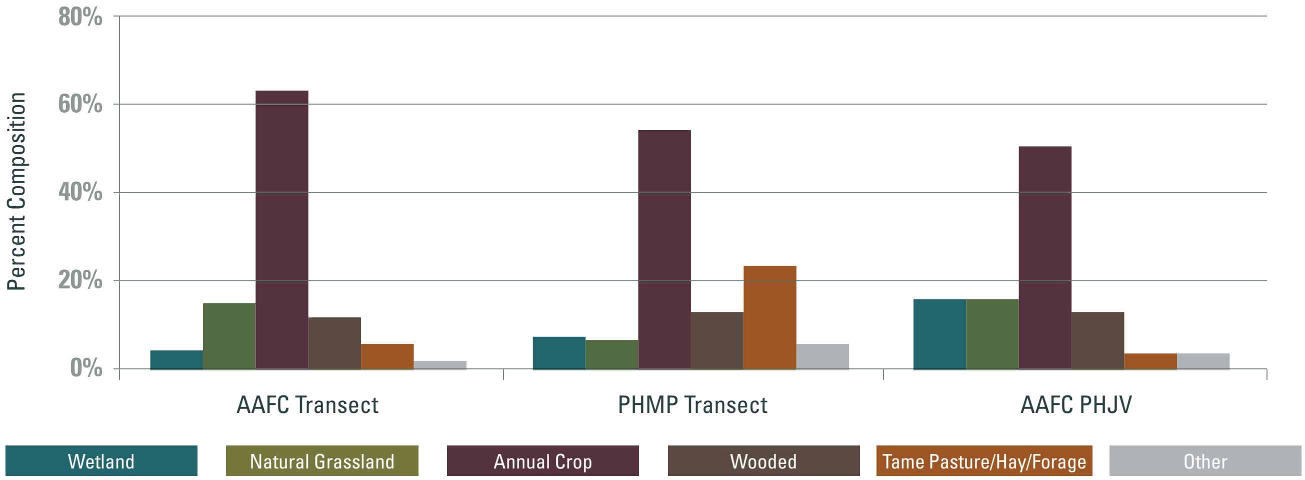
F FESCUE GRASSLAND



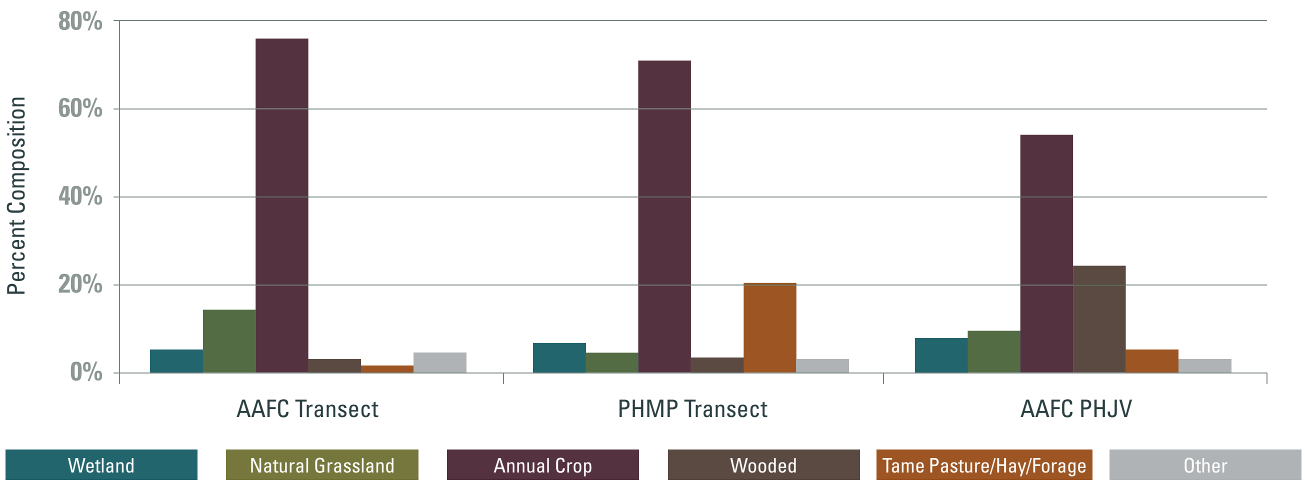
G CYPRESS UPLAND



H LAKE MANITOBA PLAIN



I SOUTHWEST MANITOBA UPLANDS



J INTERLAKE PLAIN

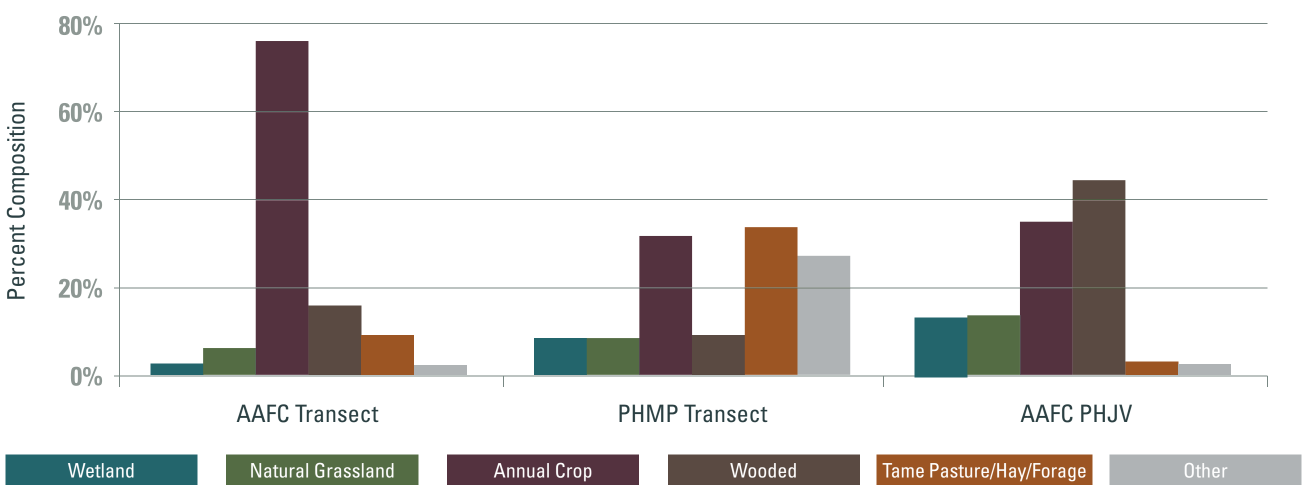


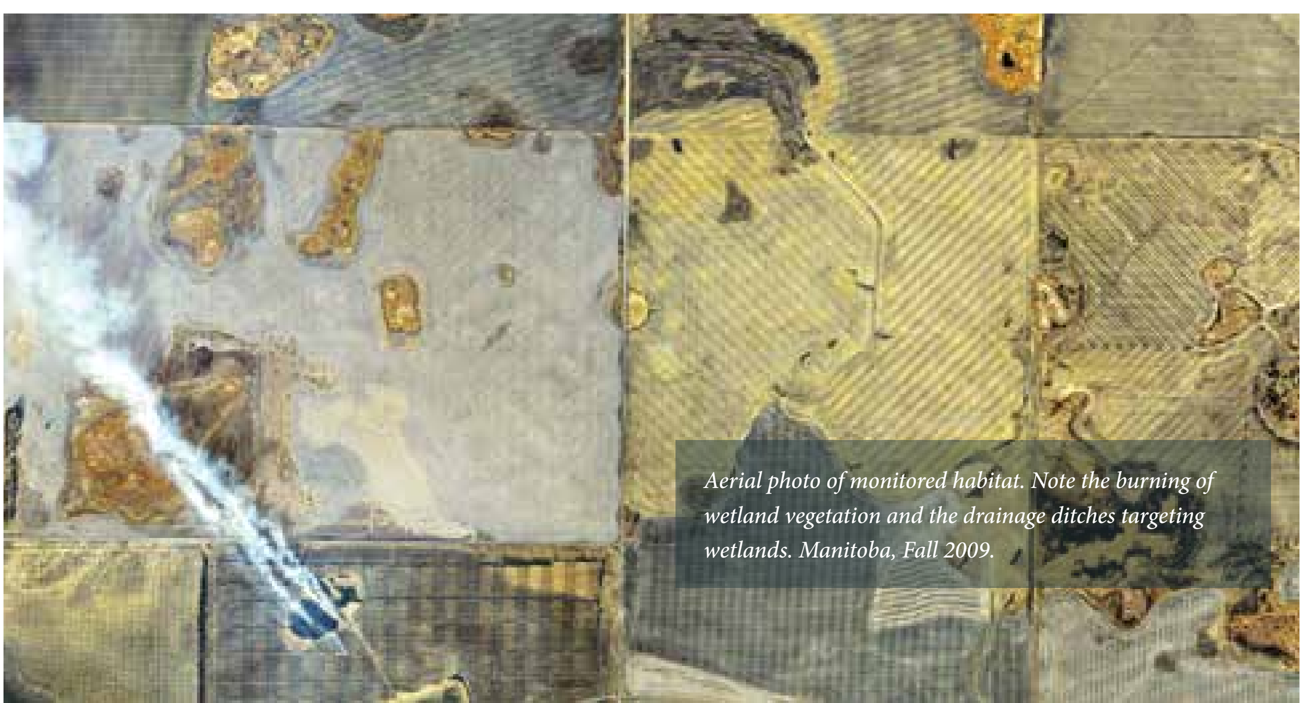
Figure 29. Comparison of AAFC and PHMP cover type proportions in (A) PHJV (Overall), (B) Boreal Transition, (C) Aspen Parkland, (D) Moist Mixed Grassland, (E) Mixed Grassland, (F) Fescue Grassland, (G) Cypress Upland, (H) Lake MB Plain, (I) SW MB Uplands, and (J) Interlake Plain Ecoregions.

Table 21. Comparison of cover type proportions (%) from AAFC and PHMP sources.

Ecoregion	Method	Annual Crop	Natural Grassland	Tame Pasture/ Hay/ Forage	Grassland Total	Wooded	Wetlands	Other
PHJV (Overall)	PHMP Transect	54.0	11.0	21.0	32.0	7.0	8.7	6.0
	AAFC Transect	58.1	12.4	17.0	29.4	6.8	4.3	1.3
	AAFC PHJV	49.8	16.0	14.7	30.8	11.6	5.9	1.9
Boreal Transition	PHMP Transect	41.0	3.0	28.0	31.0	19.0	11.0	9.0
	AAFC Transect	44.7	1.0	26.4	27.4	19.3	4.9	1.6
	AAFC PHJV	33.1	0.8	20.9	21.8	34.9	8.5	1.7
Aspen Parkland	PHMP Transect	58.0	6.0	23.0	29.0	9.0	10.0	5.0
	AAFC Transect	63.2	4.5	19.4	23.8	7.7	3.6	1.3
	AAFC PHJV	58.2	6.7	17.4	24.1	11.0	4.6	2.1
Moist Mixed Grassland	PHMP Transect	62.0	11.0	17.0	28.0	2.0	8.0	7.0
	AAFC Transect	64.6	13.6	13.3	26.9	1.9	4.7	1.1
	AAFC PHJV	61.5	15.3	12.8	28.0	3.1	5.6	1.8
Mixed Grassland	PHMP Transect	50.0	25.0	17.0	42.0	4.0	6.8	4.0
	AAFC Transect	49.2	31.2	14.9	46.1	0.7	3.0	1.0
	AAFC PHJV	44.2	36.5	12.8	49.3	1.2	3.9	1.3
Fescue Grassland	PHMP Transect	63.0	12.0	18.0	30.0	1.0	6.5	6.0
	AAFC Transect	78.3	10.6	4.4	15.1	0.8	4.2	1.6
	AAFC PHJV	60.6	23.2	6.3	29.5	3.4	2.4	4.0
Cypress Upland	PHMP Transect	35.0	42.0	16.0	58.0	4.0	1.8	2.0
	AAFC Transect	27.3	53.6	16.3	69.9	1.5	0.3	1.0
	AAFC PHJV	12.3	64.6	9.0	73.6	10.8	1.3	1.9
Lake Manitoba Plain	PHMP Transect	54.0	6.0	23.0	29.0	12.0	6.1	5.0
	AAFC Transect	63.4	14.5	5.2	19.6	11.6	3.6	1.8
	AAFC PHJV	50.5	16.3	3.0	19.2	11.9	15.7	2.8
SW Manitoba Uplands	PHMP Transect	71.0	4.0	20.0	24.0	3.0	6.0	2.0
	AAFC Transect	75.8	13.5	0.4	13.9	2.2	4.3	3.9
	AAFC PHJV	53.7	8.6	4.3	13.0	23.6	7.4	2.4
Interlake Plain	PHMP Transect	29.0	7.0	31.0	38.0	8.0	6.6	25.0
	AAFC Transect	71.3	4.6	7.6	12.2	14.1	1.5	1.0
	AAFC PHJV	32.1	12.0	1.7	13.7	40.6	11.7	1.8

MANAGEMENT RECOMMENDATIONS

1. The incredible wetland and upland resources within the PHJV delivery area are a substantial achievement not only of the PHJV partnership, but also to that of the stewards of the land in the agricultural industry. Agricultural operators, where possible, continue a practice of wetland habitat avoidance as part of ongoing production. These operators absorb the real costs associated with "going around" wetlands and conserving uplands for the benefits of all society. Market influences from the demands of a growing world population, rising costs of operations, changing climate, etc. may make the costs of avoidance less feasible in the future. The PHJV should continue to work with agricultural and other resource sectors to ensure that realistic practical solutions continue to evolve for the benefit of these valuable Canadian wetland and upland habitat resources.
2. Reliable estimates of regional wetland status, threats, and trends are critical to guide wildlife conservation efforts and evaluate ongoing habitat conservation programs. The Canadian Wildlife Service and PHJV partners should remain committed to long-term wetland habitat monitoring for the purpose of wildlife habitat conservation.
3. Monitoring wetland habitat loss is likely insufficient for gauging trends in habitat availability and suitability for many wildlife species relevant to the PHJV partnership. The PHJV should continue to evaluate and explore incorporation of wetland habitat monitoring and inventory protocols that capture additional priority wetland functions.
4. The Surface Ditching Index provides the PHJV with an indication of geographic hot-spots for wetland habitat loss and degradation. Further exploring the relationship between, wetland inventory, wetland change data products and the ditching index would improve estimates of landscape-scale wetland change over time, and help incorporate risk into wetland conservation planning.
5. The AAFC Annual Crop Inventory dataset is a valuable tool for monitoring land use and agriculture land cover trends through time. The PHJV partners should explore linkages between AAFC inventory work and PHJV priorities. In particular, an improved grassland inventory product could result from combining grassland mapping efforts.
6. Recently, wetlands have been the subject of policy efforts in all three Prairie Provinces. The driving factors behind these policies relate to the services of wetlands in the areas of hydrological impacts such as flood mitigation, water quality, and water storage; however, the preservation of biodiversity related to wetland habitats remains a difficult message to sell across sectors. The PHJV should remain the champion of the biodiversity service components that wetlands provide and should maintain focus on promoting the conservation of wetlands for migratory birds and biodiversity in general.



Aerial photo of monitored habitat. Note the burning of wetland vegetation and the drainage ditches targeting wetlands. Manitoba, Fall 2009.

7. The complete cessation of wetland drainage is not likely a realistic outcome. Where conservation of wetlands is not possible, the PHJV should continue to promote the integration of wetland habitat retention for water management and biodiversity conservation on the landscape in provincial policy, permitting, or drainage design processes. Many drainages result in consolidation of ponds or ditches and, thus, an opportunity for habitat retention on the landscape. The PHJV should be proactive in exploring ditch and retention pond designs associated with new drainage constructions that may still provide some level of habitat value. The PHJV partners should also continue to work closely with municipalities to promote conservation of wetland habitats during road constructions and maintenance operations.

8. Seasonal ditching and land contouring may be becoming more common water management activities in some landscapes. These potential wetland impacts remain difficult to detect. Late fall and late winter or early spring imagery and ground surveys in areas where these technique are commonly suspected should be incorporated into future updates of the PHMP monitoring dataset.

9. The PHJV should continue to champion the Canadian Wetland Inventory with a focus on priority areas. Wetland inventory products are critical for enhanced conservation delivery in priority areas, and when combined with monitoring products, these inventory data will provide a more complete picture related to the wetland resource.

10. Although the exact magnitude of natural grassland loss is difficult to determine, PHMP results confirm that remaining native grasslands are being converted to other land cover types. The PHJV partnership should support improvement to status and trend monitoring of natural grasslands, inclusive of the inventory of remaining grassland habitats in the PHJV.

11. Climate change scenarios within the PHJV delivery area should be evaluated with a focus on potential changes in risk of wetland and upland habitat loss due to changing climate or land use conversion.

12. The Waterfowl Breeding Ground Population and Habitat Survey dataset is another important source of monitoring information. This dataset should be modernized to allow for robust analysis of long term changes to waterfowl and wetlands in the PHJV landscape. In turn, these results can be used to guide PHJV conservation planning efforts.

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APPENDIX 1

Original classification scheme and field data form used for land cover classification

Code	Vegetation Cover	Description	Report Equivalent
Uplands			
Woodlands			
W1	Tall Trees	Stands of tall trees (> 5m)	Wooded
W2	Regular Spaced Small Trees with Tall/Mid Shrub	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 Shrub	Stands of irregularly spaced small trees (< 5m) mixed with tall/mid shrubs (0.5 to 1.5+ m)	
W4	Low Shrub	Stands of low shrub (< 5m) includes areas with predominant buckbrush, wild rose, and sagebrush	
Non-woody			
V1	Annual Crop	Annually cultivated crop including wheat, oats, barley, mixed grains, corn (for grain, for silage), rye (fall, spring), canola (rapeseed), and flaxseed. Includes stubble.	Annual Crop
V2	Improved Grass	Alfalfa and alfalfa mixtures cut for hay or silage All other tame hay cut for hay or silage (including clovers) Other fodder crops cut for hay or silage Improved pastures that have been seeded down for < 5 years and are part of ordinary crop rotation	Tame Grass
V3	Unimproved Grass	Unimproved land for grazing, "wild pastures", pastures seeded for > 5 years, and pastures containing sedges and forbs Native grasses	Natural Grassland
Wetlands			
Z1	Streams and Rivers	Streams and rivers	Open Water Ponds and Lakes
Z3	Lakes and Ponds	Permanent open water lakes and ponds that contain 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 lack submerged, shallow, open water plants	
V4	Emergent Deep Marsh	Semi-permanent shallow water with tall emergent such as reeds and rushes	Deep Marsh
Z2	Irrigation Canals	Irrigation canals	Artificial Open Water
Z5	Artificial Water	Reservoirs and dugouts	
V3	Grass and Sedge	Shallow marsh, wet meadow, and low prairie type wetlands, dominated by grass and sedge cover	Grass/Sedge Marsh

Code	Vegetation Cover	Description	Report Equivalent
		Disturbed	
V5	Disturbed Grass	Non-woody plants representing complexes of disturbed species	Other or Tame Grass
X0	Bare Surface	Bare ground including summer fallow does not include a bare field that has been seeded	Annual Crop, Other, or Development
Y0	Constructed Cover	Building, well site, compressor stations	Development

Wetland identification columns

Code	Type	Description
S	Wetland Status	Wetland is a segment of a watercourse
"1-999"	Wetland ID	Wetland number (up to 3 digits) starts at 1 for each quarter-section

Margin cover classification

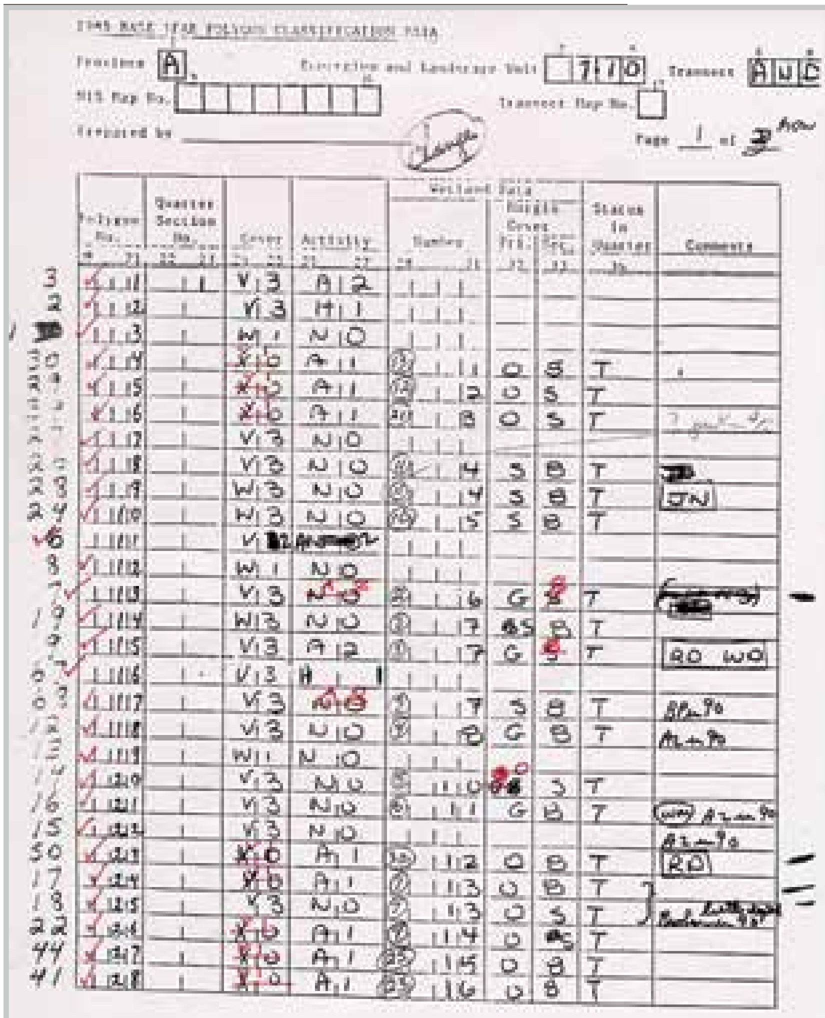
Code	Description
	Primary
Blank	Identifies polygons which are uplands rather than wetlands
0	Wetland with non-natural cover as dominant fringe type
G	Wetland with unimproved grass as dominant fringe type
S	Wetland with tree or shrub cover as dominant fringe type
	Secondary
8	Wetland with >75% of one fringe type
0	Wetland with non-natural cover as secondary fringe type
G	Wetland with unimproved grass as secondary fringe type
S	Wetland with tree or shrub cover as secondary fringe type

Extent to which wetlands are confined to quarter-section

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

Land activity classification

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.
B1	Former Ag	Former agricultural activity
B2	Former Extraction	Former activity
B3	Idle	Idle land
D0	Dwelling	Dwelling activity
M1	Wastes	Treating and disposal of wastes
E0	Extraction	Extraction activity
F0	Forestry	Forestry activity
G0	Wildlife	Wildlife and fisheries activity
H1	Road	Road
H2	Rail	Railway
H3	Transport	Other transportation
H4	Communication	Communication activity
J0	Institutional	Institutional activity
L0	Transition	Land in transition
M0	Manufacturing	Manufacturing and commercial activity
N0	None	No perceived activity
P1	Conservation	Research and conservation
P2	Flood	Flood control and drainage
P3	Other	Other activity
P4	Irrigation	Irrigation
R0	Recreation	Recreational activity
08	Unclassified	Unclassified


1985 BASE YEAR POLYGON CLASSIFICATION DATA

Province A Ecoregion and Landscape Unit 710 Transect AUC

NTS Map No. Transect Map No.

Prepared by

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Polygon No.	Quarter Section No.	Cover	Activity	Wetland Data: Number	Margin Cover: Pri.	Margin Cover: Sec.	Status in Quarter	Comments
1 1 1	1 1	V 3	A 2					
1 1 2	1	V 3	H 1					
1 1 3	1	W 1	N 0					
1 1 4	1	X 0	A 1	1 1	O	S	T	
1 1 5	1	X 0	A 1	1 2	O	S	T	
1 1 6	1	X 0	A 1	8	O	S	T	
1 1 7	1	V 3	N 0					
1 1 8	1	V 3	N 0	4	S	B	T	
1 1 9	1	W 3	N 0	14	S	B	T	JN
1 1 10	1	W 3	N 0	15	S	B	T	
1 1 11	1	[illegible]	[illegible]					
1 1 12	1	W 1	N 0					
1 1 13	1	V 3	[illegible]	16	G	[illegible]	T	[illegible]
1 1 14	1	W 3	N 0	17	G	B	T	
1 1 15	1	V 3	A 2	17	G	[illegible]	T	RO WO
1 1 16	1	V 3	H 1					
1 1 17	1	V 3	[illegible]	17	S	B	T	[illegible]
1 1 18	1	V 3	N 0	18	G	B	T	[illegible]
1 1 19	1	W 1	N 0					
1 1 20	1	V 3	N 0	1 10	[illegible]	S	T	
1 1 21	1	V 3	N 0	1 11	G	B	T	[illegible]
1 1 22	1	V 3	N 0					[illegible]
1 2 1	1	X 0	A 1	1 12	O	B	T	RO
1 2 4	1	X 0	A 1	1 13	O	B	T	
1 2 5	1	V 3	N 0	1 13	O	S	T	[illegible]
1 2 6	1	X 0	A 1	1 14	O	S	T	
1 2 7	1	X 0	A 1	1 15	O	B	T	
1 2 8	1	X 0	A 1	1 16	O	B	T	

Figure A1.1 (left). A habitat monitoring field form utilized for habitat classification during compilation of the original 1985 dataset.

Figure A1.2 (below). An example of the original 1985 aerial photography and the subsequent polygon mapping methodology applied as part of the baseline habitat delineation. All original 1985 habitat delineations were completed using Mylar overlays on which habitats were hand drawn with the use of stereo-scopes.

COMPARISONS OF MEAN GROSS AND NET WETLAND AREA LOSSES

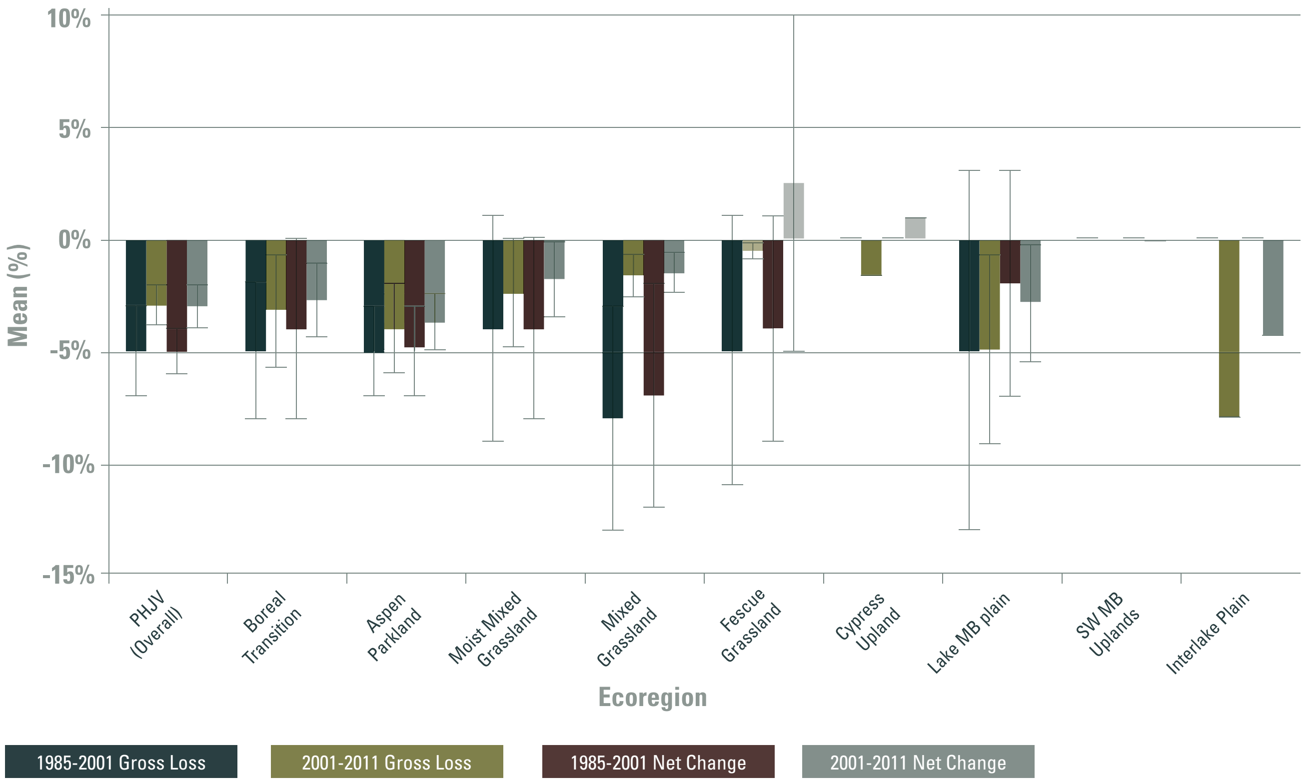

Figure A1.3 Comparisons of mean (non-weighted) gross and net wetland area losses between the 1985 and 2001 study (Watmough and Schmoll, 2007) and the current 2001 to 2011 study.

All photos provided by the Canadian Wildlife Service, Environment and Climate Change Canada

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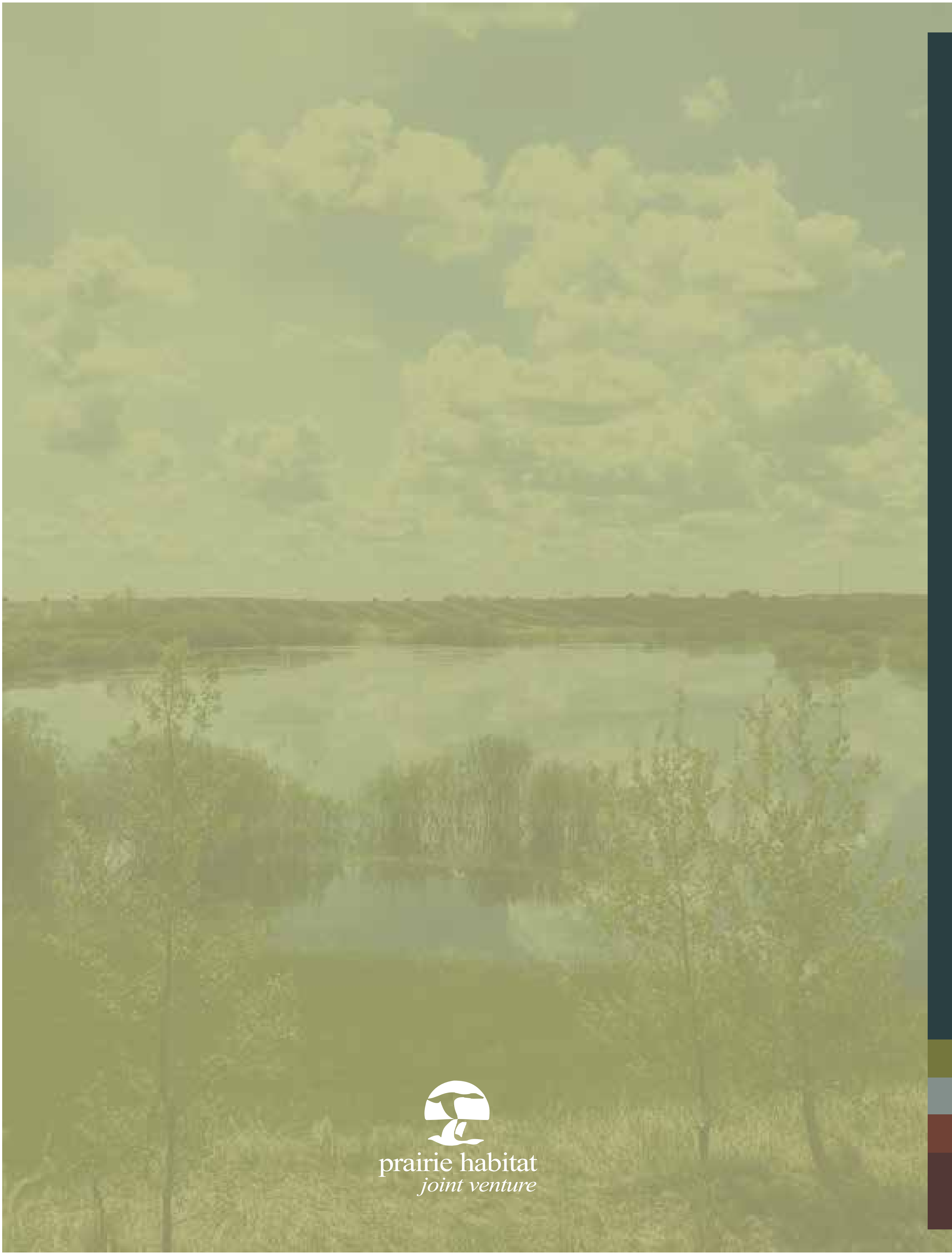
prairie habitat
joint venture