



# Bioremediation of Hydrocarbon Contaminated Soils

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# Overview – on site biological treatment

- Assessing effectiveness
- Optimization
- Revegetation
- Restoring natural cycling (e.g., nitrogen)
- Choosing valid approach to management of treatment
- Case study – bench trial for well sites in Alberta

# Site





# Excavation





# Control



# Amended

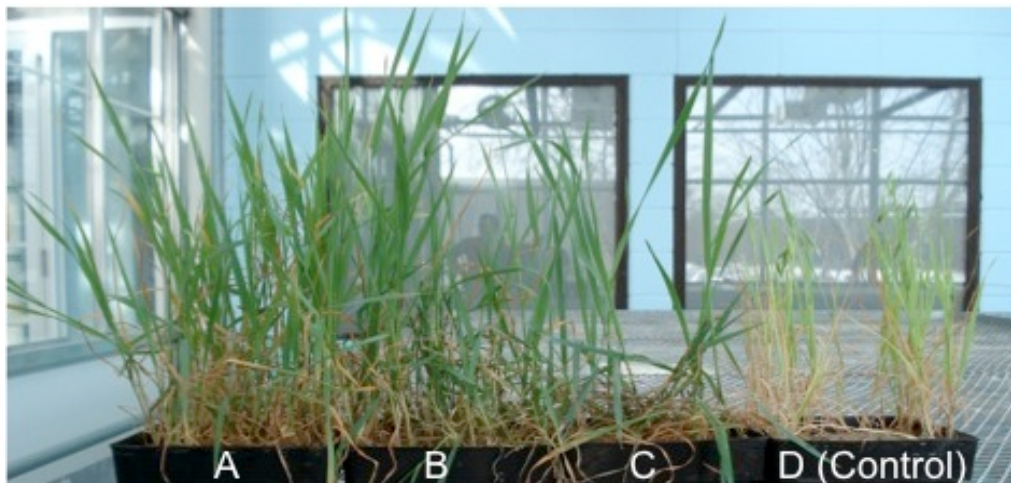
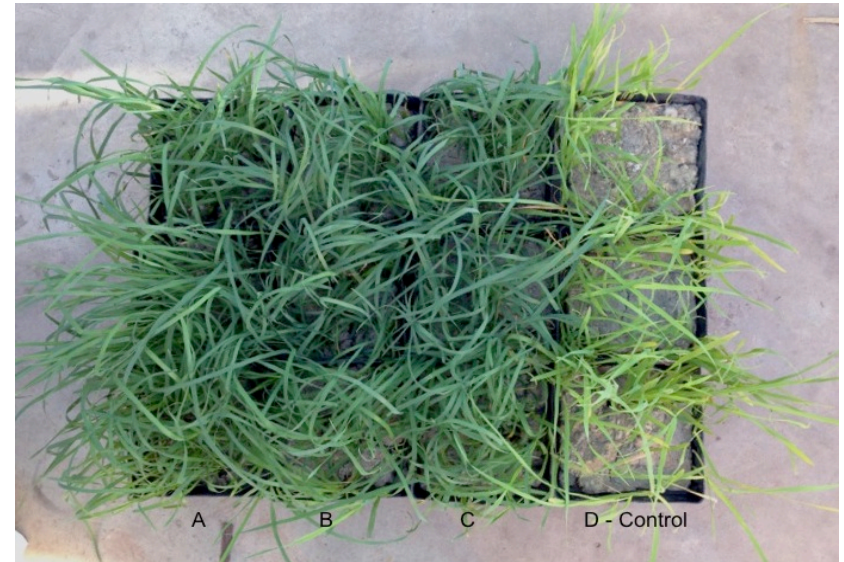


# Timeline Summary

Date		Event	Experiment
Day 0	January 14	Trial started	Bags, Micro
Day 2	January 16	Bags opened to allow some air transfer, yet retain moisture	Bags, Micro
Day 8	January 22	Plant trial started	Planted
Day 14	January 28	Stem counts on plant trial	Planted
Day 21	February 4	Stem counts on plant trial	Planted
Day 28	February 12	Stem counts on plant trial	Planted
Day 30	February 13	Analytical	Bags, Micro
Day 50	March 5	Bags mixed thoroughly and allowed to air dry	Bags
Day 60	March 15	Analytical on one set of air dried samples, remaining replicates rehydrated	Bags, Micro
Day 91	April 15	Analytical	Bags, Micro
Day 109	May 3	Analytical on plant trial soils	Planted, Micro
Day 110	May 4	Bags put into freezer	Bags, Micro
Day 112	May 6	Bags removed from freezer	Bags, Micro
Day 140	June 3	Test plant uptake of metals	Planted
Day 150	June 14	Leach Test	Bags and Planted
Day 150	June 14	Analytical on sample B post-freezing	Bags, Micro

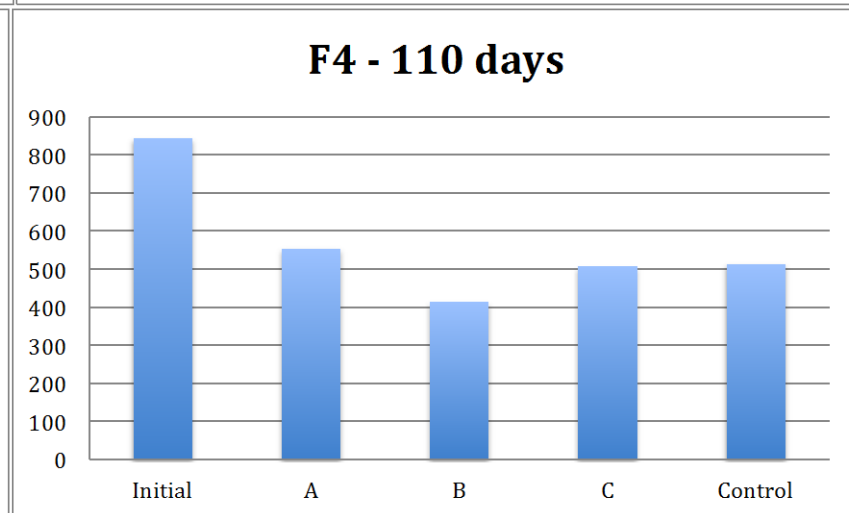
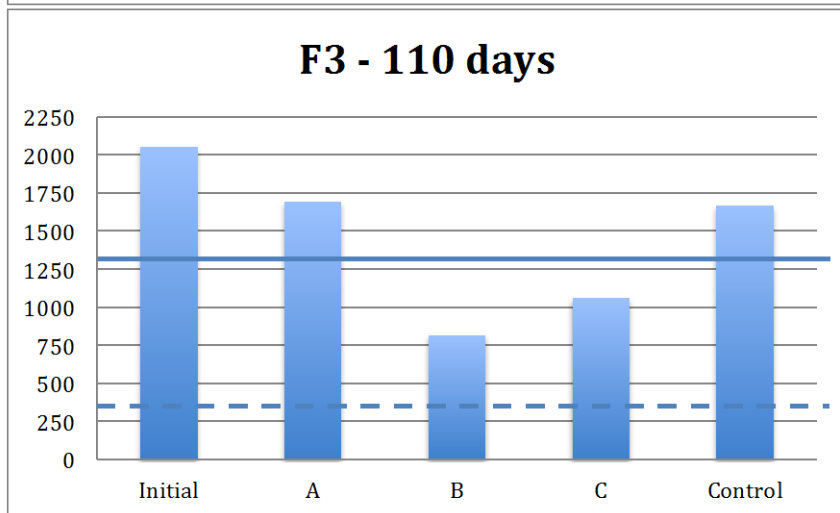
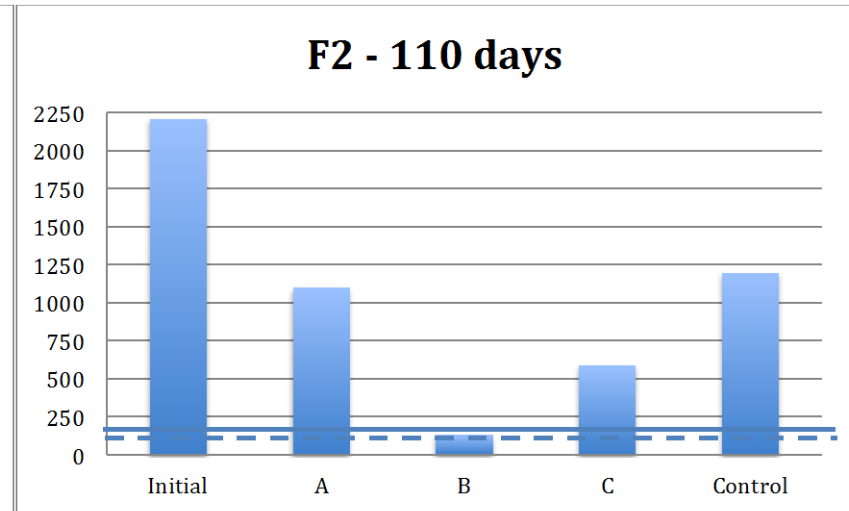
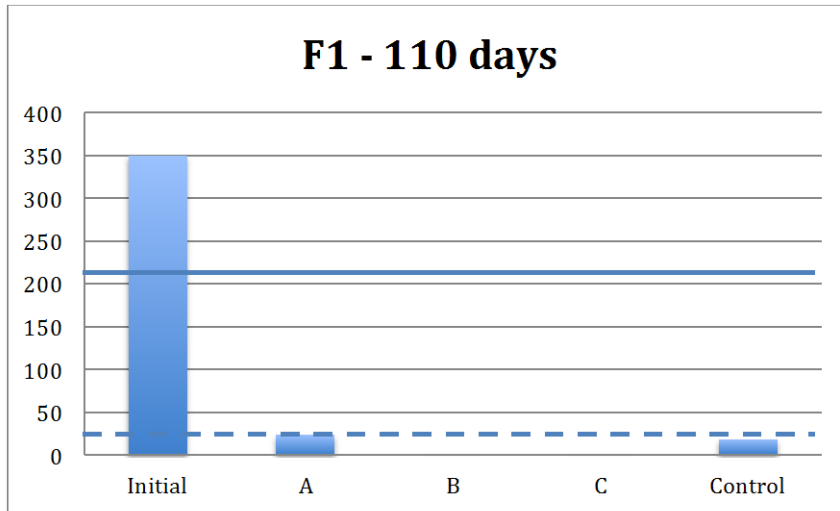


# Germination and plant health



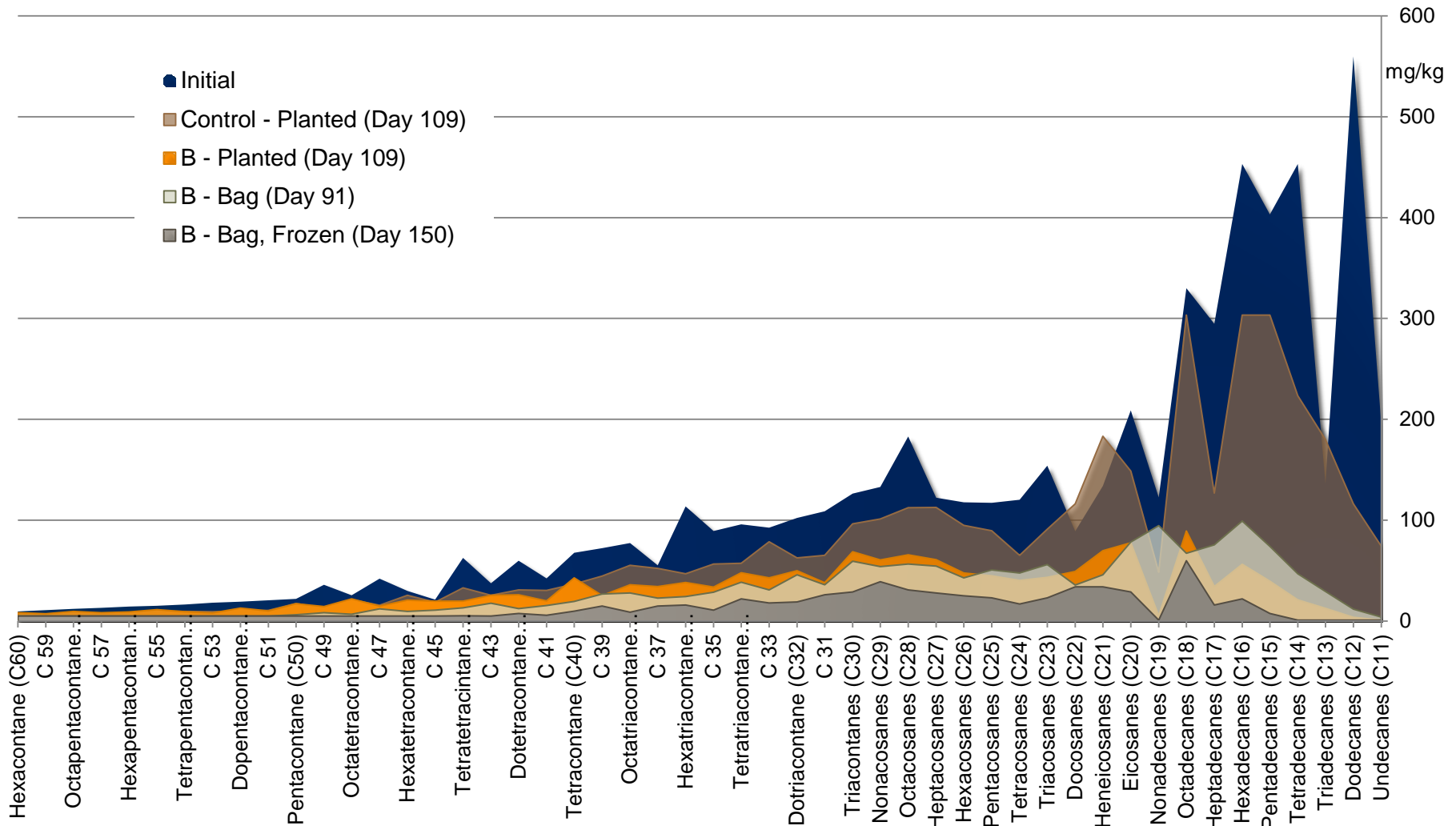
Treatment	% germination at 4 weeks
A	85
B	78
C	70
D (untreated)	65

# Results





# C11-C60 Treatment B vs Control

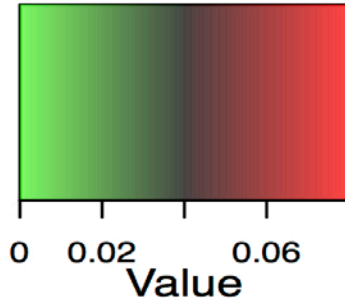


# Treated B compared to Baseline, Untreated, and AT1 Guidelines

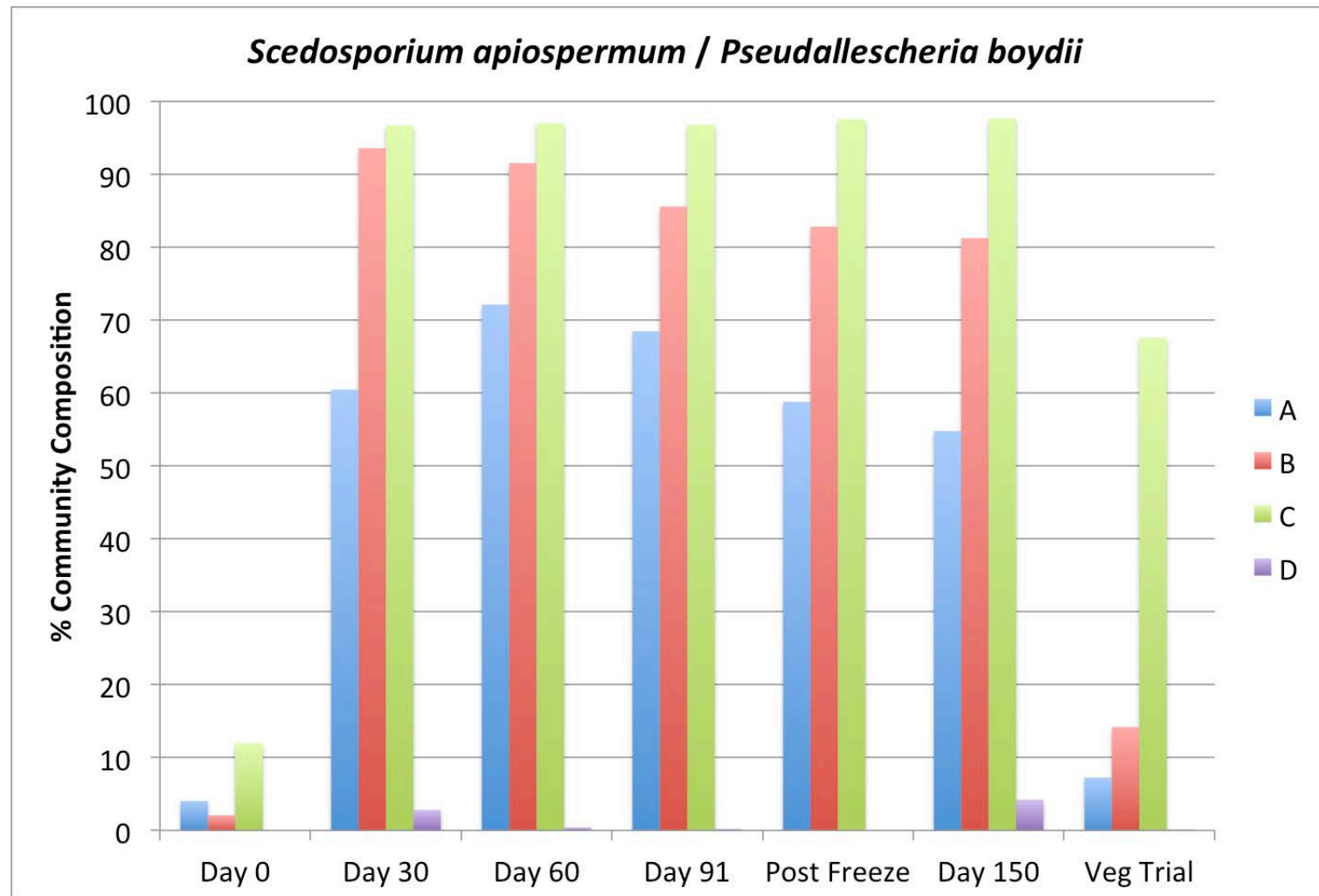
Parameter	Units	AT1 guidelines		Initial	Control "D"	Treatment "B"			% degradation	
		Fine	Coarse		Bag, mixed (91 days)	Bag, mixed (91 days)	Planted (109 days)	Bag, not mixed, freeze/thaw (150 days)	Average, B treatments	Control, untreated
<b>Ext. Pet. Hydrocarbon</b>										
F2 (C10-C16 Hydrocarbons)	mg/kg	150	130	2210	4467	268	131	30	94%	None
F3 (C16-C34 Hydrocarbons)	mg/kg	1300	300	2053	4333	820	817	400	67%	None
F4 (C34-C50 Hydrocarbons)	mg/kg	5600	2800	843	1367	262	413	110	69%	None
<b>Polycyclic Aromatics</b>										
Fluoranthene	mg/kg	0.032	0.04	0.09	0.11	0.02	0.02	0.01	80%	None
Fluorene	mg/kg	0.29	0.34	*1.04	1.27	*0.064	0.05	ND	96%	None
Naphthalene	mg/kg	0.016	0.02	4.83	2.40	0.34	0.31	0.27	94%	50%
Phenanthrene	mg/kg	0.051	0.06	1.75	3.30	0.25	0.25	0.10	89%	None
Pyrene	mg/kg	0.034	0.04	0.17	0.33	0.05	0.05	0.02	76%	None
<b>Volatiles</b>										
Benzene	mg/kg	0.046	0.07	0.06-0.6	0.06-0.6	0.04	0.07	0.07	88%	None
Toluene	mg/kg	0.52	0.49	0.14	0.10	0.05	0.10	0.10	41%	30%
Ethylbenzene	mg/kg	0.11	0.21	1.64	0.22	0.08	0.15	0.15	92%	86%
Xylenes (Total)	mg/kg	15	12.00	9.50	1.19	0.30	0.58	0.59	95%	87%
F1 (C6-C10) - BTEX	mg/kg	210	24	342	167	13	ND	ND	96%	51%



### Color Key

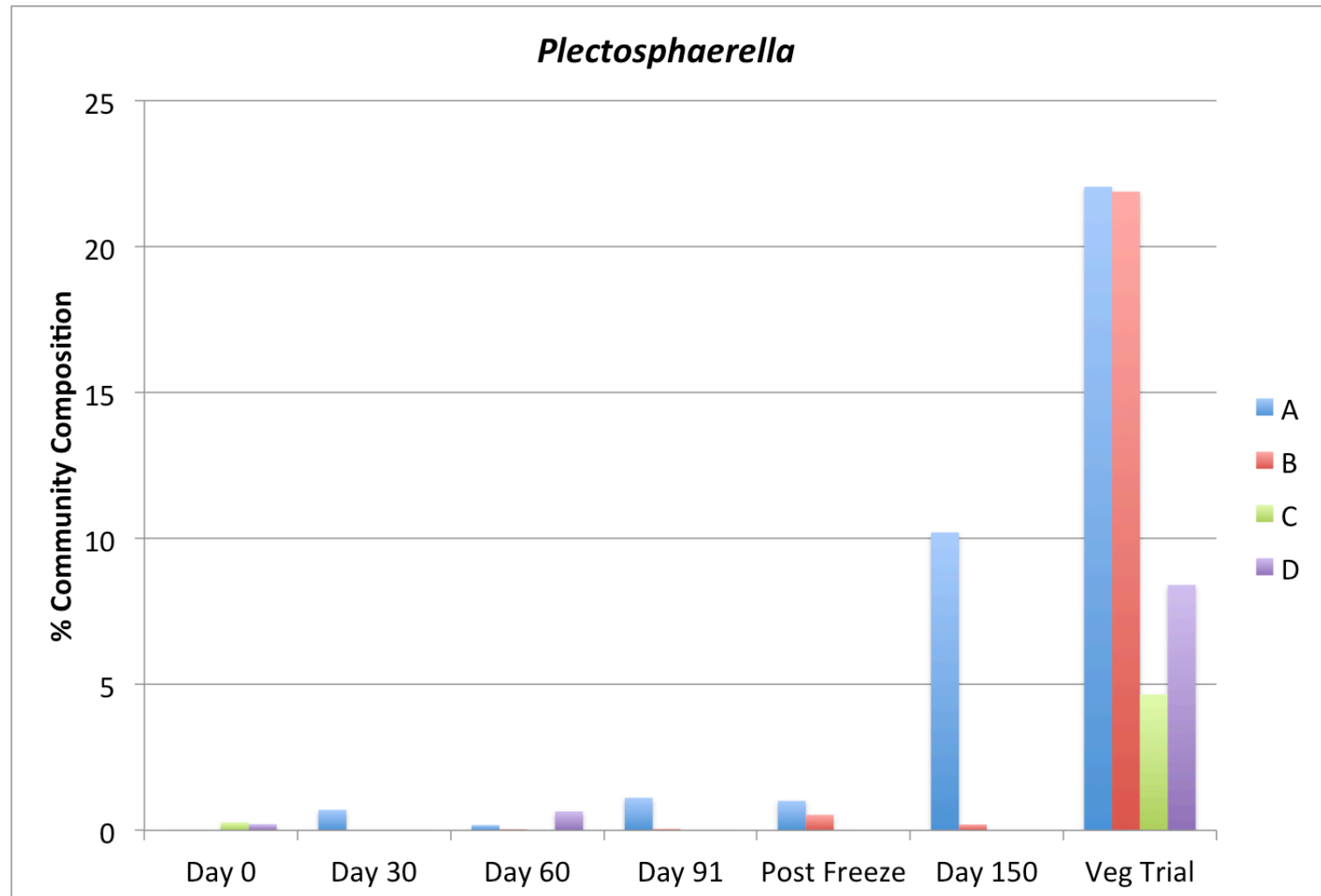


# Key players

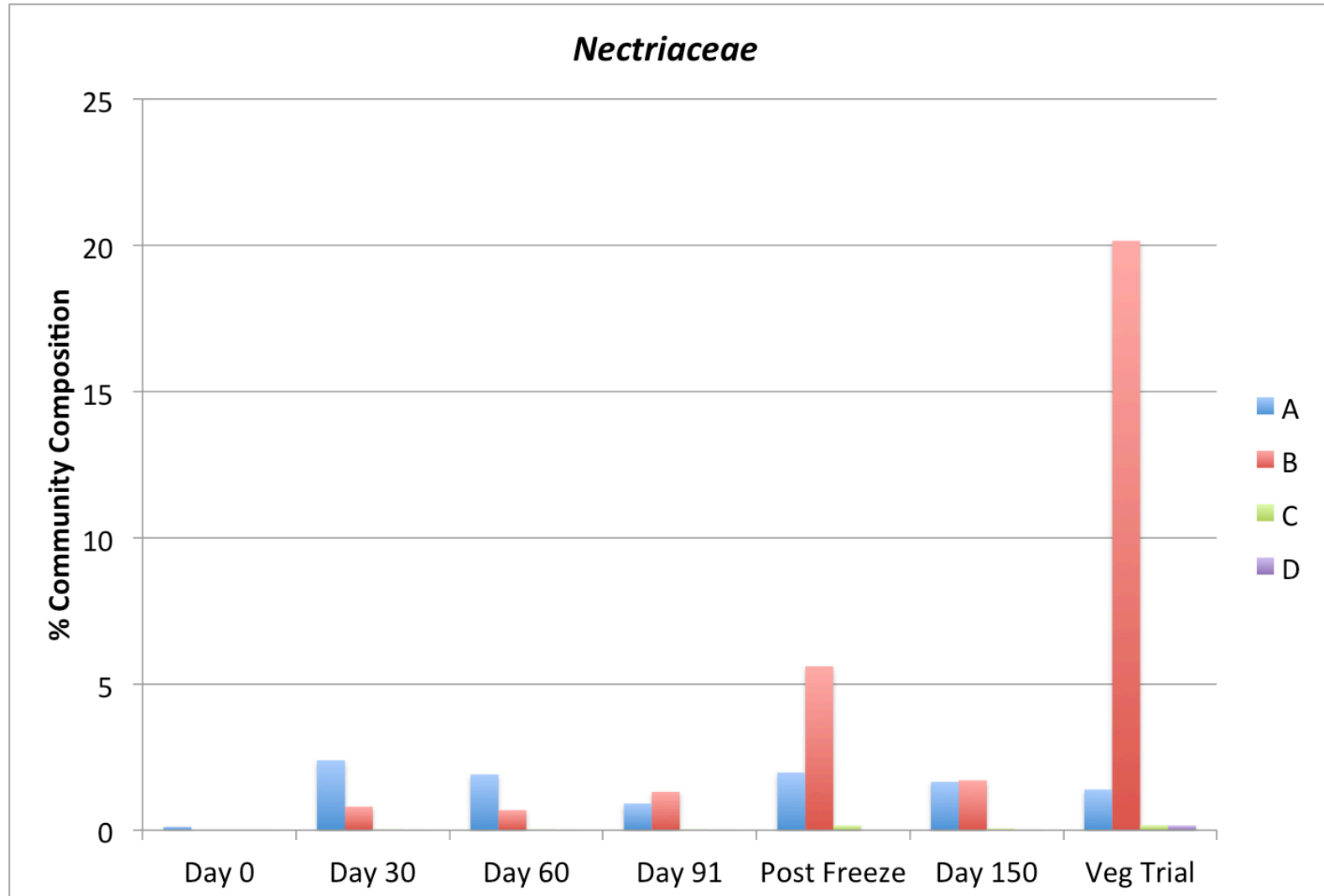




# Of interest?



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# Findings

- Composition of remediation blend affects remediation and revegetation
- Microbial profiling can assist in determining best practices and site-specific needs
- Fungi was key in remediation
  - Major implications
    - co-metabolites needed
    - mechanisms of degradation
    - effects of drying

# Thank-You



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