Prairie Habitat Joint Venture (PHJV)

Waterfowl Habitat Goals Update: *Phase 1*

Prepared for the Prairie Habitat Joint Venture Waterfowl Working Group

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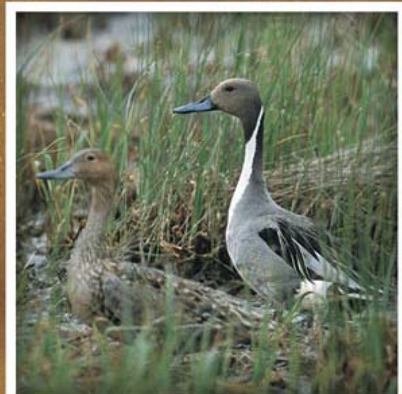

August 2004

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Prepared for:

Prairie Habitat Joint Venture
Waterfowl Working Group

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To ensure consistency in interpretation of information provided in this report, please contact the PHJV Coordinator (Deanna Dixon, CWS, Edmonton, AB) prior to citing.

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Preface

The 2004 Update to the North American Waterfowl Management Plan (NAWMP) stresses the need for development and continual refinement of biological models to link regional waterfowl habitat objectives to continental waterfowl population objectives. Given the development of new biological models within the PHJV partnership that incorporate knowledge gained through evaluation of habitat programs, an update of PHJV habitat goals to meet regional population objectives was initiated in the summer of 2003. A subcommittee of the PHJV Waterfowl Working Group undertook this task with representation from most of the PHJV partner organizations.

A strategy for updating PHJV habitat goals was developed and the elements were organized into the following three phases:

Phase I: Review of PHJV Progress and Modeling of Landscape Change on Duck (and Pintail) Productivity. Estimate duck productivity 'deficits' to be eliminated by habitat objectives. Product: ***This report****.*

Phase II: Develop habitat-based actions that address existing deficits and ongoing habitat loss within a reasonable planning horizon (15 years?). Product: Implementation Plans.

Phase III: Define an Adaptive Management Strategy for the PHJV including a process for tracking progress and adjusting course at 5-year intervals (includes monitoring of wetland and upland change), and for defining and reducing uncertainty and improving planning tools. Product: Report.

The following provides results from Phase I of the update process.

Executive Summary

Original PHJV habitat objectives, designed to meet waterfowl population goals set out by the NAWMP, were established in the mid-to-late 1980's using the best biological models linking landscape condition to waterfowl productivity. Evaluations that have occurred over the ensuing years of PHJV delivery have provided improved data on habitat-specific and landscape influences on waterfowl productivity and these results have been incorporated into new spatially explicit planning tools (the Waterfowl Productivity Model). Further, recent analysis of wetland loss conducted by the PHJV has provided province/ecoregion-specific wetland loss rates, which can be used to estimate the lost carrying capacity of the PHJV planning area for waterfowl. Given this information, and patterns of land use change extracted from the Census of Agriculture (Statistics Canada 2001), the PHJV is well positioned to estimate the impact past habitat changes have had on waterfowl productivity (including PHJV delivery), tease apart the relative impacts of wetland loss versus upland habitat change, and use this information to update habitat objectives.

This report provides results from Phase I of a strategy to update PHJV habitat goals using the Waterfowl Productivity Model and estimates of upland habitat change and wetland loss over the period 1971-2001. Our general approach involved estimating the level of duck productivity resulting from 1971 upland habitat and duck population carrying capacity and setting this productivity level as the PHJV goal. This assumes that 1971 conditions were sufficient to sustain the average duck populations of the 1970's (i.e., NAWMP Goal) and that upland change and wetland loss are the primary factors impacting productivity. Comparisons with duck productivity in 1986 (beginning of NAWMP) and 2001 (current) provide snapshots of how upland change and declining wetland habitat have impacted duck productivity over time. The difference between 1971 and 2001 duck productivity provides a 'deficit' to be eliminated by PHJV habitat goals. Subsequent phases of the strategy will model potential PHJV actions and use this information to set habitat goals that can eliminate the productivity deficit.

Our analysis of Ag Census data indicates that while land use has intensified dramatically (e.g., summerfallow replaced by annual cropping) since 1971, overall tilled land has actually decreased by ~6 million acres since 1986 and by ~ 2 million acres since 1971. Conversion of previously tilled land to hayland and pasture is responsible for the bulk of these changes. Many of these changes are the result of changes in Canadian agricultural policies since 1986 (e.g., removal of federal grain transportation subsidies, changes to the Canadian Wheat Board quota system, etc.). Concurrently, however, we have estimated that due to wetland loss, duck carrying capacity has decreased between 4.1% and 11.4% depending on province and ecoregion.

Modeling the impact of PHJV delivery on duck productivity since 1986 indicates a 0.6% increase in annual duck productivity at the prairie wide scale. Local gains as high as 15% were observed in some Census Consolidated Subdivisions (CCSs), however. These increases result primarily from approximately 200,000 acres of cropland conversion into DNC, hayland and pasture. We did not model expected gains from PHJV agreements

that secured existing uplands or wetlands from loss (no evidence of upland loss during 1986-2001; Watmough et al. 2002). While we suspect potential gains have accrued from PHJV policy and extension activities directed toward cropland conversion and fall cereals, quantifying these gains is at present, difficult. Looking forward, our model indicates that broad-scale policy efforts that result in cropland conversion to forage (such as Greencover Canada), if fully implemented, could provide very positive gains in waterfowl production.

While modeling indicates that upland changes have generally had positive impacts on duck productivity since 1986, wetland loss has negated these impacts by reducing the carrying capacity for waterfowl pairs. The combined impact is such that duck productivity in 2001 is approximately 6.7% below that of 1971. Elimination of this 'deficit' through habitat actions is the challenge for setting PHJV habitat goals. More specifically, the goals will be challenged to, **1) stop further wetland loss, 2) restore lost wetlands, especially small basins, 3) increase or maintain upland habitats in landscapes conducive for waterfowl production, and 4) improve habitat function on cultivated lands.**

Because we suspect unique habitat factors have reduced the productive capacity of pintails in the PHJV, and that our planning models likely do not effectively estimate the magnitude of habitat change impacts on pintails, the Waterfowl Working Group recognizes that a focused habitat goal-setting process is needed for this species.

Looking forward, Phase II of the goal updating process will include scenario planning to explore local and regional habitat options that will eliminate the productivity deficit. This process will require decisions about what habitat options are required, where they need to be applied, what resources are needed to achieve the change, and what time-frame is appropriate. To inform these decisions, linking our biological models to a cost-benefit analysis will be a critical step. A final step will be formalizing an adaptive management strategy for the PHJV habitat program.

Acknowledgements

This effort would not have been possible without the leadership of the PHJV, especially the Waterfowl Working Group. Specifically, Pat Kehoe (DUC) endorsed the concept and helped shepherd the process through to completion.

Brett Calverley (DUC; PHJV Coordinator) provided a review of the initial PHJV implementation strategy, summarization of initial acre goals and progress to date, and lists of key waterfowl, waterbird, and shorebird wetlands.

Deanna Dixon (CWS) provided contract support for our review of programmatic evaluations and digitizing of key moulting and staging wetlands and Garnet Raven (DUC) did the work.

Tim Sopuck (MHHC), Glen McMaster (SWA), and Brian Kazmerik (DUC) were helpful in providing data on the type and location of PHJV habitat program delivered in each Census Consolidated Subdivision (CCS).

Lyle Boychuk and Graham Thibault (DUC) extracted key Ag Census variables for the reference years and developed and applied the method by which we estimated suppressed data at the CCS level.

Gordon Matthews (DUC) provided critical GIS support.

Mike Watmough (CWS) provided unpublished data on wetland loss rates and the size class distribution of lost basins.

Llwellyn Armstrong (DUC) provided statistical advice and assisted with simulation wetland loss impacts on duck carrying capacity.

Finally, the members of the PHJV Waterfowl Working Group were helpful in keeping this process on track and provided thoughtful review at several stages in the process.

Prairie Habitat Joint Venture (PHJV) Waterfowl Habitat Goals Update: Phase I

Background

Under the 1986 North American Waterfowl Management Plan (NAWMP; USFWS and CWS 1986) agreement between Canada and the United States (and Mexico in 1994), key regions of the continent formed either breeding or wintering habitat joint ventures to deliver the objectives of the Plan. Of key importance to the Plan was to address the long-term decline in continental duck populations with an emphasis on improving recruitment from the Prairie Pothole Region (PPR) of North America. The primary factor limiting recruitment in the PPR was identified as the declining habitat needed to support successful upland nesting by waterfowl. Accordingly, a broad prescription for sustainable habitat restoration called for direct intervention to offset habitat loss in combination with a long-term strategy to revise government policies that allowed or promoted habitat loss.

The Prairie Habitat Joint Venture (PHJV) was established to oversee and steer planning and delivery of the NAWMP programs in the Canadian portion of the PPR (Figure 1; PHJV area). The PHJV is a consortium of federal, provincial, and NGO partner agencies each of which play important roles in delivering NAWMP-eligible activities. Although there are many supportive activities performed by various partner agencies, all activities support the goal of the NAWMP to restore continental waterfowl populations to the average levels of the 1970s through habitat conservation.

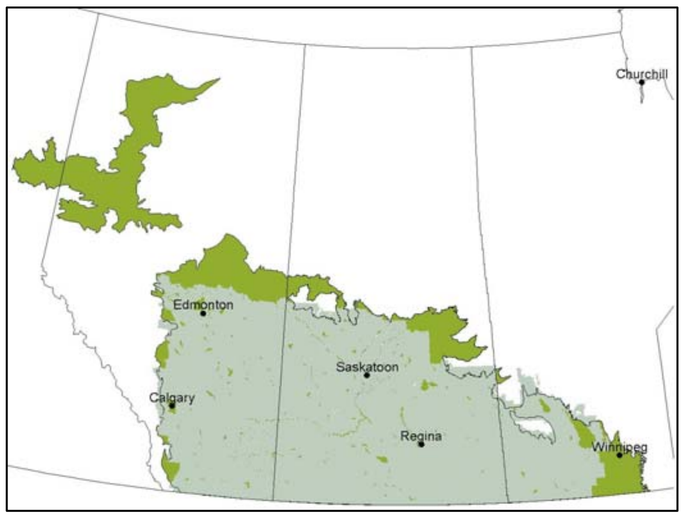

Figure 1. The Prairie Habitat Joint Venture planning region (dark green) including the Peace Parklands of Alberta. The area used in our examination of landscape change impacts on waterfowl productivity is overlain in light green.

Original Habitat Goal Setting Process (circa 1987-89)

From the original waterfowl population goal of the NAWMP, each PHJV Provincial Steering Committee was asked to identify habitat restoration steps required to achieve the continental goal. This was accomplished using a computer model (the Computer Planning Tool) that contained a biological model of waterfowl nest success-habitat relationships (the Mallard Model; Cowardin et al. 1988) and estimated costs of land management treatments. This model utilized the best data available to estimate the mix of upland management treatments required to achieve average 1970s populations. While the planning exercise focused on mallards, it was assumed that habitat sufficient to achieve mallard objectives would benefit all species. The model was used for planning in the Parkland Biome only, whereas in the Grassland and Peace Parkland Biomes, a manual exercise based on the best existing data available was used to predict acreage objectives and costs (e.g., Manitoba NAWMP Technical Committee 1987; provincial roll-ups; Table 1).

Table 1. Original acreage objectives and estimated cost of PHJV delivery by province (*Source: B. Calverley, NAWMP Coordinator*). See Appendix A for more detail.

PROVINCE	ACRES	ESTIMATED COST ($CDN)
Alberta	3,563,500	590,200,000
Saskatchewan	5,735,204	437,568,000
Manitoba	509,000	134,300,000
TOTAL	9,807,704	1,162,068,000

Initial implementation plan goals focused on upland 'treatments' to improve nest success to levels deemed necessary to meet population goals. It was assumed that there would be no net loss of existing wetland or upland habitat over the planning horizon. Where goals could not be reached through PHJV 'treatments', the difference was to be achieved through changes to, or elimination of, detrimental agricultural and tax policies. Additionally, the role of critical moulting and staging marshes was recognized and key wetlands in each province were identified as needing protection (e.g., Alberta NAWMP Technical Committee 1989).

Primary Habitat Programs Delivered Under the PHJV: 1986-2003

Habitat programs initially delivered by the PHJV through the provincial First Step Projects are grouped into the following habitat categories:

- Predator Fenced Plots
- Cover Plantings
- No Agricultural Use
- Modified Agricultural Use
    - Grazing Systems
    - Delayed Haying
    - Seed Production
    - Flushing Devices
- Wetland Complexes (includes nesting structures)
- Large Marsh
- Exclusive Agricultural Use (non-habitat)
- Conservation Farming Techniques (extension)

Each category involves a variety of agency-specific land management programs and securement techniques.

A Review of initial acre goals as set out in original Provincial implementation plans versus acres achieved to December 31, 2003 is provided in *Appendix A*.

Evaluations and Productivity Models

Concurrent with program delivery, and in the spirit of adaptive management, many programmatic evaluations have been conducted since the late 1980's (reviewed in *Appendix B*). Further, the PHJV Assessment study, conducted from 1993 to 2000 on 28-25 mile^2 study sites (3-4 sites/yr), evaluated landscape-level effects of habitat programs and furthered our understanding of landscape influences on waterfowl recruitment. As a result of evaluations, some activities have been curtailed (e.g., predator fences) while others have been expanded (e.g., winter wheat extension).

In aggregate, these evaluations also have allowed the development of a spatially explicit Waterfowl Productivity Model (WPM; Ducks Unlimited Canada, unpubl. data, *Appendix C*). This model links landscape and habitat-specific information to hatching success of the top five dabbling duck species occurring in the Canadian PPR (mallard, gadwall, blue-winged teal, northern shoveler, northern pintail) and allows retrospective, prospective, and hypothetical scenario analysis regarding landscape impacts on duck productivity.

In summary, while periodic reviews of progress have been attempted (e.g., Manitoba NAWMP Partners 1997; see also reviews by Williams et al. 1999, Riemer 2003), a biological accounting of progress using evaluation results and updated planning tools has not been attempted.

Goal Updating Process

As a starting point, the subcommittee decided to use the WPM to establish a baseline estimate of waterfowl production from the landscape condition that existed in the early 1970's. The baseline will serve as the productivity objective against which interim and current waterfowl productivity will be judged after accounting for changes in both upland and wetland habitats. This process recognizes that productivity from the region is impacted by both the amount of wetland habitat present (i.e., its carrying capacity for duck pairs) and the condition of upland habitats used by females for nesting. Following from this analysis, exploration of habitat alternatives to ameliorate lost waterfowl productivity will occur.

Key assumptions behind this approach are, 1) that the wetland and upland habitat that existed in the early 1970's was sufficient to support continental waterfowl populations at NAWMP goals with the average water conditions of the 1970's, and 2) that upland habitat change and wetland loss are the primary long-term factors impacting PPR duck productivity.

Estimating Landscape Impacts on Duck Productivity: 1971-2001

We used data from the Census of Agriculture (Statistics Canada 2001) at the Census Consolidated Subdivision (CCS) level (i.e., rural municipality or county) to provide estimates of landscape composition in each of 3 reference years; 1971 (productivity objective), 1986 (beginning of NAWMP), and 2001 (current landscape conditions). Challenges with this data included establishing consistent habitat categories among years, estimating woodland habitat, estimating grazed lands, data suppression at the CCS level, and accounting for PHJV habitat (Methods: *Appendix D*).

We used wetland area loss rates and the size characteristics of lost basins reported by Watmough et al. (2002; and unpublished data) to simulate lost carrying capacity for duck pairs. We used duck pair-wetland size regressions developed by Cowardin et al. (1995) and simulated the decline in pair carrying capacity over 14 years (Watmough's time period) from a database of wetland sizes recorded on PHJV Assessment sites. Loss rates provided by Watmough et al. (2002) were province/ecoregion-specific and were applied at that scale. We used the rate of duck pair loss resulting from simulations to adjust long-term expected populations extracted for each CCS from Ducks Unlimited Canada's pair density map of the Canadian PPR (Methods: *Appendix E*).

Given estimated landscape composition and average expected pair populations in each CCS in each of the reference years, the WPM was used to retrospectively estimate average expected hatched nests. While goal setting will be informed primarily by the difference in productivity between 1971 and 2001 given upland and wetland change, model runs also were used to explore productivity change; 1) prior to PHJV implementation (1971 –1986), 2) after PHJV implementation (1986-2001), 3) if wetlands had not been lost, but uplands changed, 4) if uplands had not changed, and only wetlands had been lost, and 5) if PHJV habitats had not been delivered. Because not all necessary input data was available for the entire PHJV planning area, our modeling efforts excluded the Peace Parklands and some northern portions of the Prairie region (Figure 1).

We think that the assumptions associated with this approach (outlined above and in Appendices) represent a reasonable start; in many instances these assumptions are testable either directly or via simulation, and we plan to conduct these evaluations in future work phases.

Note: Pintails have been singled out as species of special concern in the 2004 NAWMP Update given their extremely low populations relative to historic levels and the NAWMP population goal. Evidence suggests that the bulk of the continental population decrease in pintails has come from those birds that typically settled in the Prairie Pothole Region of Canada and hence this is an issue for the PHJV. Because we suspect unique habitat factors have reduced the productive capacity of pintails in the PHJV, and that our planning models likely do not effectively estimate the magnitude of habitat change impacts on pintails, the Waterfowl Working Group recognizes that a focused habitat goal-setting process is needed for this species. We foresee some overlap in habitat goals for pintails and those for other duck species.

Key Moulting and Staging Wetlands

To facilitate future planning and coordination with other bird groups, we; 1) compiled provincial wetland lists from the original PHJV Implementation plans and recent waterbird and shorebird plans, 2) provide geographic coordinates for these wetlands, and 3) provide notes on their current status (*Appendix F*).

Phase I Results: Landscape Change and Duck Productivity, 1971-2001

Upland Change

Our analysis of Ag Census data indicates that while land use has intensified dramatically since 1971, overall tilled land (annually cropped or summerfallow) has actually decreased by ~6 million acres since 1986 and by ~ 2 million acres since 1971. This change has resulted primarily from increases in pasture (included in 'natural' for this analysis) and hayland. These changes are widely recognized as being driven by changes in Canadian agricultural policy, primarily, removal of federal grain transportation subsidies, removal of cultivated acreage-based quotas by the Canadian Wheat Board, and federal/provincial programs promoting conversion of marginal cultivated acres (e.g., Riemer 2003). The largest single change in land use over this period has been a decrease in ~13 million acres of summer-fallowed land, most of which has become annually cropped (Table 2).

Table 2. Change in the four primary land use types composing the land base within the modeled portion of the PHJV planning area, 1971, 1986, and 2001.

	Acres within the modeled portion of the PHJV Planning Area[a]		
	1971	1986	2001[b]
Summerfallow	23,567,177	18,566,394	10,406,462
Spring/Fall-seeded Cropland	41,091,836	50,389,128	52,286,121
Tilled (sum of above)	*64,659,013*	*68,805,399*	*62,692,583*
Hayland	3,959,438	4,681,354	8,373,660
Natural[c]	52,810,370	47,942,068	50,362,578

[a] see Figure 1 for modeled portion of the PHJV planning area.
[b] PHJV acres included in 2001.
[c] the balance of uplands that are not tilled or hayland (includes grazed and ungrazed grassland, woodlands, and wetland vegetation)

Changes in land use are not distributed uniformly throughout the region (Figure 2). Continuous cropping has largely replaced summerfallow in most parts of the region except southwestern Saskatchewan. Haylands have increased everywhere but increases are most pronounced in Manitoba and central Alberta.

Since 1986, delivery of PHJV habitat resulted in approximately 1.3 million acres of upland habitat under agreements in 2001 (does not include expired leases prior to 2001). While the majority of these acres were securement of existing habitat, approximately 200,000 acres were direct conversion of cropland into DNC, hayland, or pasture (Figure 3).

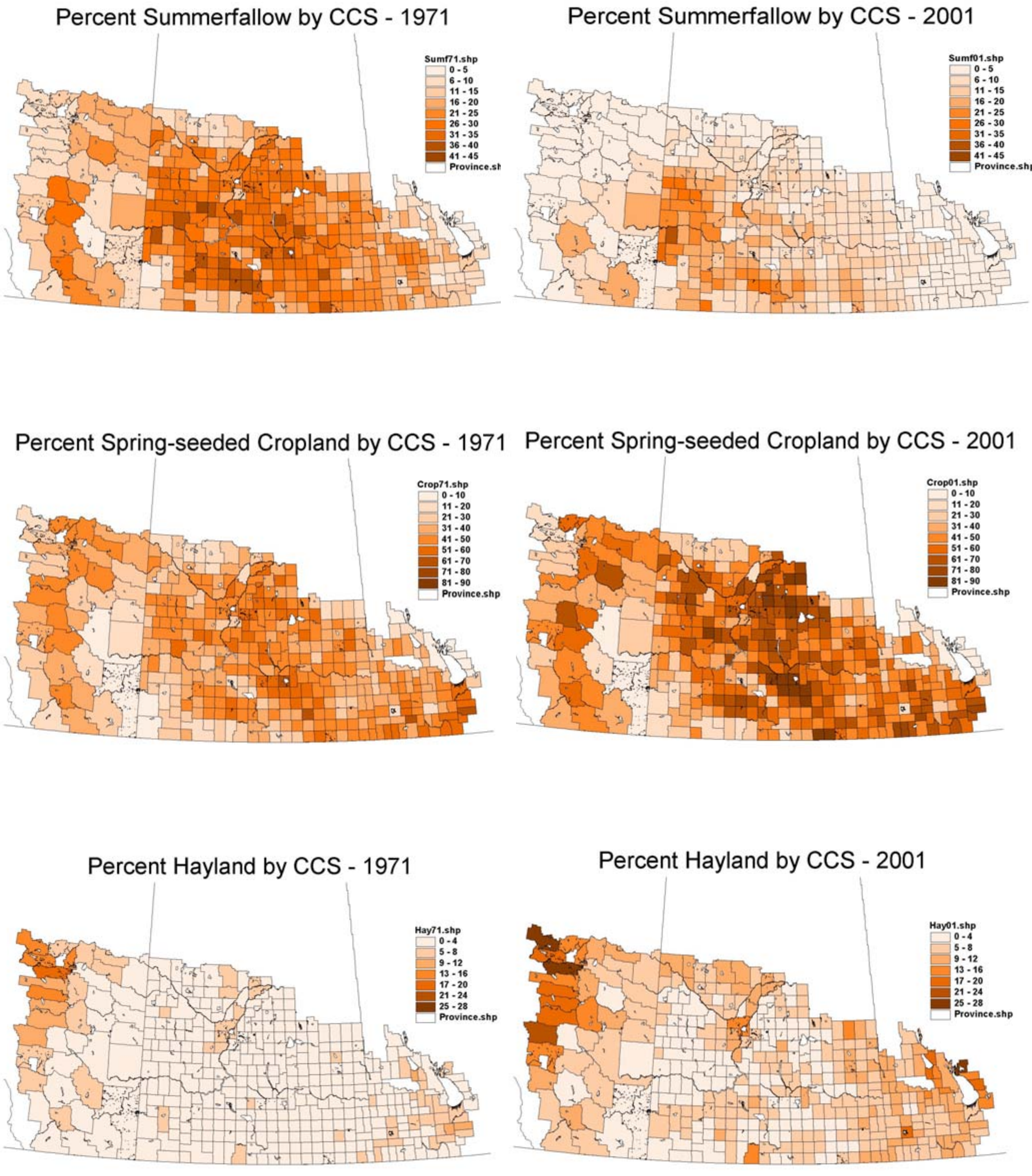

Figure 2. Spatial pattern of land use change in summerfallow, spring-seeded cropland, and hayland, 1971 versus 2001, within the modeled portion of the PHJV planning area.

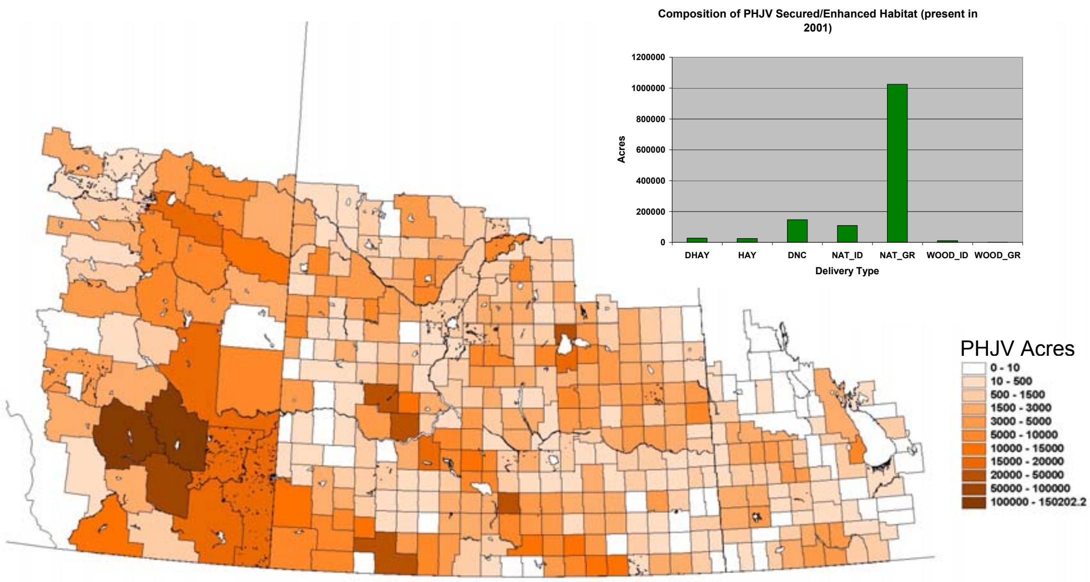

Figure 3. Spatial distribution and overall composition (bar chart) of PHJV acres within the modeled portion of the PHJV planning area.

Wetland Loss

Watmough et al. (2002, and pers. comm.) provided wetland loss rates for the period 1985-1999 by province/ecoregion. After reviewing wetland loss rates for earlier time periods, Watmough et al. concluded that wetland loss rates have probably been constant from the 1970s to present. These estimates are believed to be *conservative* due to the strict definition of wetland loss used by Watmough et al. (2002).

Extrapolating Watmough's estimates, approximately 2.4 to 7.6% of wetland area has been lost at province/ecoregion scales between 1971 and 2001 (Table 3). Decreases in duck carrying capacity at these wetland loss rates range from 4.1 to 11.4% (Table 3). At more local scales (e.g., RM of Leroy in SK, ~100mi^2), up to 90% wetland loss has been documented over this time period (Ducks Unlimited Canada, unpubl. data) with an estimated 90% reduction in duck pairs.

Table 3. Estimated percent of wetland area lost, size characteristics of lost wetlands, and estimated impact of wetland loss on waterfowl carrying capacity by province and ecoregion. Estimates are extrapolated from 1985-1999 wetland loss rates supplied by Watmough (pers. comm.) as described in Appendix E.

Prov/Ecoreg	Estimated % Wetland Area Lost (1971-2001)	Median size of lost wetland basins in Ha (min, max)	Estimated % lost duck pairs (1971-2001)	Annual Duck Pair Loss Rate (%)
AB Parkland	-5.84	0.10 (0.01, 2.97)	-10.6	-0.3717
AB Prairie	-4.59	0.12 (0.01, 2.98)	-7.9	-0.2749
SK Parkland	-2.41	0.20 (0.03, 1.55)	-4.1	-0.1402
SK Prairie	-6.69	0.15 (0.02, 12.36)	-7.6	-0.2633
MB Parkland	-7.60	0.14 (0.02, 4.13)	-11.4	-0.4036

The Impact of Landscape Change on Waterfowl Productivity: 1971, 1986, 2001

When upland and wetland changes are modeled together (i.e., actual change), annual waterfowl productivity in the Prairie region declined by 7.3% between 1971 and 1986 but increased by 0.7% between 1986 and 2001 for an overall 'deficit' of 6.7% (~78,000 hatched nests) from 1971 to present (Table 4). By separating the relative impact of wetland change versus upland change, however, an important distinction is apparent; while upland changes alone (i.e., no influence of wetland loss on the number of ducks settling on the Prairies since 1971) resulted in decreased productivity to 1986, upland change since 1986 would have more than compensated for lost uplands from 1971-1986 (+1.1%, Table 4). Unlike upland changes, wetland loss has exhibited a constant negative influence on duck production capacity over all time periods (-7.7%; 1971-2001) by reducing the number of pairs settling in the region.

Table 4. Estimated percent change in the number of hatched nests of 5 dabbling duck species in Prairie Canada as a result of 3 habitat change scenarios from 1971-1986, 1986-2001, and 1971-2001. 'Upland and Wetland Change' represents the combined effect of both influences and reflects our estimate of actual change.

	Percent Change in Duck Productivity (Estimated Hatched Nests)		
	1971-1986	1986-2001	1971-2001
Upland and Wetland Change	-7.3	+0.7	-6.7
Upland Change Only	-3.5	+4.8	+1.1
Wetland Change Only	-3.9	-3.9	-7.7

When viewed spatially (i.e., compiled at the CCS scale), changes in productivity have not been uniform across the Prairie region since wetland loss (and hence loss in duck carrying capacity), land use, and duck populations vary regionally and locally. When wetland and upland changes are considered together (Figure 4), it is apparent that despite the region-wide decrease in productivity of 6.7%, productivity has potentially improved in some local areas, especially eastern portions of the region. Because we know wetland loss influence is always negative, these gains have resulted from upland change, primarily since 1986.

Modeling productivity based on landscape change without the influence of wetland loss demonstrates locally negative influences prior to 1986, but broad positive influences since 1986 (Figure 5). Modeling productivity based on wetland loss alone (impacting duck carrying capacity of each CCS) indicates largest changes in province/ecoregions with highest loss rates as expected, but with regional decreases accentuated in CCSs with high duck populations (e.g., Buffalo Lake Region of AB, Missouri Coteau and Allan Hills of SK, Shoal Lake area of MB)(Figure 6).

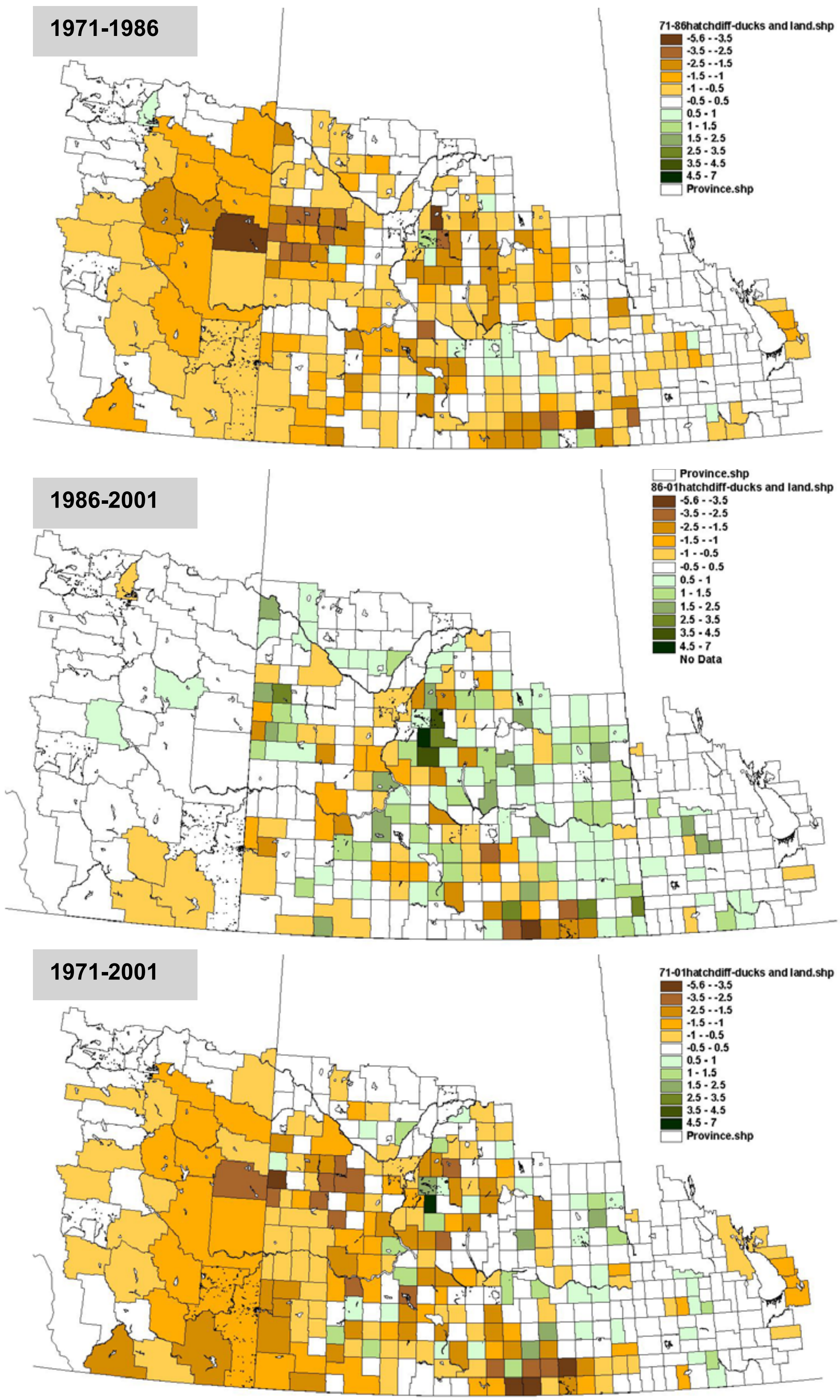

Figure 4. Spatial pattern of duck productivity change as a result of modeling wetland loss and upland change together; 1971-1986, 1986-2001, 1971-2001. The legend represents positive (green shades) or negative changes (orange shades) in the number of hatched nests per 1000 ac of CCS unit size.

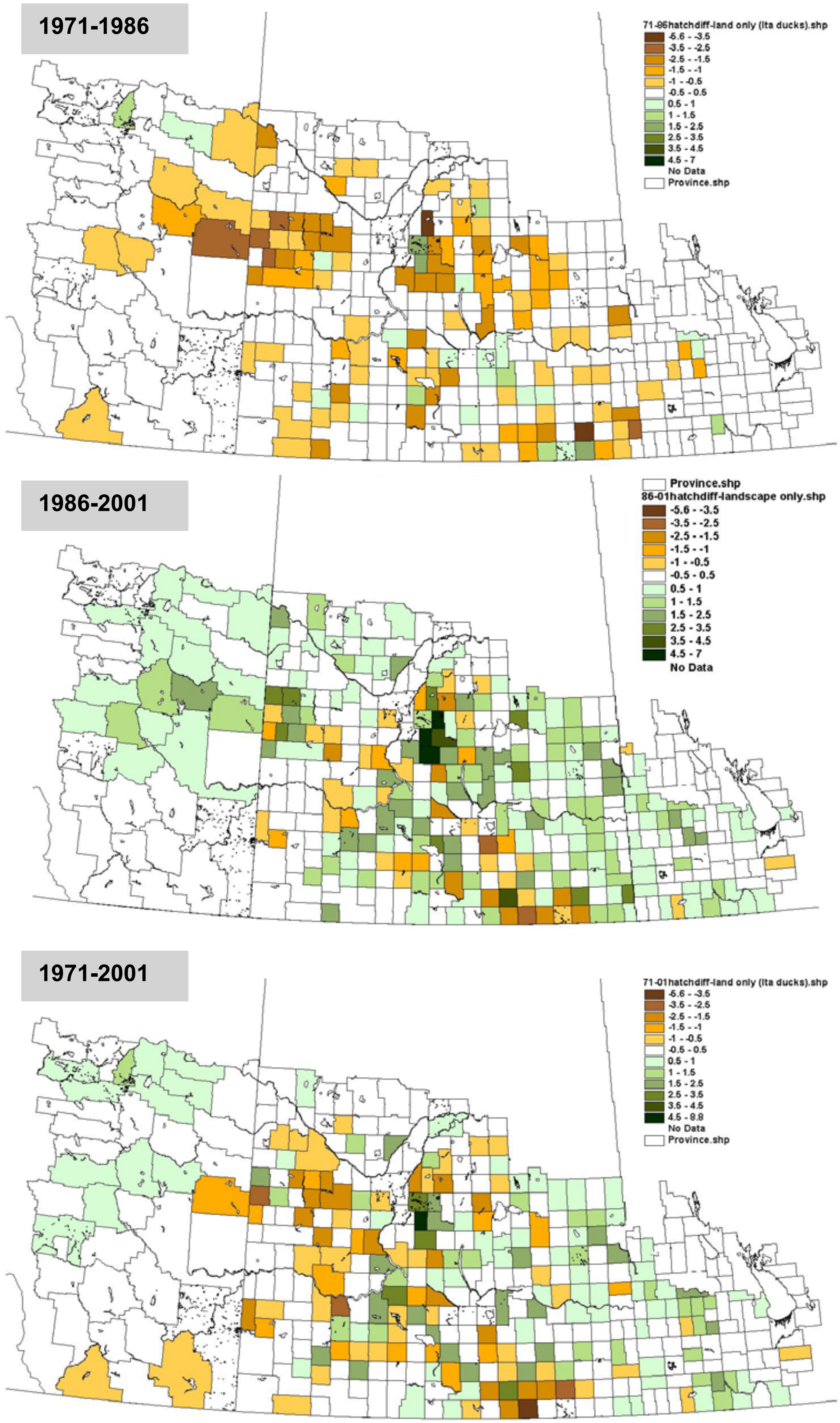

Figure 5. Spatial pattern of duck productivity change as a result of modeling upland change without the influence of wetland loss; 1971-1986, 1986-2001, 1971-2001. Legend represents positive (green shades) or negative changes (orange shades) in the number of hatched nests per 1000 ac of CCS unit size.

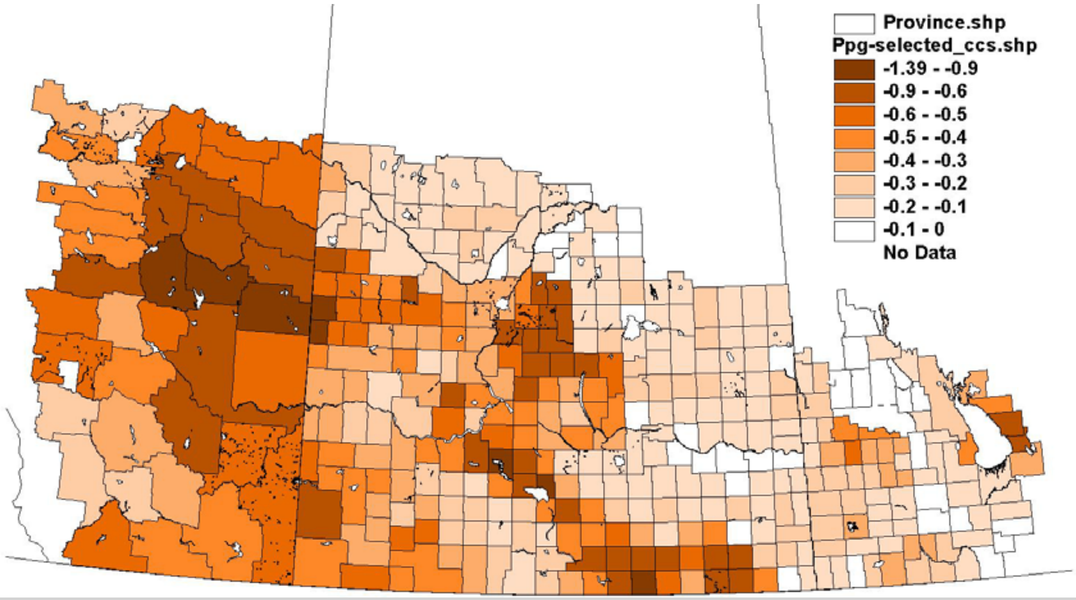

Figure 6. Spatial pattern of duck productivity change as a result of modeling wetland loss without upland change; 1971-2001. Legend represents changes in the number of hatched nests per 1000 ac of CCS unit size.

Illustrative Scenarios

Retrospective: Impact of PHJV cropland conversion programs

To further inform PHJV planning, we modeled a scenario in which all acres of PHJV habitat were converted to our "best guess" at their pre-securement land use in our 2001 landscape input file (Methods: *Appendix G*). Hence, we are comparing the 2001 landscape with PHJV habitat to an estimate of what the landscape may have looked like without PHJV habitat. Over the entire Prairie region, annual duck productivity was 0.6% (~6,000 hatched nests) higher with PHJV habitat than without. If we restrict the comparison to just those CCSs where PHJV habitat was delivered, productivity was 1.1% higher with PHJV habitat. Spatially, we see most of the gains in the Parkland CCSs in each province as well as the Missouri Coteau region of southern SK (Figure 7). Increases in productivity as high as 15% were seen in some CCSs in the Allan Hills region of SK where large amounts of DNC have been planted.

Most gains in productivity accrue from PHJV activities that convert cropland to DNC, hayland, and pasture. We did not model a loss rate in existing habitat (based on Watmough's findings) and hence, no gains accrue from the bulk of PHJV acres that 'secure' existing habitat (e.g., southern AB). As well, this analysis did not account for any acres affected through broad extension or policy efforts, despite some evidence that these efforts have impacted acres (e.g., winter wheat extension).

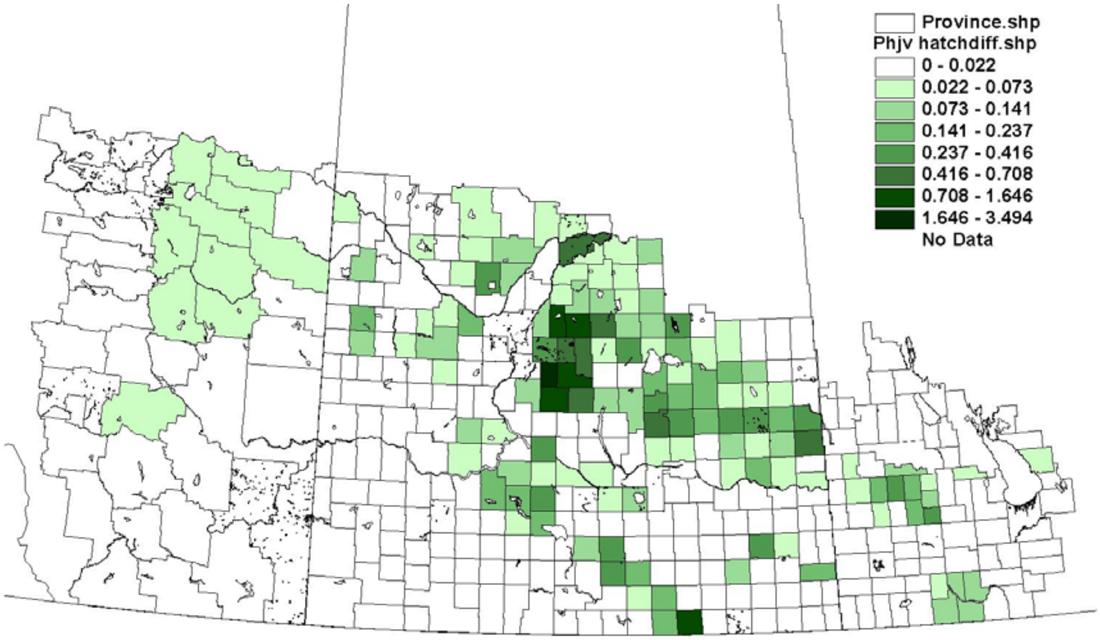

Figure 7. Spatial pattern of annual duck productivity gain as a result of PHJV cropland conversion programs. Legend represents changes in the number of hatched nests per 1000 ac of CCS unit size.

Prospective: Impact of policy-related marginal land conversion

To estimate the impact policy initiatives may have on waterfowl productivity, we estimated the impact of delivery of approximately 1.5 million acres of cropland conversion targeted to 'marginal' cropped land in Saskatchewan and Manitoba (Methods: *Appendix H*). We used information available on the distribution of marginal land to apportion these acres among CCSs. Given our assumptions, annual duck productivity from Manitoba and Saskatchewan would increase by about 2.2% (~14,000 hatched nests) with this level of conversion. Given the distribution of eligible acres, most of the gains would come from central and southeastern SK (Figure 8).

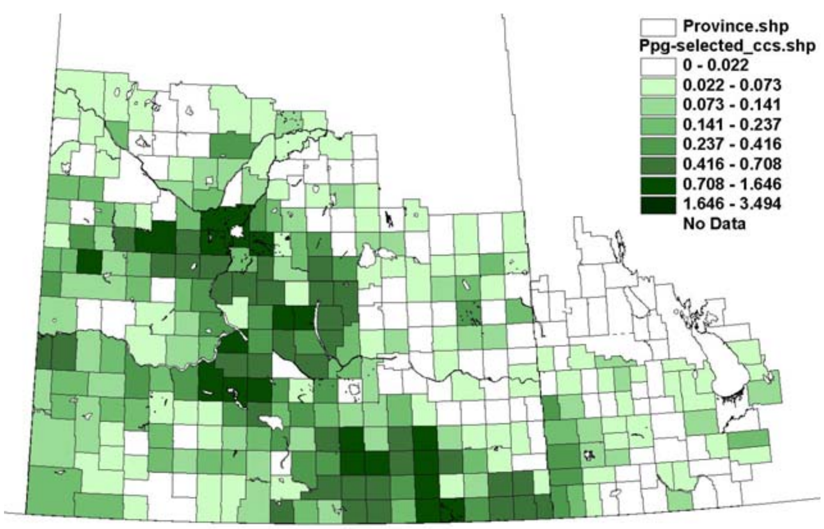

Figure 8. Spatial pattern of duck productivity change as a result of modeling the 2001 upland and wetland conditions with an additional ~1.5 million acres of cropland conversion to hayland and tame pasture in Saskatchewan and Manitoba. Legend represents changes in the number of hatched nests per 1000 ac of CCS unit size.

Discussion

The results of our review and modeling exercise indicate that from 1971 until 1986, both upland loss to tillage and wetland loss to drainage had reduced annual waterfowl production capacity in the Canadian PPR by approximately 7.3%. Between 1986 and 2001, however, primarily as a result of changes in Canadian agricultural policy, annual tillage decreased by 6 million acres and was replaced by hayland and pasture to support a growing cattle industry. Included in this change was over 200,000 acres of converted cropland delivered by PHJV partners (DNC, hayland, tame pasture; this does not include leases that had expired prior to 2001). While these changes have had a positive impact on waterfowl productivity, the continual loss of wetland habitat has undermined the ability of the prairie landscape to support historic numbers of ducks (-4% to –12% regionally, -90% in some local areas), thus reducing overall productivity potential. In 2001, our modeling exercise indicates annual duck productivity remained 6.7% below 1971 levels primarily due to wetland loss.

To return duck productivity to 1970's levels, then, PHJV goals will need to **1) stop further wetland loss, 2) restore lost wetlands, especially small basins, 3) increase or maintain upland habitats in landscapes conducive for waterfowl production, and 4) improve habitat function on cultivated lands.**

Because we suspect unique habitat factors have reduced the productive capacity of pintails in the PHJV, and that our planning models likely do not effectively estimate the impact habitat change has had on pintails, a focused habitat goal-setting process is needed for this species. We recognize that habitat goals set for pintails will benefit other species and we foresee goals being compensatory rather than additive.

Consideration of instruments appropriate to attain these goals (policy, agricultural extension, direct investment) and time horizons needed to achieve them will be important. Where direct investment in wetland or upland treatments is warranted, these activities should be highly targeted to landscapes where the most waterfowl will benefit. Modeling tools will need to be a key component of the objective setting process.

Key Assumptions and Uncertainties

Effective adaptive management requires specification of key assumptions and uncertainties in the planning process. As mentioned previously, a key assumption of the process we used is that the upland and wetland habitat that existed in the early 1970's was sufficient to maintain continental duck populations at NAWMP goals. This assumes that key ecological functions underlying the interaction of habitat and hatching success of nesting ducks have not changed and that the amounts of wetland and upland habitat are the primary driving forces of productivity.

Our analysis also assumes that wetland loss displaces ducks out of the Prairie region due to inherent spacing mechanisms and resource competition. The analysis further assumes that reproductive success in these 'other' areas is lower. Drought is a temporary mechanism displacing ducks from the Prairie region and evidence indicates that prairie droughts displace ducks to the boreal forest or tundra regions where they either do not breed or experience low reproductive success (Smith 1970, Johnson and Grier 1988). We suspect wetland loss acts like permanent drought.

While our analysis has focused on the *quantity* of habitats available, we have not been able to address potential issues with habitat *quality*. Grazing intensity on pasture habitats is not reported in the Ag Census but based on ratios of cow/calf numbers relative to pasture in the Ag Census and 30% increases in cattle size over our modeled time period (Higgins et al. 2002), we suspect it has increased dramatically (Figure 9). Grazing intensity affects different bird species in different ways but impacts on waterfowl are expected to be negative. While reduced summerfallow likely has had positive soil and water conservation impacts, the increase in continuous cropping (including stubble retention for 'conservation tillage') may have created 'sink' habitats for some nesting birds that use cropland stubble for nest sites early in spring [e.g., including the pintail (Podruzny et al. 2002)]. Despite overall reduced tillage, true native prairie, which is a critical habitat for many bird species, continues to be lost at variable rates. Our models currently do not incorporate effects of reduced habitat quality due to agricultural intensification (increased grazing intensity, reduced summerfallow, native prairie loss, larger machinery, faster seeding, fertilizer and pesticide inputs) and better information on these impacts is needed.

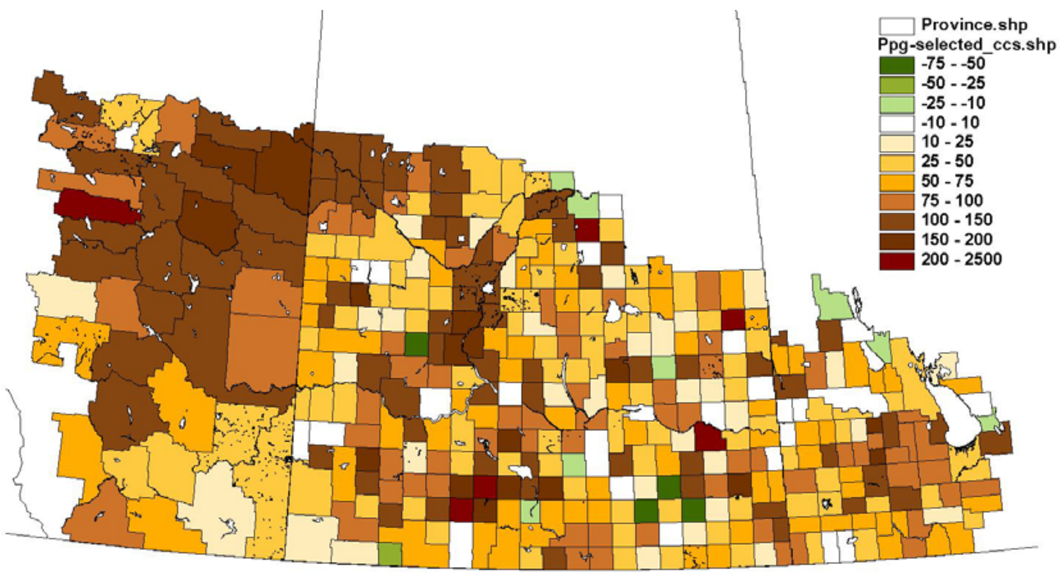

Figure 9. Estimated percent change in grazing pressure (cow mass/acre) by CCS, 1971-2001. Grazing pressure here is estimated by CCS based on reported cow/calf pairs, estimated pasture acres, and estimates of changes in mean cattle weights from 1971-2001 (cattle weights; Higgins et al. 2002).

Additional uncertainties inhibiting refinement of our knowledge regarding landscape impacts on duck productivity (and our modeling tools):

- The role of spatial and temporal variability in prairie duck productivity (i.e., pattern from process of prairie ecosystem variability [interaction of climate, food chains, habitat]).
- Wetland loss impacts at finer scales than the province/ecoregion.
- How does the wetland size-pair density relationship vary across the prairie region (we used North Dakota data)?
- Upland and wetland impacts on duckling survival (not currently modeled).
- Upland influences on duck carrying capacity; does wetland use depend on surrounding upland condition?
- Impact of partial impacts (cultivation, burning, etc.) on wetland use by ducks.
- Influence of predator community change (i.e., quantifying the change in waterfowl nest predator community and its potential impact on waterfowl; 1970's to current).

Next Steps

Defining habitat goals that address the productivity 'deficits' and their causes as outlined in this report, and further specifying an adaptive management strategy for the PHJV are the logical next steps in the process (Phases II and III). A few guiding points based on reviews and experiences in Phase I:

- The PHJV needs to review habitat monitoring needs and the current design of habitat monitoring efforts to address whether they provide data at appropriate spatial and temporal scales for adaptive decision-making. Data collection coincident with the availability of Ag Census data may be one option.
- All PHJV partners need better tracking of HOW, WHERE, and by HOW MUCH their activities (including extension and policy) have changed the landscape – this should be consistently tracked at the project level (quarter section based) and readily aggregated to larger scales. The question, "How does this activity maintain or improve duck productivity?" should be answerable and scientifically supported for all activities.
- Define a method for estimating pintail habitat goals.
- A few critical information needs to support policy actions (e.g., ecological goods and services provided by prairie wetlands) should be specified and prioritized for research.
- Planning tools (DSS, WPM, etc) need to be constantly refined and tested as new information from evaluations is made available.
- Key assumptions underlying the planning process and the models used in the planning process need to be evaluated, especially if false assumptions could dramatically affect outcomes.
- A Vision and Strategy for linking waterfowl planning with other bird planning within the PHJV needs to be developed. Key moulting and staging wetlands provide an obvious point of overlap for waterbird and shorebird planning and this may be an obvious first step. Maps of species occurrence, upland habitat composition, and condition will likely drive points of overlap with landbirds.

- Define measures of success and develop an evaluation plan as part of the adaptive management strategy.

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Appendix A. Original PHJV acreage objectives compared to actual delivery to December 31, 2003, by province (source: B. Calverley, NAWMP Coordinator)

ALBERTA

PROGRAM ELEMENTS	ORIGINAL OBJECTIVES (ac)	ACCOMPLISHMENTS TO 031231
Predator Fenced Plots	20,000	40
Cover Plantings	325,500	40,742
No Agricultural Use	660,000	68,435
Modified Agricultural Use		
Grazing Systems	874,000	541,586
Delayed Haying	430,000	21,481
Seed Production	-	533
Flushing Devices	-	57,426
Convert to Perennial Cover	-	401
Small Wetlands	?	51,964
Large Marsh	863,000	286,489
Exclusive Agricultural Use	-	2,215
Extension	391,000	Not tracked
TOTAL ACRES	**3,563,500**	**1,071,312**

Includes accomplishments of Alberta Sustainable Resource Development, Alberta Environment, Nature Conservancy of Canada and Ducks Unlimited Canada.

SASKATCHEWAN

PROGRAM ELEMENTS	ORIGINAL OBJECTIVES (ac)	ACCOMPLISHMENTS TO 031231
Predator Fenced Plots	10,960	640
Cover Plantings	42,720	123,165
No Agricultural Use	554,070	74,700
Modified Agricultural Use		
Grazing Systems	1,450,515	386,591
Delayed Haying	1,175,615	41,336
Seed Production	27,860	419
Flushing Devices	-	149,457
Convert to Perennial Cover	-	25,518
Small Wetlands	?	96,559
Large Marsh	?	151,983
Exclusive Agricultural Use	-	2,447
Extension	2,473,464	Not tracked
TOTAL ACRES	**5,735,204**	**1,052,815**

Includes accomplishments of Saskatchewan Watershed Authority (formerly Saskatchewan Wetland Conservation Corporation), the Nature Conservancy of Canada, Saskatchewan Environment and Ducks Unlimited Canada.

Appendix A (cont'd).

MANITOBA

PROGRAM ELEMENTS	ORIGINAL OBJECTIVES (ac)	ACCOMPLISHMENTS TO 031231
Predator Fenced Plots	16,000	205
Cover Plantings	21,000	24,140
No Agricultural Use	72,000	72,814
Modified Agricultural Use		
Grazing Systems	100,000	94,296
Delayed Haying	29,000	18,636
Flushing Devices	-	21,640
Convert to Perennial Cover	-	11,236
Small Wetlands	?	46,938
Large Marsh	?	64,005
Exclusive Agricultural Use	-	305
Extension	271,000	Not tracked
		-
TOTAL ACRES	**509,000**	**354,215**

Includes accomplishments of Environment Canada, Delta Waterfowl Foundation, Manitoba Conservation, Manitoba Habitat Heritage Corporation, the Nature Conservancy of Canada and Ducks Unlimited Canada.

Appendix B. A Synopsis of PHJV evaluations 1986-2003 (*Prepared by:* G. H. Raven & J. H. Devries, Ducks Unlimited Canada).

The following synopsis focuses on evaluations conducted by PHJV partners during the years of PHJV delivery from 1986-2003. This is not intended as a complete review of all research on these topics although addition work on these topics is cited in some instances. In instances where PHJV partners have compiled reviews of the existing information on management practices, a summary of those findings is presented here. Readers are encouraged to consult the primary sources for full details and other PHJV reviews (e.g., Williams et al. 1999, Riemer 2003; cited in main report).

PLANTED NESTING COVER (DNC)

Initial research indicated that fields of planted grass/legume mixtures left idle for one or more growing seasons received good use by nesting ducks and nest survival was higher than average (Duebbert 1969, Duebbert and Lokemoen 1976). Hence, planted dense nesting cover (DNC) has been a major tool used to increase duck production in the Prairie Pothole Region (PPR). It is assumed that by increasing nest survival, population recruitment will increase. Despite much evidence of higher than average nest survival (PHJV Assessment, unpubl. data), questions remain regarding population impact and variation in nest survival.

Questions also remain regarding appropriate management type and frequency to sustain long-term productivity from planted fields. Seeded grasslands may require periodic management interventions to remove litter buildup and reenergize the stand. Haying or burning is commonly used for this purpose, yet the required frequency of the interventions and the effects on bird production are poorly understood and may vary among different stand compositions and interventions.

McKinnon and Duncan (1999)

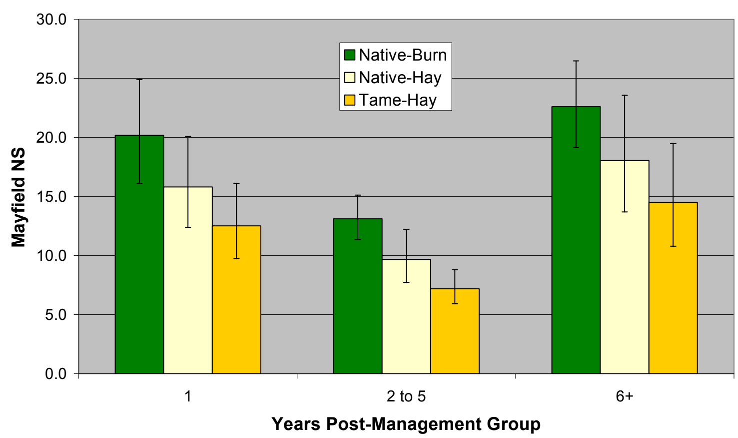
The authors analyzed data from a 3-year study in the parkland of southern Saskatchewan where 31 DNC, and 31 unmanaged plots were searched for nesting waterfowl. Mayfield nest success for the three years was higher in DNC (15%) than in the unmanaged plots (7%). Results differed among species such that mallard and gadwall had a higher nest success in DNC than in unmanaged areas, whereas blue-winged teal and northern shoveler did not. Nest success was found to vary considerably both among years and among fields within years. It was estimated that about 0.5 duck nests were initiated per acre of DNC (0.16 mallard nests/acres).

Though nest success was higher in DNC than in unmanaged areas the authors caution that overall nest success in DNC was only 15%, the threshold considered necessary for stable populations of mallards, but below the 20% believed necessary for the other species. The authors suggest that annual variation in nest success may be attributable to the number of May ponds (moisture levels). In this study, nest success rates of 15, 8, and 26% coincided with May pond counts of 1.0, 0.6, and 1.4 million, respectively, in the aspen parkland of Saskatchewan.

Calculations simulating the potential effect of DNC on the mallard breeding population show that probably only about 1% of the population is being affected by DNC in southern Saskatchewan. Based on these results, the authors question the impact of DNC on continental populations, especially given the cost of implementing this program. The authors cite evidence that at the landscape scale, increasing the proportion of perennial cover may improve nest success. The authors suggest cropland conversion to pasture as an alternative that may be more fiscally and socially feasible and yet still provide nest success benefits.

Devries (2003)

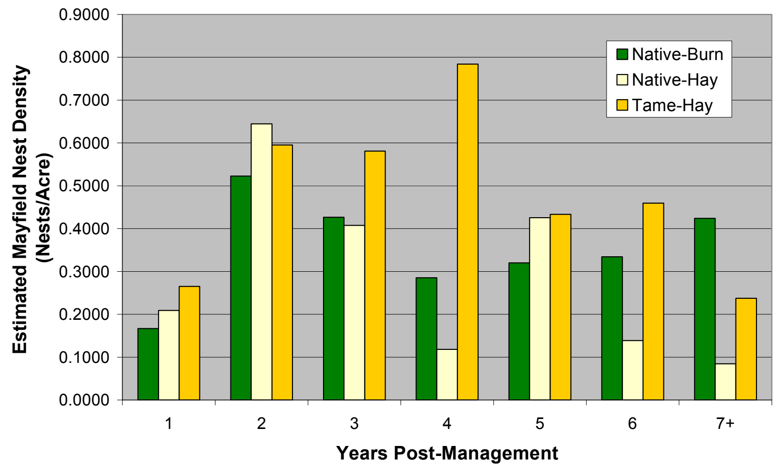
Devries (2003) examined waterfowl productivity in DNC fields under different management regimes in Saskatchewan and Manitoba from 1998 to 2001. Nest density (corrected for Mayfield nest success), nest success and hatch density was used to compare stand types (native or tame) and management types (hayed or burned). Fields also were categorized by the number of years since the management occurred and by several cover measurements.



Mayfield nest success by field type-management category and years post-management category

Nest success was found to be highest in native-burned fields, followed by native-hayed and tame-hayed fields. Success was high the year following management, lower between 2-5 years post-management, and improving again after year 5. Hatch density showed varying patterns depending on stand and management type and years post-management. Hatch density is low in native-hayed and decreases following 3 years post-management. Tame-hayed fields have their highest hatch density between 3 and 6 years post-management while native-burned fields increase in hatch density through to 7 years post-management. Nest density corrected for Mayfield nest success typically declines the year following management but increases dramatically the next year before following varying patterns depending on stand and management type. Vegetation density and maximum height peaked 2-3 years post-management and leveled off at an intermediate level.

The author concludes that both nest success and density may be maximized in native stands that are managed by burning. Productivity increases through time and peaks after 5 years post-management. Tame stands can also be productive if left unmanaged for 4-6 years and hayed native stands are most productive 3-5 years post-management.



Estimated Mayfield nest density (i.e., corrected for nest success) by field type and year post-management category

Production of all stand types can be maximized in areas with high wetland densities. Conversion of cropland to native grasses and legumes managed by fire is the preferred method of habitat restoration for waterfowl production; however, establishment and management costs for this combination are very high. The author suggests that DNC fields in the aspen parkland of Canada may be left for up to 7 years without management to maximize production. The author further expresses the need for research on the effect of grazing as a management intervention, as grassland ecosystems evolved under both fire and grazing disturbances.

SUMMARY

Planted nesting cover is one of the most effective habitat treatments to improve nest success at the field level. Affecting population level reproductive success is unlikely, however, unless widespread cropland retirement programs such as the US Conservation Reserve Program are adopted in Canada. Where DNC is established for local gains in recruitment, data indicates native grass plantings managed about once every 7 years by burning may be the most productive option, albeit the most expensive.

PREDATOR EXCLOSURES (FENCED DNC)

Electrified fences constructed around fields of DNC to exclude terrestrial predators and increase success of upland nesting waterfowl (Lokemoen et al. 1982) were a key component of initial PHJV implementation plans. Concerns were identified early, however, about the reluctance of hens to cross fences when leading their broods to water (i.e., hens would not leave their ducklings to fly over the fence). This reluctance delayed the time required to travel to water and placed the brood at risk to starvation, dehydration and predation, potentially negating any benefits of the fence.

Howerter et al. (1996)

The authors examined the effect of fenced exclosures on travel time to first wetland, duckling survival, and the mitigating effects of exit structures designed to allow more rapid egress of hen and brood from the fence. Six exclosures in southeastern Saskatchewan were studied in 1992 and 1993. Three exclosures in each year were fitted with exit structures in a cross-over design such that intact exclosures in one year were fitted with exits the next year and vice versa. Movement and survival of broods from nests in fence treatments were compared with control broods from nests outside exclosures.

Intact predator exclosures delayed exit from the fence and increased travel time to first wetland. Exits improved exit time, however, travel times to first wetland were still greater than controls. Duckling survival to the initial wetland was lower for broods hatched in intact exclosures (38%) than for modified exclosures (87%) or control broods (98%). Survival to initial wetland was lower for modified exclosures than for control broods but results were marginally significant. However, duckling survival to 14 days post-hatch did not differ between the three groups.

Influence of exclosure fence and exit installation (modified) on travel and exit times to first wetland for mallard broods in southeastern Saskatchewan, 1992-93.

		Total Travel Times (hrs)			Time Attempting Exit (hrs)			Unimpeded Travel Time (hrs)		
Treat	*n*	x	SE	Range	x	SE	Range	x	SE	Range
Intact	32	28.4	4.0	.3-100.9	23.7	3.6	0.1-100.8	1.4	0.5	0.1-16.3
Modified	31	7.1	1.5	0.4-36.2	3.2	1.0	0.1-26.3	2.1	1.0	0.1-26.3
Control	23	1.5	0.3	0.0-6.1	-	-		1.5	0.3	0.0-6.1

The authors suggest that exits be installed in existing and newly constructed predator exclosures. Exclosure exits should be installed at corners of fenced fields and adjacent to wetlands. New exclosures should only be constructed if duckling survival is likely to be high and if staff can commit considerable time for maintenance and to ensure exclosures remain predator free.

SUMMARY

Results of the above study show that the negative effects of duckling survival may counteract the benefits of predator exclosures to nesting waterfowl. Constructing exits in existing exclosures can help to alleviate this problem but not eliminate it. Construction and maintenance costs may outweigh potential benefits.

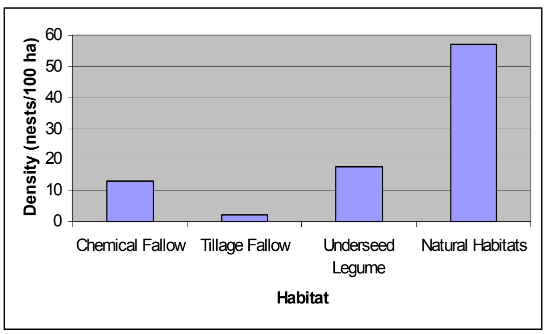
CHEMICAL FALLOW

Fallow is used as a part of annual crop rotations as a means of managing weeds, mineralizing nitrogen from organic matter and conserving moisture for the following crop year. Traditionally, tillage operations have been used to mechanically destroy weed growth and incorporate crop residues into the soil. Chemical fallow is an alternative farming practice that utilizes chemicals instead of tillage to control weed growth. This practice is considered to have soil and water conservation benefits because vegetative cover is maintained for a greater proportion of the fallow period than with traditional tillage fallow (Jahn and Schenck 1991, Richards 1991). Studies examining the benefits of chemical fallow to waterfowl are rare. The following studies compare waterfowl nest densities and success between chemical fallow fields and traditionally tilled fields as well as other habitats.

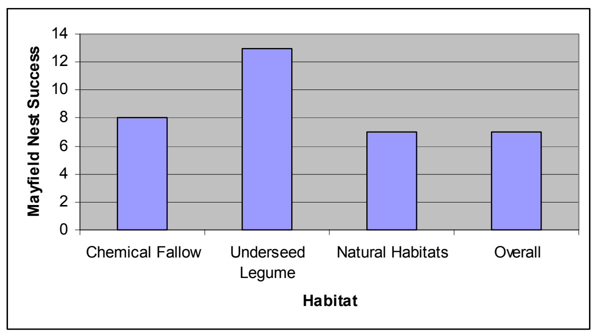
Hofman and Bjorge (1994)

The authors examined data from two years (1990 and 1991) of work done in the Buffalo Lake Moraine of south central Alberta. In 1990, 10 chemical fallow (CF), 2 underseed legume (UL), and 4 conventional tillage fallow (TF) plots were nest searched along with natural habitats (NH) within the plots. In 1991, 10 CF, 3 UL, 4 conventional TF plots, and associated NH were also searched. Nest densities and success were compared for the four habitat types and dabbling duck species.

CF habitats had higher nest densities than did TF. NH was preferred to CF by most species but Northern Pintail did not use NH more than fallow habitats. Nesting success did not significantly differ between habitat types or species but trends showed better success in CF than in NH for northern pintail and blue-winged teal. Too few nests were found in TF to estimate nest success.



Nest density by crop/natural habitat type in central Alberta, 1990-91.



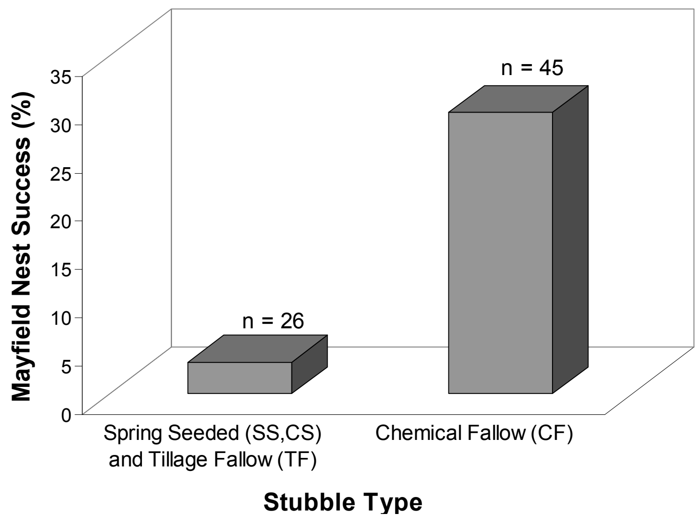
Nest success by crop/natural habitat type in central Alberta, 1990-91. Too few nests were found in tillage fallow to estimate NS.

The authors conclude that CF fields were selected more often for nesting and ducks were more successful here than in TF. However, NH was used much more than CF habitats and attractiveness seemed to be related to density of vegetation [as determined by Robel et al. (1970) measurements]. They further suggest that permanence may affect selection of CF habitats, as ducks cannot exhibit homing on these annual habitats. Surrounding wetland density was positively correlated with use of CF habitats and consequently the authors believe that the use of CF to attract ducks would be most effective in areas with high wetland densities. Also, northern pintails tended to both use and have success in CF habitats so CF fields would be most beneficial in areas with pintails.

Emery et al. (2003)

Emery et al. (2003) examined data collected from six study sites in southwestern Saskatchewan in the spring of 2003. Nest searching was conducted on 8 random quarter sections at each study site. Six crop stubble practices were identified: spring-seeded stubble (SS), chemical-fallow stubble – spring seeded (CS), tilled-fallow stubble (TF), chemical-fallow stubble (CF), idled cropland, and 2-year-old idled cropland.
One hundred and one nests were found in crop stubble of which 77% were northern pintail. Forty-three percent of pintail nests found during searches of all habitat types were in crop stubble versus 12% for other species. Nesting success in CF was similar to nesting success over all habitat types combined. Nesting success was lower for nests in stubble that was cultivated during the nesting season (SS, CS and TF) than for stubble that was chemical fallowed (CF). Sixty-four percent of hatched CF nests hatched after June 20th. Nest densities (nests/acre) were higher in CF (0.053) than in TF (0.031).

The authors conclude that replacing TF with CF may increase duckling production, as both overall nesting success and nest density were higher in CF compared to TF. However, most of the benefits of CF over TF occurred later in the nesting season, after TF fields had been tilled. Pintails would be especially vulnerable to spring tillage as 58% of nests found in the first search were in crop stubble. Nest success in CF fields was similar or higher than in other habitats, so attracting hens to CF from other habitats would not be subtracting nests from more productive areas. Since a high proportion of successful CF nests hatched late, delaying tilling operations may have considerable merit, even for TF fields. It should be noted that this data is from just one year and that over 80% of CF nests are from one study site. Also, the high breeding density of pintails and the high nest success on CF fields may not be the norm and may have been affected by water returning to the area following several years of drought.



Mayfield nest success in conventional tillage practices versus chemical fallow in southwestern Saskatchewan, 2003

SUMMARY

Though little research has been done on waterfowl use of chemical fallow fields, results from the above studies show that they could be an improvement over traditionally fallowed fields. Nest densities and nest success are higher in CF fields compared to TF fields. Attractiveness of CF fields compared to other habitats appears to be low except for pintails, which use it extensively. Nest success in CF fields is comparable to other habitats; hence this habitat may not act as an ecological sink. Benefits of CF over TF may be realized by simply delaying cultivation until later in the season.

FALL SEEDED CROPS (WINTER WHEAT, FALL RYE)

Though cropland use by nesting waterfowl has been well documented (Earl 1950, Milonski 1958, Higgins 1977, Cowan 1982, Duebbert and Kantrud 1987, Fisher 1993), little research has been conducted to quantify use or success due to potential crop damage from nest searching. Cultivation, seeding and spraying pose additional risks to waterfowl nests in cropland but a high percentage of upland habitats are in cropland in many important waterfowl breeding areas. Conservation tillage practices can provide residual cover and reduce the risks to waterfowl nesting in cropland. Fall seeded crops like winter wheat and fall rye require less tillage and planting occurs in the fall when there is no conflict with nesting waterfowl. Potential benefits of fall-seeded crops over traditional spring crops on waterfowl production are great as entire landscapes could be affected.

Devries (1999)

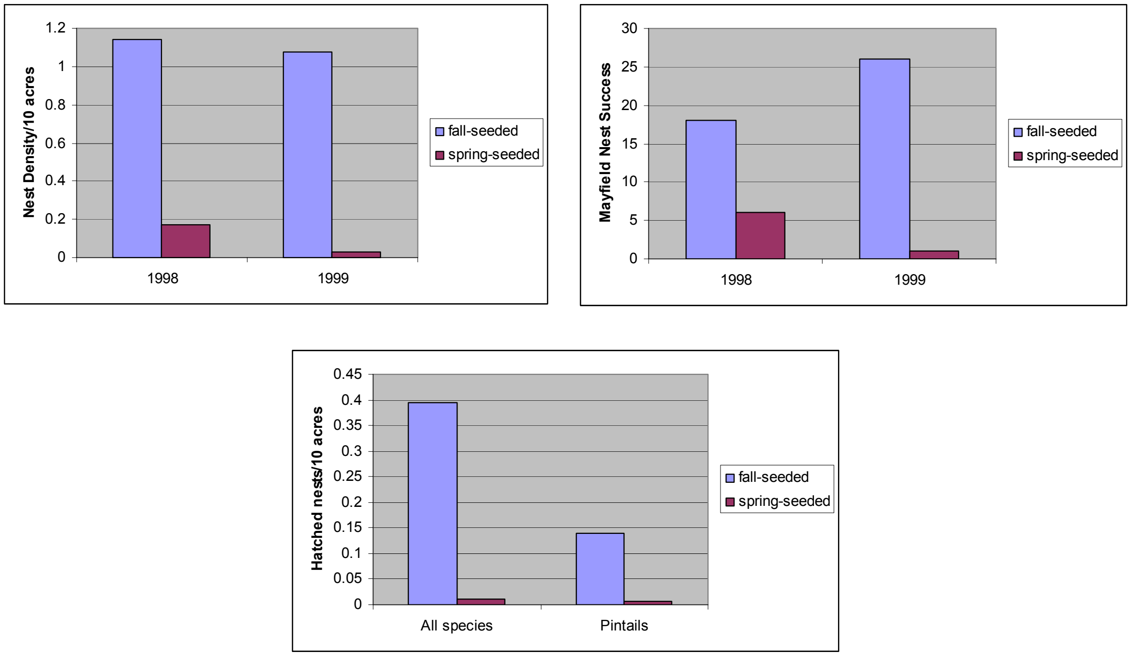
In 1996, fall-seeded croplands (1109 ac) were searched for waterfowl nests. In 1997, fall-seeded croplands (774 ac), spring-seeded croplands (730 ac), and non-cropland habitats (139 ac) were searched. All searches were conducted in southeastern Saskatchewan. Nest density was calculated as apparent nest density (nests found/acre). Productivity was estimated as the number of hatched nests per acre. Daily nest survival probability was compared among cover types.

Seven species of waterfowl nested in fall-seeded crops with mallard and blue-winged teal being the primary species. Apparent nest density was higher in fall-seeded cropland (1 nests/9 acres) than in spring-seeded cropland (1 nests/132 acres) but lower than in idle non-cropland habitat (1 nest /3 acres). Nest success averaged 22.6% in fall-seeded cropland, 54% in spring-seeded cropland, and just 6% in non-cropland habitat. Productivity was higher in fall-seeded cropland (1 hatched nest/20 acres) than in spring-seeded cropland (1 hatched nest/250 acres). Estimates of apparent nest densities are 2 to 4 times higher than those previously reported for cropland habitat (Higgins 1977, Cowan 1982, Duebbert and Kantrud 1987, Fisher 1993).

Devries (2000)

In 1998 and 1999 approximately equal areas of fall-seeded (4035 acres) and spring-seeded (3855 acres) crops were nest searched within the Missouri Coteau landscape of south-central Saskatchewan. Apparent nest density (nests found/acre), nest success, and production (hatched nests/ac) were compared between fall and spring-seeded fields.

While 5 species of dabbling duck nested in cropland, pintail and mallard were the most common nesters in the two crop types. Both nest density and nest success were higher in fall-seeded crops than in spring-seeded crops. Waterfowl production (hatched nests/acre) was approximately 36 times higher in fall-seeded crop than spring-seeded crop. Pintails hatched approximately 19 times as many nests/ac in fall crops versus spring-seeded crop.



Comparison of duck nest density (nests/10ac), Mayfield nest success, and productivity (hatched nests/10ac) in fall-seeded and spring-seeded cropland in southern Saskatchewan, 1998-99.

The author concludes that fall-seeded crops are more attractive and productive than spring-seeded crops. The breeding density of northern pintails was high in this study area and the positive effects of fall-seeded crops over spring-seeded crops on nesting waterfowl seemed to hold for pintails. Pintails on the study area frequently selected spring-seeded cropland and their nests were often destroyed by machinery thus supporting the ecological trap hypothesis where ducks are attracted to nest in unsafe habitats.

SUMMARY

The results from the above studies indicate that both duck nest density and nest success are higher on average in fall-seeded cropland than spring-seeded cropland. These results may be especially relevant to pintails, which are currently well below NAWMP population goals and have a tendency to nest in cropland. These studies also show that cropland may be more important in attracting nesting waterfowl than previously thought. Whether this translates to an ecological sink or a population source may hinge on cropping practices. Further research is required to discern where fall-seeded crops may be most valuable to waterfowl production.

NEST STRUCTURES

Artificial nesting structures have been used as a means to increase waterfowl nest success. Originally, nesting baskets were the primary structure used to target nesting mallards, however, more recently, nesting tunnels have been employed to this end.

Thompson et al. (2000)

Thompson et al. (2000) reviewed existing nesting structure evaluations and considered associated costs. Nesting tunnels have been adopted by DU as the preferred overwater nesting structure as baskets have been shown to have lower occupancy rates and are frequently used by Canada geese (McFarlane 1999, Eskowich et al. 1998). Tunnels averaged 53% occupancy and 88% success (Kowalchuk 1996, Eskowich et al. 1998, PHJV Assessment unpubl. data). Tunnels are almost exclusively used by mallards and occupancy tends to decline with decreasing mallard pair density. Low water levels may also result in decreased occupancy. Predation rates of nests in tunnels are thought to increase over time (Doty et al. 1975). Kowalchuk (1996) suggested that approximately 8% of nests are depredated but PHJV assessment data indicates that as many as 16% may be lost to predators (Devries pers. comm. 1999). Regardless, success is much higher than for ground nests.

Materials used to construct nest tunnels may affect performance. Occupancy of plastic tunnels was only 10% compared to 64% for tunnels constructed of wire mesh (Murphy 1999). Nest success was 86% and 95% respectively. Based on occupancy it would seem that wire structures are better duck producers. However, the majority of the plastic structures were in place for less than 2 years while the wire tunnels were in place for 3 years. The authors believe this calls into question the validity of the apparent preference and cites an earlier study that found 58% occupancy in plastic tunnels (Thomson 1997). The authors suggest further research concerning use of plastic and wire tunnels if occupancy rates are a primary objective of nesting tunnel programs.

Maintenance of nest tunnels is an issue as wire mesh tunnels require straw replacement, preferably on an annual basis. Volunteer/co-operator tunnel maintenance has been shown to be inconsistent and thus the authors suggest that maintenance efforts require direct support. Plastic tunnels have made maintenance easier and reduced costs. The authors believe that a maintenance interval longer than the current annual cycle may be possible.

The authors conclude that nesting tunnels are cost effective duck producers. Plastic tunnel construction is $25 with an additional $25 for installation. Annual maintenance costs are approximately $6/tunnel. With a life expectancy of 10 years, total cost of each tunnel is $110. The cost per wire tunnel is approximately double due to higher construction and maintenance costs.

SUMMARY

Nesting tunnels have been shown to be effective producers of ducks, mainly mallards. Maintenance remains an issue, however, alternate construction materials may alleviate these concerns. Due to their visibility, nesting tunnels may have a role in conservation education.

GRAZING SYSTEMS

It has been shown that residual vegetation is an important habitat feature affecting both nest density and success of upland nesting waterfowl (Martz 1967, Payne 1992). Management programs that attempt to keep residual cover on the landscape throughout the year have become more popular, even as agricultural pressure on the land increases. Managed (rotational) grazing systems appear to be an optimum program that does not take land out of agricultural production but increases residual cover for nesting waterfowl. However, evidence showing the effectiveness of grazing systems in increasing duck production has been conflicting.

Lamey and Devries (1997)

Lamey and Devries (1997) conducted a meta-analysis compiling data from 6 previously published and unpublished studies that compared the effectiveness of managed grazing systems to season-long grazing systems in increasing duck production. Specifically, the authors compared reported nest density and nest success estimates among managed grazing, season-long grazing and idle systems. Many studies had small sample sizes, thus bringing results into question. The estimation of an effect size from each study allowed this meta-analysis to synthesize results from small sample size studies into an overall mean effect size for nesting density and success.

The effect sizes of nest density and success under managed grazing systems were not significantly different from those under season-long grazing. However, in both cases, effect sizes were slightly positive showing marginally higher nest densities and success in managed grazing systems. Significant effect sizes were found contrasting nest densities in idle grass to both season-long and managed grazing systems; densities were higher in idle grass. Results for nest success were less clear but showed grazed systems may have higher nest success than idle grass.

SUMMARY

Given the results of this meta-analysis the authors believe that any benefit to waterfowl production of managed grazing systems over season-long grazing is slight. However, it is clear that cessation of grazing is associated with increased waterfowl nesting density. Therefore, larger, longer term studies may be required to measure the impact of managed grazing systems on waterfowl production. The authors suggest a reassessment of the commitment to managed grazing systems as a waterfowl management tool and suggest future studies should include control treatments, random assignment of grazing treatments, and replication of both experimental and control treatments. Also, future studies should be repeated over broad geographic and physiographic areas to increase the applicability of results.

While direct waterfowl production benefits are likely small, the case has been made that managed grazing indirectly improves duck production by making rangeland sustainable where it may otherwise be lost to cultivation. This remains an untested hypothesis.

FLUSHING BARS

Upland nesting waterfowl often use hayland as nesting cover, but mowing operations have been shown to cause high nest destruction (Labisky 1957, Milonski 1958, Ordal 1964, Gates 1965, Kirsch et al. 1978, Klett et al. 1988). The rate of female mortality caused by haying is disputed but it appears to be significant (Ordal 1964, Johnson and Sargeant 1977). The use of a flushing device mounted on haying machinery may be effective in decreasing hen mortality and consequently improve duck production.

Butterworth and Calverley (2001)

In 1993, duck mortality due to haying operations was quantified on 462 ac of hayland in the aspen-parkland region of central Alberta. In 1994, a flushing device was installed on pull-type hay mowers cutting 778 ac while a control group cutting 741 ac used no device. In 1997, 904 ac of hayland were mowed by self-propelled mowers equipped with a flushing device and 914 ac were mowed by equipment without a flushing device. In 1999, 531 ac were mowed by self-propelled mowers without the flushing device and 664 ac were mowed using the device. The study compared successful versus unsuccessful (resulting in mortality) flushing attempts by nesting ducks between fields mowed without a flushing device and fields mowed with a flushing device.

Mortality rates of 32-48% were recorded for fields mowed without a flushing device. In 1994, the flushing device on pull-type mowers was 100% effective in preventing hen mortality. In 1997 and 1999, mortality rates were 15% and 7%, respectively for fields mowed with a flushing device. Incidental observations on other wildlife species showed flushing bars have a positive affect on the survival of non-waterfowl species as well.

The authors believe that flushing bars can have a major effect on survival of female ducks nesting in hayfields. However, unless flushing bars are broadly adopted throughout major waterfowl production areas of the continent, the landscape effects may be insignificant. Consequently, the authors believe managers should attempt to restrict haying operations until after the nesting season. When this is not possible, flushing bars are an effective means of reducing wildlife mortality.

SUMMARY

From the above study and others it seems that flushing bars can effectively reduce hen mortality. However, the landscape level effect on waterfowl populations may not be significant unless flushing devices are broadly adopted. Consideration of average haying dates should also be considered as flushing bars may have little benefit where average hay dates are generally late (e.g., early July). Promotion of delayed hay cutting may be an equally effective strategy.

CROPLAND CONVERSION TO HAYLAND

The conversion of cropland to hayland is an important land use change promoted as a means of improving waterfowl productivity. Though it is assumed the conversion of cropland to hayland may benefit waterfowl, attractiveness and success of nesting waterfowl in hayland must be assessed in relation to other habitats and programs. Further to this, it is important to consider hatch chronology and the combined effects of nest success and hen mortality on recruitment. Forage cutting dates will affect the result and so must also be considered.

McMaster et al. (In Press)

The authors nest searched 34 separate hay fields throughout the Missouri Coteau of southern Saskatchewan in 1999 and 2000. Six fields were sampled in 1999 only, 10 fields were sampled in 2000 only, and 18 fields were sampled in both years. Nest density and success was quantified for waterfowl and other grassland nesting birds in haylands to determine the benefits of converting cropland to hayland.

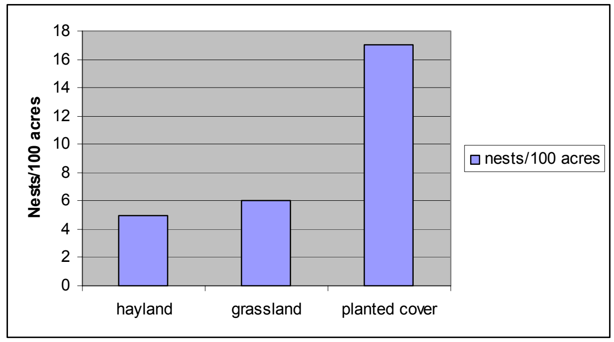
Twenty-six species of birds nested in haylands but waterfowl dominated the sample. Waterfowl nest success was relatively high (20 and 13% in 1999 and 2000, respectively) but nest density was average compared to other habitats in the PPR (0.181 and 0.212 nests/acre in 1999 and 2000, respectively). Waterfowl nest density was positively related to the amount of cropland in the surrounding landscape, and negatively related to the area of the hay field. Haying operations destroyed few nests due to wet weather and consequent late cutting dates but the authors caution that 25% of nests were active at the time of the historical average haying date.

The authors suggest that due to the vulnerability of nests to haying operations, cropland conversion to hayland programs should include agreements with private landowners to delay haying operations or use a flushing bar. This study found that hay fields need not be large or in grass dominated landscapes to have high nest success. The authors believe that conservation of native grassland with varying degrees of grazing pressure is the best way to meet the needs of grassland nesting birds. Cropland conversion to hayland may be most beneficial to birds by providing additional forage to landowners, thus reducing grazing pressure on native pastures.

Arnold (2003)

Arnold (2003) reviewed 19 studies from the PPR that provided nest densities in hayland, of which 17 also provided densities in remnant grasslands and 7 provided densities in planted cover. Ducks exhibited a weak avoidance of haylands in relation to grasslands and a strong avoidance in relation to planted cover. Hence, haylands provide average cover at best and slightly below-average cover at worst.

Thirty-nine studies provided Mayfield estimates of nest success in hayfields throughout the PPR; 38 of these provided concurrent estimates of nest success from remnant grassland habitats, 20 provided estimates for planted cover (DNC), and 19 provided estimates for all three habitat types. On average, nest success in haylands (13.8%, SD = 11.0%, n = 38) did not differ from nest success in other existing habitats (14.1%, SD = 7.5%, n = 38). However, studies that included planted cover showed nest success in hayland (10.1% ± 9.0%, n = 20) was lower than nest success in DNC (13.6% ± 7.1%, n = 20). Hence, nest success in haylands does not differ from that in existing cover, but is worse than in targeted cover programs (idle and planted cover).



Summary of relative nest densities in hayland, grassland, and planted cover as estimated from previously reported studies.

Data collected as part of a comprehensive evaluation of flushing bars (see above) are the only quantitative studies on mortality risk during haying operations. The data shows fields mowed using conventional equipment can result in one in three or even one in two hen mortalities. Flushing bars can decrease mortality by about four-fold. Nevertheless, haying operations kill about one in ten hens, even when flushing bars are used. The mortality rates are dependent on the number of active nests at the time of mowing, which may reflect a high or low percentage of the nesting effort depending on nesting chronology, success and timing of mowing. Based on nest initiation times provided from McMaster et al. (in press), anywhere from 1 to 75% of nesting hens could be vulnerable to mortality, based on mowing dates ranging from 25 June to 30 July.

SUMMARY

Simulations show that the potential for high hen mortality along with average nest densities and nest success make cropland conversion to hayland a high risk but slight reward program if increasing duck production is the goal. However, benefits from a cropland conversion program may come from increasing baseline nest success within a landscape (e.g., Greenwood et al. 1995, Reynolds et al. 2001), not by duck production in hayland per se. Therefore, it should be targeted towards landscapes with abundant wetlands to support adequate pair and brood densities. Haylands should be mowed late to mitigate risks of lost hens and nests. Payment required to delay mowing operations is too high for the potential benefits, so cropland conversion programs should be targeted to areas that already have a late average mowing date. This would also minimize restrictions (cut dates, flushing bars) to landowners, thus eliminating the need for monitoring and enforcement.

PHJV ASSESSMENT STUDY

The PHJV Assessment study was possibly one of the largest wildlife studies ever undertaken. The study examined duck nesting ecology on 27 65-km^2 study sites across the prairie-parklands of the Canadian PPR from 1993-2000. While nesting ecology of all ducks was studied (over 19,000 nests found), special emphasis was placed on mallard breeding ecology. Approximately 3,600+ radio-marked mallard females were tracked throughout the breeding season and provided data on nest habitat selection, nest survival, hen survival, duckling survival, and factors affecting each vital rate.

Anderson et al. (In Prep)

The objectives of the PHJV Assessment study (Sankowski et al. 1991, 1995) were 1) to test whether waterfowl production increased in response to the full suite of PHJV upland habitat treatments, 2) to assess the effectiveness of individual habitat interventions, and 3) to test and improve the Computer Planning Tool that was used to develop implementation plans. On PHJV Assessment sites, 0 to 20% of the total land base was affected by Joint Venture programs. This included intensive wildlife management practices, intended to maximize waterfowl production on small parcels of land dedicated to wildlife, and extensive land-use modifications, designed to enhance soil and water conservation while secondarily providing benefits for wildlife. Intensive programs generally involved purchase or lease of land and planting of dense nesting cover, idling existing natural cover, or providing nesting structures. Extensive programs were designed to maintain ground cover through modifying cropping practices, such as reduction of summer fallowing, reduced tillage, promotion of fall-seeded crops, modified grazing management, or delayed hay cutting.

Some specific results from analysis of factors influencing mallard vital rates at the *study area scale* include:

- •Nest Success
  - –Negative relationship with skunk/fox abundance
  - –Positive relationship with local may pond index
  - –Positive relationship with amount of herbaceous cover (i.e., grass, hay, wetland vegetation)

- •Duckling Survival
  - –Negative relationship with # of cold days
  - –Positive relationship with % seasonal ponds holding water
  - –Negative relationship with PHJV treatment index

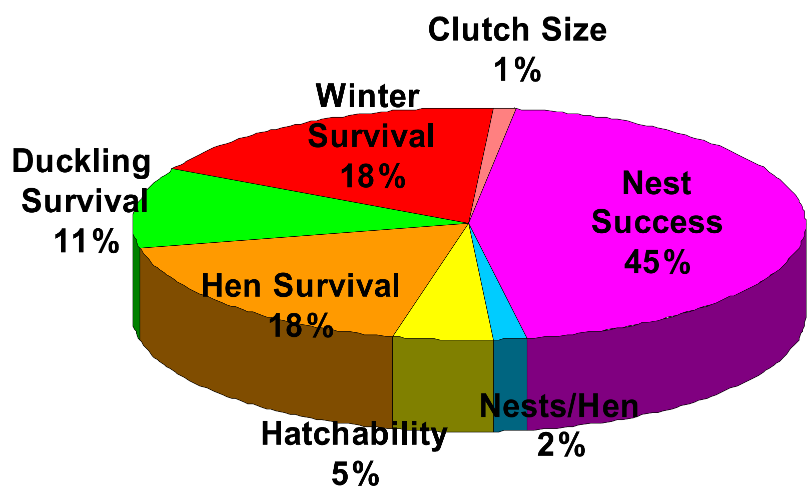
- •Adult Survival
  - –At low wetland density, decreases as percent grass increases
  - –At high wetland density, increases as percent grass increases

While analysis is still ongoing, key results from the PHJV Assessment study suggest that while individual managed habitats were more productive than unmanaged habitats on the study sites, treatment-level influences were generally not large enough to detectably impact landscape-level recruitment. Further, the Computer Planning Tool as used in the

PHJV planning process did not predict recruitment well in the Canadian parklands. Further analysis of Assessment data has provided information for the development of a new biological planning tool linking waterfowl productivity to landscape composition (the Waterfowl Productivity Model; *Appendix C*).

Hoekman et al. (2002) and Update

Hoekman et al. (2002) used data from 11 PHJV Assessment sites and other published data to estimate vital rate parameters and their contribution to mid-continent mallard population growth rate. Only data from female mallards were used for model building and a landscape scale of 60 -70 km^2 was used as a frame of reference for vital rate estimation and inference to population dynamics. Analytic and simulation-based sensitivity analyses of a stage-based matrix model were used to compare the relative importance of vital rates to mallard population growth. Vital rates considered were: clutch size, egg hatch, nest success, duckling survival, breeding incidence, re-nesting intensity, breeding survival, and non-breeding survival.



Relative importance of mid-continent mallard vital rates to population growth rate.

A recent update of Hoekman's analysis using data from all 27 Assessment sites confirms that process variation in breeding parameters had the greatest effect on variation in population growth. Nest success, survival of adult females during the breeding season, and duckling survival accounted for 74% of the variation in mid-continent mallard population growth. Further, based on new estimates of winter survival for the mid-continent mallard population, we estimate that population stability may be achieved with an average nest survival rate of 11.5% rather than 15% as traditionally held (Cowardin et al. 1985).

The authors suggest that results from future analyses of a similar nature should consider the effectiveness and cost of manipulating different vital rates. They further caution that different vital rates may not be equally susceptible to manipulation and a large change in a less sensitive vital rate may be more effective than a small change in a more sensitive vital rate. The authors also note that though their results corroborate the importance of nest success and adult female survival to management, past management of nesting habitat and predator communities have yielded modest results. Since >65% of annual female mortality can be attributed to the breeding season, the authors believe increasing female survival by decreasing nest predation during this period has high potential to increase population growth. Since predation is the primary source of mortality in each of the three most sensitive vital rates, it seems prudent to focus attention on examining the interactions of predator communities with other environmental conditions to explain the mechanisms driving variation in these vital rates.

Howerter (2003) – from Thesis Abstract

Howerter (2003) used duck nesting data from 15 65-km2 study areas (n~6,300 nests) dispersed throughout the aspen parklands of south-central Canada, to test hypotheses and build models that predict hatching rates and nest-site distributions in relation to landscape features. The author constructed separate models using landscape features generated at 3 different spatial extents (nest level, 0.45 km buffer, and 1.82 km buffer) and using 3 different habitat classification schemes (all habitat aggregated into 8, 4, or 2 classes).

Hatching rates generally increased with habitat patch size, and with distance from habitat edge and nearest wetland though relationships were complex. Several interactions improved the fit of models. Life-history theory and models of hatching rates were used to construct hypotheses about how birds should choose nest sites. The same covariates that were useful for predicting hatching rates also were useful for discriminating between nest sites and random points; however, birds did not always choose the safest habitats as nest locations. Therefore, fitness may not be maximized by nest choice. In each case, models built from landscape features generated at the smallest spatial extent had the greatest discriminatory ability; however, inclusion of variables from >1 spatial extent significantly improved our models. Finally, the author demonstrates how models can be incorporated into spatially explicit decision support tools to help guide management. Based on these results, it is clearly important to consider spatial configurations of habitats when planning habitat management.

SUMMARY

The PHJV Assessment has provided, and continues to provide, valuable data on the interaction of habitat composition and waterfowl reproductive success at individual nest, habitat and landscape scales. Results have informed PHJV management decisions during the course of the study. Further, this data has allowed an unprecedented analysis of the contributions of various vital rates to mallard population growth rate, has explored factors influencing each, and has suggested nest survival lower than 15% on average may be adequate to sustain mallard populations. Finally, it has allowed updated and regionally applicable planning tools to be built to guide ongoing efforts to provide productive landscapes for breeding waterfowl.

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Appendix C. The Waterfowl Productivity Model (WPM; documentation compiled by J. Devries and L. Armstrong)

In order to assist in landscape planning to improve waterfowl production, Ducks Unlimited Canada developed a spatially explicit biological model that estimates the impact of landscape change on mallard, blue-winged teal, northern shoveler, gadwall, and northern pintail productivity in the Prairie Pothole Region (PPR). For each species, the Waterfowl Productivity Model (WPM) combines estimates of the average nesting population within a planning area, the average nesting and renesting propensity, estimates of nesting habitat preference, landscape-scale habitat availability, and habitat-specific nest survival rates.

Biological parameters and geographic and landscape influences are based on data gathered during the Prairie Habitat Joint Venture Assessment Study and previously published data. Duck population estimates are derived from duck density maps developed for the PPR (Ducks Unlimited Canada, unpubl. data) and partitioned by spatial estimates of species composition generated from long-term U.S. Fish and Wildlife Service/Canadian Wildlife Service spring waterfowl survey data. Nest survival is dependent on species, habitat type selected for nesting, geographic location and the overall amount of 'perennial cover' in the landscape. Given a particular geographic location and landscape composition, the model estimates an expected number of hatched nests for each species in each habitat. Further, the impact of a host of habitat conservation actions and other landscape changes on productivity can be estimated. Habitats currently modeled include:

Spring-seeded Cropland (includes fallow acres)
Fall-seeded cropland
Hayland
Delayed hay
Dense Nesting Cover (DNC)
Grazed DNC
Natural-Idle (grass, shrub, wetland vegetation)
Natural-Grazed
Woodland-Idle
Woodland-Grazed
Nest Tunnels

The WPM provides a powerful biologically based tool for comparisons among alternative conservation actions in a specific landscape context. Applications are foreseen at both local and regional scales.

<u>Notes on Productivity Model Inputs and Function</u>

The WPM is designed to run on 16 mi^2 "landscapes" (a scale roughly matching the scale at which parameters were estimated and the scale of data aggregation used to create the DSS map). The model appears relatively scale-insensitive, however; when run on larger landscapes, output is similar to the sum of model runs on 16 mi^2 subunits. Habitat composition (of defined habitats), mean longitude, ecoregion, and duck population/species composition of each "landscape" comprise the primary spatially varying model inputs. The following describes the key biological parameters in the model.

Habitat Preference-Parkland

Mallards

- Based on radioed mallard nest locations in 23 Study Areas and nest density estimates for winter cereals, grazed DNC.
- Winter wheat nest density based on 1996/1997 data from SK.
- Grazed DNC availability and use for 2 Assessment sites – DON and MIX (12 nests in 1.7073 sq km)
- Ran log-ratio analysis to get relative preferences for Crop, Del Hay, DNC, Hay, Nat-Idle, Nat-Grazed, Wood-Idle, Wood-Grazed
- Converted these into nest densities and then added nest density in Fall Crop (7.35 nests / sq km) and Grazed DNC (5.50 nests / sq km) to the mix.

Blue-Winged Teal, Gadwall, Northern Pintails, Northern Shovelers

- Based on locations of nest-searched nests in 23 Study Areas
- Winter wheat and crop densities based on 1996/1997 data from SK
- Grazed DNC availability and use for 2 Assessment Sites – DON and MIX (52 BWTE, 9 GADW, 1 NOPI, 18 NOSH in 1.7066 sq km)
- Ran log-ratio analysis of nest densities to get relative preferences for Del Hay, DNC, Hay, Nat-Idle, Nat-Grazed, Wood-Idle, Wood-Grazed
- Converted these into nest densities and then added nest density in Fall Crop (13.12 BWTE nests / sq km, 2.23 GADW nests / sq km, 2.4 NOPI nests / sq km ---- note that I obtained an estimate of 1.18 from this dataset, 3.28 NOSH nests / sq km), Grazed DNC (24.00 BWTE nests / sq km, 6.30 GADW nests / sq km, 0.81 NOPI nests / sq km, 8.59 NOSH nests / sq km), and Crop (3.73 BWTE nests / sq km, 0.34 GADW nests / sq km, 1.02 NOPI nests / sq km, 0.1620 NOSH nests / sq km – note that I obtained an estimate of 0 from this dataset)

Parkland Nest Habitat Preference Values

Habitat	MALL	BWTE	GADW	NOPI	NOSH
Crop	0.8	3.7	1.1	12.5	0.5
DNC	15.6	20.4	33.3	18.5	30.5
Del Hay	3.2	13.6	7.8	4.3	9.3
Fall Crop	3.9	13.1	7.1	29.4	9.5
Grazed DNC	2.9	24.0	20.1	9.9	25.0
Hay	5.8	7.1	9.7	2.9	4.2
Nat-Idle	22.3	13.1	18.1	16.6	16.5
Nat-Grazed	7.2	5.0	2.8	5.9	4.5
Wood-Idle	22.0				
Wood-Grazed	16.3				

Habitat Preferences – Prairies

- Used relative preferences from Klett et al. (1988) for Crop, DNC, Hay, Nat-Idle

and Nat-Grazed
- Made assumptions re the relative preferences for Delayed Hay, Fall Crop, and Grazed DNC.
- For Fall Crop, assumed a preference relative to Hay based on nest densities in the Hay (99-00) and Fall Cereals (98-99) Studies. We obtained Fall Crop approx. 1.3 x Hay for MALL, 0.2 x Hay for BWTE, 0.2 x Hay for GADW, 1.3 x Hay for NOPI, and 0.5 x Hay for NOSH.
- For Grazed DNC, we assumed that its preference relative to DNC would be as in the Assessment study. We obtained Grazed DNC approx. 0.21 x DNC for MALL, 1.18 x DNC for BWTE, 0.60 x DNC for GADW, 0.54 x DNC for NOPI, and 0.82 x DNC for NOSH.
- For Del Hay, we assumed that its preference would be the average of its preferences relative to Hay and DNC from the Assessment study (except for Pintails where the preference for Del Hay would be the same as for Hay). We obtained Del Hay to be between 0.54 x Hay and 0.23 x DNC for MALL, between 1.91 x Hay and 0.67 x DNC for BWTE, between 0.8 x Hay and 0.23 x DNC for GADW, = Hay for NOPI, and between 2.21 x Hay and 0.31 x DNC for NOSH.

Prairie Nest Habitat Preference Values

Habitat	MALL	BWTE	GADW	NOPI	NOSH
Crop	0.3	0.2	0.2	4.3	0.1
DNC	42.9	29.1	37.3	30.6	35.3
Del Hay	8.5	15.6	10.2	11.8	13.3
Fall Crop	14.9	1.3	2.7	13.6	3.4
Grazed DNC	10.1	36.1	23.9	18.3	28.3
Hay	12.2	5.8	12.8	12.4	6.9
Nat-Idle	7.4	5.7	7.7	4.7	6.5
Nat-Grazed	3.7	6.2	5.2	4.3	6.2

Nest Success

Equations are based on species/habitat-specific nest success model (based on 22 Assessment sites-all but HAM through 1999).

e.g., Gadwall

logit = -0.6538 + 0.0308 * longitude, if habitat = Crop
logit = -0.4268 + 0.0308 * longitude, if habitat = DNC
logit = -0.4612 + 0.0308 * longitude, if habitat = Del Hay
logit = -0.2042 + 0.0308 * longitude, if habitat = Fall Crop
logit = -0.4542 + 0.0308 * longitude, if habitat = Grazed DNC
logit = -0.6089 + 0.0308 * longitude, if habitat = Hay
logit = -0.5562 + 0.0308 * longitude, if habitat = Nat-Idle
logit = -0.6094 + 0.0308 * longitude, if habitat = Nat-Grazed

Then,

Nest Success = $(\exp(\text{logit}) / (1 + \exp(\text{logit})))^{35}$ for Mallards and Gadwall

Nest Success = (exp(logit) / (1 + exp(logit)))^{34} for Blue-Winged Teal and Shovelers

Nest Success = (exp(logit) / (1 + exp(logit)))^{32} for Northern Pintails

Note: We examined some non-additive models as well (species*habitat interaction) Pintails in DNC had higher survival than other species (likely driven by ALW) and gadwall had lower nest survival in hay than other species. However, given sparse data we decided to stick with the additive models above; i.e. for each species, we will obtain the same relative rankings of habitat-specific nest success.

The Perennial Cover ("Kicker") Effect

Currently, the impact of conversion of cropland to other 'perennial' cover is incorporated into the model as an in increase in the 'base' nest success in all habitats within the 16-mi^2 planning 'landscape'. In the Prairie ecoregion, nest success increases 3% over base with every 10% increase in perennial cover. This is based on data from the US PPR (Reynolds, USFWS) and Canadian PPR (Greenwood). In the Parkland ecoregion, the effect is less at a 1% increase in nest success over base with every 10% increase in perennial cover (Greenwood, PHJV Assessment data).

Additional Parameters

Nesting Propensity (all species) – 0.9 based on Assessment data

Renesting Propensity (all species) – 0.7 based on Assessment data

Maximum Nests –

- 5 for Mallard (Assessment data)
- 4 for Blue-Winged Teal and Northern Shoveler (Strohmeyer, Sowls, expert opinion)
- 3 for Gadwall and Northern Pintail (Gates, Guyn, Richkus, expert opinion)

(note: mallard hen mortality is accounted for in nesting and renesting propensity estimates and similar effects are assumed for other species)

Model Stochasticity: The three most influential parameters in the WPM are nesting rate, renesting rate, and nest success. An increase of 10% in each results in approximately 8, 5.5, and 5% increases in productivity, respectively. Variability in nest habitat preference is less influential on productivity outcome. Allowing all stochastic model parameters to vary independently within their range of probability generally results in < 10% deviation in productivity estimates.

Appendix D. Estimating landscape composition, 1971, 1986, 2001; Census of Agriculture, assumptions and suppressed data adjustments.

Census Consolidated Subdivision (CCS) area was determined in Arcview (Albers Equal Area) for each of 395 CCS units within the Parkland/Grassland area of AB, SK, and MB excluding the Alberta Peace Parklands. The CCS boundary file provided by Statistics Canada excluded very large lakes and wetlands. To exclude additional non-habitat acres (small open water areas, roads etc.), CCS units were overlain on PFRA digital landcover in Arcview, acres of non-habitat were determined, and these were removed from the CCS area (note: we assumed that these non-habitat acres applied over all years). The resulting CCS area was used as the *Base Habitat Area* available for all land uses in all years.

Estimating Data Suppressed at the CCS level

Statistics Canada places the highest priority on maintaining the confidentiality of individual census questionnaires at all stages of the census process. All tabulated data have been subjected to either a “data suppression” or “random rounding” confidentiality procedure to prevent the possibility of associating statistical data with any identifiable agricultural operation or individual.

The “data suppression” procedure identified and deleted all cell values that could result in the disclosure of information relating to a specific agricultural operation. In all cases, however, suppressed data were included in aggregate subtotals and totals in each of these tables.

The “random rounding” procedure was applied to all data appearing in the farm operator tables. This technique randomly rounded all figures in these tables, including totals, either up or down to a multiple of 5. While providing protection against disclosure, this procedure does not add significant error to the data but does result in certain data inconsistencies. For an explanation, see:

http://datalib.library.ualberta.ca/data/census/2001/95F0354XCE/01002/notes/datain

Finally, data for those geographic areas with very few agricultural operations were not released separately, but were merged with data from one or more geographically adjacent areas.** This Text was Copied from the following website:

http://datalib.library.ualberta.ca/data/census/2001/95F0354XCE/01002/about/confid.htm

Data suppression within the 1986 and 2001 Census of Agriculture is evident at both the CCS (Census Consolidated Subdivision) level and at the larger CD (Census District) Level. In order to calculate consistent values amongst these areas, we used the following procedure:

We assumed that the difference in acres values between the Census Consolidated Subdivisions and the Census District data was due to data suppression.

Data suppression was found at the CCS level and the larger CD level. The sum of all CD acres was calculated by Province. The resulting value was compared to the provincial crop values from statistics Canada (PROV – SUMCD). The number of producers in the suppressed CDs were calculated and the number of producers was then divided into the difference between the CD total and Provincial total, the resulting factor was then multiplied by the number of producers in each suppressed CD to allocate the missing acres to CDs on a per producer basis.

$$\frac{\textbf{Province – Provincial Total (CD)}}{\textbf{Number Total Producers in all Suppressed CDs}} \quad \textbf{X} \quad \textbf{Number of Producers in each Suppressed CD}$$

The difference between the CCS data values and the CD data values were then calculated using the resulting table.

The CCSs that had suppressed values were identified and the sum of all farms reporting in the suppressed CCSs for the given field was calculated. We then divided the difference in acres between the sum of the CCS acres and the CD acre value by the total number of producers in the suppressed CCSs to calculate an acre value per producer. The resulting factor was then multiplied by the number of producers in each suppressed CCS unit.

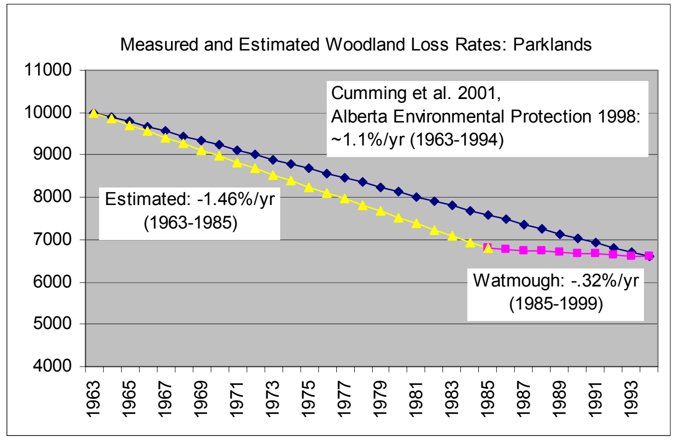
$$\frac{\textbf{CD – CCS (sum)}}{\textbf{Number Total Producers in Suppressed CCSs}} \quad \textbf{X} \quad \textbf{Number of Producers in Suppressed CCS}$$

1971,1986 and 2001 Landscape Composition: Ag Census and other data

Landscape composition for each of the reference periods was estimated using Ag Census data at the CCS level, PFRA digital landcover data (circa 1995), and several published and unpublished estimates of landscape change rates for woodland.

Spring crop, fall crop, and hay acres were taken directly from Ag Census (see "Ag Census Variables…" box below). The balance of the *Base Habitat Area* was assumed to be "Natural" and composed of woodland and non-woodland components. Apparent inconsistencies in reporting among census periods negated the use of Ag Census data to estimate this area. Where negative values for natural existed (i.e., Spring Crop+Fall Crop+Hay > *Base Habitat Area* [7 cases]), we used the sum of other lands reported in the Ag Census (woodland, unimproved and improved pasture, etc.) and adjusted cropland acres accordingly to equal the *Base Habitat Area*.

Because woodland was inconsistently reported among census years, we used CCS boundaries overlain on PFRA digital landcover data (in Arcview) to estimate woodland acres for 2001. Woodland acres in 2001 were assumed to be similar to that taken directly from the digital landcover (despite the time difference). We used 2001 woodland acres in conjunction with woodland change rates reported for the Grasslands and Parklands in Watmough et al. (2002) to estimate woodland in 1986. From 1971 to 1986 in the Parklands, we estimated loss rates based on the rates reported in Cummings et al. (2002) and Alberta Environmental Protection (1998) reconciled with Watmough et al. 2002 (see Figure). Woodland increased in the Grasslands between 1986 and 2001 (Watmough et al. 2002) and, lacking estimates, we assumed no change between 1971 and 1986. Resulting woodland acre estimates were removed from the "Natural" land pool thus creating "Woodland" and remaining "Natural" land areas. Protected lands (military bases, federal and provincial parks, provincial wildlife lands, etc.) within each CCS were assumed to consist of "Natural" and "Woodland" in the same proportion and these acres were assumed to be "Idle".



Estimating woodland loss, 1963-1985, based on published loss rates for the Parkland.

The proportion of the remaining Woodland and Natural habitat that was grazed was determined by dividing pasture acreage reported (i.e., sum of various pasture categories reported in the Ag Census) by the summed acreage of non-protected Woodland and Natural. We capped this proportion at 0.90 based on the maximum observed on PHJV Assessment sites. This proportion was then applied to both Woodland and Natural areas to estimate the acreage of 'Grazed" versus "Idle" land in these two categories. Resulting categories for input into the productivity model were:

Spring Cropland	Natural-Grazed
Fall Cropland	Woodland-Idle
Hayland	Woodland-Grazed
Natural-Idle	

Prairie Habitat Joint Venture Lands

Ducks Unlimited Canada, Saskatchewan Watershed Authority (formerly Saskatchewan Wetland Conservation Corporation), and Manitoba Habitat Heritage Corporation provided information on the location and type of habitat program or securement delivered since 1986 and still present on the ground in 2001 (i.e., excludes expired leases). These program acres were tallied by CCS and applied to the previously described landscape composition for 2001. Delayed hay acres were assumed to be captured in the Hayland reported in the AG Census and hence, these acres were removed from Hayland and added to a new category "Delayed Hay". Planted nesting cover acres were removed from the Natural-Idle pool and a new "DNC" (Dense nesting Cover) category was added. Securement of existing natural lands (through Easements, leases, etc.) was documented as being part of the existing pool of Natural or Wooded, Idle or Grazed, depending on the information provided.

Literature Cited

Alberta Environmental Protection. 1998. The boreal forest natural region of Alberta. Report to the Special Places 2000 Provincial Coordinating Committee, AEP, Edmonton, AB.

Cumming, E., K. A. Hobson, S. L. Van Wilgenburg. Breeding bird declines in the boreal forest fringe of western Canada: Insights from long-term BBS routes. Canadian Field-Naturalist 115:425-434.

Watmough, M. D. Ingstrup, D. Duncan, and H. Schinke. 2002. Prairie Habitat Joint Venture Habitat Monitoring Program Phase I: Recent habitat Trends. Environment Canada, Canadian Wildlife Service, Edmonton, AB.

Ag Census Variables Used in Estimating Landscape Composition by CCS (note: pasture category acres *were used to determine the proportion of non-cropped and non-hayed land that was grazed)*

Variables in 1971 Ag Census Tables

CRPLND	Land in crops - Acres
SUMMRF	Summerfallow – Acres
WHTWIN	Winter wheat - Acres
RYEFAL	Fall rye - Acres
TAMHAY	All tame hay - Acres
ALFALFA	Alfalfa and alfalfa mixtures - Acres
OTTAME	All other tame hay - Acres
IMPAST	Improved land for pasture or grazing - Acres
UNIMPAST	Unimproved land for pasture or grazing - Acres

Groupings for Productivity Model
Spring Crop* = CRPLND – (ALFALFA + OTTAME) – (WHTWIN + RYEFAL) + SUMMRF
Fall Crop = WHTWIN + RYEFAL
Hay = ALFALFA + OTTAME
*Note: spring crop includes summerfallow for this exercise

Variables in 1986 Ag Census Tables

CRPLND	Land in crops - Acres
SUMMRF	Summerfallow - Acres
WHTWIN	Winter wheat - Acres
RYEFAL	Fall rye – Acres
TRITCL	Triticale – Acres
TAMHAY	All tame hay - Acres
FORAGE	Forage seed for seed - Acres
IMPAST	Improved land for pasture or grazing - Acres
UNIMPST	Unimproved land for pasture, grazing or hay - Acres

Groupings for Productivity Model
Spring Crop = CRPLND – (TAMHAY + FORAGE) – (WHTWIN + RYEFAL + TRITCL) + SUMMRF
Fall Crop = WHTWIN + RYEFAL + TRITCL
Hay = TAMHAY + FORAGE

Variables in 2001 Ag Census Tables

CROP	Acres - Land in crops (excluding Christmas tree area)
SFALLOW	Acres - Summerfallow land
WHTWIN	Winter Wheat-Acres
RYEFAL	Fall Rye-Acres
TRITCL	Triticale-Acres
ALFALFA	Alfalfa and Alfalfa Mixtures-Acres
OTTAME	All Other Tame Hay-Acres
FORAGE	Forage Seed to be Harvested for Seed-Acres
TAME	Acres - Tame of seeded pasture
NATURAL	Acres - Natural or seeded pasture

Groupings for Productivity Model
Spring Crop = CROP – (ALFALFA + OTTAME + FORAGE) – (WHTWIN + RYEFAL + TRITCL) + SFALLOW
Fall Crop = WHTWIN + RYEFAL + TRITCL
Hay = ALFALFA + OTTAME + FORAGE

Appendix E. Method used to convert estimates of wetland loss (1985-1999) to lost waterfowl carrying capacity (1971-2001).

We used wetland loss data provided from the PHJV Habitat Monitoring Program (Watmough et al. 2002 and Watmough pers. comm.) to estimate lost waterfowl carrying capacity over our reference period; 1971-2001. Specifically, for each province/ecoregion, we used estimates of the percent of wetland area lost as well as the mean, median, minimum and maximum wetland sizes (in ha) that were lost. The annual loss rates observed during the 1985-1999 period investigated by Watmough et al. were assumed to be similar to loss rate for the entire 1971-2001 period based on a review of previous work reported in Watmough et al. (2002). We recognize that wetland loss rates are locally much more variable than the regional estimates we have used, however, except for a few examples, wetland loss data at finer spatial scales for the entire region are not available.

To estimate lost waterfowl carrying capacity as a result of wetland loss, we first estimated the waterfowl population on a theoretical "intact" landscape. This landscape contained all 60,613 wetland basins digitized on 25 PHJV Assessment sites (DUC-IWWR unpubl. data) and reflects a realistic distribution of wetland size classes from a wide variety of landscapes. We then used basin-specific regression equations published by Cowardin et al. (1995; Table E1) to estimate the expected number of pairs of the five most common dabbling duck species (mallard, gadwall, blue-winged teal, shoveler, pintail) occurring on each basin. The equations used were based solely on wetland size (in Ha) as follows:

$$PAIRS = A * BASINAREA + B * \sqrt{BASINAREA}$$

This regression accounts for the non-linear relationship between wetland size and waterfowl carrying capacity (i.e., 10-1ha wetlands provide more pair space than 1-10ha wetland).

Table E1. Species-specific regression coefficients for the regression of estimated duck pairs based on wetland size (in Ha).

Species	*Regression Coefficients* A	B
Mallard	0.0106	0.2899
Gadwall	0.0341	0.2848
Blue-winged Teal	0.0000	0.7376
N. Shoveler	0.0136	0.1870
N. Pintail	0.0000	0.1866

We estimated the wetland area lost from 1971-2001 using annual wetland area loss rates from Watmough, and then randomly selecting wetland basins without replacement to create a database of wetlands that equaled the estimated lost area. Wetland selection was constrained to match the size class distribution (mean, median, min, max) of lost wetlands observed by (Watmough pers. comm.) in each province/ecoregion. Lost waterfowl carrying capacity was then estimated by running the basin-specific regressions on the database of "lost" basins.

Table E2. Wetland area annual loss rates, estimated impact on waterfowl pairs, and estimated annual loss of duck pairs in each province/ecoregion of the Canadian Prairie Pothole Region.

Prov/Ecoreg	Annual Wetland Area Loss Rate(%) – from Watmough (pers. comm.)	Duck Pairs[a] – Before wetland loss (i.e., ducks on all wetlands in database)	Lost Duck Pairs over 30 years- given wetland loss rate	Annual Duck Pair Loss Rate (%)
AB Parkland	-0.2004	44676	4722	-0.3717
AB Prairie	-0.1566	44676	3541	-0.2749
SK Parkland	-0.0811	44676	1842	-0.1402
SK Prairie	-0.2306	44676	3397	-0.2633
MB Parkland	-0.2630	44676	5105	-0.4036

[a] Represents the estimated pair population supported by the 60,613 wetland basins of the simulated 'intact' landscape before province/ecoregion wetland loss rates were applied.

To account for declining waterfowl populations over time as a result of wetland loss, we adjusted the long-term average (LTA; 1961-2001) duck population inputs (i.e., DSS population estimates) for each CCS by applying the above loss rates and assuming that the LTA occurred in 1981 (i.e., middle year of the 1961-2001 span).

For example, the 1971, 1986, and 2001 estimated population in an AB Parkland CCS with an estimated LTA (1961-2000) population of 2000 pairs would be:

1971 Pairs…10 years prior to 1981 = $2000 / (1.0 - 0.003717)^{10} = 2076$

1986 Pairs…5 years after 1981 = $2000 * (1.0 - 0.003717)^{5} = 1963$

2001 Pairs…20 years after 1981 = $2000 * (1.0 - 0.003717)^{20} = 1856$

Adjusted population estimates for each CCS were used as inputs into the Waterfowl Productivity Model for scenario runs that account for wetland loss.

We recognize several assumptions have been made in this process. A few notable assumptions include; 1) wetland loss results in a permanent decrease in the ability of ducks to settle in an area (i.e., density does not increase on remaining wetlands), 2) all CCSs within a province/ecoregion have experienced the impact of wetland loss equally, and 3) regression equations developed by Cowardin for North Dakota reflect the wetland size-duck pair relationship in all regions of the PPR. We suspect 1 above is true but untested, 2 is false but we are not close to better data, and 3 is false but can be tested with existing data.

Literature Cited

Cowardin, L. M., T. L. Shaffer, and P. M. Arnold. 1995. Evaluation of duck habitat and estimation of duck population sizes with a remote-sensing-based system. Biological Science Report 2. National Biological Service, Washington, D.C. 26pp.

Watmough, M., D. Ingstrup, D. Duncan, and H. Schinke. 2002. Prairie Habitat Joint Venture Monitoring Program Phase I: Recent habitat trends. Canadian Wildlife Service, Environment Canada, Edmonton, AB, Canada. 93pp.

Appendix F. Geographic coordinates and current status (2003-04) of wetlands identified as important for each of the 3 wetland-dependent bird groups within the PHJV. Wetlands identified as important moulting and staging areas for waterfowl were extracted from the original provincial NAWMP implementation plans or have subsequently been formally added to the list. Wetlands identified as important for waterbirds host significant numbers of waterbirds during the breeding season, during migration, or meet the various criteria for Important Bird Area (IBA) site designation. Wetlands identified as important for shorebirds host significant numbers of shorebirds during the breeding season, during migration, or meet the various criteria for Potential Western Hemisphere Shorebird Reserve Network (WHSRN) sites or Important Bird Area (IBA) site designation. (Source: B. Calverley, PHJV Coordinator, from original PHJV provincial Implementation Plans, Waterbird and Shorebird Conservation Plans; Geographic coordinates provided by G. Raven and J. Devries). **Notes:** Use the text capture tool in ADOBE Acrobat to copy and paste the data below into a spreadsheet for use in GIS. Status definitions are provided at the bottom of this table.

PROV	WETLAND NAME	LAT	LONG	BIRD GROUP	STATUS	COMMENTS
AB	Beaverhill Lake	53.45887	-112.53605	Waterfowl, Waterbirds, Shorebirds	Wetlands For Tomorrow; DUC Project; IBA; Ramsar; Regional WHSRN	
AB	Frank Lake	50.54748	-113.70957	Waterfowl, Waterbirds, Shorebirds	DUC Project; IBA	
AB	Kimiwan Lake	55.75324	-116.91361	Waterfowl, Waterbirds, Shorebirds	IBA	
MB	Oak Hammock Marsh	50.17000	-97.11000	Waterfowl, Waterbirds, Shorebirds	Heritage Marsh; DUC project; WMA; IBA; Ramsar	
MB	Shoal Lakes-Vestfold	50.58000	-97.68000	Waterfowl, Waterbirds, Shorebirds	DUC Project (Vestfold); IBA; Waterfowl Refuge	
MB	Whitewater Lake	49.24000	-100.33000	Waterfowl, Waterbirds, Shorebirds	DUC project; IBA	
SK	Big Quill Lake	51.88000	-104.36000	Waterfowl, Waterbirds, Shorebirds	IBA; Ramsar; International WHSRN	
SK	Last Mountain Lake	50.80000	-105.01000	Waterfowl, Waterbirds, Shorebirds	IBA; Migratory Bird Sanctuary; Ramsar	
SK	Little Quill Lake	51.91000	-104.06000	Waterfowl, Waterbirds, Shorebirds	DUC Project; IBA; Ramsar; International WHSRN	
SK	Luck Lake	51.07000	-107.10000	Waterfowl, Waterbirds, Shorebirds	IBA	
SK	Old Wives Lake	50.10000	-105.98000	Waterfowl, Waterbirds, Shorebirds	IBA; Migratory Bird Sanctuary; Ramsar; Hemispheric WHSRN	
SK	Redberry Lake	52.69000	-107.16000	Waterfowl, Waterbirds, Shorebirds	DUC Project; IBA; Migratory Bird Sanctuary	
SK	Reed Lake	50.40000	-107.09000	Waterfowl, Waterbirds, Shorebirds	IBA; Hemispheric WHSRN	
AB	Buffalo Lake	52.47335	-112.92872	Waterfowl, Waterbirds	Wetlands For Tomorrow	
AB	Cardinal Lake	56.23587	-117.72369	Waterfowl, Waterbirds	DUC Project; IBA	
AB	Chip Lake	53.65883	-115.37434	Waterfowl, Waterbirds	Wetlands For Tomorrow; DUC Project	
AB	Eagle Lake	51.00081	-113.32511	Waterfowl, Waterbirds	IBA	
AB	Jessie Lake	54.25246	-110.73381	Waterfowl, Waterbirds	DUC Project	
AB	Kitsim Reservoir	50.45000	-112.05000	Waterfowl, Waterbirds	DUC Project; IBA	
AB	Lake Newell (reservoir)	50.44063	-111.94594	Waterfowl, Waterbirds	IBA	
AB	Milk River Ridge Reservoir	49.37112	-112.56848	Waterfowl, Waterbirds		
AB	Namaka Lake	50.93360	-113.21841	Waterfowl, Waterbirds	DUC Project; IBA	
AB	Scope Reservoir	50.06700	-111.81700	Waterfowl, Waterbirds		
AB	St. Mary Reservoir	49.30972	-113.22672	Waterfowl, Waterbirds	IBA	
AB	Stobart Lake	50.90598	-113.18708	Waterfowl, Waterbirds	DUC Project; IBA	

AB	Texas Irricana Lake	51.27735	-113.64061	Waterfowl, Waterbirds	DUC Project	Irricana Reservoir
AB	Winagami Lake	55.62863	-116.75644	Waterfowl, Waterbirds	DUC Project	
MB	Delta Marsh	50.20000	-98.15000	Waterfowl, Waterbirds	IBA; Ramsar	
MB	Marshy Point	50.52000	-98.13000	Waterfowl, Waterbirds	DUC project (partial); IBA	
MB	Oak-Plum Lakes	49.66000	-100.76000	Waterfowl, Waterbirds	DUC Project (partially); IBA	
MB	Proven Lake	50.54000	-100.02000	Waterfowl, Waterbirds	Heritage Marsh; DUC project; IBA	
SK	Bigstick Lake	50.26000	-109.32000	Waterfowl, Waterbirds	IBA	
SK	Blackstrap Reservoir	51.82000	-106.40000	Waterfowl, Waterbirds	IBA	
SK	Eyebrow Lake	50.96000	-106.18000	Waterfowl, Waterbirds	IBA	
SK	Ingebright Lake	50.36000	-109.32000	Waterfowl, Waterbirds	IBA	
SK	Pasqua Lake (11S Dysart)	50.78000	-104.04000	Waterfowl, Waterbirds		
SK	Rice Lake	52.07000	-107.11000	Waterfowl, Waterbirds	IBA	
AB	Chain Lakes	51.86452	-112.21986	Waterfowl, Shorebirds	IBA	
AB	Chain Lakes	51.85080	-112.20275	Waterfowl, Shorebirds	IBA	
AB	Chain Lakes	51.83682	-112.18298	Waterfowl, Shorebirds	IBA	
AB	Chain Lakes	51.83145	-112.16671	Waterfowl, Shorebirds	IBA	
AB	Chain Lakes	51.81995	-112.17429	Waterfowl, Shorebirds	IBA	
AB	Chain Lakes	51.80604	-112.15710	Waterfowl, Shorebirds	IBA	
AB	Chain Lakes	51.79094	-112.12284	Waterfowl, Shorebirds	IBA	
AB	Chain Lakes	51.77741	-112.11329	Waterfowl, Shorebirds	IBA	
AB	Chain Lakes	51.76861	-112.11405	Waterfowl, Shorebirds	IBA	
AB	Chain Lakes	51.75816	-112.09286	Waterfowl, Shorebirds	IBA	
AB	Chain Lakes	51.76164	-112.08309	Waterfowl, Shorebirds	IBA	
AB	Chappice Lake	50.16537	-110.36880	Waterfowl, Shorebirds	IBA	
AB	Dowling Lake	51.73406	-112.02722	Waterfowl, Shorebirds	IBA	
AB	Gooseberry Lake	52.11700	-110.71700	Waterfowl, Shorebirds	IBA	
AB	Handhills Lake	51.49252	-112.13157	Waterfowl, Shorebirds	IBA	
AB	Little Fish Lake	51.37710	-112.23263	Waterfowl, Shorebirds	DUC Project; IBA	
AB	Pakowki Lake	49.30368	-110.90081	Waterfowl, Shorebirds	IBA; DUC Project	West Arm-DUC Project
AB	Sullivan Lake	51.94036	-111.96551	Waterfowl, Shorebirds	DUC Project (W Arm); IBA	
AB	Whitford Lake	53.85791	-112.26368	Waterfowl, Shorebirds	Wetlands For Tomorrow; IBA	Whitford-Rush Lakes
SK	Basin Lake	52.61000	-105.28000	Waterfowl, Shorebirds	IBA; Migratory Bird Sanctuary	and Middle Lake
SK	Blaine Lake	52.79000	-107.01000	Waterfowl, Shorebirds	IBA	
SK	Buffer Lake (3N & 2E Vonda)	52.38000	-106.02000	Waterfowl, Shorebirds	IBA	
SK	Chaplin Lake	50.31000	-106.59000	Waterfowl, Shorebirds	IBA; Hemispheric WHSRN	
SK	Chaplin Lake	50.44000	-106.71000	Waterfowl, Shorebirds	IBA; Hemispheric WHSRN	
SK	Chaplin Lake	50.41000	-106.60000	Waterfowl, Shorebirds	IBA; Hemispheric WHSRN	
SK	Freshwater Lake	52.61000	-109.98000	Waterfowl, Shorebirds		
SK	Killsquaw Lake	52.40000	-109.09000	Waterfowl, Shorebirds		
SK	Landis Lake	52.19000	-108.51000	Waterfowl, Shorebirds	IBA	
SK	Lenore Lake	52.50000	-104.98000	Waterfowl, Shorebirds		
SK	Manitou Lake	52.74000	-109.67000	Waterfowl, Shorebirds	IBA	
SK	Muddy Lake	52.32000	-109.12000	Waterfowl, Shorebirds		
SK	Opuntia Lake	51.80000	-108.57000	Waterfowl, Shorebirds		

SK	Pelican Lake (7N Mortlach)	50.54000	-106.01000	Waterfowl, Shorebirds	IBA	
SK	Porter Lake	52.19000	-106.29000	Waterfowl, Shorebirds		
SK	Reflex Lakes	52.68000	-109.95000	Waterfowl, Shorebirds		
SK	Wells Lake	52.82000	-109.85000	Waterfowl, Shorebirds		
SK	Willow Bunch Lake	49.44000	-105.44000	Waterfowl, Shorebirds	IBA	
AB	Airport Lake	55.19338	-118.88143	Waterfowl		
AB	Airport Lake	55.19062	-118.88804	Waterfowl		
AB	Algar Lake	56.31190	-112.29191	Waterfowl		
AB	Anderson Lake	55.33932	-119.24603	Waterfowl	DUC Project	
AB	Antelope Lake	51.67137	-111.24870	Waterfowl	DUC Project	
AB	Antelope Lakes	51.29000	-112.25353	Waterfowl		
AB	Antelope Lakes	51.28660	-112.23653	Waterfowl		
AB	Antelope Lakes	51.28491	-112.22979	Waterfowl		
AB	Antelope Lakes	51.28397	-112.22441	Waterfowl		
AB	Audet Lake	57.64488	-110.91416	Waterfowl		
AB	Badger Lake	50.38157	-112.46386	Waterfowl		
AB	Bantry 1 & 2	50.36170	-111.59320	Waterfowl	DUC Project	
AB	Barbara Lake	54.52818	-110.86120	Waterfowl	DUC Project	
AB	Bartman Reservoir	51.11394	-111.45533	Waterfowl	DUC Project	
AB	Bear Lake	55.25150	-118.99578	Waterfowl	DUC Project	
AB	Bear Lake	54.22463	-114.87242	Waterfowl	DUC Project	
AB	Bear Lake	54.01699	-110.22256	Waterfowl	DUC Project	
AB	Bearhills Lake	52.93927	-113.61038	Waterfowl	DUC Project; IBA	
AB	Beaver Ranch	58.43482	-115.67125	Waterfowl		
AB	Beaverhill "A" Lake	53.37780	-112.50100	Waterfowl		
AB	Bellshill Lake	52.60358	-111.56238	Waterfowl	IBA	
AB	Bens Lake	53.66784	-111.86341	Waterfowl	Wetlands For Tomorrow; DUC Project	Bens-Watt Lake Complex
AB	Berry Lakes	51.08862	-111.50425	Waterfowl	DUC Project	
AB	Bethel Lake	55.60789	-119.96047	Waterfowl		
AB	Big Hay Lake	53.16661	-113.17583	Waterfowl	Wetlands For Tomorrow; DUC Project	
AB	Big Lake	53.60101	-113.67919	Waterfowl	Wetlands For Tomorrow; DUC Project; IBA	
AB	Bisbing Lake	55.25840	-119.64111	Waterfowl	DUC Project	
AB	Bittern Lake	53.05255	-113.07078	Waterfowl	Wetlands For Tomorrow; DUC Project	
AB	Bittern Lake North	53.07230	-113.04280	Waterfowl	Wetlands For Tomorrow; DUC Project	
AB	Black Duck Lake	56.18342	-118.45555	Waterfowl		
AB	Black Lake			Waterfowl		Unk Loc
AB	Blood Indian Creek Reser	51.25592	-111.20706	Waterfowl	DUC Project	
AB	Bowman Lake	55.09091	-119.33532	Waterfowl		
AB	Brosten Reservoir	51.36434	-111.07149	Waterfowl	DUC Project	
AB	Bruce Lake	51.20155	-113.54790	Waterfowl	DUC Project	Bruce Lake-Disney project
AB	Buffalo Bay/Horse Lakes	55.55800	-116.18300	Waterfowl	Wetlands For Tomorrow	
AB	Buffalo Lake	55.37978	-118.97573	Waterfowl	DUC Project	

AB	Bunder Lake	54.28884	-111.70024	Waterfowl	DUC Project	
AB	Cadotte Lake	56.44976	-116.39267	Waterfowl	DUC Project	
AB	Calumet Lake	57.41712	-111.76678	Waterfowl		
AB	Carroll Lakes	54.11836	-111.66034	Waterfowl	DUC Project	
AB	Cemetery Lake	55.32348	-118.83349	Waterfowl		
AB	Center Slough	52.01413	-113.86038	Waterfowl	DUC Project	
AB	Cessford Reservoir	51.02821	-111.45772	Waterfowl		
AB	Charlotte Lake	54.25512	-110.63313	Waterfowl	DUC Project	
AB	Chin Lakes	49.74293	-112.46461	Waterfowl		
AB	Chin Lakes	49.69555	-112.39216	Waterfowl		
AB	Chin Lakes	49.63437	-112.25027	Waterfowl		
AB	Clairmont Lake	55.25593	-118.76205	Waterfowl	DUC Project	
AB	Clear Lake	50.14720	-113.41732	Waterfowl		
AB	Coal Lake	53.07073	-113.26144	Waterfowl		
AB	Coaldale Lake	49.83300	-112.60000	Waterfowl		
AB	Coleman Lake	51.44093	-111.87092	Waterfowl	DUC Project	
AB	Conrad Flats	49.36540	-111.83730	Waterfowl	DUC Project	
AB	Contracosta Lake	51.68300	-111.58300	Waterfowl	DUC Project	
AB	Cowoki Lake	50.58534	-111.69043	Waterfowl		
AB	Craig Lake	51.93780	-111.57800	Waterfowl		
AB	Crawling Valley Res.	50.92214	-112.36317	Waterfowl		
AB	Crestomere Lake	52.67469	-113.91951	Waterfowl	DUC Project	
AB	Cutbank Lake	55.71888	-119.76119	Waterfowl		
AB	Cutbank Lake	55.25885	-119.12468	Waterfowl		
AB	Cutbank Lake	52.05800	-112.31700	Waterfowl		
AB	Cygnet Lake	52.28162	-114.01516	Waterfowl	Wetlands For Tomorrow; DUC Project	
AB	Cygnet Lake	52.27718	-113.97851	Waterfowl	Wetlands For Tomorrow; DUC Project	
AB	Dapp Lake	54.34129	-113.60725	Waterfowl	DUC Project	
AB	Deadhorse Lake	51.06494	-112.66584	Waterfowl		
AB	Deadwood Lake	56.71465	-117.58876	Waterfowl	DUC Project	
AB	Deep Lake	56.70281	-119.02229	Waterfowl		
AB	Deep Lake	55.24845	-119.08009	Waterfowl		
AB	Demay Lake	53.12348	-112.69763	Waterfowl		
AB	Devil Lake	58.37338	-116.78576	Waterfowl		
AB	Dishpan Lake	50.59172	-110.54547	Waterfowl		
AB	Dolcy Lake	52.64912	-110.46995	Waterfowl		
AB	Driedmeat Lake	52.83947	-112.74009	Waterfowl	DUC Project	
AB	Dusty Lake	53.13022	-112.48176	Waterfowl		
AB	East Mustus Lake	58.17357	-116.47350	Waterfowl		
AB	Edberg Slough	52.77378	-112.86137	Waterfowl	DUC Project	
AB	Egg Lake	56.07001	-111.40557	Waterfowl	DUC Project	
AB	Elhardt Lake			Waterfowl		Unk Loc
AB	Elvestad Lake	55.43973	-119.34625	Waterfowl		
AB	Erskine Lake	52.30823	-112.88269	Waterfowl	DUC Project; IBA	

AB	Farrell Lake	51.87191	-112.33203	Waterfowl		
AB	Ferguson Lake	55.26837	-118.81764	Waterfowl	DUC Project	
AB	Field and Stream Project	50.86100	-112.06560	Waterfowl	DUC Project	
AB	Fincastle Reservoir	49.83300	-111.98300	Waterfowl		
AB	Fitzgerald Lake	51.80114	-111.06586	Waterfowl	IBA	
AB	Flat Lake	54.65354	-112.90542	Waterfowl	DUC Project	
AB	Fleischman Lake	50.88200	-112.13150	Waterfowl	DUC Project	
AB	Flood Lake	56.49826	-117.81477	Waterfowl	DUC Project	
AB	Flyingshot Lake	55.13937	-118.86605	Waterfowl		
AB	Forster Reservoir	50.99281	-111.77062	Waterfowl		
AB	Forty Mile Coulee	49.59230	-114.48840	Waterfowl	DUC Project	
AB	Fresno-Honens	51.27830	-113.48750	Waterfowl	DUC Project	
AB	George Lake	56.22650	-118.56911	Waterfowl	DUC Project	
AB	George Lake	54.53478	-113.48094	Waterfowl	DUC Project	
AB	Goodfare Lake	55.27291	-119.68993	Waterfowl	DUC Project	
AB	Gopher Lake	51.71995	-111.35000	Waterfowl	DUC Project	
AB	Gordon Lake	56.51507	-110.45089	Waterfowl		
AB	Gough Lake	51.99325	-112.47012	Waterfowl		
AB	Grantham Lake	50.91700	-111.93300	Waterfowl		
AB	Grassy Island Lake	54.24312	-111.37368	Waterfowl	DUC Project	
AB	Grassy Island Lake	51.82655	-110.31329	Waterfowl	DUC Project	
AB	Gull Lake	58.43397	-116.13229	Waterfowl	DUC Project	
AB	Gummer Lake	55.36725	-118.99628	Waterfowl		
AB	Hackmatack Lake	55.18603	-119.66636	Waterfowl		
AB	Hay Lake	58.83658	-118.82505	Waterfowl	Wetlands For Tomorrow; DUC Project; IBA; Ramsar	
AB	Hay Lakes	49.20000	-111.63300	Waterfowl		2 basins
AB	Hays Reservoir	50.05877	-111.82976	Waterfowl	IBA	
AB	Helen Lake	56.54319	-117.82782	Waterfowl	DUC Project	
AB	Henderson Lake	55.34404	-119.09988	Waterfowl		
AB	Hermit Lake	55.20586	-118.96442	Waterfowl	DUC Project	
AB	Horse Lake	56.83856	-113.60733	Waterfowl	DUC Project	
AB	Horse Lake	56.30430	-110.93416	Waterfowl	DUC Project	
AB	Horse Lake	56.14218	-111.94715	Waterfowl	DUC Project	
AB	Horse Lake	55.33642	-119.71530	Waterfowl	DUC Project	
AB	Horse Lake	54.87462	-112.35264	Waterfowl	DUC Project	
AB	Horsefly Lakereservoir	49.73354	-112.10116	Waterfowl		
AB	Horseshoe Lake	56.65676	-110.99269	Waterfowl		
AB	Horseshoe Lake	54.61509	-114.25113	Waterfowl		
AB	Horseshoe Lake	54.49013	-113.78802	Waterfowl		
AB	Houcher Lake	52.40766	-110.82934	Waterfowl	DUC Project	
AB	Hughes Lake	55.19843	-118.91416	Waterfowl		
AB	Hume Creek	55.28100	-119.93325	Waterfowl		
AB	Huppie Lake	54.55349	-111.81685	Waterfowl	DUC Project	

AB	Intermittent Lake	55.34287	-118.93538	Waterfowl		
AB	Jamieson Lake	50.60947	-111.88271	Waterfowl	DUC Project	
AB	Jenson Reservoir	49.31492	-112.89790	Waterfowl		
AB	John Lake	53.73391	-110.03640	Waterfowl	DUC Project	
AB	Johnson Reservoir	50.37127	-111.84558	Waterfowl		
AB	Jones Lake	55.39110	-119.00497	Waterfowl		
AB	Kakut Lake	55.62882	-118.52849	Waterfowl		
AB	Kamisak 6	55.13460	-119.80793	Waterfowl	DUC Project	
AB	Kamisak E Lake	55.16364	-119.73089	Waterfowl		
AB	Kamisak Lake	55.16301	-119.75615	Waterfowl		
AB	Kamisak SW Lake	55.14912	-119.75615	Waterfowl	DUC Project	
AB	Kearl Lake	57.29025	-111.23634	Waterfowl		
AB	Keeping Lake	55.46131	-119.93601	Waterfowl		
AB	Keho Lake	49.94792	-113.00471	Waterfowl		
AB	Kenilworth Lake	53.32820	-110.51827	Waterfowl		
AB	Kings Lake	49.35760	-111.65820	Waterfowl	DUC Project	
AB	Kininvie Flat	50.37200	-111.50200	Waterfowl	DUC Project	
AB	Kirkpatrick Lake	51.87941	-111.31546	Waterfowl	IBA	
AB	Kleskun Lake	55.35243	-118.57703	Waterfowl	Wetlands For Tomorrow; DUC Project	
AB	La Glace East Lake	55.38418	-119.24247	Waterfowl	DUC Project	
AB	La Glace West Lake	55.38102	-119.32048	Waterfowl		
AB	Lac Des Jones	54.24734	-113.73845	Waterfowl	DUC Project	
AB	Lac Emilien	53.54437	-111.11732	Waterfowl	DUC Project	
AB	Lac Magloire	55.86675	-117.17799	Waterfowl	DUC Project	
AB	Lacrete Lake	58.19534	-116.44598	Waterfowl		
AB	Lanes Lake	52.20800	-111.98300	Waterfowl		
AB	Langdon Reservoir	50.91429	-113.47895	Waterfowl	DUC Project	
AB	Lathom Lake	50.71211	-112.29634	Waterfowl		
AB	Linton Lake	58.17103	-116.48559	Waterfowl		
AB	Little Beave Lake	54.59402	-112.35400	Waterfowl		
AB	Little Beaver Lake	52.77127	-112.97597	Waterfowl	DUC Project	
AB	Little Bow Lake (Res.)	50.19310	-112.67558	Waterfowl		
AB	Little Lake	55.19992	-119.08371	Waterfowl		
AB	Little McClelland Lake	57.45296	-111.29017	Waterfowl		
AB	Little Red Deer Marsh	52.75475	-113.14149	Waterfowl	Wetlands For Tomorrow; DUC Project	
AB	Little Utikuma Lake	55.90769	-114.74854	Waterfowl		
AB	Lost Lake	56.24008	-118.01351	Waterfowl		
AB	Lost Lake	50.14299	-112.30483	Waterfowl	DUC Project	
AB	Lost Lemon Lake	50.35400	-112.28800	Waterfowl	DUC Project (part of Circle E Project)	
AB	Louisiana Lakes	50.55672	-111.64204	Waterfowl	DUC Project	
AB	Louisiana Lakes	50.54383	-111.60797	Waterfowl	DUC Project	
AB	Louisiana Lakes	50.53855	-111.63217	Waterfowl	DUC Project	
AB	Louisiana Lakes	50.53626	-111.63984	Waterfowl	DUC Project	
AB	Louisiana Lakes	50.52305	-111.56081	Waterfowl	DUC Project	

AB	Louisiana Lakes	50.51988	-111.59223	Waterfowl	DUC Project	
AB	Louisiana Lakes	50.50040	-111.58398	Waterfowl	DUC Project	
AB	Louisiana Lakes	50.48857	-111.51617	Waterfowl	DUC Project	
AB	Louisiana Lakes	50.46399	-111.52046	Waterfowl	DUC Project	
AB	Lowden Lakes	52.14626	-112.68557	Waterfowl		
AB	Lowe Lake	55.32670	-119.17927	Waterfowl		
AB	Majors Lake	51.13008	-111.17108	Waterfowl	DUC Project	
AB	Manatokan Lake	54.46425	-110.94469	Waterfowl	DUC Project	
AB	Manawan Lake	53.89569	-113.69212	Waterfowl	Wetlands For Tomorrow; DUC Project	
AB	Many Island Lake	50.12346	-110.04474	Waterfowl	Wetlands For Tomorrow; DUC Project	
AB	Marion Lake	52.18300	-112.43300	Waterfowl	Wetlands for Tomorrow	
AB	Martin Lake	55.44286	-119.56411	Waterfowl	DUC Project	
AB	Mattoyekiu Lake	51.12818	-112.44536	Waterfowl		
AB	McNaught Lake	55.14652	-119.44920	Waterfowl	DUC Project	
AB	McNeil Lake	59.54406	-112.40575	Waterfowl		
AB	Meadowville One	55.32315	-119.21784	Waterfowl	DUC Project	
AB	Metheral	49.40330	-111.49610	Waterfowl	Wetlands for Tomorrow	
AB	Ministik Lake	53.43598	-113.01033	Waterfowl	IBA	
AB	Mud Lake	49.75374	-113.53997	Waterfowl		
AB	Mulligan Lake	55.37099	-119.12488	Waterfowl		
AB	Murray Lake	49.80352	-110.95563	Waterfowl		
AB	Mustus Lake	58.14835	-116.39450	Waterfowl		
AB	North Cache Lake	54.40920	112.99370	Waterfowl	DUC Project	
AB	Oakland Lake	51.39088	-111.83802	Waterfowl		
AB	Oldman Lake	53.87585	-114.54017	Waterfowl	DUC Project	
AB	Oldman Lake	51.70709	-111.37828	Waterfowl	DUC Project	
AB	Onetree Reservoir	50.60747	-111.82608	Waterfowl		
AB	Peace Athabasca Delta	58.73267	-111.10787	Waterfowl	Wetlands For Tomorrow; IBA; Ramsar	
AB	Peace River (Ft. Vermillion Bridge-Beaver Ranch I.R.)	58.45000	-115.88300	Waterfowl		River Section
AB	Peace River (Moose Island-Prairie Point)	58.21700	-116.58300	Waterfowl		River Section
AB	Peace River (Prairie Point-Ft. Vermillion Bridge)	58.33000	-116.31700	Waterfowl		River Section
AB	Pemukan Lake	51.95800	-110.45800	Waterfowl		
AB	Picture Butte Reservoir	49.88560	-112.77884	Waterfowl		
AB	Plover Lake	51.49307	-111.38208	Waterfowl	DUC Project	
AB	Pluvius Lake	56.57334	-117.60683	Waterfowl	DUC Project	
AB	Ponita Lake	55.50858	-119.84175	Waterfowl		
AB	Powell Lake	55.37931	-119.81054	Waterfowl	DUC Project	
AB	Preston Lake	55.36738	-119.91806	Waterfowl	DUC Project	
AB	Prouty Lake	50.25090	-112.43770	Waterfowl	DUC Project	
AB	Rail Lake	56.51563	-117.63099	Waterfowl		
AB	Railroad Lake	51.27718	-113.48606	Waterfowl		

AB	Rat Lake	59.87388	-117.00274	Waterfowl	DUC Project	
AB	Rat Lake	54.44059	-118.78190	Waterfowl	DUC Project	
AB	Ray Lake	56.66085	-119.12629	Waterfowl		
AB	Ray Lake	55.43233	-119.88203	Waterfowl		
AB	Red Deer Lake	52.71271	-113.04448	Waterfowl		
AB	Red Deer Lake	50.28497	-110.38229	Waterfowl		
AB	Reed Lake	49.17156	-112.80998	Waterfowl		
AB	Ribstone Creek Irrigation System	52.76512	-110.64980	Waterfowl	DUC Project (multiple wetland projects)	Multiple DU wetland projects associated with Ribstone Lake
AB	Ribstone Lake	52.76512	-110.64980	Waterfowl	DUC Project	
AB	Robb Lake	51.97029	-111.35583	Waterfowl	DUC Project	
AB	Rock Lake	50.69024	-112.01751	Waterfowl		
AB	Rolling Hills Lake	50.35887	-111.89885	Waterfowl		
AB	Ronald Lake	57.97148	-111.67036	Waterfowl		
AB	Roreigh	56.18171	-118.46197	Waterfowl	DUC Project	
AB	Rush Lake	53.81919	-112.20333	Waterfowl	Wetlands For Tomorrow; IBA	Whitford-Rush Lakes
AB	Rushmere Lake	51.83097	-111.13185	Waterfowl		
AB	Saline Lake	57.07849	-111.52222	Waterfowl		
AB	Sampson Lake	52.74778	-113.23771	Waterfowl		
AB	San Francisco Lake	50.59401	-112.11867	Waterfowl	DUC Project	
AB	San Joaquin	50.91427	-113.33096	Waterfowl	DUC Project	
AB	Sandy Lake	53.78833	-114.04062	Waterfowl	DUC Project	
AB	Saskatoon Lake	55.21925	-119.09369	Waterfowl		
AB	Shanks Lake	49.06897	-112.72576	Waterfowl		
AB	Sherborne Lake	49.76387	-111.81486	Waterfowl		
AB	Shoal Lake	54.25020	-114.43210	Waterfowl	DUC Project	
AB	Shooting Lake	52.18300	-112.35000	Waterfowl		
AB	Sieu Lake	51.14864	-112.40247	Waterfowl		
AB	Sinclair Lake	54.72594	-110.65838	Waterfowl	DUC Project	
AB	Smoky Lake	54.15039	-112.63874	Waterfowl	DUC Project	
AB	Snake Lake	51.94726	-112.76022	Waterfowl	DUC Project	
AB	Snipe Lake	55.12704	-116.78641	Waterfowl		
AB	Snow Lake	52.71641	-113.79522	Waterfowl	DUC Project	
AB	Sounding Creek	51.58300	-110.36700	Waterfowl		an extensive creek system
AB	Sounding Creek Reservoir	51.57647	-110.70192	Waterfowl		
AB	South Mustus Lake	58.15889	-116.36270	Waterfowl		
AB	Spotted Lake	52.49096	-113.13258	Waterfowl	DUC Project	
AB	Square Lake	59.05968	-112.47197	Waterfowl		
AB	Square Lake	54.91020	-111.83712	Waterfowl		
AB	Stirling Lake	49.52799	-112.55502	Waterfowl		
AB	Sturgeon Lake	55.10446	-117.56894	Waterfowl	DUC Project; Provincial Park	
AB	Sucker Lake	56.41968	-110.86348	Waterfowl		

AB	Sunrise	56.15241	-118.50953	Waterfowl	DUC Project	
AB	Surette Lake	58.34491	-116.68617	Waterfowl		
AB	Taber Lake	49.80296	-112.09291	Waterfowl		
AB	Texas Salt Lake	51.30160	-113.55440	Waterfowl		
AB	Tilley A Reservoir	50.49470	-111.61320	Waterfowl	DUC Project	
AB	Tilley B Reservoir	50.55030	-111.63650	Waterfowl	DUC Project	
AB	Tilley Slough	50.45128	-111.61720	Waterfowl		
AB	Timko Lake (bantry Reser	50.47650	-111.73284	Waterfowl		
AB	Travers Reservoir	50.22086	-112.84315	Waterfowl	IBA	
AB	Twelve Mile Coulee	50.18300	-111.60000	Waterfowl		
AB	Twin Lakes	55.01282	-119.60127	Waterfowl	DUC Project	
AB	Twin Lakes	55.00172	-119.58948	Waterfowl	DUC Project	
AB	Tyrrell Lake	49.38639	-112.27172	Waterfowl	DUC Project	Rush-Tyrell Project
AB	Updike Lake	55.44119	-119.80392	Waterfowl		
AB	Utikuma Lake	55.86409	-115.39199	Waterfowl	Wetlands For Tomorrow; DU Project; IBA	
AB	Valhalla Lake	55.37623	-119.45271	Waterfowl	DUC Project	
AB	Verdigris Lake	49.25193	-112.05535	Waterfowl	DUC Project	
AB	Verdigris Slough	49.15670	-111.83790	Waterfowl	DUC Project	
AB	Vermillion Lakes	53.69194	-111.65582	Waterfowl	DUC Project	
AB	Vermillion Lakes	53.68817	-111.60542	Waterfowl	DUC Project	
AB	Vermillion Lakes	53.67201	-111.54730	Waterfowl	DUC Project	
AB	Vermillion Lakes	53.65376	-111.49545	Waterfowl	DUC Project	
AB	Vernon Project	49.42640	-111.35160	Waterfowl	DUC Project	
AB	Wakomao Lake	54.16142	-113.55612	Waterfowl	DUC Project	
AB	Waterton Reservoir	49.29838	-113.68448	Waterfowl		
AB	Watt Lake	53.71051	-111.93174	Waterfowl	Wetlands For Tomorrow; DUC Project	
AB	Wavy Lake	52.87776	-112.06957	Waterfowl	IBA	
AB	Wembley Lake	55.14894	-119.14034	Waterfowl	DUC Project	
AB	West Arm Reservoir	49.36079	-111.02734	Waterfowl	DUC Project	Pakowki Lake
AB	West Buffalo Lake	55.38144	-119.01298	Waterfowl		
AB	West Muskeg Lake	56.90083	-112.49799	Waterfowl		
AB	Weston Lake	49.33426	-112.18086	Waterfowl		
AB	Whitehorse Lake	50.66471	-110.48858	Waterfowl		
AB	Wilkin Lake	55.27922	-119.34625	Waterfowl		
AB	Wilson Prairie Lake	58.18756	-116.05924	Waterfowl		
AB	Wolf Lake	58.09958	-116.47341	Waterfowl		
AB	Wolfe Lake	55.43106	-119.19190	Waterfowl	DUC Project	
AB	Wood Lake	55.15382	-118.72582	Waterfowl		
AB	Yellow Lake	49.73538	-111.50040	Waterfowl	DUC Project	
AB	Yoke Lake	55.22038	-119.67923	Waterfowl	DUC Project	
AB	Zama Lake	58.77425	-118.99262	Waterfowl	Wetlands For Tomorrow; DUC Project; IBA; Ramsar	
MB	Big Grass Marsh	50.44000	-98.87000	Waterfowl	DUC project; Waterfowl Refuge	

MB	Big Point Marsh	50.40000	-98.56000	Waterfowl		
MB	Dennis Lake	50.59000	-97.37000	Waterfowl		
MB	Dog Lake	51.04000	-98.56000	Waterfowl	DUC project; IBA	
MB	Grant's Lake	50.05000	-97.55000	Waterfowl	Heritage Marsh; DUC Project, WMA; IBA	
MB	Hecla	51.05000	-96.84000	Waterfowl	DUC project; Provincial Park	
MB	Hunter-Maple	49.52000	-100.82000	Waterfowl		4 E & 2 S Pipestone
MB	Lidcliff	50.62000	-101.14000	Waterfowl	DUC project; Heritage Marsh	
MB	Lizard Lake	49.30000	-98.41000	Waterfowl	DUC project	
MB	Netley-Libau	50.33000	-96.84000	Waterfowl	IBA	
MB	Pinemuta-Lake St. Martin	51.67000	-98.66000	Waterfowl		
MB	Portia	50.85000	-99.02000	Waterfowl	DUC project	(incl. Jarvies, Little Round, Long, Pedro, Last, Bulas, and West Bulas Lakes)
MB	Rat River Swamp	49.24000	-96.70000	Waterfowl	DUC project (partially)	
MB	Reykjavik Marsh	51.24000	-98.90000	Waterfowl	DUC project	
MB	Saskeram W.M. A.	53.82000	-101.50000	Waterfowl	DUC Project; Heritage Marsh; IBA	
MB	Summerberry	53.60000	-100.98000	Waterfowl	Heritage Marsh; DUC project; IBA	
MB	Tom Lamb W.M.A.	54.05000	-101.06000	Waterfowl	DUC project; WMA	
MB	Turtle River	51.12000	-99.64000	Waterfowl		
SK	Akerlund Lake	52.50000	-109.28000	Waterfowl		
SK	Amyot Lake	53.70000	-106.64000	Waterfowl		
SK	Anglin Lake	53.73000	-105.93000	Waterfowl		
SK	Antelope Lake	50.27000	-108.39000	Waterfowl		
SK	Aroma Lake	52.28000	-108.56000	Waterfowl		
SK	Ashe Lake	52.87000	-106.88000	Waterfowl		
SK	Aurthur Lake	52.57000	-105.44000	Waterfowl		
SK	Back Lake			Waterfowl		Unk Loc
SK	Bad Lake	51.38000	-108.44000	Waterfowl		
SK	Bainbridge Lake	53.59000	-101.98000	Waterfowl		
SK	Baird Lake	53.95000	-103.83300	Waterfowl		
SK	Bank Lake	51.58000	-105.13000	Waterfowl		
SK	Bankside Lake	53.24000	-102.41000	Waterfowl	Provincial Park	
SK	Barber Lake (3N Wiseton)	51.37000	-107.66000	Waterfowl		
SK	Barnes Lake	53.55000	-107.76000	Waterfowl		
SK	Barrier Lake	52.52000	-103.79000	Waterfowl		
SK	Beaton Lake	53.80000	-102.18000	Waterfowl		
SK	Beaufield Lake	51.78000	-109.09000	Waterfowl		
SK	Belanger Lake	53.91700	-102.01000	Waterfowl		
SK	Bell Lake	53.55000	-106.10000	Waterfowl	DUC Project	
SK	Berube Lake	53.48000	-106.95000	Waterfowl		
SK	Bewley Lake	53.82000	-102.21000	Waterfowl		
SK	Big Lake	53.86000	-102.25000	Waterfowl		

SK	Big Muddy Lake	49.14000	-104.88000	Waterfowl		
SK	Big Sucker Lake	53.42500	-106.40000	Waterfowl		
SK	Big Valley Lake	52.40000	-103.01000	Waterfowl		
SK	Binns Lake	53.58000	-102.55000	Waterfowl		
SK	Binns Lake (2)			Waterfowl		Unk Loc
SK	Birch Lake	53.46000	-108.18000	Waterfowl		
SK	Birchbark Lake	53.63000	-102.32000	Waterfowl		
SK	Birchbark Lake (4N, 12 W Smeaton)	53.55000	-105.10000	Waterfowl		
SK	Birling Lake	53.03000	-109.09000	Waterfowl		
SK	Bitter Lake	50.09000	-109.79000	Waterfowl		
SK	Bittern Lake	53.94000	-105.75000	Waterfowl		
SK	Bjork Lake	52.73000	-103.52000	Waterfowl		
SK	Bland Lake	53.50000	-107.27000	Waterfowl		
SK	Bliss Lake	49.78000	-105.51000	Waterfowl		
SK	Bloodsucker Lake	53.86000	-102.55000	Waterfowl		
SK	Bog Lake (10S 2E Cumberland)	53.76000	-102.18000	Waterfowl		
SK	Boggy Lake	50.57000	-108.47000	Waterfowl		
SK	Boucher Lake	52.45000	-105.67000	Waterfowl		
SK	Boulder Lake	51.60000	-105.24000	Waterfowl	DUC Project	
SK	Bourassa Lake	53.63000	-102.90000	Waterfowl		
SK	Braddock Reservoir	50.09000	-107.36000	Waterfowl		
SK	Bronson Lake	53.86000	-109.70000	Waterfowl		
SK	Buffalo Lake	51.77000	-105.87000	Waterfowl		
SK	Buffalo Pound Lake	50.60000	-105.41000	Waterfowl		
SK	Buffalohead Lake	53.50000	-102.73000	Waterfowl		
SK	Bulrush Lake	51.38000	-105.40000	Waterfowl		
SK	Cabri Lake	51.11000	-109.73000	Waterfowl		
SK	Cactus Lake	52.15000	-109.88000	Waterfowl		
SK	Candle Lake	53.81000	-105.25000	Waterfowl		
SK	Carps Lake	52.47000	-103.90000	Waterfowl		
SK	Carrot Lake	53.70000	-101.90000	Waterfowl		
SK	Castlewood Lake	52.09000	-108.09000	Waterfowl		
SK	Channel Lake	49.53000	-105.24000	Waterfowl		
SK	Charron Lake	52.40000	-104.32000	Waterfowl	Regional Park	
SK	Cheviot Lake	52.03000	-106.33000	Waterfowl		
SK	Chitek Lake	53.74000	-107.79000	Waterfowl	Provincial Park	
SK	Christopher Lake	53.57000	-105.83000	Waterfowl		
SK	Clarke Marsh	49.93000	-106.03000	Waterfowl		
SK	Clearsand Lake	53.83000	-105.57000	Waterfowl		
SK	Coldspring Lake	52.34000	-108.59000	Waterfowl		
SK	Crabtree Lake			Waterfowl		Unk Loc
SK	Crane Lake	50.10000	-109.08000	Waterfowl	IBA	

SK	Crescent Lake	51.02000	-102.49000	Waterfowl		
SK	Crooked Lake	50.60000	-102.75000	Waterfowl	Provincial Park	
SK	Cross Lake	53.99000	-102.07000	Waterfowl		
SK	Culdesac Lake	53.62000	-101.77000	Waterfowl		
SK	Cumberland Lake	53.98000	-102.24000	Waterfowl		
SK	Cut Beaver Lake	53.78000	-102.65000	Waterfowl		
SK	Cutbank Lake (10S Kindersley)	51.29000	-109.14000	Waterfowl		
SK	Cutbank Lake (8N 1E Morse)	50.53000	-107.00000	Waterfowl		
SK	Cypress Lake	49.47000	-109.48000	Waterfowl		
SK	Dana Salt Lake	52.24200	-105.70800	Waterfowl		
SK	Deadmoose Lake	52.29000	-105.14000	Waterfowl		
SK	Deep Lake (7S Indian Head)	50.42000	-103.68000	Waterfowl		
SK	Deep Lake (8S 12W Cumberland)	53.84000	-102.55000	Waterfowl		
SK	Delaronde Lake	53.93000	-106.95000	Waterfowl		
SK	Dewar Lake	51.61000	-109.62000	Waterfowl		
SK	Dickson Lake	52.83300	-105.30000	Waterfowl		
SK	Downie Lake	49.80000	-109.68000	Waterfowl		
SK	Drake Lake	52.44000	-109.93000	Waterfowl		
SK	Duck Lake	52.80000	-106.27000	Waterfowl		
SK	Dumbell Lake	53.97000	-102.71700	Waterfowl		
SK	Ear Lake	52.29000	-109.21000	Waterfowl		
SK	East Coteau Lake	49.04000	-104.40000	Waterfowl		
SK	Echo Lake (1 N Fort Qu'Appelle)	50.79000	-103.84000	Waterfowl		
SK	Edward Lake	53.66000	-107.74000	Waterfowl		
SK	Egg Lake (10 E Edenwold)	50.63000	-104.00000	Waterfowl		11 E (small wetland)
SK	Egg Lake (4S 2W Cumberland)	53.88000	-102.32000	Waterfowl	DUC Project	
SK	Eins Lake	52.05000	-108.52000	Waterfowl		
SK	Ekapo Lake	50.29000	-102.55000	Waterfowl		
SK	Elm Lake	53.74000	-101.89000	Waterfowl		
SK	Emma Lake	53.58000	-105.89000	Waterfowl		
SK	End Lake	52.36000	-109.20000	Waterfowl		
SK	Englishman Lake	53.40000	-109.19000	Waterfowl		
SK	Fife Lake	49.22000	-105.87000	Waterfowl		
SK	Fire Lake	52.45000	-109.40000	Waterfowl		
SK	Fishing Lake	51.83000	-103.52000	Waterfowl	Indian Reserve	
SK	Forgan Flats	51.28000	-107.73000	Waterfowl		
SK	Frederick Lake	50.03000	-105.79000	Waterfowl		
SK	Fulton Lake	51.75000	-102.42000	Waterfowl		
SK	Galletly Lake	53.92000	-109.63000	Waterfowl		
SK	George Williams Lake	52.45000	-103.93000	Waterfowl		
SK	Gillies Lake	52.83000	-106.85000	Waterfowl		

SK	Good Spirit Lake	51.54000	-102.66000	Waterfowl	Provincial Park	
SK	Goose Lake (2S 2E Tessier)	51.75000	-107.38000	Waterfowl		
SK	Goose Lake (25S 8W Cumberland)	53.61000	-102.50000	Waterfowl		
SK	Goose Lake (7E &7N Landis)	52.31000	-108.30000	Waterfowl		
SK	Gordon Lake	52.89000	-107.37000	Waterfowl		
SK	Greenstreet Lake	53.47000	-109.82000	Waterfowl		
SK	Greenwater Lake	52.52000	-103.50000	Waterfowl	Provincial Park	
SK	Grill Lake	52.20000	-109.12000	Waterfowl	DUC Project	
SK	Halkett Lake	53.65000	-106.10000	Waterfowl		
SK	Hanging Heart Lake	53.98000	-106.21700	Waterfowl		
SK	Harper Lake	53.58000	-104.92000	Waterfowl		
SK	Hay Bay Lake	53.92000	-106.99000	Waterfowl		
SK	Hay Lake	49.94000	-109.37000	Waterfowl		
SK	Helene Lake	53.53000	-108.21000	Waterfowl		
SK	Helldiver Lake	53.59000	-101.93000	Waterfowl	DUC Project	
SK	Heritage Lake			Waterfowl		Unk Loc
SK	Hewitt Lake	49.76000	-102.34000	Waterfowl		
SK	Highbank Lake	53.87000	-102.44000	Waterfowl		
SK	Highfield Reservoir	50.30000	-107.39000	Waterfowl		
SK	Hill Island Lake	53.96000	-103.03300	Waterfowl	DUC Project	
SK	Hines Lake	53.41000	-106.97000	Waterfowl		
SK	Horsehide Lake	52.75000	-103.40000	Waterfowl	DUC Project	
SK	Horseshoe Lake	51.48000	-102.61000	Waterfowl		
SK	Houghton Lake	52.37000	-105.14000	Waterfowl		
SK	Humboldt Lake	52.15000	-105.12000	Waterfowl		
SK	Hunting Lake	53.97000	-108.27000	Waterfowl		
SK	Ibsen Lake	49.79000	-104.25000	Waterfowl		
SK	Indi Lake	51.69000	-106.52000	Waterfowl	DUC Project	
SK	Iroquois Lake	53.17000	-107.02000	Waterfowl		
SK	Island Lake	53.97000	-107.73000	Waterfowl		or 49.13, -108.22
SK	Ispuchaw Lake	54.00000	-104.70000	Waterfowl		
SK	Jackfish Lake	53.07000	-108.40000	Waterfowl	DUC Project	
SK	Jansen Lake	51.91000	-104.76000	Waterfowl		
SK	Jim Creek Lake	49.08000	-104.63000	Waterfowl		
SK	Jumping Lake	52.86000	-105.46000	Waterfowl		
SK	Junction Lake	53.82000	-102.43000	Waterfowl		
SK	Junction Reservoir	49.94000	-109.50000	Waterfowl		
SK	Katepwa Lake	50.71000	-103.64000	Waterfowl		
SK	Keg Lake	53.62000	-107.03000	Waterfowl		
SK	Kennedy Lake	53.60000	-102.94000	Waterfowl		
SK	Kenosee Lake	49.82000	-102.30000	Waterfowl	Provincial Park	
SK	Keppel Lake	52.40000	-108.34000	Waterfowl		
SK	Ketchamonia Lake	51.75000	-101.68000	Waterfowl		

SK	Kettlehut Lake	50.66000	-106.51000	Waterfowl		
SK	Kimoff Lake	52.26000	-108.19000	Waterfowl		
SK	Kipabiskau Lake	52.57000	-104.18000	Waterfowl		
SK	Kitako Lake	52.46000	-104.21000	Waterfowl	DUC Project	
SK	Kiyiu Lake	51.60000	-108.90000	Waterfowl		
SK	Klogei Lake	52.31000	-103.32000	Waterfowl		
SK	Lac Huard Lake	53.76000	-107.61000	Waterfowl		
SK	Lac Pelletier	49.98000	-107.93000	Waterfowl		
SK	Ladder Lake	53.82000	-106.98000	Waterfowl		
SK	Lake of the Prairies	51.29000	-101.57000	Waterfowl		
SK	Lake of the Rivers	49.81000	-105.73000	Waterfowl		
SK	Leaf Lake	53.02000	-102.14000	Waterfowl		
SK	Leech Lake	51.07000	-102.48000	Waterfowl		
SK	Little Egg Lake	53.90000	-102.27000	Waterfowl		
SK	Little Fishing Lake	53.86000	-109.55000	Waterfowl		
SK	Little Manitou Lake	51.73000	-105.48000	Waterfowl		
SK	Little Manitou Lake	52.62000	-109.63000	Waterfowl		
SK	Little Nut Lake	52.32000	-103.51000	Waterfowl	DUC Project	
SK	Little Pelican Lake	53.76700	-107.75000	Waterfowl		
SK	Little Whitefish Lake	53.58000	-107.11000	Waterfowl		
SK	Lobstick Lake	53.66000	-102.12000	Waterfowl		
SK	Loch Lomond	51.98000	-102.74000	Waterfowl		
SK	Lonetree Lake	50.49000	-106.94000	Waterfowl		or 49.01, -104.51
SK	MacDonnell Lake	54.00000	-105.25000	Waterfowl		
SK	MacLeod Lake	53.41000	-108.27000	Waterfowl		
SK	Maiden Lake	53.44000	-108.45000	Waterfowl		
SK	Maidstone Lake	53.02000	-109.29000	Waterfowl		
SK	Mann Lake	52.28000	-102.74000	Waterfowl		
SK	Many Island Lake	50.11000	-109.99000	Waterfowl		
SK	Marean Lake	52.52000	-103.58000	Waterfowl		
SK	Marshall Lake			Waterfowl		Unk Loc
SK	Maskwa Lake	52.96000	-109.19000	Waterfowl		
SK	McAurthur Lake	52.56700	-104.40000	Waterfowl	DUC Project	
SK	McBride Lake	52.45000	-102.41000	Waterfowl		
SK	McConechy Lake	53.79000	-105.67000	Waterfowl		
SK	McGregor Lakes	53.83000	-102.10000	Waterfowl		
SK	McIntyre Lake	52.54000	-105.34000	Waterfowl		
SK	McLean Lake			Waterfowl		Unk Loc
SK	Meadow Lake	54.11000	-108.34000	Waterfowl		
SK	Meeting Lake	53.19000	-107.67000	Waterfowl		
SK	Middle Creek Reservoir	49.40000	-110.00000	Waterfowl		
SK	Midnight Lake	53.51000	-108.32000	Waterfowl		
SK	Mikinak Lake	53.72000	-108.54000	Waterfowl		
SK	Miller Lake	53.49000	-108.97000	Waterfowl		

SK	Ministikwan Lake	54.01000	-109.65000	Waterfowl		
SK	Mission Lake	50.75000	-103.71000	Waterfowl		
SK	Mistawasis Lake	53.09000	-107.24000	Waterfowl		
SK	Mizhashk Lake	52.51000	-104.17000	Waterfowl	DUC Project	
SK	Montague Lake	49.48000	-105.82000	Waterfowl		
SK	Moose Mountain Lake	49.91000	-103.08000	Waterfowl		
SK	Moosomin Lake	50.08000	-101.71000	Waterfowl		
SK	Morin Lake	53.50000	-107.06700	Waterfowl		
SK	Mud Lake	51.92000	-104.21000	Waterfowl	DUC Project	
SK	Murray Lake	53.04000	-108.30000	Waterfowl		
SK	Muskiki Lake	52.34000	-105.72000	Waterfowl		
SK	Namekus Lake	53.83000	-106.02000	Waterfowl		
SK	Neely Lake	52.72000	-102.81000	Waterfowl		
SK	Nesslin Lake	53.95000	-106.78000	Waterfowl		
SK	Newton Lake	49.32000	-107.83000	Waterfowl		
SK	Nikik Lake	52.66700	-104.33300	Waterfowl		
SK	Niska Lake	53.56000	-101.88000	Waterfowl		
SK	No Name (1 E Stalwart)	51.23000	-105.40000	Waterfowl		
SK	No Name (1 N & 1 W Blucher)	52.02000	-106.23000	Waterfowl		
SK	No Name (1 N & 4 W Thrasher)	51.42000	-108.09000	Waterfowl		
SK	No Name (1 N Druid)	51.81000	-108.77000	Waterfowl		
SK	No Name (1 N Lac Vert)	52.51000	-104.50000	Waterfowl		
SK	No Name (1 N Prelate)	50.87000	-109.40000	Waterfowl		
SK	No Name (1 N Thrasher)	51.40000	-108.03000	Waterfowl		
SK	No Name (1 S Meacham)	52.09000	-105.75000	Waterfowl		
SK	No Name (1 S Smiley)	51.62000	-109.49000	Waterfowl		
SK	No Name (1 W & 1 S Marcelin)	52.90000	-106.82000	Waterfowl		
SK	No Name (1 W Marcelin)	52.93000	-106.83000	Waterfowl		
SK	No Name (10 E & 15 N Onion Lake)	53.92000	-109.76000	Waterfowl		
SK	No Name (10 E & 5 N Middle Lake)	52.55000	-105.07000	Waterfowl		
SK	No Name (10 N & 2 E Debden)	53.67000	-106.84000	Waterfowl		
SK	No Name (10 N & 3 E Assiniboia)	49.78000	-105.87000	Waterfowl		
SK	No Name (10 W & 4 N Gravelbourg)	49.92000	-106.78000	Waterfowl		
SK	No Name (10 W Loomis)	49.21000	-108.99000	Waterfowl		
SK	No Name (10N, 2E Sturgeon Valley)	53.53000	-106.14000	Waterfowl		
SK	No Name (11 E Sturgis)	51.94000	-102.26000	Waterfowl		Stanley Lake
SK	No Name (11 N & 5 W Tompkins)	50.22000	-108.94000	Waterfowl		
SK	No Name (11 S Plenty)	51.59000	-108.64000	Waterfowl		

SK	No Name (12 S & 1 E Yorkton)	51.05000	-102.44000	Waterfowl		
SK	No Name (12 W Limerick)	49.67000	-106.56000	Waterfowl		
SK	No Name (12 W Nokomis)	51.49000	-105.29000	Waterfowl		
SK	No Name (13 W & 1 N Kerrobert)	51.95000	-109.46000	Waterfowl		
SK	No Name (15 E Gravelbourg)	49.88000	-106.18000	Waterfowl		
SK	No Name (15 N Onion Lake)	53.94000	-109.97000	Waterfowl		
SK	No Name (18S, 7E Cumberland House)	53.61700	-102.04000	Waterfowl		
SK	No Name (1S &2 W Eatonia)	51.21000	-109.46000	Waterfowl		
SK	No Name (2 E Laura)	51.85000	-107.22000	Waterfowl		
SK	No Name (2 E Thresher)	51.36000	-107.94000	Waterfowl		
SK	No Name (2 N & 1 W Brock)	51.49000	-108.78000	Waterfowl		
SK	No Name (2 N & 1 W Chagoness)	52.67000	-104.27000	Waterfowl		
SK	No Name (2 N & 3 W Coleville)	51.74000	-109.35000	Waterfowl		
SK	No Name (2 N & 4 E Surprise)	50.30000	-109.89000	Waterfowl		
SK	No Name (2 N Cabri)	50.64000	-108.46000	Waterfowl		
SK	No Name (2 N Unity)	52.48000	-109.18000	Waterfowl		
SK	No Name (2 S & 2 W Spalding)	52.26000	-104.56000	Waterfowl		
SK	No Name (2 S & 4 E Langbank)	50.02000	-102.19000	Waterfowl		
SK	No Name (2 S Mantario)	51.24000	-109.69000	Waterfowl		
SK	No Name (2 S Wilkie)	52.38000	-108.67000	Waterfowl		Flat Lake
SK	No Name (2 W Limerick)	49.65000	-106.33000	Waterfowl		
SK	No Name (23 E & 15 N Onion Lake)	53.96000	-109.45000	Waterfowl		
SK	No Name (25 N & 3 W St. Walburg)	53.99000	-109.28000	Waterfowl		
SK	No Name (28 N & 4 W Shell Lake)	53.71000	-107.20000	Waterfowl		
SK	No Name (29 S Fox Valley)	50.06000	-109.46000	Waterfowl		
SK	No Name (3 E & 5 N Broderick)	51.57000	-106.84000	Waterfowl		
SK	No Name (3 N & 1 W Sceptre)	50.89000	-109.29000	Waterfowl		
SK	No Name (3 N Mantario)	51.32000	-109.71000	Waterfowl		
SK	No Name (3 S & 1 W Landis)	52.16000	-108.49000	Waterfowl		
SK	No Name (3 S & 2 E Major)	51.82000	-109.59000	Waterfowl		
SK	No Name (3 S & 5 E Hazlet)	50.35000	-108.45000	Waterfowl		
SK	No Name (3 S Margo)	51.77000	-103.35000	Waterfowl		
SK	No Name (3 W Tompkins)	50.06000	-108.91000	Waterfowl		5 W of Tompkins
SK	No Name (4 E & 2 N Liberty)	51.17000	-105.35000	Waterfowl		Bay off of Last Mtn. Lake
SK	No Name (4 N & 4 W Marengo)	51.55000	-109.84000	Waterfowl		4 N & 3 W of Marengo
SK	No Name (4 N & 5 W Ogema)	49.64000	-105.03000	Waterfowl		

SK	No Name (4 N & 8 W Mantario)	51.34000	-109.87000	Waterfowl		
SK	No Name (4 S & 1 E Onion Lake)	53.64000	-109.92000	Waterfowl		5 S & 1 E of Onion Lake
SK	No Name (4 S & 2E Aberdeen)	52.28000	-106.25000	Waterfowl		
SK	No Name (4 S & 3 E Robstart)	49.30000	-109.20000	Waterfowl		
SK	No Name (4 S & 4 E Golden Prairie)	50.17000	-109.52000	Waterfowl		
SK	No Name (4 S & 4 E Mantario)	51.20000	-109.62000	Waterfowl		
SK	No Name (4 S & 6 E Macklin)	52.27000	-109.81000	Waterfowl		
SK	No Name (4 S Loomis)	49.14000	-108.74000	Waterfowl		
SK	No Name (4 W & 1 S Tompkins)	50.06000	-108.91000	Waterfowl		5 W & 1 S Tompkins
SK	No Name (4 W Marengo)	51.46000	-109.86000	Waterfowl		4 W & 1 S Marengo
SK	No Name (5 E Golden Prairie)	50.22000	-109.52000	Waterfowl		5 E & 3 S Golden Prairie
SK	No Name (5 E Luseland)	52.08000	-109.28000	Waterfowl		
SK	No Name (5 N Anglia)	51.63000	-108.19000	Waterfowl		small wetland
SK	No Name (5 N Cabri)	50.71000	-108.44000	Waterfowl		
SK	No Name (5 S & 10 E Limerick)	49.59000	-106.02000	Waterfowl		
SK	No Name (5 S & 2 W Saint Front)	52.30000	-104.20000	Waterfowl		
SK	No Name (5 S Rose Valley)	52.21000	-103.83000	Waterfowl		1 W Fosston
SK	No Name (5mi N Stoughton)	49.75000	-103.00000	Waterfowl		
SK	No Name (6 E & 1 S Biggar)	52.03000	-107.84000	Waterfowl		
SK	No Name (6 N & 2 W Bengough)	49.50000	-105.18000	Waterfowl		
SK	No Name (6 N & 3 W Perdue)	52.15000	-107.65000	Waterfowl		
SK	No Name (6 S & 3 W Leader)	50.80000	-109.61000	Waterfowl		
SK	No Name (6 S & 7 W Kerrobert)	51.83000	-109.34000	Waterfowl		5 S & 9 W Kerrobert
SK	No Name (6 W & 2 N Limerick)	49.68000	-106.41000	Waterfowl		
SK	No Name (6 W Howard)			Waterfowl		Unk Loc: Howard, SK?
SK	No Name (6 W St. Benedict)	52.58000	-105.55000	Waterfowl		
SK	No Name (6S, 4E Cumberland House)	53.86700	-102.16700	Waterfowl		
SK	No Name (7 E & 1 N Luseland)	52.08000	-109.28000	Waterfowl		7 E Luseland
SK	No Name (7 E & 5 S Meacham)	52.03000	-105.58000	Waterfowl		
SK	No Name (7 N & 15W Major)	51.99000	-109.97000	Waterfowl		
SK	No Name (7 S & 2 E Saint Front)	52.27000	-104.13000	Waterfowl		
SK	No Name (7 S D'Arcy)	51.34000	-108.54000	Waterfowl		
SK	No Name (7 S Handsworth)	49.76000	-102.97000	Waterfowl		6 S Handsworth
SK	No Name (7 S Kindersley)	51.38000	-109.19000	Waterfowl		

SK	No Name (7 s Macklin)	52.23000	-109.93000	Waterfowl		
SK	No Name (7 S Saint Front)	52.27000	-104.16000	Waterfowl		
SK	No Name (7 W & 1 S Wakaw)	52.63000	-105.89000	Waterfowl		
SK	No Name (7 W Pleasantdale)	52.57000	-104.68000	Waterfowl		
SK	No Name (7 W Wakaw)	52.66000	-105.89000	Waterfowl		
SK	No Name (8 N Hazenmore)	49.79000	-107.14000	Waterfowl		6 N Hazenmore
SK	No Name (8 N Ruddell)	52.73000	-107.86000	Waterfowl		
SK	No Name (8 S & 3 W St. Walburg)	53.51000	-109.27000	Waterfowl		
SK	No Name (8 S Kindersley)	51.34000	-109.22000	Waterfowl		9 S Kindersley
SK	No Name (8 W Mantario)	51.27000	-109.87000	Waterfowl		
SK	No Name (9 N & 2 W Maymont)	52.69000	-107.77000	Waterfowl		
SK	No Name (9 S & 1 E Govan)	51.19000	-104.95000	Waterfowl		
SK	No Name (9 S Macklin)	52.17000	-109.95000	Waterfowl		10 S Macklin
SK	Nut Lake	52.36000	-103.71000	Waterfowl		
SK	Okemasis Lake	52.90000	-106.28000	Waterfowl		
SK	Onion Lake	53.71000	-109.89000	Waterfowl	DUC Project	
SK	Oscar Lake	53.62000	-105.85000	Waterfowl		
SK	Osimisk Lake	53.97000	-106.85000	Waterfowl		
SK	Overflow Lake	53.16000	-102.49000	Waterfowl		
SK	Paddling Lake (5W 1S Leask)	53.00000	-106.89000	Waterfowl		
SK	Paddling Lake (9N 1W Blaine Lake)	52.96000	-106.91700	Waterfowl		
SK	Patience Lake	52.13000	-106.33000	Waterfowl		
SK	Patoto Lake	53.69000	-102.11000	Waterfowl		
SK	Paysen Lake	50.71000	-106.74000	Waterfowl		
SK	Peck Lake	53.89000	-109.59000	Waterfowl		
SK	Pelican Lake (1E Domremy)	52.78000	-105.70000	Waterfowl		
SK	Petabec Lake	53.71700	-102.20800	Waterfowl		
SK	Pike Lake	51.89000	-106.80000	Waterfowl		
SK	Pingwi Lake	52.66000	-104.28300	Waterfowl		
SK	Piwei Lake	52.49000	-103.47000	Waterfowl		
SK	Ponass Lake	52.27000	-104.01000	Waterfowl	DUC Project	
SK	Proctor Lake	51.71000	-106.64000	Waterfowl	DUC Project	
SK	Rabbit Lake	52.61000	-107.00000	Waterfowl		
SK	Radisson Lake	52.49000	-107.41000	Waterfowl		
SK	Ranch Lake	52.49000	-104.77000	Waterfowl		
SK	Rat Lake	53.73300	-102.23300	Waterfowl		
SK	Raven Lake	52.21000	-103.27000	Waterfowl		
SK	Redearth Lake	53.52000	-102.88000	Waterfowl		
SK	Reid Lake Reservoir	50.03000	-108.12000	Waterfowl		
SK	Round Lake (14N 4W Whitewood)	50.54000	-102.39000	Waterfowl	Indian Reserve	

SK	Round Lake (2S 2E Kinlach)	52.36000	-103.40000	Waterfowl		
SK	Rousay Lake	52.16700	-102.55000	Waterfowl	DUC Project	
SK	Royal Lake	53.08000	-106.88000	Waterfowl		
SK	Ruby Lake	52.97000	-102.35000	Waterfowl		
SK	Rush Lake	53.07000	-109.07000	Waterfowl		
SK	Russell Lake	53.23000	-108.21000	Waterfowl		
SK	Sakwasew Lake	51.86000	-103.39000	Waterfowl		
SK	Saline Lake	51.79000	-103.20000	Waterfowl		
SK	Salt Lake	49.28000	-104.70000	Waterfowl		
SK	Scentgrass Lake	52.96000	-108.18000	Waterfowl	DUC Project	
SK	Seagram Lakes	52.61000	-109.40000	Waterfowl	DUC Project	
SK	Seagram Lakes	52.59000	-109.33000	Waterfowl	DUC Project	
SK	Shallow Lake (6S 6E Assiniboia)	49.52000	-105.83000	Waterfowl		
SK	Shallow Lake (6W 3N Kerrobert)	51.99000	-109.29000	Waterfowl		
SK	Shell Lake	53.22000	-107.16000	Waterfowl		
SK	Shoal Lake	53.48000	-102.71700	Waterfowl		
SK	Shoe Lake	49.73000	-105.35000	Waterfowl		
SK	Sidney Lake	53.77000	-109.61000	Waterfowl		
SK	Silver Lake	51.68000	-103.23000	Waterfowl	DUC Project	
SK	Snakehole Lake	50.51000	-108.47000	Waterfowl		
SK	Snipe Lake	51.23000	-108.86000	Waterfowl		
SK	Soda Lake	53.00000	-109.32000	Waterfowl		
SK	Spence Lake			Waterfowl		Unk Loc
SK	Spruce Lake	53.56000	-109.09000	Waterfowl		
SK	Stink Lake	51.05000	-107.36000	Waterfowl		
SK	Stinking Lake	52.44000	-104.66700	Waterfowl		
SK	Stockwell Lake	51.36000	-107.17000	Waterfowl		
SK	Stone Wall Lake	51.78000	-103.15000	Waterfowl		
SK	Stony Lake	53.48000	-108.54000	Waterfowl		
SK	Strawberry Lake (5N 1E Odessa)	50.36000	-103.77000	Waterfowl		
SK	Strawberry Lakes (5N 3E Odessa)	50.35000	-103.70000	Waterfowl		
SK	Street Lake	51.86000	-109.36000	Waterfowl		
SK	Sturgeon Lake	53.42000	-106.04000	Waterfowl		
SK	Sylvander Lake	53.46000	-107.67000	Waterfowl		
SK	Taits Lake	49.16000	-108.76000	Waterfowl		
SK	Tatagwa Lake	49.62000	-104.01000	Waterfowl		
SK	Tenaille Lake	50.10800	-109.50000	Waterfowl		
SK	Teo Lakes	51.54000	-109.34000	Waterfowl		
SK	Teo Lakes	51.59000	-109.41000	Waterfowl		
SK	Teo Lakes	51.62000	-109.43000	Waterfowl		

SK	Teo Lakes	51.59000	-109.38000	Waterfowl		
SK	Thackeray Lake	52.54000	-108.69000	Waterfowl		
SK	Thomson Lake	49.77000	-106.60000	Waterfowl		
SK	Tobin Lake	53.59000	-103.47000	Waterfowl		
SK	Torch Lake	53.71000	-105.27000	Waterfowl		
SK	Tramping Lake	52.00000	-108.79000	Waterfowl		
SK	Trappers Lake	53.79200	-106.03300	Waterfowl		
SK	Turnberry Lake	53.60000	-101.77000	Waterfowl		
SK	Turtle Lake	53.59000	-108.64000	Waterfowl		
SK	Twelve Mile Lake	49.48000	-106.22000	Waterfowl		
SK	Usinneskaw Lake	51.79000	-103.36000	Waterfowl		
SK	Vanscoy Lake	52.08000	-107.55000	Waterfowl		
SK	Wakaw Lake	52.67000	-105.60000	Waterfowl		
SK	Waldsea Lake	52.28000	-105.20000	Waterfowl		
SK	Wapisew Lake	53.77000	-102.46000	Waterfowl		
SK	Waskesiu Lake	53.94000	-106.16000	Waterfowl		
SK	Waterhen Lake	53.89000	-102.41000	Waterfowl	DUC Project	
SK	Waterhen Marsh	52.84000	-105.04000	Waterfowl	DUC Project	
SK	West Coteau Lake	49.04000	-104.53000	Waterfowl		
SK	White Gull Lake	53.92000	-105.08000	Waterfowl		
SK	White Heron Lake	51.90000	-109.06000	Waterfowl	DUC Project	
SK	Whitebear Lake (5S Elrose)	51.06000	-108.08000	Waterfowl		
SK	Whitebear Lake (9N Carlyle)	49.78000	-102.26000	Waterfowl	Indian Reserve	
SK	Whitehorse Lake			Waterfowl		Unk Loc: possibly Whiteshore Lake 52.12, -108.29
SK	Whitepond Lake			Waterfowl		Unk Loc
SK	Williams Lake			Waterfowl		Unk Loc
SK	Windy Lake	52.31000	-103.11000	Waterfowl		
SK	Winniford Lake	52.69000	-108.38000	Waterfowl		
SK	Winter Lake	53.71000	-106.89000	Waterfowl		
SK	Witchekan Lake	53.43000	-107.58000	Waterfowl		
SK	Wolverine Lake	52.01000	-105.23000	Waterfowl		
SK	Worthington Lake	53.95000	-109.61000	Waterfowl		
SK	York Lake	51.16000	-102.49000	Waterfowl		
SK	Zella Lake	51.97000	-109.23000	Waterfowl		
SK	Zelma Reservoir	51.83000	-105.84000	Waterfowl		
SK	Zoller Lake	52.35000	-109.61000	Waterfowl		
SK	Kutawagan Lake	51.61000	-104.71000	Waterbirds, Shorebirds	IBA; PFRA controlled access	
AB	Antoine Lake	54.77000	-112.08000	Waterbirds		
AB	Cooking Lake	53.42000	-113.04000	Waterbirds		
AB	Dalemead Lake	50.92000	-113.62000	Waterbirds		
AB	Hastings Lake	53.42000	-112.92000	Waterbirds		
AB	Lac La Biche	54.84000	-111.97000	Waterbirds	IBA	

AB	Lac Ste. Anne	53.70000	-114.40000	Waterbirds		
AB	Lesser Slave Lake	55.46000	-115.35000	Waterbirds	IBA	
AB	McGregor Lake	50.49000	-112.87000	Waterbirds	IBA	
AB	Miquelon Lake	53.25000	-112.93000	Waterbirds	IBA	
AB	Moose Lake	54.25000	-110.91000	Waterbirds		
AB	Muriel Lake	54.15000	-110.69000	Waterbirds	IBA	
AB	Portage Lake	54.96000	-112.05000	Waterbirds		
AB	Therien Lakes	53.96000	-111.33000	Waterbirds		
MB	Douglas Marsh	49.85000	-99.65000	Waterbirds	IBA	
MB	Clandeboye Bay, Lake Manitoba	50.23000	-98.10000	Waterbirds		
MB	Duck and Sand Reef Island, Lake Manitoba	50.86000	-98.56000	Waterbirds	IBA	
MB	Sandy Bay, Lake Manitoba	50.52000	-98.63000	Waterbirds	IBA	
SK	Galloway Bay, Lake Diefenbaker	50.78000	-108.45000	Waterbirds	IBA	
SK	Southey Area	50.93000	-104.50000	Waterbirds		
AB	Cipher Lake	52.68000	-110.08000	Shorebirds		
AB	Gillespie Lake	52.33000	-110.18000	Shorebirds		
AB	Killarney lake	52.61000	-110.15000	Shorebirds	IBA	
AB	Leane Lake	52.57000	-110.07000	Shorebirds	IBA	
AB	Reflex Lake (Salt Lake)	52.67000	-110.00000	Shorebirds		
AB	Metiskow Lake	52.44000	-110.65000	Shorebirds		
AB	Sounding lake	52.16000	-110.47000	Shorebirds	IBA	
AB	Baxter Lake	52.92000	-110.73000	Shorebirds		
MB	Gull Bay, Lake Winnipeg	52.88000	-98.94000	Shorebirds	IBA	
SK	Lake Diefenbaker	50.72000	-107.50000	Shorebirds		
SK	Burke Lake	52.17000	-106.30000	Shorebirds	potential WHSRN site	
SK	Coteau Lakes	49.05000	-104.48000	Shorebirds	IBA	

Heritage Marsh: Under the Heritage Marsh Program (SK, MB), Government and private conservation groups work together to purchase or designate land as a Heritage Marsh and provide funds to maintain and enhance these marshes. Levels of protection vary.
Wetlands for Tomorrow: The equivalent of the Heritage Marsh Program in Alberta. Levels of protection vary.
Important Bird Areas (IBA): An Important Bird Area (IBA) is a site providing essential habitat for one or more species of breeding or non-breeding birds. These sites may contain threatened species, endemic species, species representative of a biome, or highly exceptional concentrations of birds. One of the main goals of the IBA program is to ensure the conservation of sites through the development and implementation of conservation plans in partnership with local stakeholders for priority IBAs. These stakeholders include landowners, naturalists, hunters, government agencies and municipalities, aboriginal groups, scientists, etc. Protection is not inherent with this designation.
Migratory Bird Sanctuary: Migratory Bird Sanctuary Regulations prohibit disturbance of migratory birds, their eggs, and their nests within an MBS. The regulations also prohibit disturbance of migratory birds' habitat when MBSs are established on federal Crown land. Management includes monitoring wildlife, maintaining and improving wildlife habitat, periodic inspections, enforcement of hunting prohibitions and regulations, and the maintenance of signs. Research is

also an important function of the protected areas; CWS staff carry out and coordinate research at some sites.

Western Hemisphere Shorebird Reserve Network (WHSRN): The objective of WHSRN is to identify and designate a chain of hemispheric, international, and regional sites of critical importance to shorebirds. These sites allow shorebirds to complete their annual migrations with each site providing the resources needed by the birds to enable them to reach the next area or to survive. For conservation to be successful, all the links in the chain need to be preserved, since removal of one vital area could disrupt the entire system. Protection is not inherent with this designation.

Ducks Unlimited Canada Project (DUC): Wetlands owned or managed in whole or in part by Ducks Unlimited Canada primarily for breeding or staging waterfowl. Water level control is often a feature. Levels of protection vary.

Ramsar: Ramsar is an international convention that seeks to ensure the sustainable, wise use of wetland resources including designation of wetland sites of international importance and to ensure that all wetland resources are conserved, now and in the future. Canada has worked closely with Mexico and the United States in a continental framework to promote the goals of the Ramsar Convention through the North American Waterfowl Management Plan and the actions of the Trilateral Committee on Wildlife Conservation and Ecosystem Management, including the recent establishment of a Trilateral Working Table on Wetlands. Protection is not inherent in this designation.

Appendix G. Method used to estimate the change in annual duck productivity resulting from PHJV 'Direct Program' acres.

The impact of PHJV direct program acres (i.e., acres secured through purchase or legal agreements) was estimated in each CCS by converting these lands into assumed pre-securement land uses as follows:

Existing PHJV Program Acres (i.e., present in 2001)	Converted to:
Planted Nesting Cover (DNC):	Spring-seeded cropland
Delayed Hay:	Regular hayland
Conversion to Hayland	95% to spring-seeded cropland, balance remained in hayland
Natural-Idle	50% assumed to remain Natural-Idle, 50% converted to Natural-Grazed
Natural-Grazed	No Change (+50% of above)
Woodland-Idle	50% assumed to remain Woodland-Idle, 50% converted to Woodland-Grazed
Woodland-Grazed	No Change (+50% of above)

Model runs on 2001 CCS landscapes with PHJV direct program acres were compared to a 2001 landscape with the above conversions. The difference in productivity reflects an estimate of the impact of PHJV direct program on waterfowl productivity.

This simulation does not account for extension or policy activities that potentially could affect substantial additional acres.

Appendix H. Estimating the Impact of a large-scale cropland conversion program on waterfowl production (modeled after the Greencover Canada program but not necessarily equivalent to it).

The impact of a large-scale cropland conversion program on annual waterfowl production for the years following delivery was estimated as follows:

- Estimated cost/acre for establishment: $45
- Dollars available for delivery in Prairie Canada: 0.7 X $100M = $70M
- Potential acres delivered: $70M/$45 = ~ 1.55 million acres
- Distribution among provinces (equal to the provincial proportion of the tilled acre pool for Prairies): 167,400 ac in MB, 987,350 ac in SK, 394,630 ac in AB
- Lyle Boychuk and Graham Thibault (Regina DU) estimated the eligible acres of 'marginal' cropland by CCS based on Saskatchewan and Manitoba crop insurance productivity ratings as per PFRA criteria (as per Greencover Canada…this information was only available for SK and MB). Converted acres were relatively apportioned among CCSs to sum to the above totals by province.
- We assumed 50% of the converted acres would be seeded for hayland and 50% for tame pasture.
- 2001 Landscape Input file for the Productivity Model was adjusted to account for the estimated cropland conversion in each CCS.

Model runs on 2001 CCS landscapes were compared to 2001 landscapes with the above conversions. The difference in productivity reflects an estimate of the impact of a large-scale cropland conversion program on waterfowl productivity.