

Pond Biology

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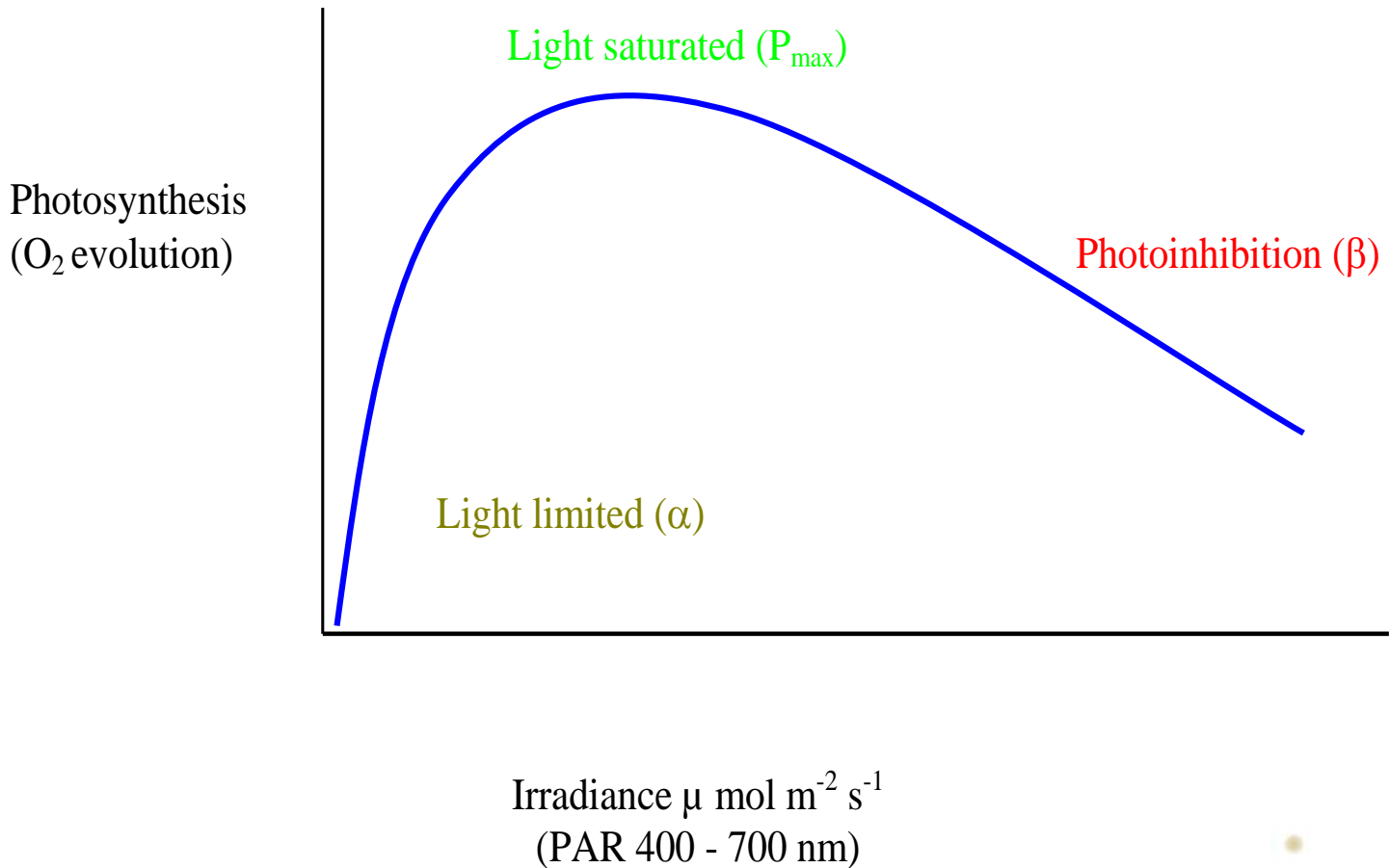
Flinders University, Adelaide, South Australia

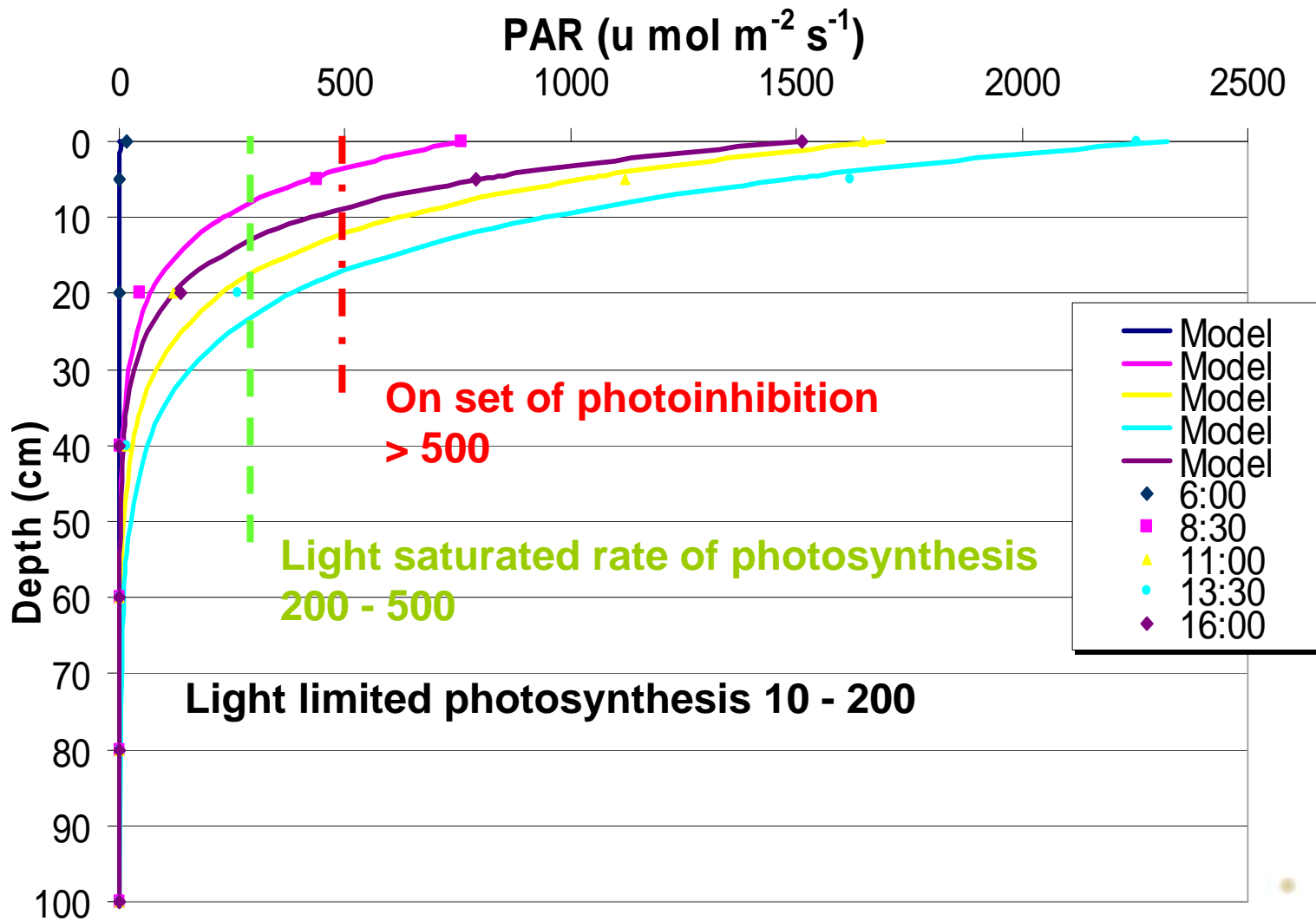
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(1) Photosynthesis and the underwater light climate

- Algal photosynthesis is a crucial component of pond biology (DO, pH, nutrient removal, pathogen die-off)
- Influenced by underwater light climate and
- Temperature; which may vary 12°C in 1m depth

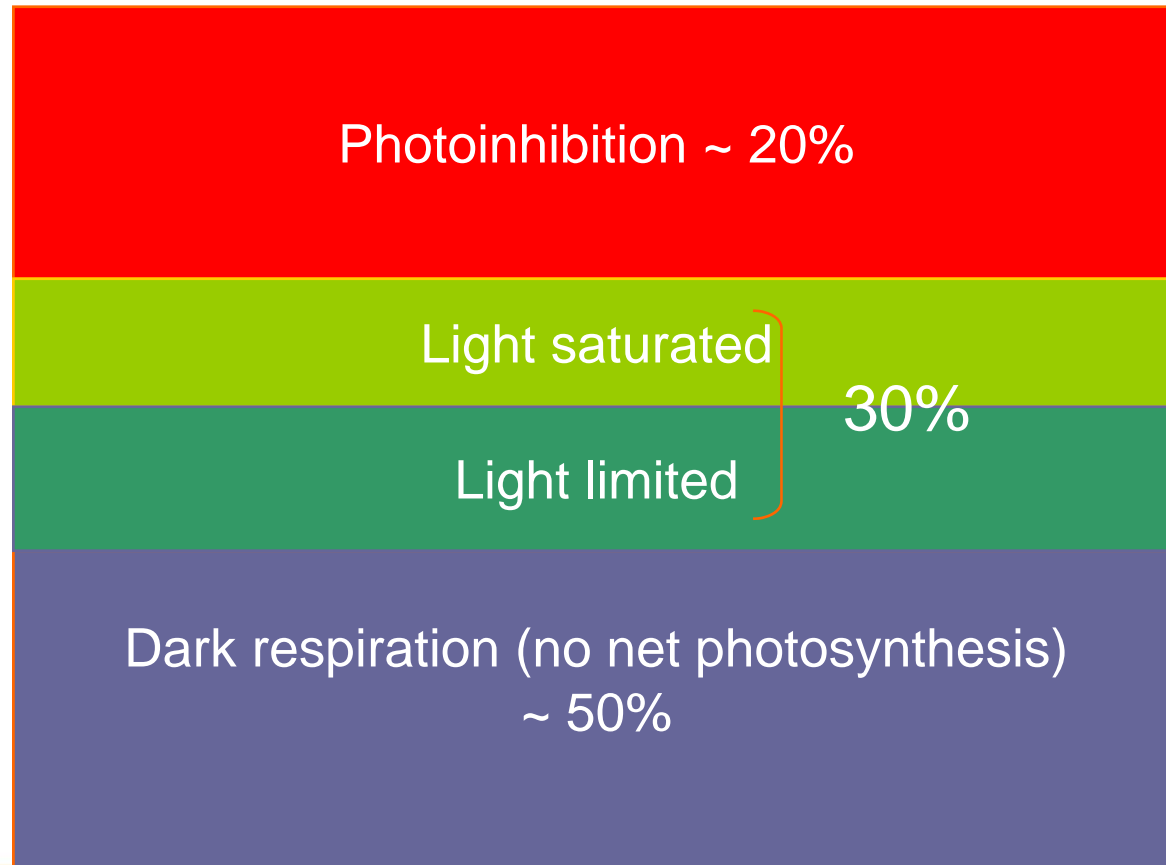
Photosynthesis irradiance curve





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Photosynthetic zones within a lagoon



Underwater light climate and photosynthesis

- Does this matter?
- Desirable to attempt to better understand and optimise photosynthesis?
- Measurement of photosynthetic rates
 - ^{14}C
 - measurements in situ
- Many designs consider only temperature: is this sufficient?
- Would better understanding of photosynthesis lead to better design models?

(2) Algal species composition and survival and influence on removal strategies.



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Dissolved air flotation / filtration
Bolivar WWTP (11GL/yr)

(2) Algal species composition and survival and influence on removal strategies.

- Performance of Bolivar DAF/F influenced by algal species composition.
- *Euglena*, *Chlorella*, *Chlamydomonas*, copepod and cladocerans (*Daphnia*) result in higher NTU in the effluent.
- Breakthrough, headloss, increased frequency of filter backwashing.
- Local council WSP membrane filters (0.45 μ) blocked by picoplankton.

Interventions to improve pond effluent quality ?

- **Biomanipulations:**
 - Rock filters, duckweed cover, attached growth media –
 - » phytoplankton population reduced but problem species not selectively removed (Short, 2008)
 - » Zooplankton, including problem zoop, reduced (Short, 2008)
 - Zoop ponds to enhance phytop grazing

Interventions to improve pond effluent quality ?

- Modifying hydraulic conditions to improve settling
 - Management of off-takes, depth, wind direction
 - Enhancing sedimentation; pond modification eg baffles
- Autoflocculation
- Algal survival
 - No influence of DO regime
 - Lower survivorship in light
 - Prolonged survival in dark (Short et al. 2008)

Interventions to improve pond effluent quality ?

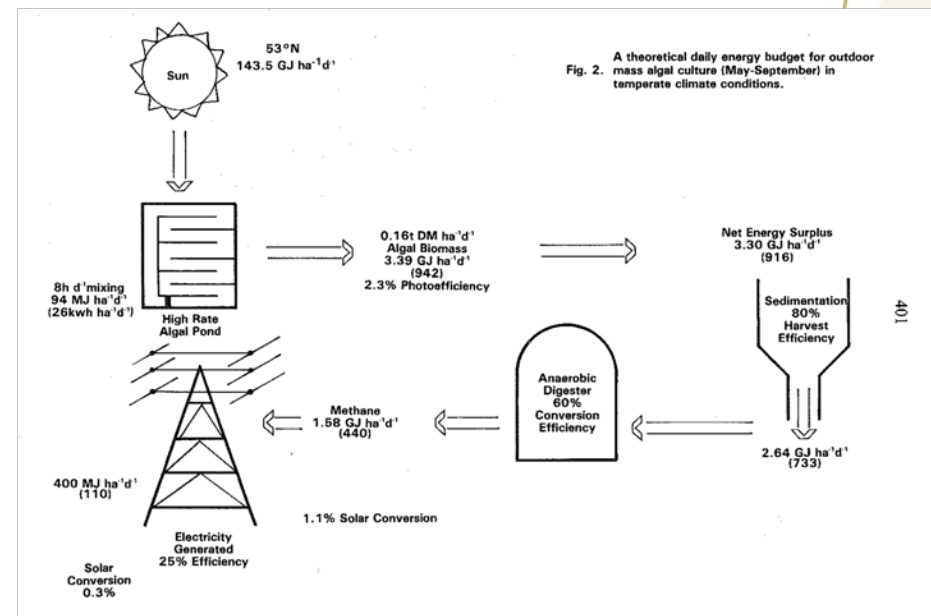
- Other options?
- Research needs?

(3) Role of sediment biology in pond performance- a neglected area?

- What do we know/need to know re:
 - rate of sedimentation
 - chemical composition
 - decomposition rates
 - water – sediment exchange
- Important for
 - (Pathogen survival – protozoa)
 - Nitrogen transformations
 - Carbon cycle
 - Climate change gases

(4) Wastewater treatment, energy consumption/production and carbon sequestration

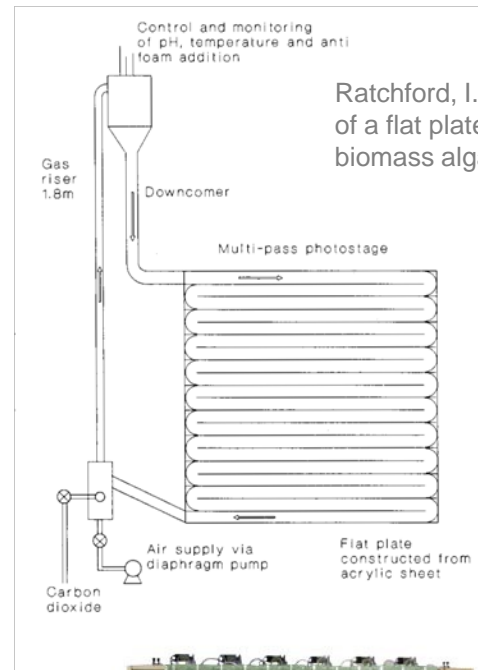
- This is where I started in 1980!
- Energy savings compared with WWTPs eg ASP
- Production via biomass
 - CH₄?
 - pyrolysis?
 - H₂ ?



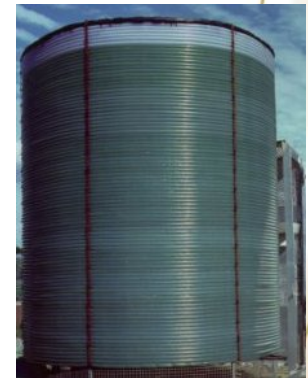
Fallowfield, H.J. & Garrett, M.K. (1985) An energy budget for algal culture on animal slurry in temperate climatic conditions. In **Energy from Biomass** (Eds. Palz, W., Coombs, J. & Hall, D.O.) Applied Science Publishers.

(4) Wastewater treatment, energy consumption/production and carbon sequestration

- Mixed cultures/pure cultures?
- Biology of open ponds v closed photobioreactors?
- Role of algae in carbon sequestration?
 - Wastewater treatment
 - Integration of WWT and flue gas
 - Role for ponds in gas stripping from other processes eg agri- / food wastes.



Ratchford, I.A.J. & Fallowfield, H.J. (1992) Performance of a flat plate, air-lift reactor for the growth of high biomass algal cultures. *J. Applied Phycology*. 4, 1- 9.



<http://www.fishace.com.au/algae.html>



http://blog.makezine.com/archive/2007/04/how_to_make_a_photo_bio_r.html