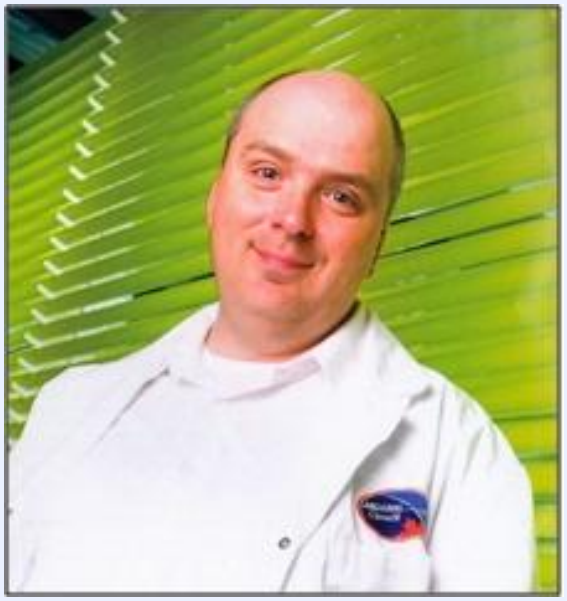
Integrating Wastewater Treatment and Algal Carbon Capture

Presented at
BIO Pacific Rim Summit, Vancouver
By
Paul Kadota
October 12, 2012

metro vancouver

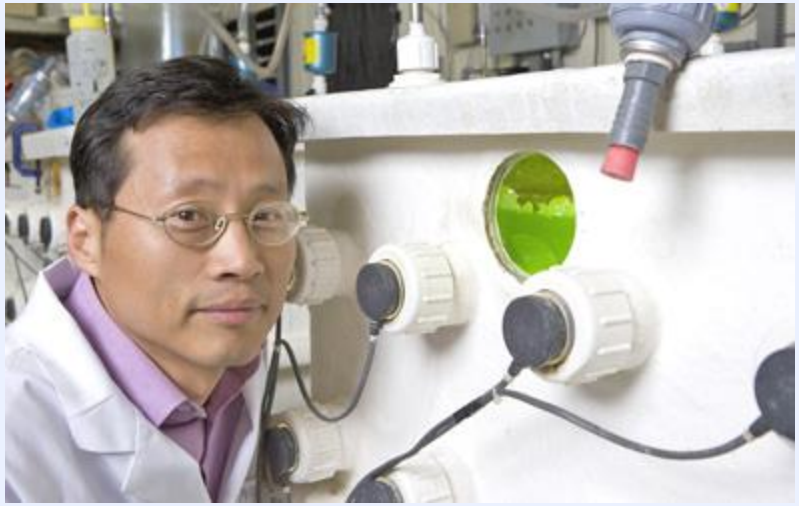
Co-Authors

National Research Council of Canada (Halifax, NS)
Aquatic and Crop Resource Development



Patrick McGinn, PhD

Kyoung Park, PhD



Outline

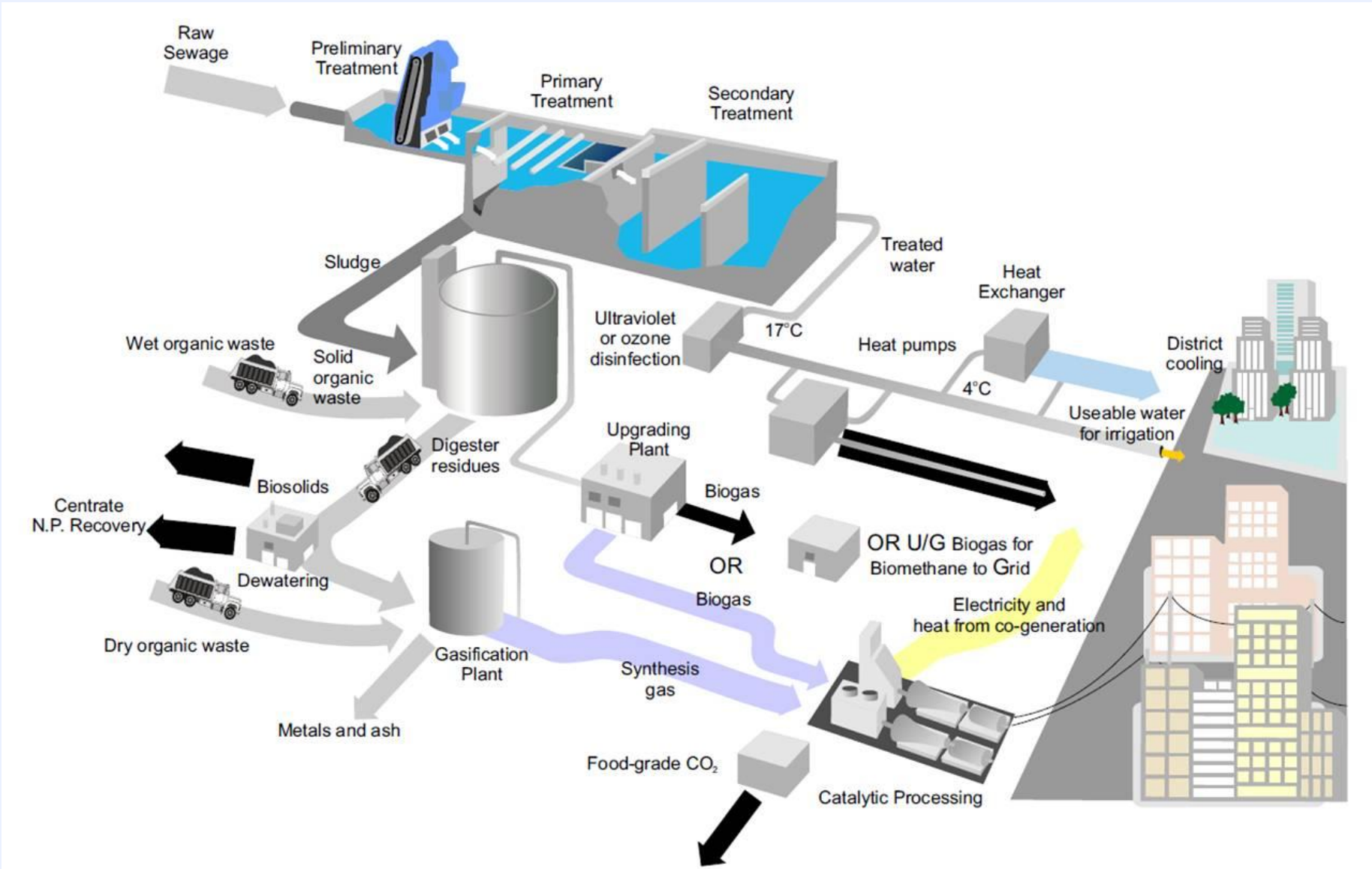
1. Metro Vancouver – the regional government
2. Integrated Resource Recovery opportunities
3. Laboratory cultivation
4. Cultivation results
5. Next Steps

Metro Vancouver

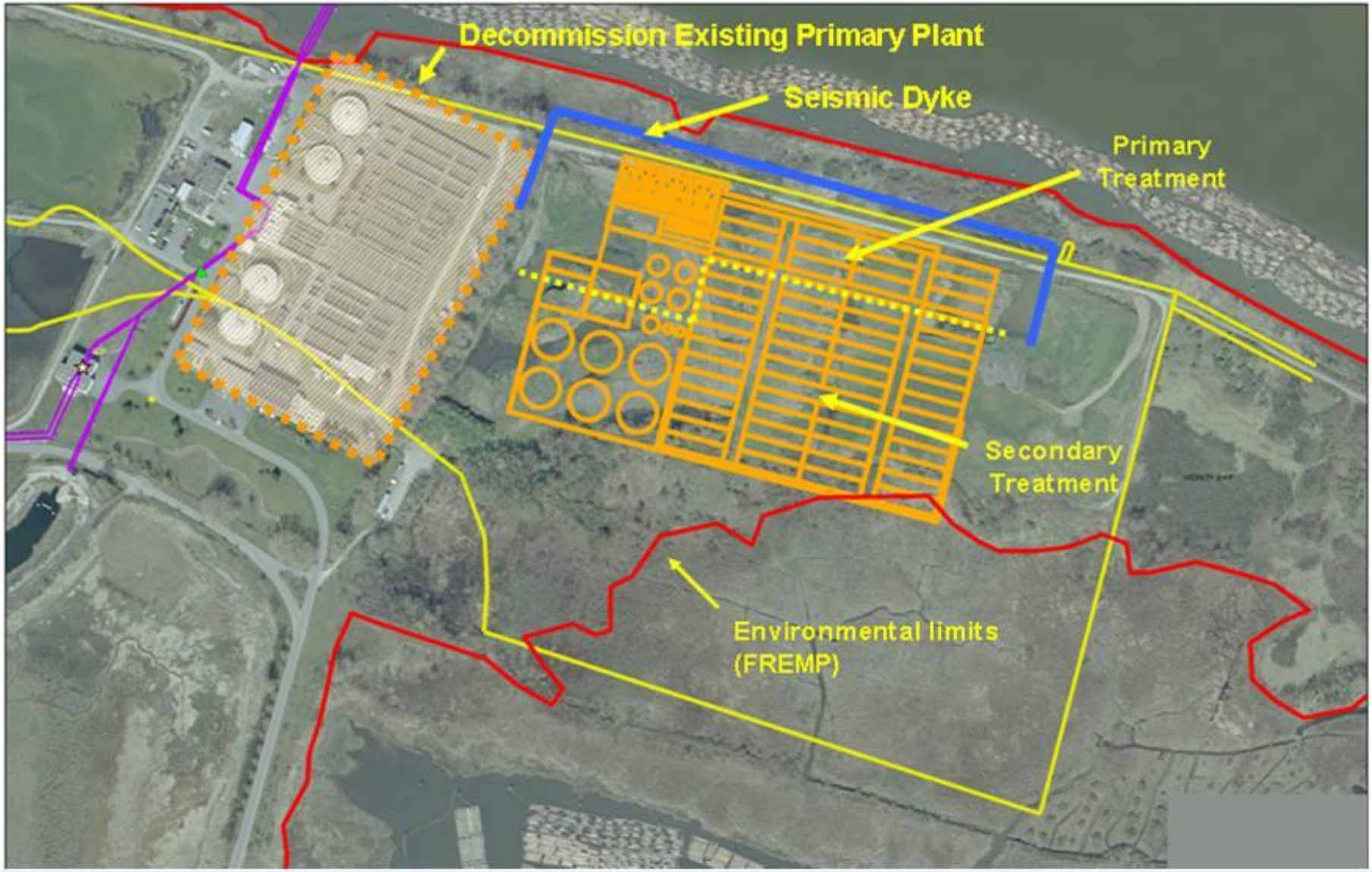
- 24 local governments
- Primary roles: water, sewerage, solid waste, air quality, parks, regional planning
- Population: 2.3 million

Sewerage System

Integrated Resource Recovery (IRR)

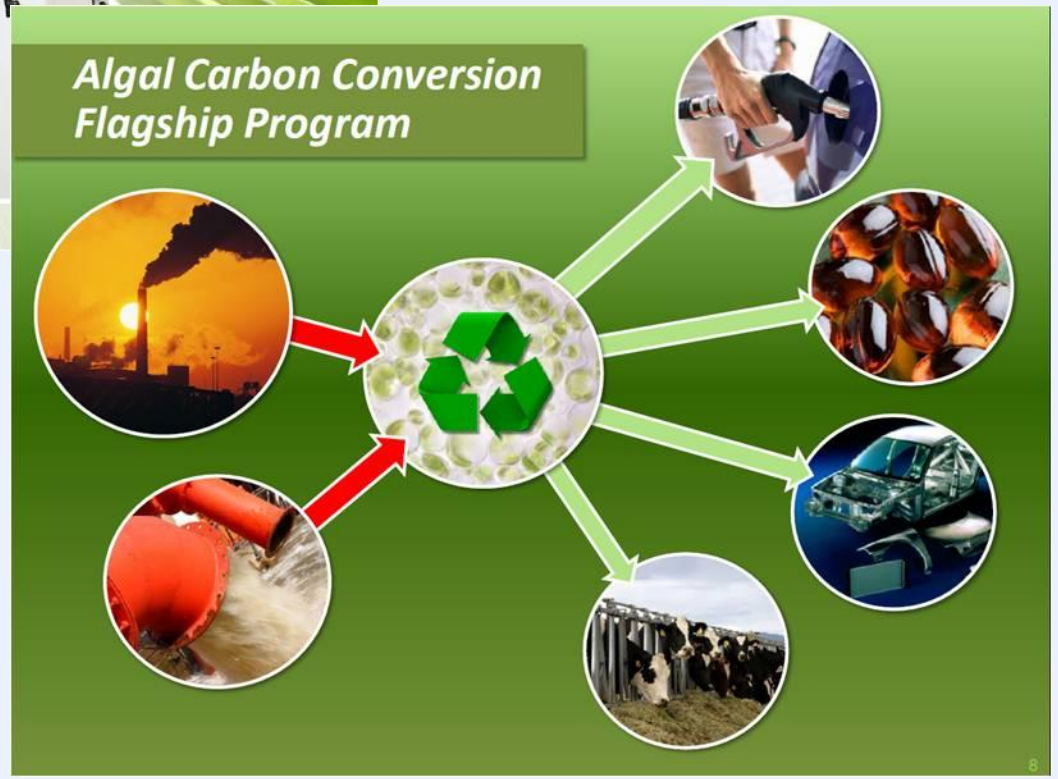


New Iona Island WWTP



IRR Opportunities

National Research Council



Emissions
+
WWTP Effluent
→
Bioproducts

Laboratory Cultivation

Dissolved nutrient analysis of Annacis Island WWTP effluent

Wastewater Type	NH_3-N	PO_4^{3-}-P	TKN	Nitrate + Nitrite	TOC
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Final Effluent 1 (FE1)	13.8	0.75	5.52	0.38	13.5
Final Effluent 2 (FE2)	15.3	0.91	12.0	0.72	14.6
Centrate	1280	231	1040	11.04	194

Laboratory Cultivation

Growing media treatments

Media Designation	NH_3-N (mg/L)	PO_4-P (mg/L)	TOC (mg/L)
FE1	13.8	0.75	13.5
FE1-Centrate(1%)	26.4	3.06	15.9
FE2	15.3	0.91	14.6
FE2-Centrate(1%)	28.1	3.2	16.5
DIH2O-Centrate(1%)	12.8	2.31	1.94

Laboratory Cultivation

Shake-Flask Growth Trials

Two microalgae species grown in Annacis Island effluent:

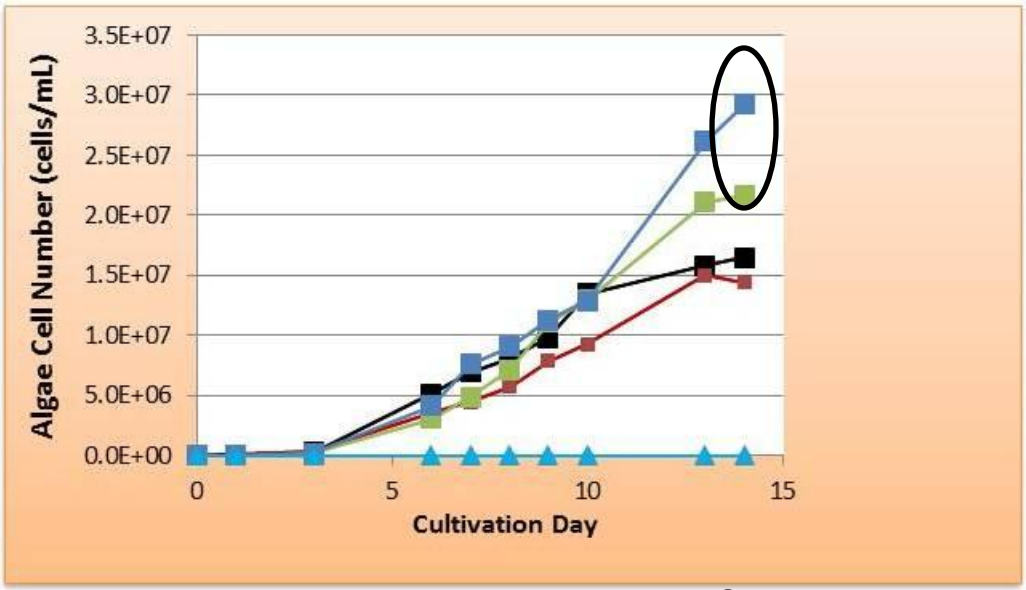
- ***Scenedesmus sp. AMDD***
- ***Chlorella sorokiniana***

Growth Conditions

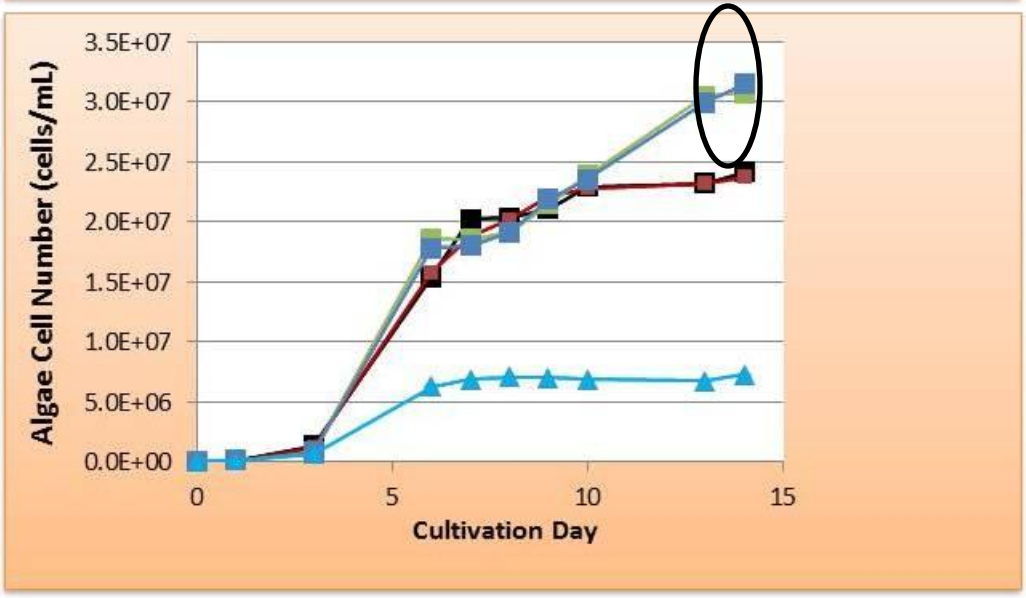
- **75 μmol photons m^{-2} s^{-1}**
- **22 °C**
- **2% CO_2 in air**

Cultivation Results

Microalgae Growth Curves



***Scenedesmus* sp. AMDD**



Chlorella sorokiniana

FE1
FE1-Centrate(1%)
FE2
FE2-Centrate(1%)
DIH_2O-Centrate(1%)

Cultivation Results

Effect of Further Centrate Additions

Microalgae Species	Wastewater Type	Final Biomass ($g\ L^{-1}$)	Cell Number ($cells\ mL^{-1}$)	Growth Rate ($div.\ d^{-1}$)	Nutrient Removal (NH_3-N, %)	Nutrient Removal PO_4-P, %)
Scenedesmus sp. AMDD	FE2-Centrate(2%)	0.98	33877333	1.88	99.8	100
	FE2-Centrate(5%)	1.12	34003692	1.88	99.9	100
	FE2-Centrate(10%)	0.68	24509538	2.60	75.6	57.5

- 100% nutrient removal observed at 2% and 5% centrate addition
- 10% centrate addition lowered final biomass quantity

Cultivation Results

Summary

- Annacis Island wastewater effluent is a useful resource for the intensive cultivation of freshwater microalgae
- Yields of *Scenedesmus* sp. AMDD biomass were significantly enhanced to >1.1 g/L in effluents blended with 5% centrate wastewater
- Nitrogen and phosphorus were completely recovered by algal growth in effluent blended with 5% centrate; nutrient recovery was reduced in effluent cultures blended with 10% centrate

Pilot Test

Requirements to move from lab to industrial setting

- Consortium
  - Qualified people with knowledge
  - Better / cost efficient technologies
  - Financial backing
  - Industrial site
  - Governments, private sector, industries, academics

Industrial Site

Sustainability Academy:
Annacis Wastewater Centre

The Challenge

By 2014, answer this:

"Should algal cultivation processes be specified in the design of the new Iona Island WWTP?"