SANDIA BIOSCIENCE

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Investigating the chemical and biological landscape of microalgae cultures to reduce or mitigate pond crashes

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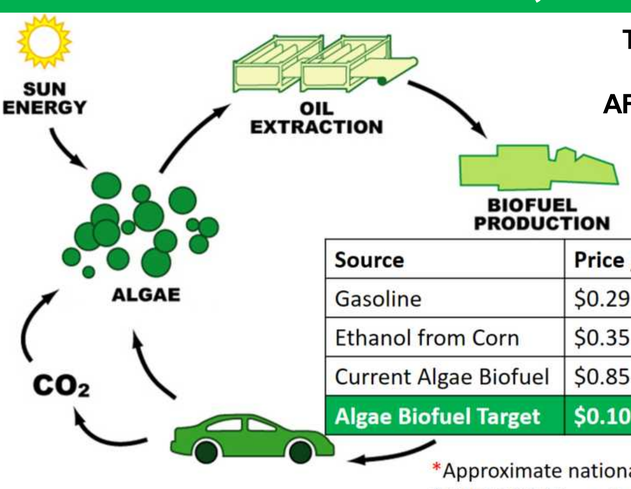
Biofuel is the future, but there are serious economic barriers to overcome before it becomes our reality.

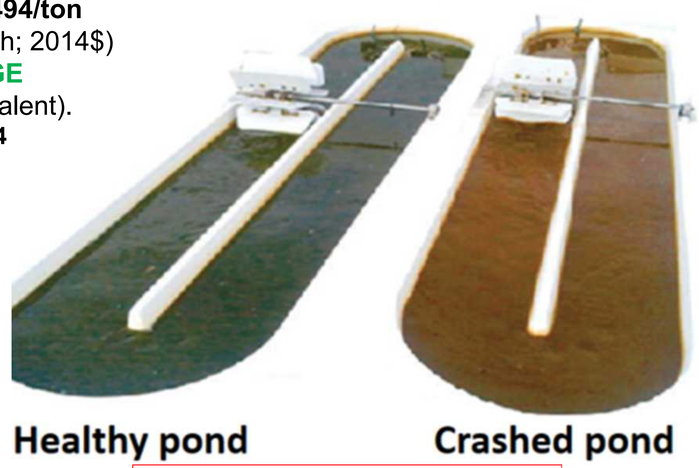


Target selling prices for algae biomass in 2022 is $494/ton AFDW (ash-free dry weigh; 2014$) **to achieve $5/GGE** (gasoline gallon equivalent). **BETO MYPP, 2014**

Source	Price /lb	Price /gal
Gasoline	$0.29	$2.49*
Ethanol from Corn	$0.35	$2.92*
Current Algae Biofuel	$0.85- $3.67*	$7.06 - $30.46
Algae Biofuel Target	**$0.10 – 0.25***	**$1.50 - $2.10**

*Approximate national average for 2017
*2017 DOE Alternative Fuel Price Report
*Sun et al, *Energy,* 36 (2011) 5169-51795.
*BETO Multi-Year Program Plan, March 2016

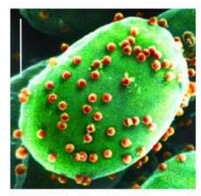
Crashed ponds caused by various **algal predators**:




Brachionus plicatilis, marine rotifer

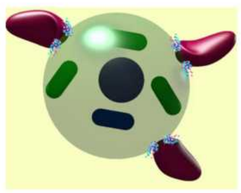

Marine planktonic copepod, *Calanus*

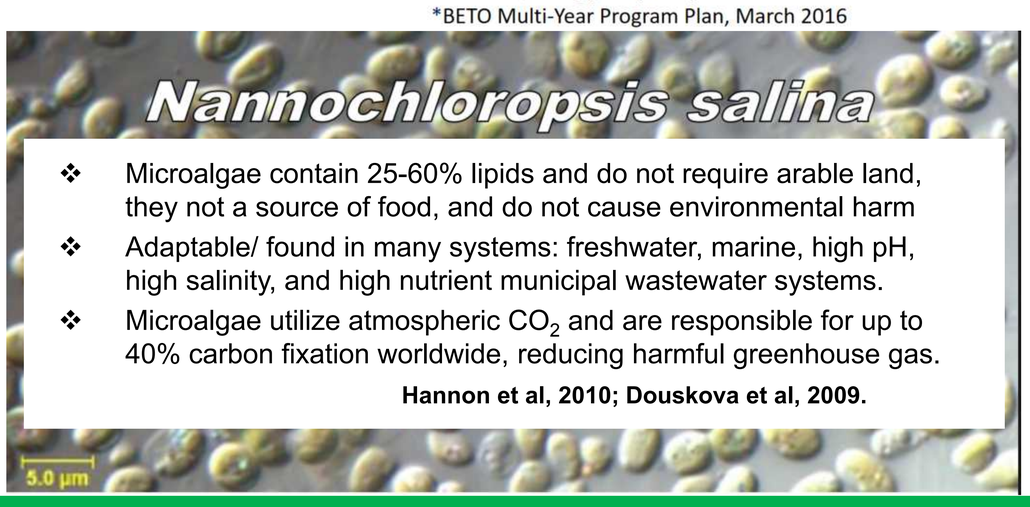

Oxyrrhis marina, dinoflagellate


alga infected with chlorovirus

Poterioochromonas, a golden algae or chrysophyte


Numerous parasitic chytrids attack the filament of a green alga


Vampirovibrio chlorellavoras bacterial predation on green alga, *Chlorella*.



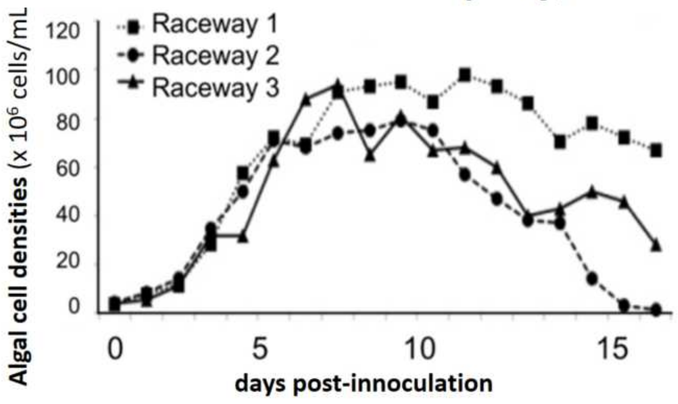
- Microalgae contain 25-60% lipids and do not require arable land, they not a source of food, and do not cause environmental harm
- Adaptable/ found in many systems: freshwater, marine, high pH, high salinity, and high nutrient municipal wastewater systems.
- Microalgae utilize atmospheric CO_2 and are responsible for up to 40% carbon fixation worldwide, reducing harmful greenhouse gas.

Hannon et al, 2010; Douskova et al, 2009.

Algal population crashes cause **losses of up to 30% of annual crop production** from the typical open raceway system.

Richardson et al, 2014.

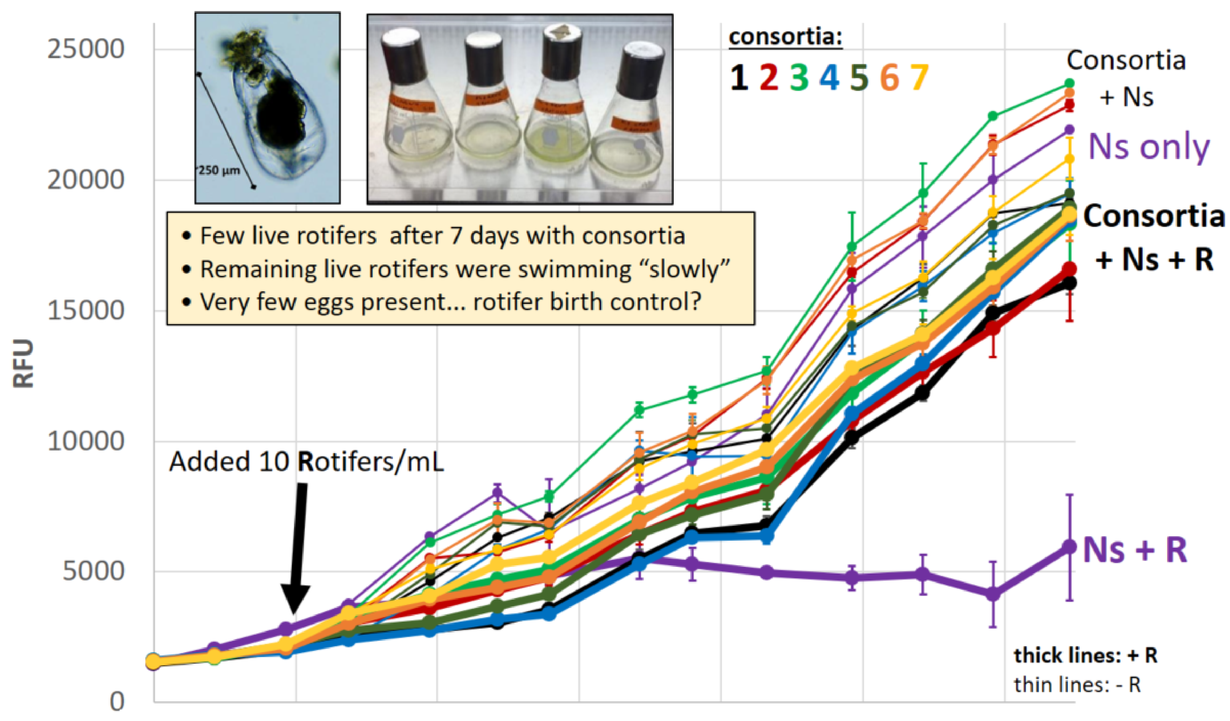
Pond crashes: *N. salina* growth in biological replicate raceways at Texas Agrilife. Raceways show moderate to severe **biomass loss** as a result of algal predation.



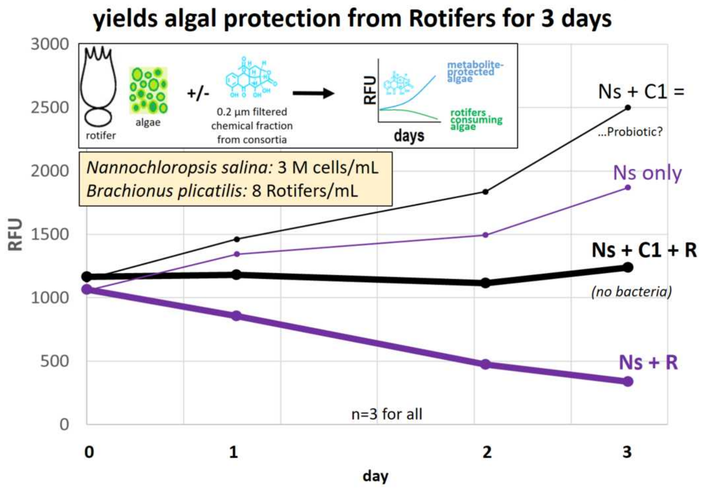
Carney et al. 2016

At Sandia, we are studying the chemical ecology of algal culture systems in order to develop biological and chemical tools that will stabilize algal production systems,deter predation, and mitigate pond crashes.

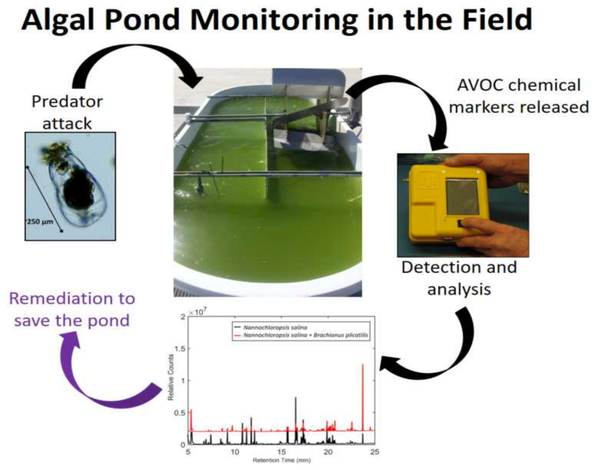
Bacterial consortia protect algae from rotifers



Chemical fraction from consortia-1 *(sans bacteria)* yields algal protection from Rotifers for 3 days



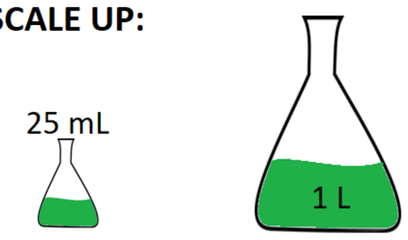
Algal Pond Monitoring in the Field



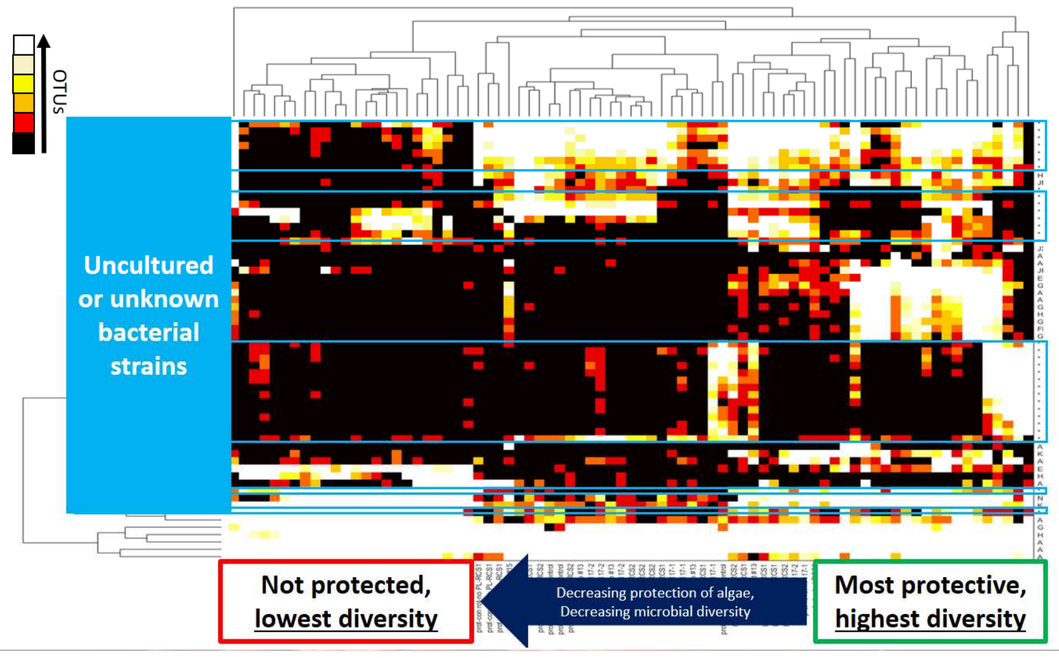
AVOCs: Algal Volatile Organic Compounds

Summary & Future Work

- **Protective bacterial consortia testing and analysis**
  - 16S MiSeq analysis for bacterial identification → determine core genera
  - Consortia simplification experiments
- **Chemical ecology analysis of algal systems**
  - What chemicals are responsible for the bacterial consortia protection?
  - Metabolomics: chemical analysis via UPLC-MS and NMR
  - Metagenomics: bacteria responsible for chemicals
  - Biosynthetic pathway for metabolite → express in bacteria
  - Engineer POSSE bacteria for co-culture with algae
- **Survey AVOCs for differences between algae +/- rotifers**
  - Identify biomarkers of predation, quantify differences
  - Test field deployable system on raceways, field trials
- **SCALE UP:**



Protective consortia have more bacterial diversity



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