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Visualizing Algae Production Potential in Canada

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The current modeling strategy

Waste water treatment plant and CO_2 sources data

Nutrient availability & locations for wwtp plants & CO_2 sources in British Columbia, Alberta, Southern Ontario, &Nova Scotia.

User defined model parameters

Mass balance related

Algae Molecular Composition per Atom P

Adjust numbers in blue. Default for C, N, P is "Redfield ratio". Default for H and O compared to C from Bayless? et al (need citation).

P O N C H

1 59 16 106 191

If nitrogen load data are available, or phosphorous load data are available, but not both:

- (•) Assume missing constituent is unlimited
- ( ) Do not calculate productivity potential for that WWTP

Algal Nutrient Uptake Efficiencies:

Nitrogen	80 %
Phosporous	80 %
Carbon	80 %

0 % 20 % 40 % 60 % 80 % 100 %

Max distance to move CO2

0 20 40 60 80 100

0 km

Average Solar Resource by Region

Alberta	4,393 MJ/m²/yr
Nova Scotia	4,393 MJ/m²/yr
Southern Ontario	4,937 MJ/m²/yr

Default values estimated by visual inspection of Plate 12B of Hydrological Atlas of Canada. Canada Dept of Fisheries & the Env. , Atmospheric Env. Service, 1975

S Ontario: 115-120 Alberta & N Scotia: 100-110 KCal/cm2,

Photon transmission % by region

Alberta	75 %
Nova Scotia	85 %
Southern Ontario	85 %

% Photons not lost to reflection. Default values based on extrapolation from Figure 4 in Weyer, Bush, Darzins, and Willson 2010

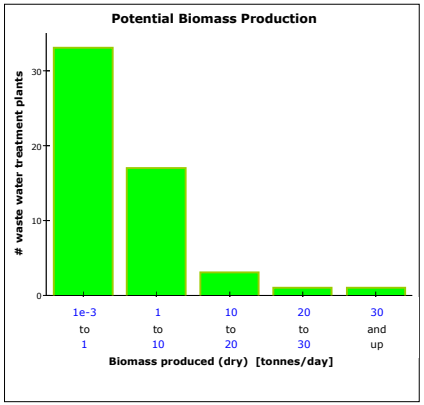
Algae and environment specific parameters

Photon utilization efficiency	45 %
Photosynth. quantum requirement	8
Chemical energy in CH2O	480 KJ/mol
Biomass accumulation efficiency	50 %
Biomass energy content	22 KJ/g
Oil content of algal cells	40 %
Algal oil density	918 kg/m³

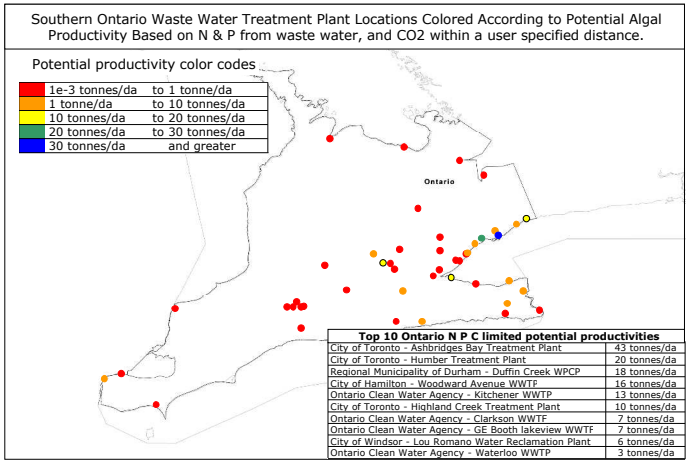
Parameters and default values based on Weyer, Bush, Darzins, and Willson 2010 "Theoretical Maximum Algal Oil Production"

Energy related

Visualization



Southern Ontario Waste Water Treatment Plant Locations Colored According to Potential Algal Productivity Based on N & P from waste water, and CO2 within a user specified distance.



Top 10 Ontario N P C limited potential productivities	
City of Toronto - Ashbridges Bay Treatment Plant	43 tonnes/da
City of Toronto - Humber Treatment Plant	20 tonnes/da
Regional Municipality of Durham - Duffin Creek WPCP	18 tonnes/da
City of Hamilton - Woodward Avenue WWTP	16 tonnes/da
Ontario Clean Water Agency - Kitchener WWTP	13 tonnes/da
City of Toronto - Highland Creek Treatment Plant	10 tonnes/da
Ontario Clean Water Agency - Clarkson WWTF	7 tonnes/da
Ontario Clean Water Agency - GE Booth lakeview WWTF	7 tonnes/da
City of Windsor - Lou Romano Water Reclamation Plant	6 tonnes/da
Ontario Clean Water Agency - Waterloo WWTP	3 tonnes/da

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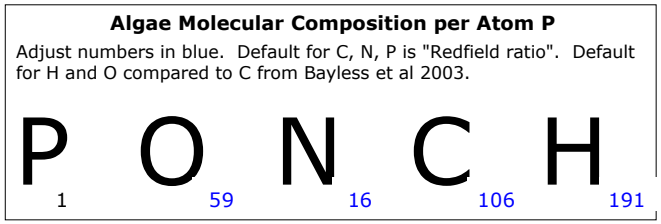
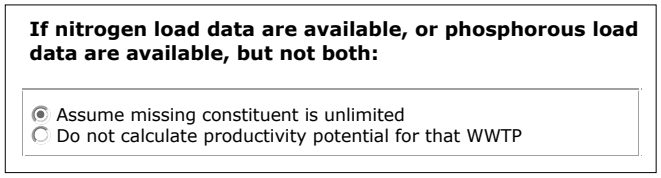
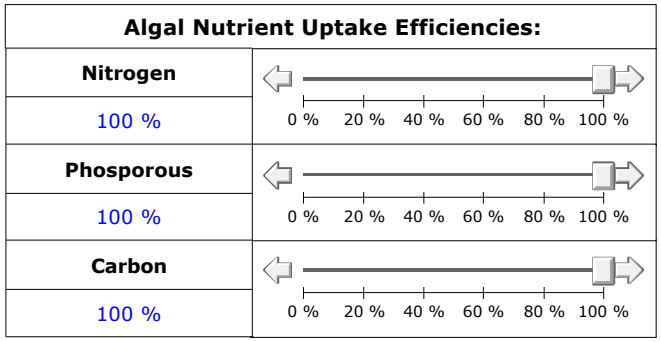
PONCH: a dynamic visualization tool

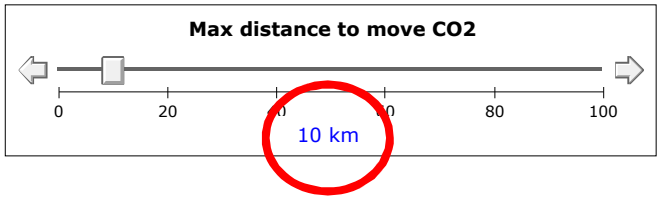
Mass balance:

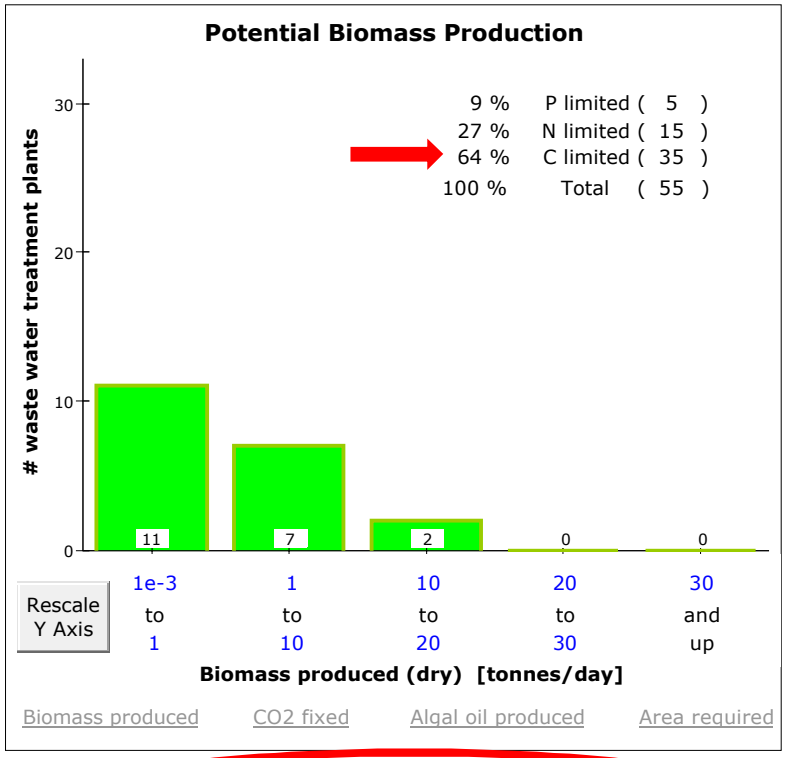
Model evaluates nutrients available at all waste water treatment plants including CO2 within a user defined radius of each.

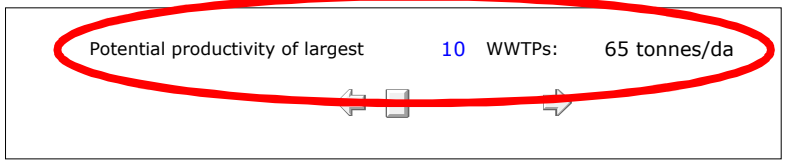












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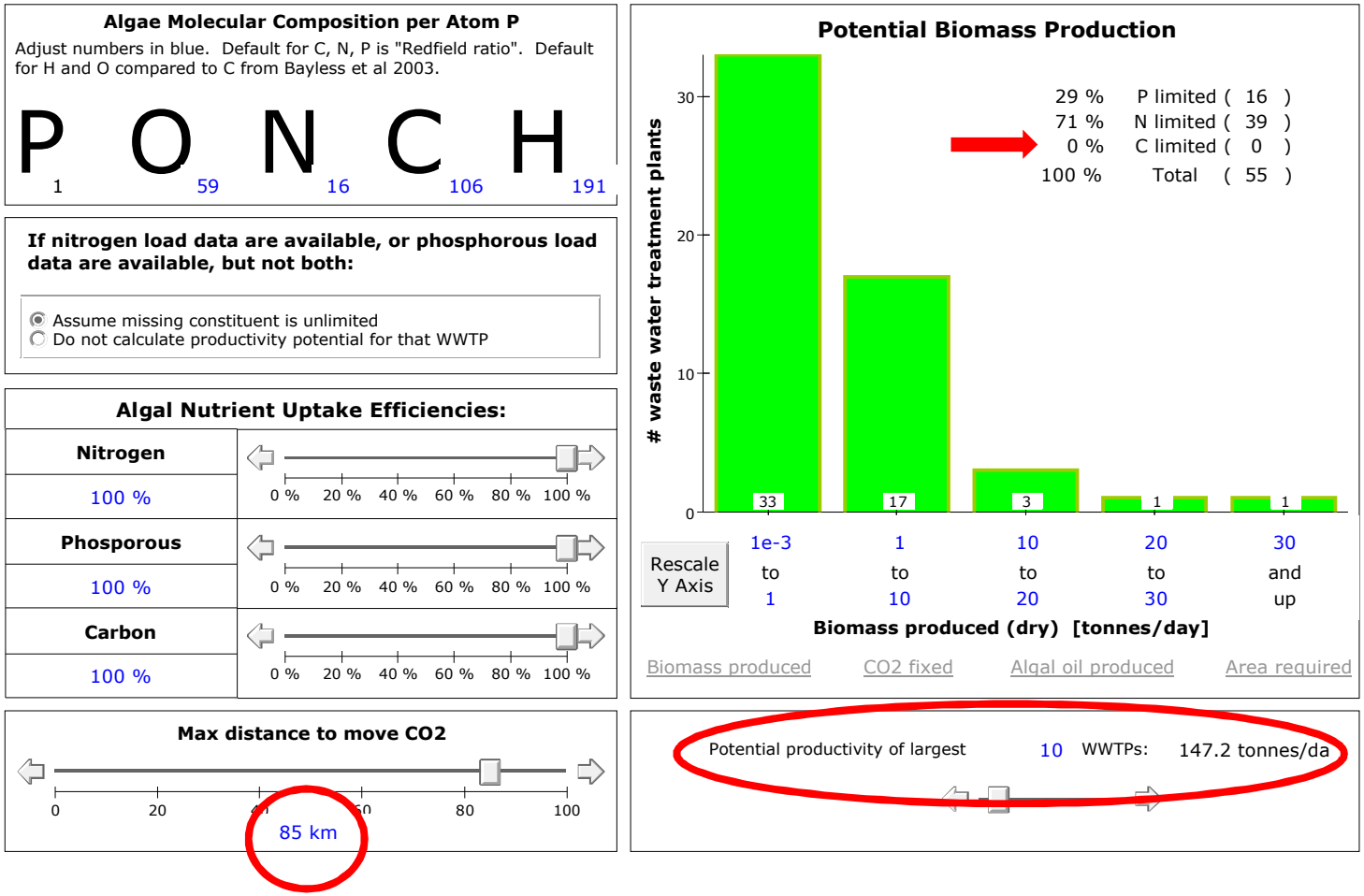

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Spatial Visualization

Southern Ontario Potential Algal productivity

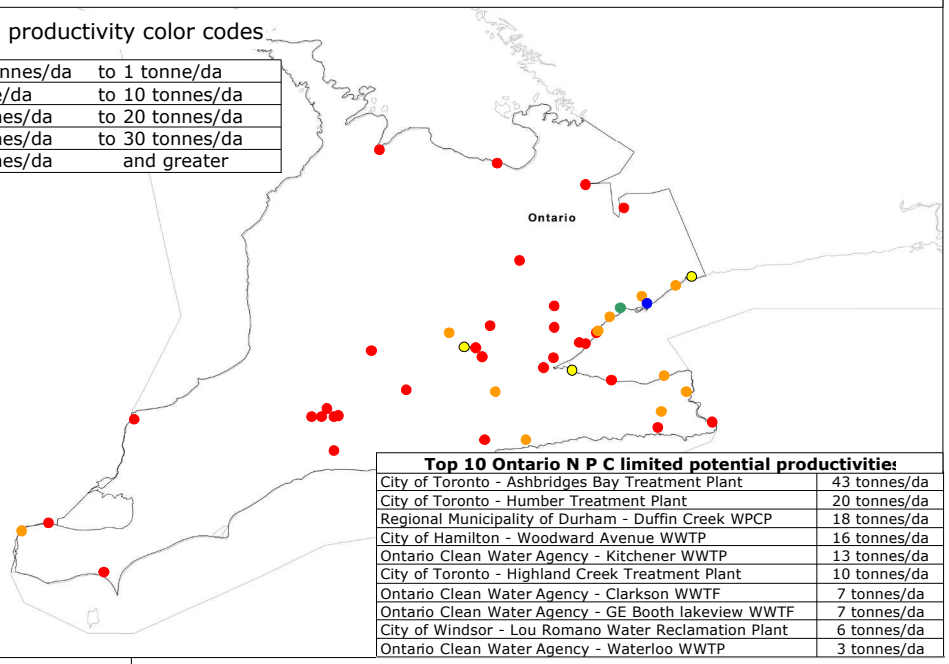
Using CO_2 sources within 85 km:

Using CO_2 sources within 10 km:

Southern Ontario Waste Water Treatment Plant Locations Colored According to Potential Algal Productivity Based on N & P from waste water, and CO2 within a user specified distance.

Potential productivity color codes

1e-3 tonnes/da	to 1 tonne/da
1 tonne/da	to 10 tonnes/da
10 tonnes/da	to 20 tonnes/da
20 tonnes/da	to 30 tonnes/da
30 tonnes/da	and greater



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Southern Ontario Waste Water Treatment Plant Locations Colored Accor
Productivity Based on N & P from waste water, and CO2 within a user

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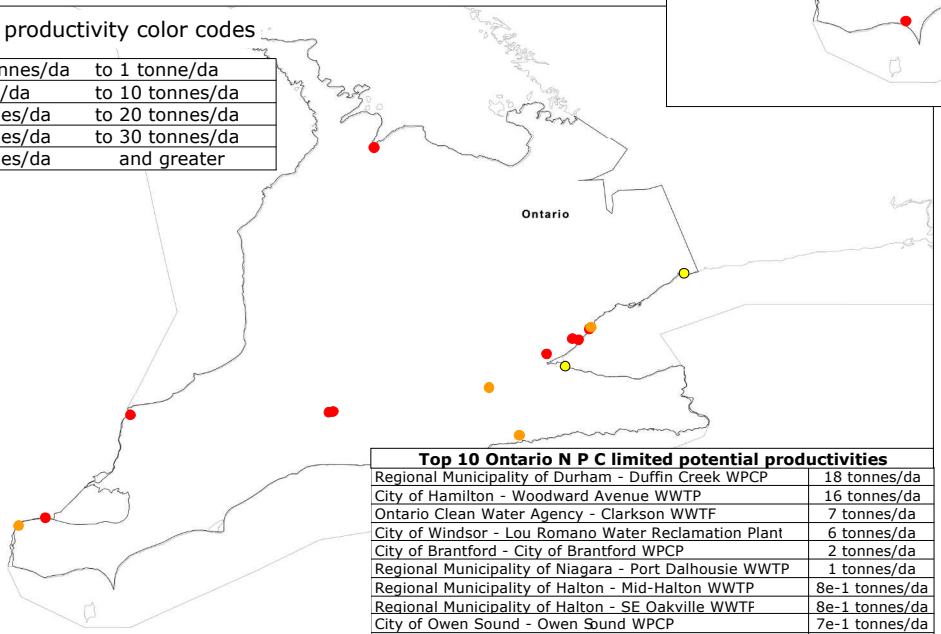

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City of Brantford - City of Brantford WPCP	2 tonnes/da
Regional Municipality of Niagara - Port Dalhousie WWTP	1 tonnes/da
Regional Municipality of Halton - Mid-Halton WWTP	8e-1 tonnes/da
Regional Municipality of Halton - SE Oakville WWTF	8e-1 tonnes/da
City of Owen Sound - Owen Sound WPCP	7e-1 tonnes/da
City of Sarnia - Water Pollution Control Centre	6e-1 tonnes/da

Best sites change as distance to CO2 constraint is relaxed (Only 3 of top 10 sites for 10km are in top 10 for 85km)

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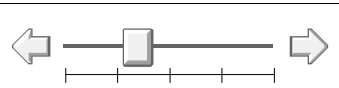
Energy content and area requirements

Energy potential:

Model structure and default parameter values for evaluation of energy content of algae per incident photon based on equations in Weyer, Bush, Darzins, and Willson 2010 "Theoretical Maximum Algal Oil Production"

Resulting area requirements calculated from default solar resource estimated by visual inspection of Plate 12B of Hydrological Atlas of Canada. Canada Dept of Fisheries & the Env., Atmospheric Env. Service, 1975

Average Solar Resource by Region		
Alberta		Default values estimated by visual inspection of Plate 12B of Hydrological Atlas of Canada. Canada Dept of Fisheries & the Env. , Atmospheric Env. Service, 1975 S Ontario: 115-120 Alberta & N Scotia: 100-110 KCal/cm2,
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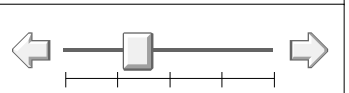
Nova Scotia		
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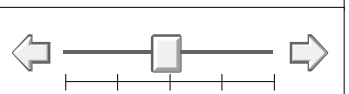
Southern Ontario		
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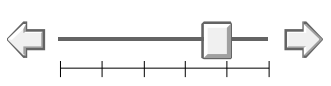
Photon transmission % by region		
Alberta		% Photons not lost to reflection. Default values based on extrapolation from Figure 4 in Weyer, Bush, Darzins, and Willson 2010
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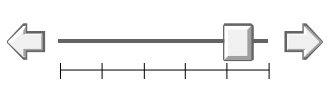
Nova Scotia		
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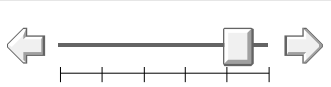
Southern Ontario		
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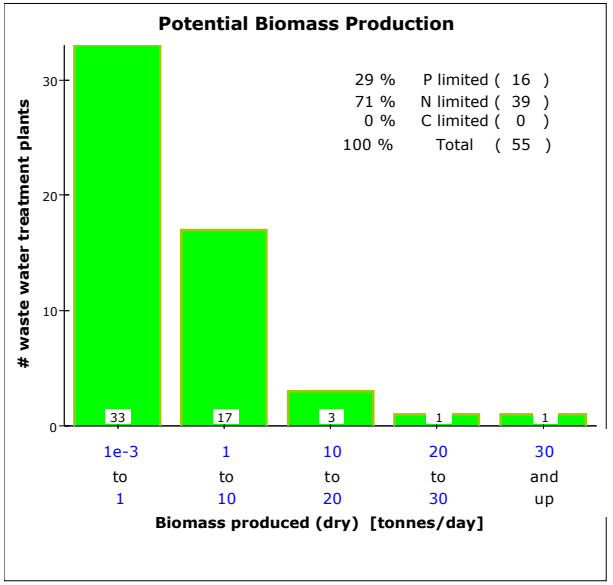
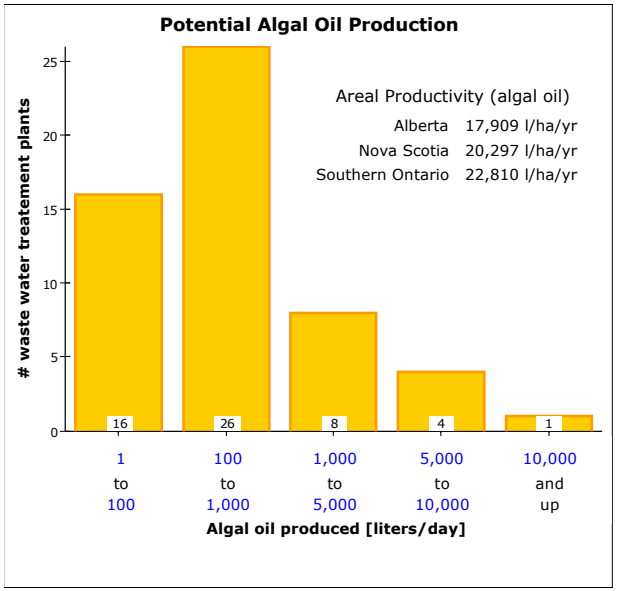
Algal oil density	918 kg/m³	

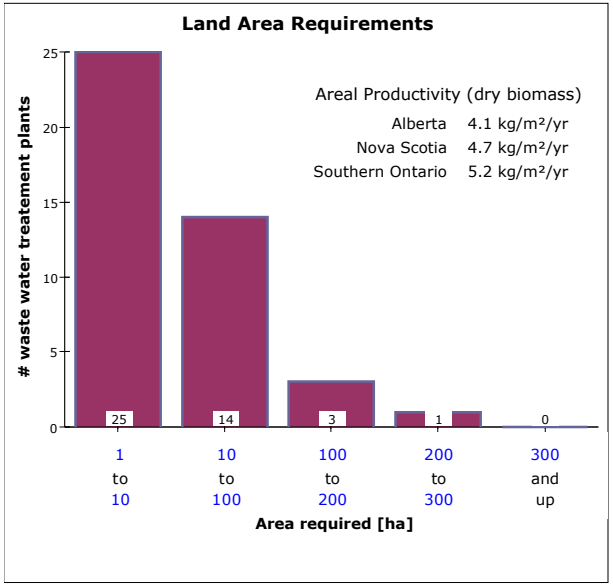
Visualization options

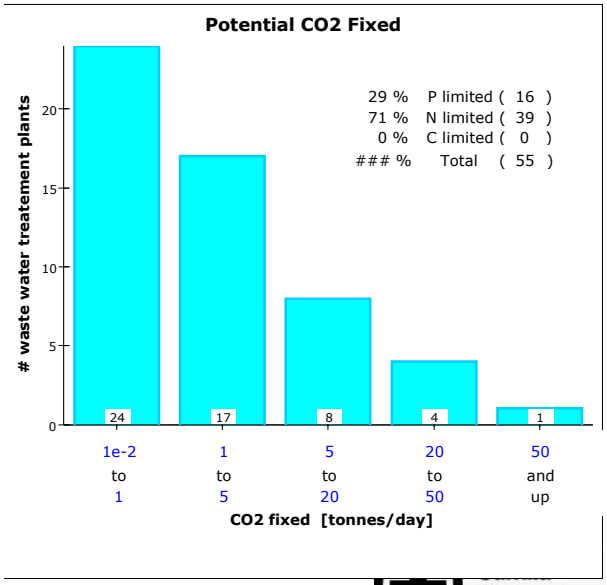
Histograms and maps can be viewed as a function of

- biomass production potential (previous slides)
- Potential rate at which CO2 is fixed
- Algal oil (biocrude) production potential
- Area requirements









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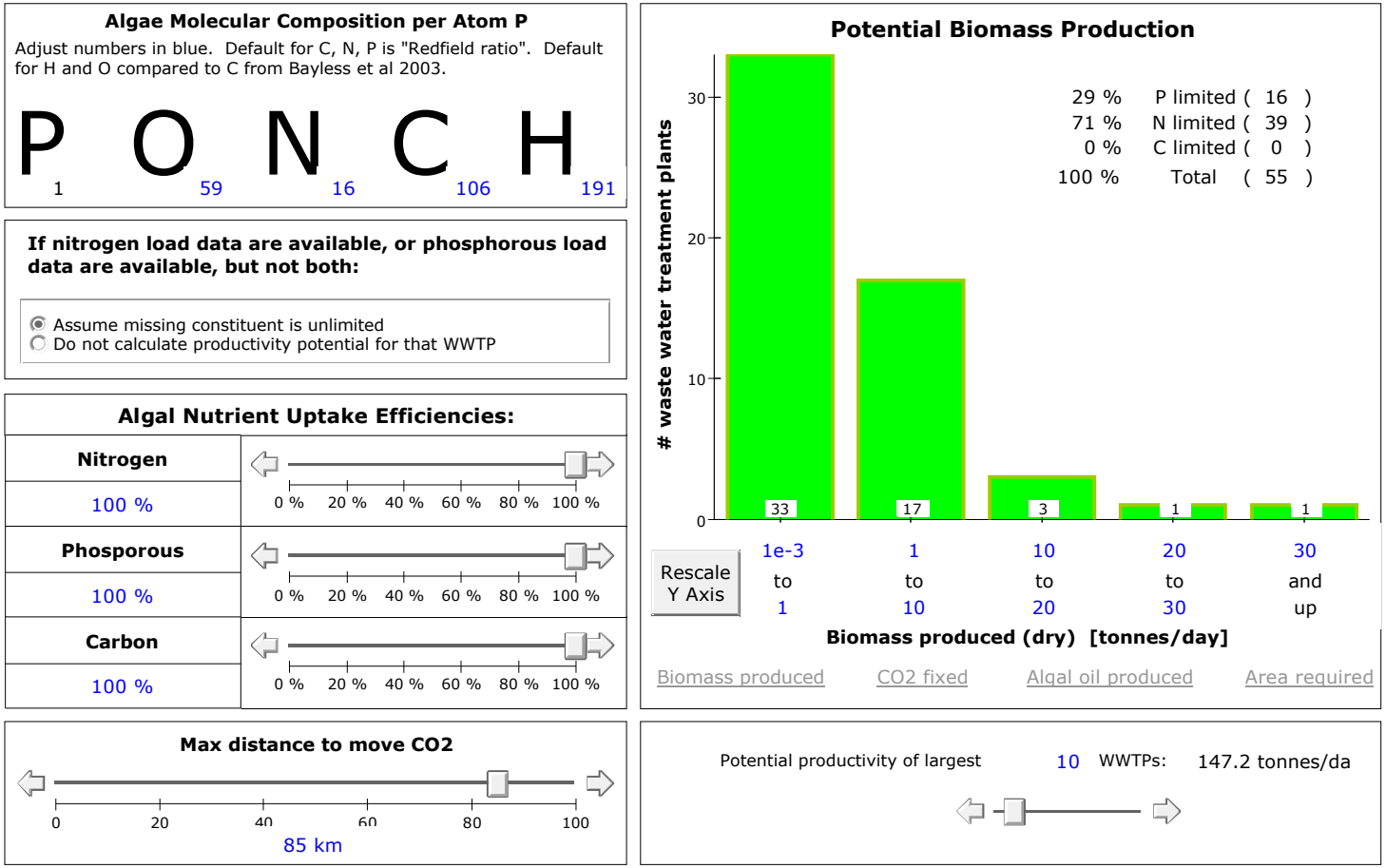
The PONCH list

Next steps:

- Incorporation of additional wwtp nutrient and flow data from a recently completed survey of plant operators.
- Incorporation of British Columbia plants
- Incorporation of land availability information
- Incorporation of economics to estimate costs of production
- Nutrient recycling possibilities
- Coproduct anaerobic digestion to produce CH_4 then electricity

PONCH: a dynamic visualization tool

Questions?



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