Trends in Transitory Impacts on Wetland Margins in Prairie Canada (1986-1990)

By Marc Schuster

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Fulfillment of the Requirement for the Degree
Master of Natural Resource Management

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TRENDS IN TRANSITORY IMPACTS ON WETLAND MARGINS IN PRAIRIE CANADA (1986-1990)

A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of Master of Natural Resources Management.

By

Mr. Marc Schuster

ABSTRACT

This report is a description of the agricultural impacts on wetland margins in prairie Canada. The objectives of this study were to determine trends in transitory agricultural impacts to wetland margins in prairie Canada, and the relationship of these impacts to water permanence. Approximately 10,000 potential wetlands, within 65 transects, and associated impaction data were analyzed, per year, over a five year period.

Cultivation was found to be the most dominant agricultural impact to wetland margins, followed by grazing, haying, burning and clearing. Total impacts to wetland margins generally increased from Manitoba to Alberta. Impact rates were, for the most part, higher in grassland areas than in parkland areas. Overall, agricultural impacts tended to decrease with water permanence, except grazing and haying. The rate of agricultural impacts remained relatively constant over the study period.

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1.0 INTRODUCTION

1.1 PREAMBLE

The principle breeding habitats of many important waterfowl species in North America such as Mallard (Anas platyrhynchos), Northern Pintail (A. acuta), Blue-winged Teal (A. discors), and Canvasback (Aythya valisineria), are the shallow basin wetlands in the prairie pothole region of south-central Canada and north-central United States (Klett et al. 1988, Turner et al. 1987). These areas can produce a high number of waterfowl when ducks returning in the spring arrive to court, nest and rear broods (Hochbaum 1987, Talent et al. 1982).

The surrounding habitat of a wetland is important when assessing waterfowl breeding capability because sufficient cover is necessary for success of upland duck nests (Talent et al. 1982, Duebbert 1974). For example, Higgins (1977) determined that lack of natural cover resulted in ducks nesting in cultivated fields, causing nest losses due to farming activities. Grazing has also been shown to have a negative effect on nest success (Kirsch et al. 1978, Kirsch 1969). Furthermore, nests in remnants of natural cover are vulnerable to predators (Higgins 1977, Jones and Hungerford 1972, Martz 1967).

The wetland edge, or margin, in the prairie pothole region is a transition zone between farmland and wetland (Hochbaum and Caswell 1990, Hochbaum et al. 1988). Wetland margins tend to contain a diverse array of species, having organisms from the two zones they buffer, as well as species unique to the margin area (Hochbaum et al. 1988).

The pothole region of prairie Canada includes areas of high quality agricultural soils. Demand for increased agricultural production has led to intensive farming operations that have included cultivation of areas of low agricultural potential, such as wetlands. This alternate use of wetlands can affect waterfowl populations. Sugden and Beyersbergen (1984) found that present land use practices in the Saskatchewan parklands area lowers recruitment rates (the number of young added to the fall population by spring breeding adults) in local duck populations. For example, prior to the promotion of practices that impact wetlands, 40 percent of mallards successfully hatched clutches. At present, nest success rates across prairie Canada are less than 15 percent (Hochbaum et al. 1988, Greenwood et al. 1987), considered to be the minimum level necessary for mallard populations to be self-sustaining (Cowardin et al. 1985).

Talent et al. (1982) stressed the importance of the "wetland complex" in mallard brood rearing. The "wetland complex", as defined by Hubbard (1988) is an area that contains many basins with varying water levels and cover types in close proximity to one another. Agricultural practices have increasingly encroached upon these areas and wetland margins have been the most adversely affected in the prairie pothole region (Hochbaum et al. 1988, Turner et al. 1987). Loss of suitable nesting cover as well as increased predation are poor conditions for nest success. The amount of cover available to conceal nests is one of the more important variables that influence waterfowl production (Hochbaum et al. 1987).

The factors that make potholes so attractive to waterfowl, their small size and scattered distribution, also make them vulnerable to intensive agricultural pressures (Morgan 1985). These pressures may be influenced by several factors; including politics, economics, attitudes, climate, and government incentive programs (Leitch 1983).

1.2 ISSUE STATEMENT

Wetlands and their associated habitats have suffered impacts of varying degrees over the years. Waterfowl recruitment rates have been depressed in prairie Canada (Canadian Wildlife Service 1992) in part due to loss of nesting habitat in upland areas and at wetland edges, and associated nest depredation due to increased predator activity. In some areas, 57 percent of the wetland basins and approximately 74 percent of the margins have been negatively impacted (Turner et al. 1987).

Data on waterfowl habitat loss collected by government agencies were comprehensive, but few studies have been conducted on wetland margins. The information provided by this study can be important for the development waterfowl population management plans, and habitat management plans.

1.3 OBJECTIVES

This study examined data collected by waterfowl researchers in prairie Canada during the 1986 to 1990 period of the "Spring Breeding Population Surveys" administered by the Canadian Wildlife Service and United States Fish and Wildlife Service. The **primary objective** was to determine geographic and temporal trends of transitory impacts on wetland margins in Prairie Canada from 1986 to 1990.

Secondary objectives of this research included:

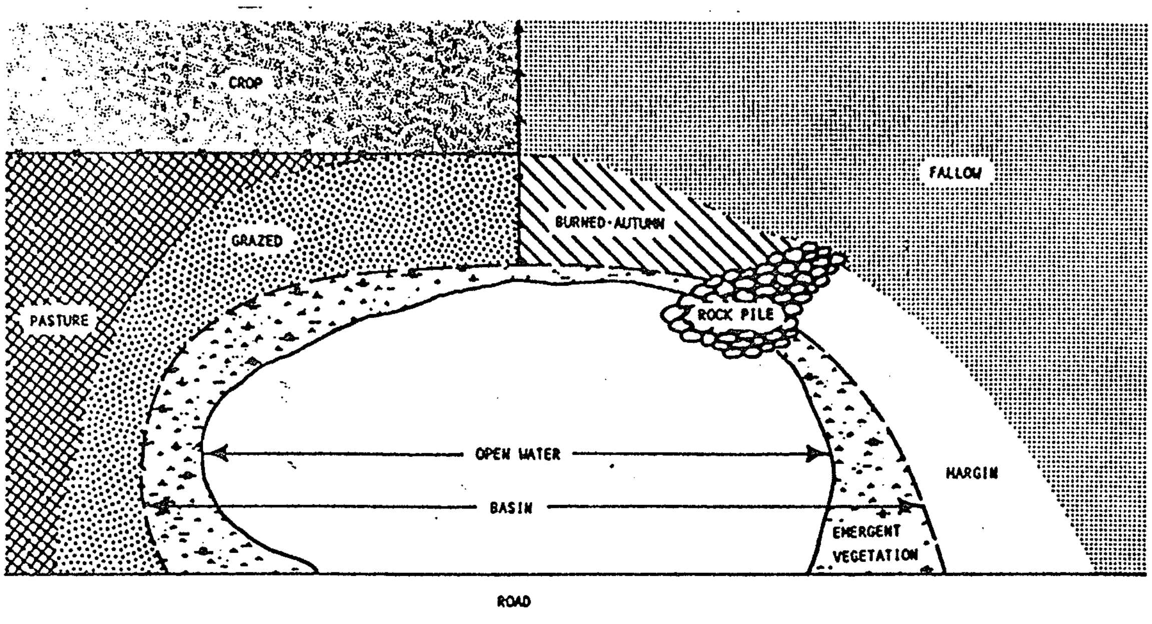
1) Determining the relationship of impacts to water permanence (ie. pond type, or depth).
2) Prioritizing impact types.
3) Exploring, with reference to the literature, reasons for observed differences, trends, and effects on waterfowl breeding habitat.
4) Recommending strategies for future management programs.

1.4 DEFINITION OF TERMS

For purposes of this study the wetland basin is defined as being that area from the centre of the wetland to the edge of the wet meadow zone (United States Fish and Wildlife Service and Canadian Wildlife Service 1987). Millar (1976) defined the wet meadow zone as being that area at the edge of the basin that has a predominate mixture of fine textured grasses, sedges and occasionally willow shrubs (Salix spp.). The margin is the area contiguous with the basin extending 10 metres outward, and the upland is that area beyond this (Figure 1.1).

Wetlands are classified based on a method described by Shaw and Fredine (1956). This classification system relies on water depth as a classification system and therefore dissimilar wetlands are sometimes classified as the same "type". The wetland classes, or types, are dry, temporary (Type I), seasonal (Type III), semi-permanent (Type IV), permanent (Type V), streams, and artificial impoundments. Type II wetlands are alkaline wet meadows and are not present in the study area.

Type I ponds, sometimes called temporary or ephemeral, refer to temporary water, sheet water, and wet depressions which can be expected to last less than three weeks after initial observation and have less than 15 cm of water depth. Type III, or seasonal, ponds refer to basins containing natural aquatics which normally are dry by midsummer but are



			IMPACTION (%)		
POND NO.	MARGIN WIDTH	POND TYPE	BASIN	MARGIN	UPLAND
1	8	4/5	5 F 20 I	20 C 50 G 20 BA	40 P 10 C 50 F

Figure 1.1: Schematic representation of wetland with associated impaction data.
Where: F = Filled (in the basin)
I = Impacted
C = Cultivated (in the margin)
G = Grazed
BA = Burned Autumn
P = Pasture
C = Crop (in the upland)
F = Fallow (in the upland)

Source: United States Fish and Wildlife Service and Canadian Wildlife Service, 1987.

expected to retain water for at least three weeks following the observation, which usually takes place in May. These wetlands normally have a uniform vegetative cover and contain at least 15 cm of water. Type IV, or semi-permanent, ponds have sufficient water depth that will likely last through the brood season but may become dry during late August or September. These wetlands usually contain water during at least 7 out of 10 years, and the vegetation is normally clumped covering all but the centre of the wetland.

Type V ponds are permanent deep marshes or lakes that have sufficient water to persist through the summer and fall. These wetlands normally are characterized by a peripheral rim of aquatic vegetation bordering an open body of water. Steams that meander through the transect are counted as separate water bodies each time they occur within the transect boundaries. Artificial water bodies may include dugouts, stock ponds, borrow pits, or anything that can hold water and is man-made.

Impacts are treated as either permanent or transitory and include such classifications as burning, haying, clearing, grazing, cultivating, filling or draining. Permanent impacts are those that impact the habitat in such a way that they are reversible only through active restoration and include draining and filling (Turner et al. 1987). Transitory impacts include cultivation, haying, grazing, burning and filling. These impacts affect wetland margins in such a way that the habitat would naturally recover if left undisturbed (Turner et al. 1987).

1.5 ASSUMPTIONS AND LIMITATIONS

This study assumes that the data recorded over the years is valid and provides an accurate representation. This study was limited to the analysis of wetland margins in prairie Canada and did not include the United States. Habitat conditions were not related to waterfowl recruitment rates, nor were effects on non-game species considered.

1.6 IMPORTANCE OF RESEARCH

Turner et al. (1987) studied the agricultural impacts on wetlands in prairie Canada. They stated that transitory impacts on wetland margins could have similar serious effects on waterfowl habitat as permanent impacts if allowed to persist for a long period of time, or if not managed properly. Transitory impacts can therefore become a limiting factor in waterfowl nest success.

Sugden and Beyersbergen (1984) reported that despite the impact of intensive farming on waterfowl habitat, little information was available on the extent of farming impacts in the most important duck-producing areas. Further, they state that habitat management programs require current information on the habitat available for upland nesting ducks, in order to make informed resource management decisions.

2.0 REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

The small shallow-basin wetlands of north-central United States and south-central Canada are among the most important duck producing areas of North America (Klett et al. 1988, Turner et al. 1987). The Prairie Pothole Region within this area is one of the more important places for waterfowl production as it produces close to 50 percent of the ducks but contains only 10 percent of the continental breeding range (Smith et al. 1964). The largest expanse of agricultural land in Canada is found in the prairie-parkland region (Turner and Caswell 1989). More than 80 percent of the high capability waterfowl production areas are located in south central Saskatchewan and adjacent parts of Manitoba and Alberta (Pierce 1981).

The fertile prairies of the Great Plains region of the United States and Canada have been highly modified by agriculture (Cowardin et al. 1985, Sugden and Beyersbergen 1984, Higgins 1977). More marginal areas of farmland have been brought into production, mainly because of economic pressure, lack of education, and legislative and institutional policies (Rakowski and Jurick 1986, Morgan 1985). This has had detrimental effects on wetlands and their associated habitat.

Nest success rate is a critical determinant for both duck production and the size of fall flight (Johnson et al.

1987, Cowardin and Johnson 1979). Although much of the native grassland in prairie Canada was converted to cropland long ago (Archibald and Wilson 1980, Kiel et al. 1972), loss of wetlands and duck nesting habitat has been severe and will probably continue in the future (Cowardin et al. 1985). For example, seasonal wetlands valuable for waterfowl production are threatened by agricultural drainage or modification from tillage (Duebbert and Frank 1984). The preservation and management of these wetlands must be emphasized. Boyd (1985) suggested that changes in marginal farming practices are one of the greatest threat to duck habitat, simply because the best farming areas have already been so extensively modified. Much of the native pasture that remains in Prairie Canada is in areas marginally suited to grain farming, and the loss of this habitat poses a great threat to continental duck populations. There are, however, some suggestions that human exploitation (eg. hunting) and other factors have exerted a greater negative factor on waterfowl populations than breeding habitat alteration and destruction (Trauger and Stoudt 1979, 1978).

Despite the impact intensive farming may have on waterfowl habitat, little information is available on the extent of farming in important duck-producing areas (Sugden and Beyersbergen 1984). The majority of previous studies of wetland degradation focused largely on drainage and other permanent impacts, and tended to ignore the more common transitory impacts that, if inflicted annually, are equivalent to being permanent (Turner et al. 1987). As Sugden and Beyersbergen (1984) suggest, habitat management programs need current information on the habitat available for upland nesting ducks. Knowledge of the amount and distribution of existing habitat will help direct programs and funds into areas and programs where greatest benefits can be derived.

Literature available that dealing exclusively with wetland margins is not abundant. Discussion will therefore focus on similar habitats and the effect on waterfowl nest success when impacts occur in these habitats.

2.2 WATERFOWL HABITAT REQUIREMENTS

The decline in recruitment rates and duck populations has been the result of a combination of factors including: drought, agricultural impactions to nest cover and lower nest success caused by predators (Johnson et al. 1989, Boyd 1985, Sugden and Beyersbergen 1984). There are also suggestions that the situation may have been complicated by liberal duck hunting regulations in North America, during the period of 1979 to 1984 (Caswell et al. 1987, Hochbaum et al. 1985). Further, during dry years some birds may be displaced further north or to the next best available habitat (Derksen and Eldridge 1980, Smith 1970, Hansen and McKnight 1964). To better understand how this study relates to breeding habitat, a brief discussion will follow on the major habitat requirements for nesting waterfowl.

2.2.1 Nest Site Selection

Several critical events occur in the life of prairie ducks in pothole habitat. Reproduction is the most important of these events, since all other events adjust to the timing and success of reproduction (Batt et al. 1989). The amount and type of cover is an important consideration in nest site selection. There are some basic requirements all duck species seek when selecting a suitable nesting site. For example, some requirements are water, food, sufficient cover and a loafing area (Sowls 1955, Hochbaum 1944). Access to plentiful food resources is particularly important following the loss of a nest, as the level of nesting activity is closely linked to food abundance. All of these factors become important to the female as she decides where to nest. In fact, Hammond (1964) stated that nesting will be delayed until conditions improve, or else nesting may fail altogether. Krapu (1981) noted that ducks will renest several times after a nest is destroyed as long as food is abundant, however, nesting efforts decrease as food supply deteriorates. Conversely, Griffith (1948) suggested that a lack of cover, not food, was more often the factor limiting nesting. Kaminski and Prince (1981) also found that there was no relationship between the abundance of mallard pairs and food.

Among the dabblers, mallards (Anas platyrhynchos) and gadwalls (A. strepera) prefer to nest in cover that is tall, dense, and which may be grassy herbaceous or brushy (Bellrose 1980). Blue-winged teal (A. discors), green-winged teal (A. crecca), northern shoveler (A. clypeata) and northern pintail (A. acuta) prefer to nest in grassy vegetation of short to medium height, although northern pintail accepts closely grazed prairie grasslands and grain stubble fields for nest sites (Bellrose 1980). Consequently, northern pintail are much more vulnerable to cultivation, than other species. Northern pintail that nest in these grazed areas would also be vulnerable to predation. Generally though, Clark (1988) found that cropland and short grass prairie tend to be avoided by dabbling ducks.

Nelson and Duebbert (1973), Jarvis and Harris (1971) and Duebbert (1969) demonstrated that large blocks of dense cover with residual herbaceous material close to wetlands attracted higher densities of nesting waterfowl. The presence of residual vegetation during spring and summer is an important factor in nest site selection for many species of waterfowl, upland game and non-game birds (Kirsch et al. 1978). It has been found that properly grazed mixed-grass prairie can provide adequate nesting habitat for dabbling ducks (Duebbert et al. 1986).

In addition to upland conditions, wetland type plays an important role in waterfowl ecology. Stewart and Kantrud (1973) determined that conditions were optimum for breeding dabbling ducks during years when a large number of seasonal (type III) ponds were present. They also state that semipermanent (type IV) and permanent (type V) ponds were the principle habitats for breeding diving ducks, but were also important to dabbling ducks during dry years. This is further supported by Kantrud and Stewart (1977), who show that densities of total ducks were highest on permanent wetlands, relatively high on semipermanent wetlands, moderate on temporary wetlands, low on undifferentiated tilled wetlands, and very low on ephemeral wetlands.

Of the two main groups of ducks, ephemeral and seasonally flooded wetlands have been found to receive high use by breeding dabbling ducks (Clark 1988, Swanson and Meyer 1977). If the first nesting is successful, shallow wetlands that receive high pair use in the spring, increase in importance. If unsuccessful, renesting birds are forced to lay clutches in June or early July, and wetlands that hold water for a longer period increase in importance to breeding females. This pattern of behaviour demonstrates how different agricultural impacts may come into play, depending on the type of wetland used, and the time at which it is used during the nesting season.

Divers are generally overwater nesters, so margin impacts may not be as much of a negative factor as with dabblers. In fact, divers seem to favour semi-permanent and permanent wetlands which are in turn, less likely to be impacted than seasonal wetlands (Hochbaum et al. in prep., Clark 1988, Bellrose 1980). Since divers are for the most part overwater nesters, they are less likely to be impacted by adverse agricultural activity than upland nesting ducks.

Seasonal wetlands also provide a source of protein-rich invertebrate foods for breeding hens. Swanson et al. (1986) and Krapu (1981, 1979, 1974) have demonstrated the physiological importance of diets high in invertebrates to nesting hens. The use of seasonal wetlands is attributed to the faster rate of warming in the spring, as opposed to semi-permanent and permanent wetlands, thereby causing invertebrates to be more readily available.

Krapu (1974) stated that a natural wetland complex in a nontilled state provides a long-term capability to maintain an adequate food base for breeding waterfowl. This is supported by Talent et al. (1982) who state that natural wetland complexes with a sizeable seasonal wetland component afford optimum brood-rearing habitat for Mallards. Owing to the complex territorial requirements of ducks, an abundance of different wetlands is needed to accommodate the different waterfowl species (Clark 1988, Mulhern et al. 1985, Duebbert and Frank 1984, Talent et al. 1982).

2.3 EFFECTS OF HABITAT LOSS

Habitat loss affects ducks in several ways. For example, the use of marginal land for agriculture may force ducks to nest in agricultural fields, resulting in high losses from farming activities (Higgins 1977). Furthermore, nests in the remnants of natural cover were found by Higgins (1977) to be vulnerable to predators. Good duck production from untilled, good quality upland habitats occurs frequently and consistently with good water conditions. Poor production is most often associated with drought or poor upland vegetative conditions. Intensity of land use and predation can also suppress production in these habitats (Hochbaum 1987, Boyd 1985). Adams and Gentle (1978) felt that the assurance of continued waterfowl production in the parkland is dependant on the area, distribution and condition of wetland margins. Dwyer (1970) showed that the characteristics of the land adjacent to potholes are important in attracting breeding waterfowl.

Losses of grassland, wetland, planted cover habitats, and wetland margins due to intensive farming practices may cause more ducks to nest in cropland and hayland where nests are exposed to increased risks by predation and farming operations.

2.3.1 Predation

Predation, both avian and mammalian, was the greatest cause of egg losses in most reported studies of duck production. The American crow (<u>Corvus brachyrhynchos</u>), which is generally recognized as an important avian predator of duck eggs (Johnson et al. 1989, Smith 1971, Stoudt 1971, Hammond 1940, Kalmbach 1937), becomes more successful as habitat is converted to cropland (Johnson et al. 1989, Smith 1971, Stoudt 1971, Kalmbach 1937). Hill (1984) found that concealment provided by tall, dense vegetation apparently reduced crow predation of duck nests. Dwernchuck and Boag (1972) showed that artificial nests on mammal-free islands had lower predation rates by gulls and crows when tall vegetation concealed the eggs from above. Concealment was most critical during the laying period when eggs were exposed and females were less attentive to nests (Hill 1984, Dwernchuck and Boag 1972). Favourable concealment due to dense cover could make searching difficult and cause crows to hunt elsewhere (Olton et al. 1981).

Sugden and Beyersbergen (1987) found that nest survival increased with cover height and density, and reached a maximum when the cover was about 70 centimetres in height. They postulated that tall, dense cover represents a behavioral deterrent as well as a physical barrier to crows hunting on foot. Their results indicated that where crow predation is severe, protection and enhancement of shrub cover would be a beneficial technique for increasing nest success of particular duck species.

Mammalian predators include red fox (Vulpes vulpes), mink (Mustela vison), striped skunk (Mephitis mephitis), raccoon (Procyon lotor), badger (Taxidea taxus) and Franklin's ground squirrel (Spermophilus franklinii) (Johnson et al. 1989, Sargeant and Arnold 1984, Balser et al. 1968, Reardon 1951). Of these, the red fox is probably the most serious predator on upland-nesting ducks in the Prairie Pothole region (Johnson et al. 1989, Sargeant and Arnold 1984, Sargeant et al. 1984, and Sargeant 1972). The Franklin's ground squirrel, however, did not figure significantly in a study conducted by Johnson et al. (1989), except in local situations.

Johnson et al. (1989) found that high plant productivity increases the abundance of alternative prey for the predators they considered. Thus predation rates on waterfowl nests tended to be lower in years and study areas with higher proportions of seasonal or semipermanent wetlands. In general, less nesting habitat allows predators to concentrate foraging efforts on the small patches of cover that are left for waterfowl to use.

2.3.2 Agricultural Impacts

Agricultural practices can have similar negative effects on waterfowl nest success as predation although they are sometimes less obvious. Available evidence suggests that present land-use practices in the pothole region will favour low recruitment rates in local duck populations (Hochbaum et al. 1988). Sugden and Beyersbergen (1984) found that the average percentage of annually tilled upland in Saskatchewan parklands was 82.7 percent, which indicates a high degree of intensive farming.

Land use practices that remove all or part of the vegetation on an annual basis would have an adverse effect on upland nesting birds. For example Sugden and Beyersbergen (1985) thought the overall success of duck nests would be higher in zero-tilled fields than in stubble fields that are annually cultivated. Rodgers (1983) felt that undercutting of wheat stubble saves a large number of duck nests, as well as permitting survival of flightless young and reducing injury to incubating adults.

Agricultural activities in non-cultivated areas can result in degraded nesting habitat. Indiscriminate burning and overgrazing pastures can leave minimal residual vegetation for nesting waterfowl (Kirsch et al. 1978, Kirsch 1969, Gates 1965, Bue et al. 1952). Martz (1967) documented lower duck nesting success in mowed and burned grassland. Kirsch (1969) showed inverse relationships between the degree of grazing and nesting success. Higgins (1986) found that nesting success of ducks and other ground-dwelling birds was greater on fall burned, than on spring burned plots, when averaged over the following three to four growing seasons. However Fritzell (1975) found that early-nesting ducks were more susceptible to destruction of nests by fire than later-nesting species. There has been some evidence, however, that the burning of margins does not influence pond use by breeding ducks (Hochbaum et al. 1985). Nest success is probably affected by the loss of cover vegetation.

2.4 MANAGEMENT TECHNIQUES

2.4.1 Nesting Cover

Establishing planted cover and managing native prairie are standard procedures for providing nesting cover on managed wildlife lands in the Prairie Pothole Region (Klett et al. 1988, 1984; Schranck 1972). The use of easements to secure a habitat base has been found by some to be inadequate. For example, Higgins and Woodward (1986) found that in an area where 20 year easements were used as a management tool, average drainage rates were ten times higher during the four post-contract years than during the twenty contract years on the same tracts of land. Twenty year easements only delayed wetland drainage, and were of limited value for securing a long-term habitat base. Wetland easements are also often difficult to enforce (Sidle 1981).

Alternative farming methods, such as conservation tillage, may provide safer nesting habitat for ducks nesting in cropland (Duebbert and Kantrud 1987, Cowan 1982). Sugden and Beyersbergen (1985) found the overall success of duck nests would be higher in zero-tilled fields than in fields that are annually cultivated. Although conservation tillage may benefit ground-nesting birds, there is some concern that the accompanying increased uses of herbicides poses some risk (Rodgers and Wooley 1983).

Boyd (1985) suggested that large native pastures containing brush were the best duck nesting habitat remaining in much of Prairie Canada. The potential of native pastures to support ducks, especially mallards, far outweighs that which can be expected from comparable-sized areas of cropland. Productive nesting cover minimizes predation and interspecific harassment and therefore, improves nesting success (Giroux 1981, Duebbert and Kantrud 1974, Keith 1961). In a study performed in North Dakota by Greenwood et al. (1987), common characteristics among study areas with high nest success included a large block of land in native pasture, numerous wetlands containing water, and low predator density. There is, however, some evidence that conflicts with the hypothesis that large tracts of native cover produces more ducks (Clark and Nudds 1991, Clark et al. 1991). Clark et al. (1991) concluded that the merits of establishing large tracts of cover are unpredictable and that more experiments are needed to determine the most cost-effective patch size.

Kirsch et al. (1978) stated that land use practices that remove all or part of the vegetation annually would have an adverse effect on upland nesting ducks. They also stated that the presence of residual vegetation during spring and summer is an important habitat factor in nest site selection for many species of waterfowl, upland game, and non-game birds. If cultivation of a wetland occurs, residual cover is eliminated the following spring and sites must often remain in an undisturbed state for several years before new stands suitable for nesting cover become established (Krapu et al. 1979).

2.4.2 Grazing and Burning

There is evidence that managed grazing practices can prove beneficial to both farmers and waterfowl (Trottier 1992). The findings of Mundinger (1976) and Gjersing (1975) indicate that the numbers of breeding waterfowl pairs and production of forage increase on rest-rotated pastures compared to those continually grazed.

Burning can have similar beneficial effects for waterfowl and landowners. As Fritzell (1975) noted, burning is an efficient tool in wildlife habitat management but if done indiscriminately, it reduces the quantity and quality of suitable nesting cover for adequate duck production. Higgins (1986) recommended that burning plans in northern grasslands include no greater frequency than every other year, but may be as infrequent as every third year. Post-fire effects on biota apparently are most severe during the first post-fire year and lessen during the next two or three growing seasons. Nest success in future years will vary with farming practices and predator populations unless suitable management practices can be developed and applied.

2.5 LANDOWNER ATTITUDES

Landowner attitudes have also been shown to play a part in wetland loss. In a study performed by Lodge (1967), discussions with some farmers revealed that their main reason for drainage and cultivation of wetlands was often the inconvenience of such wetlands. Farmers usually stated their reason thus: "Even if we don't get a crop from the slough, it's less trouble to go through it than around it". Fritzell (1975) found that farmers used burning as an agricultural technique to control the growth of woody vegetation, weeds, removing old bottom from a potential hay crop, to dry out fields in the spring, to increase hay production and simply because "my father did it".

Although the importance of pothole habitat to waterfowl and people is great (Morgan 1985), it lies largely in the hands of private landowners in western Canada (Rakowski et al. 1974). Sayler et al. (1982) suggested that future progress of government preservation programs would be improved by developing additional features compatible with landowner concerns and by addressing problems which influence initial attitude formation. The diversity in farmer's perceptions of the problem and their attitudes towards proposed solutions, as discussed by Christensen and Norris (1983), implies that educational programs must be tailored to meet a variety of situations. There is also evidence to suggest that landowners look favourably upon wetland preservation if the financial burden did not rest solely with them, and if information about conservation practices were made available to them (Josephson 1992, Morgan 1985, Sayler et al. 1984, Christensen and Norris 1983).

2.6 SUMMARY

At present, agricultural practices continue to impact the basins and margins of prairie wetlands. The latest figures show that approximately 23 percent of wetland basins and 78 percent of wetland margins were impacted to some degree in prairie Canada in 1992 (Caswell et al. 1993).

Wildlife managers need to provide landowners with incentives to modify farming practices and to retain remaining idle land to benefit wildlife. Implementation of habitat conservation programs on private lands seems likely only if there are economic incentives to landowners (Peterson and Madsen 1981, Ryder and Boag 1981, Hedlin 1969). This is supported by Leitch and Kaminski (1985) who also state that habitat management programs by government and private conservation organizations should increase the availability of quality wetland complexes in the agricultural areas of North America, where agriculture and depredation conjointly depress recruitment.

3.0 METHODS

3.1 THE DATA

Data collected during the spring Waterfowl Breeding Population Surveys (WBPS) from 1986 to 1990 were analyzed. These surveys, conducted by biologists from the Canadian Wildlife Service (CWS), with the support of natural resource agencies in the prairie provinces, included an assessment of wetlands and the surrounding habitat along designated survey routes. The study areas included parts of southern and central Alberta and Saskatchewan, and western Manitoba.

The Breeding Population and Habitat Survey was performed annually during the approximate period May third to May 25th. Criteria used for initiation of the survey were spring breakup, build-up of representative waterfowl in traditional breeding areas, and the dispersal of paired waterfowl into breeding territories (United States Fish and Wildlife Service and Canadian Wildlife Service 1987).

Study areas consisted of 65 transects that comprise the southern Prairie Canada ground portion (strata 26-40) of the annual waterfowl breeding population survey (Figure 3.1), (United States Fish and Wildlife Service and Canadian Wildlife Service 1987). Transects varied from 16-28.8 km in length by 0.4 km in width. All wetlands were individually numbered on aerial photographs, and the incidence of land-use impacts was recorded for each wetland basin and margin

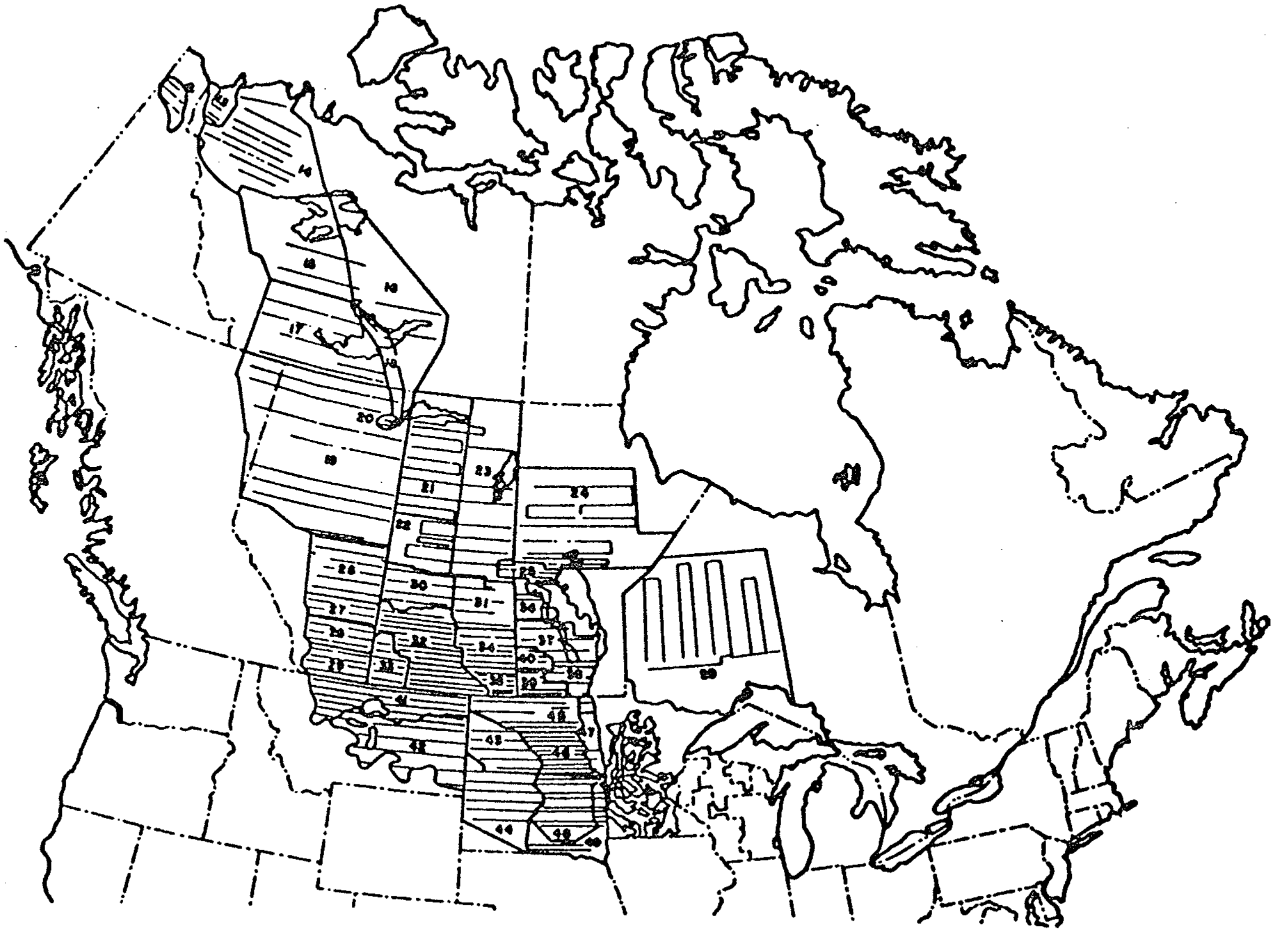


Figure 3.1: Transect areas in the North American prairies.

Source: United States Fish and Wildlife Service and Canadian Wildlife Service 1986 by on-site visual inspection (Turner et al. 1987). To minimize observer bias the previous year's data was edited on-site (Figure 1, Appendix A). Upwards of 10,000 potential wetlands across the prairie-parkland region were monitored annually from 1986 to 1990.

Impacts were treated as permanent or transitory, and included hayed, grazed, burned, drained, filled, cultivated and cleared. Drainage and filling of wetland basins were considered permanent impacts, reversible only through active restoration. Transitory impacts included haying, burning, clearing, grazing and cultivating.

3.2 ANALYSIS

The data from 1986 to 1990 were used in this study because analysis had already been conducted for the time period 1981 to 1985. Impacts on available waterfowl breeding habitat (pond types III-V, streams and artificial wetlands), were studied and presented in graphic form. These ponds represent the most important duck producing habitat. This was done on a province by province basis as well as for the total prairies. Impacts were also studied in total grasslands and total parklands.

The next step included a breakdown of each impact on particular wetland types. This was presented as a five-year average in graphic form for each area under study. Consistency of the database was difficult to ensure owing to the subjective method in which impaction data were collected, and the variability of wetland types from year to year. As well, the sampling procedure used to select transects was not random, and was stratified for waterfowl populations, not necessarily habitat type. It was therefore unclear as to how much weight each observation should be given in each transect. Consequently no formal tests of hypotheses were made. Detail is provided by the tables in Appendix B which show the data used to create the graphs.

The data used for this study did not represent each type of grassland habitat that occurs in the prairies. Only one general classification is used for grasslands. The study was therefore not able to determine if different grassland types influence any particular agricultural practice.

4.0 RESULTS

Approximately 10,000 potential wetlands (65 transects) were monitored across prairie Canada in a five-year period from 1986 to 1990. A high percentage of the wetlands were in a degraded condition in 1986 and remained so through to 1990. For example, 78 percent of available waterfowl habitat in prairie Canada (pond types III-V, streams and artificial wetlands) were impacted in 1986 and except for a slight drop in 1987 remained the same for the duration of the study (Table 1, Appendix B).

4.1 PRAIRIE CANADA

4.1.1 All Transects

The rate of total impact on available waterfowl habitat in prairie Canada stayed roughly the same over the five-year study period (Figure 4.1). In prairie Canada, cultivating in the margin was the most prevalent type of transitory impact.

During the 1986-1990 period, dry ponds were cultivated the most, followed by type I ponds, and types III to V ponds. Artificial ponds and streams were cultivated the least (Figure 4.2 and Table 4, Appendix B). Grazing showed the reverse trend, impacting dry ponds the least, followed by type I ponds, pond types III to V, artificial ponds, and impacting streams the most (Figure 4.3 and Table 6, Appendix B). Haying in the margin was the next most serious impact, affecting dry ponds the least. Type I and artificial ponds

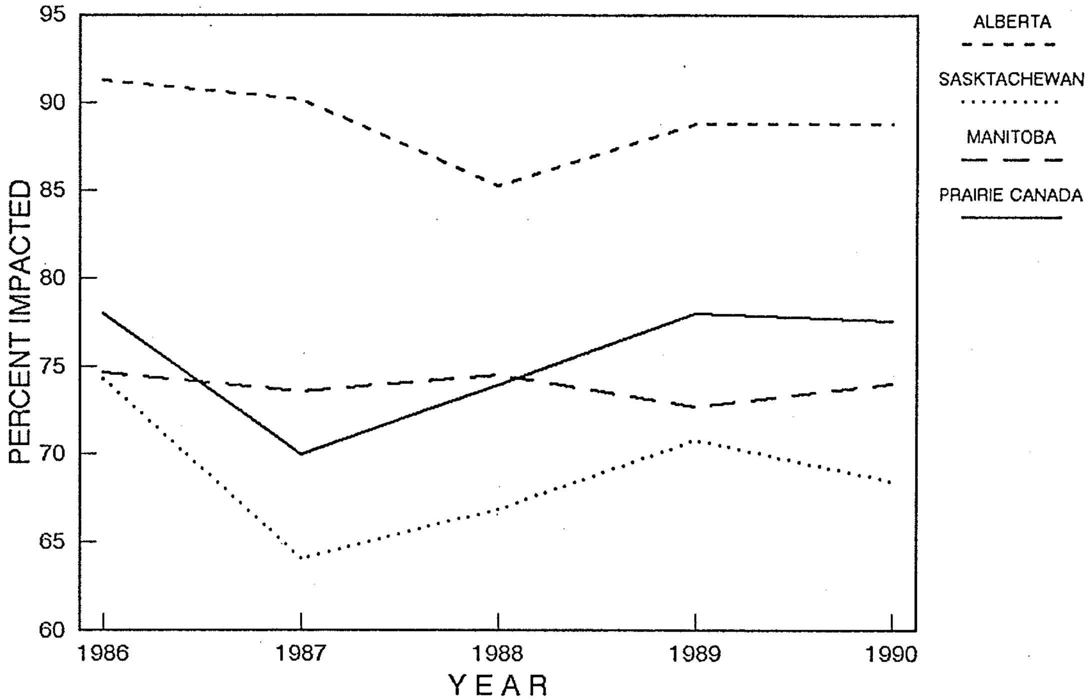


FIGURE 4.1: PERCENT OF WETLAND MARGINS IMPACTED BY TOTAL IMPACTS IN PRAIRIE CANADA, 1986-90 (POND TYPES III-V, STREAMS AND ARTIFICIALS).

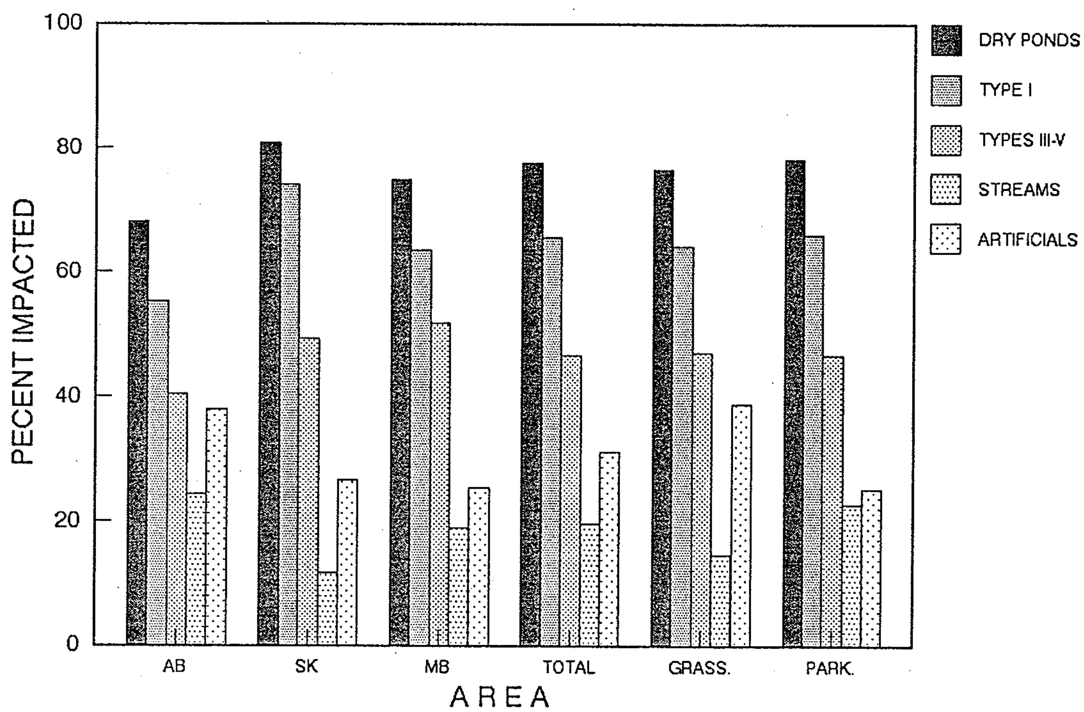


FIGURE 4.2: PERCENT OF WETLAND MARGINS IMPACTED BY CULTIVATION IN PRAIRIE CANADA (1986-90 AVERAGE).

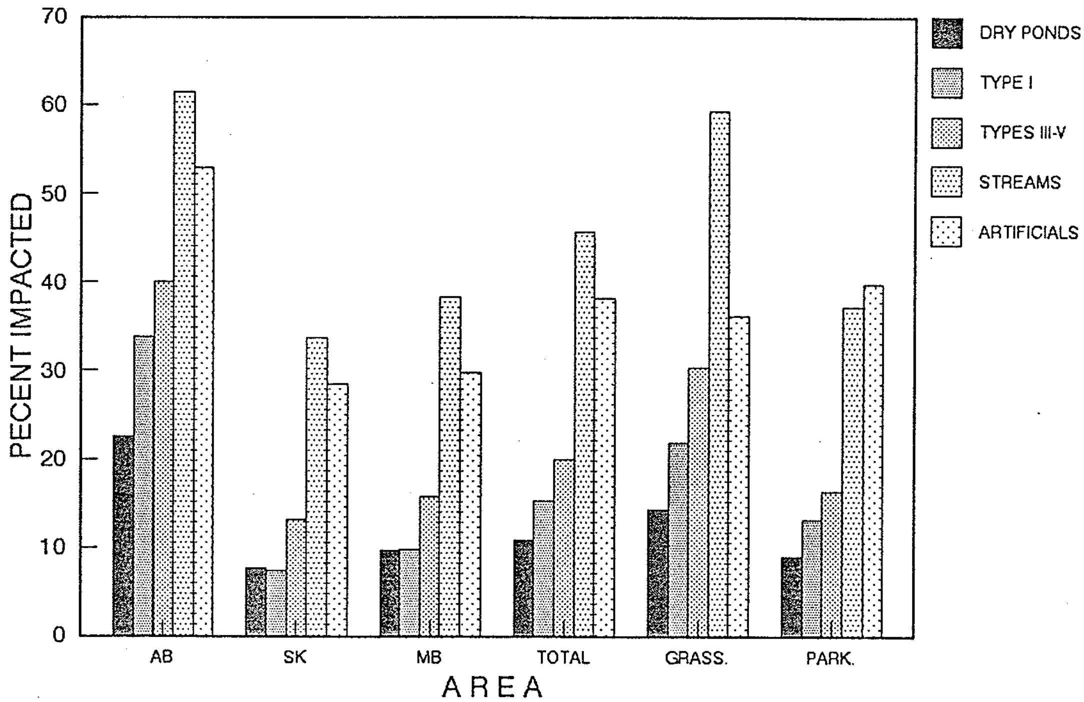


FIGURE 4.3: PERCENT OF WETLAND MARGINS IMPACTED BY GRAZING IN PRAIRIE CANADA (1986-90 AVERAGE).

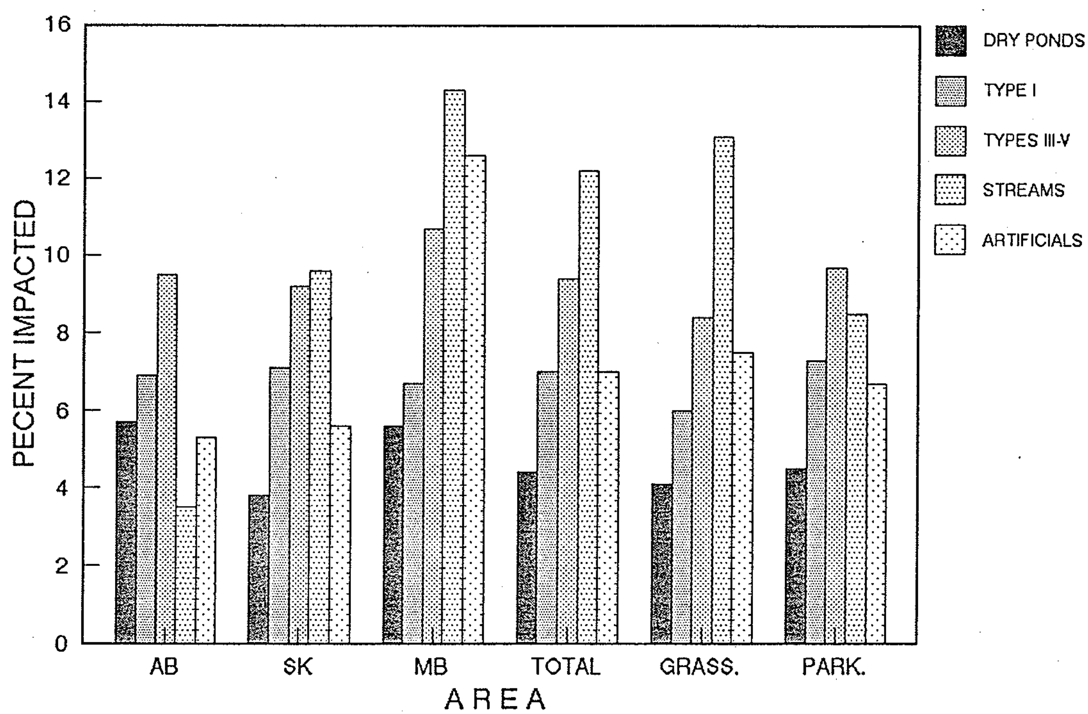


FIGURE 4.4: PERCENT OF WETLAND MARGINS IMPACTED BY HAYING IN PRAIRIE CANADA (1986-90 AVERAGE).

were impacted at about the same rate, followed by type III to V ponds and streams (Figure 4.4 and Table 8, Appendix B). Burning and clearing occurred the least (Figures 4.5 and 4.6).

4.1.2 Grassland Transects

Wetland margins in the grassland ecozone were generally impacted at a higher rate than parkland margins (Figure 4.7). The differences usually amounted to approximately six percent between the parkland and grassland (Table 1, Appendix B). Total impacts averaged 83 percent on available waterfowl habitat.

Cultivation, which was the most frequent single impact, was quite sporadic in the grassland transects as well as the parklands, but generally averaged around 40 percent (Figure 4.8 and Table 3, Appendix B). Dry ponds were the most impacted, followed by type I ponds, pond types III to V, artificial ponds streams (Figure 4.2 and Table 2, Appendix B).

Grazing occurred at a higher rate in the grasslands than the parklands (Figure 4.9). During the study period, 35 percent of available waterfowl habitat was impacted by grazing in the grassland (Table 5, Appendix B). The rate of grazing also tended to increase with water permanence (Figure 4.3).

The rate of haying tended to decrease during the study

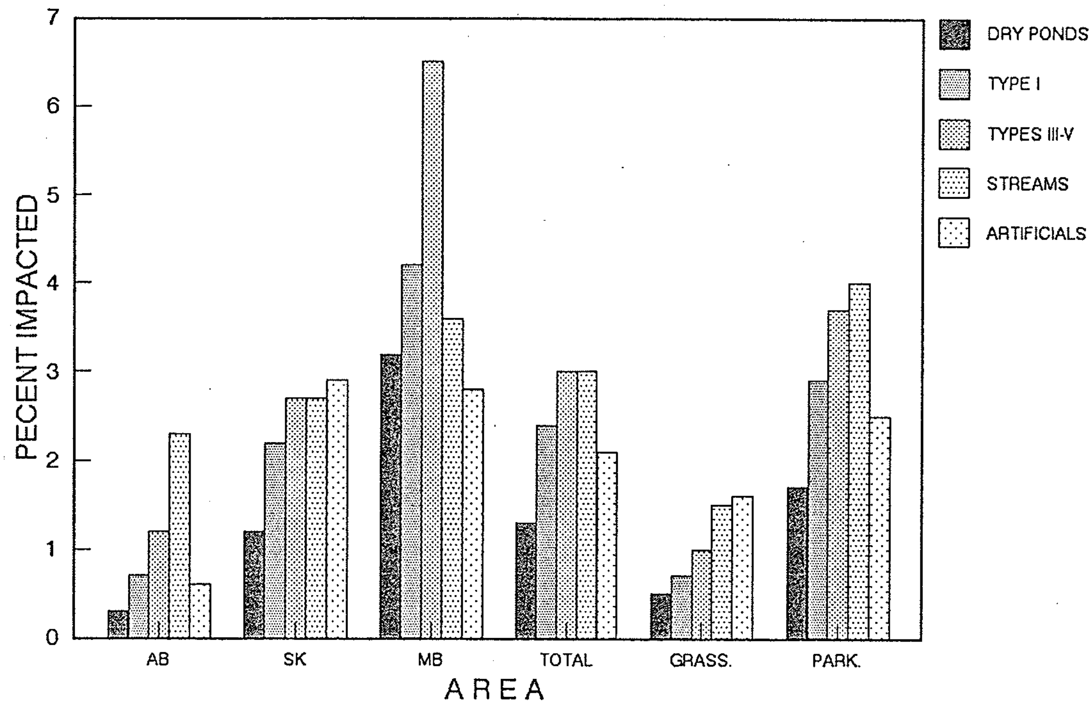


FIGURE 4.5: PERCENT OF WETLAND MARGINS IMPACTED BY BURNING IN PRAIRIE CANADA (1986-90 AVERAGE).

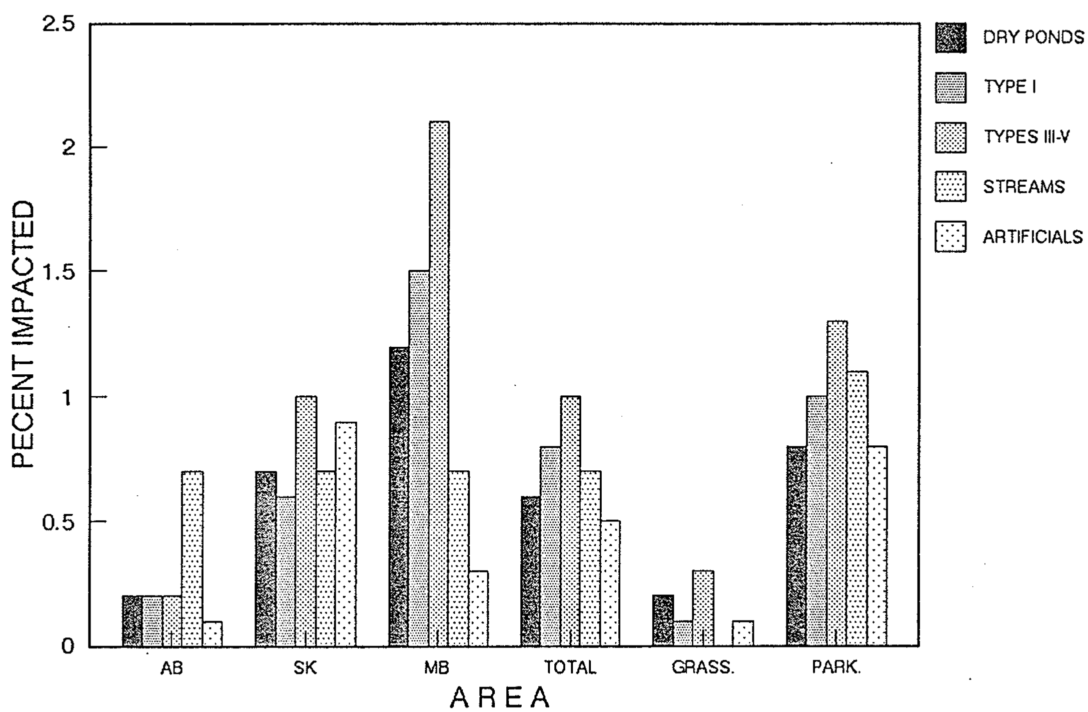


FIGURE 4.6: PERCENT OF WETLAND MARGINS IMPACTED BY CLEARING IN PRAIRIE CANADA (1986-90 AVERAGE).

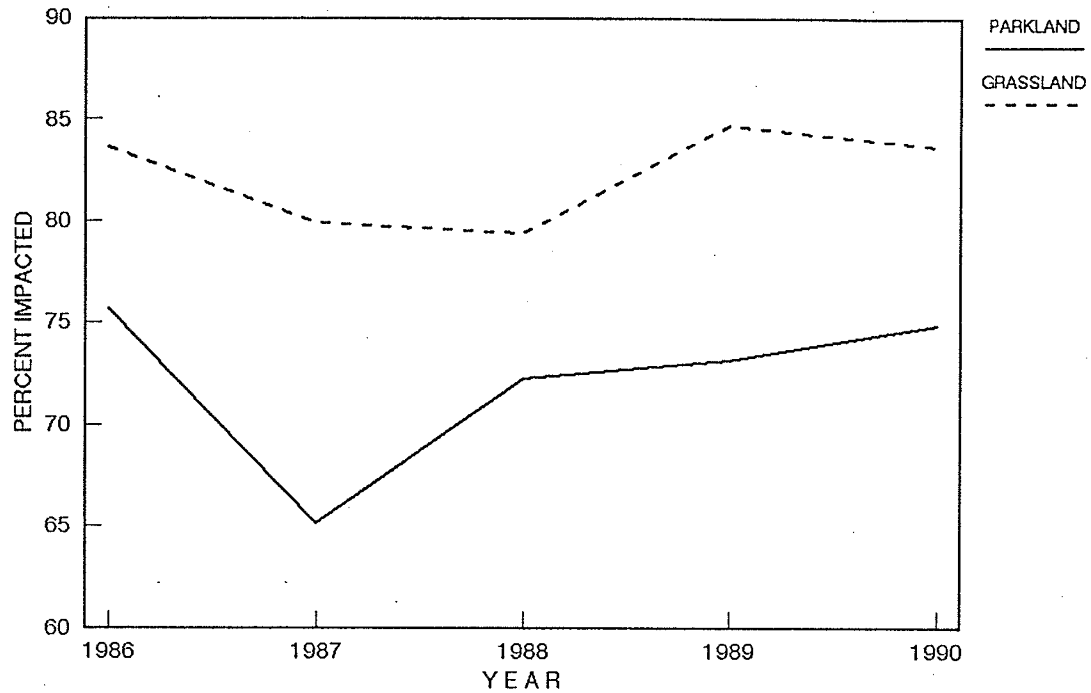


FIGURE 4.7: PERCENT OF WETLAND MARGINS IMPACTED BY TOTAL IMPACTS IN PARKLAND AND GRASSLAND PRAIRIE CANADA, 1986-90 (POND TYPES III-V, STREAMS AND ARTIFICIALS).

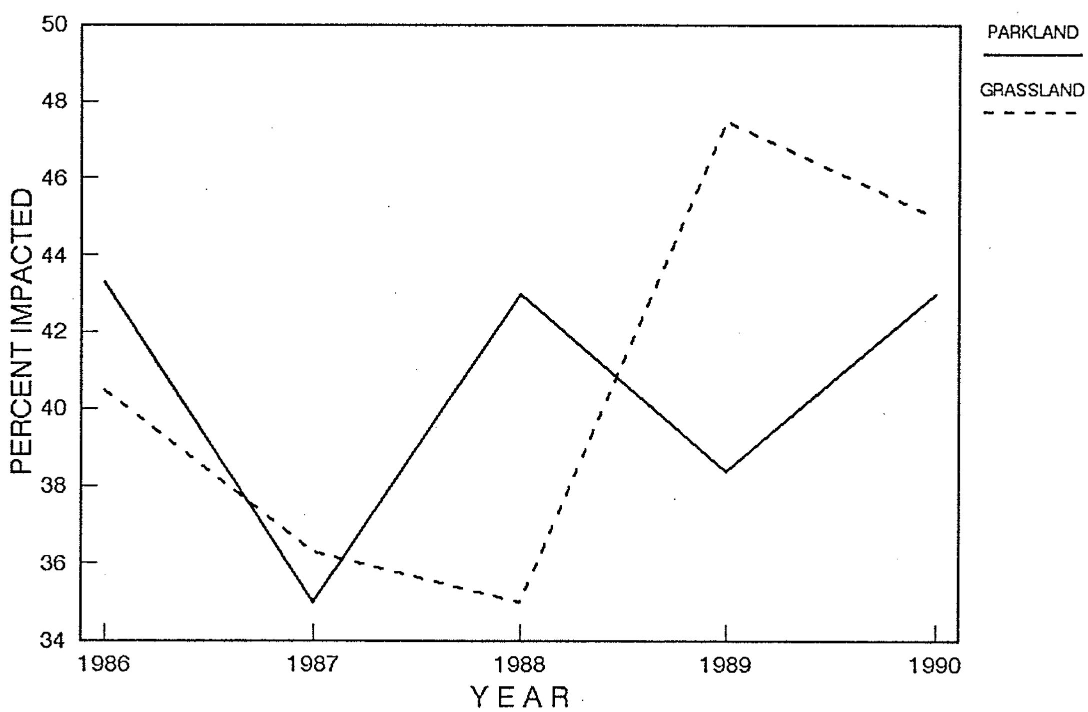


FIGURE 4.8: PERCENT OF WETLAND MARGINS IMPACTED BY CULTIVATION IN PARKLAND AND GRASSLAND PRAIRIE CANADA, 1986-90 (POND TYPES III-V, STREAMS AND ARTFICIALS).

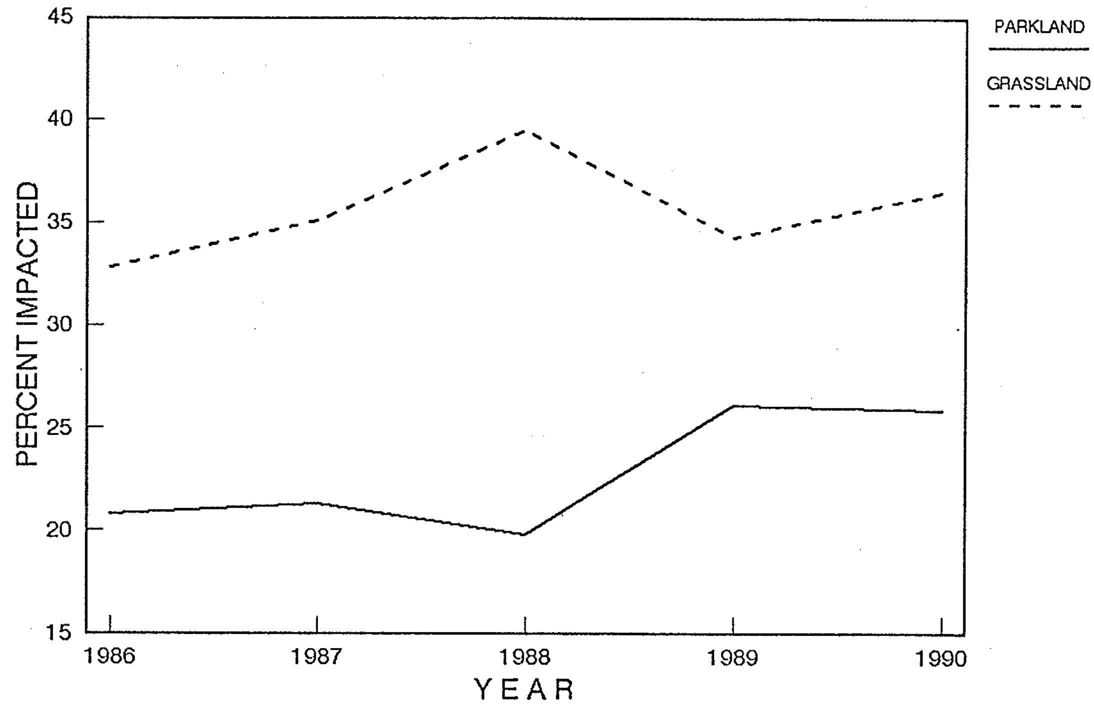


FIGURE 4.9: PERCENT OF WETLAND MARGINS IMPACTED BY GRAZING IN PARKLAND AND GRASSLAND PRAIRIE CANADA, 1986-90 (POND TYPES III-V, STREAMS AND ARTIFICIALS).

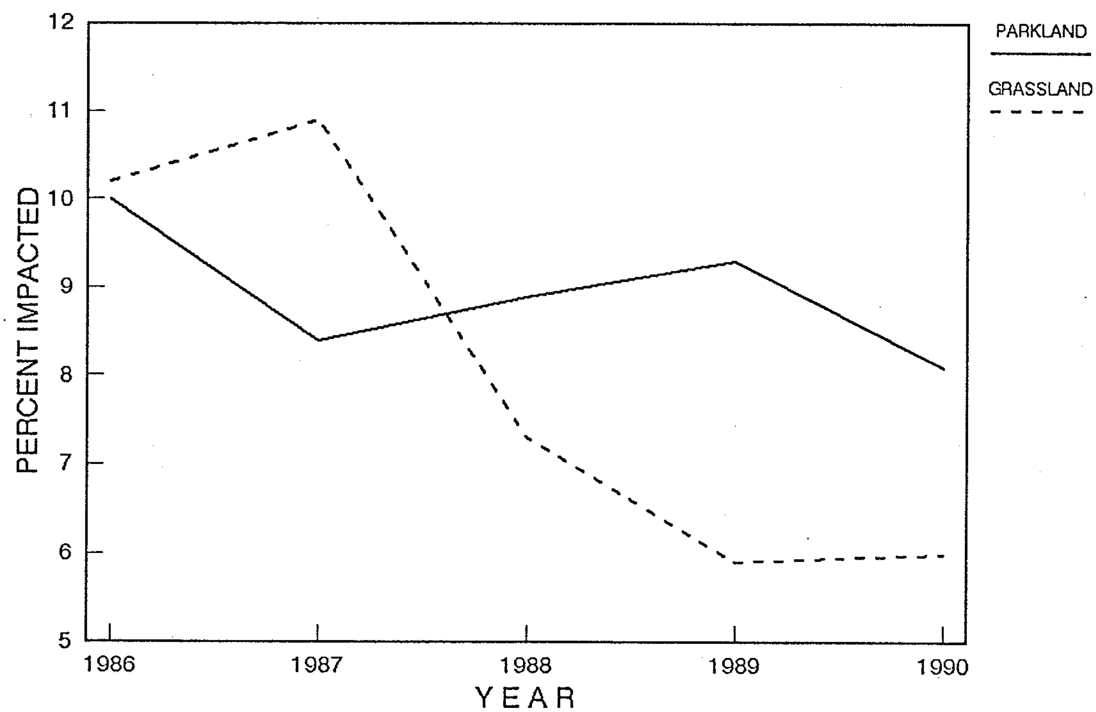


FIGURE 4.10: PERCENT OF WETLAND MARGINS IMPACTED BY HAYING IN PARKLAND AND GRASSLAND PRAIRIE CANADA, 1986-90 (POND TYPES III-V, STREAMS AND ARTIFICIALS).

period in the grassland transects (Figure 4.10). The average rate of impact on available waterfowl habit was nine percent (Table 7, Appendix B). Figure 4.4 shows that the rate of impact increases with the availability of water.

Burning and clearing are the last two impacts of importance, and both occurred at a rate lower than that found in the parkland transects (Figures 4.11 and 4.12). Burning also tended to increase with water permanence (Figure 4.5). Clearing is somewhat more sporadic but generally occurred at a lower rate than in the parklands (Figure 4.6).

4.1.3 Parkland Transects

The same pattern of impacts were found in the parklands as were found in the grasslands, in that cultivating is the activity that impacts the most wetlands, followed by grazing, haying, burning, and clearing. The rate of total impacts on available waterfowl habitat occurs at a lower rate in the parklands than in the grassland transects (Figure 4.7). During the study period, 72 percent of available waterfowl habitat was impacted (Table 1, Appendix B).

Cultivation, however, occurred at roughly the same rate, affecting 41 percent of the margins (Table 3, Appendix B). The rate of impact tended to decrease with water permanence (Figure 4.2). Grazing occurred at a lower rate

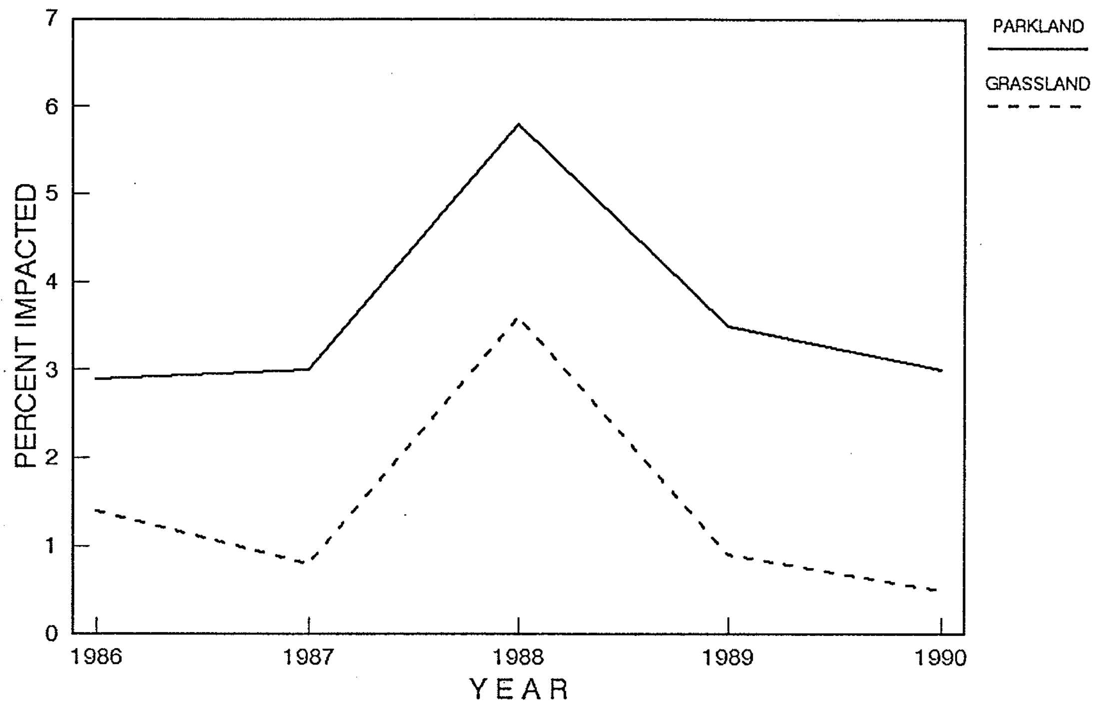


FIGURE 4.11: PERCENT OF WETLAND MARGINS IMPACTED BY BURNING IN PARKLAND AND GRASSLAND PRAIRIE CANADA, 1986-90 (POND TYPES III-V, STREAMS AND ARTIFICIALS).

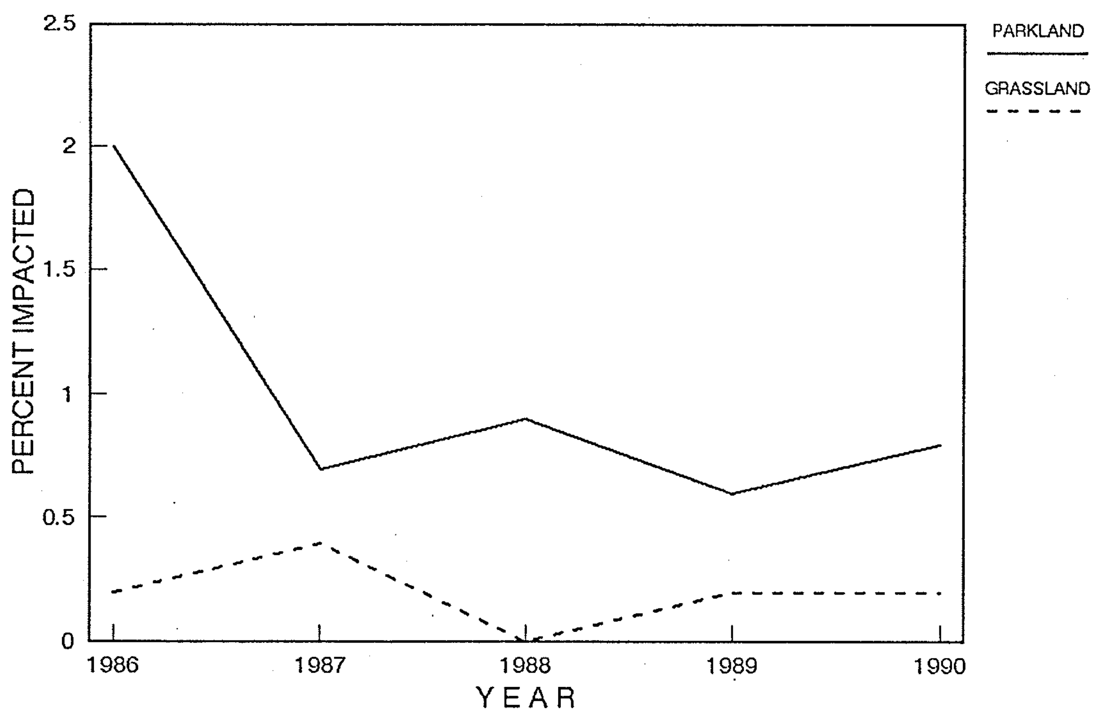


FIGURE 4.12: PERCENT OF WETLAND MARGINS IMPACTED BY CLEARING IN PARKLAND AND GRASSLAND PRAIRIE CANADA, 1986-90 (POND TYPES III-V, STREAMS AND ARTIFICIALS).

in the parklands than in the grasslands (Figure 4.9), affecting 22 percent of available waterfowl habitat, while 35 percent were affected in the grasslands (Table 6, Appendix B). The incidence of grazing also tended to increase with water permanence (Figure 4.3).

Burning, however, occurred at a greater rate in the parklands than in the grasslands (Figure 4.11). An average of four percent of waterfowl wetlands were affected in the parkland compared to one percent impacted in the grassland (Table 10, Appendix B). Clearing occurred at a slightly higher rate in the parkland transects than in the grassland transects (Figure 4.12 and Table 11, Appendix B).

4.2 MANITOBA

4.2.1 Total Impacts

The percentage of total impacts on available waterfowl habitat (types III-V, streams and artificial ponds) in all of Manitoba remained fairly constant through the study (Figure 4.1 and Table 1, Appendix B).

Dry ponds and type I ponds showed the most impaction on the margin, followed by type III to V ponds, streams, and artificial wetlands (Figure 4.13 and Table 2, Appendix B). All ponds showed a general increase in impaction rate from 1986 to 1990, except for streams and artificial wetlands which remained relatively constant (Figure 4.13).

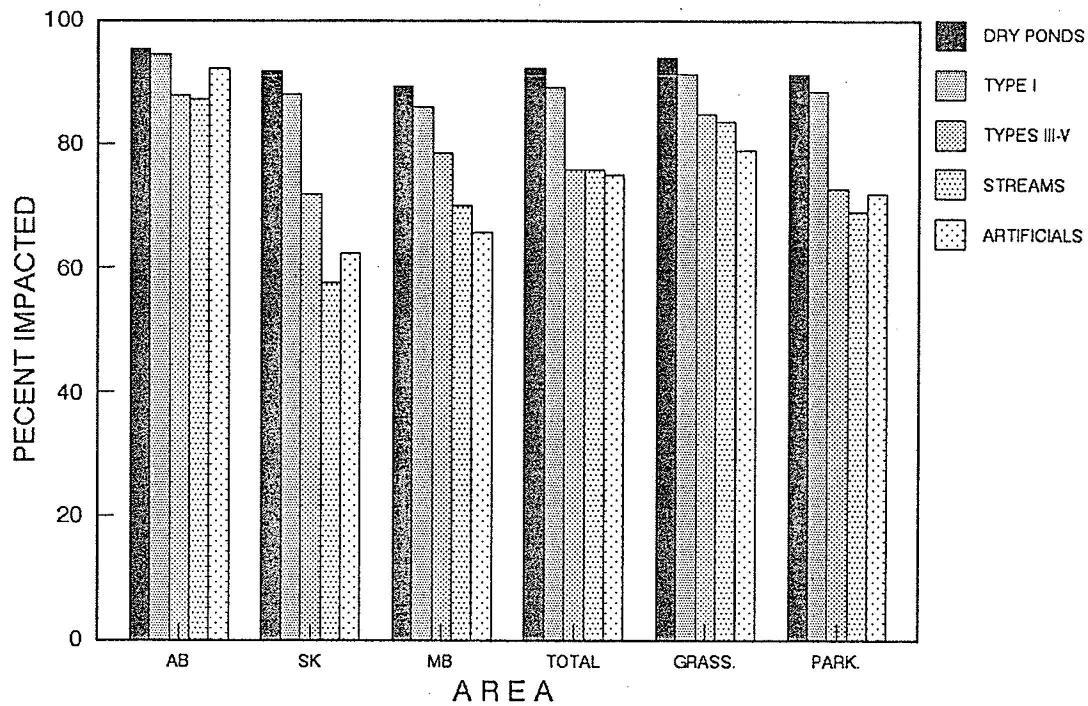


FIGURE 4.13: PERCENT OF WETLAND MARGINS IMPACTED BY TOTAL IMPACTS IN PRAIRIE CANADA (1986-90 AVERAGE).

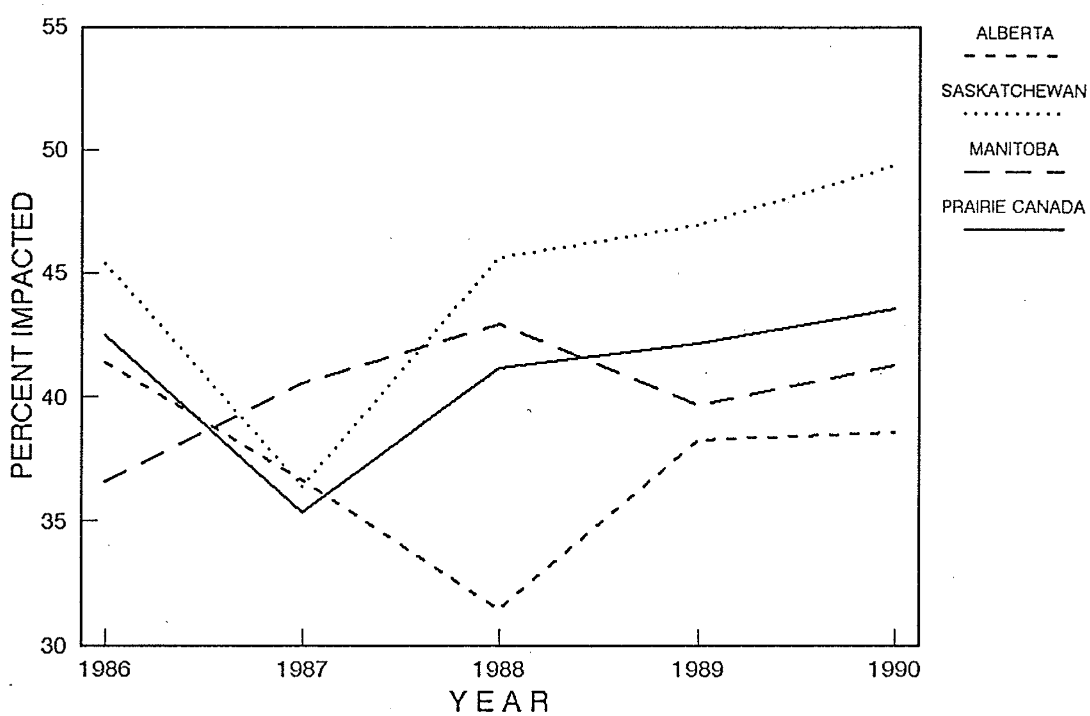


FIGURE 4.14: PERCENT OF WETLAND MARGINS IMPACTED BY CULTIVATION IN PRAIRIE CANADA, 1986-90 (POND TYPES III-V, STREAMS AND ARTIFICIALS).

4.2.2 Cultivation

Cultivation on wetland margins was by far the highest rated impact type in Manitoba. This rate of impact increased slightly from 1986 to 1990 (Figure 4.14). For available waterfowl habitat in Manitoba (pond types III to V, streams and artificial ponds), and average of 40 percent of surveyed ponds were impacted (Table 3, Appendix B).

In terms of pond types, dry ponds were the most heavily impacted. Impaction rates generally declined on ponds with more permanent water (Figure 4.2 and Table 4, Appendix B).

4.2.3 Grazing

Grazing was the second highest of all impact types. An average of 23 percent of available waterfowl wetlands were impacted over the five year study period (Figure 4.15 and Table 5, Appendix B). The rate of impact tended to increase with water permanence (Figure 4.3 and Table 6, Appendix B).

4.2.4 Haying, Burning and Clearing

Haying, burning and clearing were the three types of impacts that affected wetlands the least. Haying decreased slightly between 1986 and 1990 on affected waterfowl wetlands (Table 7, Appendix B). The incidence of haying occurred at a greater rate in Manitoba than the other prairie provinces (Figure 4.16) and tended to increase with water permanence (Figure 4.4 and Table 8, Appendix B).

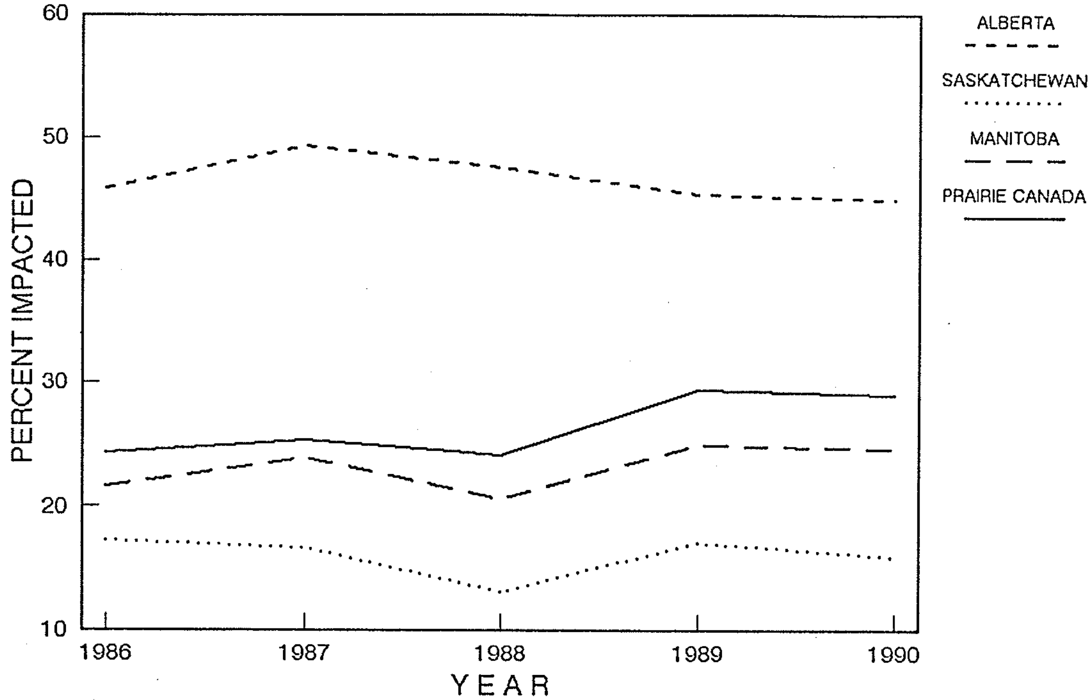


FIGURE 4.15: PERCENT OF WETLAND MARGINS IMPACTED BY GRAZING IN PRAIRIE CANADA, 1986-90 (POND TYPES III-V, STREAMS AND ARTIFICIALS).

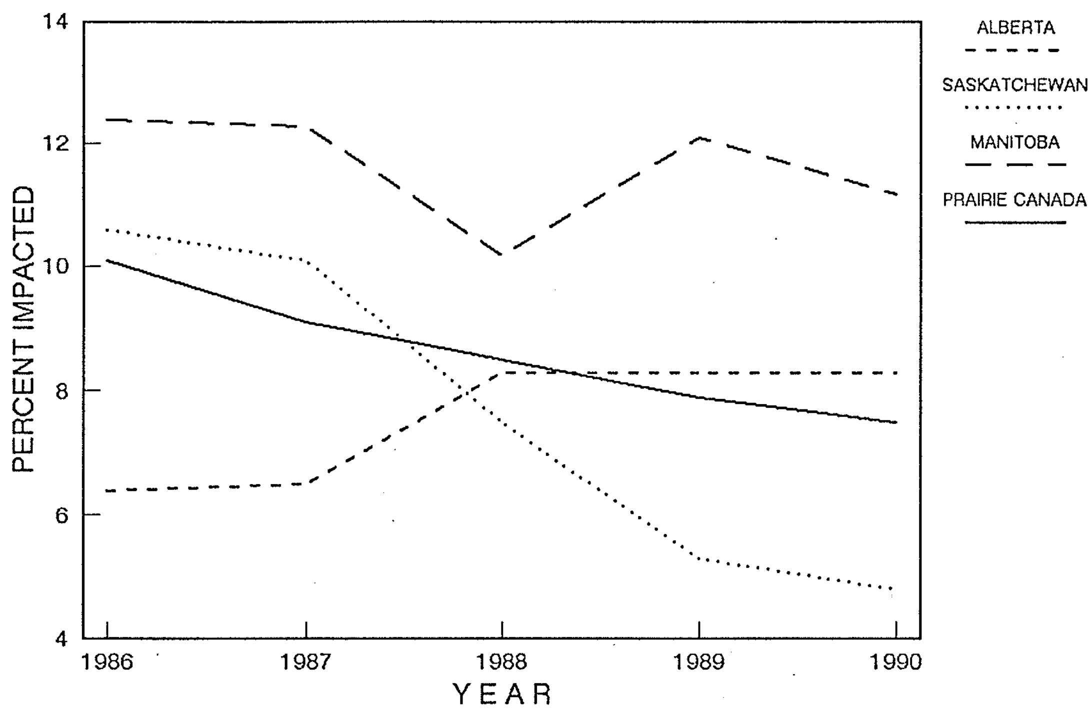


FIGURE 4.16: PERCENT OF WETLAND MARGINS IMPACTED BY HAYING IN PRAIRIE CANADA, 1986-90, (POND TYPES III-V, STREAMS AND ARTIFICIALS).

Burning occurred only minimally on wetland margins in Manitoba, although at a higher rate than in the other provinces (Figure 4.17). For the available waterfowl wetlands, an average of five percent were impacted over the study period (Table 9, Appendix B). Burning did not show a significant difference in rate between pond types. However, the impact rate on waterfowl wetlands was slightly higher than other wetland types (Figure 4.5 and Table 10, Appendix B). All pond types showed similar increases in burning in 1988.

Overall, of the five impact types, clearing occurred the least in Manitoba. Yet in 1986, Manitoba experienced the highest level of clearing in the prairie provinces (Figure 4.18). By 1990, however, clearing had dropped to a level between that of Alberta and Saskatchewan (Figure 4.18 and Table 11, Appendix B). The rate of clearing also tends to increase with water permanence (Figure 4.6 and Table 12, Appendix B).

4.3 SASKATCHEWAN

4.3.1 Total Impacts

In general, total impact rates were lower in Saskatchewan than in Manitoba (Figure 4.1). Impacts on available waterfowl habitat in Saskatchewan decreased slightly from 1986 to 1990 (Figure 4.1 and Table 1, Appendix B). Dry ponds demonstrated the most impacts to the margins

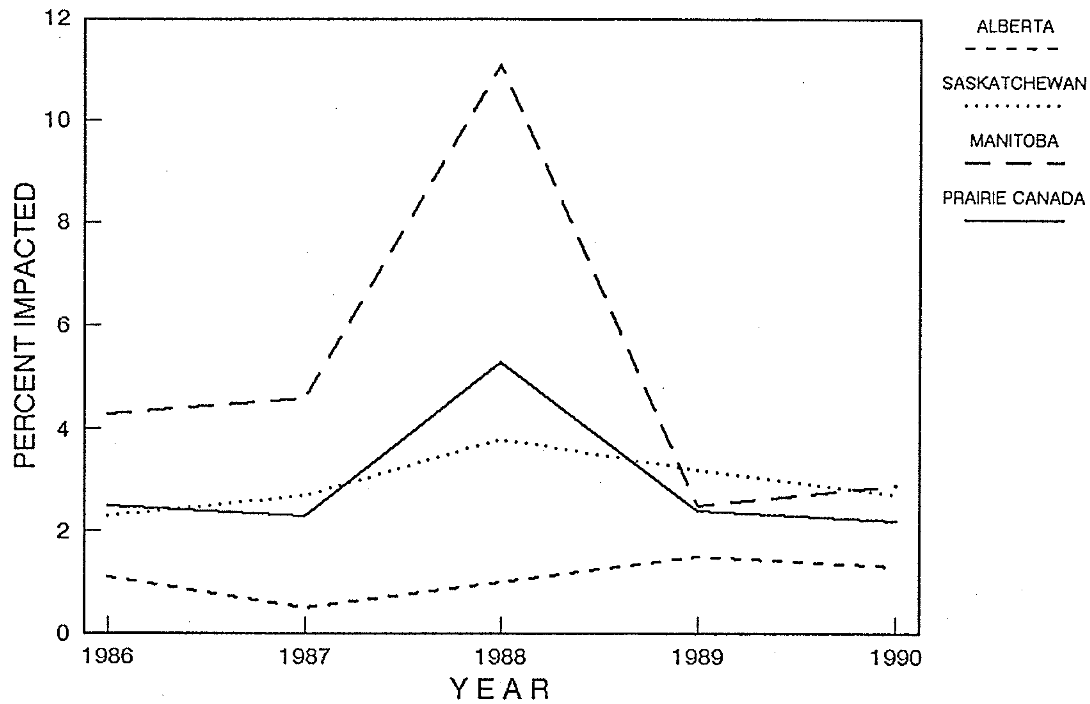


FIGURE 4.17: PERCENT OF WETLAND MARGINS IMPACTED BY BURNING IN PRAIRIE CANADA, 1986-90 (POND TYPES III-V, STREAMS AND ARTIFICIALS).

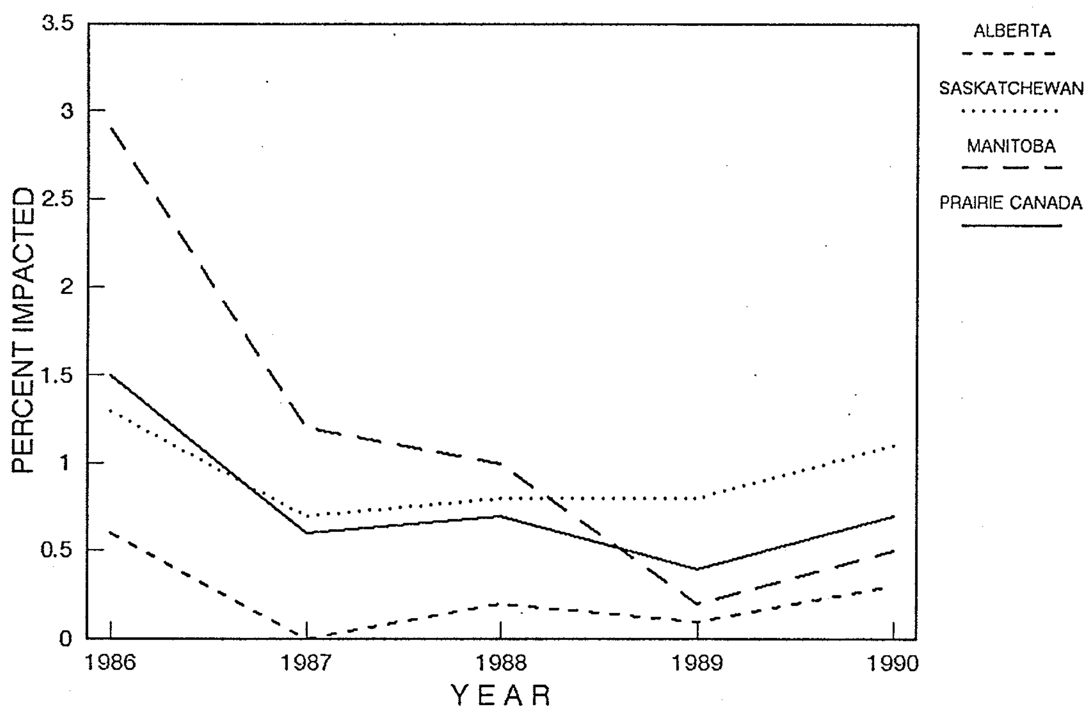


FIGURE 4.18: PERCENT OF WETLAND MARGINS IMPACTED BY CLEARING IN PRAIRIE CANADA, 1986-90 (POND TYPES III-V, STREAMS AND ARTIFICIALS)

followed by type I ponds, pond types III to V, artificial wetlands and streams (Figure 4.13 and Table 2, Appendix B).

4.3.2 Cultivation

Cultivation on the margin generally occurred at a higher rate in Saskatchewan than in Manitoba (Figure 4.14). The rate of impact also tended to increase over time during the study period (Figure 4.14 and Table 3 Appendix B). Dry ponds were the most impacted with the impact rate tending to decrease with water permanence (Figure 4.2, Table 4, Appendix B).

4.3.3 Grazing

The rate of grazing tended to decrease slightly over time or remained constant. Saskatchewan experienced the least amount of grazing of the three prairie provinces (Figure 4.15) with a five-year average of 16 percent (Table 5, Appendix B).

Impacts also appeared to increase with water permanence (Figure 4.3 and Table 6, Appendix B).

4.3.4 Haying, Burning and Clearing

Haying, burning and clearing were of the least importance in terms of impaction rate. An average of nine percent of waterfowl wetlands were impacted by haying during the study period (Figure 4.16 and Table 7, Appendix B).

Haying also tended to increase with water permanence (Figure 4.4 and Table 8, Appendix B).

Total burning in Saskatchewan was much less than in Manitoba, but still greater than in Alberta (Figure 4.17). In 1986, the available waterfowl habitat was only two percent impacted by burning. This figure remained stable over the five-year period (Table 9, Appendix B). Other pond classifications showed similar impact rates when averaged over five years (Figure 4.5 and Table 10, Appendix B).

Clearing impacts occurred the least in Saskatchewan, and remained relatively constant during the study period (Figure 4.18). Dry ponds, over the five-year period, averaged one percent impacted, as did type I ponds, types III-V ponds, streams and artificial wetlands (Figure 4.6 and Table 12, Appendix B).

4.4 ALBERTA

4.4.1 Total Impacts

Alberta experienced the highest percentage in the prairie provinces of total transitory impacts on available waterfowl habitat (Figure 4.1). The five-year average for total impacts was 89 percent (Table 1, Appendix B). Dry ponds were impacted the most, followed by type I ponds, artificial wetlands, pond types III to V, and streams (Figure 4.13, and Table 2, Appendix B).

4.4.2 Cultivation

Cultivation rates were generally not as high in Alberta as in the other two prairie provinces, (Table 3, Appendix B) except in 1986, where the rate was between that of Manitoba and Saskatchewan (Figure 4.14). The rate of impact also tended to decrease over time. When the five year averages were examined, cultivation tended to decrease with increased water permanence (Figure 4.2 and Table 4, Appendix B).

4.4.3 Grazing

Grazing occurred at the highest rate in Alberta of all the prairie provinces (Figure 4.15). The rate of impact remained fairly constant over the five year period (Table 5, Appendix B).

Dry ponds were the least impacted pond type, and the rate of impact tended to increase with water permanence (Figure 4.4 and Table 6, Appendix B).

4.4.4 Haying, Burning and Clearing

Haying in Alberta generally occurred at a rate lower than the other two prairie provinces, averaging eight percent over the study period (Figure 4.16 and Table 7, Appendix B). Pond types III-V were impacted at a slightly higher rate than other wetlands (Figure 4.4 and Table 8, Appendix B).

The frequency of burning was also the least in Alberta compared to the other two prairie provinces (Figure 4.17 and Table 9, Appendix B). None of the wetland classes showed significant rates of burning (Figure 4.5 and Table 10, Appendix B).

Clearing occurred at the lowest rate when compared to the other impacts in Alberta and was also lower than the other provinces (Figure 4.18 and Table 11, Appendix B). None of the wetlands under study were impacted to any significant extent by clearing (Figure 4.6; Table 12, Appendix B).

5.0 DISCUSSION

5.1 GEOGRAPHIC DIFFERENCES IN IMPACT TYPES

Transitory impacts occur at different rates across prairie Canada, increasing from Manitoba to Alberta. In general terms, however, the hierarchy of these impacts remained the same throughout the study area with cultivation occurring at the greatest frequency, followed by grazing, haying, burning and clearing. These results are similar to those found by Turner et al. (1987). The differences in rates of impact can be explained to some extent, by examining the different agricultural practices throughout the prairies. What follows is a discussion of grassland, parkland, and provincial impact rates.

5.1.1 Parkland and Grassland

Total impacts occur at a much higher rate in grassland transects than in the parkland. This reflects the higher vulnerability of wetlands in grassland areas, where more frequent drought conditions result in higher rates of agricultural activity (Turner and Caswell 1989). Parklands, on the other hand, have a slightly higher annual rainfall, lower mean summer temperatures and a lower rate of evaporation than grasslands (Sanderson 1976). These areas are under less agricultural pressures and may consequently offer more dependable areas for duck production.

Some impacts, however, did not exhibit a distinct difference in rate between the two areas. Cultivation, for example, showed a wide range of variability over the five-year period, yet the average rate of impact was relatively equal in both areas. Grazing, on the other hand, clearly occurred at a higher rate in the grassland than in the parkland, indicating the importance of the cattle industry in the grassland area. Haying also occurred to a greater extent in the grassland area. This finding is supported by Trottier (1992) who noted that almost all of the grassland not used for the grain industry is grazed by livestock, or hayed. Conversely, burning occurred at a greater rate in the parkland than in the grassland. This may reflect a desire on the part of farmers to control the growth of woody vegetation (Fritzell 1975). Clearing also occurs at a greater rate in the parkland, possibly for the same reason.

5.1.2 Prairie Provinces

Livestock farming is a dominant industry in Alberta (Turner et al. 1987), and this is reflected by the rate of grazing in that province. In Alberta, grazing on the margin occurs at almost twice the rate as in Manitoba, the province exhibiting the next highest rate.

Saskatchewan exhibited the highest rate of cultivation of all the prairie provinces. The importance of grain farming in this province may also help to explain this trend

(Turner et al. 1987, Rakowski and Jurick 1986). Grazing occurs the least in Saskatchewan, which probably reflects the minimal importance of the cattle industry, compared to the other two provinces.

Manitoba follows the same general pattern as the other two provinces, with cultivation as the highest rated impact. A noticeable trend in Manitoba is the rate of burning. This impact occurred at a much higher rate in Manitoba than Alberta or Saskatchewan, and was emphasized during 1988, which was a dry year. During 1988, Manitoba experienced warm temperatures and minimal rainfall. In fact, many temperature records were broken in May and June of that year (United States Fish and Wildlife Service and Canadian Wildlife Service 1988). One of the possible reasons for the extent of burning in Manitoba is that the survey segments occur almost exclusively in the parkland (Turner and Caswell 1989). As the results indicate, burning occurs at a higher rate in Parkland than in Grassland transects.

5.2 WATER PERMANENCE AND IMPACT RATE

Generally, impacts tend to decrease with water permanence (ie. depth), likely because of the easy access afforded to the landowner by dry or temporary wetlands. It is much easier to move large machinery around dry and temporary wetlands than large, more permanent wetlands (Lodge 1967). During drought years farming practices also appear to intensify, especially when coupled with favourable grain prices (Turner et al. 1987). Generally, increased impacts during drought complicates an already difficult situation, and creates an additional hardship for nesting birds during dry years, as well as during subsequent years.

Some impact types, however, display a reverse trend. Grazing, for example, increases with water permanence, and presence of streams and artificial wetlands. This may also be explained by the fact that livestock farmers depend on wetlands as a source of forage for their livestock, particularly during periods of drought (Krapu 1981). Haying also tends to increase with water permanence. This may be because less permanent wetlands tend to be cultivated by farmers. During dry years, the permanent wetlands experience some draw down, and become available for haying and grazing activities.

5.3 EFFECTS OF TRANSITORY IMPACTS

Due to the study limitations, it would be difficult to determine from the database the extent to which cultivation would affect available breeding habitat. Upland conditions are of paramount importance, however, the data do not differentiate between true fallow fields or stubble fields that have been tilled. In the latter case, some cover is afforded by the organic debris left on the surface. This type of cover may be used by some species, such as northern

Pintail (Sowls 1955). In either case, however, the quality of available habitat is seriously affected by cultivation. Cultivation around wetlands tends to increase when water is low; and it is also probable that two or more years of high water are necessary before good cover is reestablished, provided the activity is not repeated (Rogers 1964).

Grazing poses less of a negative impact for birds than cultivation, because there is usually some type of cover left behind for hens to nest in. This, however, depends on the type of grazing and whether enhancement practices such as rotational grazing, are used (Trottier 1992). Some studies have found that carefully controlled grazing practices may improve nesting for some species, and that different waterfowl species show different responses to a variety of grazing management schemes (Holecheck et al. 1982). It should be noted that the collecting method for this type of impact does not allow for differentiation between overgrazed, and rotationally grazed, pastures. If some of the pastures were on a rotational system, better cover would be available than with traditional practices.

Haying can have a dramatic effect on upland-nesting waterfowl depending on the frequency and season of activity (Kadlec and Smith 1992). If, for example, there is only one cut, it would be best if it occurred later in the summer after the nesting season. It would generally then, not have a negative effect on nesting waterfowl, unless the nesting season has been delayed. Duebbert and Frank (1984) recommended that mowing of nesting cover be delayed until July 21st, or even August first. It was not possible to determine from the results of the research the time at which haying had occurred.

Burning can be a harmful activity that could have an negative affect on waterfowl if handled improperly. Kadlec and Smith (1992) note that fire should be timed in relation to the period in the life history of waterfowl that the management plan is designed to enhance. Higgins (1986) noted that the nesting success of ducks was greater on fall burned than on spring burned plots. Conversely, Hochbaum et al. (1985) concluded that burning of pond margins alone, had little effect on breeding duck occupancy of small wetlands, but that further study was needed to determine if waterfowl production would be negatively affected.

Clearing was found to occur the least in the area under study. This activity differs from all others in that it usually occurs only once. After a pond has been cleared of the surrounding brush, other agricultural impacts will usually follow.

It should be noted that cultivation is an agricultural impact that occurs on the majority of wetlands, but in some cases the total margin is not impacted. That is to say some wetlands may only have a small portion of the margin cultivated while the remainder will be unaffected.

Conversely, grazing, haying, burning and clearing are usually total impacts, where the complete margin will be affected by the activity.

5.4 WATERFOWL PREDATORS

Land use changes have favoured the establishment and maintenance of predators that are adapted to prey on ducks, their eggs, and young in the prairie pothole region (Cowardin et al. 1983). Since there are only narrow strips of habitat surrounding these wetlands, predators have a relatively easy time of searching for prey. Sugden and Beyersbergen (1984) noted that nests in the remnants of natural cover were vulnerable to predators. If agricultural impacts reduce available habitat even more, predators are able to concentrate foraging efforts on these smaller patches of cover.

Taking this into account, it follows that the remnants of natural cover impacted by an activity, such as cultivation, would afford a good opportunity for predators to seek out waterfowl. This is providing, of course, that the birds have already nested in the remaining cover. Most predators, except mink and raccoon, prey on duck nests or adults occupying nests in upland habitats (Swanson and Duebbert 1986).

Other practices, such as haying or grazing, reduce the amount and density of cover available to provide concealment, even if a ten meter strip of margin surrounds the pond. Certain predators would be able to take advantage of this situation. Clark and Nudds (1991) found that the importance of concealment was dependant upon the predator community. For example, concealment for nest success was important when bird predation was prevalent, but when mammals, or both birds and mammals were present, nest concealment was much less important. As Smith (1971) stated, the American crow is an important egg predator of nesting parkland ducks.

5.5 MANAGEMENT INITIATIVES - RELEVANCE TO RESEARCH

According to the North American Waterfowl Management Plan (NAWMP), the major threats to both duck and geese populations continue to be the degradation and loss of habitat in breeding, migration and wintering areas (United States Fish and Wildlife Service and Canadian Wildlife Service 1986). As Turner and Caswell (1989) suggested, identification of factors which cause habitat loss is one of the first steps in resolving the problem. The NAWMP is an initiative that seeks to rebuild duck populations through habitat restoration programs. Consequently, it is useful to know what types of impacts are most prevalent in the available breeding habitat, and what types of ponds are most likely to be impacted. The NAWMP proposes to reverse the trend of habitat loss through direct and indirect programs.

Direct programs are designed to be delivered to landowners and involve adopting land-use practices that benefit waterfowl, and the promotion of soil and water conservation. Indirect programs attempt to change government policies which impact on the waterfowl resource (Turner and Caswell 1989).

There are a number of federal and provincial legislative acts, policies and programs that promote and encourage habitat destruction. These policies show little consideration for their long-term environmental consequences (Thornton et al. 1993, Rakowski and Jurick 1986, Weiss 1982, Sawatzky 1979). For example, Thornton et al. (1993) states that the Gross Revenue Insurance Plan (GRIP) has several flaws that may contribute to a negative impact upon the landscape. Among these are inadequate disincentives to prevent undesirable changes in land use, a failure to promote crop diversification, and production insurance that penalizes producers who adopt soil conservation practices. Farris and Cole (1981) stated that national agricultural policy is the primary influence on agricultural land use, and therefore on farmland wildlife habitat. Recognition of this is important to the implementation of any strategy for wildlife habitat restoration.

It will never be possible to buy all the land needed to protect sufficient duck habitat. Therefore, methods must be found to induce private landowners to manage their lands so as to maintain their value to waterfowl. Weiss (1982) suggested that a regional strategy towards habitat management should be considered. This would involve interaction among government officials, private landowners, and interested groups. This is supported by Mann (1974) who state that a balanced type of environmental planning would be the best approach.

Conservation easements and covenants are mechanisms which can be used to conserve land in its natural state, through either partial or complete restrictions on use or development (Scarth 1984). Although these management schemes may be effective, there is a problem with enforcing the agreement to ensure compliance (Scarth 1984, Sidle 1981).

The information provided by this research, will greatly assist in the development of management programs for specific areas of the prairies as suggested by Wiess (1982). For example, most of the high capability waterfowl habitat in Manitoba is located within the aspen parkland (Pierce 1981). Since some impacts are more prevalent in the parkland, it would be more efficient to address these impacts on a higher priority basis than in a grassland habitat. In other words, knowledge of the amount and distribution of agricultural impacts, provided by this research, may help to direct programs and funds into areas where greatest benefits can be expected.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 SUMMARY

Over 40 percent of the original wetlands in the prairie-parkland region of Canada have been lost. This is a serious problem which is further exacerbated by the continuing loss and degradation of wetlands (United States Fish and Wildlife Service and Canadian Wildlife Service 1986). The degradation of wetlands is influenced by several factors, including politics, attitudes, climate and economics (Leitch 1983, Sawatzky in press). Though wetlands have societal value, these habitats rarely convey any economic benefits to landowners. However, converting a wetland into agricultural production enables landowners to produce a commodity for which compensation can be received. The worth of wetlands must be translated into terms that can readily be understood and used by society (Brande 1980).

Governments have contributed to the problem with inconsistent programs, and policies, which in general have favoured wetland destruction (Turner and Caswell 1989, Rakowski and Jurick 1986). Boyd (1985) suggested that changes in marginal farming practices are presently the greatest threat to ducks, with respect to habitat loss. Much of the native pasture that remains in prairie Canada is in areas marginally suited to grain farming, and the potential threat to duck populations posed by the destruction of this habitat, is great. All possible strategies that may help to offset agricultural impacts should be considered by waterfowl managers (Zittlau 1979).

This research has determined that agricultural impacts have not changed significantly in recent years. From the research, it can be inferred, that if management plans are not successful, more destruction can be expected. The knowledge that this research provides is important to help improve habitat conditions that may assist in rebuilding waterfowl populations. However, efforts should also be made to pair this information with other management programs, such as restrictive hunting regulations. This would ultimately have a much greater effect in rebuilding duck populations, than simply considering this research in isolation from other management programs.

6.2 CONCLUSIONS

A number of trends and differences in transitory impacts across prairie Canada were examined and the following conclusions were reached.

(1) Transitory impacts occurred at different rates across the prairies, generally increasing from Manitoba in the east to Alberta in the west.

(2) The rate of total impacts remained high and did not significantly change during the five-year study period.

(3) A definite hierarchy of transitory impacts exists with cultivation being the most common, followed by grazing, haying, and to a lesser extent, burning and clearing.

(4) The above mentioned hierarchy of impacts remained the same within each prairie province as well as within the grasslands and parklands.

(5) Transitory impacts generally occurred at a higher rate in the grassland transects than in the parkland transects. Burning and clearing, however, were slightly higher in the parkland transects.

(6) Total impacts and cultivation decreased with water permanence although grazing, haying and burning displayed the reverse trend.

6.3 RECOMMENDATIONS

No single program or policy should be relied upon exclusively to achieve waterfowl habitat restoration or enhancement goals. All those who share in the future use of the prairies should strive towards a balanced approach of environmental planning. Bearing this in mind, the following recommendations are offered:

(1) An aggressive approach should be taken in educating landowners in the benefits of alternative farming practices, such as rotational grazing, delayed haying, and zero-till. However, education programs designed merely to inform landowners about the existence of habitat degradation may fail to increase the use of conservation practices. Therefore, direct programs delivered to the landowner that increase awareness should be followed up by the transfer of knowledge about practices that can solve the problem. Farmers would be the primary beneficiaries of such programs, through improved soil and water conditions. Waterfowl would be one of the secondary beneficiaries through improved habitat.

As alternative farming practices become commonplace and farmers learn to place greater value on the roles of wetlands and vegetative cover as conservers of soil and moisture, food and shelter for wildlife will at least be partially restored after years of destruction.

(2) Wildlife habitat management plans for waterfowl should be tailored to areas where they would have the greatest effect. The North American Wildlife Management Plan (NAWMP) should pay particular attention to the level of losses of existing wetland margins. As these areas have a demonstrated importance in the life cycle of waterfowl, consideration should be given to their maintenance and management in addition to new habitat creation.

Habitat management plans should also be targeted on the types of wetland habitat impacted the most by agricultural practices. For example, a delayed haying initiative or rotational grazing program would have a greater positive impact on improving waterfowl habitat in grassland areas than in parkland areas, where these practices occur at a lesser rate. These types of programs would also have a more positive effect on artificial wetlands, streams and more permanent ponds, than on ephemeral wetlands. Since we know that ephemeral wetlands are important in the early stages of the breeding season, it would also be prudent to direct effort into conservation tillage practices, that would directly effect these wetlands.

(3) Efforts should be directed into changing agricultural programs and policy. In the long run, indirect programs would have a great effect on the agricultural land base. For example, conservation easements have been used to a great degree in the United States, with some success. Attempts should be made to accelerate their use in Canada. The concept of providing income tax credits to individuals that donate conservation easements should be explored.

Programs such as the Gross Revenue Insurance Plan (GRIP) should be modified so that they no longer provide disincentives for crop diversification, and so that they provide adequate incentives to prevent negative changes in land use.

(4) Further study of the Waterfowl Breeding Population Survey (WBPS) database is recommended. Since 1991 the number of wetlands being surveyed by researchers in the WBPS has been increased to approximately 30,000. It may prove useful to examine the expanded survey to determine if the trends identified by this study still persist.

LITERATURE CITED

Adams, G.D. and G.C. Gentle. 1978. Spatial changes in waterfowl habitat, 1964-74, on two land types in the Manitoba Newdale Plain. Can. Wildl. Serv. Occ. Paper No. 38. 29p.

Archibald, D.W., and M.R. Wilson. 1980. The natural vegetation of Saskatchewan prior to agricultural development. Can. J. Botany. 58: 2031-2043.

Balser, D.S., H.H. Dill, and H.K. Nelson. 1968. Effect of predator reduction on waterfowl nesting success. J. Wildl. Manage. 32(4): 669-682.

Batt, B.D.J., M.G. Anderson, C.D. Anderson, and F.D. Caswell. 1989. The use of prairie potholes by North American ducks. In Northern Prairie Wetlands. Van Der Valk, A. ed. 204-227.

Bellrose, F.C. 1980. Ducks, geese and swans of North America. 3rd ed. Harrisburg, Pa.: Stackpole. 544p.

Boyd, H. 1985. The large-scale impact of agriculture on ducks in the Prairie Provinces, 1956-81. Can. Wildl. Serv. Prog. Notes 149. 13p.

________. 1981. A fair future for prairie ducks; cloudy further north. Trans. 46th N.A. Wildl. Conf. 85-93.

Brande, J. 1980. Worthless, valuable, or what? An appraisal of wetlands. J. Soil & Water Conserv. Jan-Feb. 12-16.

Bue, I.G., L. Blankenship and W.H. Marshall. 1952. The relationship of grazing practices to waterfowl breeding populations and production on stock ponds in western South Dakota. Trans. 17th N. Amer. Wildl. Nat. Resour. Conf. 396-414.

Canadian Wildlife Service. 1992. Status of migratory game birds in Canada with proposals for 1993 hunting regulations. Can. Wildl. Serv. unpubl. rep. December, 1992. 26p.

Caswell, F.D., R.C. Bazin, and M.H. Schuster. 1993. Prairie waterfowl status report: a briefing document. Can. Wildl. Serv. Unpubl. Rep.

____________, G.S. Hochbaum, D.J. Nieman and B.C. Turner. 1987. Temporal and geographic differences of mallard survival/recovery rates in prairie Canada. Trans. 52nd. N.A. Wildl. & Nat. Res. Conf. 285-297.

Christensen, L.A. and P.A. Norris. 1983. Soil conservation and water quality improvement: what farmers think. J. Soil and Water Cons. 38(1): 15-20.

Clark, R.G. 1988. Use of wetlands by breeding waterfowl. In Proceedings of the symposium on water management affecting the wet-to-dry transition: planning at the margins. W. Nicholaichuk & H. Steppuhn, eds. Water Studies Institute, Regina. 233-242

Clark, R.G. and T.D. Nudds. 1991. Habitat patch size and duck nesting success: the critical experiments have not been performed. Wildl. Soc. Bull. 19: 534-543.

______________, and R.O. Bailey. 1991. Populations and nesting success of upland-nesting ducks in relation to cover establishment. Can. Wildl. Serv. Prog. Note. 193: 6p.

Cowan, W.F. 1982. Waterfowl production on zero-tillage farms. Wildl. Soc. Bull. 10(4): 305-308.

Cowardin, L.M., and D.H. Johnson. 1979. Mathematics and mallard management. J. Wildl. Manage. 43: 18-35.

______________, D.S. Gilmer, and C.W. Shaiffer. 1985. Mallard recruitment in the agricultural environment of North Dakota. Wildl. Monogr. 92. 37p.

______________, A.B. Sargeant and H.F. Duebbert. 1983. Problems and potentials for prairie ducks. J. Nat. Hist. Soc. Minn. no.4

Derksen, D. V. and W.D. Eldridge. 1980. Drought displacement of pintails to the arctic coastal plain, Alaska. J. Wildl. Manage. 44(1): 224-229.

Duebbert, H.F. 1974. Nesting cover: a critical need for prairie ducks. Naturalist. 25: 25-27.

______________. 1969. High nest density and hatching success of ducks on South Dakota cap lands. Trans 35th N.A. Wildl. Conf. 218-228.

______________, and H.A. Kantrud. 1987. Use of no-till winter wheat by nesting ducks in North Dakota. J. Soil and Water Conserv. 42: 50-53.

______________, and A.M. Frank. 1984. Value of prairie wetlands to duck broods. Wildl. Soc. Bull. 12: 27-34.

______________, and H.A. Kantrud. 1974. Upland duck nesting related to land use and predator reduction. J. Wildl. Manage. 38: 257-265.

______________, J.T. Lokemoen, and D.E. Sharp. 1986. Nest sites of ducks in grazed mixed-grass prairie in North Dakota.Prairie Nat. 18: 99-108.

Dwernchuck, L.W. and D.A. Boag. 1972. How vegetative cover protects duck nests from egg-eating birds. J. Wildl. Manage. 36: 955-958.

Dwyer, T.J. 1970. Waterfowl breeding habitat in agricultural and nonagricultural land in Manitoba. J. Wildl. Manage. 34: 130-136.

Farris, A.L. and S.H. Cole. 1981. Strategies and goals for wildlife habitat restoration on agricultural lands. Trans. 46th N. Amer. Wildl. and Nat. Resour. Conf. 130-136.

Fritzell, E.K. 1975. Effects of agricultural burning on nesting waterfowl. Canadian Field-Naturalist 89(1): 21-27.

Gates, J.M. 1965. Duck nesting and production on Wisconsin farmlands. J. Wildl. Manage. 29(3): 515-523

Giroux, J.F. 1981. Use of artificial islands by nesting waterfowl in south-eastern Alberta. J. Wildl. Manage. 45: 669-679.

Gjersing, F.M. 1975. Waterfowl production in relation to rest-rotation grazing. J. Range Manage. 28(1): 37-42.

Greenwood, R.J., A.B. Sargeant, D.H. Johnson, L.M. Cowardin and T.L. Shaffer. 1987. Mallard nest success and recruitment in Prairie Canada. Trans. 52nd N.A. Wildl. & Nat. Res. Conf. 298-309.

Griffith, R. 1948. Improving waterfowl habitat. Trans. 13th N. Amer. Wildl. Conf. 609-618.

Hammond, M.C. 1964. Ducks, grain and American farmers. In Waterfowl Tomorrow. J.P. Linduska, ed. U.S. Dept. Interior, Bur. Sport Fisheries and Wildl. Washington, D.C. 417-424.

____________. 1940. Crow-waterfowl relationships on federal refuges. Trans. N. Am. Wildl. Resour. Conf. 5:398-404

Hansen, H.A., and D.E. McKnight. 1964. Emigration of drought-displaced ducks to the Arctic. Trans. N. Am. Wildl. Nat. Resour. Conf. 29: 119-129.

Hedlin, R. 1969. Economic values of small wetlands. In Saskatoon wetlands seminar., Can. Wildl. Serv. Rep. Ser. no.6. 25-28.

Higgins, K.F. 1986. A comparison of burn season effects on nesting birds in North dakota mixed-grass prairie. Prairie Nat. 18: 219-228.

____________. 1977. Duck nesting in intensively farmed areas of North Dakota. J. Wildl. Manage. 41: 232-242.

____________, and R.O. Woodward. 1986. Comparison of wetland drainage during and after protection by 20-year easements. Prairie Nat. 18: 229-233.

Hill, D.A. 1984. Factors affecting nest success in the mallard and tufted duck. Ornis Scand. 15: 115-122.

Hochbaum, G.S., and F.D. Caswell. 1990. The effects of drought and agricultural practices on prairie ducks. Can. Wildl. Service. unpubl. MS. 19p.

______________, R.K. Brace and W.F. Cowan. 1988. Wetland edges: buffer zones between agriculture and wildlife. In Proceedings of the symposium on water management affecting the wet-to-dry transition: planning at the margins. W. Nicholaichuk & H. Steppuhn, eds. Water Studies Institute, Regina. 245-256.

______________, F.D. Caswell, and A.H. Kooyman. 1985. Prairie waterfowl harvest program 1979-1984: A progress report on stabilized hunting regulations in Manitoba. Can. Wildl. Serv. unpubl. rep. Winnipeg. 96p.

______________, F.D. Caswell, B.C. Turner, and D.J. Nieman. 1987. Relationships among social components of duck breeding populations, production and habitat conditions in prairie Canada. Trans. 52nd N.A. Wildl. & Nat. Res. Conf. 310-319.

______________, L.T. Kummen and F.D. Caswell. 1985. Effects of agricultural burning on occupancy rates of small wetlands by breeding ducks. Can. Wildl. Serv. Prog. Notes. No. 155. 3p.

_______________, P.N. Hebert, and F.D. Caswell. In Prep. Correlation of wetland types with use by social components for five species of duck breeding in prairie Canada.

Hochbaum, H.A. 1944. The canvasback on a prairie marsh. American Wildlife Institute. Washington, D.C. 201p.

Holechek, J.L., R. Valdez, S.D. Schemnitz, R.D. Prieper, and C.A. Davis. 1982. Manipulation of grazing to improve or maintain wildlife habitat. Wildl. Soc. Bull. 10:204-210.

Hubbard, D.E. 1988. Glaciated prairie wetland functions and values: A synthesis of the literature. U.S. Fish & Wildl. Serv. Biol. Rep. 88(43). 50p.

Jarvis, R.L. and S.W. Harris. 1971. Land-use patterns and duck production at Malheur National Wildlife Refuge. J. Wildl. Manage. 35: 767-773.

Johnson, D.H., and J.W. Grier. 1988. Determinants of breeding distributions of ducks. Wildl. Monogr. 100:37p.

_______________, A.B. Sargeant and R.J. Greenwood. 1989. Importance of individual species of predators on nesting success of ducks in the Canadian Prairie Pothole Region. Can. J. Zool. 67: 291-297.

_______________, D.W. Sparling, and L.. Cowardin. 1987. A model of the productivity of the mallard duck. Ecol. Model. 38: 257-275.

Jones, R.E. and K.E. Hungerford. 1972. Evaluation of nesting cover as protection from magpie predation. J. Wildl. Manage. 36(3): 727-732.

Josephson, R.M. 1992. An economic evaluation of land use changes in southwestern Manitoba. A report to the Manitoba Habitat Heritage Corporation. Winnipeg. 51p.

Kadlec, J.A. and L.M Smith. 1992.Habitat management for breeding areas. In Ecology and management of breeding waterfowl. B.D. Batt, A.D. Afton, M.G. Anderson, C.D. Ankney, D.H. Johnson, J.A. Kadlec, and G.L Krapu, eds. Univ. of Minn. Press. Minneapolis, MN. 590-610.

Kalmbach, E.R. 1937. Crow-waterfowl relationships in the prairie provinces. Trans. 2nd N. Am. Wildl. Conf.: 380-392.

Kaminski, R.M. and H.H. Prince. 1981. Dabbling duck and aquatic macroinvertebrate responses to manipulated wetland habitat. J. Wildl. Manage. 45(1): 1-15.

Kantrud, H.A., and R.E. Stewart. 1977. Use of natural basin wetlands by breeding waterfowl in North Dakota. J.Wildl. Manage. 41: 243-253.

Keith, L.B. 1961. A study of waterfowl ecology on small impoundments in southeastern Alberta. Wildl. Monographs No. 6.

Kiel, W.H., A.S. Hawkins, and N.G. Perret. 1972. Waterfowl habitat trends in the aspen parkland of Manitoba. Can. Wildl. Serv. Rep. no.18, 61p.

Kirsch, L.M. 1969. Waterfowl production in relation to grazing. J. Wildl. Manage. 33: 821-828.

_____________, H.F. Duebbert, and A.D. Kruse. 1978. Grazing and haying effects on habitat of upland nesting birds. Trans.43rd N.A. Wildl. Conf. 486-497.

Klett, A.T., T.L. Shaffer, and D.H. Johnson. 1988. Duck nest success in the Prairie Pothole region. J. Wildl. Manage. 52: 431-440

_____________, H.F. Duebbert, and G.L. Heismeyer. 1984. Use of seeded native grasses as nesting cover by ducks. Wildl. Soc. Bull. 12: 134-138.

Krapu, G.L. 1981. The role of nutrient reserves in Mallard reproduction. Auk. 98: 29-38.

___________. 1979. Nutrition of female dabbling ducks during reproduction. Pages 59-70 in T.A. Bookhout, ed., Waterfowl and wetlands - an integrated review. Proceedings of a symposium held at the 39th Midwest Fish Wildl. Conf. December 1977, Madison, Wisconsin.

___________. 1974. Foods of breeding pintails in North Dakota. J. Wildl. Manage. 38(3): 408-417.

___________, L.G. Talent and T.J. Dwyer. 1979. Marsh nesting by mallards. Wildl. Soc. Bull. 7(2): 104-110.

Leitch, W.G. and R.M. Kaminski. 1985. Long-term wetland-waterfowl trends in Saskatchewan grassland. J. Wildl. Manage. 49(1): 212-222.

Leitch, J.A. 1983. Economics of prairie wetland drainage. Trans. Amer. Soc. Agric. Eng. 26: 1465-1470.

Lodge, R.W. 1967. Agricultural use of wetlands. Can. Wildl. Serv. Rep. no.6. 11-15.

Mann, G.E. 1974. The prairie pothole region. A zone of environmental opportunity. Naturalist. 25(4): 2-7.

Martz, G.F. 1967. Effects of nesting cover removal on breeding puddle ducks. J. Wildl. Manage. 31: 236-247.

Millar, J.B. 1976. Wetland classification in western Canada: a guide to marshes and shallow open water wetlands in the grasslands and parklands on the prairie provinces. Can. Wildl. Serv. Rep. Ser. no. 37. 38p.

Morgan, J.P. 1985. An analysis of landowner attitudes toward techniques of wetland preservation in the prairie pothole district of Manitoba. Natural Resources Institute. University of Manitoba. 112p.

Mulhern, J.H., T.D. Nudds and B.R. Neal. 1985. Wetland selection by mallards and blue-winged teal. Wilson Bull. 97: 473-485.

Mundinger, J.G. 1976. Waterfowl response to rest-rotation grazing. J. Wildl. Manage. 40(1): 60-68

Nelson, H.K. and D.F. Duebbert. 1973. New concepts regarding the production of waterfowl and other game birds in areas of diversified agriculture. Int. Congr. Game Biol., Stockholm, Sweden. XI 18p.

Olton, D.S., G.E. Handelmann, and J.A. Walker. 1981. Spatial memory and food searching strategies. In Foraging behaviour: ecological, ethological, and physical approaches. A.C. Kamil and T.D. Sargent, eds. Garland STPM Press, New York. 333-354.

Peterson, C.C. and C.. Madsen. 1981. Property tax credits to preserve wetlands and native prairie. Trans. 46th N. Am. Wildl. and Nat. Res. Conf. 125-129.

Pierce, T.W. 1981. Canada Land Inventory, land capability for wildlife-waterfowl. Summary report. Environment Canada Lands Directorate. Rep. No. 16: 20p.

Rakowski, P.W. and D.R. Jurick. 1986. A review of legislation to determine its effect on migratory bird habitat. Can. Wildl. Serv. MS rep. No. WNR 86-3.

_______________, R.W. Nero and R.C. Hutchison. 1974. Present status of waterfowl habitat in the prime duck production area of Manitoba. Can. Wildl. Serv. Winnipeg. 10p.

Reardon, J.D. 1951. Identification of waterfowl nest predators. J. Wildl. Manage. 15: 386-395.

Rodgers, R.D. 1983. Reducing wildlife losses to tillage in fallow wheat fields. Wildl. Soc. Bull. 11(1): 31-38.

_____________. and J.B. Wooley. 1983. Conservation tillage impacts on wildlife. J. Soil and Water Conserv. 38(3): 212-213.

Rogers, J.D. 1964. Effects of drought on reproduction of lesser scaup. J. Wildl. Manage. 28: 213-222.

Ryder, J.P., and D.A. Boag. 1981. A Canadian paradox - private land, public wildlife: can it be resolved? Canadian Field-Naturalist. 95: 35-38.

Sargeant, A.B., and P.M. Arnold. 1984. Predator management for ducks on waterfowl production areas in the northern plains. In Proc. Eleventh Verte. Pest. Conf. Calif., Davis. D.O. Clark, ed. 161-167.

Sawatzky, H.L. 1979. Prairie potholes. Blue Jay. 37(1): 3-8

______________. In Press. Misfit institutions, rational decisions, endangered species.

Sayler, R.D., R.A. Stromstad and M.E. Winger. 1984. Wetland preservation conflicts in North Dakota: economic incentives and landowner attitudes. Prairie Nat. 16(2): 63-78.

Scarth, J. 1984. A review of private land habitat programs. Natural Resources Institute, University of Manitoba. Winnipeg, Manitoba. 110p.

Schranck, B.W. 1972. Waterfowl nest cover and some predation relationships. J Wildl. Manage. 36(1): 182-186.

Shaw, S.P. and C.G. Fredine. 1956. Wetlands of the United States, their extent, and their value to waterfowl and other wildlife. U.S. Dept. of Interior, Fish and Wildl. Serv. Circular 39, Washington, D.C. 67p.

Sidle, J.G. 1981. Wetland easements and their enforcement in North Dakota. Wildl. Soc. Bull. 9(4): 273-279.

Smith, A.G. 1971. Ecological factors affecting waterfowl production in the Alberta parklands. U.S. Fish and Wildl. Serv. Resour. Publ. 98. 49p.

___________, J.H. Stoudt, and J.P. Gollop. 1964. Prairie potholes and marshes. In Waterfowl Tomorrow. J.P.Linduska, ed. U.S. Gov. Printing Off., Washington, D.C. 39-50.

Smith, R.I. 1970. Response of pintail breeding populations to drought. J. Wildl. Manage. 34: 943-946.

Sowls, L.K. 1955. Prairie Ducks. A study of their behaviour, ecology and management. Wildlife Management Institute. Library of Congress. 193p.

Stewart R.E. and H.A. Kantrud. 1973. Ecological distribution of breeding waterfowl populations in North Dakota. J. Wildl. Manage. 37(1): 39-50.

Stoudt, J.H. 1971. Ecological factors affecting waterfowl production in the Saskatchewan parklands. U. S. Fish Wildl. Serv. Resour. Publ. No. 99.

Sugden, L.G, and G.W. Beyersbergen. 1987. Effects of nesting cover density on American Crow predation of simulated duck nests. J. Wildl. Manage. 51: 481-485.

_________________________________. 1985. Prediction of duck nest survival in conventional and zero-tilled stubble fields. Can. Wildl. Serv. Prog. Note 156:6p.

_________________________________. 1984. Farming intensity on waterfowl breeding grounds in Saskatchewan parklands. Wildl. Soc. Bull. 12: 22-26.

Swanson, G.A. and M.I. Meyer. 1977. Impact of fluctuating water levels on feeding ecology of breeding blue-winged teal. J. Wildl. Manage. 41(3): 426-433.

_____________, T.L. Shaffer, J.. Wolf, and F.B. Lee. 1986. Renesting characteristics of mallards on experimental ponds. J. Wildl. Manage. 50: 32-38.

Talent, L.G., G.L. Krapu, and R.L. Jarvis. 1982. Habitat use by mallard broods in south central North Dakota. J. Wildl. Manage. 46: 629-635.

Thornton, F., J. Bowman, and D. Struthers. 1993. Agricultural policy review part 1: Gross Revenue Insurance Plan. Blue Jay. 51(1): 5-9.

Trauger, D.L. and J.H. Stoudt. 1979. Spatial and temporal habitat relationships of breeding dabbling ducks in prairie wetlands. In Waterfowl and wetlands - an integrated review. T.A. Bookhout, ed. North Central Section, Wildl. Soc., Madison, Wisconsin.

______________________________. 1978. Trends in waterfowl populations and habitats on study areas in Canadian parklands. Trans. 43rd N. Am. Wildl. and Nat. res. Conf. 187-205.

Trottier, G.C. 1992. Conservation of Canadian prairie grasslands. A landowners guide. Canadian Wildlife Service. 92p.

Turner, B.C. and F.D. Caswell. 1989. Waterfowl population and habitat status. 6th International Waterfowl Symposium. K.H.Beattie, ed. 12-26.

___________, G.S. Hochbaum, F.D. Caswell, and D.J. Nieman. 1987. Agricultural impacts on wetland habitats on the Canadian prairies, 1981-1985. 206-215.

United States Fish and Wildlife Service and Canadian Wildlife Service. 1988. 1988 status of waterfowl and fall flight forecasts. 40p.

____. 1987. Standard operating procedures for aerial waterfowl breeding ground population and habitat surveys in North America. 100p.

____. 1986. North American Waterfowl Management Plan. 19p.

Weiss, P.J. 1982. Waterfowl habitat preservation: the potential role of federal and Manitoba legislation. Natural Resources Institute, University of Manitoba. Winnipeg, Manitoba. 93p.

Zittlau, W.T. 1979. An environmental assessment of agricultural practices and policies: Implications for waterfowl habitat management. Natural Resources Institute, University of Manitoba. Winnipeg, Manitoba. 282p.

APPENDIX A

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

PROVINCE/STATE: STRATUM: TRANSECT: SEGMENT: - GLENOR MAY ____, 19___ SHEET 8 OF 19

CREW LEADER: ____________ ASSISTANTS: ____________ START: _____ FINISH: _____ (CST)

WIND: CLOUD: PRECIP:

POND NO.	MW	POND TYPE	BASIN	MARGIN	UPLAND	MAL	BLK	GAD	WIG	GWT	BWT	SHO	PIN	RED	CAN	SCP	RNG	GOL	BUF	SCO	RUD	MER	OTH	TOTAL	COOT
		WETLANDS				WATERFOWL SPECIES																			
67	7	FP		100 H 30 C	50 H 50 F																				
68	4	3/6		100 H 60 C	50 F 50 C																				
69	4	FP		100 H 60 C	50 F 50 C																				
69A	4	FP		100 H 60 C	50 F 50 C																				
70	0	1/3	100 C	100 C	100 C																				
71	4	3/5		60 C 100 H	100 H																				
72	10	3/5		100 H	100 H																				
73	2	3/6		80 C	100 F																				
73A	0	DRY	100 C	100 C	30 S 70 F																				
73B	0	DRY	100 D	100 C	100 F																				
73C	2	FP		80 C	100 F																				
73D	0	DRY	100 C	100 C	100 F																				

Figure 1: Ground crew data form

APPENDIX B

Table 1. Percentage of total impacts on wetland margins in Prairie Canada. (Pond types III-V, streams and artificials)

YEAR	AB	SK	MB	Total Prov.	Total Grass.	Total Park.
1986	91	74	75	78	84	76
1987	90	64	74	70	80	65
1988	85	67	75	74	79	72
1989	89	71	73	78	85	73
1990	89	69	74	78	84	75
1986-90 AVG.	89	70	74	76	83	72

Table 2. Percentage of total impacts on wetland margins by wetland type in Prairie Canada (1986-90 averages)

Pond Type	AB	SK	MB	Total Prov.	Total Grass.	Total Park.
DRY	95	92	89	92	94	91
I	94	88	86	89	91	88
III	91	75	82	79	85	77
IV	81	63	73	69	84	65
V	77	48	63	60	77	57
Streams	87	58	70	76	83	69
Artificials	92	62	66	75	79	72
III-V	88	72	78	76	85	73
III-V, Art. & Str.	89	70	74	76	83	72
I, III-V, Art, Str.	90	73	77	78	84	76
Total Ponds	93	87	84	88	91	86

Table 3. Percentage of cultivation on wetland margins in Prairie Canada. (Pond types III-V, streams and artificials)

YEAR	AB	SK	MB	TOTAL PROV.	GRASS.	PARK.
1986	41	45	37	43	41	43
1987	37	36	41	35	36	35
1988	32	46	43	41	35	43
1989	38	47	40	42	48	38
1990	39	49	41	44	45	43
1986-90 AVG.	38	44	40	41	41	41

Table 4. Percentage of cultivation on wetland margins by wetland type in Prairie Canada (1986-90 averages)

Pond Type	AB	SK	MB	Total Prov.	Total Grass.	Total Park.
DRY	68	81	75	78	77	78
I	55	74	63	66	64	66
III	45	53	55	51	49	51
IV	33	39	46	39	43	38
V	26	21	38	25	10	27
Streams	24	12	19	19	14	22
Artificials	38	26	25	31	39	25
III-V	40	49	52	47	47	46
III-V, Art. & Str.	38	44	40	41	41	41
I, III-V, Art, Str.	42	50	46	46	45	46
Total Ponds	58	73	62	68	68	68

Table 5. Percentage of grazing on wetland margins in Prairie Canada.
(Pond types III-V, streams and artificials)

YEAR	AB	SK	MB	TOTAL PROV.	GRASS.	PARK.
1986	46	17	22	24	33	21
1987	49	17	24	25	35	21
1988	48	13	21	24	40	20
1989	45	17	25	30	34	26
1990	45	16	25	29	37	26
1986-90 AVG.	47	16	23	26	35	22

Table 6. Percentage of grazing on wetland margins by wetland type in Prairie Canada (1986-90 averages)

Pond Type	AB	SK	MB	Total Prov.	Total Grass.	Total Park.
DRY	23	8	10	11	14	9
I	34	7	10	15	22	13
III	39	13	16	19	28	16
IV	39	13	14	19	36	15
V	44	17	18	27	68	21
Streams	61	34	38	46	59	37
Artificials	53	28	30	38	36	40
III-V	40	13	16	20	30	16
III-V, Art. & Str.	47	16	23	26	35	22
I, III-V, Art, Str.	44	15	20	24	33	20
Total Ponds	31	9	14	15	19	13

Table 7. Percentage of haying on wetland margins in Prairie Canada. (Pond types III-V, streams and artificials)

YEAR	AB	SK	MB	TOTAL PROV.	GRASS.	PARK.
1986	6	11	12	10	10	10
1987	7	10	12	9	11	8
1988	8	8	10	9	7	9
1989	8	5	12	8	6	9
1990	8	5	11	8	6	8
1986-90 AVG.	8	9	12	9	9	9

Table 8. Percentage of haying on wetland margins by wetland type in Prairie Canada (1986-90 averages)

Pond Type	AB	SK	MB	Total Prov.	Total Grass.	Total Park.
DRY	6	4	6	4	4	5
I	7	7	7	7	6	7
III	10	9	11	9	9	9
IV	9	11	12	10	6	11
V	9	11	8	9	2	10
Streams	4	10	14	12	13	9
Artificials	5	6	13	7	8	7
III-V	10	9	11	9	8	10
III-V, Art. & Str.	8	9	12	9	9	9
I, III-V, Art, Str.	7	8	11	9	8	9
Total Ponds	6	5	8	6	5	6

Table 11. Percentage of clearing on wetland margins in Prairie Canada. (Pond types III-V, streams and artificials)

YEAR	AB	SK	MB	TOTAL PROV.	GRASS.	PARK.
1986	1	1	3	2	0	2
1987	0	1	1	1	0	1
1988	0	1	1	1	0	1
1989	0	1	0	0	0	1
1990	0	1	1	1	0	1
1986-90 AVG.	0	1	2	1	0	1

Table 12. Percentage of clearing on wetland margins by wetland type in Prairie Canada (1986-90 averages

Pond Type	AB	SK	MB	Total Prov.	Total Grass.	Total Park.
DRY	0	1	1	1	0	1
I	0	1	2	1	0	1
III	0	1	2	1	0	1
IV	0	2	3	2	1	2
V	0	1	2	1	0	1
Streams	1	1	1	1	0	1
Artificials	0	1	0	1	0	1
III-V	0	1	2	1	0	1
III-V, Art. & Str.	0	1	2	1	0	1
I, III-V, Art, Str.	0	1	2	1	0	1
Total Ponds	0	1	1	1	0	1