Aquatic vegetation in the Rotorua Lakes - weed issues and potential avenues for solutions: Focus today on Lake Rotoiti TAG discussion 30 May 2016 -

Clive Howard-Williams

Overarching question: How do we deal with the context of invasive weeds now that we are getting HAB under control? (Same questions for all lakes? Need clear, currently-relevant questions for a position paper)

1. What are the consequences of invasive weed growth, the history and options for control, (Past current and future).
2. What is the succession of species invasion will it get worse?
3. What are the risks associated with these invasive weeds spreading?
4. What are native aquatic species of the littoral zone and their values

5. What are the impacts of the associated water clarity improvements on weed and weed habitat? (relation between weed growth, eutrophication and water clarity)

6. Possible control measures/options/experience (eg in our region and elsewhere) and typical costs and challenges (include value of cordons)

7. What are the current BOPRC monitoring programmes
    1. Lakes SPI; what does this mean? Incursion monitoring?
    2. How do we compare with other regions? Can we improve?

8. What are the agencies involved and their current actions?
    Options to improve efficiency of these.

Any other questions?

Three Key Historical Documents: (Preceded by several papers in the NZ Journal of Marine and Freshwater Research (University of Auckland Botany Department) back to the 1960s)

1. Silvester, W.B. 1981 *Future Options for the Rotorua Lakes District (FORLD): Report 11 - Waterweeds and algae.* University of Waikato, Hamilton 48p. + Appendix
(reviews and provides references to work up to 1981)

2. Richmond, C.J. 1981 *Macrophytes in the Rotorua lakes: A review of distribution and nuisance.* Wildlife Service, Rotorua.

3. Clayton, J.S. et al. 1990 *The aquatic vegetation of 15 Rotorua lakes.* Aquatic Plants Section, Ministry of Agriculture and Fisheries, Ruakura. 101p (the first standardised survey of aquatic vegetation across the lakes)

More recently:

- Burton, T. and Clayton, J. 2015 *Assessment of the Rotorua Te Arawa lakes using LakeSPI -2015.* NIWA Client Report for Bay of Plenty Regional Council 50p.
- 2015 Lakes Water Quality Society Symposium on invasive weeds on the Rotorua Lakes area

Understanding the role of littoral zone vegetation

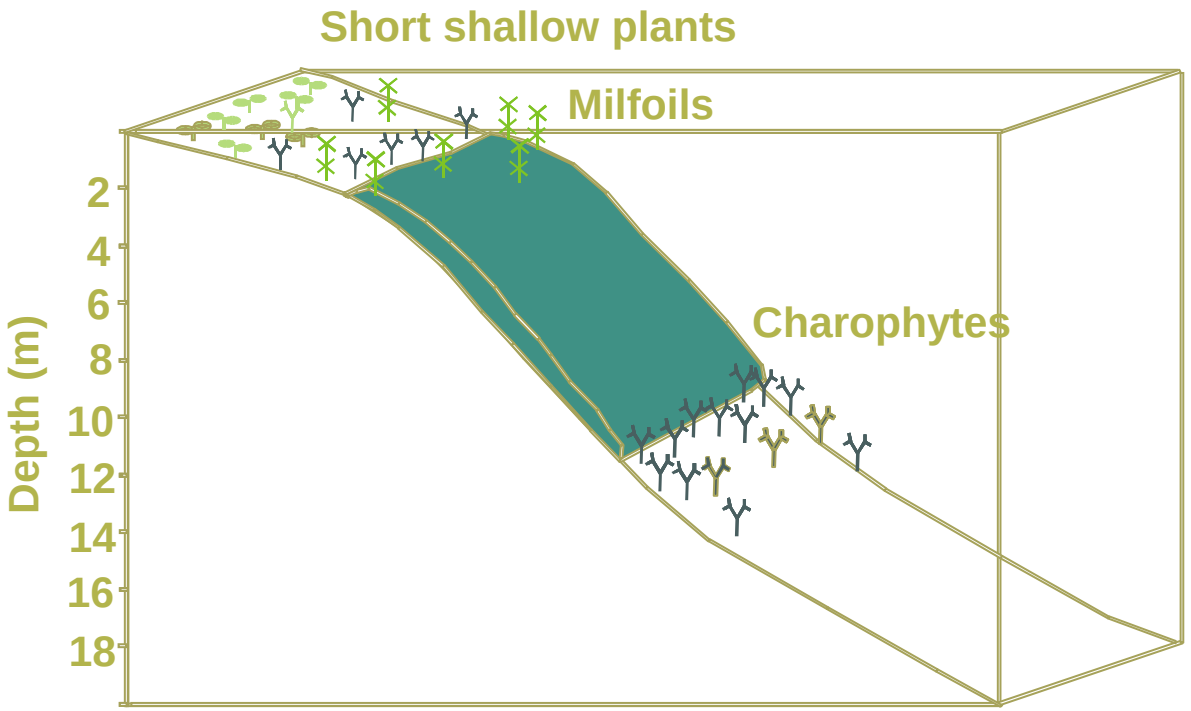
Littoral zone vegetation plays a very important role in lake ecosystem health even large deep lakes such as Lake Rotoiti where this zone may be less that 10% of the lake area.

High environmental variability in the littoral zone means high biodiversity and complex ecosystem structures.

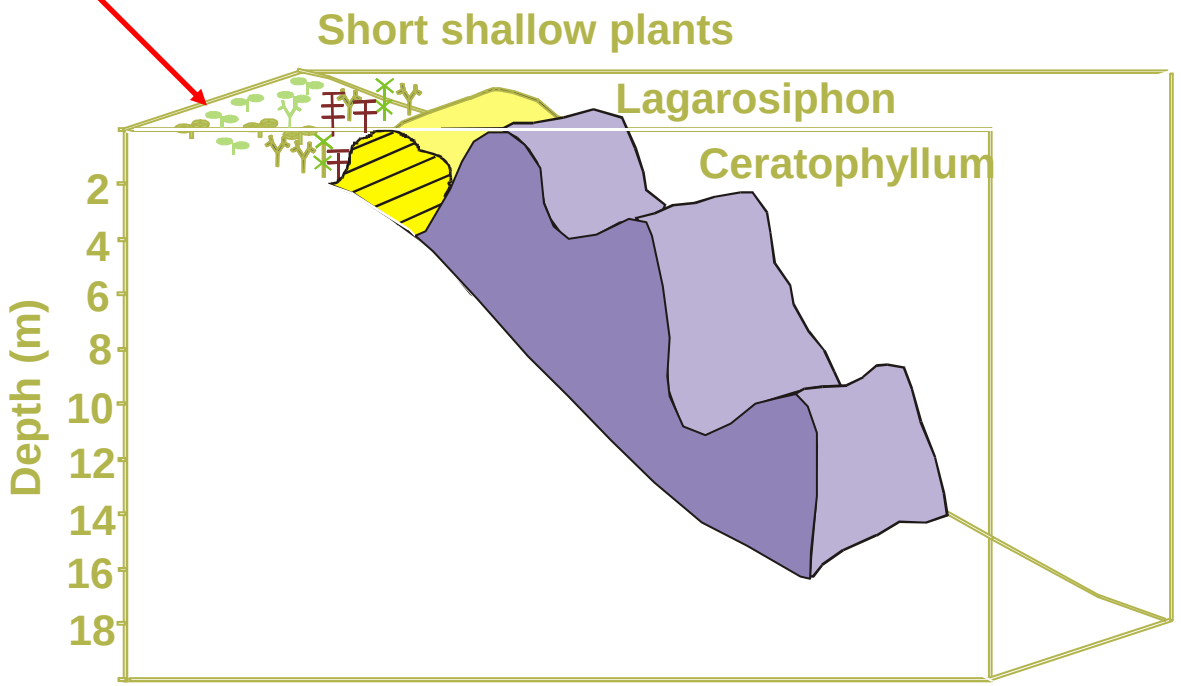
Native and exotic plants of the littoral zone:

- form the interface between land and lake with nutrient and sediment attenuation
- provide food for herbivores and bottom feeding scavenger and filter-feeding animals,
- form a substrate for other plants (epiphytes) and animals,
- form breeding substrates and shelter for invertebrates and fish and
- provide a rich feeding ground for fish-eating and plant-eating birds
- “sediment grooming” maintains lake clarity
- Impact on lake oxygen and biogechemical cycles.

The problem of invasive species



Generalised representation of littoral zone aquatic plant changes from native condition to current state of invasive species colonisation



Lake Rotoiti for TAG discussion today

Recognising the importance of littoral zone vegetation, what is it that exotic weeds are doing that native aquatic species would not?

1. Nuisance value to recreation, (boating, swimming, access, aesthetics….)
2. Altering geochemical and oxygen dynamics (unquantified)
3. Effects on mahinga kai (unquantified)
4. Reduced native biodiversity ….. Others?

Question 1: What is the succession of species invasion and will it get worse?

Lake Rotoiti would always have had a valuable littoral zone of aquatic plants and in places such as Okawa Bay there would have been high density and biomass of these.

In general the biomass of aquatic plants in Lake Rotoiti has increased as a result of a succession of invading weeds (Elodea – Lagarosiphon – Ceratophyllum – Egeria?)

Between 1970s and 1980s there was little change in the distribution of invasive weeds suggesting that their habitat maximum had been reached. Has it?

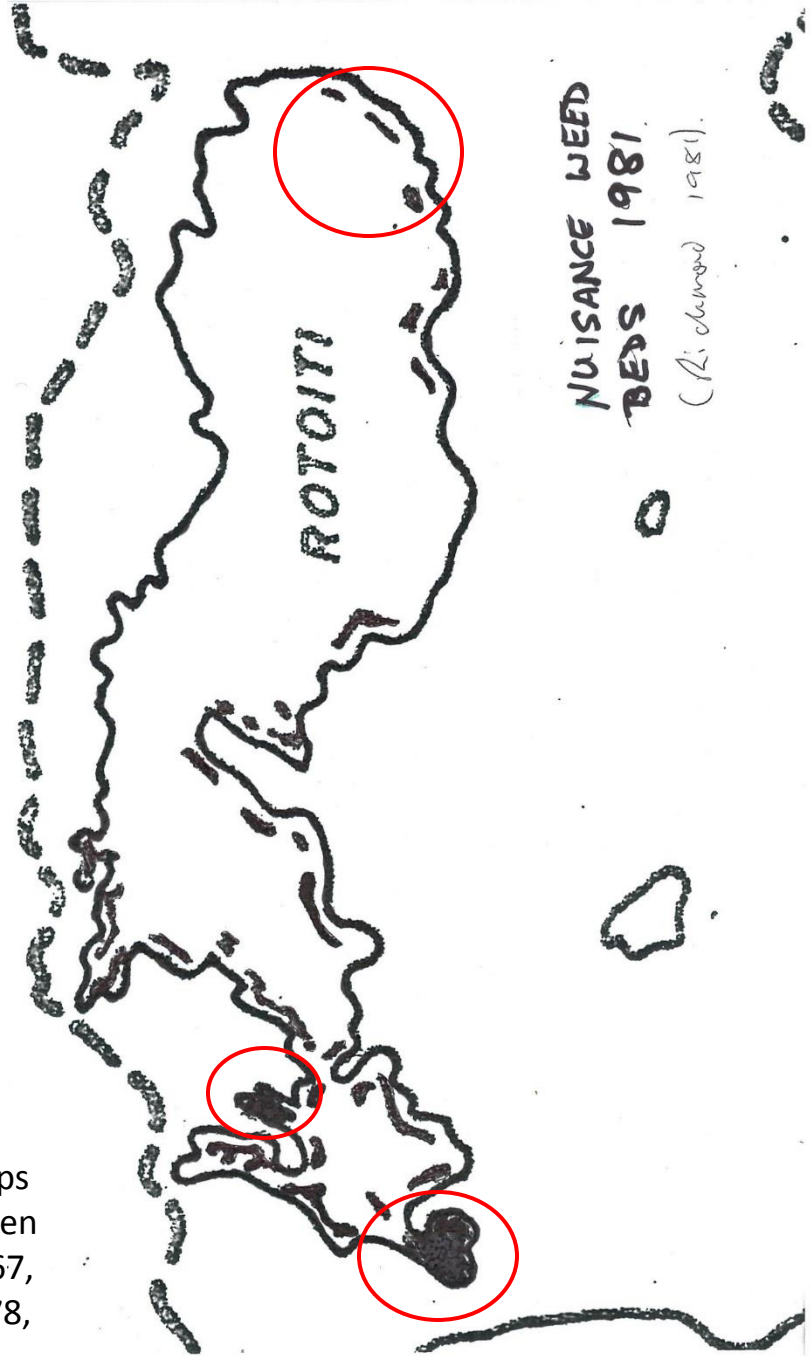
CH-W hypothesis: Very little additional space for new weedbed development in Lake Rotoiti

Changes to weed beds have and will be, related to changing proportions (rather than total cover) between Lagarosiphon, Egeria and Ceratophyllum. Most changes will be seen in Okawa Bay

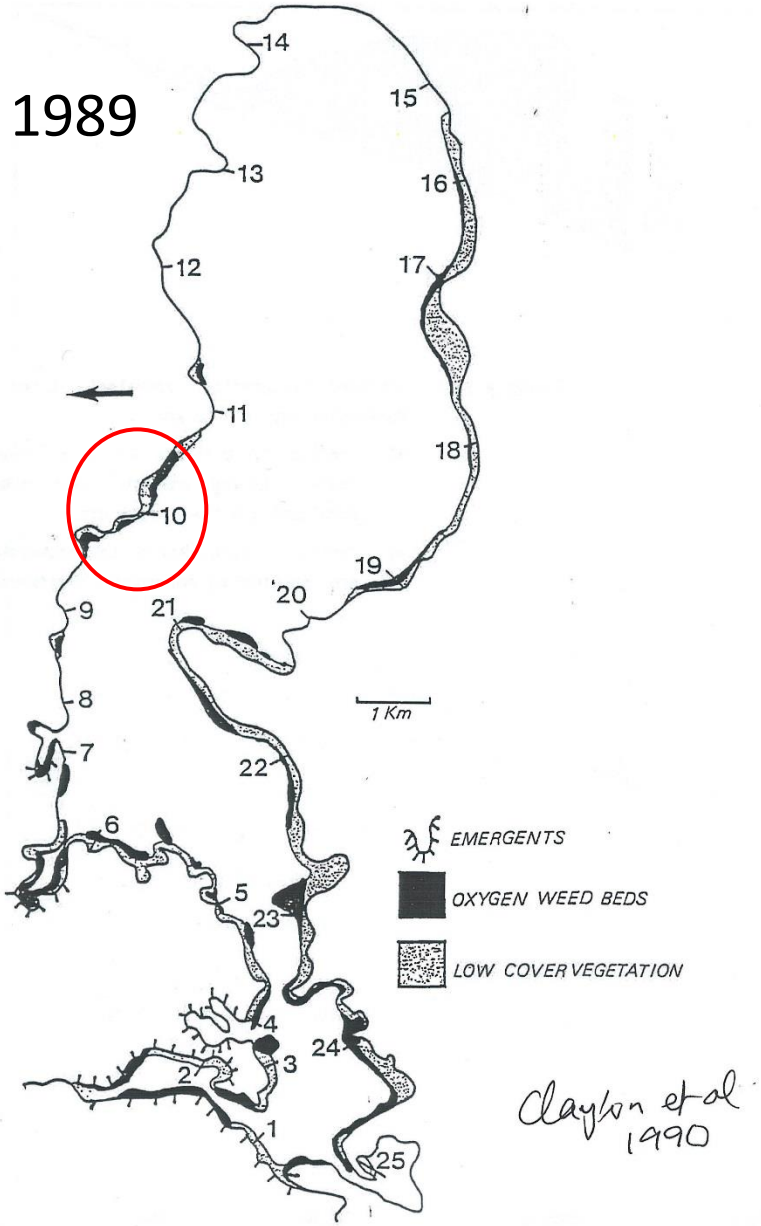
Okawa Bay has a history of rapid vegetation change between years and even at different times of year. Native species dominance follows spraying….

In late 1970s, successful twice-yearly spraying of Lagarosiphon resulted in a return of native *Potamegeton ochreatus* to Okawa Bay. This would, if left, have required control if residents wanted a weed-free bay…..Spraying will be needed for on-going management

1979



1989



2016?

Note: early Weed maps for L. Rotorua have been produced in 1963, 1967, 1970, 1973, 1976, 1978, 1985

- Succession is well known. We just need to compile this in a spatial manner. ie Succession in Okawa Bay, sucession on North vs South shores etc…

- Native weedbeds may extend further down the profile to deeper water (ie to a more natural state as water clarity increases) but exotic weeds such as Lagarosiphon and Egeria are not able to colonise deep water (ca 6m and Elodea can grow to 11 m)

- LakeSPI is a valuable monitoring tool for lake ecosystem health . It is not designed to measure weed distribution or to focus on specific weed management priorities

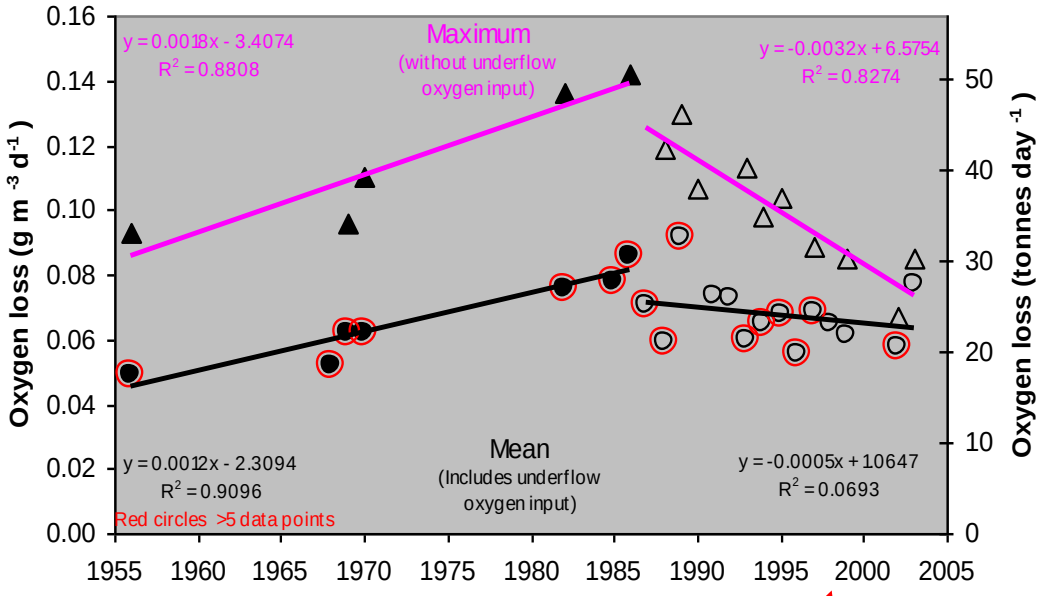
- Development of a lake- specific Aquatic Weed Management Plan for Lake Rotoiti (and other lakes) will be essential (negotiations now underway). This must include a remapping of the native and exotic weed beds for the whole lake.

- New technologies. Geo-referenced high sensitivity mapping (sonar based). Much quicker and cheaper, repeatable (Rowan Wells –NIWA)

Question 2. Altering geochemical and oxygen dynamics

From LWQS: Can the slow recovery of the anoxic hypolimnion be attributed to decay of the weedbeds that have established around the periphery of the lake?

1. Oxygen loss rate from the hypolimnion ca. 25 tonnes/day (Gibbs)



2. Macrophyte decay will contribute to this loss as it adds to the decay by phytoplankton and decay by other inflowing organic matter
and to the residual sediment oxygen demand that increased between 1995 and 1990.

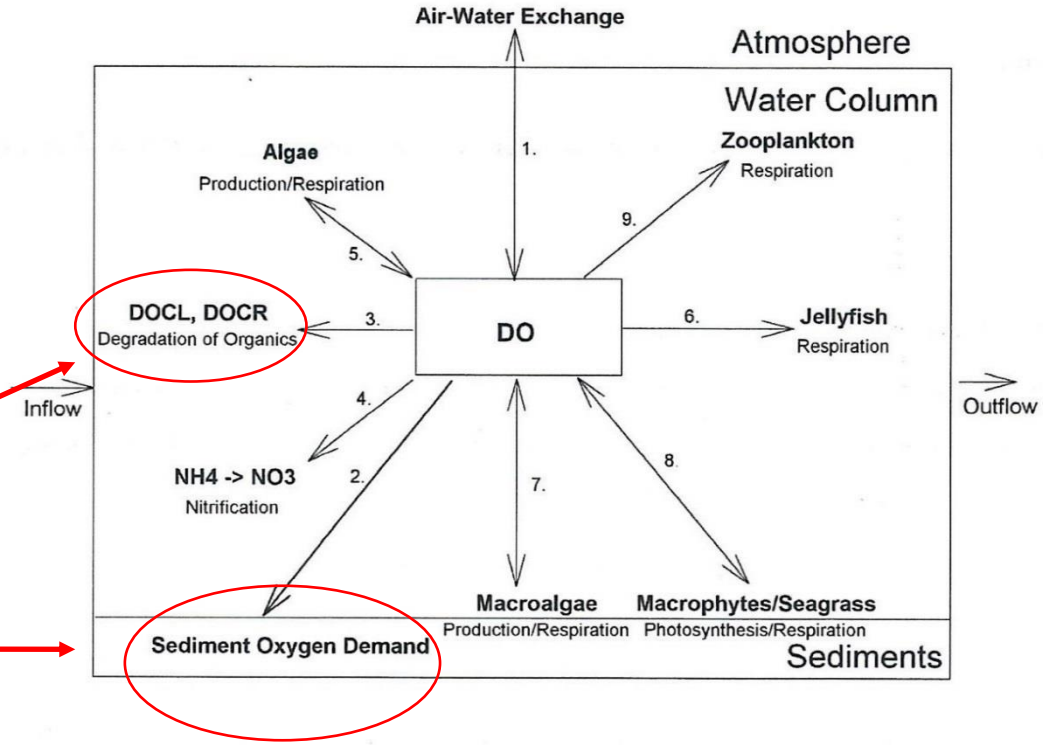


Figure 4.1 Simplified schematic of the dissolved oxygen (*DO*) dynamics within CAEDYM.

3. **Initial estimate of the contribution of macrophyte decay to Lake Rotoiti oxygen consumption:**

- Lake area 3435 ha; Dense (exotic?) weed bed area 225 ha (6% of total lake area);
  Lake weedbed biomass 2250 tonnes (@ 1kg (dry mass)/m^2) or 10 tonnes/ha)

- Production/Biomass ratio 1.2/1 (*Howard-Williams* 1986 for Potamogeton pectinatus *see also Vollenweider 1974*)

- Therefore, annual amount of weed that can be decayed = 2700 tonnes

- Total oxygen consumption over decay period for submerged macrophytes ca. 400 mg O2/g (dry wt) decayed (400 kg O_2/tonne dry wt) (*Bianchini et al. 2016*)

- Total oxygen consumption for the whole lake weedbeds annual production 2250 t x 400kg = 900 t O_2or **2.4 t/day**.

Therefore, assuming the total biomass of weedbeds ends up in the hypolimnion (not likely) oxygen consumption may contribute 10% to total oxygen loss from the lake's hypolimnion. This is an overestimate and is a static calculation.

Oxygen consumption is a dynamic process so would be better modelled using the ELCOM/CAEDYM model for Lake Rotoiti. Macrophyte decay can be included in pathway 3 of the CAEDYM Oxygen dynamics module.

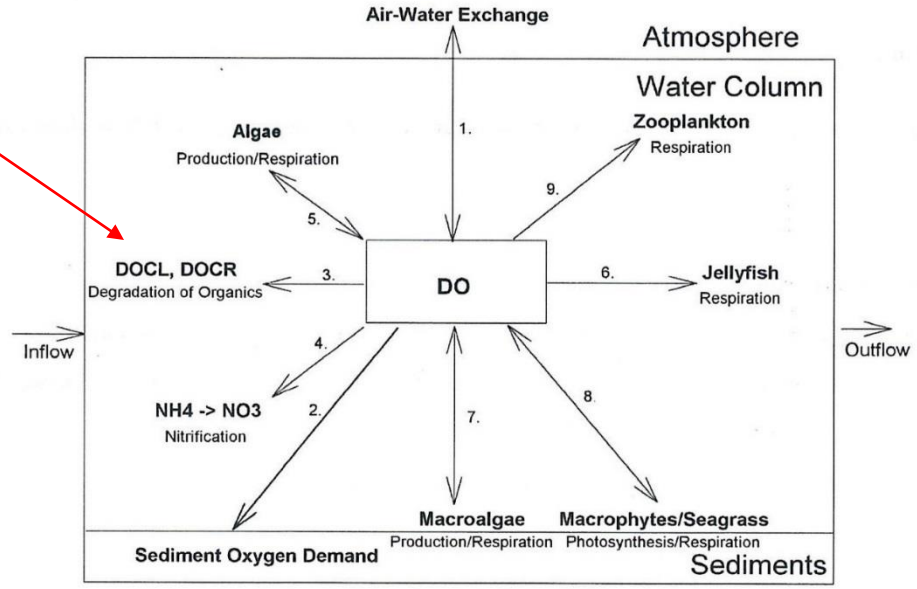


Figure 4.1 Simplified schematic of the dissolved oxygen (*DO*) dynamics within CAEDYM.

Salutary Reminder: **Recommendations for better aquatic weed management 15 years ago!**

Clayton J.S. and Wells, R.D.S 2001 Weed management in the Rotorua Lakes. In Lakes Water Quality Society Symposium on '*Research needs in the Rotorua Lakes*'

1. A management plan for aquatic plants in the Rotorua Lakes based on scientifically defensible management strategies and politically sensitive representations (Lake-specific 'Aquatic Weed Management Plans')

2. A Water Weed Technical Committee should be established to address broader issues of aquatic plants in the Rotorua Lakes and ensure wider agency, Iwi and public involvement (Can this be done through this TAG?)

3. An effective region-wide aquatic plant monitoring and preventative management programme should be established to maintain a current record of the extent and spread of existing weed species and to enable effective containment or removal of new infestations (This would follow any lake-specific 'Aquatic Weed Management Plans')