NATIVE SPECIES IN RECLAMATION OF DISTURBED LANDS

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March 1977

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ABSTRACT

When reclamation seeks to reintegrate disturbed lands into the natural landscape, use of native species could have decided ecological, economic and aesthetic advantages. As products of millions of years of adaption to varied environments, native species generally require no maintenance, are self perpetuating, and are visually integrated with surrounding landscapes. In the practical sense, native seed is presently unavailable commercially. Therefore, research is necessary on the collection of native seed and cuttings, the storage and treatment of seed for dormancy breaking and germination, the time of seeding and methods of propagation for maximum seedling establishment, the growth on different materials and sites, the selection of proper species combinations (including agronomics), and on the practical and cost aspects of commercial production. By observation in nature, and by lab experiments, native species should be evaluated for their role in succession, erosion control capability, contribution to soil humus, palatability for wildlife and visual integrating capabilities.

Initially, research priority should be given to species suitable for difficult sites where agronomic species are relatively unsuccessful or costly to maintain (e.g. high elevations, steep slopes, dry areas).

The immediate goal of this research would be the production of a catalogue of native species suitable for reclamation of disturbed lands in British Columbia. This catalogue would contain all available information on areas, sites, conditions, etc. for which species would be suitable as well as information on species germination, propagation, and early maintenance requirements.

Establishment of an independent Reclamation Research Institute is proposed to fund and coordinate this research in connection with other aspects of reclamation in the province.

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In this paper we set forth arguments favoring the use of native species in reclamation of mined lands in British Columbia, mention problems this might entail, research which should be done, and where, how it might best be coordinated and suggest how this information might most readily be made available to reclaimers.

Before going further, some distinction should be made between native and agronomic species. An agronomic species is a plant selected and bred for specific agricultural purposes such as forage, hay, or cover crops. These species are genetically uniform and require intensive management for vigorous growth and reproduction. Native species occur naturally within a region and have adapted through millenia to local climates and habitats. They are genetically diverse self-perpetuating species requiring no maintenance to grow vigourously in their native habitats.

To date, most reclamation has relied on agronomic species because seed is readily available in bulk from commercial producers at low cost. Where the reclamation objective is to return the land to agricultural production, agronomic species are the logical choice. However, when fertilization and/or irrigation are cut off, "instant green" agronomics often do very poorly. Two such sites are the Similkameen Mining operation at Princeton and Placid Oil's Bull River Copper site.

When the reclamation objective is to re-integrate the site into the natural landscape, a durable, self-maintaining plant cover of native species has obvious benefits. Nature has been reclaiming drastically devastated areas with native species since time began. Learning how she does this might save a few dollars.

Unlike Europe (e.g. Schiechtl, 1973) and apart from the traditional efforts of forestry and horticulture, relatively little thought has been given to using native species for reclaiming disturbed lands. In Alberta and British Columbia seed of a number of native grasses and forbs has been collected and germination and field tests made by mining companies or their consultants. These tests are basically in an early stage of development, so relatively little information has been accumulated. For example, Kaiser Resources, a leader in the reclamation of coal mined lands in British Columbia, set up test plots of native grasses and forbs only last summer and started germination tests this winter, although they have done work with native shrubs for a number of years. Their research in native shrubs has included propogation by seeds and cuttings and field trials of certain species. Native shrubs have been used on a limited scale for reclamation attempts and erosion control by British Columbia's Fish and Wildlife Branch, Parks Branch, and Department of Highways. Horticulturalists use some native shrubs for landscaping, but ridiculous as it sounds, the available commercial stock of B.C. natives apparently comes only from European growers.

Some reclamation trials with native grasses and forbs have been done in the arctic regions of the Northwest Territories, and in the Rocky Mountains of Colorado, Idaho, and Montana (Nishimura, 1974; Farmer et al, 1976; Harrington, 1946). Arctagrostis latifolia (Polar Grass) was used in trials in the Northwest Territories and although after two years its performance was inferior to the agronomics used, after seven years it was many times more successful (Hernandez, 1973). Many native species have been tried or suggested in western North America (see Appendix) and a preliminary literature review shows that a fair amount of information is available on test trials and germination of native shrubs and herbs.

One of the reasons for the relative lack of both research and reclamation trials with native species is the lack of readily available seed or nursery stock. Also, in many situations, agronomic species either do well, or are preferred, depending on ultimate land use goals. Agronomic seed is readily available at low cost, so in such situations there is little incentive to consider use of native species. On the other hand, agronomic species generally do not do well in harsh environments such as the alpine tundra. In most lowland situations where intensive management such as fertilization and/or irrigation is eliminated, agronomics eventually die out. Native species can play an important role in these situations and have a number of ecological, economic and aesthetic advantages.

In harsh environments such as the alpine tundra native species have evolved and adapted to the normal alpine conditions as well as to the extremes. Thousands of years of evolution have resulted in diverse genetic populations of each species that are able to survive harsher than normal alpine conditions because of adaptations to cold and frost during the growing season. Native species in other environments have similarly evolved and adapted to both normal and extreme conditions of their particular habitats.

Conversely, agronomic species (originally selected from a native species stock somewhere) are propagated for specific agricultural purposes. Different varieties of these agronomics are available, but these are still basically selected for agricultural use, and continued maintenance is necessary to keep a good cover for any extended period of time. In alpine or other non-agricultural extreme areas they will generally not go to seed, or will rapidly die if fertilization is stopped. For these reasons agronomic species usually do not have the capacity for vigorous growth in all the varied environments in which they are used.

Certain native species are known as pioneers, because they will invade areas after natural disturbance such as fire, flooding, or mass wasting. Pioneer species are adapted to the environmental conditions in the area thereby enhancing their chance of successful establishment. They also initiate humus accumulation and nutrient cycling in the early stages of succession making the site suitable for other species. Eventually most pioneers are out-competed by other natives better adapted to the "improved" conditions. Stable self perpetuating plant communities requiring no maintenance develop in the long run. Use of these pioneer species, possibly with some fertilization, irrigation or other site preparation and in combination with agronomics in reclaiming sites could result in reduced management cost because natural plant succession to self-maintaining communities will be accelerated. Further, a diverse native plant cover such as this will encourage long term stability of the vegetation.

In order to minimize the management cost, selection of appropriate local races, or ecotypes, of native species has proven value. Foresters have known and applied this for years when selecting different provenances of trees to get the best wood production. The use of these ecotypes that are genetically suited to certain areas will likely result in increased revegetation success.

In addition to their ecological and economic advantages, native species generally integrate better visually into the surroundings than either agronomic or introduced species. Their growth form, color, and texture seem to blend into the natural landscape and as a result they are aesthetically more pleasing.

The disadvantages of using native species at present are largely practical ones: unavailability and/or high cost of stock or seed; little knowledge of what species to use, when, and under what conditions; the immediate requirement of plant materials for reclaiming specific sites now; and lack of certification of stock quality, to mention a few.

Bearing these points in mind a great deal of observational and experimental research and field testing on native species should be set in motion as soon as possible. Some areas where such studies are needed follow.

For example, determining local races appropriate for reclamation requires inventory of the vegetation for each general area (e.g. alpine of Northeast Coal Block) and evaluation of likely reclamation species on the basis of, among other things, their place in succession, role in nutrient cycling, nitrogen fixing capability, contribution to the buildup of humus, amelioration of the site conditions to encourage the buildup of the microflora and fauna palatability for wildlife, ease of propagation, and the range of habitats to which they are adapted. This information can play an important role in determining the suitability of different species -and local races of these species (i.e. ecotypes) - for different types of mine waste.

Collections of seed, cuttings, transplants, etc. should be made for each promising species, and seed storage and dormancy breaking requirements should be determined. Methods of propagation should be evaluated, along with the best timing and methods for seeding of each ecotype to ensure a high seedling establishment in a particular environment. In harsh environments, the time of seeding is critical to ensure a favorable microclimate for both germination and seedling establishment.

In nature, groups of species often interact in mutually advantageous ways. Therefore, different combinations of native and/or agronomic species should be evaluated. Also, staggering the time of seeding of different groups of species may be very important. The possible advantages of sowing agronomics immediately for erosion control and for the addition of organic matter to the soil, followed by the seeding of native species should be explored. Such organic/native mixes should be further researched because of the high shoot to root production in the agronomics as compared to the initial high root to shoot production in the native species (Ziemkiewicz, P.; pers.com. 1977).

In some harsh alpine environments viable seed crops occur in only the best summers, therefore most species are well adapted to vegetative (non-seed) methods of reproduction. In such cases where seed collection is a problem, techniques such as using plugs of natural vegetation may be valuable in innoculating sterile soils with microorganisms, as well as accelerating invasion of the native flora. Coordinating this technique with seeding of agronomic species for erosion control and organic matter additions should also be examined.

In evaluating native species, reclamation objectives as well as site conditions will undoubtedly determine which species are appropriate. A reclamation objective of improved wildlife habitat would likely require a different combination of species than a goal of pulpwood forest. Microsite variations could also influence success and should be taken into consideration. In extreme cases, such as where toxic materials are to be revegetated, and conventional site ameliorating methods are unsuccessful, then native species showing mild tolerance of these conditions might be selected and experimentally bred for increased tolerance to revegetate these sites.

These are a few of the areas where research in native species could lead to improved reclamation and reduced costs in British Columbia. Clearly the collection of such information through research and testing would take some time for all the Province. Some information exists already in the literature but needs to be retrieved and interpreted for reclamation purposes. This would provide the basis for more clearly defining research priorities and establishing research programming. However, because of the urgency of getting research underway now we feel that research priority should be given to difficult sites where agronomic species are relatively unsuccessful or costly to maintain such as steep slopes, dry areas, and alpine tundra.

A major goal of this research would be the production of an annotated catalogue of native species suitable for reclamation of disturbed lands in British Columbia. This manual could be started now with existing information and eventually would contain all available information on-, each species pertinent to reclamation as well as best methods for ensuring reclamation success (regional and site suitability where-when-how to collect, store, propagate; role in succession; other species features.) Research to achieve this goal should be initiated now.

Who should do the research? Traditionally this is the universities' domain because of its close relation to professional training and education, staff with research interests, graduate students, research facilities, independent (usually insufficient) funding, and detachment from vested interests. However, university research is criticized because results are often slow in coming, difficult to comprehend, and of little practical value to land managers. But this is changing as more university research is geared to finding practical answers. Should government or industry foot the bill? And who should determine research priorities? Because of their immediate concern with actual reclamation problems should companies do the research or contract it out to consultants? Or, should it be a collaborative effort of universities, private consultants, government and industry with some central group controlling the direction of the research?

We feel a joint effort would be most fruitful, with research priorities and funding being administered under an independent British Columbia Reclamation Institute which would be concerned with lands disturbed by any means - mining, electric power generation, construction, forestry, highways, etc. - and whose membership would come from public and private land use agencies.

With such coordination, with the growing emphasis on not only revegetation but also long term maintenance of green cover, and with the ecological, economic and aesthetic benefits which native species clearly have to offer, the payoff to reclaimers from supporting more research in native species for reclamation in British Columbia should be obvious.

APPENDIX

This list summarizes a preliminary investigation of the literature by W.F. Hubbard (see Hubbard & Bell, 1977).

NATIVE SPECIES IN MONTANE RECLAMATION

1. Native species that been used for reclamation test plots and trials:

Shrubs and Trees:

Amelanchier alnifolia	Saskatoon
Betula nana	Dwarf Birch
B. papyrifera	Paper Birch
Cornus stolonifera	Red Osier Dogwood
Juniperus communis	Mountain Juniper
J. horizontalis	Creeping Juniper
Picea engelmanii	Engelmann Spruce
P. glauca	White Spruce
Pinus contorta	Lodgepole Pine
Populus tremuloides	Trembling Aspen
Pseudotsuga menziesii	Douglas Fir
Rosa Woodsii	Woods's Rose
Rubus idaeus	Red Raspberry
Sambucus racemosa	Red Elderberry
Shepherdia canadensis	Buffaloberry
Symphoricarpos albus	Snowberry

Forbs:

Achillea millefolium	Yarrow
Agastache urticifolia	Horsemint
Artemesia norvegica	Mountain Sagebrush
Aster alpinus	Boreal Aster
Balsamorhiza sagittata	Arrowleaf Balsamroot
Epilobium angustifolium	Fireweed
Heracleum lanatum	Cow Parsnip
Lupinus alpestris	Alpine Lupine
Osmorhiza occidentalis	Western Sweet-cicely

Penstemon nitidus	Shining Penstemon
P. whippleanus	Whipple's Penstemon
Phacelia heterophylla	Varileaf Phacelia
P. sericea	Silky Phacelia
Vicia americana	Common Vetch
V. cracca	Bird Vetch

Grasses and Sedges:

Agropyron dasystachyum	Thick-spiked Wheatgrass
A. smithii	Bluestem Wheatgrass
A. spicatum	Bluebunch Wheatgrass
Agrostis scabra	Winter Bentgrass
Arctagrostis latifolia	Polar Grass
Bromus carinatus	California Brome
B. ciliatus	Fringed Brome
B. tectorum	Cheatgrass
Calamagrostis Canadensis	Canada Reedgrass
Carex bigelowii	Sedge
Danthonia parryi	Parry's Oatgrass
Deschampsia caespitosa	Tufted Hairgrass
Eriophorum vaginatum	Cotton Grass
Festuca ovina	Sheep Fescue
Koeleria cristata	Prairie Junegrass
Phleum alpinum	Alpine Timothy
Poa alpina	Alpine Bluegrass
Trisetum spicatum	Spiked trisetum

II. Native species that have been proposed for reclamation trials*:

Shrubs and Trees;

Abies lasiocarpa	Subalpine Fir
Acer glabrum var.douglasii	Douglas' Maple
Alnus sinuate	Sitka Alder
A. tenuifolia	Mountain Alder
Arctostaphylos uva-ursi	Bearberry
Betula occidentalis	River Birch
Ceanothus sanguineus	Redstem Snowbrush
C. velutinus	Sticky-laurel
Crataegus oxyacantha	Hawthorn
Pinus albicaulis	White Bark Pine
P. banksiana	Jack Pine
P. flexilis	Limber Pine
Populus balsamifera	Balsam Poplar
P. trichocarpa	Black Cottonwood
Potentilla fruticosa	Shrubby Cinquefoil
Rhododendron albiflorum	White Rhododendron
Salix alaxensis	Alaska Willow
S. arctica	Arctic Willow
S. polaris	Willow
S. reticulata	Willow
Spiraea lucida	Spiraea

Forbs proposed:

Artemesia caudate	Artemesia
A. frigida	Pasture Sagebrush
Corydalis aurea	Golden Corydalis
Dryas drummondii	Yellow Mountain-avens
D. octopetala	White Dryad
Epilobium latifolium	Red Willow-herb
E. watsonii	Watson's Willow-herb

Equisetum arvense	Field Horsetail
Hedysarum alpinum	Alpine Sweetvetch
Polygonum bistortoides P.	American Bistort
viviparum	Alpine Bistort
Saxifraga tricuspidata	Prickly Sazifrage
Sedum stenopetalum	Wormleaf Stonecrop
Veronica cusickii	Cusick's Speedwell

Grasses:

Agropyron scribneri	Spreading Wheatgrass
Calamagrostis montanensis	Plains Reedgrass
C. rubescens	Pinegrass
Carex spp.	Sedges
Festuca brachyphylla	Alpine Fescue
F. idahoensis	Idaho Fescue
Helictotrichon hookeri	Spike-Oat
Festuca scabrella	Buffalo Bunchgrass
Hordeum jubatum	Foxtail Barley
Poa cusickii	Cusick's Bluegrass
P. fendleriana	Mutton Grass
P. lanata	Woolly Bluegrass
P. sandbergii	Sandberg's Bluegrass

* This list is by no means complete

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Acknowledgments:

We appreciate the advice and help of those who read the manuscript, particularly Bill Hubbard, Biocon Research, Ltd. The opinions expressed are our own.