

FINAL Report
USEPA-Great Lakes Restoration Initiative
Grant No. GL00E00588-0
Sand Point Wildlife Habitat Restoration
Project Period: September 30, 2010 to November 30, 2012
Principal Investigator: Pamela Nankervis, Wildlife Biologist

Project Background and Goals

Sand Point has great potential for recreational activities and wildlife, however its natural resources were negatively impacted by industrial copper mining sand (known locally as “stamp sands”) discharged by an early 20th century stamp mill. The stamp sands were disposed of into Lake Superior and over time deposited by lake currents onto the Sand Point property. The Sand Point property was subsequently listed as a brown field site. Assessment and cleanup work was conducted with assistance from the U.S. EPA and other agencies from 2002 to 2006. In 2006, a 6”-10” cap of sandy-loam soil was distributed over 33.6 acres of stamp sands and seeded with a short grass mixture to protect vulnerable coastal wetlands that border the brown field property. While the cleanup solution was successful in stabilizing the existing stamp sands and reducing impact to the surrounding environment, additional steps to add relief in the topography and native plant species through the GLRI program helps to reduce erosion potential and restores and enhances wildlife habitat on the property. Prior to the GLRI restoration project, the dominant plant species on site were alfalfa, short grass and bird’s foot trefoil with only ten species being detected on pre-treatment study plots. Already in just the first growing season, the diversity of species has increased to 67 total herbaceous species being detected within monitored plant plots as well as 22 species of trees and/or shrubs (see Appendix 1). Common species have changed to include grass spp., clover spp., black-eyed susan, birds-foot trefoil, narrow-leaf plantain, oxeye daisy, parasol whitetop and goldenrod spp..

Wildlife species will benefit long-term from increased cover provided by relief in topography and from the diversity of plant species that upon maturity will provide hard and soft mast, browse, and seeds. Wildlife species that will benefit include but are not limited to: a variety of songbirds, ducks and shorebirds, bald eagle*, gray wolf*, black bear, coyote, bobcat, gray fox, otter, American bittern*, sora, woodcock*, marsh wren*, hooded merganser, and trumpeter swan*. All of these species have been detected on Sand Point property through ongoing wildlife surveys by the KBIC Natural Resource Department. (*Species identified by KBIC as culturally significant and the State of Michigan lists as species of special concern or threatened.)

The *two goals* of this project were:

1. **Stabilization and Added Relief in Topography;** The first goal was to further protect the cap by placement of planted mounds, boulders, and taller grass, trees and shrub species to lift the wind and provide microclimate conditions more favorable to plant growth. The site treatments as designed will a) help decrease potential wind erosion and sediment loading back onto the cap and into adjacent wetlands, b) increase aesthetic quality for visitors, and c) provide sheltered areas of microclimate to allow a wider variety of plants to take root naturally.
2. **Wildlife Habitat and Biodiversity;** The second goal was to restore and enhance wildlife habitat and biodiversity on the 33.6 acre brown field site at Sand Point by introducing a diverse combination of herbaceous plants as well as trees and shrubs. Species were selected that have the best chance for survival under current conditions and plants that are beneficial as food sources to birds, pollinators and a variety of animals. Irrigation to be provided for two growing seasons.

KBIC Natural Resource Department recently established a plant program that includes invasive species control and native plant propagation in a growing dome and outdoor locations planted for seed collection to help

supplement this project area as needed. It is through the KBIC plant program that long-term tracking of natural succession, control of invasive species, and additional native and cultural plantings will be on-going long after this restoration initiative.

Projected Project Outputs

QAPP projections: Per ACRE; 200-320 trees and shrubs (3-6 species), 2-4 mounds, 0.5 acre seed plot (15-30 species per seed mixture), irrigation for two growing seasons

QAPP projections: 3,650 cubic yards of mound soil, 1,360 cubic yards top soil, 150 boulders

Completed Project Outputs

The 33.6 acres of capped brown field site was prepared for planting of native species of plants beneficial for wildlife food. Mounds and boulders were placed for relief in topography and to provide microclimate.

Site stabilization and relief outputs include:

- 1) delivery and installment of mound soil (3,484 cubic yards total), average 1.9 mounds per acre (58 total mounds),
- 2) delivery and placement of top soil (1,541 cubic yards total) plus weed control of 34 total ½ acre seed plots,
- 3) delivery and installation of 3,018 ft gravel maintenance/walking path (388 cubic yards), and
- 4) delivery and placement of 98 total boulders for microclimate and wind erosion control.

The 33.6 acres of capped brown field site was improved by planting native seeds, shrubs and trees and irrigated for two growing seasons.

Wildlife habitat and biodiversity outputs include:

- 1) A total 223 lbs of native seed was planted across the 33.6 acre area in seed plots, on mounds, and in two gardens (56 total native species were planted including seed and KBIC greenhouse transplants, (see Table 1)
- 2) 34 total 0.5 acre seed plots were planted with site specific combinations of native seed (6-12 species per mixture) and common oats
- 3) 58 total soil mounds were planted with native seed, trees, shrubs and a cover crop of common oats
- 4) A total of 442 square yards of beach grass was planted between the sand beach and the cap to help block the blowing sand
- 5) A total 662 live stake shrubs and trees (6 spp) were planted around the edge of the south pond to provide cover and food for wildlife
- 6) A total of 13,380 trees and/or shrubs were planted across the 33.6 acre area; approximately 398 total trees and/or shrubs were planted per acre (3-6 different species per acre),
- 7) A two acre pollinator garden was installed at the south entry gate and planted with 14 native species of herbaceous plants grown in the KBNRD greenhouse, plus two species of native seed from KBIC (mounds, top soil, boulders, trees and shrubs in the garden area were provided through GLRI funds as part of the 33.6 acres),
- 8) A 0.5 acre meditation garden was installed at the north entry gate and planted with 6 species of native seed,
- 9) A total of 154 species (69 additional species to those found in monitored plots) were detected within the project area; these species were most likely brought in with soil and/or already present yet undetected during pre-treatment surveys (See appendix 2)
- 10) Irrigation system was installed and operational throughout the 2011 and 2012 growing seasons.

Table 1. Sources and species names of herbaceous plants, trees and shrubs that were planted on the 33.6 acre project area in 2011 and 2012. Toumey Nursery (operated by the U.S. Forest Service) donated sweet grass and cedar, KBIC Natural Resources Committee donated purple and yellow coneflower and harebell, Keweenaw Greenhouse (local privately owned business) donated coreopsis and some annual plants, species listed in the greenhouse column were provided by KBIC Natural Resources Department.

Plant Species	Scientific Name	Greenhouse Species	Donated Species	LS Tree Farm
1 Tobacco	<i>Nicotiana rustica</i>	x		x
2 White sage	<i>Salvia apiana</i> (SAAP2)	x		
3 Sweetgrass	<i>Hierachloe R. Br.</i>	x	x	x
4 Bee balm/wild bergemont	<i>Monarda fistulosa</i>	x		x
5 Black-eyed Susan	<i>Rudbeckia hirta</i>	x		x
6 Primrose	<i>Oenothera biennis</i>	x		
7 Lanceleaf coreopsis	<i>Coreopsis lanceolata</i>	x	x	x
8 False sunflower	<i>Helopsis helianthoides</i>	x		
9 Thimbleweed	<i>Anemone cylindrica</i>	x		
10 Harebell	<i>Campanula rotundifolia</i>	x	x	
11 Big bluestem	<i>Andropogon gerardi</i>	x		
12 Little bluestem	<i>Schizachyrium scoparium</i>	x		x
13 Canada wild rye	<i>Elymus canadensis</i>	x		x
14 Hairgrass	<i>Deschampsia flexuosa</i>	x		
15 Poverty oats	<i>Danthonia spicata</i>	x		
16 Grass-leaved goldenrod	<i>Euthamia graminifolia</i>	x		x
17 Downy goldenrod	<i>Solidago puberula</i>	x		
18 Yellow avens	<i>Geum aleppicum</i>	x		
19 Tall meadow rue	<i>Thalictrum dasycarpum</i>	x		x
20 Blue vervain	<i>Verbana bastata</i>	x		
21 Joe-pye weed	<i>Eupatorium maculatum</i>	x		x
22 Fringed sedge	<i>Carex crinita</i>	x		
23 Wild columbine	<i>Aquilegia canadensis</i>	x		
24 Pearly everlasting	<i>Anaphalis margaritacea</i>	x		x
25 Blue flag iris	<i>Iris versicolor</i>	x		
26 Soft rush	<i>Juncus effusus</i>	x		x
27 Common milkweed	<i>Asclepias syriaca</i>	x		x
28 Fireweed	<i>Epilobium angustifolium</i>	x		x
29 Pale purple coneflower	<i>Echinacea pallida</i>	x	x	
30 Yellow coneflower	<i>Echinacea paradoxa</i>		x	
31 Common oats	<i>Avena sativa</i>			x
32 Beach grass	<i>Ammophila breviligulata</i>			x
33 Aster species	<i>Asteracea</i>			x
34 Bluejoint	<i>Calamagrostis canadensis</i>			x
35 Green bulrush	<i>Scirpus atrovirens</i>			x
36 Woolgrass	<i>Scirpus cyperinus</i>			x
37 Water plantain	<i>Alisma subcordatum</i>			x
38 Rice cutgrass	<i>Leersia oryzoides</i>			x
39 Hop sedge	<i>Carex lupulina</i>			x
40 Fox sedge	<i>Carex vulpinoidea</i>			x
41 Beggar ticks	<i>Bidens frondosa</i>			x
42 Mannagrass mix	<i>Glyceria spp.</i>			x
43 Boneset	<i>Eupatorium perfoliatum</i>	x		x
44 Smooth aster	<i>Symphyotrichum laeve</i>	x		x
45 Virgins bower	<i>Clematis virginiana</i>	x		x
46 Canada goldenrod	<i>Solidago canadensis</i>	x		x
47 Bottlebrush grass	<i>Hystrix patula</i>	x		x
48 Cheerful sunflower	<i>Helianthus laetiflorus</i>	x		
49 Red milkweed	<i>Asclepias incarnata</i>	x		
50 Big leaf aster	<i>Aster macrophyllus</i>	x		
51 Marsh marigold	<i>Caltha palustris</i>	x		
52 Vanilla sweetgrass	<i>Hierachloe odorata</i>	x		x
53 Blue-eyed grass	<i>Sisyrinchium angustifolium</i>	x		
54 Sweet flag	<i>Acorus calamus</i>	x		
55 Wild ginger	<i>Asarum canadense L.</i>	x		
56 Rough blazing star	<i>Liatris aspera</i>	x		
Shrub and Tree Species				
1 White cedar	<i>Thuja occidentalis</i>		x	
2 Northern red oak	<i>Quercus rubra</i>			x
3 Quaking aspen	<i>Populus tremuloides</i>			x
4 Red maple	<i>Acer rubrum</i>			x
5 White birch	<i>Betula papperifera</i>			x
6 Balsam fir	<i>Abies balsamea</i>			x
7 White pine	<i>Pinus strobus</i>			x
8 Sand bar willow	<i>Salix exigua</i>			x
9 Serviceberry	<i>Amelanchier arborea</i>			x
10 Mountain ash	<i>Pyrus americana</i>			x
11 Elderberry	<i>Sambucus canadensis</i>			x
12 Ninebark	<i>Physocarpus opulifolius</i>			x
13 Nannyberry	<i>Viburnum lentago</i>			x
14 Pin cherry	<i>Prunus pensylvanica</i>			x
15 Choke cherry	<i>Prunus virginiana</i>			x
16 American highbush cranberry	<i>Viburnum trilobum</i>			x
17 Red osier dogwood	<i>Cornus sericea baileyi</i>			x
18 Winterberry	<i>Ilex verticillata*</i>			x
19 Silky dogwood	<i>Cornus amomum</i>			x
20 Blueberry	<i>Vaccinium angustifolium</i>			x
21 White Spruce	<i>Picea glauca</i>			x

Methodologies

Site Prep: Soil for mounds and gardens was delivered in late spring and early summer of 2011. Maintenance/walking trails were installed in summer of 2011 and late summer of 2012. Additional gates for access were installed in fall 2011. Soil tilling, weed control and soil treatment were conducted in early fall 2011.

Planting: Seeding of cover crop of common oats and native seed on mounds and in seed plots were completed in late fall of 2011. Planting of young native plants grown in the KBIC greenhouse and local field-collected seed took place in the south garden during spring and summer of 2011 and more throughout spring and summer of 2012. To avoid invasive species encroachment throughout the project area, invasive weed control took place throughout the growing seasons of 2011 and 2012. Planting of trees and shrubs throughout the project area took place in June of 2012. Planting of the two garden areas was completed by KBIC Natural Resources Department personnel; plantings across the remainder of the project area were completed by Lake Superior Tree Farm personnel.

Boulders: Acquisition and placement of 98 boulders took place in fall of 2012 with the completion of boulder placement done by November 10, 2012. Boulders were acquired from KBIC lands on an opportunistic basis and 98 were able to be collected and placed by the end of the project period by KBIC Public Works Department.

Irrigation: Irrigation was installed in summer of 2011 and watering took place on the first three acres of planted area in 2011. An additional mobile, self-propelled unit was installed in June 2012 and operated through September of 2012 to irrigate the remainder of the project area. Wet conditions in spring 2012 delayed ability and need to start earlier. More wet conditions took place in September and October 2012 and therefore, irrigation was stopped.

Monitoring: Pre-treatment measures of plants took place on October 3, 2011 in 26 one-meter plots placed approximately 100 meters apart on a north-south transect across the project area (see map Appendix 3). Percent cover per species based on Braun-Blanquet Cover Abundance (BBCA) was recorded for each plot, as well as total percent cover and total percent bare ground using the same abundance classes. BBCA classes are as follows: (1= \leq 1, 2=1-5, 3=5-25, 4=25-50, 5=50-75, 6=75-95, 7=95-100). Pre-treatment plant monitoring was conducted by a professional contract botanist, Janet Marr who does plant inventory for KBIC on a multitude of projects.

Post-treatment monitoring of 29 one-meter mound plots (approximately 50% of the total mounds) and 26 one-meter seed plots took place between August 13 and August 23, 2012. Seed plots were placed approximately 100 meters apart on a north-south transect with a randomly placed start point (see map Appendix 3). Percent cover per species based on BBCA was recorded for each plot, as well as total percent cover and total percent bare ground using the same BBCA classes. Random numbers were used to select which mounds were surveyed and then the most representative section was used for the plot. Seed and mound plot measures were conducted by contracted botanist, Janet Marr with assistance from KBIC Natural Resources Department staff.

Percent survival of shrub and tree species was monitored on 40 ten-meter tree/shrub plots between August 20 and 23, 2012 (see map Appendix 3). Number of living and dead trees and shrubs were counted per species on each plot. Shrub and tree plot measures were conducted by KBIC Natural Resources Department staff with oversight and assistance from the contracted landscaper from Lake Superior Tree Farm who did the plantings.

Data summary

Pre-treatment summary:

The average overall percent cover class for pre-treatment plots was 5.0 (± 0.8 s.d.) signifying 50-75% cover and 3.2 (± 1.3 s.d.) average cover-class of bare ground signifying 5-25%. The average number of species detected per plot was 4.1 (± 1.7 s.d.). If moss coverage was not considered, the overall average cover was 3.1 (± 1.4 s.d.) signifying 5-25% of average herbaceous cover.

A total 10 species of plants were identified in all 26 one-meter pre-treatment survey plots. The species identified were alfalfa, unspecified grass species, birds-foot trefoil, unspecified moss species, unspecified clover species, cinquefoil, unspecified plantain species, hair grass, black medic, and yarrow. Alfalfa, grass, trefoil and moss were the most common species found at over 50% of the survey plots (Table 2).

Table 2. Average BBCA percent cover class and percent occurrence out of twenty-six 1 m² survey plots that each species was detected on the Sand Point project area during PRE-TREATMENT monitoring on October 3, 2011. (*BBCA cover classes are as follows: 1 = $\leq 1\%$, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-95%, 7 = 95-100%)

Common Name	Scientific Name	Average Cover Class*	No. Plots Detected (n=)	Percent Occurrence
Alfalfa	<i>Medicago sativa</i>	3.3	23	88.5
Grass spp.	<i>Poa spp.</i>	4.6	22	84.6
Birds-foot trefoil	<i>Lotus corniculata</i>	3.3	19	73.1
Moss spp.	<i>Bryophyta spp.</i>	3.0	16	61.5
Clover spp.	<i>Trifolium spp.</i>	1.8	9	34.6
Cinquefoil	<i>Potentilla recta</i>	1.9	8	30.8
Plantain spp.	<i>Plantago spp.</i>	1.5	4	15.4
Hair grass	<i>Deschampsia</i>	3.7	3	11.5
Black medic	<i>Medicago lupulina</i>	1.0	2	7.7
Yarrow	<i>Achillea millefolium</i>	2.0	1	3.8

Of the twenty-six pre-treatment survey plots 12 (46%) had grass species with cover estimates over 50%, 7 (27%) plots had alfalfa with cover estimates between 25-50%, and 9 had birds-foot trefoil cover estimates between 25-75%. Moss was found in 16 plots with an average percent cover of 5-25%.

First growing season SEED PLOT summary:

A total of 45 species of herbaceous plants were identified in the 26 seed plots surveyed and one unidentified species. The most common species were grass spp., clover spp., black-eyed susan, birds-foot trefoil, narrow-leaf plantain, and goldenrod spp. which were found in at least 50% of the plots (Table 3).

Table 3. Average BBCA percent cover class and percent occurrence out of twenty-six 1 m² surveyed SEED plots that each species was detected on the Sand Point project area during the first growing season (August 13-23, 2012) after seeding with native plants. (*BBCA cover classes are as follows: 1 = $\leq 1\%$, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-95%, 7 = 95-100%)

Common Name	Scientific Name	Average Cover Class*	No. Plots Detected (n=26)	Percent Occurrence
Grass spp	<i>Poaceae</i>	2.4	21	80.8
Blackeyed Susan	<i>Rudbeckia hirta</i>	1.4	16	61.5

Clover spp	<i>Trifolium spp</i>	2.7	16	61.5
Bird's-foot trefoil	<i>Lotus corniculatus</i>	1.0	15	57.7
Narrowleaf plantain	<i>Plantago lanceolata</i>	1.5	15	57.7
Goldenrod spp	<i>Solidago spp</i>	2.8	13	50.0
Oxeye Daisy	<i>Leucanthemum vulgare</i>	1.0	11	42.3
Aster	<i>Asteraceae</i>	3.0	10	38.5
Cockspur	<i>Echinochloa spiralis</i>	1.5	10	38.5
Canadian horseweed	<i>Conyza canadensis</i>	1.0	8	30.8
Lambsquarters	<i>Chenopodium album</i>	1.8	8	30.8
Common oat	<i>Avena sativa</i>	2.0	6	23.1
Plantain spp	<i>Plantago spp</i>	2.3	6	23.1
unknown	<i>UI</i>	2.0	6	23.1
Alfalfa	<i>Medicago sativa</i>	1.0	5	19.2
Black medick	<i>Medicago lupulina</i>	1.0	4	15.4
Parasol whitetop	<i>Doellingeria umbellata</i>	1.0	4	15.4
Common cinquefoil	<i>Potentilla simplex Michx.</i>	2.0	3	11.5
Witchgrass	<i>Panicum capillare</i>	2.0	3	11.5
Woodsorrel	<i>Oxalis</i>	2.6	3	11.5
bittercress	<i>brassicaceae</i>	1.0	2	7.7
Calico aster	<i>Symphyotrichum lateriflorum</i>	2.5	2	7.7
Hairy Cat's ear	<i>Hypochaeris radicata</i>	1.0	2	7.7
Moss spp	<i>Bryophyta</i>	1.8	2	7.7
Queen Anne's lace	<i>Daucus carota</i>	3.0	2	7.7
Sheep Sorrel	<i>Rumex acetosella</i>	2.2	2	7.7
stinkbells or	<i>agrestis</i>	1.0	2	7.7
Sulphur cinquefoil	<i>Potentilla recta</i>	2.8	2	7.7
Buttercup	<i>Ranunculus</i>	1.0	1	3.8
Cinquefoil	<i>Potentilla</i>	2.0	1	3.8
Common Selfheal	<i>Prunella vulgaris</i>	1.3	1	3.8
Crabgrass	<i>Digitaria</i>	2.0	1	3.8
Dandelion	<i>Taraxacum</i>	1.0	1	3.8
Elderberry	<i>Sambucus</i>	2.0	1	3.8
Evening primrose	<i>Oenothera biennis</i>	1.0	1	3.8
Goldentop	<i>Euthamia</i>	2.0	1	3.8
Northern mountain	<i>Sorbus decora</i>	2.0	1	3.8
Panic Grass	<i>Poaceae Panicum</i>	1.0	1	3.8
Prairie fleabane	<i>Erigeron strigosus</i>	1.0	1	3.8
Red clover	<i>Trifolium pratense</i>	1.0	1	3.8
Sedge	<i>Carex</i>	2.0	1	3.8
Smooth Blue aster	<i>Symphyotrichum laeve</i>	1.0	1	3.8
Strawberry	<i>Fragaria</i>	2.0	1	3.8
Timothy	<i>Phleum pratense</i>	1.0	1	3.8
Western Brackenfern	<i>Pteridium aquilinum</i>	1.7	1	3.8
Wild basil	<i>Clinopodium vulgare</i>	1.0	1	3.8

The average number of species detected per plot was 8.3 (± 3.0 s.d.). Average BBCA cover classes for all 26 seed plots was 4.8 (± 0.8 s.d.) signifying about 50% herbaceous cover and 3.7 (± 1.1 s.d.) cover class of bare ground signifying close to 25% bare ground. This is not much different in percent ground cover than pre-treatment conditions, but the diversity of species present doubled from 4.1 species found in pre-treatment plots to 8.3

species within the first growing season. Greater species diversity may be due in part to the source and quantity of soil brought on site for seed plots in addition to the planting of seed. A total 1,541 cubic yards of top soil was purchased from private farm property within 10 miles from the project area.

First growing season MOUND PLOT summary:

A total of 52 species of herbaceous plants (2 unidentified) and 5 shrubs (1 unidentified) were detected in 29 mound plots surveyed. The most common species were black-eyed susan, clover spp. , grass spp., oxeye daisy, narrow-leaf plantain, parasol whitetop, and goldenrod spp. which were found in over 50% of the plots (Table 4).

Table 4. Average BBCA percent cover class and percent occurrence out of twenty-nine 1 m² surveyed MOUND plots that each species was detected on the Sand Point project area during the first growing season (August 13-23, 2012) after seeding with native plants. (*BBCA cover classes are as follows: 1 = ≤1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-95%, 7 = 95-100%)

Common Name	Scientific Name	Average Cover Class*	No. Plots Detected (n=29)	Percent Occurrence
Blackeyed Susan	<i>Rudbeckia hirta</i>	2.9	26	89.7
Clover spp	<i>Trifolium spp</i>	1.9	26	89.7
Grass spp	Poaceae	1.9	22	75.9
Oxeye Daisy	<i>Leucanthemum vulgare</i>	3	22	75.9
Narrowleaf plantain	<i>Plantago lanceolata</i>	2.4	21	72.4
Parasol whitetop	<i>Doellingeria umbellata</i>	2	16	55.2
Goldenrod spp	<i>Solidago spp</i>	2.3	15	51.7
Cockspur grass	<i>Echinochloa</i>	2.3	11	37.9
Unknown	UI	1.1	10	34.5
Witchgrass	<i>Panicum capillare</i>	2.1	10	34.5
Common oat	<i>Avena sativa</i>	2	9	31.0
Black medick	<i>Medicago lupulina</i>	1.9	8	27.6
Chickweed	<i>Caryophyllaceae</i>	1	8	27.6
Lambsquarters	<i>Chenopodium album</i>	2.3	8	27.6
Plantain spp	<i>Plantago spp</i>	1.3	8	27.6
Canadian horseweed	<i>Conyza canadensis</i>	1.7	7	24.1
Unknown A	UI	1	7	24.1
Common tansy	<i>Tanacetum vulgare</i>	1.5	6	20.7
Bird's-foot trefoil	<i>Lotus corniculatus</i>	1.6	5	17.2
Canada goldenrod	<i>Solidago canadensis</i>	2.8	5	17.2
Queen Anne's lace	<i>Daucus carota</i>	1.6	5	17.2
Timothy	<i>Phleum pratense</i>	1.2	5	17.2
Virginia strawberry	<i>Fragaria virginiana</i>	1.4	5	17.2
Bittercress	<i>Brassicaceae</i>	1.5	4	13.8
Blueberry	Vaccinium	1.5	4	13.8
Cinquefoil	<i>Potentilla</i>	2	4	13.8
Speedwell	<i>Veronica</i>	1.3	4	13.8
Common mullein	<i>Verbascum thapsus</i>	1.7	3	10.3
Common yarrow	<i>Achillea millefolium</i>	1.3	3	10.3
Fleabane	<i>Erigeron</i>	1.7	3	10.3
Prostrate knotweed	<i>Polygonum avicular</i>	2	3	10.3

Sheep Sorrel	<i>Rumex acetosella</i>	1.3	3	10.3
Common Selfheal	<i>Prunella vulgaris</i>	1	2	6.9
Curly dock	<i>Rumex crispus</i>	2.5	2	6.9
Flat-top goldentop	<i>Euthamia graminifolia</i>	1	2	6.9
Northern mountain ash	<i>Sorbus decora</i>	1.5	2	6.9
St. Johnswort	<i>Hypericum perforatum</i>	1	2	6.9
Unknown shrub	<i>UI</i>	1.5	2	6.9
Winged pigweed	<i>Cycloloma atriplicifolium</i>	2.5	2	6.9
Woodsorrel	<i>Oxalis</i>	1	2	6.9
Yellow nutsedge	<i>Cyperus esculentus</i>	2.5	2	6.9
Alfalfa	<i>Medicago sativa</i>	1	1	3.4
Aster	<i>Asteraceae</i>	2	1	3.4
Chokecherry	<i>Prunus virginiana</i>	1	1	3.4
Crabgrass	<i>Digitaria</i>	3	1	3.4
Dandelion	<i>Taraxacum</i>	1	1	3.4
Evening primrose	<i>Oenothera</i>	2	1	3.4
Field pussytoes	<i>Antennaria neglecta</i>	1	1	3.4
Goatsbeard	<i>Tragopogon</i>	1	1	3.4
Hawthorn	<i>Crataegus</i>	2	1	3.4
Mint	<i>Lamiaceae</i>	1	1	3.4
Panicgrass	<i>Panicum</i>	1	1	3.4
Sagebrush	<i>Artemisia</i>	2	1	3.4
Sedge	<i>Carex</i>	1	1	3.4
Serviceberry	<i>Amelanchier</i>	5	1	3.4
Spotted knapweed	<i>Centaurea stoebe</i>	3	1	3.4
Strawberry	<i>Fragaria</i>	1	1	3.4

The average number of species detected per mound plot was 11.4 species (± 2.7 s.d.). Average BBCA cover class for all 29 mound plots was 4.7 (± 0.9 s.d.) signifying about 50% herbaceous cover and 3.9 (± 0.9 s.d.) cover class of bare ground signifying close to 25% bare ground. This is not much different in overall percent ground cover than pre-treatment conditions, but the diversity of species present was nearly triple compared to the number of species found in pre-treatment plots (4.1 species). Greater species diversity may be due in part to the source and quantity of soil brought on site for the mounds in addition to the planting of seed. A total 3,484 cubic yards of mound soil was acquired from Tribal property within 5 miles from the project area.

First growing season TREE/SHRUB summary:

A total 13,380 trees and/or shrubs were planted across the project area and included 19 different species with one additional species and one unidentified being detected during surveys (Table 5). Approximately 398 trees and/or shrubs were planted per acre. There was an overall 89.8% survival (± 9.8 s.d.) of trees/shrubs as measured in 40 total 10 m² survey plots.

Table 5. Average percent survival and percent occurrence out of forty 10 m² TREE/SHRUB plots surveyed that each species was detected on the Sand Point project area during the first growing season (August 13-23, 2012) after planting with native trees and shrubs.

Common Name	Scientific name	Total Counted	Percent Survival	Percent Occurrence (n=40)
Nanny Berry	<i>Viburnum lentago</i>	221	88.7	50
Serviceberry	<i>Amelanchie</i>	102	88.2	35
Beaked Hazelnut	<i>Corylus cornuta</i>	71	90.1	32.5
Choke Cherry	<i>Prunus virginiana</i>	59	69.5	30
Ninebark	<i>Physocarpus opulifolius</i>	67	94.0	30
Elderberry	<i>Sambucus</i>	54	96.3	27.5
Red Osier Dogwood	<i>Cornus sericea</i>	54	100.0	27.5
Red Maple	<i>Acer rubrum</i>	9	88.9	22.5
Eastern White Pine	<i>Pinus strobus</i>	6	100.0	15
Mountain Ash	<i>Sorbus</i>	10	90.0	12.5
Balsam Fir	<i>Abies balsamea</i>	3	66.7	7.5
Northern Red Oak	<i>Quercus rubra</i>	3	100.0	7.5
Quaking Aspen	<i>Populus tremuloides</i>	17	100.0	7.5
Winterberry	<i>Ilex verticillata</i>	4	100.0	7.5
Blueberry	<i>Vaccinium angustifolium</i>	7	100.0	5
Silky Dogwood	<i>Cornus obliqua</i>	3	100.0	5
Red Oak	<i>Quercus rubra</i>	2	100.0	5
Sand Bar Willow	<i>Salix interior Rowlee</i>	4	100.0	5
Unidentified	UI	1	100.0	2.5
White Spruce	<i>Picea glauca</i>	1	100.0	2.5
Willow spp.	<i>Salix spp.</i>	1	100.0	2.5

The most common species detected were nanny berry, service berry, beaked hazel, choke cherry, and ninebark which were found in at least thirty percent of the total 40 plots surveyed (Table 5). Mature trees and shrubs will provide wind break, shade from glaring sun, and microclimate areas more suitable for plants to grow.

Challenges, events, and experiences:

There was a delay in locating the most appropriate mound soil, so the installation of the mounds, seed plots and planting of cover crop was delayed later than anticipated so the cover crop did not grow as robust as anticipated. Many of the native species of seed planted require two growing seasons to reach maturity and so results (colorful wildflowers) will be more measurable and obvious in the second growing season and beyond.

The northern end of the project area was challenging. Beach grass was planted along the edge of the stamp sand where the cap begins and shrubs were more densely planted at the northern end to counter act the strong constant winds that blow sand back over the capped area. The wind is stronger on the north end due to the proximity of the mouth of Keweenaw Bay and less protection provided from land which is further distant across the bay. We also placed more boulders on the north end to reduce wind erosion where wind-blown sand was most evident.

The project area has been visited by various educational and environmental groups to view the process and progress of restoring a natural area after long term deposition of mining waste material. We estimate that a minimum of 400 people have toured the project area from various groups that include a KBIC Mining Forum group, KBIC Summer Youth, Keweenaw Bay Ojibwa Community College student groups, Michigan Tribal Environmental Group (MTEG), Michigan Technological University students, Houghton/Hancock Alternative School, Hancock Middle School, and Northern Michigan University student groups.

Conclusions and recommendations:

Overall, the biodiversity of Sand Point has increased dramatically in only one growing season. Although, overall percent cover of the land has not changed significantly yet (Figure 1), the number and quality of species available for wildlife has improved dramatically. Following several growing seasons, we anticipate the total percent herbaceous cover will increase above the pre-treatment level. Average numbers of species detected in pre-plant survey plots compared to post- planting survey plots have more than doubled. Total species of plants detected from pre-treatment plots to the first growing season has increased by five times more (Figure 2).

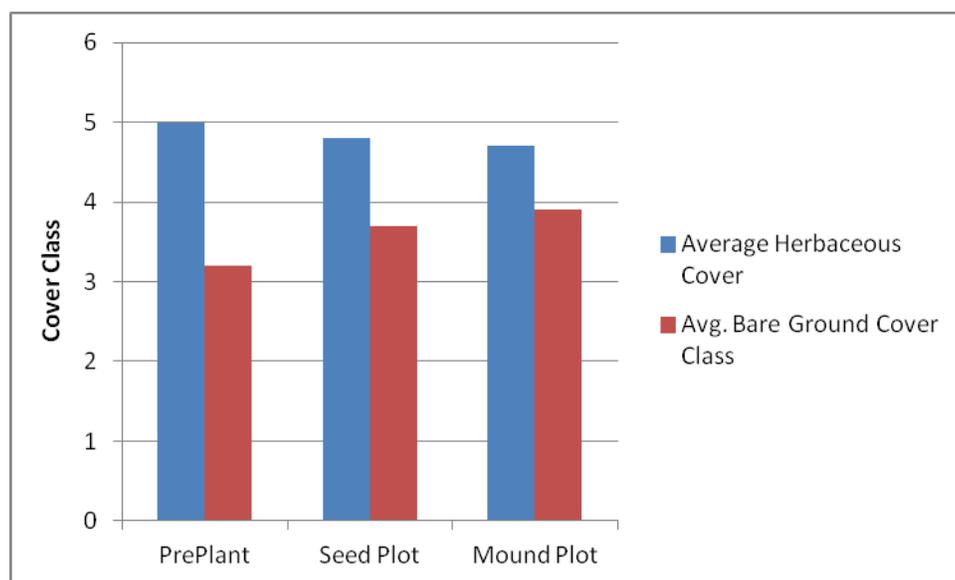


Figure 1. Average overall percent herbaceous cover and bare ground at pre-treatment monitoring plots measured in 2011 compared to post-planting seed plots and mound plots measured in 2012.

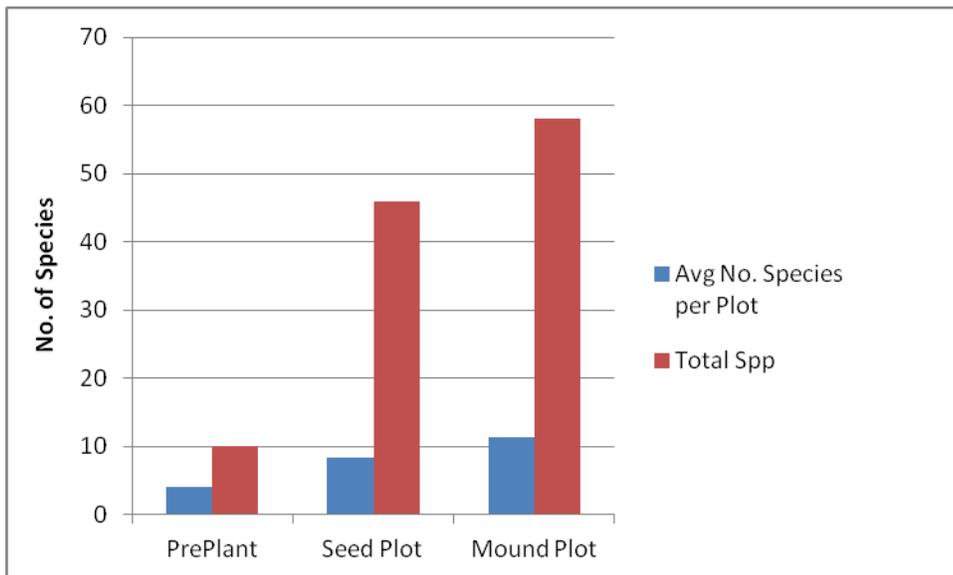


Figure 2. Total number of species and average number of species per monitoring plots for pre-treatment plots measured in 2011 compared to seed plots and mound plots measured in 2012.

Of the total 114 herbaceous species detected within the project area, both within and outside the official monitoring plots (Appendix 2), as many as 48 species could be considered non-native. This does not necessarily mean they are or will become troublesome and invasive. We intend to focus eradication efforts on non-native species that tend to be most invasive by outcompeting and taking over large areas. Most notably we will target spotted knapweed, Canada thistle, bull thistle, and tansy to begin eradication efforts. While we proceed with control efforts we will monitor and control other non-natives as deemed necessary.

There has been anecdotal evidence to an increase in song birds. Additionally, frogs, turtles, geese and deer were observed regularly. Some damage has been caused by wildlife to young plants, trees and shrubs (e.g. tangled, pushed, eaten etc.). Bird surveys are scheduled to be completed in spring 2013 and compared with baseline data from 2009 surveys.

Sand Point is a sacred traditional area for the Keweenaw Bay Indian Community. The results of this GLRI restoration project will be appreciated and cared for in perpetuity. KBIC Natural Resources Department has a plants program that includes native plant propagation and invasive species control. Sand Point will continue to be the number one priority area to maintain within this program. Sand Point is an area that community members gather for annual traditional powwows, collect medicinal plants, host annual events for youth, and spend leisure time camping and fishing. The opportunity to improve a degraded brown field area back into a lush natural environment rich in plants and wildlife habitat has been a gift to future generations of the Keweenaw Bay Indian Community, the general public and local birds and wildlife.

Maps and Photo Documentation:

Please see Appendix for photo documentation and maps (cd of photos has also been sent)

APPENDIX 1. Sixty-seven herbaceous plant species and twenty-two tree/shrub species detected from **all monitoring plots** on the project site that include pre-treatment surveys 2011 and post-treatment surveys 2012.

Herbaceous Plants		Herbaceous Plants	
Common Name	Scientific	Common Name	Scientific
Alfalfa	<i>Medicago sativa</i>	Sedge	<i>Carex spp</i>
Aster	<i>Asteraceae</i>	Sheep Sorrel	<i>Rumex acetosella</i>
Bird's-foot trefoil	<i>Lotus corniculatus</i>	Smooth Blue aster	<i>Symphyotrichum laeve</i>
bittercress	<i>Brassicaceae</i>	Speedwell	<i>Veronica</i>
Black medick	<i>Medicago lupulina</i>	Spotted knapweed	<i>Centaurea stoebe</i>
Blackeyed Susan	<i>Rudbeckia hirta</i>	St. Johnswort	<i>Hypericum perforatum</i>
Blueberry	<i>Vaccinium</i>	Stinkbells or milkvetch	<i>agrestis</i>
Buttercup	<i>Ranunculus</i>	Strawberry	<i>Fragaria</i>
Calico aster	<i>Symphyotrichum lateriflorum</i>	Sulphur cinquefoil	<i>Potentilla recta</i>
Canada goldenrod	<i>Solidago canadensis</i>	Timothy	<i>Phleum pratense</i>
Canadian horseweed	<i>Conyza canadensis</i>	Virginia strawberry	<i>Fragaria virginiana</i>
Chickweed	<i>Caryophyllaceae</i>	Western Brackenfern	<i>Pteridium aquilinum</i>
Chokecherry	<i>Prunus virginiana</i>	Wild basil	<i>Clinopodium vulgare</i>
Cinquefoil	<i>Potentilla</i>	Winged pigweed	<i>Cycloloma atriplicifolium</i>
Clover spp	<i>Trifolium spp</i>	Witchgrass	<i>Panicum capillare</i>
Cockspur	<i>Echinochloa spiralis</i>	Woodsorrel	<i>Oxalis</i>
Cockspur grass	<i>Echinochloa</i>	Yellow nutsedge	<i>Cyperus esculentus</i>
Common cinquefoil	<i>Potentilla simplex</i> Michx.		
Common mullein	<i>Verbascum thapsus</i>	Shrubs & Trees	
Common oat	<i>Avena sativa</i>	Common Name	Scientific
Common Selfheal	<i>Prunella vulgaris</i>	Balsam Fir	<i>Abies balsamea</i>
Common tansy	<i>Tanacetum vulgare</i>	Beaked Hazelnut	<i>Corylus cornuta</i>
Common yarrow	<i>Achillea millefolium</i>	Blueberry	<i>Vaccinium angustifolium</i>
Crabgrass	<i>Digitaria</i>	Blueberry	<i>Vaccinium</i>
Curly dock	<i>Rumex crispus</i>	Choke Cherry	<i>Prunus virginiana</i>
Dandelion	<i>Taraxacum</i>	Dogwood	<i>Cornus</i>
Elderberry	<i>Sambucus</i>	Eastern White Pine	<i>Pinus strobus</i>
Evening primrose	<i>Oenothera biennas</i>	Elderberry	<i>Sambucus</i>
Field pussytoes	<i>Antennaria neglecta</i>	Mountain Ash	<i>Sorbus</i>
Flat-top goldentop	<i>Euthamia graminifolia</i>	Nanny Berry	<i>Viburnum lentago</i>
Fleabane	<i>Erigeron</i>	Ninebark	<i>Physocarpus opulifolius</i>
Goatsbeard	<i>Tragopogon</i>	Northern Red Oak	<i>Quercus rubra</i>
Goldenrod spp	<i>Solidago spp</i>	Quaking Aspen	<i>Populus tremuloides</i>
Goldentop	<i>Euthamia</i>	Red Maple	<i>Acer rubrum</i>
Grass spp	<i>Poaceae</i>	Red Oak	<i>Quercus rubra</i>
Hairy Cat's ear	<i>Hypochaeris radicata</i>	Redosier Dogwood	<i>Cornus sericea</i>
Hawthorn	<i>Crataegus</i>	Sand Bar Willow	<i>Salix interior</i> Rowlee
Lambsquarters	<i>Chenopodium album</i>	Serviceberry	<i>Amelanchie</i>
Mint	<i>Lamiaceae</i>	Silky Dogwood	<i>Cornus obliqua</i>
Narrowleaf plantain	<i>Plantago lanceolata</i>	White Spruce	<i>Picea glauca</i>
Northern mountain ash	<i>Sorbus decora</i>	Willow	<i>Salix</i>
Oxeye Daisy	<i>Leucanthemum vulgare</i>	Winterberry	<i>Ilex verticillata</i>
Panic Grass	<i>Poaceae Panicum</i>		
Panicgrass	<i>Panicum</i>	Moss spp	<i>Bryophyta</i>
Parasol whitetop	<i>Doellingeria umbellata</i>		
Plantain spp	<i>Plantago spp</i>		
Prairie fleabane	<i>Erigeron strigosus</i>		
Prostrate knotweed	<i>Polygonum avicular</i>		
Queen Anne's lace	<i>Daucus carota</i>		
Red clover	<i>Trifolium pratense</i>		
Sagebrush	<i>Artemisia</i>		

Appendix 2 Continued. [* = non-native; ? = some species are natives and others are non-native] Species names came from Voss & Reznicek (2012). Field Manual of Michigan Flora.

Herbaceous Plants		
?	<i>Prunella vulgaris</i>	heal-all or common self-heal
	<i>Pteridium aquilinum</i>	bracken fern
	<i>Rudbeckia hirta</i>	black-eyed susan
*	<i>Rumex acetosella</i>	sheep-sorrel
*	<i>Rumex crispus</i>	curly dock
	Santalaceae	geocaulon or bastard-toadflax
	<i>Schizachyrium scoparium</i>	little blue stem
	<i>Scirpus atrovirens</i>	green bulrush
	<i>Scirpus cyperinus</i>	woolgrass
	<i>Scutellaria galericulata</i>	common skullcap
	<i>Solidago canadensis</i>	Canada goldenrod
	<i>Solidago</i> sp.	goldenrod
?	<i>Stellaria</i> sp.	chickweed or stitchwort
	<i>Symphyotrichum laeve</i>	smooth blue aster
	<i>Symphyotrichum lateriflorum</i>	calico aster
*	<i>Tanacetum vulgare</i>	common tansy
*	<i>Taraxacum officinale</i>	dandelion
	<i>Thalictrum dasycarpum</i>	tall meadow rue
*	<i>Tragopogon</i> sp.	goat's beard
	<i>Trientalis borealis</i>	star-flower
*	<i>Trifolium hybridum</i>	alsike clover
*	<i>Trifolium pratense</i>	red clover
*	<i>Trifolium</i> sp.	clover
*	<i>Verbascum thapsus</i>	mullein
?	<i>Verbena</i> sp.	vervain
?	<i>Veronica</i> spp.	speedwell
	Wild seed mix	Wild seed mix
		false sunflower
		purple coneflower
		yellow coneflower

APPENDIX 3. Map of Sand Point Restoration site showing location of monitored plant plots, 2011 and 2012.



Pre-treatment May 2011 South End



August 2012 same location on South End



Pre-treatment stop facing south, May 2011.



Same location facing south in September 2012 (irrigation hose visible)



Pre-treatment photo from May 2011



Same location in June 2012



Pre-treatment photo stop May 2011



Same location June 2012, notice seed plots, mound plots, shrubs and trees.



Pre-treatment photo stop May 2011



Same location in June 2012, note the serpentine seed plot, distant mound plots, trees and shrubs

