REVEGETATING SAND AND GRAVEL BORROW PITS IN MAINE

Problem Definition

Sand and gravel borrow pits cover about 200,000 acres in Pennsylvania, New York, and the New England states.[1] In most operations the overburden material is seldom stockpiled for reclamation. After mining ceases, the extremely droughty spoils on these sites strongly inhibit the reestablishment of indigenous vegetation. A rapid transition from biennial and perennial plants[2] to very open stands of birches (Betula spp.) and pines (Pinus spp.) is common with very little soil profile development. The few trees that result are stunted, low value specimens which accumulate most of the very limited on-site nutrients in their biomass.[3] The excessive drainage, very low organic matter, and low percentage of soil fines further inhibit herbaceous plant establishment.

Typically, when seedings are made to revegetate these sites, cool season grass mixtures include such species as ryegrass (Lolium perenne L. and L. multiflorum Lam.)., Kentucky bluegrass (Poa pratensis L.), and red or tall fescue (Festuca rubra L. or F. arundinacea Schreb.). Good initial establishment usually results when a timely, well mulched seeding receives favorable rainfall. Unfortunately, the lush growth declines to a sparse plant population within three or four years, resulting in a need for replanting. The need for effective cover led to a series of test plantings throughout New England and New York which were established in 1975-1977. Cool season grasses, legumes, and warm season grasses were compared.

Conclusions from 1975-1977 Plantings

Cool season grasses achieved their best soil cover during the first growing season, then declined in vigor. This decline was most rapid on sites having percent fines[4] less than 10 percent. Legumes produced their best stands during the second growing season on sites having percent fines above 15 percent. The warm season grasses had comparatively lower initial soil cover, but improved steadily on sites with both low and higher percent fines. After 6-8 years, the tested species had the following effectiveness ratings:

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[1] Soil Conservation Service, U.S. Department of Agriculture. 1981. RCA Part I. Agency Review Draft. Tables 6-29, pp.6-74..

[2] Andreae, M.I. and Cavers, P.B. 1981.

[3] Odum, E.P. 1971. Fundamentals of Ecology.

[4] Percent fines in the surface layer to 6" depth. Fines are those particles passing through a 200 mesh sieve.

SPECIES	VARIETY/SELECTION	EFFECTIVENESS RATING*
Warm Season Grasses		
Switchgrass	Blackwell	63
Little bluestem	Camper	55
Big bluestem	Kaw	54
Little bluestem	Blaze	53
Deertongue	Tioga	24
Caucasian bluestem	Caucasian	16
Legumes		
Birdsfoot trefoil	Empire	42
Crownvetch	Chemung	37
Flatpea	Lathco	34
Narrowleaf Trefoil	NY-811	26
Cool Season Grasses		
Canada bluegrass	Common	17
Sheep fescue+	Common	15
Tall fescue	Ky-31	13
Red fescue	Common	10
Redtop	Common	7
Kentucky bluegrass	Common	0

*Rating is sum of stand and vigor for all 7 sites and 3 reps when poor=1, fair=2, good=3; eighty-four (84) is the maximum possible rating.

C3 and C4 Grasses – How Are They Different?

Just above we mentioned the cool season and warm season grasses. These are also known as C3 and C4 grasses due to their respective (and different) ways of carrying out photosynthesis. Most recent texts covering botany or plant science discuss the C3 and C4 photosynthetic pathways in detail. We will merely try to explain how to use the differences to best advantage.

In brief, the C_4 (warm season) grasses are roughly twice as efficient in their use of light, water, and nutrients to manufacture plant tissue, as are the C_3 and C_4 photosynthetic pathways in detail. We will merely try to explain how to use the differences to best advantage.

In brief, the C_4 (warm season) grasses are roughly twice as efficient in their use of light, water, and nutrients to manufacture plant tissue, as are the C_3 (cool season) grasses. The warm season grasses, therefore, are more productive under dry, sterile conditions than are cool season grasses. Interestingly, most of the common cool season grasses are not native to this continent – they are European/Asian in origin. The warm season grasses we are now using are native, and most are native to the Northeast. They are tall grasses (4 to 7 feet) with very extensive root systems capable of 10 to 15 foot depths.

Selecting Revegetation Species

In work covered in the references we have characterized sands and gravels into three groups based upon how cool season grasses, warm season grasses, and legumes seem to perform when planted in them. The three groups are distinguished by their "fines" content determined as percent by weight. Fines are those small particles which will pass through a 200 mesh sieve (0.074mm). The more fines a sand or gravel has, the better will be it's ability to hold moisture and nutrients and hence the easier it will be to revegetate.

We found that where the fines are less than about 15 percent, only the warm season grasses provide successful, long-term cover. Between 15 and 20 percent the tap-rooted, perennial legumes are also successful. Above 20 percent the cool season grasses become a third choice with reasonable success. Are these numbers set in concrete? No, but it may be another ten years before we have reason to change them due to additional experience.

Recommended Procedures

Since the early 1980s, many test plantings have been made on sand and gravel pits, comparing warm season grass species and cultivars, and establishment methods. While most of this work has taken place in New Hampshire, Vermont, and New York, a few plantings in Maine have also been made. Our trials have shown that warm season grasses will grow on sites with all aspects (N, S, E, W) in USDA hardiness zones 4 and warmer. North aspect microsites in zones 4a and most north facing slopes in zone 3 allow for only limited growth of warm season grasses. We recommend a cool season grass mix for those sites. The issue on such sites is not winter hardiness but lack of heat units to promote acceptable warm season grass growth. The current recommendations for successful long-term cover on sand and gravel pits are as follows:

Site Preparation

Some sand and gravel pits have side slopes that are very steep. These should be reduced to 2:1 or preferably 3:1 which will allow for improved stability and better seeding success. Large rocks and debris should be buried during the grading process.

Topsoil is extremely expensive to purchase, haul, and spread, and in any case why rob Peter to pay Paul? Spreading topsoil to allow for successful revegetation of sand and gravel pits results in two sites with degraded capabilities. Warm season grasses, for a slightly higher seed cost, can save thousands of dollars in topsoil cost.

Organic matter in the form of compost or by products will be advantageous if available at no/low cost. Added to sands and gravels, organic matter will greatly improve water and nutrient holding capacity. This will hasten the succession to climax or sub-climax cover types that are native to the region.

Seed Mixtures

A. Where percent fines (by weight passed 200 mesh sieve) are less than 15.

MIX #1 Species	Varieties (select one) [5]	Lb. Per Acre PLS [6]
Coastal panicgrass	Atlantic	3.0
Switchgrass	Trailblazer, or Blackwell, Or Shelter	3.0
Big bluestem	Niagara	4.0
Sand bluestem	Goldstrike	2.0
Little bluestem	Aldous or Camper	2.0
Sand lovegrass	Bend, NE-27	3.0

For color, diversity, and wildlife benefits added:

Blackeyed susan	Golden Jubilee	0.5
Maximilian Sunflower	Prairie Gold	0.5

B. Where percent fines are between 15 and 20, use Mix #1 or

MIX #2 Species	Varieties (select one) [5]	Lb. Per Acre [7]
Flatpea	Lathco	10.0
Perennial pea	Lancer	2.0
Crownvetch	Penngift or Chemung	10.0
Tall fescue	Ky-31 or Rebel	10.0

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5 Varieties are listed in preferential order.

6 Warm season grass seed is sold and planted on the basis of pure live seed (:PLS). An adjustment is made to the bulk pounds of seed to compensate for inert material and dead seed. % PLS=% Germination x % Purity 1.0 PLS lb. = 1.0 $\frac{\text{bulk x 1}}{\text{\% PLS}}$

7 Legume and cool season grass seed is sold and planted on a bulk basis, the weight is not compensated for dead seed and inert material.

C. Where percent fines are above 20, use mixes #1 or #2 or:

MIX #3 Species	Varieties (select one) 5	Lb. Per Acre 7
Canada bluegrass	common	10.0
Tall fescue	Ky-31 or Rebel	10.0
Redtop	Streeker	2.0
Birdsfoot trefoil	Viking or Empire	5.0

Dormant seedings are not recommended for mixtures 1 or 2, and should be used only as a last resort for mixture 3.

Planting Date

Plant as early in the spring as possible. In Maine this is shortly after snow is off the site. The cutoff is June 15. Mixture #3 can also be planted in late summer from August 1 to September 15.

Fertility Amendments at Planting

Soil amendments are best applied to meet needs determined with a soil test. Sand and gravel mine residues that contain low fines and low organic matter are very low in nitrogen, phosphorus, and potassium. Such residues have limited exchange capacity to tie up nutrients that are excess to plant needs. As soil fines increase, the potential increases for significant levels of nutrients to be present.

These fertilizer recommendations are made recognizing the limited exchange capacities and limited ability of seedling plants to extract nutrients from a growth medium.

MIX #1:	Lime	1 ton/acre	on sites with pH below 6.0
	Fertilizer	N-50 lb/ac actual $P_2 0_5$-50 lb/ac actual $K_2 0$-50 lb/ac actual Such as 250 lb of 20-20-20	(ammonium nitrate form)

Repeat fertilizer application in June of year 2.

MIX #2:	Lime	2 ton/acre on sites with pH below 6.5
	Fertilizer	N-25 lb/ac actual (ammonium nitrate) $P_2 0_5$-50 lb/ac actual $K_2 0$-50 lb/ac actual B (boron) -1 lb/ac

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MIX #3:	Lime	1 ton/acre	on sites with pH below 6.0
	Fertilizer	N-50 lb/ac actual (ammonium nitrate) $P_2 0_5$-75 lb/ac actual $K_2 0$-75 lb/ac actual	

Repeat fertilizer application in May of year 2.

Seed Procurement

Seed for mixes 1 and 2 take longer to obtain because these species are not 'stocked' by local businesses. Therefore, 1-3 months advanced planning is necessary to have them on hand for the appropriate planting dates. Source lists are available from the Natural Resources Conservation Service (NRCS) Plant Materials Specialist.

Seeding Procedure

a. Broadcast the seed, lime, and fertilizer by hand or with hydroseeder.
b. IMPORTANT: On the same day, track in the seed with a bulldozer having cleats with at least 1 ¼ inch depth. Operate up and down slope, offsetting each pass to completely cover the surface with tracks. Double tracking (double coverage) is not beneficial.

NOTE: A failure to track in the seed will result in failure of seed mixes 1 and 2 in every case, and will reduce the initial establishment success with mix 3.

Mulching

Mix 1 is best planted without mulch. Warm season grass seedlings do not appreciate shading.

Mix 2 will benefit from a heavy (2 ton/ac) mulch of straw or hay.

Mix 3 will benefit from a moderate mulch (1 ton/ac) of straw, hay or wood fiber mulch.

Stand Development

The species in mixes 1 and 2 are deep rooted, long-lived perennial plants. They put most of their initial energy into root systems during the establishment year, and often have meager top growth. New users often think that the planting is a failure, but they rarely are if procedures outlined here are followed.

Percent cover by the end of the first growing season is typically in the 20-30 percent range for mixes 1 and 2, and in the 50-60 percent range for mix 3 on those sites where mix 3 can be successfully used.

Wildlife Value

Warm season native grasses become tall in the second or third growing season. They will provide exceptional wildlife cover for ground nesting birds and very good cover for small animals and deer.

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