DESIGN GUIDELINES

FOR

HABITAT REINTRODUCTION WITHIN AGRICULTURAL LANDSCAPES

A DEMONSTRATION STUDY

by

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A Practicum Submitted in Partial fulfillment
of the Requirements for the Degree
Master of Landscape Architecture.

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Winnipeg, Manitoba, Canada
1988

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ABSTRACT:

In southern Manitoba, there is a significant need to reintroduce diverse, ecologically sound environments to redress serious events of watershed habitat loss and accompanying landscape deterioration. Soil erosion, water pollution, and declining wildlife populations are the results of current agricultural practices and policy.

The adoption of ecologically sound farming and water management practices compatable with the environmental requirements of native plant and animal communities will restore stability to the local ecosystem, diversity and interest to the landscape and a stronger sense of place for people of the region.

This study describes methods for effectively reintroducing habitat as part of a farms drainage network and the positive effect this has on soil and water conservation, both of which ultimately stimulate increased agricultural production.

1. Introduction:

1.1 General Prospect:

In a recent newspaper article, Mr. Monte Hummel, the current president of the World Wildlife Fund of Canada declared;

> "The prairie grasslands and the aspen parklands are the most endangered wildlife habitat in this country," . . . "it houses just about half of the endangered birds and mammals that have been classified in Canada."1

In further remarks he states that; " 70% of the worlds' extinctions are caused by the loss of habitat, and currently there are 168 species on the endangered species list in Canada."[2] In southern Manitoba, an estimated 70 % of the wetland habitat has been lost since 1928[3] and a significant portion of the remainder is at risk. These alarming statistics and are sure to increase unless action is taken to reverse the trend.

The impact of habitat removal on the environment is pervasive and effects a broad, interconnected system of soil, water, plants, animals and people. As a result, actions taken to improve the viability of marginally productive farmland typically have far greater regional costs than the net benefit to the individual landowner. Mr. Hummels' summary exhorts; "people and governments have to learn how to conserve ecological systems in times of drought and when climate conditions improve."[4].

The loss of prairie watershed habitats and "wetland" potholes has lessened this potentially rich lands' ability to carry diverse wildlife populations and has fostered myriad environmental problems. The land is losing its ability to support our population as well as wild populations of plants and animals, and in vast areas can no longer retain the moisture and subsequently the food producing soil resources needed by human and animal populations alike.

The increasingly apparent causes of environmental problems need to be addressed with a view to establishing a balance between the need for productive agricultural land and the need to; protect the lands abililty to produce; sustain native populations of plants and animals, buffer the environment against the extremes of the prairie climate, and direct the appropriate utilization of land for non - agricultural uses.

1.2 Purpose of Study

This study describes methods for effectively reintroducing habitat as part of a farms drainage network and explores the merits of small scale wateshed rehabilitation projects and their impact on the ecology and visual landscape. The focus is on the tangible advantages of establishing an environmental heirarchy within any given landscape or watershed region.

The overall goal of this practicum is to outline a strategy and guidelines for reintroducing habitat on a site specific basis. The guidelines can be used to assist landowners, concerned with restructuring their specific drainage control needs, to adapt habitat reintroduction methods to differing sites and conditions.

The aims of this practicum are twofold. Assessment of the typical circumstances and consequential impact of habitat deterioration on the local and regional environment will define a set of goals and objectives for the restoration of deteriorating local watershed areas. The goals and objectives framework will be used to formulate guidelines for the resurrection of obliterated drainage courses and networks.

The guidelines will outline the short and long term actions required for successful habitat reintroduction and the specific requirements of other related uses and activities. Strategies are site specific; dealing with ponds and impoundments, in addition to drainage courses, however the principles can be applied regionally. Other avenues of exploration will reveal opportunities for the design and integration of natural communities and the spinoff benefits for agriculture, recreation and tourism.

As a follow up, the principles of habitat reintroduction and development of the on-farm drainage network will be demonstrated by applying guidelines to a specific site.

Using criteria developed for site selection, design opportunities are explored for the sites restructuring and long term use. Applying principles for habitat reintroduction and design guidelines will

demonstrate how the reintroduction and development of ecologically diverse habitats should be integrated into the existing farm landscape. The demonstration will focus on the significant benefit reintroducing habitat will have for the people and wildlife of a region or place.

The demonstration study will examine a small, farming site, northwest of Winnipeg, describe the opportunities present and propose restructuring of the local drainage network within which habitat reintroduction would take place.

The main objectives are:

1.) outline drainage management and utilization for the improvement of soil and water quality

2.) structure habitat around the drainage network for the improvement of wildlife ecology

3.) reintroduction of wildlife habitat as a means of increasing local recreation opportunities and diversity of the landscape

The backdrop is a working agricultural landscape which will remain, will shape and be shaped by habitat reintroduction.

ENDNOTES:

1"Climatic shift raises fears for wildlife," Winnipeg Free Press, 26 June 1988, sec. 1, p. 2.

2 ibid p.2

3 Province of Manitoba, Department of Mines, Resources & Environmental Managemnent pamphlet: Habitat Enhancement Landuse Program.

4"Climatic shift raises fears for wildlife," Winnipeg Free Press, 26 June 1988, sec. 1, p. 2.

2. Background Issues:

The complexity of environmental systems and creation by governments of functional agencies committed to the preservation or enhancement of single or a select few environmental values[1] leads to narrowly focused problem solving. This reflects the increasing trend toward specialization in many areas of human activity. A compounding influence is the assumption that scarcity is the greatest problem facing society. This perception leads to increased output in terms of increased agricultural acreage and expanded land drainage, etcetera. In an effort to overcome the perception, however many items of value to people such as beauty, diversity, self development and growth, a pleasing environment, are often given secondary consideration[2].

The aim of any strategy for revising our approach to problems involving the land is to reconcile human and environmental needs and frame a solution to fit those needs. The challenge of this approach will be to deal with interrelated problems using a wholistic methodology, integrating all aspects of the environment.

The issues relating to the agricultural community and their resulting environmental impact are categorized below. Reducing the negative impact of human activity is crucial for the longterm survival of many wild species and is one focus of this study.

2.1 Farm economic and social crisis:

The definition of the farm has been undergoing a gradual shift. In the traditional view, the farm is seen as the families "homestead" and as such is a sacred entity to be kept within the family group in perpetuity. This is a widely held belief and one that has emotionally charged the process surrounding this decades' nationwide spate of the farm foreclosures. Families live on the farm, have a sense of the seasons through which they work the land. The farm is the centre of social, financial and spiritual life, and an active part of the larger farm and rural community.

This contrasts sharply with the increasing trend towards large, fragmented farming operations run as agri-businesses, where the emphasis is on corporate rather than family goals. Under this system of tenure landowners are generally not residents and neither are their staff. The transition from family farm to corporate farm typically involves the consolidation of operating facilities to central locations, making many former farm yards redundant. These are then removed to increase productive acreage. The resulting loss of landmarks and places erodes what is regarded as "countryside". It is fair to say that the real farm crisis on the prairies is an ecological one; the farmers are manageing, but the land is in dire peril.[3] What emerges is a landscape less ecologically sound and of less visual interest than its predecessor.

The current polarity within the farming community is summarized clearly by the following passage from Lois Ross' book Prairie Lives; the changing face of farming:

"There are two types of farmers, the entrepreneur and the interdependent, environmentally concerned farmer, representing the differences between agribusiness and agriculture. Agribusiness refers to a corporate-controlled agriculture and, as authors Roger Burbach and Patricia Flynn put it in their book AGRIBUSINESS IN AMERICA, "an integrated food system that extends from farm to factory to consumer - from food production to the manufacture of farm implements and pesticides to food processing and food marketing." It is an industrial form of farming where success is based on specialization and expansion, with profit the main concern. The strategy is short-term and fast-paced.

Agriculture on the other hand, has traditionally placed emphasis on a sense of rural community and the things that sustain a community or culture. The emphasis, rather thatn being primarily on the dollar sign, is placed on such factors as a strong population base, meaning many farmers, and cooperation among neighbours and within the community, and protection of the environment and the soil through diversity. This means of course protection of a whole livelihood for the future generations of farmers who will make up the community and farm the land."4

Issues:

- declining rural populations and an increasing sense of isolation makes distances seem greater and the sense of isolation more pronounced
- increasing per capita infrastructure costs due to declining population
- political disparity between rural and urban areas (80% of global population in year 2000 will be urban)
- loss of family farms and a sense of community
- lack of job opportunities in rural communities
- need to develop alternate, additional revenue sources from the land
- general lack of tourist attractions and recreation opportunities in many farming areas
- conflict between agricultural, recreational and residential land uses

2.2 Soil erosion:

Canada is facing the worst agricultural crisis in its history and will lose a major portion of its production capability unless action is taken quickly[5]. Erosion is accelerated by summer fallow, certain types of machinery and monoculture farming due primarily to the desire for increased productivity.

Trees slow snow melt in the spring, extending the runoff period. Standing stubble performs a similar function at the micro climatic level. The reverse is true of summer fallow which, at the soil surface, acts as a heat sink and actively facilitates snow melt, at a time when the ground is frozen and cannot absorb the available surface moisture. Estimates put the loss of available moisture over the 20 month fallow period at 75 to 95%[6]. The situation is aggrevated in soils low in organic content, which tend to compact, then freeze, forming an impervious barrier to moisture absorption and retention. The net result is an increase in surface runoff, a situation which worsens if followed by a drier than normal growing season.

Issues:

- erosion damage due to wind: regional and site specific
- loss of shelter belts
- summer fallowing and excessive soil tillage
- removal of soil cover and organic material in the surface soil layer through burning of crop residues
- erosion damage due to flowing water: regional and site specific

2.3 Flooding and drainage control:

Due to flat topography and the clay soils of southern Manitoba, much of the area is subject to precipitation excess in terms of agricultural suitability. Figure 1 shows those parts of the province most directly affected. Historically, provincial policy has actively pursued land drainage and encourage landowners to drain land to increase agricultural capacity. Current reconstruction costs per mile of drain run between 30,000 and 50,000 exclusive of land costs.[7] Today, much of the spending is aimed at flood damage reduction, bridge replacement, drain reconstruction, upgrading of dyking and drain maintenance.

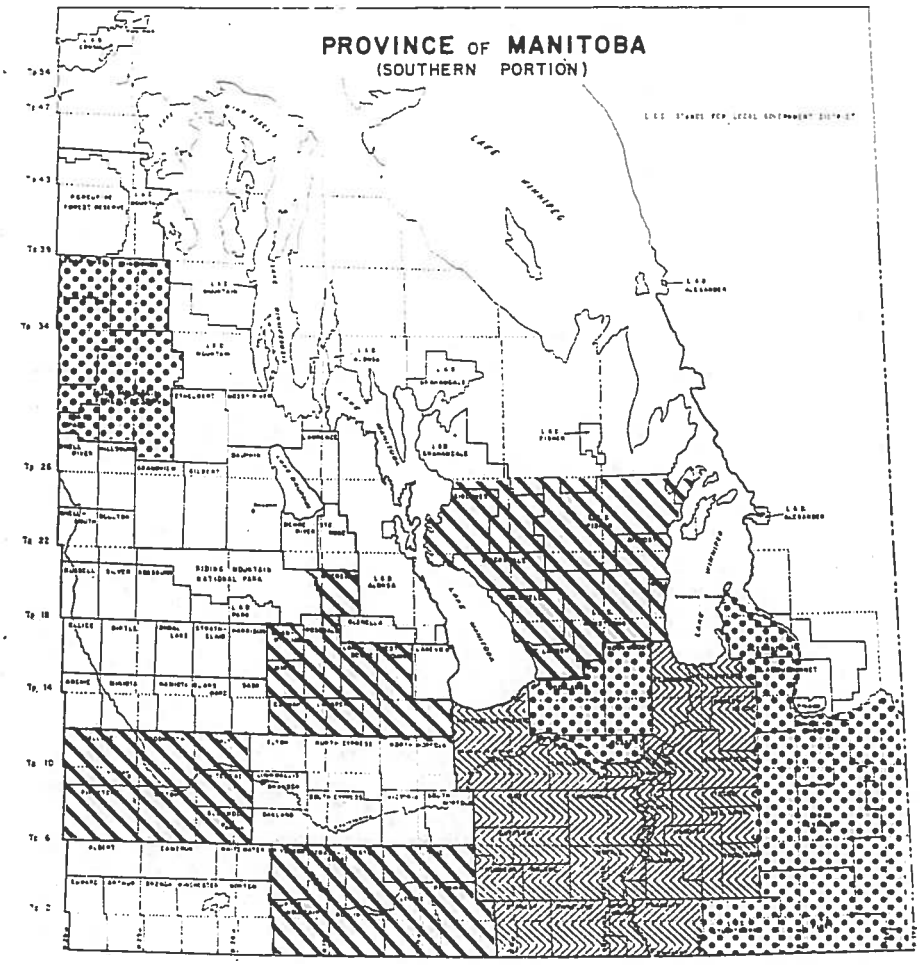
Issues:

- inundation of cropland (seasonal or event) chronic and occasional (spring runoff and storm)
- removal of excess precipitation from croplands; spring
- downstream flooding increase due to the expansion and alteration of natural drainage networks to accommodate agricultural production
- increasing capital costs for development of flood control measures to protect downstream regions
- increasing cost of maintenance of provincial drains (cleaning out silt and plant growth)

2.4 Water pollution:

Canadians typically over estimate the size of the freshwater resource and are of the attitude that water is an expendible commodity.[8] Pollution is a by-product of this perception.

GEOGRAPHIC DISTRIBUTION OF LANDS
SUSCEPTIBLE TO PRECIPITATION EXCESS



Group 1

Group 2

Group 3

Group 4

Fig. 1: Manitoba lands subject to occassional precipitation excess.

As a result, the effect of sediments and pollution on freshwater lakes and rivers increases algal growth and turbidity, reduces water quality, supresses natural plant growth and lowers recreation value. In most cases, due to the costs of dredging and chemical treatment, cleanup is normally impractical, therefore emphasis in eutrophication control must be on prevention.[9] This will require effective planning and management in the watershed.

Currently, the costly removal of sediment constitutes a large expenditure by provincial authorities. Compiled records indicate that expenditures to the mid 1970's for the maintenance of agricultural drains averaged around 2.8 million dollars annually (1976 $) or 5-6 million if converted to 1988 dollars.[10]

As an example, the Turtle River Conservation District expects to be spending 75% of its annual drainage budget which currently is 1.7 million, on drain maintenance by the year 1995.[11] In response, their strategy for reducing costs is to improve vegetative cover and create wildife habitat. This method of prevention costs as little as one fifteenth of the cost of sediment removal.[12]

Issues:

- increased sediment volumes in spring and storm runoff
- excessive nutrient loading from farm fertilizers, feedlot operations accelerates process of eutrophication of lakes and rivers
- downstream water pollution
- ground water contamination by fertilizer and chemical pesticide residues

2.5 Contemporary farming practice:

The green revolution has increased global food production, in turn creating a glut of those food stuffs produced by Canadian farmers. Over supply has meant slumping prices and a decline in farm income. Rising input costs due to infertility and increasing mechanization exascerbate the financial dilemna. In order to make a profit, farmers caught in this situation see expanding their cropping operation as the only way to increase revenues. The current Canadian Wheat Board grain quota system magnifies this problem by basing volume sold on actual cultivated acreage.[13]

"Farmers who need to pay for expensive equipment through maximum production often plough away wind-breaks and waterways or cultivate steep slopes. They may increase production but they also create new erosion problems for themselves, and for others".[14]

This effort to service increasing debt load increases demand for productive farm acreage. The acreage can be obtained by clearing current holdings or buying additional lands and fully utilizing these acquired areas. This process speeds the rate of habitat loss. The removal of treed areas increases the risk of wind erosion and cleared land increases runoff rates and peak flood elevations downstream.

Issues:
- dependance on agricultural monoculture
- declining soil quality; fertility

- heavy reliance on chemical fertilizers to sustain crop yields
- increasing size and capital cost of farm implements
- increasing average farm size; gross acreage
- loss of homesteads (farm yards) as land is consolidated
- detrimental effect of contemporary farming practices on soil and water quality

2.6 Habitat loss; landscape and environmental damage:

Clearing the land changes the landscape and is the obvious clue to the environmental changes that are occuring. The loss of landmarks and landscape features is the most readily perceived consequence of land clearing. The subsequently felt environmental costs are not as clearly definable, nor understood by the general public, decision making agencies or at times, the scientific community.

Habitat loss occurs through disturbance of an ecologically stable area and the removal of certain essential components. This loss may be partial, where the carrying capacity of the altered environment is reduced or when it can no longer support certain species, or the loss may be total when the resulting environment is suitable only for an entirely different set of organisms.

Erosion of the visual landscape is the loss of places or landmarks, commonly and historically associated with a geographic area or locality. The obliteration of rural

landmarks is often the combined result of farm consolidation, road construction or water control and drainage projects. The requirements of modern farm equipment, and the move toward ever larger machines results in the removal of trees, bush, potholes and small water courses in order to facilitate farming operations. Coupled with the desire for higher production acreage, the loss of valuable habitat continues, despite the dubious net gain from the practice of bringing marginally productive lands under cultivation. In terms of wildlife habitat, water conservation, on-site runoff retention, groundwater recharge, erosion protection and visual diversity the net regional loss outweighs the small benefit accruing to individual landowners.

The loss of landmarks leaves a landscape less visually diverse, less "knowable" for the local population and of less interest and intrinsic beauty to passersby. This perception is magnified in the absence of significant topography and by a grid land subdivision system that locates objects in the landscape with little regard for natural features or topography. This description fits the farming country of southern Manitoba.

Issues:

- declining wildlife habitat acreage
- effect of herbicide and pesticide use on native populations of plants and animals.
- loss of wildlife populations and the associated spiritual value of these natural resources.
- loss of places and local, regional landmarks

- loss of visual diversity
- loss of shelter belts
- species extinctions and genetic resources, diversity

Endnotes:

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1 Neil A. Swainson, ed. Managing the Water Environment. (Vancouver: University of British Columbia Press, 1976) p.19

2 ibid. p.99

3 Carole Giangrande, Down to Earth: The Crisis in Canadian Farming (Toronto: House of Anansi Press Ltd., 1985), p. 76

4 Lois L. Ross. Prairie Lives: the changing face of farming.(Toronto, Between the Lines, 1985) p. 85

5 Soils at Risk: Canadas' Eroding Future. A Report on Soil Conservation by the Standing Committee on Agriculture, Fisheries, and Forestry, to the Senate of Canada, Hon. H. O. Sparrow, Chairman (Ottawa: Senate of Canada, 1984), p.3

6 Fred, A. Curtis, Face of the Prairies: 2003. Regina, Saskatchewan, Canada, Community Planning Association of Canada, 1985), p. 202

7 Personal conversation with John Water Resources Branch, September 1, 1988.

8 Fred, A. Curtis, Face of the Prairies: 2003. Regina, Saskatchewan, Canada, Community Planning Association of Canada, 1985), p. 69

9 William M. Marsh, Environmental Analysis for Land Use and Site Planning. (New York: McGraw Hill Book Company, 1978), p.257

10 Province of Manitoba. Manitoba Water Commission. A Review of Agricultural Drainage in Manitoba. 1977, p. 28.

11 Province of Manitoba. Manitoba Natural Resources, Conservation Districts Authority, Turtle River Conservation District Draft Management Plan: 1988 - 2008. 1987, pamphlet.

12 Beckett, Jackson, Reader, Inc. (B.J.R. Inc.) Soil Erosion and Sedimentation Control. (Lansing, Michigan, Department of Agriculture, 1973, reprint ed. Reston Virginia: Environmental Design Press, 1981) p.1

13 Fred, A. Curtis, Face of the Prairies: 2003. Regina, Saskatchewan, Canada, Community Planning Association of Canada, 1985), p.91

14 Lois L. Ross. Prairie Lives: the changing face of farming.(Toronto, Between the Lines, 1985). p. 85

3. GOALS AND OBJECTIVES FOR HABITAT REINTRODUCTION

The following discussion is based on the main issues and environmental questions facing the farm community and country as a whole. A rational response to spiralling incidence of habitat loss and environmental deterioration is needed. The priorities for the reintroduction of habitat and a process for on-farm ecological stabilization are outlined here.

3.1 Overview

Coordinated habitat preservation or restoration currently being carried on in Manitoba is done by outside agencies or groups, and not as a rule by individual landowners. Financial and political constraints prevent government agencies from creating habitat and their role is one of protecting the existing habitat base on provincial lands. However, the potential impact on the overall availability of habitat by individual landowners undertaking small scale habitat reintroductions is significant.

Currently, the response to threatened, significant habitats is to designate the area as a wildlife preserve, place a legal boundary around the parcel, and purchase the land if held privately. The provincial government, through the Department of Natural Resources and the Conservation Districts Authority carries out habitat protection in this manner. In addition, Ducks Unlimited and the Manitoba Wildlife Federation are two privately funded organizations actively engaged in the preservation of wildlife habitat.

The protection of designated areas, in any form, for wildlife habitat is a laudable objective. As such this method of preserving valuable habitats by removing the threat of agricultural encroachment is an important action for the survival of numerous wildlife species.

Despite the positive effect of these actions, this approach has several short comings. One of the most notable is the increased risk to survival faced by isolated populations, concentrated by the limits of their remaining habitat. In situations of this type, faunal populations are susceptible to disease epidemics and food shortages which can be catastrophic for the species in question. In the absence of neighbouring populations capable of replenishing breeding stock, the affected population may recover slowly or decline altogether. This scenario is too familiar in situations where habitat blocks have been designated and the balance of the areas land base is used almost exclusively for agriculture.

Second, is the dollar cost. Given the limited budgets of public and private agencies and the ongoing maintenance costs of projects already in place, less money will be available in future to continue the process of acquiring valuable habitat. This does not mean funds would not be available in a crisis situation, but it will mean fewer, increasingly more critical habitats will be protected in this way. The net result will be an increase in the loss of key habitats and further declining wildlife populations due to continuing encroachment by agriculture.

While considerable effort and money is devoted to habitat preservation it is primarily aimed at "game" species with economic value. Problems arises when habitat conducive to the reproductive success and survival of these species is less favourable for non-game species. Habitat for these species is only preserved if it happens to overlap that of a favored game species. The value of many species, while not as game and an attraction to tourists, is in their ability to control other species that cause considerable damage to agricultural crops and livestock. The current trend toward farm consolidation and habitat removal is of particular concern for beneficial species.

Finally, the designation of certain areas as wildlife preserves implies a separation between natural and man-controlled environments and inherently suggests that it is an either or situation. This need not be the case. While certain species are sensitive to human activity and disturbance in their environment, many others thrive in close proximity to human populations provided there is adequate food and cover. Therefore, in order to expand an ecologically balanced farming landscape, decisions on farming activity and landuse must recognize and accommodate the ecological principles governing the relationship between land, water, plant and animal populations. The benefits of this accommodation will accrue to wildlife, farmers and the community at large.

3.2 Ecological Principles as a Basis for Decision Making

In describing an ecosystem the principle state may be variously designated as being in equilibrium, stable or balanced[1] based on the particular set of physical and biological factors present. Through changes in plant cover actions modify soils, influence climate, affect geomorphic processes and change the quantity and quality of some surface waters.[2] Figure 2 shows the interaction between environmental factors and the potential for instability resulting from indescriminate actions on the part of agencies and landowners.

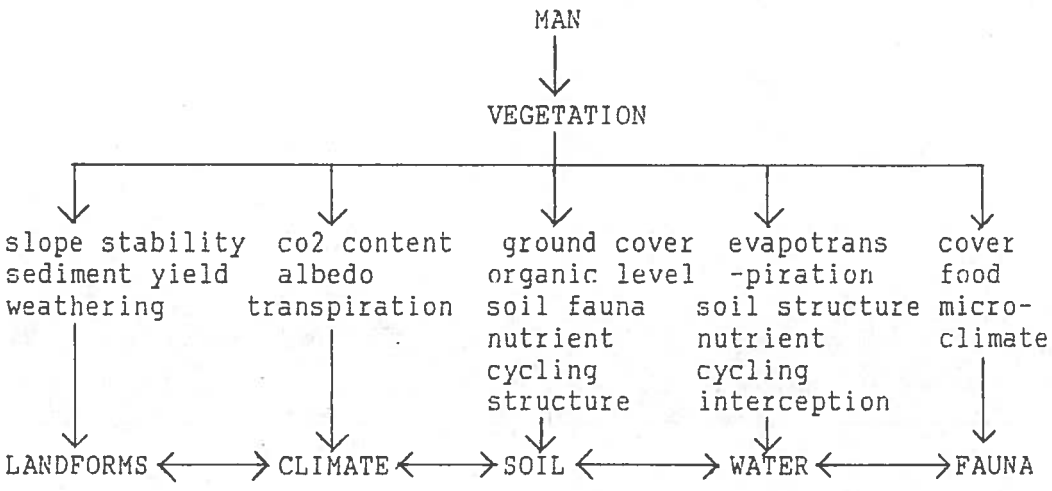


Fig. 2: Some ramifications of man induced vegetation change.[2]

The ecological principles relating to ecosystem development, restoration and management of land, tree planting and landscape design, conservation of species and habitats, etc., all have applications to the planning process[3] and should form the basis for all decision making related to land use.

The stability of an ecological community is a function of its species diversity.[4] A large number of ecological niches is reflected by its counterpart of a large number of species. Farmland by comparison exhibits the antithesis of this situation, where wildlife remains largely a fortuitous crop of the land; unplanned, and sometimes unwelcome.[5]

The overall effects of chemical farming practices and modern landuse developments on wildlife are clear: complex land and vegetation systems which might support many species are so simplified that few species survive.[6] This situation is reversible, although the production of specific crops limits the extent of niche variability realized.

Of primary concern to land use and decision making is the commonly held attitude that because of the complexity of ecological systems additional study is necessary. This position perpetuates the causes of environmental deterioration, therefore the immediate need is for the effective application of ecological principles that are already known[7] and to augment the process of future decision making with an expanding base of environmental knowledge.

Recognition of the following ecological principles will allow for the development of agricultural landscapes which will be inherently m re stable and capable of providing longterm benefits to wild flora and fauna, conservation of water and soil resources, agricultural productivity and the spiritual value of seeing landscapes reflective of place and natural beauty.

3.2.1 Soil Ecology

The cycles that permit nutrients to flow in the soil are all interdependant. Soil organisms, bacteria and fungi play an essential role in biochemical transformations; nitrification, sulfur oxidation, nitrogen fixation and mycorrhizal association, in addition to producing excretions which stimulate plant feeding.[8]

Actions which inhibit these dynamic processes, render the soil less productive, limiting nutrient uptake by plants and the ability to produce crops. Excessive soil disturbance from summerfallowing, tillage and use of chemical fertilizers, herbicides and insecticides all reduce biological activity within the soil.

3.2.2 Microclimate and "Edge" Conditions

Microclimatic change has a dramatic effect on a sites ability to maintain animal, plant and microbial populations. Variability of the microclimate, by increasing humidity, shading, wind protection and soil moisture have a profound effect on increasing the populations which are able to establish.

The concept of edge is critical to understanding habitat suitability. Natures patterns are almost always irregular and wildlife benefits from these patterns for various ecological reasons, including maintenance of breeding territory and escape from predators.[9]

Woody plant growth is thickest at ground level along the edge of forested areas where light penetrates the tree canopy. This increases the food supply for insects which are subsequently food for birds and mammals. This dense growth also provides excellent cover for protection from climate and predators.

Small interconnected habitats increase the survivability of animal populations by providing a buffer against fluctuating conditions. The main factor in natural population control of upland birds is high winter mortality[10] due primarily to lack of food and cover.

Increasing diversity by managing land in small blocks, through rest-rotation pasture and strip cropping increases edge between fields, increasing food variety and wildlife populations. In Manitoba, in terms of diversity of wildlife, the aspen-grassland habitat is optimal principally due to the abundance of "edge" condition associated with frequent transitions between grassland and aspen bluffs.[11]

3.2.3 Water Regime

Water is the source of life. Increasing the soils ability to store water, increase groundwater supplies and reduce the degree of evaporative loss from exposure to wind and sun, is a function of vegetative cover. Disturbances of soil protecting vegetation and litter

will adversely effect moisture retention capability. Increasing the availability of water has a stabalizing effect on plant and animal populations.

Stabalizing the annual flow of water within a given watershed reduces the seasonal stress placed on the plant and animal community during periods of excess and drought by mitigating the severity of each extreme.

3.2.4 Population Dynamics

For plant and animal populations there are two opposing forces operating in growth and development. The ability to reproduce at a given rate and opposition to growth from all the forces of the physical and biological environment.[12] All aspects of the environment influence the number and spatial distribution of biological populations.

Undisturbed, populations coexist in relative equilbrium, subject primarily, to biological regulation through myriad intra and interspecific interactions.[13] Territorial behavior limits the total number of breeding pairs of birds, mammals and insect species, therefore limiting the potential for population growth. Interaction of populations; refuge from predators to territorial boundaries and increases in the potential food supply are linked to heterogeneity in the environment.[14] Figure 3 shows the relationship between 3 species of birds and the structure of their habitat.

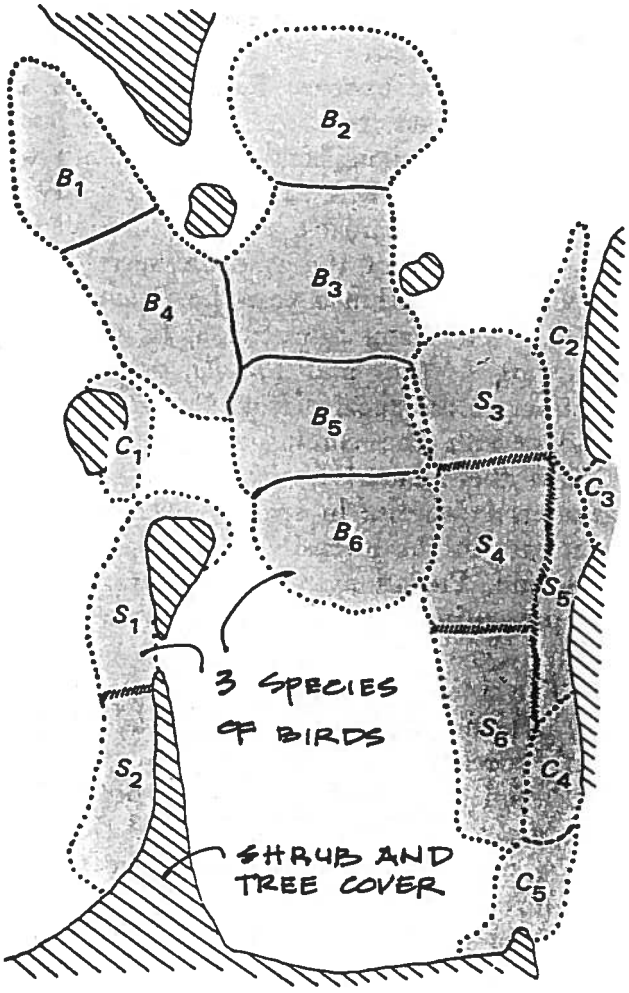
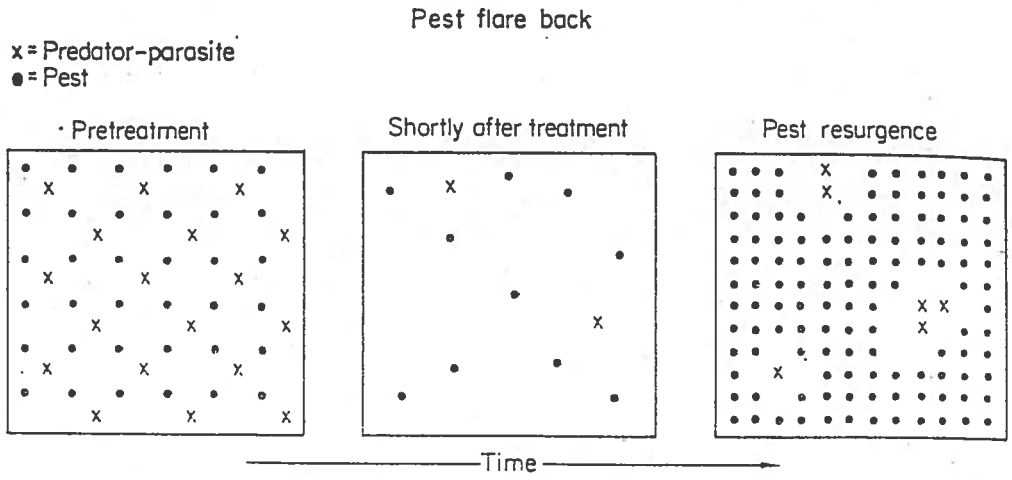


Fig. 3: Relationship between territory and habitat shape for three bird species.

In fields containing estimates of 300 to 350 arthropod species, only 20% were phytophagous (feeding on plant tissue)[15], the balance were parasitic or predatory, nectar or detritus feeders. All important to the control and stability of crop and insect populations. This typifies the complex interspecific relationships found within ecosystems.

The response to any factor that is moderately destructive to both predator and prey will increase the average prey population and decrease the predator."[16] This is a function of higher reproductive rates among prey species. Figure 4 shows a schematic representation of a pest species resurgence following insecticide application.



Diagrammatic sketch of the influence of a chemical treatment on natural enemy-pest dispersion and resulting pest resurgence. The squares represent a field or orchard immediately before, immediately after, and some time after treatment with an insecticide for control of a pest species represented by the solid dots. The immediate effect of treatment is a strong reduction of the pest, but an even greater destruction of its natural enemy (enemies), represented by × 's. The resulting unfavourable ratio and dispersion of hosts (pest individuals) to natural enemies permits a rapid resurgence of the former to damaging abundance. (Smith and van den Bosch, 1967).

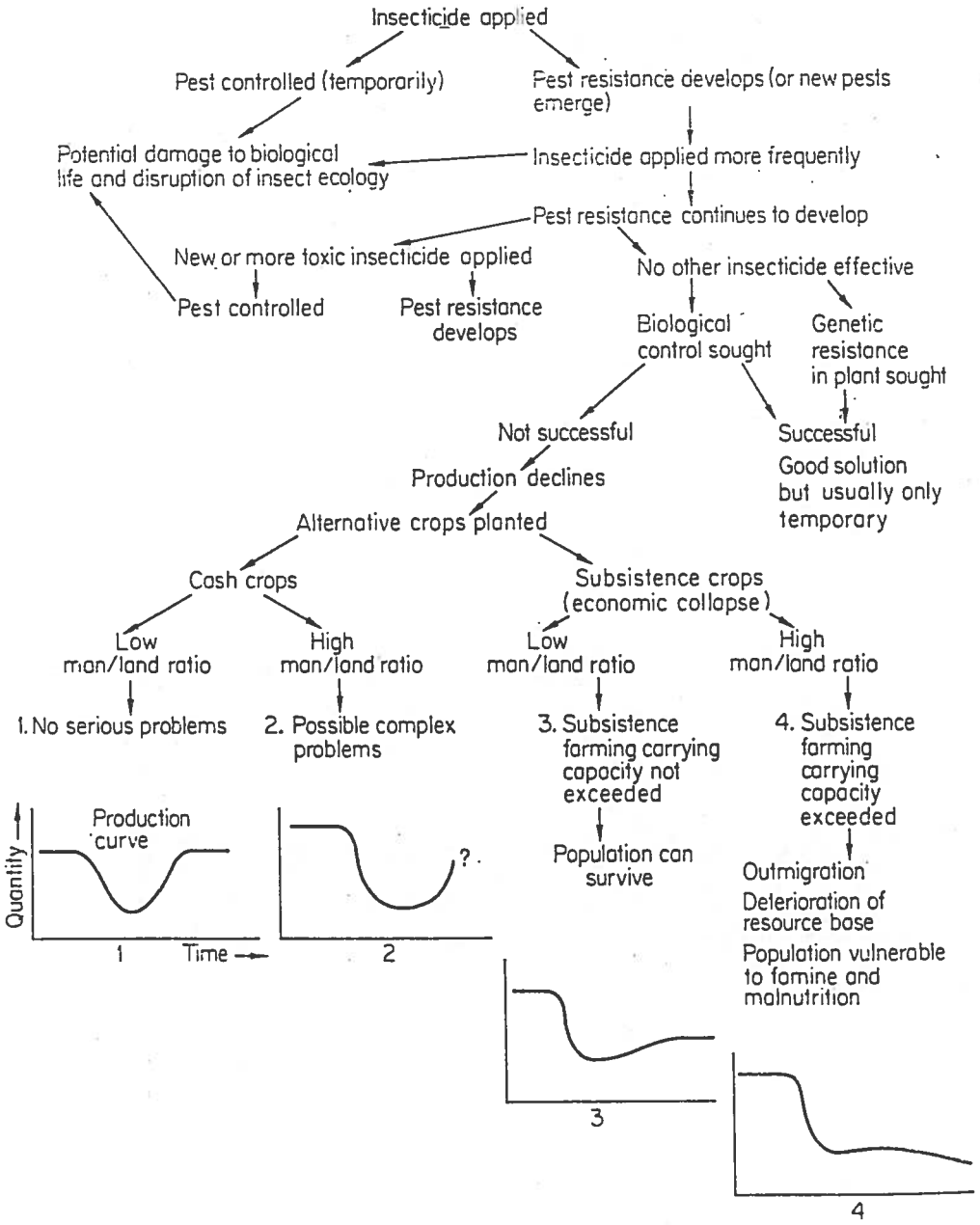
Fig. 4: Pest species resurgence.

This illustration depicts the potential implications associated with instability, precipitated by actions which disrupt the equilibrium of dynamic populations creating rapid growth of prey species in the absence of the predator species.[17] As an example, insects are essential food for young grouse survival therefore the impact of widespread pesticide use can be catastrophic. Birds and other biological control agents are only capable of maintaining insect prey numbers at reasonable levels when the food supply is stable. Fluctuations in the food supply, particularly during the brood rearing season will reduce predator numbers through migration, starvation or a reduction in reproductive success.

The potential longterm effects of pesticide use and risk to the resource base can be seen in figure 5. Excess tillage, use of chemical fertilizers, removal of vegetative cover and drainage of wetlands and potholes can produce similar imbalances within an ecosystem.

3.2.5 Biological Control

The concept of integrated pest control is defined as the deliberate artificial mimicking of just enough of that diversity of selection pressures acting in nature, to relieve the selection pressure acting in nature for aany one agent. Its' general aim is to use a mixture of biological, cultivational, and chemical means



Possible consequences of insecticide use.

Fig. 5: Potential longterm effects of pesticide use.

to keep pest populations at levels that are not economically significant.[18] The net effect of this approach to integrating control mechanisms into the environment reduces long term costs and the risk of serious crop pest outbreaks.

> "Birds working in concert with predatory insects, crop rotation, good soil, ... play an important role in preventing severe insect infestations."[19]

Considering the potential of individual insect-eating birds to consume up to 250,000 insects per year[20] the dollar value of birds destroying insects is incalculable.[21] Similarly, the majority of native sparrow, grossbeak, crossbill and horned lark eat weed seed and do more good than harm.[22] Appendix 1 contains a listing of bird species common to southern Manitoba and their dietary composition.

Among insect populations, common control agents include Syriphid flies (larvae) and Robber flies (adult and larval forms) are predatory, voracious feeders. The larvae eat grasshopper eggs, cutworms, adults take winged insects and grasshoppers as well. Adult Tachinid flies are nectar feeders whereas the larvae are parasitic to many insects particularly army worms, many caterpillars, and cutworms.[23] The parasitic larvae of Trichograma, Ichneumon, and Chalcid wasp species are effective in protecting field crops from a variety of pest insects. Spiders are very important predators, consuming a wide

range of insect prey. Their principle requirements are shady, humid locations and significant crop residues, not surprisingly their populations decrease under intensive cultivation practices.

Despite the potential of biological agents, control will never be 100% effective, nor is it in the interest of the predator or overall ecosystem stability. As a result developing biological controls requires an enlightened attitude on the farmers part, with the understanding that while some depredation of field crops may occur, the damage in economic terms is slight and the loss can be recouped by reduction of input costs, improved soil quality and fertility, and a much reduced longterm risk of pest infestation.

3.3 General Direction

The overall goal of habitat reintroduction is to provide cover and food for wildlife species and coordinate development of the on-farm drainage network as part of the habitat system.

Widespread habitat restoration based on re-creation of pre-agricultural environments is not generally realistic. It is possible, however, to establish and expand a habitat network capable of supporting significant, sustainable wild floral and faunal populations through compatable integration of habitat within existing farm layouts.

The reintroduction of habitat areas has significant spin-off benefits for the environment, for soil conservation, drainage and flood control, the reduction of water pollution, stabilization of steam flow rates, ground water recharge, and providing recreation opportunities. As such there are secondary goals and objectives which potentially may be satisfied by habitat development or that may be considered worthy of inclusion in the planning for a reintroduction project.

3.4 Specific Goals and Objectives

3.4.1 Promote sense of community

- create places recognizable to local residents
- increase rural population base through more intensive and diverse agricultural management

3.4.2 Increase recreation opportunities

- develop wildlife viewing areas
- expand hunting opportunities for local residents and landowners (extent of use will depend on other, adjacent land uses)
- develop fishing and swimming opportunities where possible
- develop recreation fields in sheltered, central areas
- develop roadside pull-offs, pic nic areas, and berry picking opportunities

3.4.3 Improve farm income

- reduce crop losses due to flooding , drought and insects
- introduce additional revenue sources, from hunting, fish farming, orchards or tree nurseries
- increase municipal tax base to reduce farm tax levies
- increase tourism and promote farm vacations

3.4.4 Reduce wind erosion

- interrupt wind, reduce velocity
- improve soil cover (summer and winter)

3.4.5 Reduce waterborne soil erosion

- promote development of full season soil cover
- slow runoff velocity
- develop erosion resistant channels, drainage courses

3.4.6 Reduce impact of downstream flooding

- retain a percentage of all precipitation and runoff onsite
- extend the period of runoff following a storm event by slowing the release of storm water to downstream water courses

3.4.7 Reduce longterm maintenance cost of Provincial drainage system

- trap eroded soil near the source, to facilitate recovery
- removal of silt from runoff will reduce deposition problems downstream
- reduce wind erosion
- reduce the sediment carrying capacity of runoff by reducing the rate of flow
- reduce the size and cost of flood protection and drainage channels

3.4.8 Minimize summer storm flooding on cereal acreage

- promote in-field drainage to on site detention and retention ponds and basins
- locate stripped and recovered soil to fill low areas and assist in positive field drainage

3.4.9 Improve soil quality and fertility

- reduce wind drying effects
- aid in the retention of organic material on soil surface
- increase soil fauna, microbial populations

3.4.10 Reduce and eliminate pesticide use

- Reintroduce populations of organisms that prey on crop pests and weed species
- promote organic farming methods such as crop rotation, zero and minimum tillage

3.4.11 Reduce the use of chemical fertilizers

- encourage use of composting field residues and respreading manure and trapped soil
- use legume crop rotations and green manures
- diversify farming operations to allow forage and pasture to be used to improve soil structure

3.4.12 Reintroduce on-farm wildlife habitat

- integrate habitat into farming operation
- develop on least productive acreage
- maximize habitat type, territory size and density on limited acreage

3.4.13 Restore visual diversity to local landscape

- reflect local topography and drainage pattern
- provide roadside points of interest, views
- establish points of orientation within the local landscape
- increase the number of "focal" experiences along road corridors, increase the rythym of experiences

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1 Walter Firey, Man, Mind and Land: A Theory of Resource Use. (Glencoe, Illinois: The Free Press Ltd., 1960) p. 21

2 Andrew Goudie, The Human Impact: Mans' Role in Environmental Change. (Oxford: Basil Blackwell, 1981), p.25

3 R. D. Roberts and T. M. Roberts, eds. Planning and Ecology. (London: Chapman and Hall, 1984), p.1.

4 Edward J. Kormondy, Concepts of Ecology, Concepts of Modern Biology Series, (Englewood Cliffs, New Jersey: Prentice Hall Inc., 1969), p.159.

5 Robert B. Oetting, ed. Manitobas' Wildlife Heritage: a guide for landowners. (Winnipeg: Province of Manitoba, Department of Mines, Resources and Environmental Management, Development and Extension Services, 1973), p.8.

6 Ibid., p.8.

7 R. F. Dasmann, J. P. Milton and P. H. Freeman, eds., Ecological Principles for Economic Development. (London: John Wiley and Sons Ltd., 1973), p.vii

8 Grace Gershuny and Joseph Smillie, The Soul of the Soil: A Guide to Ecological Soil Management. 2nd ed. (Erle, Quebec: GAIA Services, 1986), p.18

9 Robert B. Oetting, , ed. Manitobas' Wildlife Heritage: a guide for landowners. (Winnipeg: Province of Manitoba, Department of Mines, Resources and Environmental Management, Development and Extension Services, 1973), p.12.

10 Ron Allensen, "The Landscaped Oasis", Harrowsmith. Vol. XII, Number 75. (Camden East, Ontario: Camden House Publishing Ltd. 1987) p. 69.

11 Robert B. Oetting, ed. Manitobas' Wildlife Heritage: a guide for landowners. (Winnipeg: Province of Manitoba, Department of Mines, Resources and Environmental Management, Development and Extension Services, 1973), p.14.

12 Edward J. Kormondy, Concepts of Ecology, Concepts of Modern Biology Series, (Englewood Cliffs, New Jersey: Prentice Hall Inc., 1969), p.63.

13 Ibid., p.91.

14 Ibid., p.95.

15 R. F. Dasmann, J. P. Milton and P. H. Freeman, eds., Ecological Principles for Economic Development. (London: John Wiley and Sons Ltd., 1973), p. 161.

16 Edward J. Kormondy, Concepts of Ecology, Concepts of Modern Biology Series, (Englewood Cliffs, New Jersey: Prentice Hall Inc., 1969), p.97.

17 R. F. Dasmann, J. P. Milton and P. H. Freeman, eds., Ecological Principles for Economic Development. (London: John Wiley and Sons Ltd., 1973), p.152

18 Ibid., p.159

19 Ron Allensen, "The Landscaped Oasis", Harrowsmith. Vol. XII, Number 75. (Camden East, Ontario: Camden House Publishing Ltd. 1987) p. 66.

20 Robert B. Oetting, , ed. Manitobas' Wildlife Heritage: a guide for landowners. (Winnipeg: Province of Manitoba, Department of Mines, Resources and Environmental Management, Development and Extension Services, 1973), p.55.

21 Ron Allensen, "The Landscaped Oasis", Harrowsmith. Vol. XII, Number 75. (Camden East, Ontario: Camden House Publishing Ltd. 1987), p. 66.

22 Robert B. Oetting, , ed. Manitobas' Wildlife Heritage: a guide for landowners. (Winnipeg: Province of Manitoba, Department of Mines, Resources and Environmental Management, Development and Extension Services, 1973), p.55.

23 Roger B. Yepsen Jr., ed., The Encyclopedia of Natural Insect and Disease Control. (Emmaus, Pennsylvania: Rodale Press, 1984), p. 436

4. Habitat Reintroduction Guidelines: Methods and Benefits

Using ecological principles, outlined in section 3.2 as a basic framework of understanding, enabled the designation of specific guidelines for implementing habitat reintroduction. The guidelines are focused in the following manner:

4.1 Soil Protection and Improvement

4.2 Procedures for Establishing and Maintaining Vegetation for Food and Cover

4.3 Drainage Network Development and Utilization

4.4 Habitat Configuration Adapted to Behavioral Characteristics

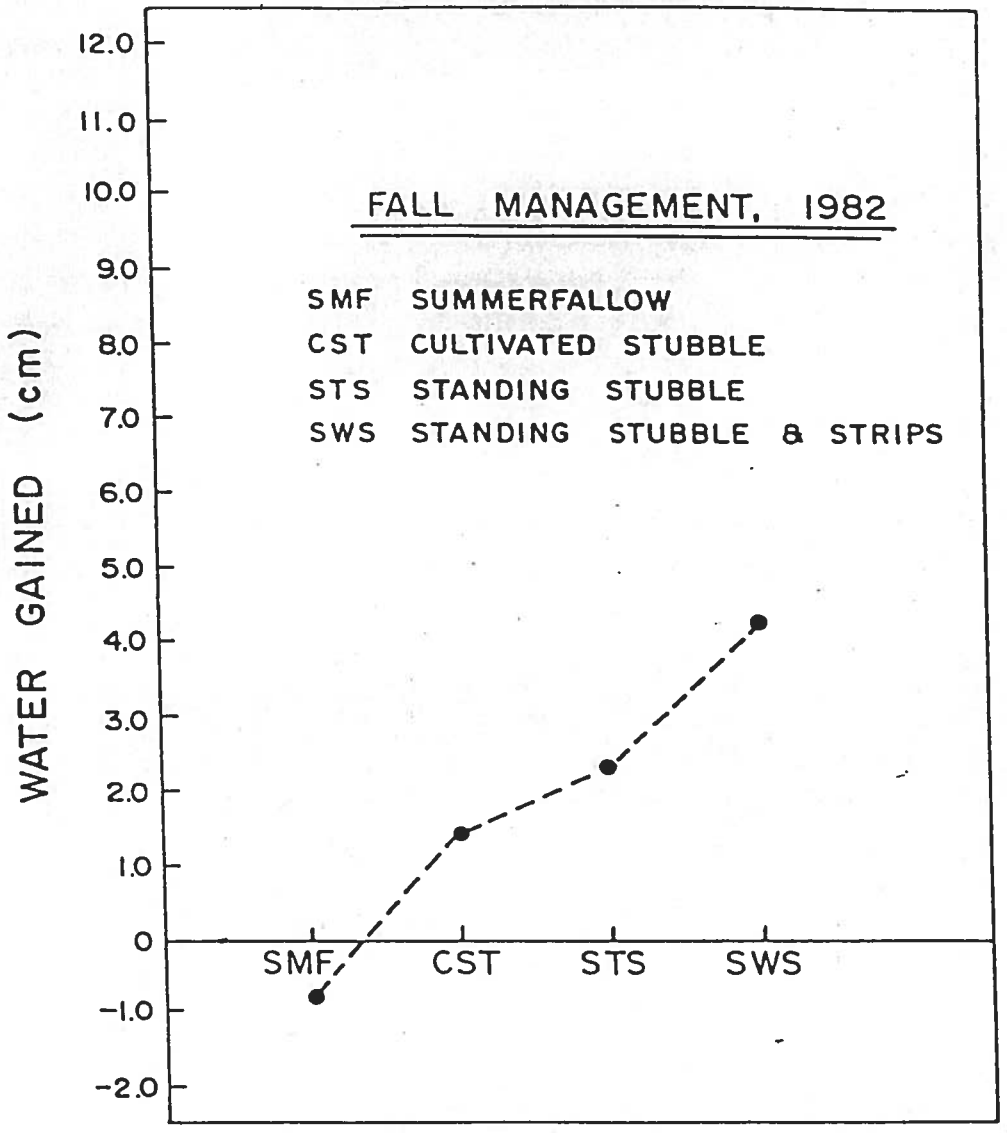
4.5 Expanding Local Landscape Diversity

While the guidelines are separated into sub-categories, they relate directly to the concept of ecosystem and are based on that fundamental understanding. Used in combination, the guidelines describe the methods for successfully achieving habitat reintroduction over the long term.

4.1 Soil Protection and Improvement

The forms of agriculture most extensively used in the midwest (and Canada) create conditions that favour the breakdown rather than the buildup of soil aggregates, and that inevitably leads to soil erosion.[1] The most important factors in reducing wind erosion minimize soil surface disturbance and exposure. This can be achieved through judicious tillage

practices or the adoption of zero tillage as a method of operation. Figure 6 shows the potential for soil moisture gain under differing management practices.



Stubble management increased the soil water storage by approximately 5 cm, compared to fallow, over the 1982-83 winter period.

Fig. 6: Relationship between soil management and moisture gain

With zero tillage, many farmers worry about the loss of production and research has indicated that this is true in the short term but within five years production is equal or better than conventional yeilds and production costs are from 10-30% lower with organic methods.[2] In one Manitoba example it was shown that under zero tillage soil management there are no sacrificed yeilds, no added production costs; or caused loss of money. Organic matter in the soil has increased significantly over five years, reversing declining levels of organic material under conventional tillage. Soil friability is improved, rain infiltrates much more readily, crop maturity is not delayed, and wind and water soil erosion has been totally eliminated.[3]

4.1.1 Retain Soil Cover Year Round

Method: By combining minimum tillage or zero tillage and leaving standing crop residues on fields in the fall, or planting crops such as winter wheat, wind erosion potential is reduced.

Benefit: Retains both soil and soil moisture, and traps snow cover. Makes land more receptive to absorption in spring by incorporating organic content of the soil.[4]

4.1.2 Plant Eroded Marginally Productive Sites to Permanent Cover

Method: Hill tops are prone to wind erosion and can be stabalized by seeding to grass and forage mixture of 2/3 grass species to 1/3 legume species. Plant or allow woody shrubs to colonize centres of larger bluffs. (see figure 7)

Benefit: Trap moisture in winter which is slowly released to upper, cultivated slopes in spring improving moisture absorption. Provides cover, food and nest sites for song birds, upland game.

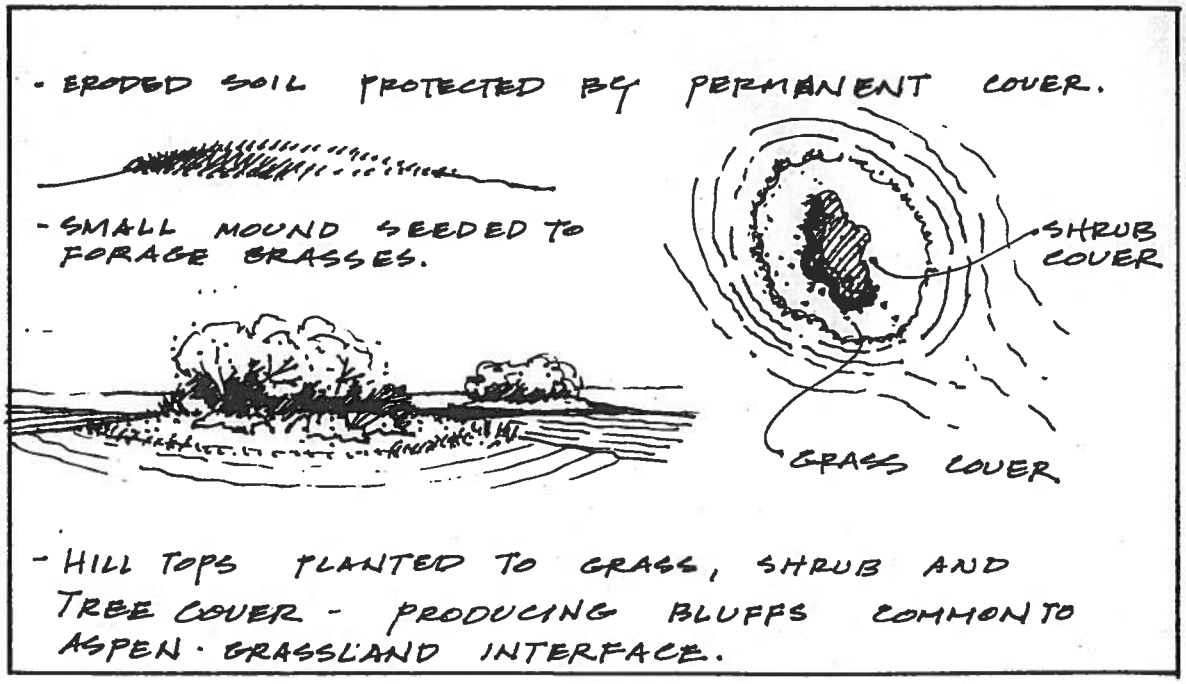


Fig. 7: Planting for soil stabalization

4.1.3 Plant Shelterbelts Across Sloping Terrain

Method: Plant shelterbelts in hilly terrain to follow a consistent contour. Critical on permanently tilled slopes. Avoid planting lines directly up slopes. (see figure 8)

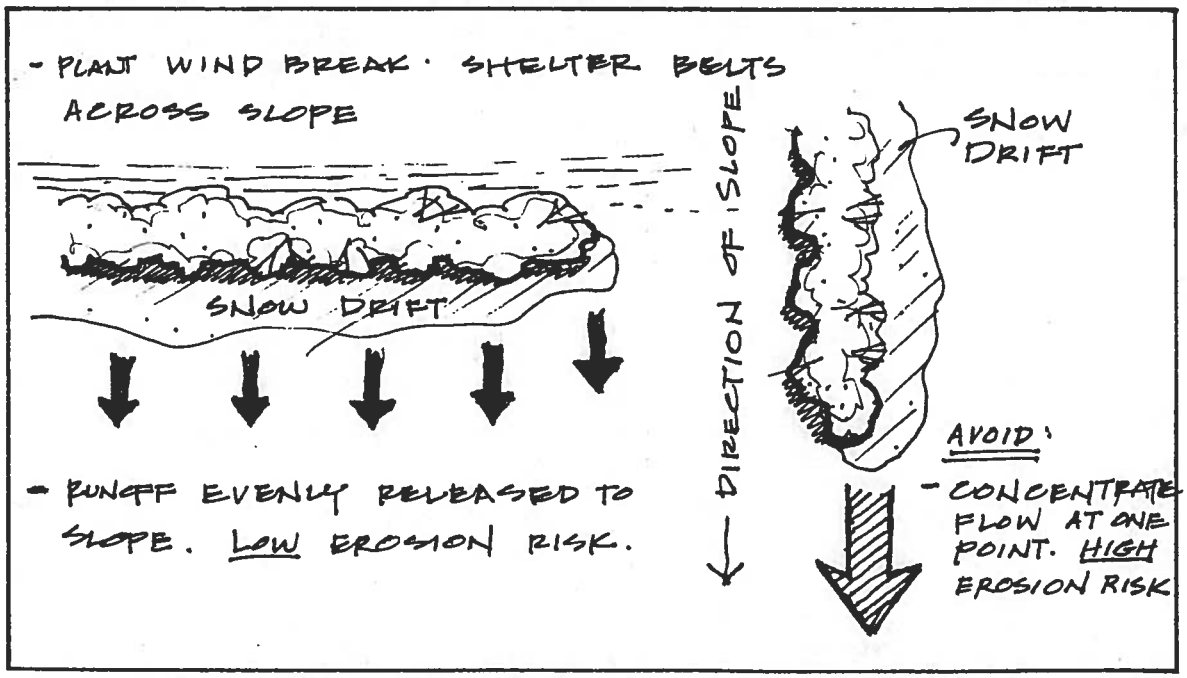


Fig. 8: Orientation of hillside shelter belts.

Benefit: Snow trapped by shelter belt will spread runoff over entire slope increasing moisture available to drought prone slopes. Reduces risk of erosion from rapid melting down slope from drift location.

4.1.4 Create Mositure Retaining Diversions On Sloping Sites

Method: Cut shallow, diversion or retention basins 12" deep, 10-15' wide across slope on upper 1/2 to 1/3 of slope. Plant shelterbelt trees on the north side to allow thick grass cover to line diversion and out compete weed species. (See Figure 9)

Benefit: Helps to reduce overland flow during storms, particularly on downhill slopes where erosion risk increases during intense runoff. Will trap eroded material and increase the amount of water absorption on up hill portion of slope. Increased availability of moisture will benefit shelterbelt planting establish and become effective.

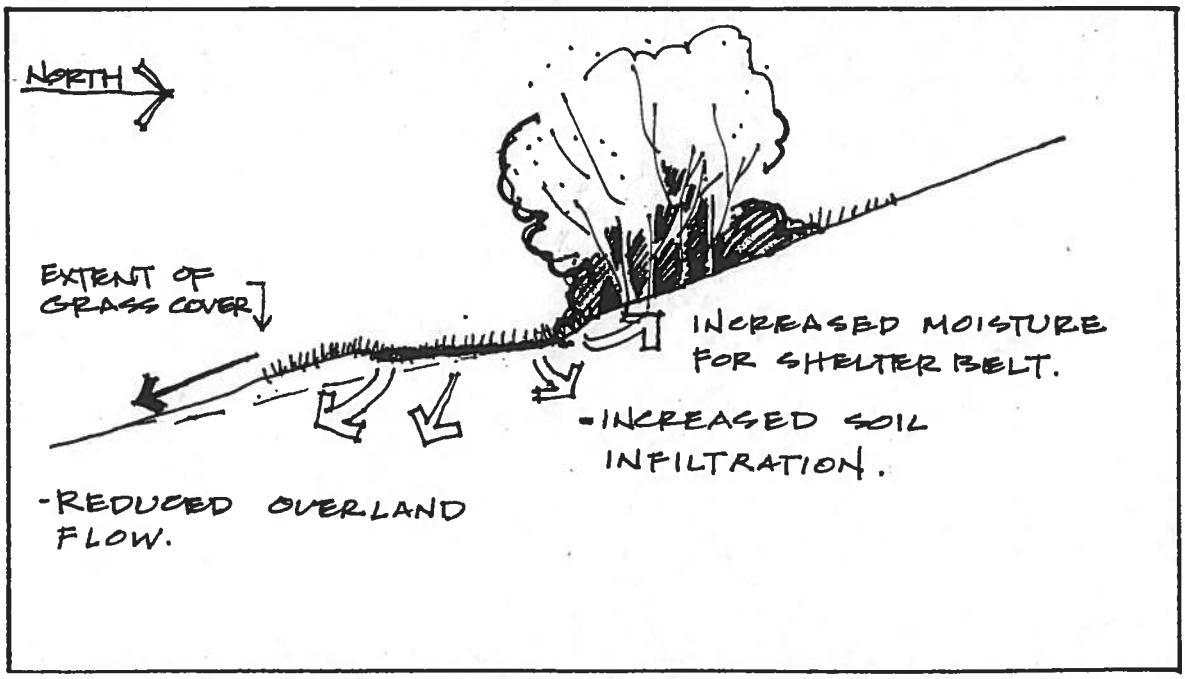


Fig. 9: Hillside moisture retention.

4.1.5 Protect Existing Riparian Vegetation

Method: Limit cattle grazing to a level which will not cause significant dieback, overbrowse or overbrowsing or trampling, by rotation of pasture on a three year cycle.

Benefit: Riparian vegetation is capable of building organic soils better able to store soil moisture and protect the integrity of stream channels. Removal of riparian growth reduces long term summer flows and resistance to soil erosion.5

4.1.6 Prepare Poor, Eroded Areas to Accept Seed by Gouging Soil Surface

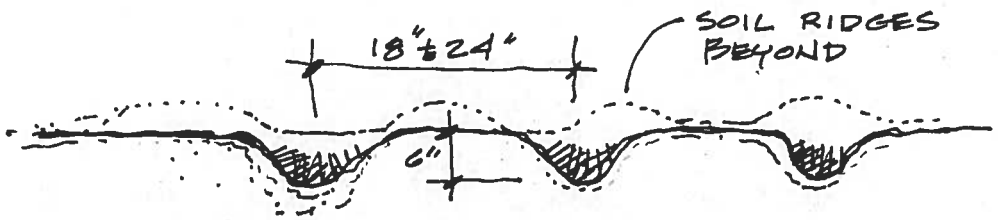
Method: The soil surface is opened or gouged throughout the area to be seeded. This can be accomplished using machinery as shown in Figure 10 or by using an 8-12" post hole auger or other attachment. Seed over top and loose soil can be harrowed lightly into pits to cover seed.

Benefit: Aids snow accumulation and retention on hill tops and sloping sites, and speeds the process of revegetation.6 Plants can benefit greatly from a small increase in available moisture under xeric conditions.

4.2 Procedures for Establishing and Maintaining Vegetation for Cover and Food

As noted in Section 3.2, plant material is essential for wildlife survival by 1). providing food for many species of insects, birds and mammals, who in turn provide food for predators further along the food chain. 2). Cover for breeding, protection from predators and from the elements must be present in order for populations to establish within a given area, Diversity of vegetative cover is critical to promote species diversity which in turn expands and stabilizes the food chain.

—At the Emery study area, seeding and gouging simultaneously with the gouger developed at the Missoula Equipment Development Center. December 1977.



- SEED AND ORGANIC MATTER COLLECT IN PITS AIDING GERMINATION AND ESTABLISHMENT. BY TRAPPING MOISTURE.

Fig. 10: Soil surface gouging for moisture retention.

The Provincial Farm Rehabilitation Agency has long been involved in promotion of shelterbelt plantings and is actively engaged in growing starter material for landowners. Appendix 2 contains a listing and description of many of the available species and the benefits wildlife derive from each one. Appendix 3 contains tables listing grasses, herbs and woody species suitable for riparian sites, and decribes propegation methods, flood tolerance and growth rate.

The following list includes plants of particular significance to wildlife:

Grasses:

Intermediate Wheat grass
Tall Wheat grass
Smooth Brome

Herbs:

Alphalfa
Sweet Clover

Pond Vegetation:

Acorus calamus
Iris versicolor
Phragmites communis
Polygonum muhlenbergii
Sagittaria latifolia
Scirpus acutus
Scirpus fluviatilis
Sparganium eurycarpum
Vallisneria sp.
Musk grass Chora sp.
Lemna sp. (duck weed)
Potomagenton sp.

Woody Perennials: (hardy zone 2)

** = valuable food
+ = moisture tolerant

** Chokecherry
** Dogwood
Hawthorn
** Rose
Red Elder
* Russian Olive
* Saskatoon
Sea buckthorn
* Siberian Crab Apple
Ussurian Pear
Buffalo Berry
Burr Oak
Caragana
Hazelnut
Common Juniper
*+Dwarf Honeysuckle
*+Paper Birch
** Raspberries
Nanny Berry
Pincherry
Willow
Villosa Lilac
* Manitoba Maple
Poplar
American Elm
Siberian Elm
Green Ash
Scotch Pine
Colorado Spruce
* White Spruce
Wild Plum
Potentilla
Silver Berry
Common Hackberry
Mountain Ash
+Alder

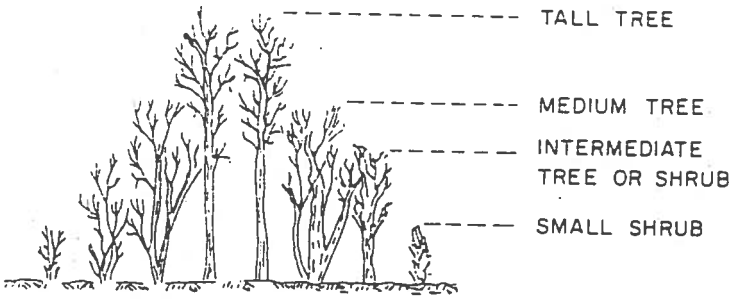
4.2.1 Plant 15' wide grass cover strips along shelterbelt edges and existing bluff - field edges.

Method: Plant border along edge with a mixture of 70-75% grasses and 25-30% legumes. A thick stand can be obtained by using 45% intermediate wheat grass, 25% tall wheat grass, 20% alphalfa and 10% sweet clover at a rate of 8 lbs. grass to 2 lbs. legume per acre.8

Benefit: Provides good groundcover, excellent nesting habitat for ducks and upland game and harbours food species. Aids snow trapping function of shelterbelt and suppresses weed growth. Once well established, it will be self perpetuating.

4.2.2 Plant shelter belts 6-8 rows wide using a variety of material sizes.

Method: Plant a variety of material sizes with tallest species in the centre to smallest shrubs along the edge. Plant grass border after shrubs have become established. Figure 11 shows plan and section views of shelter belt plantings being promoted by P.F.R.A.



MULTIPLE ROW WILDLIFE PLANTINGS
(CROSS-SECTION)

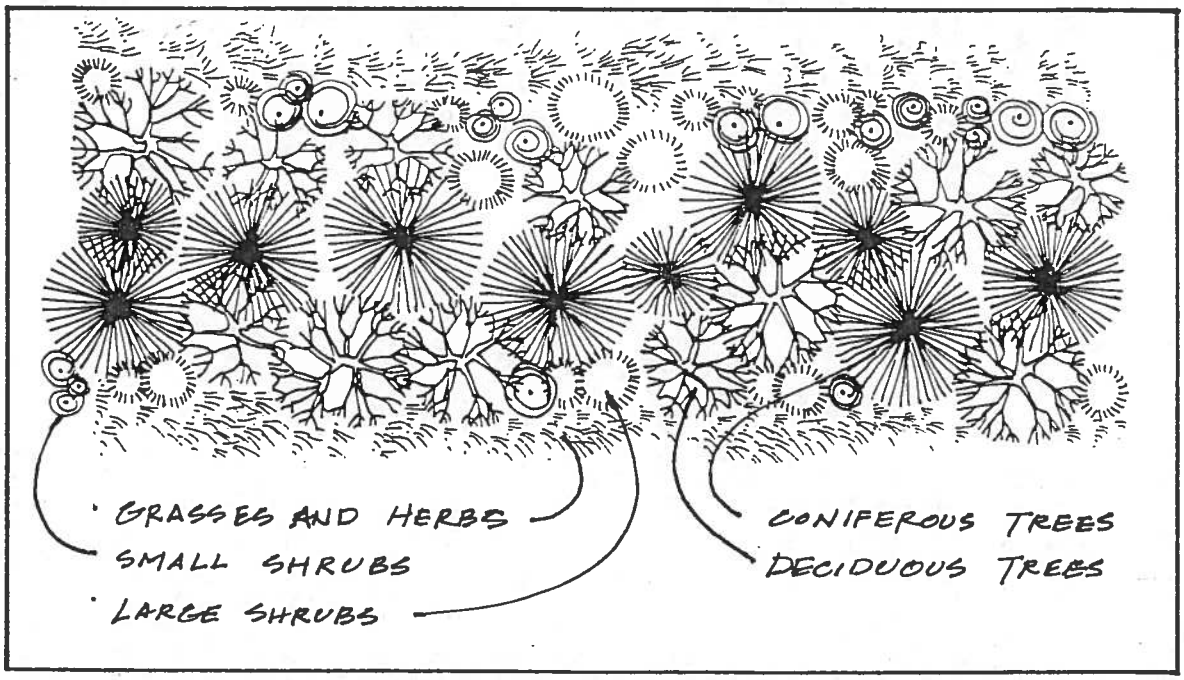


Fig. 11: Mature shelter belt plantings.

4.2.3 Plant lure crops in field corners, next to marsh, ponds or woodlots.

Method: Plant crop that will attract species away from principle crop. Plant in areas where regular crops are hit and miss, as in or along wet areas and areas heavily shaded by trees. Leave an acre of standing crop for every 160 acres of field crop(). Barley, when swathed, is an excellent lure crop.

Benefit: Lure crops intercept animals headed toward fields, particularly if convenient and close to cover. Lure crops are remarkably successful in eliminating or reducing waterfowl depredation of field crops.9 Additional saving is realized by reducing input cost on marginal areas.

4.2.4 Establish block cover plantings 150' wide N/S with a 50/50 mixture of food and cover plant species, where little existing wood land is available.

Method: Plant similarly to shelter belt but 15 to 20 rows wide with a core of coniferous trees and a 50/50 mix of food and cover between deciduous trees and shrubs. Link to shelter belt system, or locate at a field corner as shown in Figure 12.

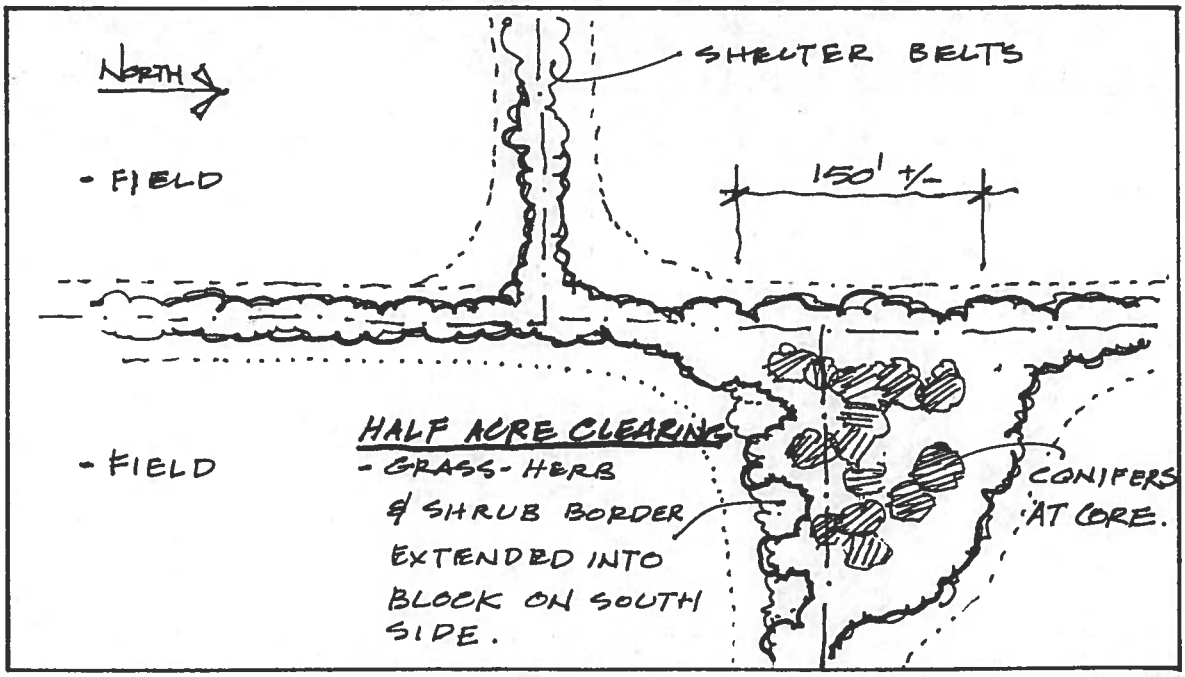


Fig. 12: Typical cover block at field corner.

Benefit: Provides ciritcal winter protection for many resident species of birds and deer.

4.2.5 Create gently undulating soil surfaces to create a variety of growing conditions.

Method: In addition to gouging, more pronounced undulation and elevation changes can be incorporated into planted areas by pushing up small mounds of material or by placing and contouring excavated material from drain or swale construction.

Benefit: Encourages a wider range of plants and cover types to become established. This increased diversity will increase the numbers of animal species which will be able to occupy the site. Provides protected vantage points.

4.2.6 Create half acre clearings on the southern exposures of existing bluffs and woodlots.

Method: Clear existing trees and pile brush at the edges of the clearing. Create an opening every 200-300 yards. Plant 1/2 acre clearing to woodland border mix (70% grass/30% legume). (See Figure 12). Clearing may be up to 5 acres on large woodlot.

Benefit: Sun catch areas are valuable protection for winter feeding areas. Cut stumps will resprout and create both browse and cover.

4.2.7 Create living brush piles.

Method: Hinge cut brush and saplings and bend onto ground. Cut several adjacent saplings so that their heads end up on top of each other in one location. Figure 13 shows a typical example. Poplar and Willow sp. are suitable.

Benefit: Creates dense hiding places for voles and rabbits, etc. and provides a renewing source of browse at ground level.for deer and upland game birds.

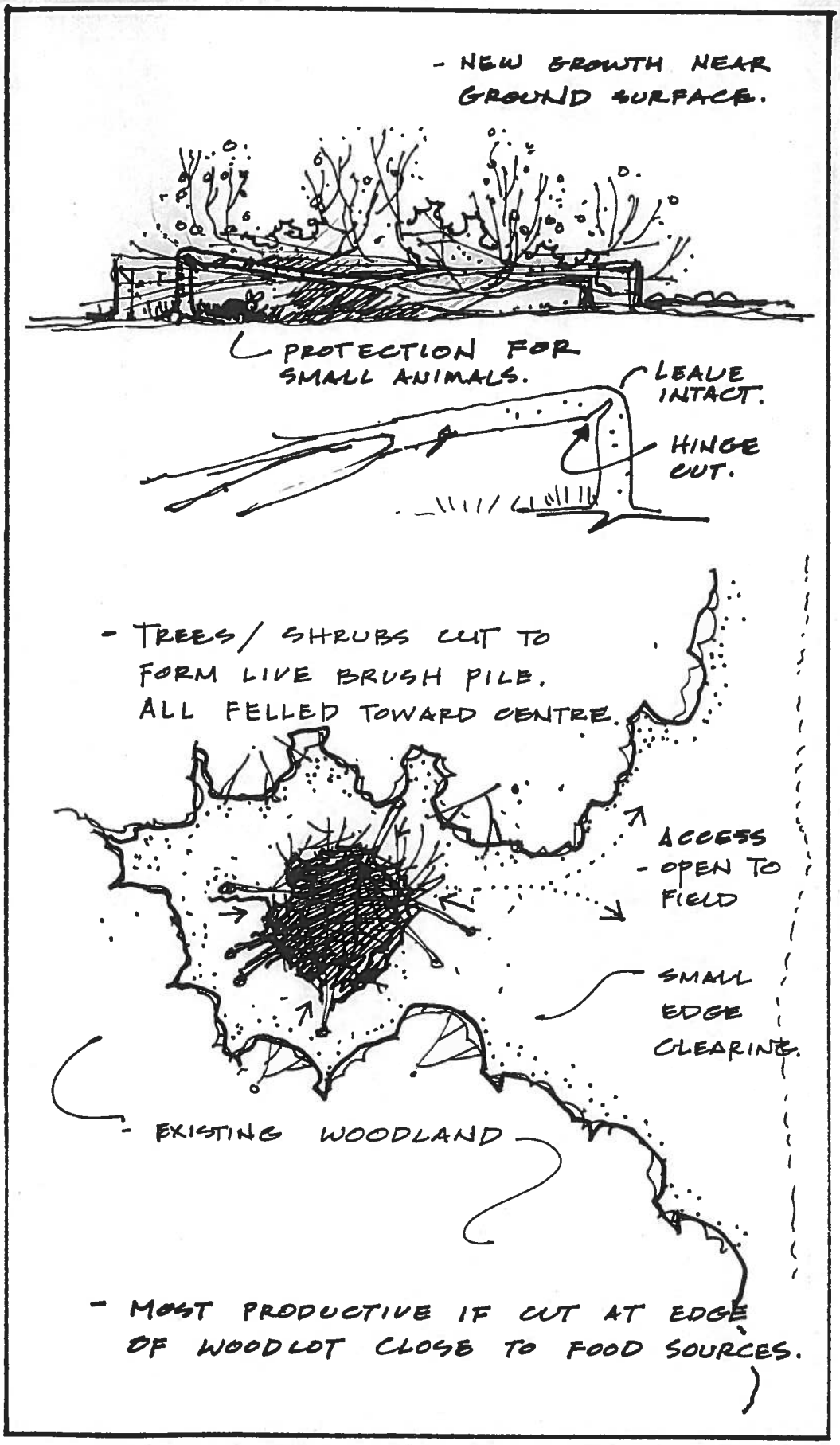


Fig. 13: Living brush pile

4.2.8 Plant multiple rows up sloping sites in newly planted areas.

Method: Plant new material up the slop from the toe at pond or marsh edge. Use native, locally dug materials to increase survival rate. Use barley as a nurse crop and allow natural vegetation to fill in as barley dies out.

Benefit: Allows a percentage of plantings to establish in suitable location. This material will establish and spread quickly in suitable zone.

4.2.9 Develop perch-planting locations.

Benefit: Decide on an area where new windbreak or clump planting is to be located. By placing large branches upright in the ground or by stringing a single wire strand between fence posts laid out in the desired configuration, birds perching will self seed the prepared location. Till soil to provide surface where seed can establish. Continue tilling to suppress grass growth until young plants are well established.

Benefit: Seeded plants will be favourite food types and provided at no charge. Low cost means of propagation. Advantage of wire is that hedge effect will quickly be established.

4.2.10 Plant hardwood cuttings in spring, following runoff.

Method: Many native species can be propegated by cuttings including Willow, Dogwood, Poplar, Hawthorn, and Plum. See Appendix 3 for propagation methods and suitability. Figure14 shows methods for planting large diameter Willow (a) and Poplar (b) stumps. Willow cuttings may establish if unrooted but success is variable. Increase survival rate by collecting in fall during dormant period from similar local sites. Cut into 12' to 20" lengths and treat with commercial fungicide, rooting hormone and freeze in bundles of 50 plus. Thaw for 2-3 weeks at 5 degrees C to break dormancy. Set in pots to root. Plant in spring.

Poplar posts can be cut in spring prior to sap flow. Score trunk and dip in rooting hormone at 1 oz. per 30 gallons until planted.10

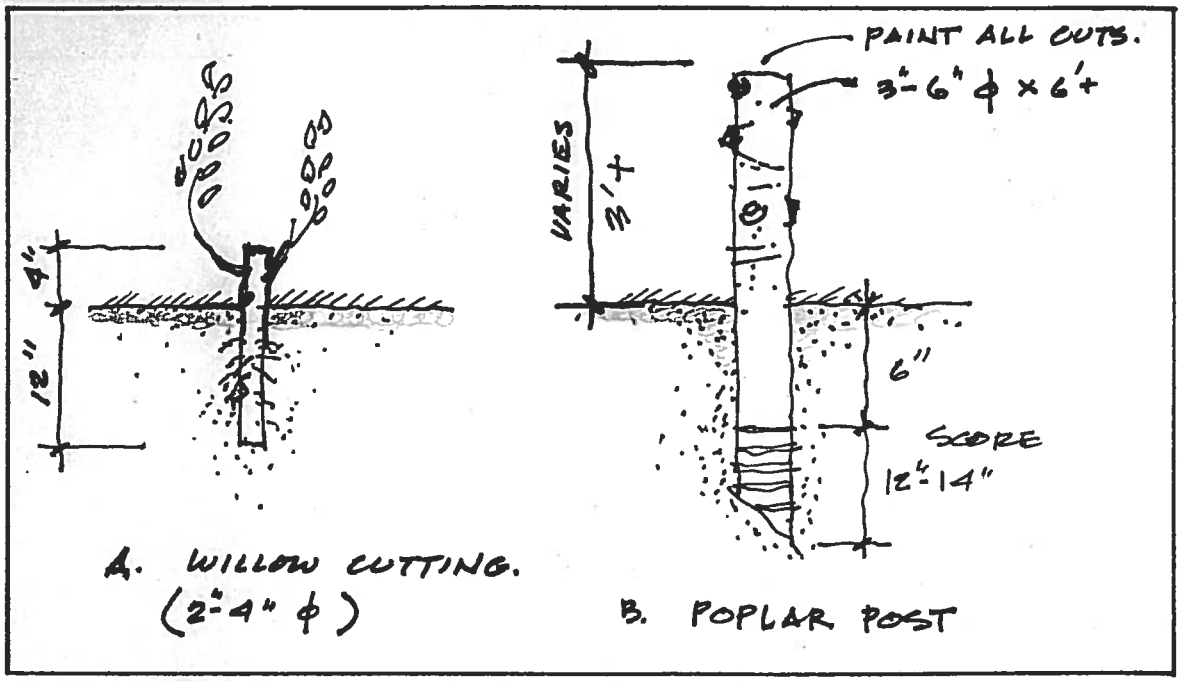


Fig. 14: Large diameter hardwood cuttings.

Poplar may be rooted similarly, using 2" root cuttings.11 Place slow release fertilizer in hole. Avoid fertilizing surface which will stimulate grass growth.

Benefit: Larger diameter cuttings have a higher survival rate and can withstand drying, flooding, rodent damage and browsing better than seedlings.Pt12 Pre-rooted cuttings are better able to withstand competition. Spring planting increases survival up to 4 times. Plant deeper if dry conditions are anticipated.

4.2.11 Transplant locally available marsh and meadow plants as small plugs to accelerate habitat development.

Method: Prepare soil surface by tilling in fall and plant 3" to 6" plugs as soon as runoff abates. If available, seed may be hand broadcast onto firm seed bed. Fall plant only in areas not to be affected by runoff.

Benefit: Speeds plant development and reduces erosion risks. Labour cost may be high, however, little site preparation is required.13

4.2.12 Conduct rehabilitation and maintenance of habitat areas in an incremental manner.

Method: Mowing and burning of grass cover for rejuvination purposes should be conducted on a three to five year cycle.

a) Figure 15 shows annual burning (A) and mowing (B) scenarios based on a 3 year cycle. Note the bulk of grass cover is undisturbed in any one year.

b) Drawdown ponds during wet years to suppress aquatic vegetation. Mow grass drainage swales semi-annually (wetted perimeter only).

Benefit:

a) Retention of 2/3+ of ground cover every year will minimize the impact of cover and food losses on wildlife in the area. Spring burning will leave winter cover intact and will not effect nesting prior to mid April. Leaving majority of cover from year to year increases ground nesting success for dabbling ducks. Maintaining an irregular pattern enhances the protective nature of the edge condition.

b) Minimize back flooding and maintain continuous cover in swale to prevent erosion.

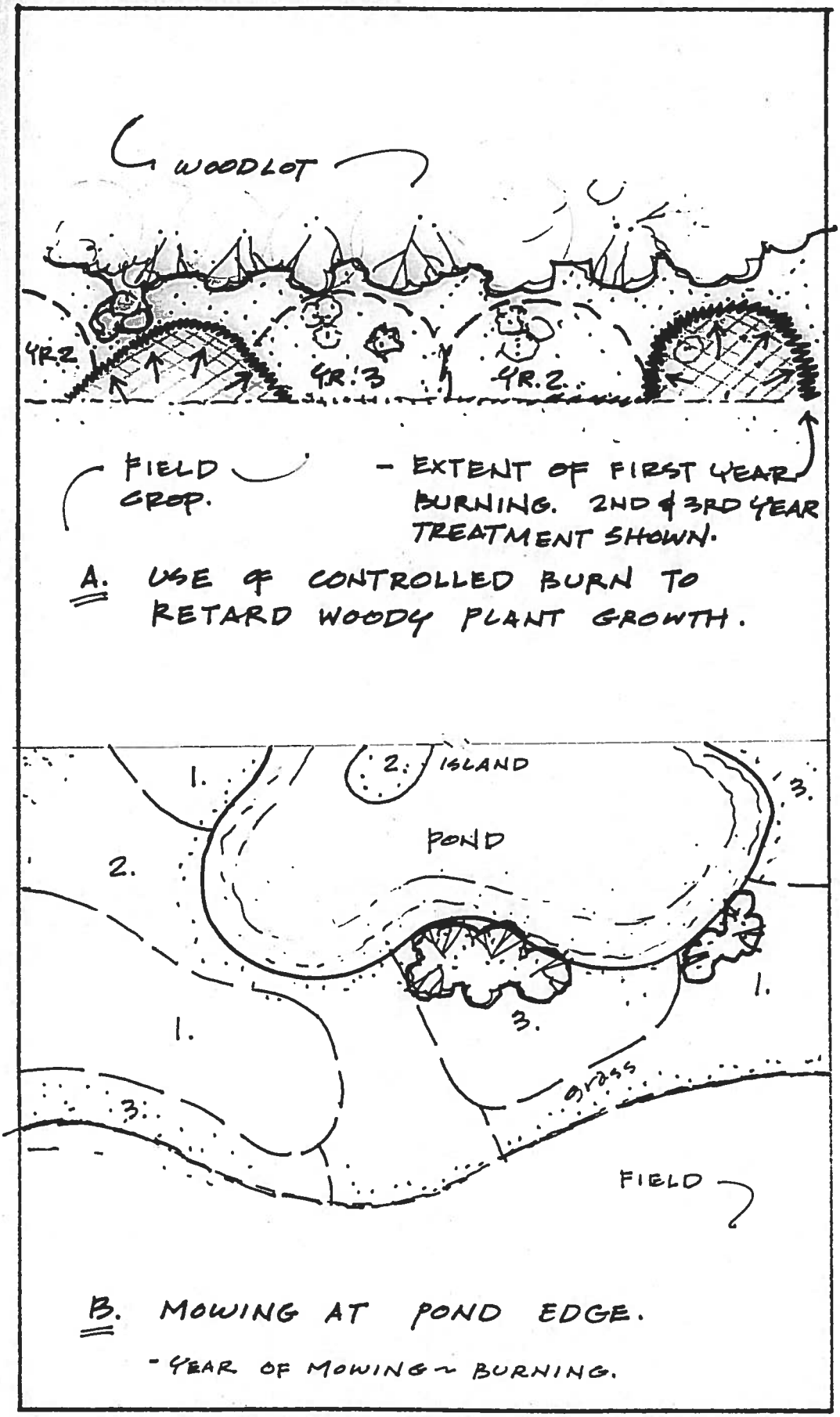


Fig. 15: Cyclical rejuvination of grass cover.

4.3 Watershed Development and Utilization

Onsite retention of drainage and controlled release of excess runoff has significant benefits for individual landowners, wildlife and the region at large. Without including ephemeral streams, small streams order 1-4, as shown in Figure 16 constitute 85% of stream mileage worldwide[14], therefore, the potential for mitigating downstream flooding holding and controlling the release of water in small "headwater" areas is considerable.

The concept of landowners taking greater responsibility for storing water on their land is promoted by the Conservation Districts Authority as a means for reducing expenditures on large downstream drainage works.[15]

The guidelines in this section define methods for creating an onsite drainage network which designates the location of channels, retention or detention basins and outlets to the regional drainage system. Development of a permanent drainage pattern with characteristics similar to an ephemeral stream, wetland complex as shown in Figure 17 will improve water quality, provide flood abatement and benefit wildlife.

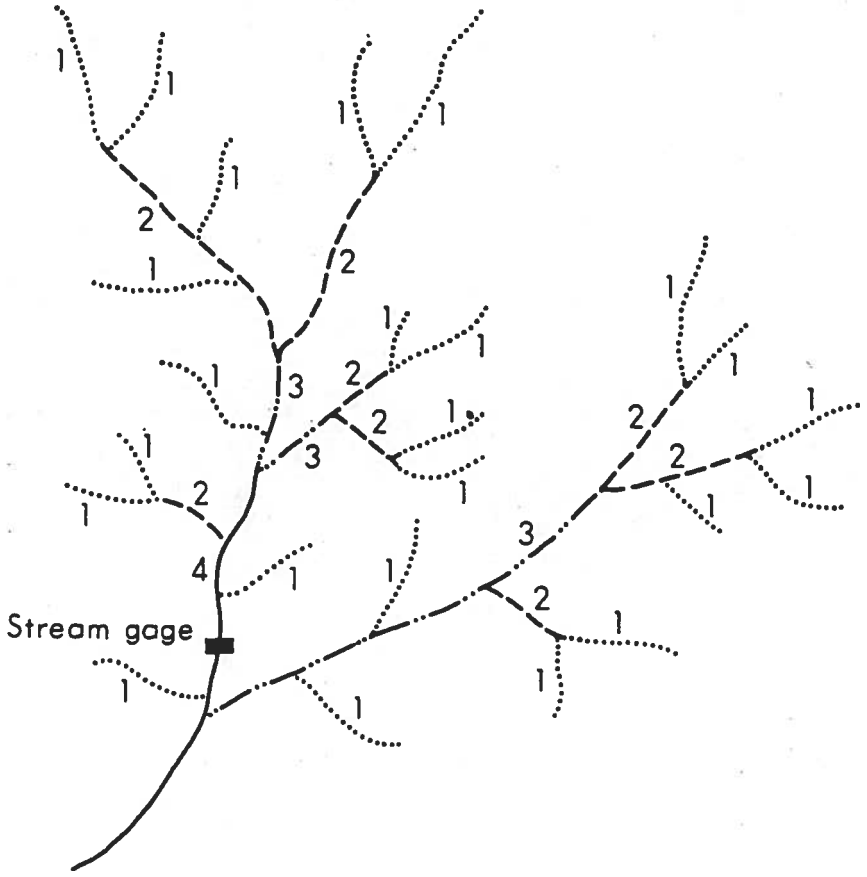
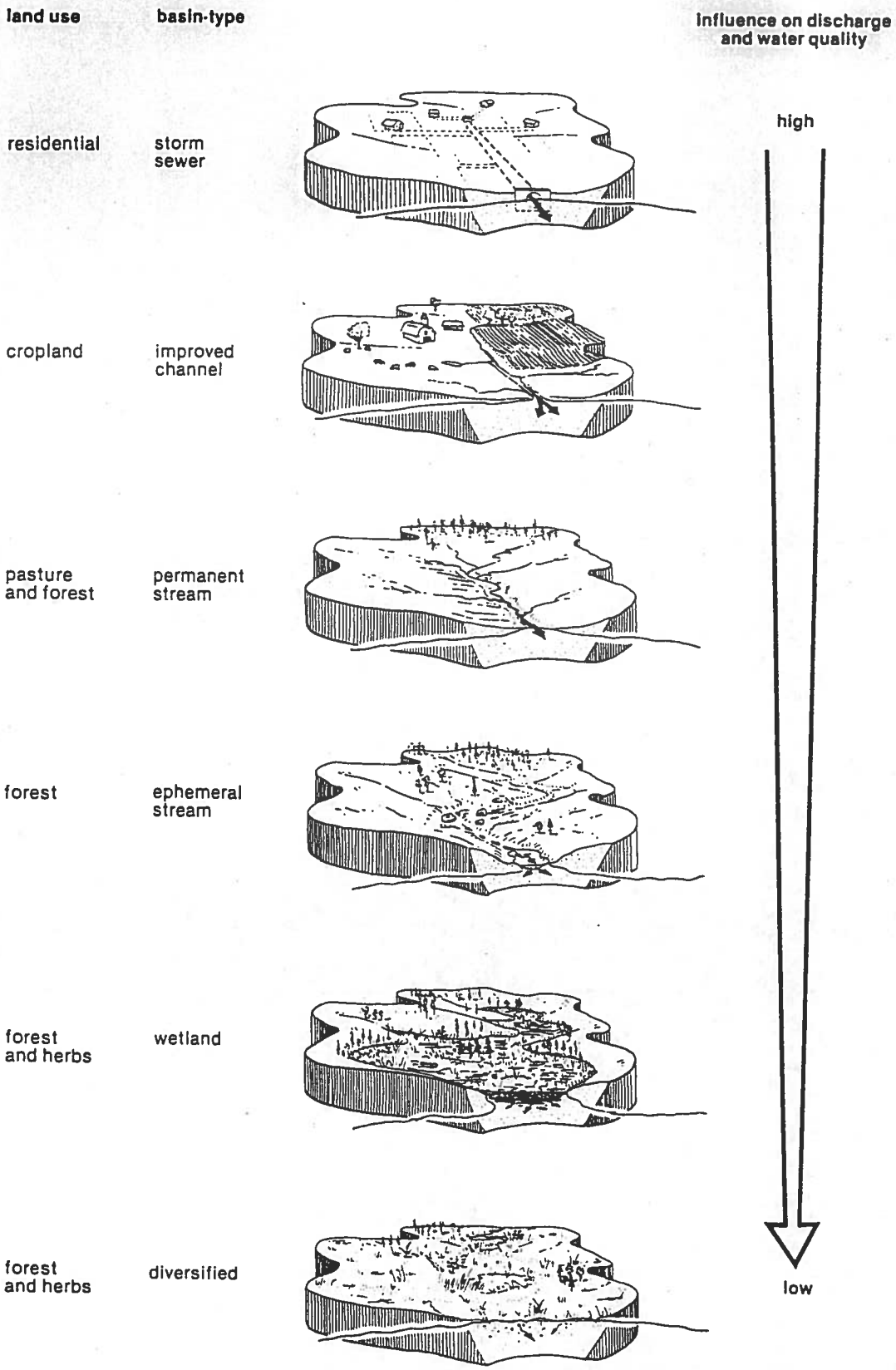


Fig. 16: Composition of typical watershed showing extensive first order network.



Six types of small drainage basins, each with different development and drainage systems. The runoff that each contributes to the lake is regulated by the efficiency of the flow system, an example of the connectiveness concept (from Marsh and Borton, 1976).

Fig. 17: Drainage basin influence on discharge and water quality.

4.3.1 Locate existing low areas and establish extent of permanent drainage network.

Method: Examine fields to locate low areas, and eroding slopes and direction of overland flow (see Figure 19). Determine where flow has caused erosion to occur. Once pattern has been located shape drainage channel (as seen in figure 18) ensuring positive flow and seed to grass-legume cover.

Where shelterbelts are required plant along Plant shelter belts (where required) along channels edge, ensuring a southerly exposure for channel. Once drainage pattern has been determined the following items can be designated as part of the permanent drainage network. (see Figure 19).

1. Sediment Basin - (See Figure 21)
2. Grass channel -(see Figure 18)
3. Temporary pond 3' deep
4. Permanent pond 6-9' deep (see fig. 28)
5. Shelter belt along north side of channel
6. Field shelter belts as required running N/S at 400-500 o.c.
7. Extent of cropped area
8. Potential expansion of habitat cover or lure crop planting

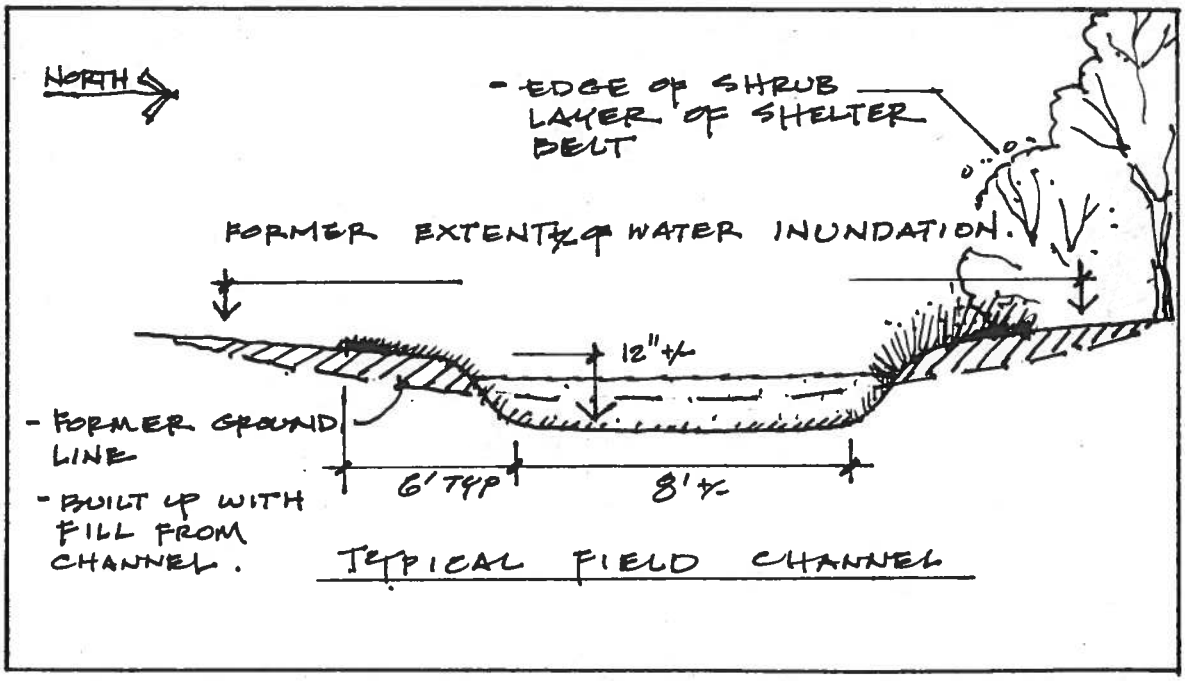


Fig. 18: Cross section of field channel.

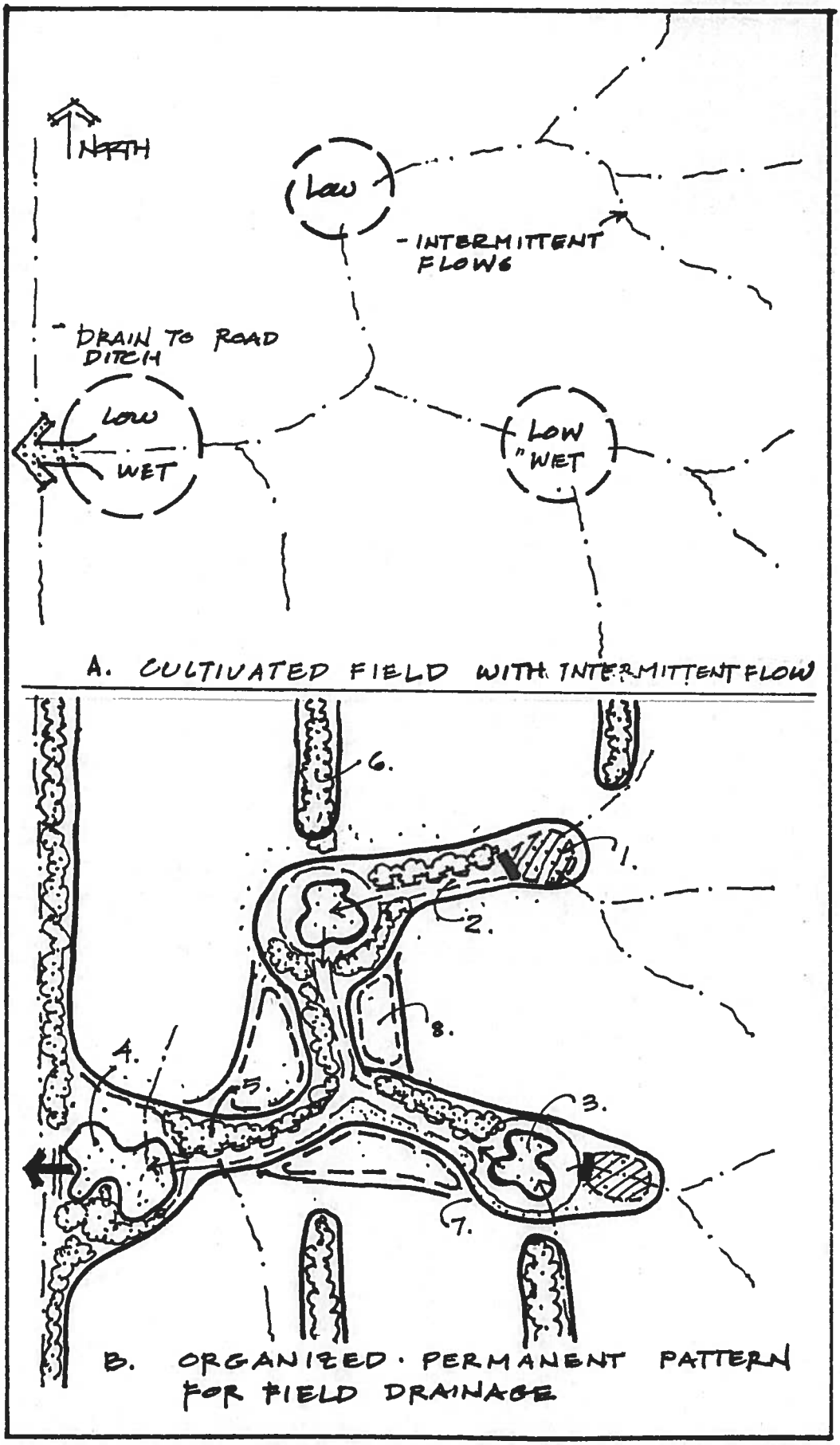


Fig. 19: Existing drainage and proposed reorganization.

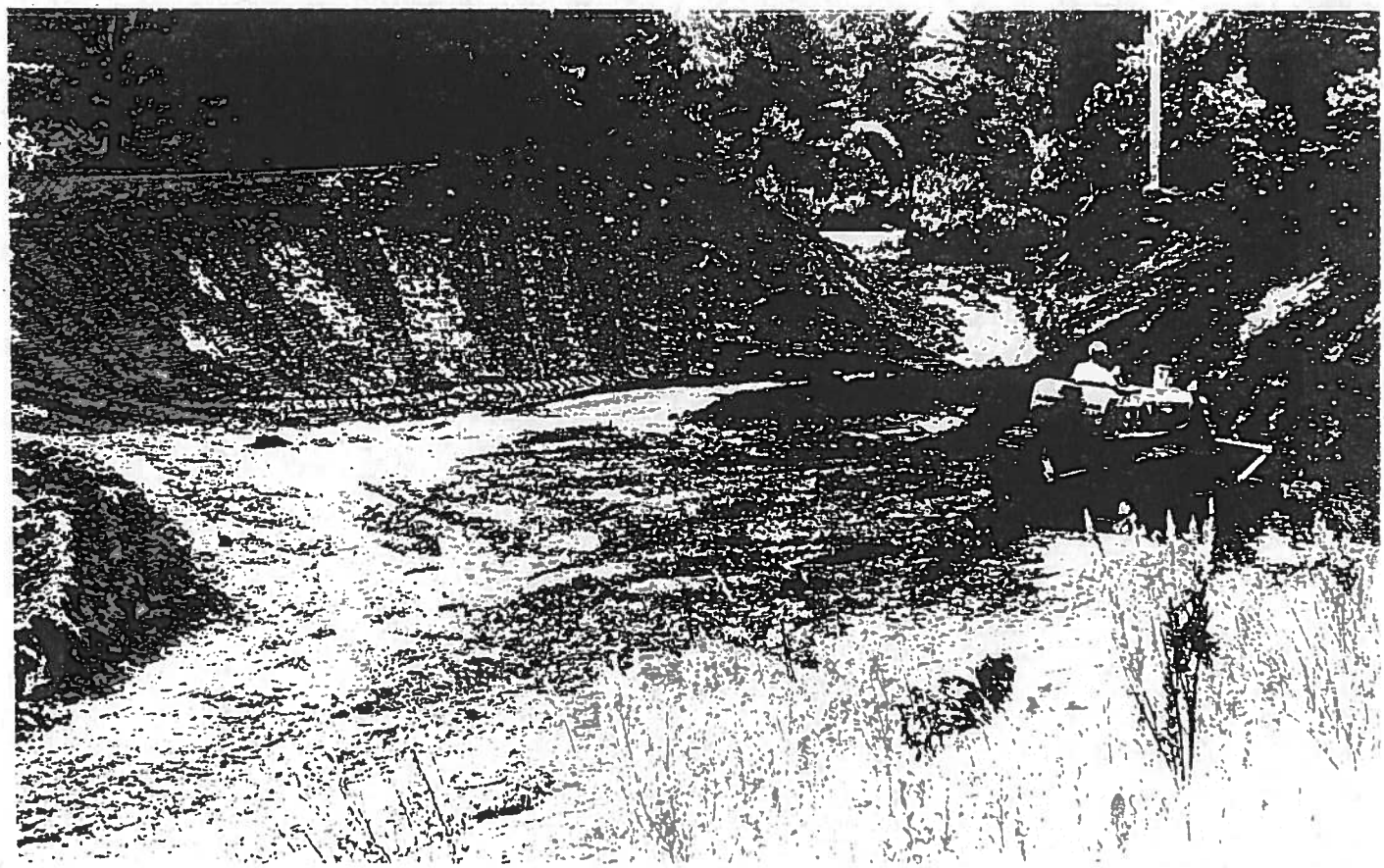


Fig. 20: Dam construction on existing low area to build pond.

Benefit: Minimizes downstream sediment load, retains percent of runoff water on site and provides extensive wildlife cover.

4.3.2 Excavate ponds in existing low, wet areas being fed by grassed channels.

Method: Figure 20 shows the use of a bulldozer to excavate and create an impoundment by blocking the outlet of an existing low spot on a drainage course. Pond depth to 3' will provide ponds which may dry-up during late summer, depths of 6' and over are required if a pond is intended to be a permanent waterbody. Excavate in early summer to allow vegetation to establish.

Benefit: Will collect excess runoff and retain a percentage of all spring and storm runoff on site. Recharges water table and provides habitat and food for aquatic birds, mammals. Temporary ponds are excellent for ducks as a food source. Drawdown kills successional growth and promotes insect population growth in spring.

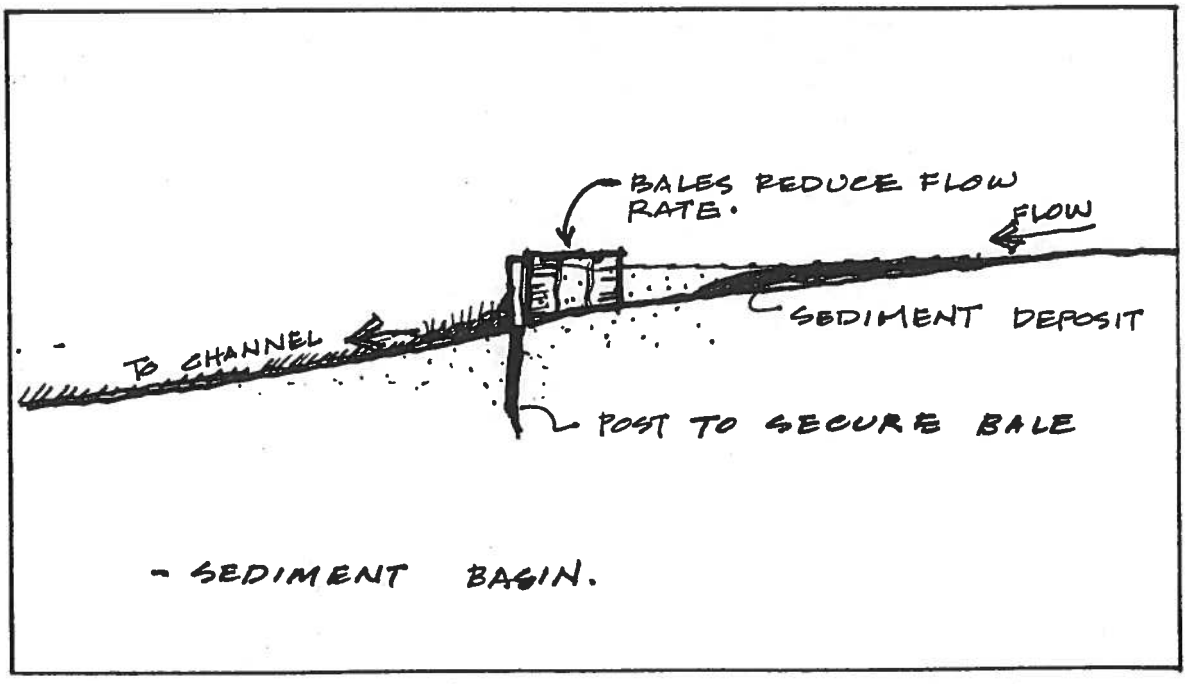


Fig. 21: Straw bale check dam at upstream end of permanent drainage network.

4.3.3 Construct small control dams at upstream ends of permanent drainage system.

Method: Construct a small, field stone check dam (Figure 22), Gabion (Figure 23) or hay and straw bale check dam at the beginning of permanent channel area. Figure 21 shows a typical cross section. Clean out sediment regularly. Plant barley or grass after excavation.

16

Composition of stone sizes - check dam.
For flows not exceeding: A 1.0 m3/sec
B 0.75 m3/sec

Stone Sizes (cm)	% (A)	% (B)
10-14	25	25
15-19	20	20
20-30	25	55
31-45	30	0
	100	100

It is important to include smaller stone to avoid formation of jets of water which can erode channel banks and bottom and risk collapse of the structure. Maximum dam height 2 metres.

Because no flow data likely will exist on small watersheds, size breakdown should reflect the potential runoff volumes anticipated in the water course.

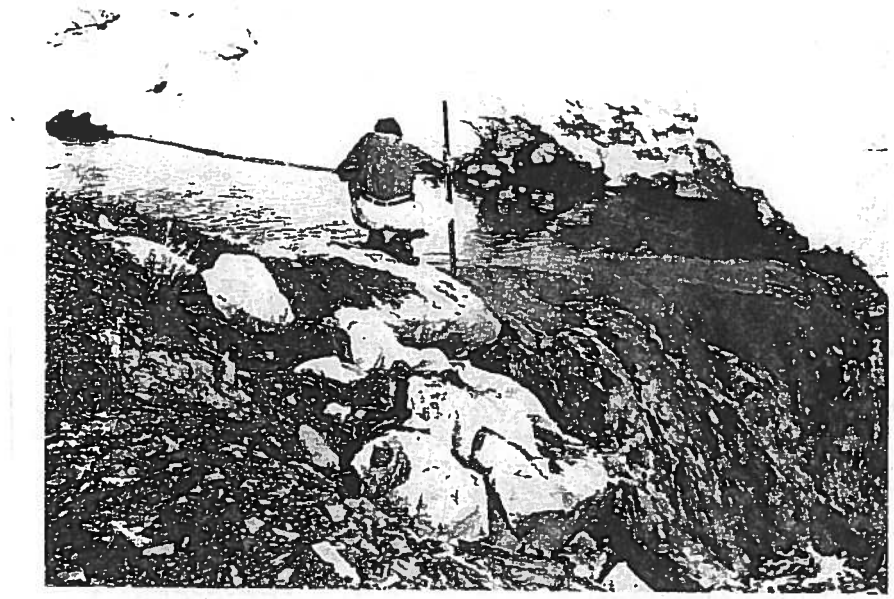
If flow volumes are available use the following formulas to calculate distribution.

$W = 2.44 (10^{-5}) * V6$

Where W = weight of rock (average)
Where V = velocity of flow

Rock composition by weight should be:
65% < W 35% > W

Construct by dropping stone into place by machine to improve compaction, finish by hand plugging with small stones. Spread fill upstream to prevent it washing away.



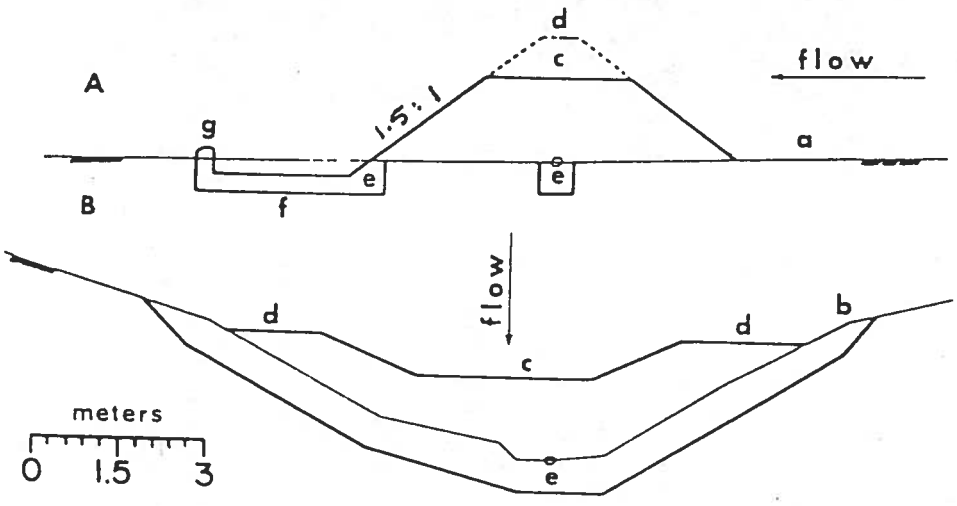


Fig. 22: Rock check dam

Fig. 23: Wire gabion drop structure

Benefit: Prevents eroded soil from entering and filling or blocking drainage system and ponds. Facilitates removal and respreading on surrounding field area. Organic matter in sediment, plus plant material makes excellent green man re. Larger sediment traps, alluvial deposits, make excellent aquifers, increasing channel storage capacity, decreasing gradients and peak flows.17

4.3.4 Protect outlet channels from ponds with non-erodable materials.

Method: The most common method is to use field stone to protect the outlets, as shown in figure 24. Ensure protected outlet is wide and deep enough to allow passage of excess water without causing erosion of banks or channel downstream. Protect channel downstream for a distance equal to 1.5 x the height of the dam.18 The wider the outlet, the more energy is dissipated in the outlet flow.

Benefit: Easy to maintain grouted or loose field stone riprap. Prevents erosion of spillway and protects ponds integrity.

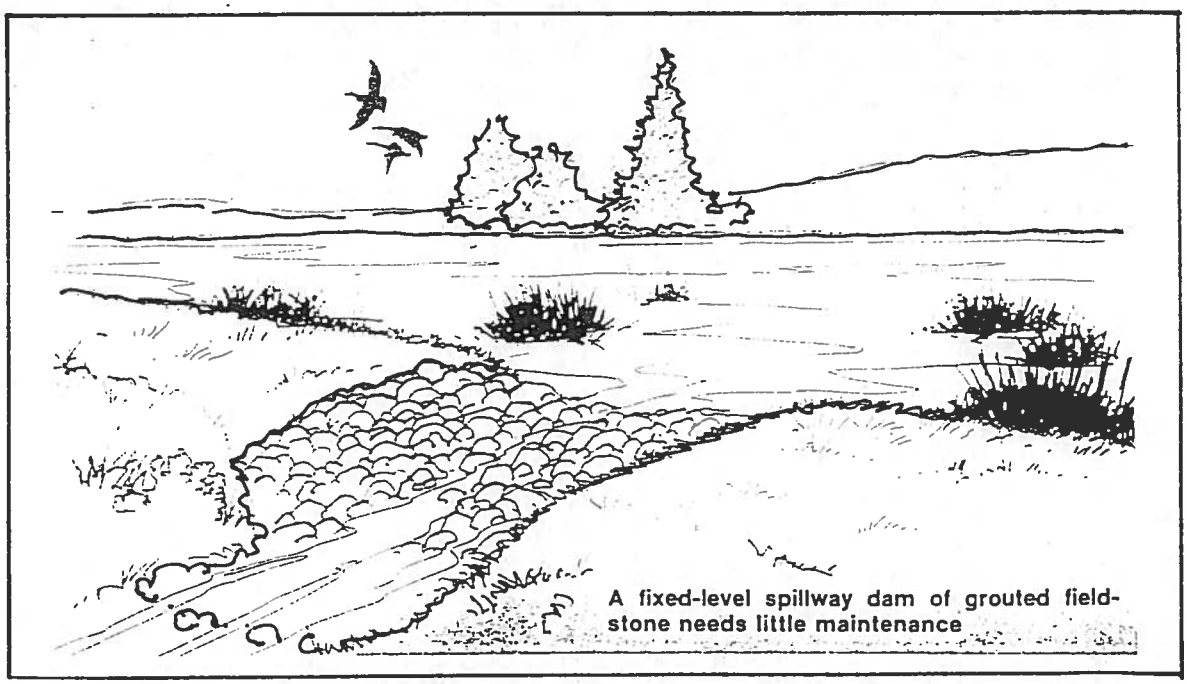


Fig. 24: Grouted fieldstone spillway.

4.3.5 Provide up to one acre of pond surface for every 10 acres of area to be drained.

Method: Calculate acreage, that is being drained to the pond directly via the drainage channels using an air photo or topographical map In Manitoba, 10 acres of catchment area should provide enough water to fill a one acre pond with 2' to 6' depth. Smaller drainage will not allow ponds to fill during dry years. Drainage areas in excess of 200 acres may create problems due to excess runoff.

Benefit: At a ratio of around 1:10 the ponds will retain the majority of surface runoff from the site. Reduces downstream flooding. Several small ponds in series have ability to retain additional water volume.

4.3.6 Plant trees to shade pond edge of permanent ponds.

Method: Plant trees along the south s de of ponds to produce dense shade. Orient pond if possible in an east-west direction so more pond may be shaded. (see Figure 25).

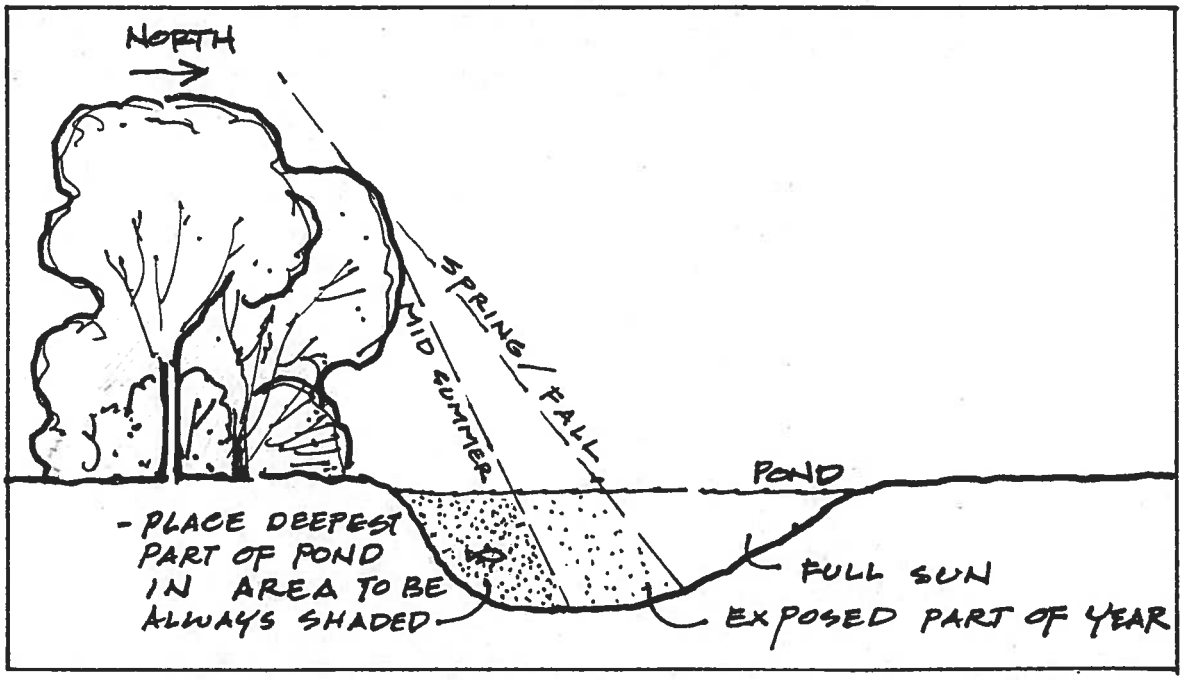


Fig. 25: Shading of permanent pond surface.

Benefit: Shading reduces water temperature and trees will reduce wind and evaporative loss. Lower temperatures reduce algal growth rate, and improves oxygen content critical for fish and other aquatic organisms.

4.3.7 Protect ponds from cattle damage if used for stock watering

Method: Fence off a portion of the pond adjacent to the outlet. Riprap sides and bottom of fenced portion with round field stone and gravel. Tamp down to prevent it from being dislodged. Pond may be designed such that the outlet can easily be fenced off as shown in Figure 26. Place sediment trap downstream to catch manure.

Benefit: Reduces turbidity and erosion caused by trampling. Animal waste will be washed out of pond. Protects shoreline habitat, nests from from trampling.

4.3.8 Treat land use starting upstream and proceeding downstream.

Method: Plant, seed in upstream portions of drainage system first and proceed downstream in stages.

Benefit: Begins to protect channel integrity and reduce risk of plants being washed away.

4.3.9 Construction of dams and check dams should begin downstream and proceed upstream.

Benefit: Sites disturbed by construction activity are erosion prone. When working upstream any eroded material will be caught by the first structure preventing pollution of waters further downstream.

Prior study of sediment control measures indicates that land use modifications and revegetation can reduce sediment loads by 25-60% and in conjunction with control structures, sediment loading can be reduced by 60-75%.20

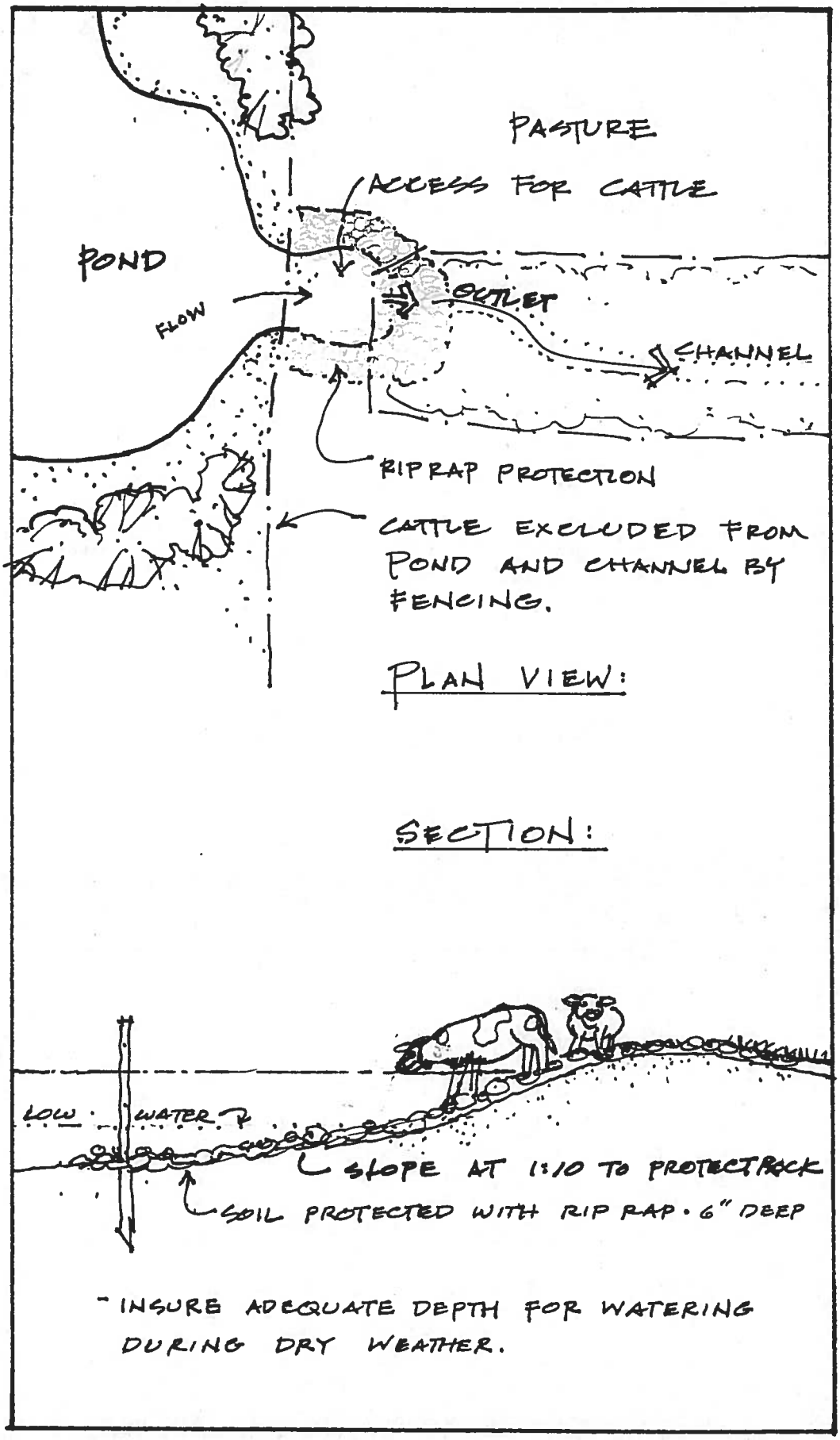


Fig. 26: Pond protected from cattle trampling.

4.4 Configure Habitat to Suit Behavioral Characteristics

The behavior characteristics of species relate directly to the landscape or habitat. Behavior is involved in the success off the animal in caring for itself, in seeking shelter, in obtaining food, in escaping enemies, in courtship and mating, in caring for the young. It is a mechanism that, in part, reduces competition between animals and controls population densities.[21]

The degree to which available habitat is conducive to animal species depends not only on its presence but on its configuration and composition as well. The extent of territories are largely determined by the vigour of the holders, the amount of competition and sufficient food supply.[22] Habitat variety and structure create spaces which are defensible, therefore increasing provision of edge structure will expand the food supply and opportunities for territory establishment, in turn increasing the population of territorial species within the area. The following guidelines describe methods for manipulating land forms and vegetation to attract and sustain more, diverse wildlife populations.

4.4.1 If habitat area is to be removed, plan and implement habitat development and drainage control measures prior to removal.

Method: Begin by developing new habitat area and following establishment begin removal of existing cover.

Benefit: Provides alternate food and cover for displaced fauna. This will enhance survival rate and prevent loss of the population.

4.4.2 Do not burn brush piles - reuse them as cover.

Method: Place brush in piles or unwanted field stone at the edge of wooded areas on grassy site. (see Figure 13). Place 2' to 3' high, cover rocks with soil to encourage plant growth.

Benefit: Small mammals and birds will use them as cover and nest sites. Being near food sources increases their productivity. Several smaller, separated piles provide increased shelter and nesting opportunities.

4.4.3 Leave large, dead trees standing.

Method: Refrain from removing standing deadwood. In some cases it may be advisable to "plant" a dead tree trunk in an exposed area. Salvaged telephone poles will perform a similar function.

Benefit: Deadwood provides nesting opportunities for bird species and perching, roost sites. These are preferred by hawks and owls and influence their choice of nesting and territorial range. Their presence will keep rodent species in check.

4.4.4 Link shelter belts and existing bluffs with cover plantings.

Method: Plant grass strips or leave standing stubble within fields and between habitat areas. Connect existing bluffs by planting grass strip and blocks of trees along an undulating line within grass cover. Figure 27 indicates relationship between existing bluffs and configuration of proposed linkage.

Benefit: Animals use this cover to travel within the habitats and avoid detection by predators. The presence of well developed movement corridors helps increase animal populations by reducing predator success rates. Also functions as windbreak and nesting habitat.

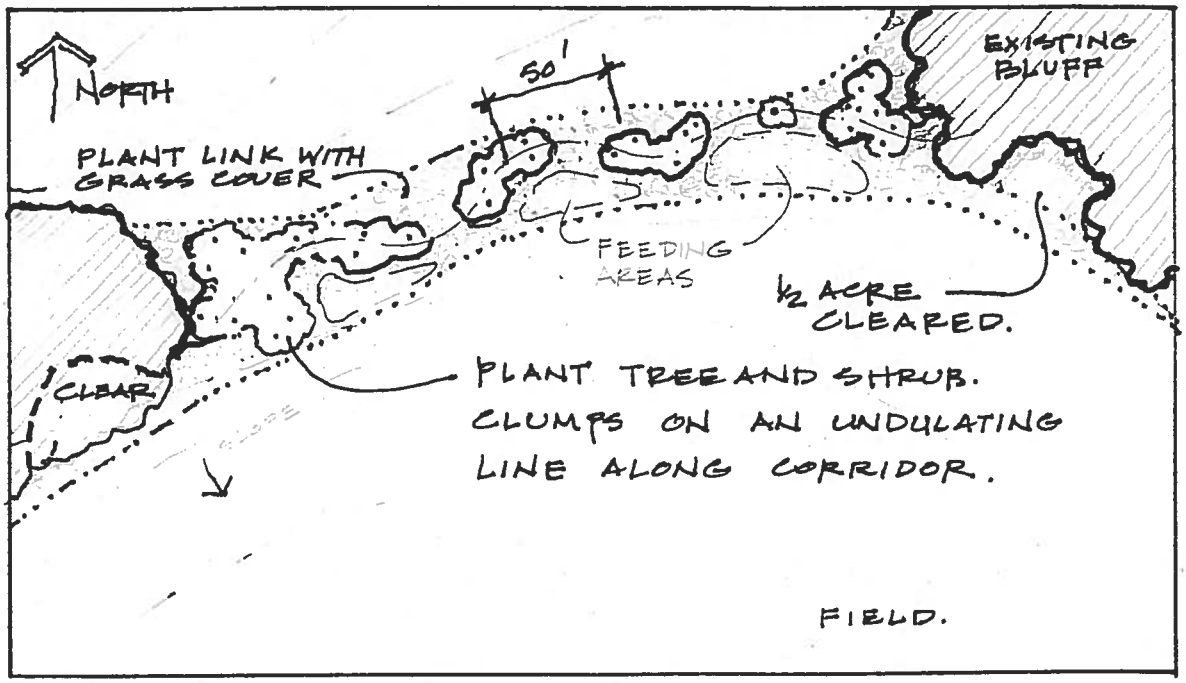


Fig. 27: Habitat corridor between existing bluffs.

4.4.5 Plant shelter belts with curving lines; undulating edge condition.

Method: Offset plantings of shelter belt trees within linear strip designated for shelter belt (see Figure 28).

Benefit: Provides protection for animals foraging along shelter belt. Creates sun catches and wind shelter on southern exposure during winter. Straight line off grass border means farming operation will not be impeded. Studies have shown that as "edge" increases, the population of upland game birds increases.23 Observations record greater nesting activity at the end or at breaks in shelter belts, seldom in the middle of a long shelter belt run due to the increase in edge condition.

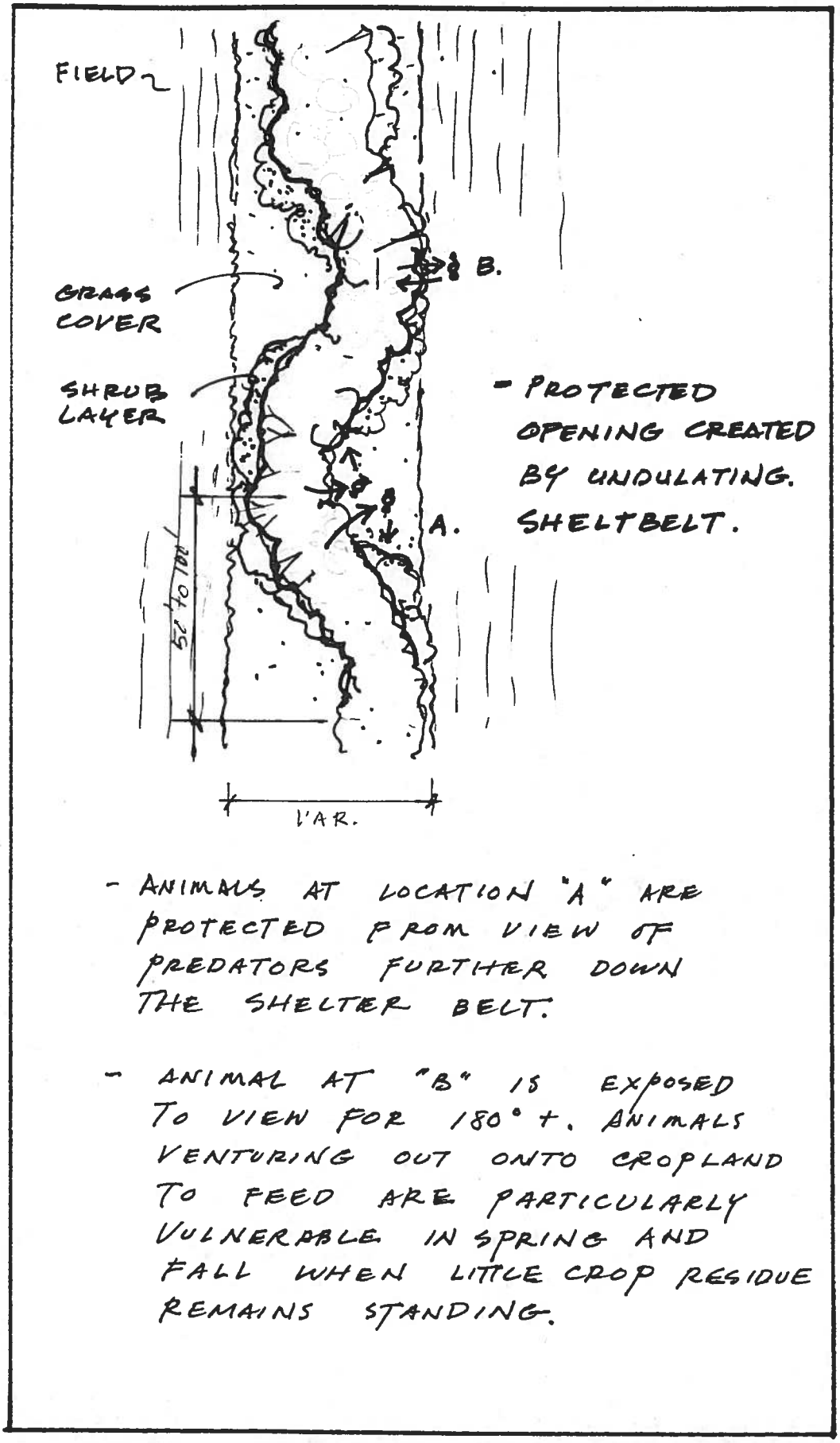


Fig. 28: Undulating shelter belt with protected openings.

4.4.6 Leave strips of cover around existing ravines.

Method: Leave cover strip of 100' (+) wide along the full length of natural ravine or gully, or plant with shrubs and trees in a similar manner to shelter belt planting.

Benefit: Protects erosion prone banks and provides excellent refuge for wildlife during inclement weather.

4.4.7 Maintain "no-spray" perimeter around habitat blocks.

Method: If spraying of chemicals, fertilizer is required leave a "no-spray" buffer of 300' plus around wildlife habitat. Expand buffer as predator population increases.

Benefit: Protects populations from total disruption of insect food supply. Remaining populations of insects will be controlled by predators concentrated on food search adajacent to habitat.

4.4.8 Develop wildlife ponds with extensive edge, loafing sites and perimeter cover to attract and sustain ducks and aquatic mammals.

Method: Figure 29 shows a conceptual layout for a 2 acre pond which has 2 to 3 times the edge of a round pond of equal surface area. Develop bush along 1/3 of pond edge with a minimum 30' wide irregular cover strip around pond. Locate 4 to 5 loafing sites per acre of marsh.24 Seed perimeter to tall grass-legume-sedge mixture to promote cover in excess off 24". Construct 15-20' diameter islands using fill from pond or field stone covered with 12" soil. Figure 30 shows pond cross section with 50% proportion of pond less that 2' deep. Backfill bottom of "waterfowl" pond with topsoil to enhance plant growth.25

Renovate existing dugouts by digging shallow shelf at one end to promote emergent plant and insect growth. Avoid shading shallows.

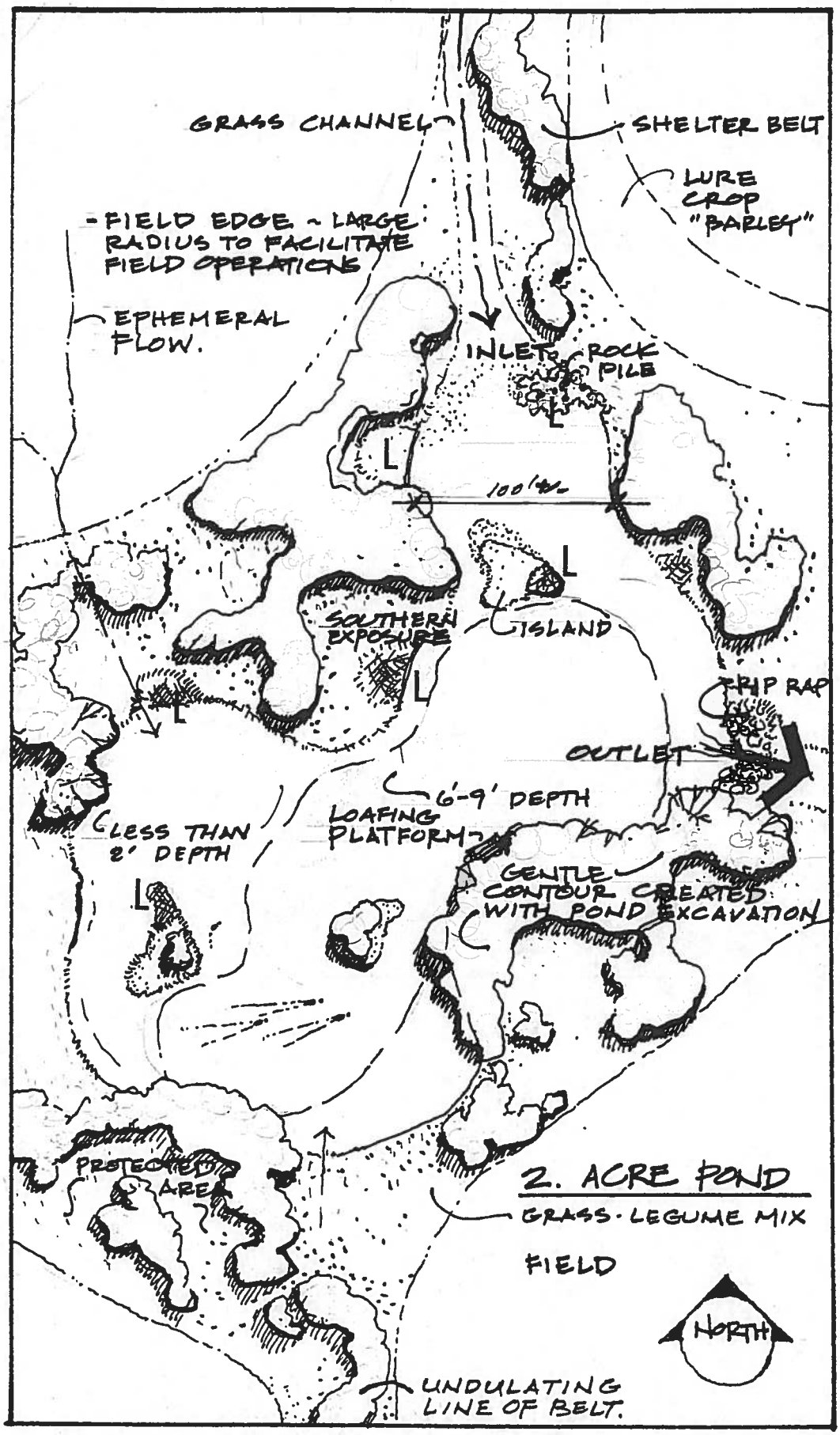


Fig. 29: Form and habitat development for a permanent pond.

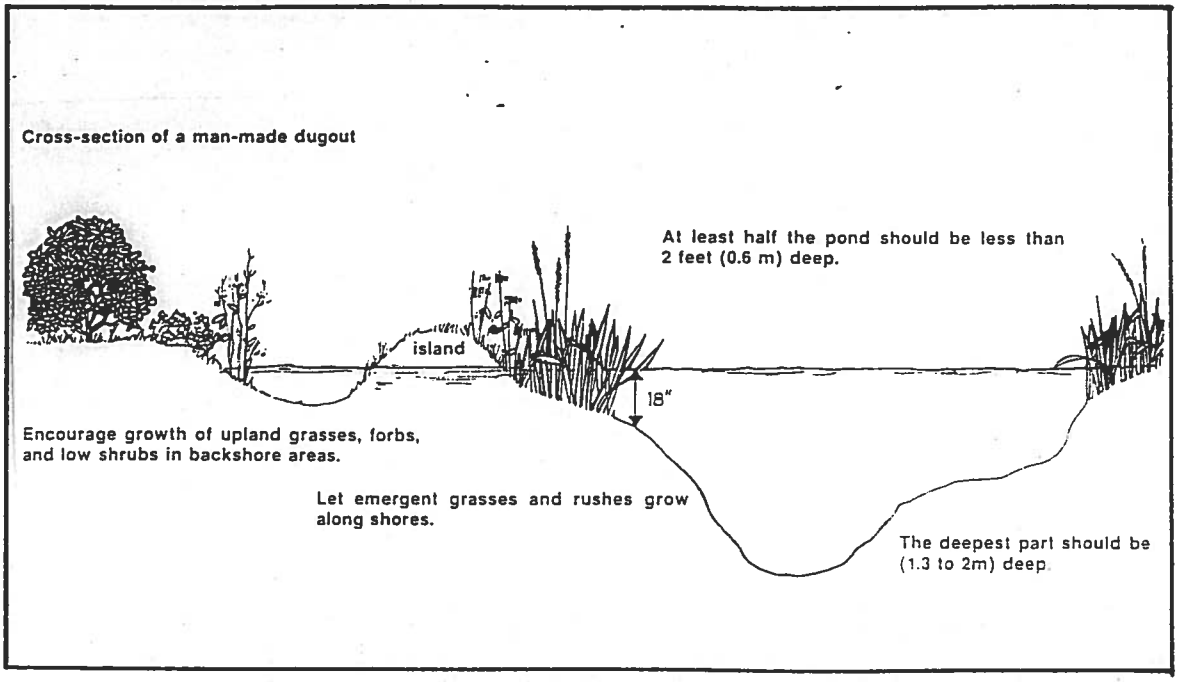


Fig. 30: Typical cross section of wildlife pond.

Benefit: The greatest number of breeding ducks per surface acre of pond occur on ponds between 1 and 2 acres, due to relatively high ratio of edge and cover present. Loafing areas are critical for male birds defending territory so their inclusion is critical. Broods seldom found on ponds of less than 1 acre. Irregular shape provides protected habitat as do islands, and protection from wave action which suppresses the emergent plant growth on which aquatic insects depend.

4.4.10 Create log loafing platforms.

Method: Lash small logs or poles together to form a platform and counter balance with larger logs on shore. Figure 31 shows placement over deep portion of pond on south side.

Benefit: Provide permanent loafing-waiting spot for ducks, creates shaded area below for fish to seek shelter and escape predators. Shade helps reduce water temperatures and improves survival rate of fish species.

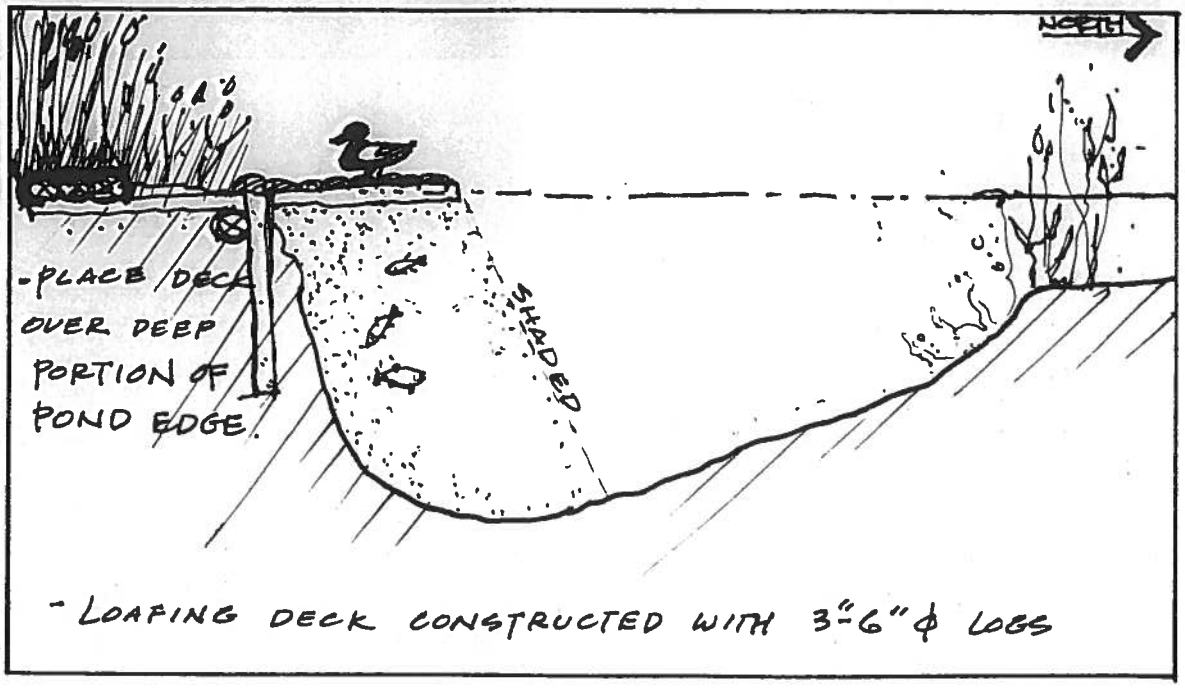


Fig. 31: Log loafing platform.

4.4.10 Use straw bales to create nesting or loafing platforms.

Method: Place bales in 2-3' of water in clearing in emergent vegetation. Place round bales on end.

Benefit: Muskrats will use submerged bales as a platform for house construction. Their activity benefits other animals by keeping water open on small ponds.

4.5 Expanding Local Landscape Diversity

4.5.1 Create ponds and bluffs close to roads.

Method: Examine the overall drainage and habitat pattern and locate, where possible, ponds and bluffs closer to roads or potential viewing areas. Figure 34 portrays the conditions that would result from the development of a pond and cover block adjacent to the intersection.

Benefit: More opportunity to see wildlife and interesting places. Ponds and trees tend to reflect changing environmental conditions and

provide greater range of images in the landscape, compared with field crops alone.

4.5.2 Follow the contour of the site when implementing drainage or habitat development.

Method: Assess the existing topography and plant shelterbelts and bluffs in a sympathetic manner, by reflecting the shape of the land. Map 4 indicates the location of shelterbelts and channels which reflect the existing topography and use it as a means of defining spaces and field orientation.

Benefit: The sympathetic siting of these elements will enhanse the overall landscape and add to the complexity anbd beauty of the setting, through addition of textures, shapes and colors.

End notes:

1R. Michael Miller and Julie D. Jastrow, "Influence on soil structure supports Agricultural Role of Prairies, Prairie Restoration".Restoration and Management Notes. V.4., No. 2 (winter, 1986): p. 62.

2Carole Giangrande, Down to Earth: The Crisis in Canadian Farming. (Toronto: The House of Anansi Press, 1985) p. 162.

3Soil at Risk: Canadas' Eroding Future. p. 78.

4 Soil at Risk: Canadas' Eroding Future. p. 77.

5 rm-120 Increasing summer flow in small streams through management of Riparian areas and adjacent vegetation: a synthesis. p. 209.

7 Jon Bryan Burley, "Retention Pond Revegetation Methods Tested", Restoration and Management Notes. V.3., No. 2 (winter, 1985): p. 81.

8 Robert B. Oetting, ed., Manitobas' Wildlife Heritage: a guide for landowners. (Winnipeg: Province of Manitoba, Department of Mines, Resources and Environmental Management, Development and Extension Services, 1973), p. 8.

6 Fergusson, R. B., and Frischknecht, N. C., eds. United States Department of Agriculture, Forest Service, INT.335. p. 7.

9 Oetting, Robert B., ed. Manitobas' Wildlife Heritage: a guide for landowners. (Winnipeg: Province of Manitoba, Department of Mines, Resources and Environmental Management, Development and Extension Services, 1973), p. 27.

13 RM-120 (See 3-4) p.113

12 RM-120 p.111

11 Ronald, W. G., 1980 Tower Poplar (Canadian Journal of Plant Science 60:1055-1056) p. 1056

10 RM-120 p. 513

14 RM-120 p.209

15 Alonsa Conservation District - pamphlet, Draft Management Plan

17 Heede: State of our Knowledge, p.11

19 Increasing Wildlife on Farms and Ranches, p.168B

16 Heede: p.18

20 Heede: p.12

21 Smith: Ecology and Field Biology, p.42

23 PRFA pamphlet, Planting for Wildlife, p.3

22 Kormondy, Edward, J., Concept of Ecology, p.97

25-4 Inc. Wildlife/Kansas State, p.58B

24 MWH. p.23

25 Increasing Wildlife, Kansas, p.169B

18 Heede: p. 24.

5. Demonstration Site Description, Analysis and Application of Design Guidelines.

"Every site, natural or manmade, is in some degree unique, a web of things and activities."1

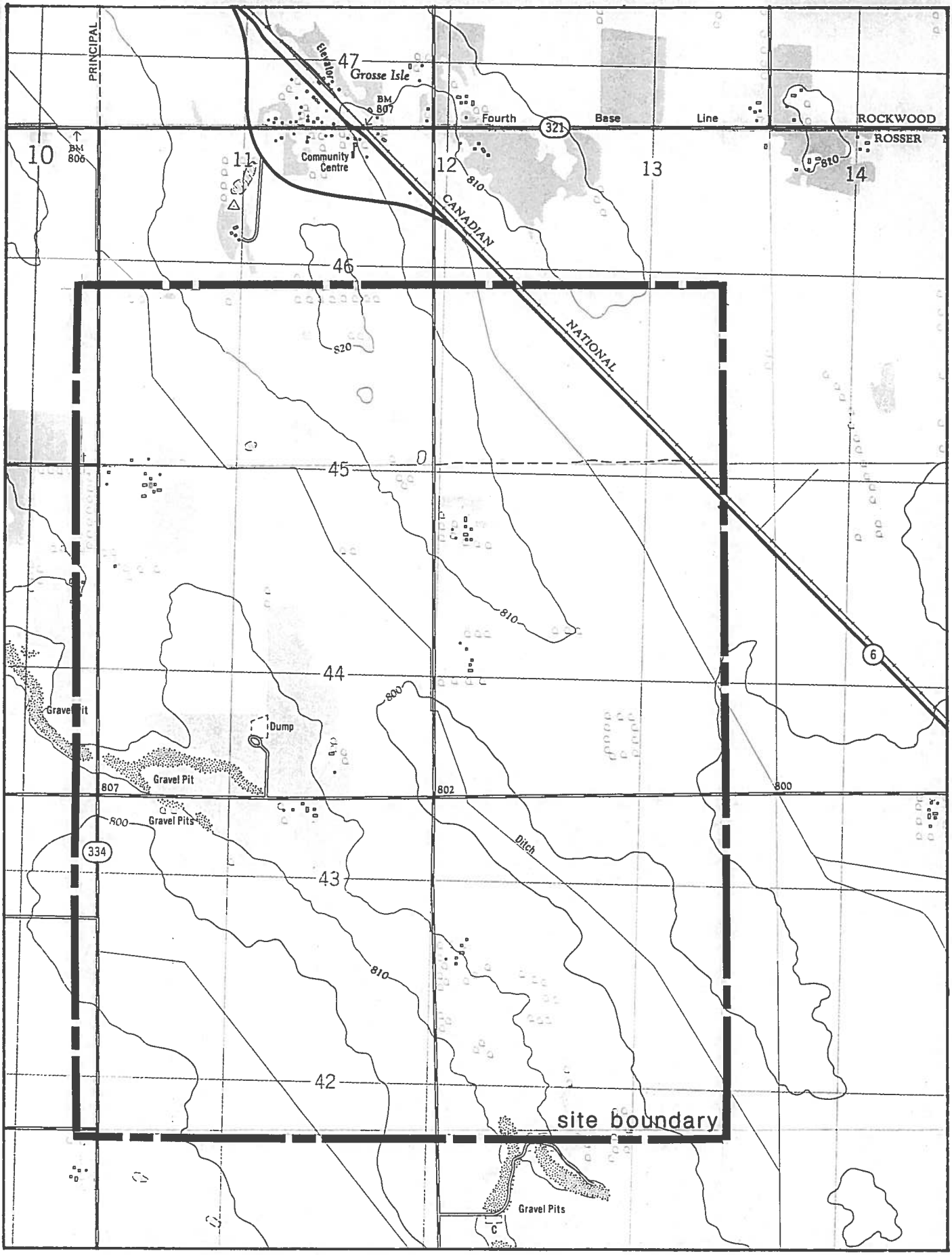
This assertion by Kevin Lynch underscores the notion that while guidelines make valid generalizations about actions required to promote habitat restoration, each site will require careful examination of its inherent characteristics in order to successfully restore habitat capable of supporting resident populations of flora and fauna.

5.1 Criteria for study site selection:

- primary landuse to be cultivated farm acreage
- existing provincial drainage system on or adjacent to the site
- easily definable watershed boundary, not prone to external flooding
- general drainage, erosion problems evident

5.2 Site description and analysis.

The demonstration site is located north west of Winnipeg, just one kilometre south east of the village of Grosse Isle which is situated on highway no. 6. There are seven farm yards located on the site and several homes on small acreages. Map 1 shows the site in proximity to Grosse Isle.



Map 1: Location Map.

The topography is quite pronounced in the immediate area due to the presence of a series of ridges running northwest to southeast, at approximately 45 degrees to the provincial road grid. The maximum elevation change is approximately 20' from the ridge top to the centre of the agricultural drains at the low points. The grade change occurs over distances of from 1000' to 1200' feet. Contour information is contained on Map 1, and shows the relative grade change between ridge top and lower lying areas.

Aerial photographs (see Map 2) reveal the presence of several large blocks of woodland habitat, primarily associated with ridge top and residential development around farm yards. This relationship is due primarily to the drought prone nature of the thinning ridge soils, and the value of the underlying gravel resource. The ridges have fewer standing water problems than the lower lying land which makes home and building sites more attractive. The surrounding lands are used almost exclusively for field or forage crops. Map 2 shows a field pattern influenced by both the road grid and the influence of topography in the form of drains which flow in a south easterly direction.

With the exception of the cover blocks on the ridge top there is little tree cover present on the site in the form of shelter belts, or shrub cover along field margins. The bulk of road ditch and drain network is leased for hay cutting. While the cover woodlots are large, the block in the centre being approximately 13 acres, they are separated by considerable distance and are not connected in any way. Figure 32 shows the ground cover typically found on the ridge top areas. The soil profile on the ridge as shown is only present in areas not yet cultivated. There are several instances of severe soil erosion

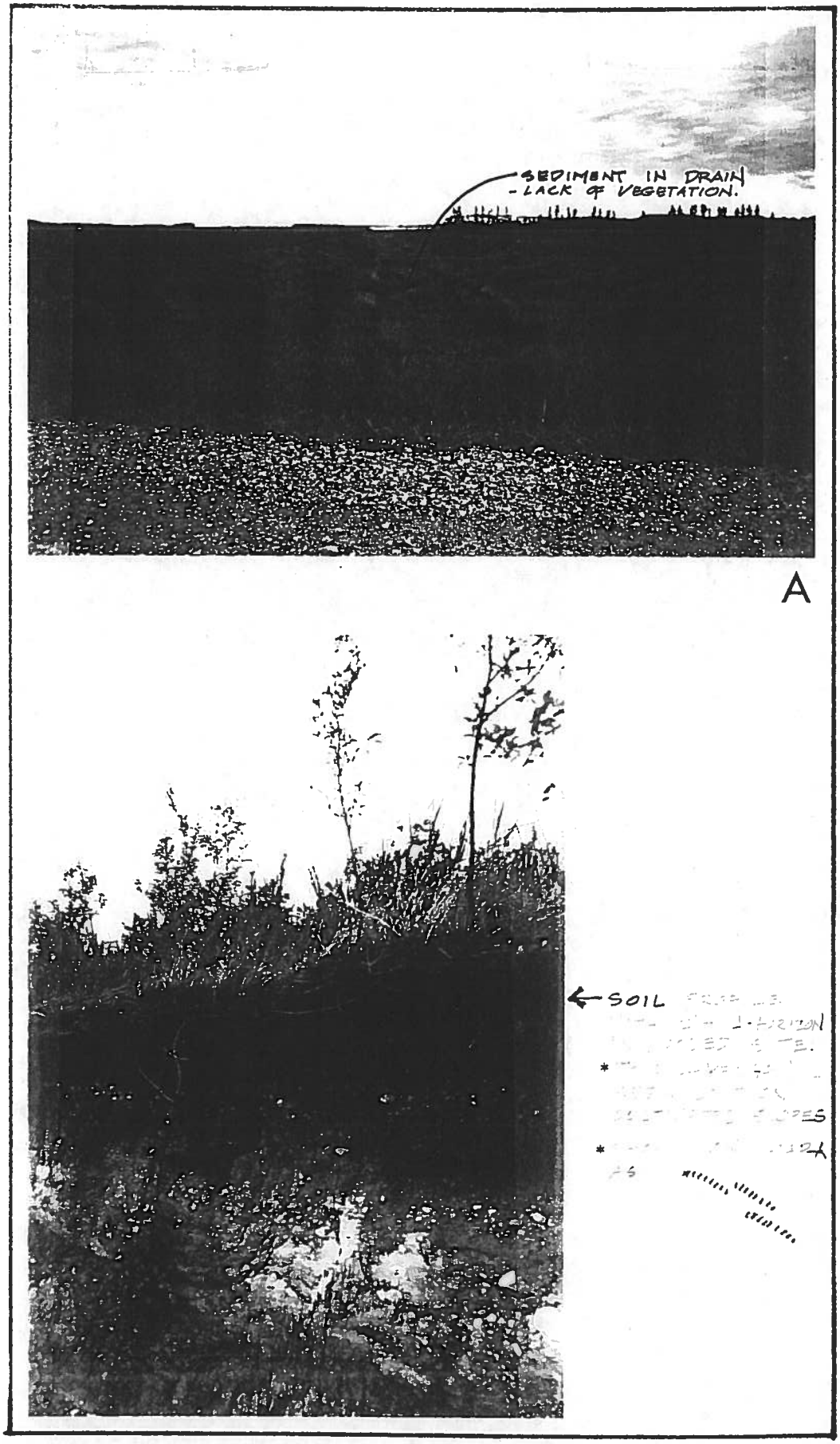


Fig. 32: Site conditions.

primarily on the cultivated ridge in the lower centre of Map 2 and shown (hatched) on analysis Map 3.

The main points coming from the site analysis are:

1. Existing cover is present, however the blocks are isolated and all have linear edge conditions, minimal for the acreage currently under treed cover.

2. There are few field shelterbelts and there is evidence of significant soil erosion from wind as described for the ridge and open areas, and water borne as evidenced by the channel sedimentation shown in photograph "A", Figure 32.

3. There are several small, intermittent ponds or low areas on the lower slopes, indicative of an irregular drainage pattern.

4. The influence of the overall slope on site drainage is to reduce the retention of runoff moisture, and this leaves the site prone to drought and erosion.

5. The presence of agricultural drains promotes rapid runoff removal.

6. With only two exceptions, the bulk of the road network runs through or beside crop areas, passing little of visual interest. Figure ~~34~~ 33 typifies this lack of texture and diversity.

5.3 Opportunities and Constraints

The result of current environmental conditions is a landscape of limited interest, yet the potential for diversity and extensive habitat network development exists in the presence of the larger wooded areas, gentle sloping topography and the three agricultural drains that divide the site. There is a real opportunity to demonstrate the applicability of

habitat development and moisture conservation measures on the upper slopes within the site and to develop a collection system to direct overland flow to several smaller wildlife ponds adjacent to both the drains and the road system. One opportunity will be to take advantage of the junction of the road and drain system, just southeast of the sites' centre and shown in Figure 33.

5.4 Application of Design Guidelines

5.4.1 Strategy for habitat and drainage network implementation.

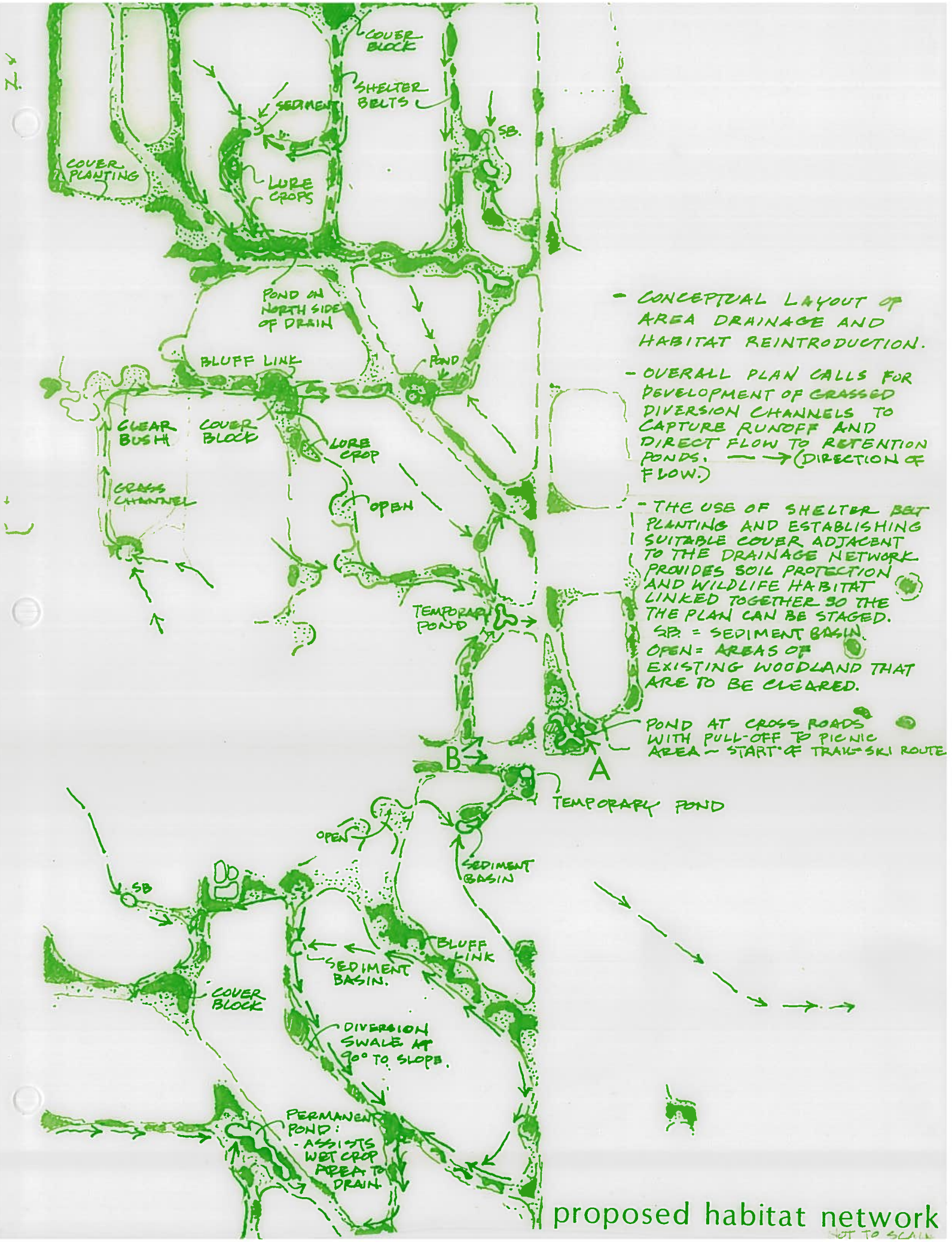
The objective is to determine the nature and configuration of the planned drainage network by locating existing ephemeral flows and linking them in a permanent fashion, around which the habitat network will be developed. Map 4 indicates the framework to be employed to achieve the integration of habitat and drainage network development.

5.4.2 Proposed drainage and habitat network.

The site conditions indicated the following:

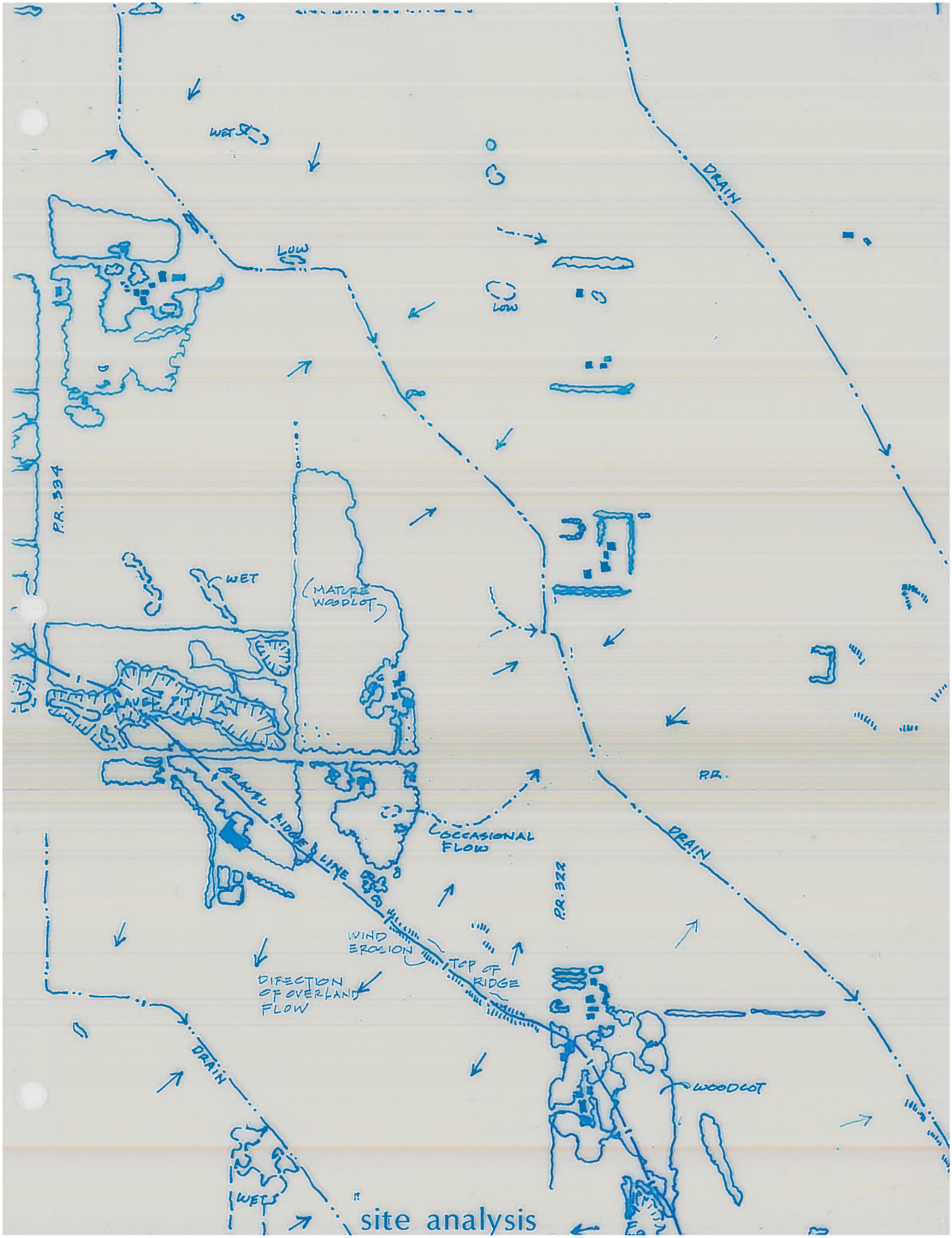
Situation: Due to the consistent nature of the site slopes, most overland flow does not find a channel as it travels downhill toward the drains. No significant concentration of surface water occurs prior to flow reaching the drain. Low moisture retention on slopes.

Solution: Flow will be diverted and trapped by grassed channels and shelterbelts running across the slopes, extending the distance runoff will travel, and concentrating the flow in a number of locations in order to create ponds which will enhance wildlife cover and the opportunity to expand species diversity and numbers. Runoff will be intercepted by small sediment basins prior to entering the permanent field

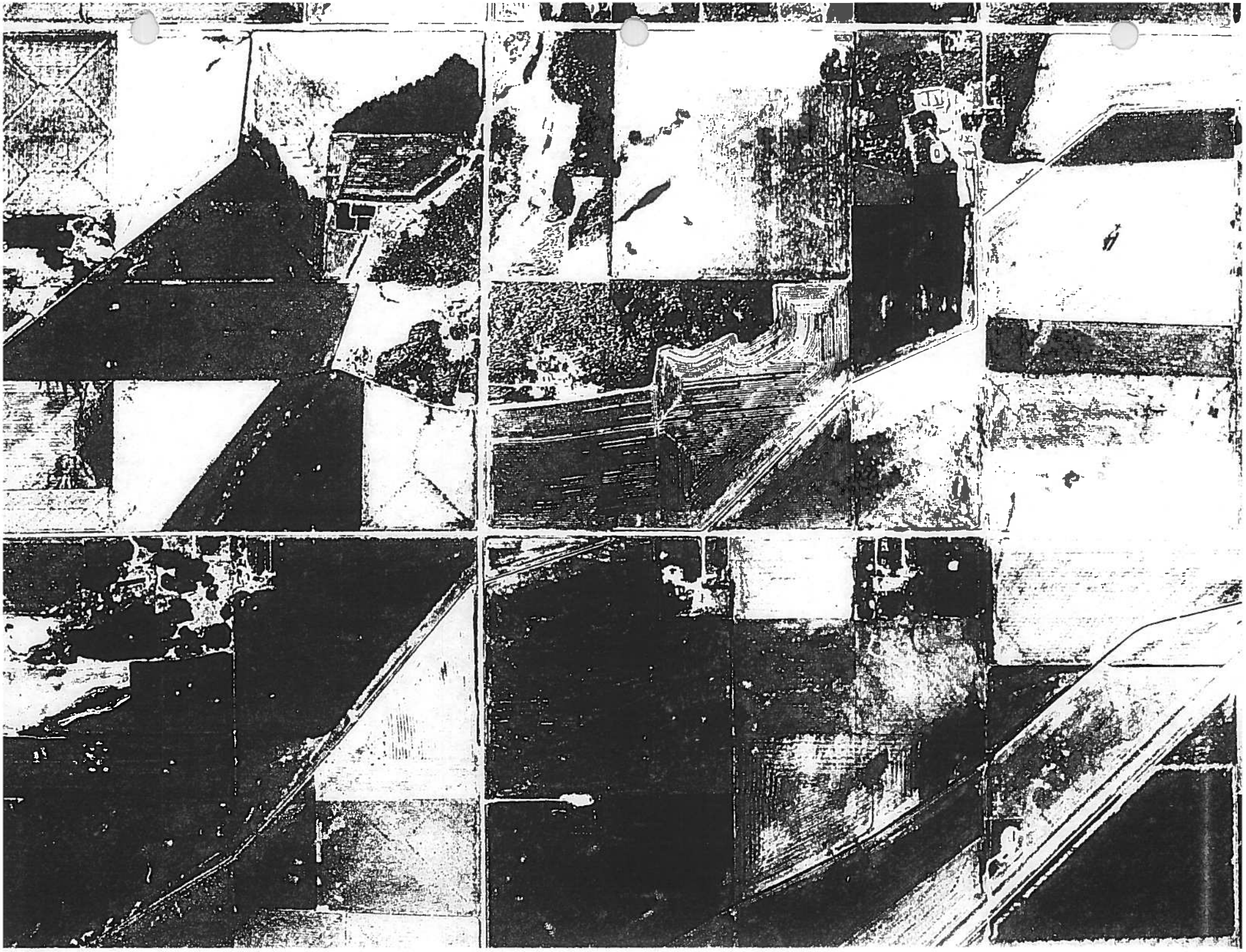


proposed habitat network

NOT TO SCALE



site analysis



channels. Locating the ponds adjacent to the drains will allow for the addition of water to the ponds by backflooding from the drains during spring runoff, thereby reducing the overall peak flow in the drains and insuring the ponds will have adequate water supply if uphill slopes are unable to retain adequate snow cover. The proposed drainage pattern is indicated on Map 4.

Situation: Soil erosion on the ridge tops due to summerfallow and exposure to winds. Existing woodlots are isolated and uniform in vegetation cover pattern and edge condition.

Solution: Develop corridor shelterbelts linking the main cover blocks. and on ridge top locations. This will stabalize the soil erosion problem, trap snow to improve the water table on the upper slopes and provide habitat strategically located between the existing woodlots. The existing woodlots would be rejuvinated by clearing small pockets along the southerly edges to improve "edge" availability. When combined, the actions to provide additional habitat and linkage will substantially increase the available "edge" for wildlife use.

Situation: The view from the road is uninspired in most locations as evident in Figure 33. What is needed is objects in the foreground, at roadside on which passersby can focus and that will bring diversity to the scene and a greater sense of place and identity to the area.

Solution: In order to achieve this the field shelterbelts and ponds are brought out to the edge of the road where possible. This will add rythym to the experiences along the road and enhances the experience of being in this place, providing a landscape with greater complexity and interest. The potential of the transition from existing conditions to a post reintroduction landscape in comparing the view experienced in Figure 33 and the subsequent view following location of pond and cover plantings in the same location. This scene has greater value by virtue of the immediacy of the surroundings and the greater potential wildlife sightings.

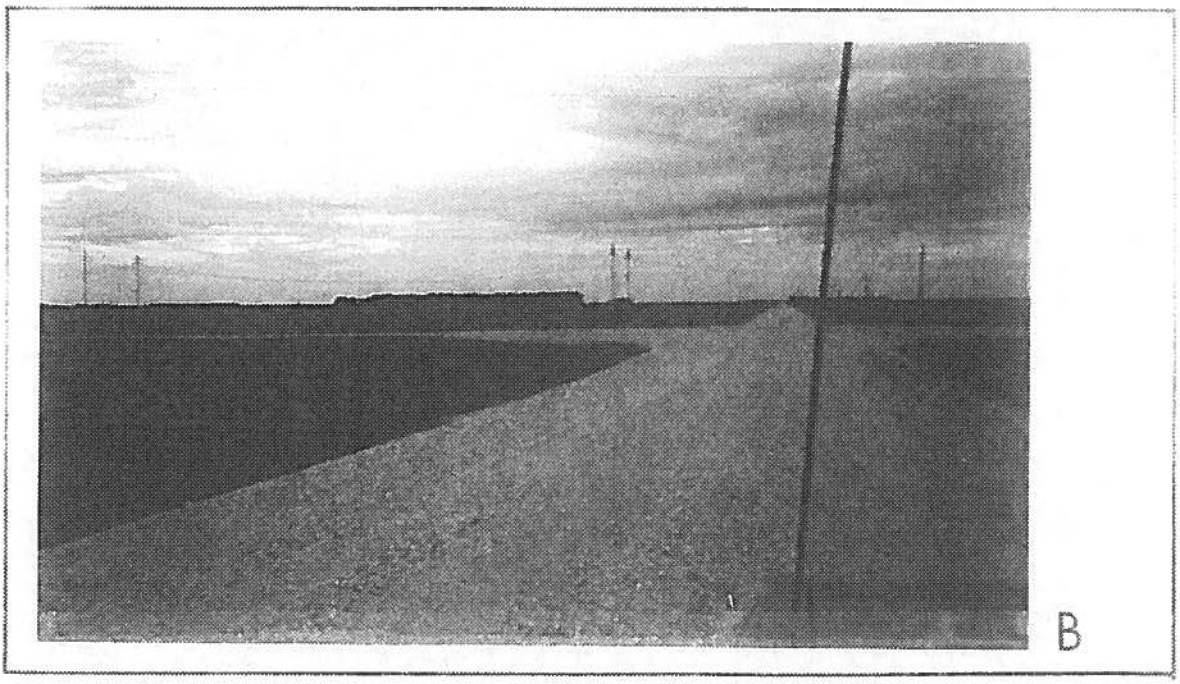


Fig. 33: Existing view looking east at location B.

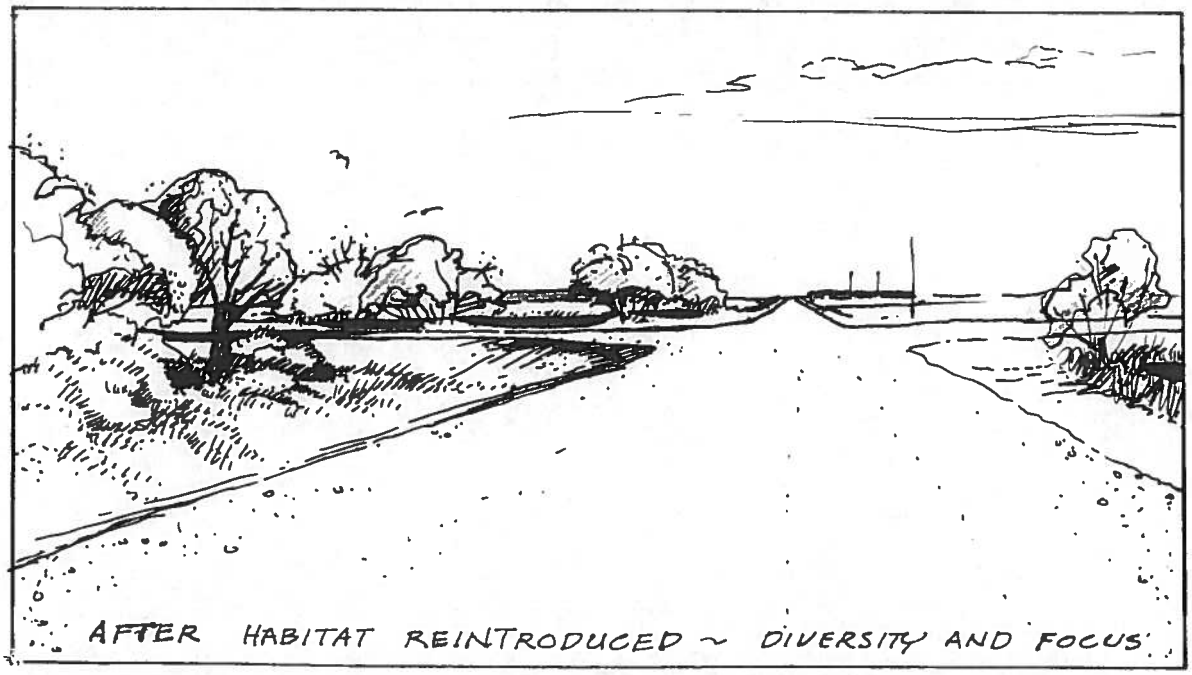


Fig. 34: Future landscape following habitat reintroduction.

ENDNOTES:

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[1] Kevin Lynch, Site Planning, 2nd ed. (Cambridge, The MIT MIT Press, 1971), p. 5.

6. Conclusion and Summary of Guidelines

6.1 Conclusion

The preceding discussion has focussed on the need for an integrated approach to development of on farm drainage, water management and the reintroduction and enhancement of wildlife habitat. The guidelines show how the process of integration can be successfully implemented.

The protection of water and soil resources is of paramount importance to Manitobans, and Canadians. Our economic well being hinges on physically protecting the land. The adoption of agricultural practices and policies which will lead to water efficient farming, will result in increased production of up to 60%[1] and be compatible with wildlife and habitat creation.

The value of ecosystems are harder to define in economic terms, yet are equally important factors in estabishing how land use decisions are made. Beyond utility of the environment, spiritual value is an essential component of the landscape and all things within it. The presence of myriad wildlife forms serves as accent within the landscape and enriches the perception of place and time. The diverseness of places and events that makes them memorable. It is in our spiritual best interest to retintroduce habitat, by adding rather than subtracting from the landscape around us.

6.2 Summary of Guidelines

4.1 Soil Protection and Improvement

4.1.1 Retain Soil Cover During All Seasons

4.1.2 Plant Eroded Marginally Productive Sites to Permanent Cover

4.1.3 Plant Shelterbelts Across Sloping Terrain

4.1.4 Create Mositure Retaining Diversions On Sloping Sites

4.1.5 Protect Existing Riparian Vegetation

4.1.6 Prepare Poor, Eroded Areas to Accept Seed by Gouging Soil Surface

4.2 Procedures for Establishing and Maintaining Vegetation for Cover and Food

4.2.1 Plant 15' wide grass cover strips along shelterbelt edges and existing bluff - field edges.

4.2.2 Plant shelter belts 6-8 rows wide using a variety of material sizes.

4.2.3 Plant lure crops in field corners, next to marsh, ponds or woodlots.

4.2.4 Establish cover plantings 150' wide N/S with a mixture of food and cover plant species. Where little existing wood land is available.

4.2.5 Create gently undulating soil surfaces to create a variety of growing conditions.

4.2.6 Create half acre clearings on the southern exposures of existing bluffs and woodlots.

4.2.7 Create living brush piles.

4.2.8 Plant multiple rows up sloping sites in newly planted areas.

4.2.9 Develop perch-planting locations.

4.2.10 Plant hardwood cuttings in spring, following runoff.

4.2.11 Transplant locally available marsh and meadow plants as small plugs to accelerate habitat development.

4.2.12 Conduct rehabilitation and maintenance of habitat areas in an incremental manner.

4.3 Watershed Development and Utilization

4.3.1 Locate existing low areas and establish extent of permanent drainage network.

4.3.2 Excavate ponds in existing low, wet areas being fed by grassed channels.

4.3.3 Construct small control dams at upstream ends of permanent drainage system.

4.3.4 Protect outlet channels from ponds with non-erodable materials.

4.3.5 Provide one acre of pond surface for every 10 acres of area to be drained.

4.3.6 Plant trees to shade pond edge of permanent ponds.

4.3.7 Protect ponds from cattle damage if used for stock watering

4.3.8 Treat land use starting upstream and proceeding downstream.

4.3.9 Construction of dams and check dams should begin downstream and proceed upstream.

4.4 Habitat Configuration to Suit Behavioural Characteristics

4.4.1 If habitat area is to be removed plan and impleement habitat development and drainage control measures prior to removal.

4.4.2 Do not burn brush piles - reuse them as cover.

4.4.3 Leave large, dead trees standing.

4.4.4 Link shelter belts and existing bluffs with cover plantings.

4.4.5 Plant shelter belts with curving lines; undulating edge condition.

4.4.6 Leave strips of cover around existing ravines.

4.4.7 Maintain "no-spray" perimeter around habitat blocks.

4.4.8 Develop wildlife ponds with extensive edge, loafing sites and perimeter cover to attract and sustain ducks and aquatic mammals.

4.4.9 Create artificial loafing platforms.

4.4.10 Use straw bales to create nesting or loafing platforms.

4.5 Expanding Local Landscape Diversity

4.5.1 Create ponds and bluffs close to roads.

4.5.2 Follow the contour of the site when implementing drainage or habitat development.

ENDNOTES:

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[1] Face of the Prairies: 2003 p.64

APPENDICES

APPENDIX 1. Feeding requirements of many common bird species.

FEEDING REQUIREMENTS

Green-backed heron: Fish, frogs and invertebrates
Mallard: Vegetative matter, nymphs and larvae of aquatic flies and beetles
Wood duck: Acorns, beech nuts, water plants
Killdeer: Beetles, grasshoppers, caterpillars, ants, crustaceans and invertebrates
Red-tailed hawk: Rodents, snakes, lizards and rabbits
American kestrel: Mainly insects, small mammals, reptiles
Northern bobwhite: Exclusively seeds
California quail: Plant leaves and seeds of legumes
Ring-necked pheasant: Corn, grass, seeds and small insects
Mourning dove: Grass seeds, grain crops and variety of other seeds
Common ground dove: Mainly seeds of grasses and forbs; some insects
Barn owl: Rodents
Great-horned owl: Skunks, rats, squirrels, grouse, weasels, snakes and insects
Eastern screech owl: Worms, crayfish, voles, mice, small birds, insects
Chimney swift: Flying insects taken on the wing
Ruby-throated hummingbird: Flower nectar, tree sap, some insects
Anna's hummingbird: Flower nectar, tree sap, some insects
Black-chinned hummingbird: Flower nectar and small insects
Red-bellied woodpecker: Acorns and other tree fruit; some insects
Red-headed woodpecker: Acorns, wild berries, fruit and nuts; insects and small invertebrates
Common flicker: Ants; other insects and berries
Hairy woodpecker: Mainly insects and spiders; some fruits and seeds
Downy woodpecker: Insects, berries and seeds
Eastern kingbird: Winged insects like bees; occasionally berries
Eastern phoebe: Mainly insects and spiders; occasionally berries
Least flycatcher: Exclusively insects and spiders
Tree swallow: Mainly winged insects
Violet-green swallow: Exclusively insects
Purple martin: Insects caught on the wing
Cliff swallow: Insects; some berries
Barn swallow: Mainly insects; some berries
Blue jay: Acorns, beech nuts, tree mast, insects, birds' eggs, nestlings, voles and mice
Black-billed magpie: Insects, seeds, berries, eggs, mice and carrion
Common crow: Animal and vegetable matter
Tufted titmouse: Mainly insects; also seeds and berries
Black-capped chickadee: Mainly insects and invertebrates; also seeds and berries
Carolina chickadee: Mainly insects; also seeds, berries and other fruit
Bushtit: Mainly insects; also seeds and berries
Western bluebird: Mainly insects, spiders and other invertebrates; also berries
Wood thrush: Insects, worms, invertebrates, larvae, berries and seeds
Brown creeper: Insects; also spiders and seeds
White-breasted nuthatch: Insects, spiders, nuts, seeds and berries
Red-breasted nuthatch: Insects, egg cases, pine seeds, berries and fruit
Winter wren: Invertebrates, insects and spiders
House wren: Insects, spiders and larval forms
Carolina wren: Insects and all types of invertebrates; also seeds
Blue-gray gnatcatcher: Mainly insects; other invertebrates including spiders
Ruby-crowned kinglet: Insects, spiders, egg cases; some fruit
Golden-crowned kinglet: Insects, spiders and some berries
Eastern bluebird: Insects ; also berries, fruit and seeds
American robin: Earthworms, grubs, larvae, insects, spiders; also berries, fruit and seeds
Loggerhead shrike: Large insects, small mammals, small birds and their young
Gray catbird: 50% animal matter, 50% berries, fruit and seeds
Mockingbird: Wild berries, seeds, insects and invertebrates
Brown thrasher: Insects, small invertebrates, some fruit and seeds
Cedar waxwing: Mainly berries and seeds; also insects
Veery: Insects, spiders and other invertebrates; also snails and berries
Hermit thrush: Insects, spiders, small snails, berries and seeds
White-eyed vireo: Insects, spiders and other invertebrates; also berries
Red-eyed vireo: Mainly insects, spiders and other invertebrates
Orange-crowned warbler: Mainly insects and spiders; also seeds and berries
Black and white warbler: Insects, eggs, larvae, pupae, also spiders
Yellow-rumped warbler: Spiders, insects, berries, fruit and seeds
Yellow-throated warbler: Mainly insects and spiders
Yellow warbler: Mainly insects; also berries
Common yellowthroat: Insects
American redstart: Insects, spiders, fruit and seeds
Rose-breasted grosbeak: Insects and fruit; also fruit, seeds and cherry blossom
Northern cardinal: Mainly seeds and fruit; also insects and spiders
Blue grosbeak: Seeds, berries and fruit; also insects, spiders, egg cases and larvae
Indigo bunting: Mainly insects and spiders; also seeds and fruit
Painted bunting: Insects, spiders, berries and seeds
Rufous-sided towhee: Seeds, fruit and insects
Brown towhee: Seeds, fruit, variety of insects
Savannah sparrow: Mainly seeds; also insects
Song sparrow: Mainly seeds; also insects and invertebrates
Tree sparrow: Mainly insects and some seeds
Field sparrow: Seeds and insects; also berries
Chipping sparrow: Seeds, insects, spiders and other invertebrates
Dark-eyed junco: Mainly insects and seeds
White-throated sparrow: Weed seeds and insects
White-crowned sparrow: Insects and berries; also seeds
House finch: Seeds, fruit and some insects
Purple finch: Mainly seeds and fruit; also insects
Northern oriole: Mainly insects and spiders; also fruit and seeds
American goldfinch: Mainly seeds; also insects
Scott's oriole: Insects, various fruits and flower nectar
Orchard oriole: Mainly insects, spiders and other invertebrates; also seeds and berries
Brown-headed cowbird: Grain, seeds, berries and other fruit; some insects
Boat-tailed grackle: Seeds, fruit, insects, small mammals, fish
Brewer's blackbird: Grain, seeds and fruit; also insects and invertebrates
Common grackle: Insects, grass seeds, worms, eggs and young birds
Eastern meadowlark: Insects, grubs, grass seeds and weed seeds
Red-winged blackbird: Insects, and seeds
Fox sparrow: Insects, seeds and fruit
Dickcissel: Grass seeds, grain and insects
Red crossbill: Pine seeds, other fruit and seeds
Evening grosbeak: All types of seeds and fruit
Pine siskin: Seeds and some insects
Common redpoll: Mainly insects and fruit

APPENDIX 2. Plant material and description of wildlife value of stock available from the P.F.R.A. nursery in Indianhead, Saskatchewan.

Trees and Shrubs For Wildlife Plantings

The PFRA Tree Nursery grows and distributes a limited quantity of trees and shrubs for wildlife plantings only (Table 1). This section outlines and illustrates these species, their requirements and uses in wildlife plantings.

Table 1: Species Available from the PFRA Tree Nursery for Wildlife Plantings

Species	Mature Height	Within Row Spacing
Buffaloberry*	4 - 6 m	1.0 m
Bur Oak	15 - 20 m	2.0 m
Choke Cherry*	7 m	1.3 m
Dogwood	1.5 - 2 m	0.5 - 1.0 m
Hawthorn	5 m	1.0 m
Hedge Rose	2 m	1.0 m
Red Elder	3 m	1.0 m
Russian Olive	8 m	2.5 m
Saskatoon	2 - 3 m	1.0 m
Sea-buckthorn	3 m	1.3 m
Siberian Crabapple	8 - 10 m	2.0 m
Ussurian Pear	8 m	2.0 m

*Also available for general distribution

Buffaloberry

(Shepherdia argentea Nutt.)

Buffaloberry is native to the southern parts of Western Canada, occurring naturally in river valleys and around sloughs. Although it prefers moist, well-drained sites, it will tolerate some spring flooding and is drought hardy. Buffaloberry is tolerant to saline and alkaline soils.

Buffaloberry is a bushy, tall shrub that grows 4 to 5 metres in height. Because it suckers freely it forms a dense irregular hedge. The lateral branches have sharp spines at the tip and are formed at right angles to the main branch. The leaves are opposite, linear, 2 and 5 cm in length, and silvery on both sides. The small yellow flowers, appearing in late June or early July, are borne in clusters along stems. The buffaloberry produces male and female flowers on separate plants; only the female plants bear fruit. Fruit ripens in July August and varies from scarlet to orange in color.

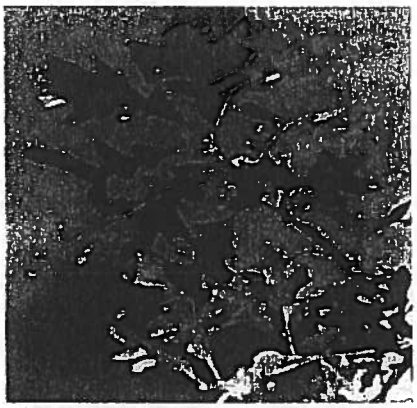
Uses for Wildlife: Buffaloberry is of minor importance as a browse species but the fruit is an important winter food for game birds and other species such as waxwings that remain for the winter. The suckering habit provides excellent edge cover and also assures continuation of the species.

Bur Oak

(Quercus macrocarpa Michx.)

Bur oak is a hardy, long-lived tree, adapted to a wide range of soils. Under the favorable conditions of eastern Manitoba it may attain a height of 15 to 20 metres but farther west it is reduced to a small scrubby tree. A tap-rooted species, the bur oak takes a few years to establish after transplanting but will grow at a moderate rate thereafter.

The bark is gray and flaky, becoming deeply furrowed as the tree matures. Branches often have corky ridges or wings. The leaves are dark, shiny green above, grayish white and slightly woolly beneath, and are deeply cut with rounded lobes. The fruit is an acorn, 2 to 2.5 cm long, resting in a shallow fringed or "mossy" cup.



Due to its deep tap-root system bur oak is difficult to plant. It is slow growing on dry sites and may be reduced to a large shrub in exposed areas.

Uses for Wildlife: As a wildlife species bur oak [illegible] food for woodpeckers, jays, flickers and chipmunks. Game birds such as the wild turkey, ruffed grouse and wood duck utilize bur oak for cover as well as food. Mule and whitetailed deer browse the twigs and foliage and eat the acorns.

Black-fruited Choke Cherry

(Prunus virginiana L. var. melancocarpa [A. Nels.] Sarg.)

Choke cherry is a native shrub or small tree that occurs throughout the Prairie provinces. It is commonly found bordering bluffs, particularly on the south side, and along fencelines and riverbanks. Although choke cherry is moderately drought hardy, it performs best in a moist, well-drained location.

Choke cherry has a moderate growth rate and under favorable conditions, will reach a height of 7 metres in 20 to 25 years. It thrives under good light conditions and suckers readily. The leaves are dark green, 6 to 12 cm long, elliptic in shape, and have sharply serrated margins. Flowers appear the first part of June in long drooping clusters at the ends of branches. The fruit matures from late July to early September.

A limitation to use of this species in wildlife plantings is that frozen choke cherry leaves may contain concentrations of hydrocyanic acid which could be poisonous to hoofed animals.

Uses for Wildlife: Choke cherry fruit is relished by sharp-tailed and ruffed grouse and songbirds such as grosbeaks, jays and waxwings. The twigs and foliage are browsed by whitetailed and mule deer.

Red-osier Dogwood

(Cornus stolonifera Michx.)

Red-osier dogwood is a native shrub commonly found in woodlands, coulees and along water courses throughout the Prairies. A fast-growing shrub, dogwood is adapted to both wet and dry sites and a wide range of soil types.

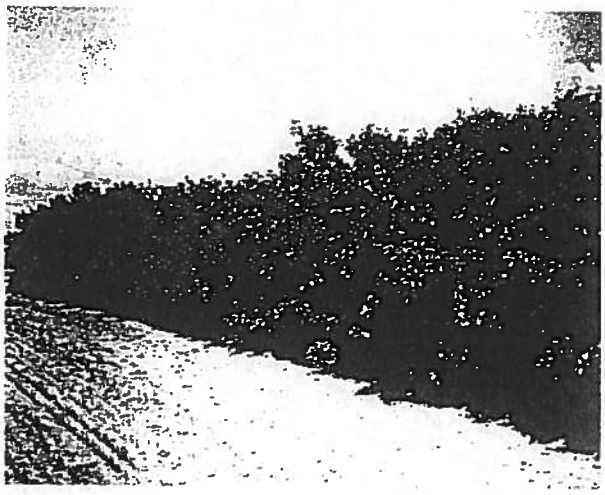
This shrub will grow 1 to 3 metres in height and has bright-reddish branches that make it conspicuous in winter. The lower branches are prostrate and may root at the tip. The leaves are oval and borne oppositely. White flowers which appear in flat-topped clusters in early June are followed by white berries.

Uses for Wildlife: Dogwood is a preferred browse species of deer and rabbits. The fruit provides summer food for robins, cedar waxwings and gamebirds. Provision of dense cover is its main value to wildlife.

Hawthorn

(Crataegus sp.)

A native across Canada, there are many species of hawthorn and their characteristics vary considerably. In general, hawthorn is a wide-spreading, bushy tree bearing stout thorns on its branches and stems. Although it prefers a rich, moist, well-drained soil, it will grow almost anywhere and is often found on the slopes of coulees, in river valleys, and in open woods.



Hawthorn can range from 1.5 to 7.5 metres in height, depending on the species. Leaves are simple, 1.25 to 5 cm long, serrate or shallowly lobed. White flowers in showy clusters are borne on the tips of branches in spring.

The fruit resembles a small apple, is red to reddish-brown or black at maturity and often remains on the tree during winter. Hawthorn is susceptible to cedar apple rust and also to pear slug infestations in early August.

Uses for Wildlife: The fruit of the hawthorn is consumed by a number of song and gamebirds while the leaves and succulent shoots provide forage for deer and rabbits. Hawthorn provides an important brood-rearing habitat for the ruffed grouse and serves as a nesting site for brown thrashers, robins, blue jays and mourning doves. Its thorny branches serve as a deterrent to nest predators.

Hedge Rose

(Rosa rugosa Thunb.)

Hedge rose, a thicket-forming, deciduous shrub, was introduced to Canada from Asia. It is well adapted to our climate and to a wide range of soil types.

The hedge rose may reach a height of 2 metres. The stems are stout, spiny and hairy. Leaves are compound — pinnate with 5 to 9 leaflets. The flowers are solitary, range in color from purple to white, and are produced abundantly over a long season beginning in June. The fruit, often called a hip, is oblong, 2 to 2.5 cm in diameter, and brick red in color.

Uses for Wildlife: The hedge rose provides nesting, cover and winter cover for many thicket-dwelling birds. The rose hip is a favoured food of the sharp-tailed grouse and the shrub is browsed by whitetailed and mule deer.

Red Elder

(Sambucus racemosa L.)

Red elder is a low-growing, native deciduous shrub. It thrives in moist conditions and tolerates saturated soils but is not drought resistant. Native stands of red elder are not found in abundance in dry areas such as the Prairies.

Red elder is a fast-growing, dense species reaching a height of 3 to 4 metres. It propagates readily from seed as well as from root suckers and layering of branches. Leaves are compound with 3 to 7 leaflets, and are sharply and coarsely saw-toothed. Branches are stout and pithy. The flowers are creamy white and borne in terminal clusters and the fruit which follows is bright red and conspicuous.

Red elder is not drought tolerant and may tip-kill in winter, however regrowth in spring is rapid.

Uses for Wildlife: Red elder berries provide food for songbirds, upland gamebirds and squirrels. It is of minor importance as a browse species.

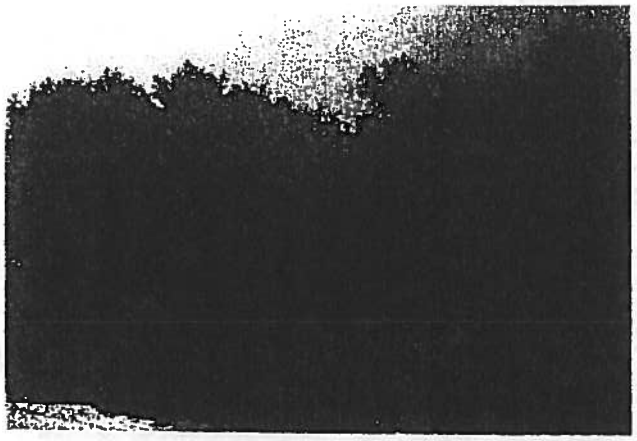
Russian Olive

(Eleagnus angustifolia L.)

Russian olive, a shrub or small tree, is a native of Eurasia which has occasionally spread from cultivation to the wild in Western Canada. It is drought hardy and tolerant to saline and alkaline soils but is susceptible to stem canker disease.

Russian olive will reach a height of 7 metres in its 10 to 20 year life span. Both thorny and thornless types of the species exist. Branchlets are silvery in color while the older wood is reddish-brown. The long, narrow leaves are greenish above and silvery beneath. Yellow flowers are produced in small clusters on twigs in early summer. The silvery-coated fruit is drupe-like containing a large nut.

Russian olive is not a sought-after species on the Prairies.

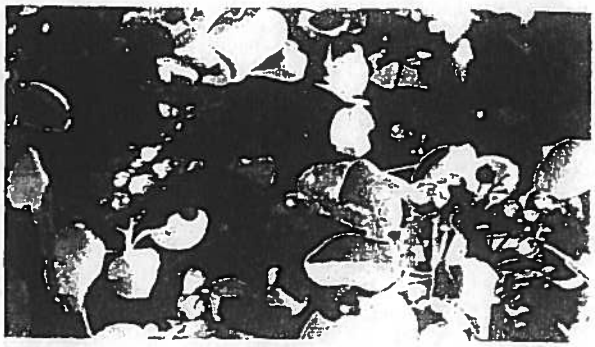


Uses for Wildlife: Russian olive has very little value as a browse species but it provides excellent cover and protection for partridge, pheasant, and sharp-tail grouse. The fruit provides fall and winter food for songbirds, pheasants, cedar waxwings and sharp-tail grouse.

Saskatoon

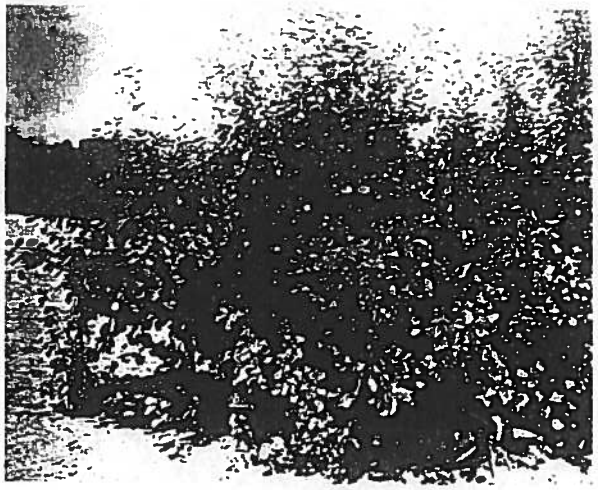
(Amelanchier alnifolia Nutt.)

Saskatoon is a native shrub or small tree, common in coulees, bluffs and open woodlands throughout the Prairie provinces. It grows well on a wide variety of soils and there is some evidence that it is moderately tolerant to salinity. Thriving in both sunny and partially shaded sites, the saskatoon is also drought tolerant.



Saskatoon is fairly slow growing and will reach a height of 2 to 3 metres at maturity. It propagates by seed, root sprouts and also by stolons, forming colonies. The branches are smooth, greyish or brownish, bearing leaves oppositely. White flowers appear early in the season and the fruit, purple and berry-like, usually ripens in July.

Limitations of saskatoon include numerous insect and disease problems such as cedar apple rust. As well, the species is difficult to establish.



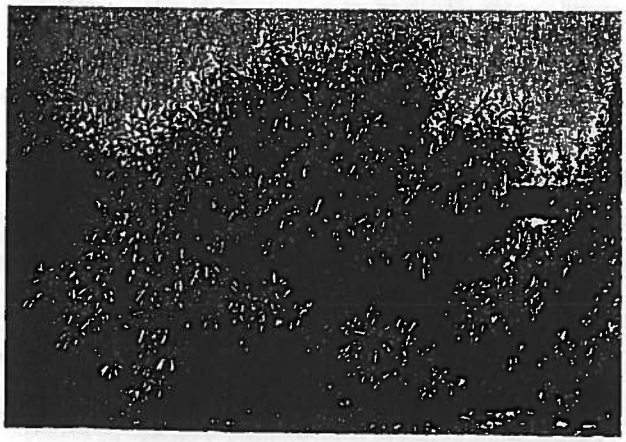
Uses for Wildlife: Saskatoon provides cover and nesting and roosting sites for several bird species. Saskatoon berries are sought by numerous song and game birds as well as whitetail and mule deer. Rabbits browse the twigs.

Sea-buckthorn

(Hippophae rhamnoides L.)

Sea-buckthorn was introduced from Eurasia and is sometimes found naturalized in the wild. This shrub or small tree is drought resistant and well adapted for growth on sandy soil and steep slopes. It also possesses some tolerance to salinity.

Sea-buckthorn will reach a height of 2 to 5 metres and has a tendency to sucker if the roots are injured. Male and female flowers are produced on separate plants. Both are required in a stand for fruit production.



Branches are grey and spiny with silvery-white leaves. Small yellowish flowers appear in spring before the leaves and attractive yellowish-orange berries follow. The berries persist on the tree through winter.

Uses for Wildlife: Deer browse sea-buckthorn and the fruit is an important source of winter food for pheasants and other gamebirds.

Siberian Crabapple

(Malus baccata [L.] Borkh.)

Siberian crabapple is a vigorous, winter and drought-hardy tree. An introduction to Canada, it is well adapted to a wide range of soils and climatic conditions.

Siberian crabapple has a large spreading crown and may reach a height of 7 to 9 metres given favorable conditions. The bark is ridged, dark grey to reddish-grey in color. White showy flowers are produced in early spring and the tree bears very small, berry-like, red or yellow fruit later in the season. Siberian crabapple is susceptible to fire blight.

Uses for Wildlife: The dense growth form of Siberian crabapple provides high-quality cover for roosting, loafing and nesting for birds. This species is important to many song and game birds and squirrels, as the fruit is usually maintained well into the winter. Rabbits, whitetail and mule deer also browse this species.

Ussurian Pear

(Pyrus ussuriensis Maxim.)

Ussurian pear is a neat, upright-growing, low-headed tree. An introduced species, it is both drought and winter hardy and is quite fast growing. This species performs poorly on heavy soils and is not recommended for saline areas.

Ussurian pear will form an impenetrable, tall hedge reaching a height of 6 metres. The flowers, appearing in May, are large, white and showy. The fruit is a small, round, green pome.

Uses for Wildlife: Ussurian pear is of minor importance as a browse species and the fruit is of limited value to wildlife. However, it does provide good cover and protection.

APPENDIX 3. Suitable grasses, sedges, herbs and woody perennials for restoration of riparian sites.

Table 25—(Con.)

Species	Areas[1]	Habitat	Abundance	Rooting habit	Comments
Carex nardina Hepburn sedge	Alp.	Open meadows	Abundant	Densely caespitose	Short stature, open cover.
Carex nebrascensis Nebraska sedge	Val.-Asp.	Marshes and meadows, alkali tolerant	Common	Strongly rhizomatous	Excellent soil stabilizer, palatable, widely distributed.
Carex nigricans Black alpine sedge	SF-Alp.	Well-drained meadows	Frequent	Creeping rootstock	Good cover for wet areas.
Carex praegracilis Slim sedge	Val.-Asp.	Dry to moist, alkali bottomlands	Abundant	Long, creeping rootstocks	Large plant, dense, persistent, moderately palatable.
Carex rostrata Beaked sedge	Val.-SF	Streams, water's edge, standing water	Abundant	Culms from stout, long rhizomes	Principal species for streambank stabilization, low palatability, fluctuating water level, wide elevational range.
Carex rupestris Rock sedge	Alp.	Dry slopes and meadows	Abundant	Short rhizomes	Vigorous, spreads rapidly, limited distribution.
Carex saxatilis	LPP-SF	Water's edge	Abundant	Culms from long, creeping rootstocks	Excellent streambank cover, limited distribution.
Carex scirpoidea Downy sedge	Alp.	Dry and wet meadows	Abundant	Rhizomatous	Vigorous, spreads rapidly.
Carex simulata Analogne sedge	PP-SF	Bogs and wet meadows, calcareous soils	Frequent	Long, creeping rootstocks	Excellent cover, widely distributed.
Carex vallicola Valley sedge	Sage-Asp.	Dry slopes	Abundant	Caespitose	Spreads onto dry grass-sage sites.
Eleocharis palustris Spikerush	Val.-SF	Wet meadows and streams, alkali tolerant	Abundant	Rhizomatous	Spreads rapidly, low palatability, wide elevational range.
Juncus arcticus var. *balticus* Baltic rush	Val.-Asp.	Wet and semiwet meadows	Abundant	Rhizomatous	Principal species for stabilization. Use adapted ecotypes, spreads aggressively, persists with grazing.
Juncus drummondii Drummond rush	LPP-Alp.	Wet and dry meadows	Common	Caespitose	Spreads after disturbance, occupies infertile soil.
Juncus ensifolius Swordleaf rush	Sage-SF	Streams, wet meadows, seeps	Abundant	Strongly rhizomatous	Moderately palatable, wide elevational range.
Juncus longistylis Longstyle rush	Sage-SF	Wet meadows, streams	Common	Rhizomatous	Moderately palatable.
Juncus torreyi Torrey rush	Val.-PJ	Streams, wet meadows, seeps, alkali tolerant	Common	Strongly rhizomatous	Spreads onto disturbances.
Scirpus acutus Tule bulrush	Val.-Mtn.B.	Lake edge	Abundant	Rhizomatous	Tall, rank, dense patches, restricted to water's edge.
Scirpus maritimus Saltmarsh bulrush	Mtn.B.	Lake edge, stream bank, alkali sites	Abundant	Rhizomatous	Dense patches, spreads rapidly.

[1]Areas: Alp. = alpine, SF = spruce-fir, Asp. = aspen, LPP = lodgepole pine, PP = ponderosa pine, Mtn.B. = mountainbrush, PJ = pinyon-juniper, Sage = big sagebrush, Val. = valley.

Table 26—Grasses recommended for direct seeding and transplanting riparian sites. Scientific names from Welsh and others (1981).

Species	Areas of adaptation[1]	Origin	Seeding trait	Transplant capability	Growth rate	Rooting habit	Salinity tolerance[2]	Flooding tolerance	Palatability	Spreadability
Agropyron elongatum										
Tall wheatgrass	Mtn.B.-V	Introduced	Excellent	Good	Rapid	Large clump	MT	Moderate	Fair	Good
Agropyron repens										
Quackgrass	Asp.-V	Introduced	Fair	Excellent	Slow	Rhizomatous	MT	Moderate	Good	Excellent
Agropyron smithii										
Western wheatgrass	PP-SDS	Native	Poor	Excellent	Slow	Rhizomatous	MS	Moderate	Good	Good
Agropyron trachycaulum										
Slender wheatgrass	SF-PJ	Native	Excellent	Excellent	Rapid	Rhizomatous	MS	Sensitive	Excellent	Good
Agrostis stolonifera										
Redtop	Salp.-SF	Introduced	Fair	Good	Moderate	Rhizomatous	MS	Moderate	Good	Excellent
Alopecurus pratensis										
Meadow foxtail	Alp.-Mtn.B.	Introduced	Excellent	Good	Rapid	Rhizomatous	MT	Tolerant	Good	Excellent
Bromus carinatus										
Mountain brome	Alp.-PJ	Native	Excellent	Excellent	Rapid	Rhizomatous	MT	Moderate	Good	Good
Bromus erectus										
Meadow brome	Alp.-PJ	Introduced	Excellent	Excellent	Moderate	Rhizomatous	MT	Moderate	Good	Excellent
Bromus inermis										
Smooth brome	Alp.-Mtn.B.	Introduced	Good	Excellent	Moderate	Rhizomatous	MT	Moderate	Good	Excellent
Calamagrostis canadensis										
Bluejoint reedgrass	SF-Sage	Native	Good	Excellent	Moderate	Rhizomatous	MT	Tolerant	Good	Excellent
Calamagrostis epigeois										
Chee reedgrass	Alp.-PJ	Introduced	Poor	Good	Slow	Rhizomatous	MT	Tolerant	Good	Good
Dactylis glomerata										
Orchardgrass	Alp.-Sage	Introduced	Good	Good	Rapid	Bunch	MS	Sensitive	Excellent	Fair
Deschampsia caespitosa										
Tufted hairgrass	Alp.-SF	Native	Poor	Fair	Slow	Bunch	MT	Tolerant	Fair	Poor
Distichylis spicata										
Saltgrass	V	Native	Poor	Excellent	Slow	Rhizomatous	T	Tolerant	Fair	Excellent
Elymus cinereus										
Great Basin wildrye	Mtn.B.-V	Native	Good	Good	Moderate	Large clump	T	Moderate	Good	Fair
Elymus giganteus										
Mammoth wildrye	Mtn.B.-Sage	Introduced	Fair	Good	Moderate	Rhizomatous	T	Tolerant	Good	Good
Elymus junceus										
Russian wildrye	Mtn.B.-V	Introduced	Fair	Good	Moderate	Bunch	T	Moderate	Excellent	Fair
Elymus triticoides										
Creeping wildrye	JP-V	Introduced	Good	Excellent	Moderate	Rhizomatous	T	Tolerant	Poor	Good
Festuca arundinacea										
Reed fescue (alta or tall)	Asp.-SDS	Introduced	Excellent	Excellent	Rapid	Rhizomatous	T	Tolerant	Good	Excellent
Hordeum brachyantherum										
Meadow barley	Alp.-Asp.	Native	Excellent	Excellent	Moderate	Bunch	T	Tolerant	Fair	Good
Lolium perenne										
Perennial ryegrass	SF-PP	Introduced	Excellent	Good	Rapid	Small bunch	MT	Sensitive	Good	Good
Phalaris arundinacea										
Reed canarygrass	Asp.-V	Native	Poor	Excellent	Slow	Rhizomatous	T	Tolerant	Fair	Excellent
Phleum pratense										
Timothy	Asp.-Mtn.B.	Introduced	Good	Good	Rapid	Bunch	MS	Moderate	Good	Good
Poa pratensis										
Kentucky bluegrass	Asp.-PJ	Introduced	Fair	Good	Slow	Rhizomatous	MT	Moderate	Good	Excellent
Poa secunda										
Sandberg bluegrass	Mtn.B.-Sage	Native	Fair	Good	Slow	Bunch	MT	Moderate	Good	Fair
Sitanion hystrix										
Bottlebrush squirreltail	Mtn.B.-SDS	Native	Good	Fair	Moderate	Bunch	MT	Moderate	Good	Good
Sporobolus airoides										
Alkali sacaton		Native	Fair	Good	Slow	Bunch	MT	Moderate	Good	Excellent

[1]Areas of adaptation—Alp. = alpine; SF = spruce-fir; Asp. = aspen; Mtn.B. = mountainbrush; PJ = pinyon-juniper; PP = ponderosa pine; Sage = big sagebrush; Salp. = subalpine; SDS = salt desert shrub; V = valley bottom.

[2]Salinity tolerance—S = sensitive; MS = moderately sensitive; MT = moderately tolerant; T = tolerant.

Table 27—Broadleaf herbs recommended for planting of riparian sites. Scientific names from Welsh and others (1981).

Species	Areas of adaptation[1]	Origin	Seeding trait	Transplant capability	Growth rate	Salinity tolerance[2]	Flooding tolerance	Palata-bility	Spread-ability
Achillea millefolium lanulosa									
Western yarrow	Alp.-V	Native	Excellent	Excellent	Rapid	MS	Moderate	Poor	Excellent
Artemisia ludoviciana ludoviciana									
Louisiana sagewort	Alp.-Sage	Native	Excellent	Excellent	Rapid	MS	Moderate	Poor	Excellent
Aster chilensis adscendens									
Pacific aster	Asp.-V	Native	Poor	Excellent	Moderate	MS	Moderate	Excellent	Excellent
Bassia hyssopifolia									
Fivehook bassia	PJ-SDS	Native	Excellent	Good	Rapid	T	Tolerant	Good	Good
Coronilla varia									
Crownvetch	PJ-Mtn.B.	Introduced	Good	Excellent	Rapid	MS	Moderate	Good	Good
Epilobium angustifolium									
Fireweed	Asp.-Mtn.B.	Native	Excellent	Good	Rapid	S	Moderate	Fair	Excellent
Heracleum lanatum									
Common cowparsnip	Alp.-Mtn.B	Native	Poor	Poor	Poor	S	Sensitive	Excellent	Fair
Linum lewisii									
Lewis flax	Asp.-Sage	Native	Excellent	Good	Moderate	S	Sensitive	Good	Good
Medicago lupulina									
Black medic	Asp.-Sage	Introduced	Excellent	Good	Moderate	MT	Moderate	Good	Good
Medicago sativa									
Alfalfa	Asp.-Sage	Introduced	Excellent	Good	Rapid	MT	Moderate	Excellent	Fair
Melilotus officinalis									
Yellow sweetclover	Asp.-Sage	Introduced	Excellent	Poor	Rapid	MT	Moderate	Good	Excellent
Potentilla glandulosa glandulosa									
Gland cinquefoil	Asp.-PP	Native	Good	Excellent	Moderate	S	Moderate	Fair	Good
Senecio serra									
Butterweed groundsel	Asp.-PP	Native	Good	Excellent	Moderate	S	Moderate	Good	Good
Sidalcea oregana									
Oregon checkermallow	Asp.-Mtn.B.	Native	Good	Good	Moderate	S	Moderate	Fair	Good
Smilacina racemosa amplexicaulis									
Western Solomons-seal	Asp.-Mtn.B.	Native	Poor	Fair	Slow	S	Moderate	Excellent	Fair
Trifolium fragiferum									
Strawberry clover	V	Introduced	Good	Fair	Moderate	MT	Moderate	Excellent	Excellent
Trifolium hybridum									
Alsike clover	Asp.-Mtn.B.	Introduced	Good	Fair	Moderate	S	Moderate	Good	Good
Valeriana edulis									
Edible valerian	Asp.-Mtn.B.	Native	Poor	Fair	Slow	S	Moderate	Fair	Fair

[1]Areas of adaptation—Alp. = alpine; Asp. = aspen; PP = ponderosa pine; Mtn.B. = mountainbrush; PJ = pinyon-juniper; Sage = sagebrush; SDS = salt desert shrub; V = valley bottoms.
[2]Salinity tolerance—S = sensitive; MS = moderately sensitive; MT = moderately tolerant; T = tolerant.

Table 29—Areas of occurrence of several willow species useful in riparian revegetation. Scientific names from Goodrich (1983).

Species	Areas of adaptation		Origin of roots	Prevalence of roots	Period required for:		Comments
	Zones	Habitat			Root formation	Stem formation	
					------- Days -------		
Salix amygdaloides Peachleaf willow	Aspen—big sagebrush	Stream edges, pond margins, soils saturated seasonally.	Callus cut	Moderate	10-20	10	Moderate rooting capabilities
Salix bebbiana Bebb willow	Spruce-fir—aspen	Edges of streams, occasionally well-drained soils.	Roots throughout entire length of stem	Moderate	10	10-20	Roots freely
Salix boothii	Aspen—sagebrush	Stream edges and standing water, confined to wet soils.	Roots mostly at lower one-third of stem	Abundant	10-15	10-15	Roots freely
Salix brachycarpa Barrenground willow	Subalpine—spruce-fir	Wet sites and well-drained soils.	Roots throughout entire length of stem	Abundant	15-20	15-25	Roots freely
Salix drummondiana Drummond willow	Spruce-fir—upper sagebrush	Edges of streams and ponds.	Roots throughout entire length of stem	Abundant	10	10	Roots freely
Salix exigua Sandbar willow	Spruce-fir—sagebrush	Edges of streams, wet sites, sometimes well-drained soils.	Roots throughout entire length of stem	Moderate	10-15	10	Easily rooted
Salix geyeriana Geyer willow	Subalpine—aspen—upper sagebrush	Edges of streams, frequent wet meadows.	Roots throughout entire length of stem	Few to moderate	10	10-15	Fair rooting capabilities
Salix glauca Grayleaf willow	Subalpine—spruce-fir	Wet and dry sites, widely distributed, occupies seeps and edges of snowbanks.	Roots throughout entire length of stem	Few to moderate	10	10	Requires special treatment to root
Salix lasiandra Pacific willow	Aspen—upper sagebrush	Wet soils, edges of streams and ponds.	Roots throughout entire length of stem	Abundant	10	10-15	Easily rooted
Salix lasiolepis Arroyo willow	Aspen—mountainbrush	Restricted to stream edges.	Callus and lower one-third of stem	Few to many	10	10	Erratic rooting habits
Salix lutea Shining willow	Aspen—sagebrush	Mostly along streams, may occur on sites that remain dry for short periods.	Entire stem section, most abundant at lower one-third	Moderate	10	10	Roots easily
Salix planifolia Tealeaf willow	Subalpine—aspen	Wet sites, edges of streams, wet meadows.	Roots throughout entire length of stem	Few to moderate	10	10-15	Fair rooting capabilities
Salix scouleriana Scouler willow	Spruce-fir—aspen	Well-drained soils, forest understory.	Callus cut	Moderate	10-15	10-15	Requires special treatment to root
Salix wolfii Wolf willow	Spruce-fir—aspen	Stream edges and ponds.	Roots throughout entire length of stem	Few to moderate	10-15	10-15	Erratic rooting

Table 28—Woody species recommended for riparian disturbances. Scientific names from Welsh and others (1981).

Species	Areas of occurrence		Adaptation to disturbed sites	Methods[2] of culture	Establishment traits			Comments
	Zones[1]	Habitat			Seedling establishment	Growth rates	Soil stability value	
Alnus tenuifolia Thinleaf alder	SF-Mtn.B.	Stream edge and well-drained soils.	Excellent	NS, CS, DS	Excellent	Rapid	Excellent	Easily established, adapted to harsh sites, grows rapidly.
Amelanchier alnifolia Saskatoon serviceberry	Asp.-Mtn.B.	Well-drained soils, seeps occasional.	Good	NS, CS	Fair	Slow	Good	Slow to establish, sensitive to understory competition.
Artemisia cana viscidula Silver sagebrush	Asp.-Sage	Well-drained and moist soils, valley bottoms.	Fair	DS, NS, CS	Good	Rapid	Fair	Well adapted to exposed moist soils able to tolerate flooding for short time.
Artemisia tridentata tridentata Basin big sagebrush	Mtn.B.-SDS	Deep, well-drained soils, occasional flooding.	Excellent	DS, NS, CS	Good	Rapid	Fair	Useful for planting extremely disturbed and well-drained soils.
Artemisia tridentata vaseyana Mountain big sagebrush	Asp.-Mtn.B.	Well-drained soils, moist sites.	Excellent	DS, NS, CS	Good	Rapid	Fair	Adapted to disturbed sites, suited to moist but not saturated soils.
Artemisia tripartita Tall threetip sagebrush	Asp.-Mtn.B.	Well-drained soils, moist sites.	Excellent	DS, NS, CS	Excellent	Rapid	Fair	Well suited to eroded exposed soils, spreads quickly.
Atriplex canescens Fourwing saltbush	Mtn.B.-V	Well-drained soils, frequent flooding and shallow water table.	Good	DS, NS	Excellent	Rapid	Good	Useful for well-drained and disturbed soils.
Atriplex gardneri Gardner saltbush	SDS-V	Semiarid deserts. Withstands seasonal flooding, and alternating wet/dry period.	Fair	DS, NS, CS	Fair	Moderate	Fair	Adapted to arid sites subjected to seasonal saturated soils.
Betula occidentalis occidentalis Water birch	SF-Mtn.B.	Stream edges.	Good	NS	Excellent	Rapid	Excellent	Establishes well by transplanting, adapted to streambanks and bogs.
Ceanothus sanguineus Redstem ceanothus	SF-PP	Moist soils, seeps, well-drained soils.	Good	DS, NS, CS	Excellent	Rapid	Excellent	Not adapted to saturated soils but useful in planting disturbed streambanks.
Chrysothamnus nauseosus consimilis Thinleaf rubber rabbitbrush	Sage-V	Well-drained soils, sites occasionally flooded.	Good	DS, NS, CS	Excellent	Moderate	Fair	Suited to heavy saturated soils.
Cornus stolonifera stolonifera Redosier dogwood	SF-Mtn.B.	Stream edges and well-drained soils.	Good	DS, NS, CS, RC	Excellent	Rapid	Excellent	Easy to grow and establish, useful for disturbed sites, requires fresh aerated water.
Crataegus douglasii Douglas hawthorn	Asp.-Sage	Stream edges and well-drained soils.	Good	NS	Fair	Slow	Good	Slow growing, but well suited to disturbed streambanks.
Elaeagnus angustifolia Russian olive	Mtn.B.-V	Stream edges, seeps, flooded sites, and well-drained soils.	Excellent	DS, NS	Excellent	Rapid	Good	Easy to establish, can become weedy.
Elaeagnus commutata Silverberry	PJ-V	Stream edges and well-drained soils.	Excellent	NS, CS	Excellent	Rapid	Good	Easily established, grows rapidly, adapted to harsh sites.
Holodiscus discolor Rockspirea	SF-Mtn.B.	Well-drained and moist soils, occasional seeps.	Good	NC, CS	Fair	Moderate	Good	Erratic establishment, but suited to disturbed sites.
Lonicera tatarica Tatarian honeysuckle	Mtn.B.-Sage	Well-drained and moist soils, occasional wet sites.	Excellent	NC, CS, DS	Excellent	Rapid	Good	Easily established, provides immediate cover, well adapted to different soil conditions.
Pachistima myrsinites Myrtle pachistima	SF-Asp.	Moist soils and seeps, requires some shade.	Fair	NS, CS	Fair	Slow	Good	Common to upland slopes, not well adapted to disturbances.
Physocarpus malvaceus Mallow ninebark	SF-Asp.	Moist and well-drained soils.	Fair	NS, CS	Fair	Moderate	Good	Requires good sites.
Populus angustifolia Narrowleaf cottonwood	Asp.-Sage	Well-drained and wet sites, edges of streams, ponds, bogs.	Good	NS, CS, RC	Good	Rapid	Good	Establishes easily, grows rapidly.
Populus fremontii fremontii Fremont cottonwood	Mtn.B.-V	Moist soils, seeps, frequently wet sites.	Good	NS, CS, RC	Good	Rapid	Good	Establishes easily, grows rapidly, furnishes good cover.
Populus tremuloides Quaking aspen	SF-Asp.	Well-drained and moist soils, occasionally occurs at edges of streams.	Fair	NS, CS, RC	Good	Rapid	Good	Considerable ecotypic differences, not well suited to highly disturbed sites, occupies wide range of moisture.
Potentilla fruticosa Bush cinquefoil	Alp.-PP	Stream edges, wet meadows.	Excellent	NS, CS	Good	Moderate	Excellent	Valuable species for riparian disturbances, establishes well and provides excellent site stability.
Prunus virginiana melanocarpa Black chokecherry	SF-PJ	Well-drained, moist soils, occasionally occurs at streams' edges.	Fair	NS, CS, RC	Good	Moderate	Good	Widely adapted, larger transplant stock establishes and grows rapidly.
Rhamnus purshiana Cascara buckthorn	SF-PP	Moist soils, frequently wet sites.	Fair	NS, CS	Fair	Moderate	Good	Limited plantings, plants perform well on disturbed sites.
Ribes aureum Golden current	Asp.-Sage	Well-drained moist sites.	Excellent	NS, CS	Excellent	Excellent	Good	Widely adapted, easily established, excellent site stability.
Rosa woodsii Woods rose	Asp.-Mtn.B.	Moist and well-drained soils, seeps and frequently streambanks.	Excellent	NS, CS, W, RC	Excellent	Moderate	Good	Widely adapted, easily established, excellent site stability, principal species for riparian disturbances.
Rubus spp.	Asp.-PP	Well-drained soils, frequently wet sites	Excellent	NS, CS, W, RC	Excellent	Moderate	Good	Well adapted to eroded sites, limited range of distribution.
Salix (see table 29)								
Sambucus racemosa pubens microbotrys Red elder	Asp.-PP	Moist sites, occasional seeps and streambanks.	Good	NS, CS	Fair	Moderate	Good	Adapted to restricted sites, establishes slowly on disturbed sites.
Sarcobatus vermiculatus Black greasewood	SDS-V	Sites with shallow water tables, occasionally flooded sites.	Good	NS, W	Fair	Slow	Good	Difficult to establish, well adapted to valley bottoms and salty soils.
Shepherdia argentea Silver buffaloberry	Mtn.B-V	Well-drained sites, edges of streams and ponds.	Good	NS	Good	Moderate	Good	Adapted to valley bottoms and saline soils.
Sorbus scopulina scopulina Green's mountain ash	SF-Asp.	Moist soils, ocassional seeps and stream bottoms.	Fair	NS, CS	Fair	Slow	Good	Not well adapted to disturbed soils, establishes slowly.
Symphoricarpos albus Common snowberry	SF-Asp.	Moist sites and well-drained soils.	Good	NS, CS, W, RC	Fair	Moderate	Excellent	Not well suited to extreme disturbed soils, once established grows well, plant large 1-0 or 2-0 stock.
Symphoricarpos occidentalis Western snowberry	SF-Mtn.B.	Moist sites, occasionally streambanks and valley bottoms.	Good	NS, CS, W, RC	Fair	Slow	Excellent	Plants not well adapted to disturbed soils, provides excellent stability and spreads well.
Symphoricarpos oreophilus Mountain snowberry	Asp.-Sage	Well-drained soils, edges of streams.	Good	NS, CS, W, RC	Fair	Slow	Excellent	Plants not well adapted to disturbed soils, provides excellent stability and spreads well.

[1]Alp. = alpine; SF = spruce-fir; Asp. = aspen; PP = ponderosa pine; Mtn.B. = mountainbrush; PJ = pinyon-juniper; Sage = big sagebrush; SDS = salt desert shrub; V = valley bottoms.
[2]DS = direct seeding; RC = rooted cuttings; NS = nursery-grown seedling, CS = container-grown seedling; W = wilding.

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