Reuse Options for Cladophora Biomass

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Table 1. Total elemental analysis results from *Cladophora* collected at Door County, WI. (ND = not detected, DWB = dry weight basis)

Total Elemental Analysis				
Parameter tested	**Result**	**Units (DWB)**	**Category 1**	**Category 2**
Arsenic (As)	ND	mg/Kg	x	
Beryllium (Be)	ND	mg/Kg	x	
Boron (B)	63	mg/Kg	x	
Acenaphthene	ND	ug/Kg	x	
Acenaphthylene	ND	ug/Kg	x	
Anthracene	ND	ug/Kg	x	
Benzo (a) anthracene	ND	ug/Kg	x	
Benzo (a) pyrene	ND	ug/Kg	x	
Benzo (b) fluoranthene	ND	ug/Kg	x	
Benzo (g,h,i) perylene	ND	ug/Kg	x	
Benzo (k) fluoranthene	ND	ug/Kg	x	
Chrysene	ND	ug/Kg	x	
Dibenzo (a,h) anthracene	ND	ug/Kg	x	
Fluoranthene	ND	ug/Kg	x	
Fluorene	ND	ug/Kg	x	
Indeno (1,2,3-cd) pyrene	ND	ug/Kg	x	
Methyl-1-Naphthalene	ND	ug/Kg	x	
Methyl-2-Naphthalene	ND	ug/Kg	x	
Naphthalene	ND	ug/Kg	x	
Phenanthrene	ND	ug/Kg	x	
Pyrene	ND	ug/Kg	x	

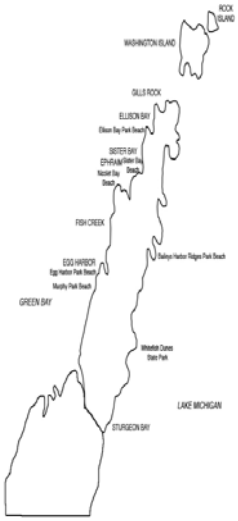
Table 2 Total elemental analysis results from *Cladophora* collected at Racine, WI.
(ND = not detected, DWB = dry weight basis)

Total Elemental Analysis				
Parameter tested	**Result**	**Units (DWB)**	**Category 1**	**Category 2**
Arsenic (As)	ND	mg/Kg	x	
Beryllium (Be)	ND	mg/Kg	x	
Boron (B)	1100	mg/Kg	x	
Acenaphthene	ND	ug/Kg	x	
Acenaphthylene	ND	ug/Kg	x	
Anthracene	ND	ug/Kg	x	
Benzo (a) anthracene	ND	ug/Kg	x	
Benzo (a) pyrene	ND	ug/Kg	x	
Benzo (b) fluoranthene	ND	ug/Kg	x	
Benzo (g,h,i) perylene	ND	ug/Kg	x	
Benzo (k) fluoranthene	ND	ug/Kg	x	
Chrysene	ND	ug/Kg	x	
Dibenzo (a,h) anthracene	ND	ug/Kg	x	
Fluoranthene	ND	ug/Kg	x	
Fluorene	ND	ug/Kg	x	
Indeno (1,2,3-cd) pyrene	ND	ug/Kg	x	
Methyl-1-Naphthalene	ND	ug/Kg	x	
Methyl-2-Naphthalene	ND	ug/Kg	x	
Naphthalene	ND	ug/Kg	x	
Phenanthrene	ND	ug/Kg	x	
Pyrene	ND	ug/Kg	x	

Category 1 refers to industrial byproducts to contain less than the concentration stated in the WI Dept. of Natural Resources NR538 (Beneficial Use of Industrial Byproducts) code.
Data compliments of Amy Vanden heuval

Table 3. BTUs/lb for *Cladophora* samples taken from different locations in WI. BTUs/lb of different tree species calculated from seasoned cord weight and BTUs/cord.

Cladophora		Tree Species			
Sample Location	**BTU/lb**	**Hardwoods**	**Cord Weight (lbs)**	**BTUs/Cord (millions)**	**BTUs/lb**
Whitefish Dunes (1)	4825	Black Ash	2,992	19.1	6384
Whitefish Dunes (2)	4999	White Ash	3,689	23.6	6397
Whitefish Dunes (3)	3974	Red Oak	3,757	24	6388
Racine	5548	Beech	3,757	24	6388
Whitefish Bay	4088	White Birch	3,179	20.3	6386
Lily Bay	3373	Grey Birch	3,179	20.3	6386
Bailey's Harbor	5847	YellowBirch	3,689	23.6	6397
Lakeside	1526	Paper Birch	3,179	20.3	6386
Anclam	2982	Red Maple	2,924	18.7	6395
		Soft Maple	2,924	18.7	6395
		White Elm	3,052	19.5	6389
		AmericanElm	3,052	19.5	6389
		Sugar Maple	3,757	24	6388
		Softwoods			
		White Cedar	1,913	12.2	6377
		Eastern White Pine	2,236	14.3	6395
		Western White Pine	2,236	14.3	6395
		Ponderosa Pine	2,380	15.2	6387
		Balsam Fir	2,236	14.3	6395



Data compliments of Amy Vanden Heuval

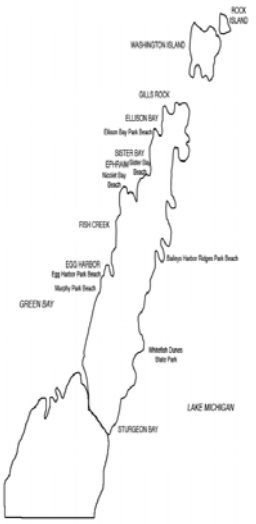
Objective: To use a composting system to test if *Cladophora* can be used as an alternative product for compost.

To be used in vegetable and flower gardens; therefore diverting the biomass from area landfills

Test Site: Village of Ephraim Wastewater Treatment Plant

Treatments:

- 100% *Cladophora*
- 50% *Cladophora*/50% Wood Chips
- 75% *Cladophora*/25% Wood Chips
- 25% *Cladophora*/75% Wood Chips



Parameters

- Weight
- Volume
- Temperature
- pH
- Nitrogen
- Phosphorus
- Potassium

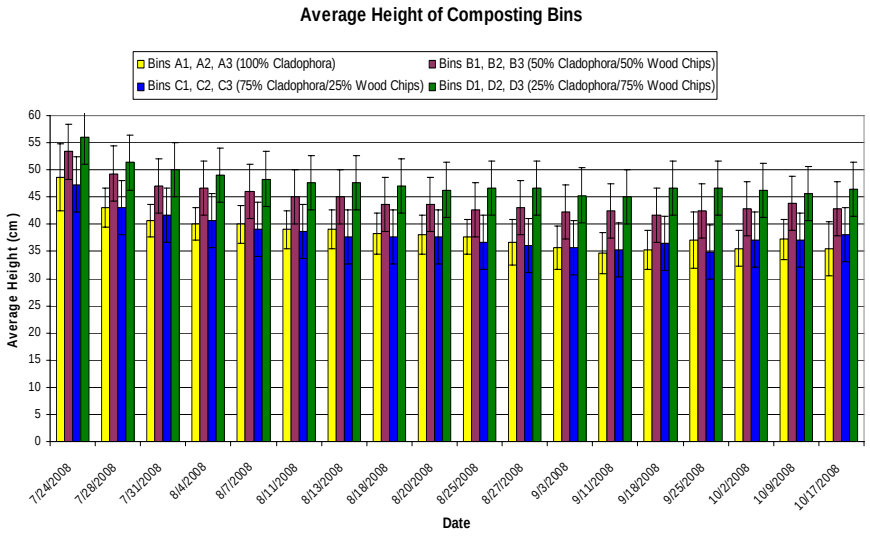


Figure 1: Volume change of compost bins based on differences in height of compost between initial and final measurements.

Table 4: Change in Weight of compost bins determined by avg. differences between initial and final weights.

Compost Bin #	Avg. Initial Weight (lbs)	Avg. Final Weight (lbs)	Avg. Difference (lbs)
A1 thru A3	1411	807	604
B1 thru B3	982	724	258
C1 thru C3	559	450	110
D1 thru D3	428	420	8

A Bins: 100% *Cladophora;*
B Bins: 50% *Cladophora*/50% Wood Chips;
C Bins: 75% *Cladophora*/25% Wood Chips;
D Bins: 25% *Cladophora*/75% Wood Chips

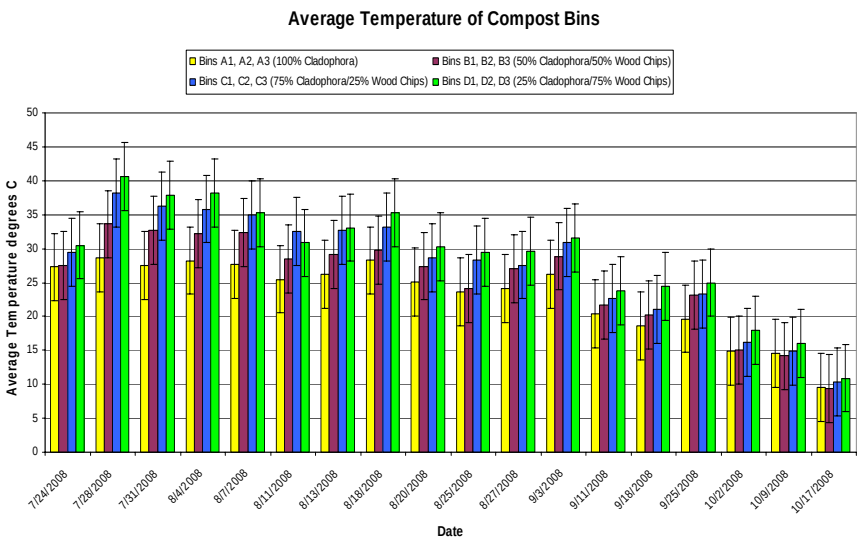


Figure 2: Average temperature of compost bins from initial to final sampling.

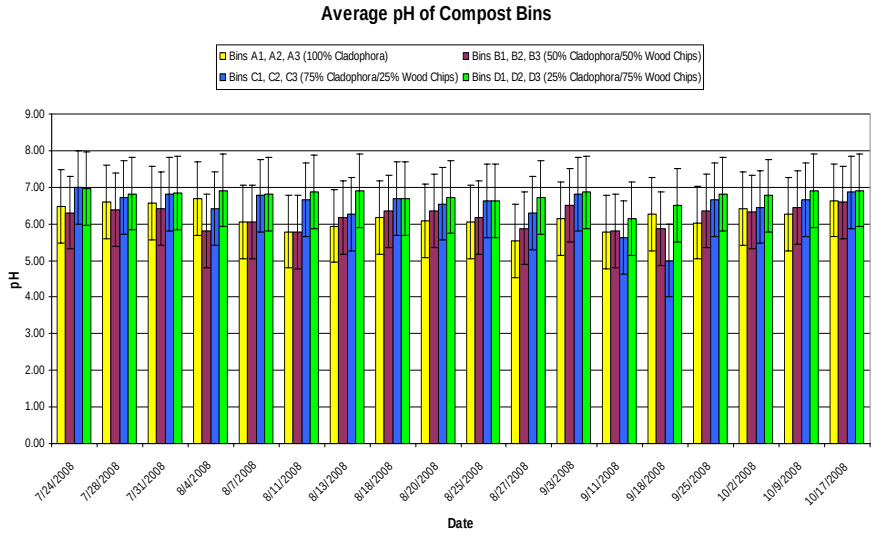


Figure 3: Average pH of compost bins from initial to final sampling.

Table 5: Analysis of raw material used in composting system.

Raw Material	TKN (ppm)	NH_4-N (ppm)	NO_3-N (ppm)	Total Inorganic N (ppm)	Total Organic N (ppm)
Cladophora (avg. of 2 samples)	**11,350**	**359.48**	**3.81**	**363**	**10,986**
Wood Chips (avg. of 2 samples)	**1750**	**25.59**	**5.24**	**31**	**1719**

Table 6: Analysis of raw material used in composting system.

Raw Material	Available P (ppm)	Total P (ppm)	Available K (ppm)	Total K (ppm)
Cladophora (avg. of 2 samples)	**5.5**	**550**	**366**	**1250**
Wood Chips (avg. of 2 samples)	**20**	**300**	**267**	**2000**

TKN: Total Kjeldahl Nitrogen
NH4-N: Ammonium
NO3-N: Nitrate
P: Phosphorus
K: Potassium

Table 7: Initial analysis of composting samples for organic and inorganic nitrogen.

Compost Bin	Avg. TKN (ppm)	Avg. NH_4-N (ppm)	Avg. NO_3-N (ppm)	Avg. Total Inorganic N (ppm)	Avg. Total Organic N (ppm)
Bins A1 thru A3	11,500	544.75	7.07	549.46	10,950.5
Bins B1 thru B3	4,200	170.40	21.33	191.73	4008. 3
Bins C1 thru C3	5,733	283.84	57.22	321.98	5411.4
Bins D1 thru D3	3,933	83.66	14.32	97.98	3835.4

Table 8: Final analysis of composting samples for organic and inorganic nitrogen.

Compost Bin	Avg. TKN (ppm)	Avg. NH_4-N (ppm)	Avg. NO_3-N (ppm)	Avg. Total Inorganic N (ppm)	Avg. Total Organic N (ppm)
Bins A1 thru A3	9675	167.92	368.68	536.6	9138.4
Bins B1 thru B3	4366.7	57.85	176.31	234.2	4132.5
Bins C1 thru C3	4133.3	29.40	4.18	32.2	4101.1
Bins D1 thru D3	3800	15.24	8.05	20.6	3779.4

A Bins: 100% Cladophora; B Bins: 50% Cladophora/50% Wood Chips; C Bins: 75% Cladophora/25% Wood Chips; D Bins: 25% Cladophora;75% Wood Chips

Table 9: Initial concentrations of phosphorus and potassium from compost samples.

Compost Bin	Available P (ppm)	Total P (ppm)	Available K (ppm)	Total K (ppm)
Bins A1 thru A3	9	443	393	1052
Bins B1 thru B3	4	222	443	592
Bins C1 thru C3	4	293	366	887
Bins D1 thru D3	21	315	550	1553

Table 10: Final concentrations of phosphorus and potassium from compost samples.

Compost Bin	Available P (ppm)	Total P (ppm)	Available K (ppm)	Total K (ppm)
Bins A1 thru A3	5	425	272	1200
Bins B1 thru B3	3	267	203	800
Bins C1 thru C3	5	333	335	1133
Bins D1 thru D3	19	333	341	1267

A Bins: 100% Cladophora; B Bins: 50% Cladophora/50% Wood Chips; C Bins: 75% Cladophora/25% Wood Chips; D Bins: 25% Cladophora;75% Wood Chips

Can *Cladophora* biomass be pelletized and be burned in pellet stoves, etc. as an alternative heat source?

Cladophora was evaluated by "Renewafuel" for thermal potential

Results:

•Thermal potential of 7792 BTU's (moisture and ash free)

•Thermal potential of 4239 BTU's (some moisture and not ash free)

•Too high in ash to be used as a primary combustible material, but may be used as a secondary combustible material

Summary

•*Cladophora* may be used for home or municipal composting systems.

•The 75% *Cladophora* to 25% wood chip mixture makes the preferred composting system.

• Inorganic Nitrogen was in high enough concentration to make good compost.

• Not much difference seen in potassium and phosphorus concentrations from initial samples to final samples.

•*Cladophora* may have the potential to be used as a secondary combustible material or additive to primary combustible material.

Future Research

•Can *Cladophora* be used as an additive with cow manure generated from mega farms to produce methane?

•Can *Cladophora* be used as an additive with wastewater treatment sludge to produce methane?

•Can *Cladophora* be used as an alternative when other seasonal waste products are not available?

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