PRAIRIE POTHOLES*

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I am going to discuss the hydrological, biological and economic aspects of prairie potholes, but from the perspective of a practising farmer, and not strictly that of a geographer. Much of what I have to say reflects my own land-management decisions and their ecological and economic consequences. I acknowledge the tremendous difficulty of isolating any single variable in the complex interactions of many variables: precipitation, temperature, soil chemistry, soil structure, landscape configuration, and so on, to say nothing of relatively non-variable factors (often unrecognized) which affect management decisions.

To a significant extent, the remaining wildlife habitat occurs on land which is privately owned. Farmers and wildlife interests have often been thrust into adversary roles, but farmers are nevertheless usually successful in continuing to carry out their "land improvement". To a great degree, however, it is not the farmers but anachronistic background institutions which are at fault.

Take the average prairie slough or pothole. It captures local runoff and provides aquatic and dry land habitat for a wide range of birds and animals, while at the same time recharging the groundwater and diminishing water loss from the region through surface flow. Collectively, the slough and pothole, left to do their job, confer many benefits, esthetic and practical. Not the least of these are the reductions in erosion and downslope flooding which, by their delaying action, they collectively achieve. Yet, although farmers do not deny these facts, they persist in draining and ditching, "improving" their land, and destroying habitat for wildlife. What are the reasons for this? I will discuss three points that have become evident from my observations and research, and that of my students.

Firstly, the Canadian grain marketing system encourages farmers to "improve" their land because the acreage on which delivery quotas are based can be increased by the addition of non-native pasture, new breaking, and the like, up to one-third of the other declared acreage. Thus the farmer who has 450 eligible quota acres in crop may add to his quota-entitled acreage as much as 150 acres of non-native pasture and new breaking.

Secondly, when land is assessed as a basis for taxation, a value is placed on "unimproved" land and wasteland. In the majority of cases the owner therefore thinks such land should yield him some economic return.

Thirdly, there is a pervasive notion that elaborate drainage works are essential throughout the agricultural portion of Manitoba. Yet, the meteorological record directly contradicts this. Nowhere in agro-Manitoba is there a long-term or even medium-term surplus of moisture.

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The ratio of precipitation to potential evapo-transpiration ranges from approximately 1:1 in the northeast sector, to an average annual deficit of 150 mm or more in the southwest. The occasional surpluses that do accrue are due primarily to two factors. Winter snows, largely owing to inappropriate land management practices, tend to melt quickly and run-off over frozen ground. The same inappropriate practices have, over the years, resulted in mineralization, formation of plow-pan, etc., which have reduced the hydraulic conductivity of our agricultural soils to a level well below the potential rate of precipitation. Even in its virgin condition, much of our soil (particularly our heavier soils) had a hydraulic conductivity of 10 mm per hour or less. Owing to land management practices destructive of humus (chiefly summerfallowing and the burning of crop residues), this has been generally reduced to one-half that figure or less. We have then, in every growing season, the prospect of one or more rains at rates of 25-50 mm/hour, or even more, falling on thirsty plants rooted in soil with a reserve field capacity equal to or in excess of the total precipitation, but subject to a rate of absorption of 10 mm, 5 mm or even less, per hour. The result — frequent instances of massive runoff, on-farm ponding and drown-out, and even occasional regional flooding in downslope areas, despite the overriding shortfall. The reaction has been to call for more drains on one hand and more control structures on the other. The engineering fraternity, projecting foresight from hindsight, appear to have accepted the overall situation in respect to rates and volumes of run-off (and the consequent threat of floods) as inevitable, and to believe that construction of reservoirs and control structures is the only available remedy, cost what they may. Yet our runoff volumes and flooding problems — insofar as they are a consequence of management practices — go right back to the first two factors cited, which encourage the farmer to "improve" as many acres as possible on his farm.

In the light of this, I want to propose a few changes which I believe could exert a modest but pervasive influence upon land management decisions, in the interest of both farmers and wildlife. I also want to suggest that wildlife interests might promote their own objectives while at the same time building goodwill and reducing conflicts-of-interest between themselves and the major land-use decision-makers.

Firstly, I would suggest that pressure be brought to bear upon the Federal Government and the Canadian Wheat Board, to modify the quota-entitlement regulations. I would propose that, up to perhaps a maximum of 20 acres per quarter-section, "unimproved" acreage be made eligible for transfer into quota entitlement, in much the same way as "improved" non-cropped acreage is now eligible. This would remove much of the incentive to "improve" residual farm acreage, often in ways best described as "mutilation", particularly when slough and pothole bottoms prove to be saline and incapable of producing crops. Considering that most of the "unimproved" land in agro-Manitoba is situated in areas where the range of commercial crops is pretty much restricted to those which are subject to quota, such a modification would also introduce an element of "equal-opportunity". On my own farm, situated in the Agassiz Basin near the US border, I plant half my acreage to crops which are subject to quota, and half to others. I am thus exercising my options in such a way

A prairie pothole filled with spring runoff. *Gary W. Seib*

as to effectively double my delivery quota, by the simple device of transferring my non-quota acreage to wheat, barley, and other quota crops. However, outside of the Pembina Triangle and the Portage Plains, which in any event have little "unimproved" land left, this is not a generally available option. In these other areas, therefore, my proposed modification of the quota system should be advantageous to farmers.

I think 20 acres per quarter-section is a fair figure, for two reasons. Firstly, there are now relatively few farms left with more than that number of "improvable" unimproved acres per quarter. Secondly, one should discourage the creation of a land market based fundamentally on the attached delivery quota entitlement. Special consideration might be given to a higher acreage figure in cases where highly desirable wildlife habitat areas greater in extent than 20 acres per quarter section occur, perhaps subject to long-term dedication to "non-improvement". If the Wheat Board objects to these suggested acreage increases, I propose that the transfer of "unimproved" acreage be achieved at the expense of summerfallow, which now carries the transfer entitlement. Throughout most of agro-Manitoba, recent scientific investigations have shown that summerfallowing, which used to be practiced for moisture conservation and weed control not only meets these goals poorly, but has certain major pernicious effects, particularly through upward trans-

location of salinity into the root zone, and because it contributes to runoff and erosion by water and wind. Fallow land placed in grass or forage would continue to be eligible for the quota entitlement. Continuous grassland cropping, without much intervention by man, is one way of describing agro-Manitoba as most of it was when the Great Spirit was farming it by himself, from the time the last glacial age waned until a hundred years or so ago.

In the matter of taxation, I would propose that all land assessed as "wasteland" be removed from the taxable land base, and the tax burden be transferred, on a municipality-wide basis, to cultivated land. Similarly, one-half the tax burden currently imposed on land in native hay and woodlots might be shifted to the cultivated acreage. The effect should be to deter the invasion and destruction of residual acreages of marginal and sub-marginal land whose optimum long-term function may perhaps be best achieved by leaving it in its present state.

Last winter, with a team of four graduate students from the Natural Resources Institute, I carried out a study of the R.M. of Harrison and found that these suggestions appeared workable. This does not mean that the farmer cannot have an economic yield from such wasteland. Wildlife biologists agree that farmers might use such land for grazing and/or haying practically without restriction after about the second week of July, by which time ground-nesting birds have reared their young.

Thirdly, the obvious answer to problems that are deemed to necessitate costly drainage systems is the modification of land-management practices to capture and place in reserve incoming moisture *where it falls at the rate that it falls*. Two major benefits would accrue. Crop yields would inevitably be improved because we would be realizing the potential inherent in the capturable precipitation. Let us not forget, either, that the nearer to the optimum the soil moisture is, the better the results from fertilizers and herbicides. Retention of organic matter and maintenance of high infiltration rates are important; in 100 years we have reduced the legacy of some thousands of years by half or more. However, it need not take thousands of years to make up the lost ground. Our farming practices actually come near to simulating a simplified grassland ecology with emphasis on annuals. We can grow great amounts of organic matter, and by eliminating fire, which used to be a limiting factor, rapidly restore even badly mineralized soils to much higher levels of hydraulic conductivity and field capacity than they now possess, or for that matter, possessed in their virgin state.

The incidence of both localized and generalized flooding, with the losses that these imply, could and would be much reduced. Few persons realize the impressive amounts of water that gather as a result of even a light runoff from a modest area. Thus, 25 mm of runoff from one square mile translates into 65,000 cubic metres (52 acre-feet, or 13 million gallons), 10 mm of runoff from a drainage basin such as that of the Pembina River (3300 sq. mi.) yields some 85 million cubic metres (68,000 acre feet). Over the Red-Assiniboine watershed, embracing some 111,000 sq. mi., 10 mm of runoff generate a total of over 2.8 billion cubic metres (2.25 million acre-feet) or roughly one-third the average annual discharge as measured at Winnipeg. If lost as runoff, it represents a tremendous destructive force, especially since, by constantly amplifying our

Prairie potholes provide important habitat for waterfowl such as this Northern Shoveler drake. *Doug Gilroy*

drainage networks, we have virtually guaranteed its progress from higher to lower elevations at great volume and velocity. Although only 37,500 sq. mi. of the Red-Assiniboine watershed lies within Manitoba, and although only about 70% of this area is in agricultural use, this still leaves 26,250 sq. mi. where Manitobans can take the initiative in changing water management through land management. Since snowmelt accounts for the bulk of the annual runoff, the retention of an additional inch of moisture from the annual snowmelt in Manitoba alone would reduce the total Red-Assiniboine runoff by 1.4 million acre-feet — 20% of the annual average. Total discharge, however, tends to fluctuate some 50% to either side of the mean. Let us assume, therefore, that Manitoba farmers accept the challenge of capturing an additional inch of snow-

melt. What effect could that have on runoff peaks, even though our neighbours in Saskatchewan and the US make no such attempt? Relative to the 1950 flood, that achievement would have reduced the rate of discharge at Winnipeg from 103,400 c.f.s. to 95,000 c.f.s., or by 25% of the excess of discharge over the river's bankfull capacity. There would still have been major flooding, both inside and outside the city, but the size of the devastated area, considering the extreme flatness of the terrain, in which even modest additional overspill floods large additional areas, would have been much smaller. An equivalent performance by Saskatchewan would have cut the rate of overspill to roughly half of what it was, and the same achievement by our American neighbours would have reduced it to one-quarter. All other arguments aside, such an achievement would not only have benefitted the headwater region of the basin, in which the runoff period was followed by a dry spell lasting until late June, but would have forstalled tens of millions of dollars in property losses and hardships. Indeed, had the farmland within the whole Red-Assiniboine basin been in a condition to retain an additional inch of snowmelt or subsequent rain, it is likely that no flood at all would have occurred. The reasons are simple: firstly, to achieve it at all, the ground would have had to have had a relatively evenly-distributed snow cover. This would have meant, (a) lightly frozen ground below, capable of being infiltrated by meltwater, and (b), a uniform high reflectivity which would have retarded the rate of melt, therefore the rate of runoff and downslope accumulation, and, hence, quite conceivably, this positive time-factor might very well have disposed of the remaining flood threat.

I am persuaded that our farmers could achieve such a change, at considerable economic and environmental benefit to themselves and to the rest of society, but without incurring additional economic burdens. This is what I have concluded from my own experience of the past five years in the consistent application of these land-management ideas. I think that if we could eliminate crop-residue burning, clear tillage by disc or plow, and summerfallowing, as the land-management practices most detrimental to maintenance of land productivity, 90% of our goal would be attained.

How could this be implemented? Could the farmer be asked to sign an affidavit as to the acreage on which *none* of these malpractices had been carried on, thus qualifying him for a remission of that portion of his tax bill which represents no service to the land *per se* (i.e. essential drains, accesses, roads, etc.)? The amount of this remission would be made up to the Municipality from Provincial and/or Federal sources. Those who chose not to respond to these incentives would not be hounded, harassed or harried in any way. They would simply pay the *entire* bill, as of yore!

I believe that relatively simple incentives could motivate vastly better land management than is being currently practiced in agro-Manitoba. There is little point in isolating sloughs and potholes and other wastelands for discussion; we must consider the whole agricultural land-use pattern. It is my conviction that, if we can motivate farmers to bring the agricultural land to an optimal state of environmental health, our sloughs and potholes and other wildlife habitats can get an almost free ride on the shirt tails of that process.