Wetland plants and their use in water Quality Management – Species selection

Introduction

A report to investigate the selection of plant species for swimming pool water quality control. Prepared by Dave Wilson of Aquagreen, PO Box 756, Howard Springs NT, 0835.

The report briefly touches on the qualities of twenty suggested plants for the cleaning of water in a swimming pool aquatic plant bio filter. This report highlights a need for further investigation of the antibacterial qualities of wetland plants, particularly wether the substances produced by the plants operate in the substratum or open water. there is also a brief look at setting up a natural plant filter for a swimming pool. This also has application to Garden Ponds and Aquaponics.

Background

Traditional water quality management in swimming pools has been the complete oxidisation of all organic matter with chlorine to remove the chance of the swimmers coming into contact with any harmful small organisms. This chlorinated water is generally unpleasant on the swimmers. In recent years salt with an electric charge to split the chlorine from the sodium has been used to similar effect. This is more pleasant than the original method of sterilisation.

Traditional water quality measurements for swimming pools is a general measurement of water quality parameters coupled with a measurement of the amount of bacteria present. The measurements are recorded then things added to the water to make up the levels of required substances to standard measurements. The Queensland Government has some printed guidelines available on line. A Reference is attached.

Hardness
The operator measures hardness, total hardness or general hardness with an inexpensive reagent test kit and adjusts it up with a form of soluble calcium and magnesium. Magnesium sulphate mixed with calcium chloride works and is available from pool shops or agricultural supplies.

Alkalinity
Other names for alkalinity are carbonate hardness or acid buffering capacity. It is lowered over time and adjusted up with sodium bicarbonate.

Temperature
Can be manipulated in the swimming pool by heaters or lowered with chillers. Generally not manipulated by the average pool owner. Solar heating is achieved by solar blankets or pumping water slowly through large lengths of small black tubing exposed to full sun.

pH
generally falls in a pool by the action of organic acids and is kept to neutral or higher with the addition of bicarbonate raising the alkalinity. It is measured with an inexpensive reagent test kit or a meter that has been calibrated.

Discussion

Difficulty with differing nutrient levels – it may be difficult to keep growing and managing a healthy stand of aquatic wetland plants with differing nutrient inputs and to keep enough growth occurring so that nutrient spikes are taken up quickly. This tendency can be countered by having some species that can react quickly to changing nutrient levels. Three species that come to mind are Hydrilla, Najas and Ceratophylum.

Nutrient import and export – Wetland plant filters rely on competition of the plants to remove nutrients in sufficient quantity to deny nutrients for, or conditions that would be suitable for undesirable organisms, large and very small to grow. Plants need to be able to keep the nutrient levels in the water very low to inhibit the production of harmful organisms. The wetland needs to have room to expand which will cause the need for regular harvesting.

Measurements in modern swimming pool water quality management are related to temperature, pH, total hardness, alkalinity, chlorine levels and bacteria counts. These numbers do not completely transfer to natural pools.
Measurements growing successful water plants include total hardness levels, alkalinity, nutrient levels, pH, temperature, light intensity and light duration.

Manipulating the plants to achieve the desired water quality measurements is something that may not be an exact science and will depend in some extent on the acquired skills and interests of the pool manager. It is advised that water quality records linked in with plant management practises and plant growth observations be kept to enable a clearer picture of what is happening. These records will also help when the qualities of an organic system are compared with those of the traditional methods of pool water management.

Wetland Plants and Bacteria Levels - The most difficult aspect of the plant filter in swimming pools will be the concept that wetland plants have the ability to kill harmful bacteria. The inhibiting chemicals produced by plants that inhibit the growth of harmful bacteria are called allelopathic chemicals. Plants produce complex chemicals that act on other plants, bacteria, invertebrates and fishes. These chemicals are produced to give plants an edge in the competition for space and defences against things that eat them.

Allelopathy is the main reason why the water exhausted from a healthy growing wetland filter will be very clean of bacteria. The choice of a plant that has good chemical control over bacteria will be very important to the success of the filter. There are plants that will also produce algae inhibitors. It is not the scope of this report to investigate the various qualities of bacteria inhibiting plants but they are one of the main keys to the ultimate success of the wetland plant filter.

Plant species that are mentioned as producing these chemicals are listed. Phragmites, Ceratophyllum, Potamegeton, Vallisneria and Myriophyllum. One of the best fighters of green water will be other alga such as cladophora which appears to inhibit the production of green water. The operator success in the management of the wetland plant filter will increase with his or her knowledge of the relationships between the various plants. Combinations of plants that fight against each other with the production of various chemicals will also enhance bacteria killing properties of the plant filter.

Further investigation into the anti bacterial properties of some of the allelopathic chemicals will help with understanding of wetland plant water filter. These substances include, alkaloids, terpenoids, sulphated phenoliuc compounds. If allelopathic reactions of plants can be induced via stress or combinations of plants that kill off harmful bacteria, this will be one of the best tools of the wetland plant filter manager.

The Plants

A suggested list of NT natives for the tropics. Other plants would be more suitable in cooler climates.

1. ***Lepironia articulata***

Common name - sometimes referred to as Blue Rush
Natural distribution – NSW, Qld, NT, WA, Madagascar, Fiji.
prefers sandy or organic substrates in water with stable levels to one meter deep.
Culture technique - Reproduced by seed but more easily by rhizome.
Use as a nutrient management species. It is reported in to be a good nutrient management plant with access among vegetation in shallow water for mosquito eating fish species.

2. ***Colocasia esculenta***

Common name – Native Taro

Natural distribution – native to Kimberley region of WA and NT. Found throughout Asia.

Preferred position in wetland, Grows in permanently wet places.

Culture technique, soils, fertilisers etc. Best grown in a substrate of low to medium nutrient. Propagation is vegetative or by seed, inducing the plant to set seed is not necessary as it sends out plenty of runners. Will grow best if grown in a substrate. Use as a nutrient management species. Traditional uses - Some Aboriginal people are reported to eat the tubers.

3. ***Hanguana malayana***

Common name - Hanguana

natural distribution – Native to NT and Qld and through South East Asia

preferred position in wetland, growth habit (Floating, emergent, preferred water depth etc.) Grows in permanently wet areas, a pure stand of 4 sq. kilometrs is present in the NT Arafura Swamp.

Culture technique, soils, fertilisers etc. propagation, vegetative or by seed, inducing the plant to set seed. Reproduced by vegetative propagation, produces long rhizomes. Slow growing producing pencil thick roots along the rhizome. Then hairs which hold sediment.

Use as a nutrient management species is not fully explored. Has some potential as an ornamental species.

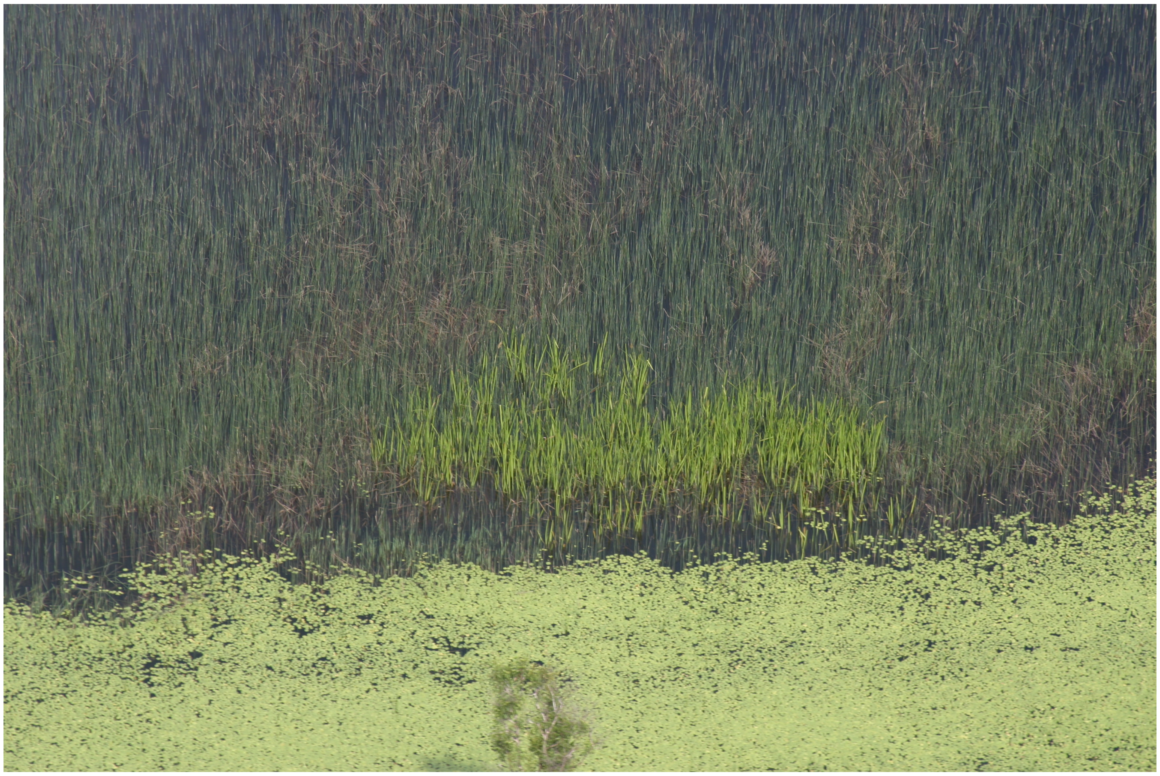
4. ***Phragmites vallatoria***

Common name – none known
Natural distribution – Africa, Asia, WA, NT, SA and Qld.
preferred position in wetland, growth habit (Floating, emergent, preferred water depth etc.) Grows in shallow water along the margins of floodplain swamps and along rivers.
Culture technique, soils, fertilisers etc. propagation is vegetative or by seed, inducing the plant to set seed is not necessary as it is easily reproduced by vegetative means. Use as a nutrient management species is not fully investigates but its southern relative is reported to be used as a wetland plant filter and used for cardboard manufacture. Traditional uses include the shaft of a small fast spear called Dhindhie, the invisible spear I East Arnhem Land, you cant see it coming.

5. ***Schoenoplectus litoralis***

Common name – called bulrush on a couple of over seas web sites.
natural distribution – Southern Europe to Australia, NT, Qld, WA.
Preferred position in wetland, growth habit – grows in shallow waters around the margins of swamps and inland rivers forming large stands. Also has tolerance to salts. Propagation is vegetative or by seed, inducing the plant to set seed is not necessary as it multiplies vegetatively easily. Its use as a nutrient management species is not fully investigated.

6. ***Actinoscirpus grosus***
Common name - Bull Sedge
It grows three meters tall and has a three sided stem.
Natural distribution – Pakistan, Indo China to Northern Australia
Preferred position in wetland is shallow waters on clay soil.
Propagation is by seed or vegetative.
Use as a nutrient management species is not fully investigated



7. ***Scleria poaeformis***
Common name – No common name aparent.
A tall rush to 2.2 meters with pale green leaves. Looks like typha at first glance except the plants are pale green.
Natural distribution – Africa, from India through Indo China to Northern Australia, NT and Qld.
Preferred position in wetland – Grows in shallow water forming large clumps. Grows in low nutrient areas in organic substrates.
Propagation is best done vegetatively or it will reproduce by seed.
Not investigated as a wetland filter plant but because of its ability to grow in sandy low nutrient areas may be suitable.

8. ***Eleocharis sundiaca***
Common name – None known
Natural distribution – Indonesia and Australia (WA, NT)
Mid to dark green tubular stem to 1.2 meters high.
Preferred position in wetland - Grows in water to a meter deep forming large colonies, grows on clay or sandy soils in seasonally inundated swamps
Culture technique – reproduces by seed or vegetatively spreading by a thin rhizome
Propagation is by seed or vegetative.
use as a nutrient management species is not fully investigated but this species appears to be tolerant of a wide range of wet habitats. It is found in very nutrient poor areas.

9. ***Eleocharis geniculata***

Common name – Canadian Spikesedge used over seas.
Natural distribution – North America, widespread throught tropical and subtropical areas globally, in Australia it is recorded in WA, NT, SA and Qld.
Preferred position in wetland – Grows on the edge of wetlands, creeks, swamps and billabongs.
Propagation is by seed or vegetative. Spreads easily by seed. Grows in low nutrient areas.
Use as a nutrient management species is not fully investigated.

10. ***Monochoria vaginalis***

Common name – none found

Natural distribution – Japan, China, South east Asia, New Guinea and in Australia it occurs in WA, NT and perhaps Qld.

Preferred position in wetland – Grows on the margins of non permanent creeks and billabongs during the wet season.

Propagation is by seed.

Use as a nutrient management species is not fully investigated. The species is used as a vegetable in southern and eastern Asia. It is also used as a medicinal plant in Asia, the roots and leaves are used to treat asthma and stomach ache.

11. ***Ipomea aquatica***

Common name - Kankong

Natural distribution – Pantropical, in AustraliaQld, NT and WA.

Preferred position in wetland – grows on the margins of wetland swamps and billabongs sending floating stems across the surface. Propagation is by seed or vegetative. Send long vine like runners across water surface. Use as a nutrient management species is not fully investigated. Its other uses include an Asian food vegetable where the leaves and stems are consumed.   Aboriginal people dig up the tuber or yam and use that as food. The native form is slightly different to the form available at Asian vegetable markets.

12. ***Ludwegia adscendens***
Common name – not known
Natural distribution – From India to China down to North Australia where it occurs in NT and Qld.
Preferred position in wetland – grows on margins of billabongs and floodplain channels, on drying mud after receding wet seasons. Grows on floating mats of vegetation.
Propagation is by seed or vegetative. Send long vine like runners across water surface.
Use as a nutrient management species has been looked into and the plant has shown broad scale antbacterial attributes and should be included in any swimming pool filter.

13. ***Persicaria attenuata***

Common name - Knotweed

Natural distribution – Timor, New Guinea and in Australia it occurs in NSW, Qld, NT, WA and SA.

Preferred position in wetland - Grows in wet soils out into deeper water of floodplain billabongs.

Propagation is by seed or vegetative. It sends long vine like runners across water surface.

Its use as a nutrient management species has not been fully investigated however there are reports that this species has some antibacterial properties.

14. ***Ceratopteris thalictroides***

Common name – Native Water Sprite
Natural distribution – Pan-tropical, in Australia it occurs in NSW, Qld, NT and WA.
Preferred position in wetland - grows on the margins of floodplain billabongs, swamps and slow flowing rivers. Can grow in deep water as a floating plant.
Propagation is vegetative with small plantlets being produced from mature leaves.
Use as a nutrient management species is not investigated. It is used as an edible vegetable in Asia.

15. ***Marsilea mutica***

Rainbow Nardoo
Natural distribution - New Caledonia and all mainland states in Australia
Preferred position in wetland – Grows in shallow water and on wet soil.
Culture technique – it reproduces itself vegetatively.
Propagation is vegetative. Send long vine like runners across water surface.
Its use as a nutrient management species is still under investigation.

16. ***Pistia stratiotes***
Water Lettuce
Natural distribution – Native to Qld and NT – Pantropical distribution.
Preferred position in wetland – Floats in water of all depths
Culture technique – grows floating in water or on mud, reprocuces mostly be thin rhizome and can grow into a large volume in a short time with the correct conditions.
Use as a nutrient management species is nor fully investigated but will be useful in the rapid uptake of nutrients.

17. ***Hydrilla verticillata***

Common name – Water Thyme
Natural distribution – Southern Europe, Africa, Australia. Introduced to the Americas where it deemed a weed.
Preferred position in wetland – a fully aquatic plant using all areas in the waterway.
Propagation is mostly vegetative.
Use as a nutrient management species has not been investigated but it may be useful as it has the ability to grow rapidly taking up water nutrients from a broad range of water quality parameters.

18. ***Najas tenuifolia***

Common name – Water Nymph
Natural distribution – endemic to Australia found in all mainland states except SA.
Preferred position in wetland – fully aquatic, grows in many depths, has the ability to completely fill a billabong toward the end of the dry season.
Propagation is mostly vegetative.
Use as a nutrient management species has not been investigated but it may be useful as it has the ability to grow rapidly taking up water nutrients.

19. ***Vallisneria caulescens***

Common name -Branching Vallisneria, Natural distribution – Queensland endemic. Preferred position in wetland, growth habit – grows submerged, fully aquatic in water from a few cm to several meters deep. Propagation is mostly vegetative but will set seed if both sexes of plant are present. Use as a nutrient management species has not been investigated but this plant will grow rapidly to take up nutrients.

20. ***Vallisneria nana***

Common name - Native Val
Distribution - Tropical Australia NT, WA and Qld
Preferred position in wetland, growth habit – grows submerged, fully aquatic in water from a few cm to several meters deep.
Culture technique, soils, fertilisers etc. - propagates by vegative methods, also sets seed if male and female plants are present. Inducing the plant to set seed can occur in cooler weather or if starved of nitrogen. It will spread rapidly when nutrients are present, if a form from a low nutrient area is obtained it would better suit swimming pool filter in the substrate section.

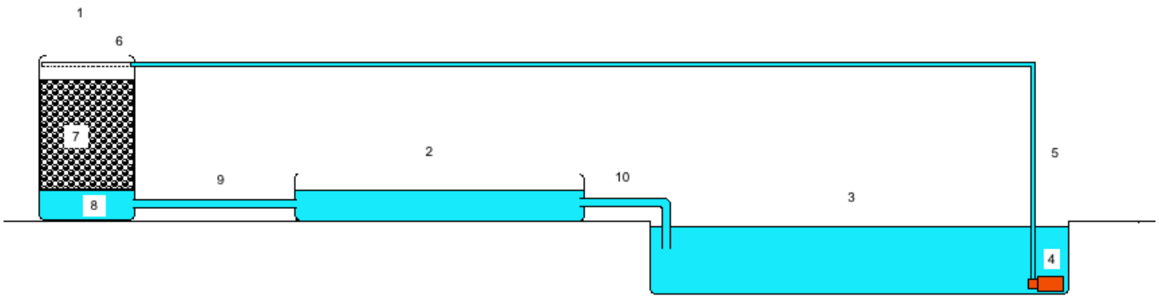
Potting Mixes and submerged substrates.

Potting mixes for plants are basically two types, a rich mix we call floodplain mix. A poor mix we call escarpment mix.

rich mix - equal parts fine shall grit, peat (no coco peat) local laterite soil.
poor mix equal parts river sand, peat (no coco peat) local laterite soil

Fertilisers behave differently in water and if misused can cause lots of algae.
Problem solving is a huge subject that can be dealt with later. Algae is a big subject.

A concept plan for a pool with a plant filter.



1. Bio filter, approximately 10% of the pool size
2. Plant filter, 50 to 80 cm deep approximately 40% of the pool volume, filled with various water plants
3. Natural swimming pool, a place to swim with your fish
4. Low wattage circulating pump to turn over the pool volume once every 4 hours.
5. Pipe line from pump to bio filter
6. Spray bar at top of bio filter medium
7. Medium such as tied up bags/balls of waste plastic shade cloth
8. Space filled with water at bottom of bio filter, a large drain tap to flush sediment accumulation
9. Balance pipe from bio filter to plant filter
10. Balance pipe from plant filter to swimming pool

Water quality management in a plant pool filter involves keeping general parameters similar to the traditional pool except no chlorine or salt is used. The following levels are a suggestion and designed to help with plant growth. Where possible plant friendly minerals are used in the manipulation of water quality and are the same as one would do in a normal fish pond. The following numbers and minerals are a suggestion to get one started and can be manipulated to suit conditions if changes are required.

General Hardness - a suggested level is 100 to 200 parts per million (PPM) the tendency is to fall and the level is increased with dolomite lime which dissolves slowly, also lime mixed 50/50 with magnesium sulphate can be used. Using the previous minerals one adds approximately 20 grams to the ton of pond water to raise hardness 10 ppm. This is not an instant result and some time must be allowed when dolomite lime and garden lime are used. Another mix used by author in aquatic plant production ponds is a mix of 10parts Potassium sulphate, 7 parts Magnesium sulphate and 6 parts calcium chloride. This will give a more instant rise in hardness levels and 20 grams of the above mix will increase hardness by 7.2 ppm.

Alkalinity or Carbonate Hardness
Known as KH in the aquarium world and Alkalinity in the swimming pool world it is not total alkalinity as used in the chemistry world but a measurement of the acid binding capacity of water measured by dripping (titration) a weak acid solution into a sample of pool water with a small amount of pH indicator added. The indicator changes colour when the solution has enough weak acid dripped into it to reach a pH of 4. The adjustment of this parameter is done by adding a bicarbonate, in the

swimming pool Sodium bicarbonate is generally used but in a natural pool it is suggested that Potassium bicarbonate be used to adjust up the

pH - generally fussed over by the fish keepers but is just an indicator that acid levels need adjusting up, or if a very high pH is present in the water then there can be a danger for the fish if there is a sudden rise in ammonia/ammonium, the ratio of these changes with ph and in high pH the water is more toxic to fish life.

Temperature
Temperature can be manipulated by heating or chilling, light and shading help, if the water needs to be warmed a series of black plastic pipes can be used as a solar heater. Tall reeds in the plant filter can be used to shade the water along with more floating plants such as water lettuce. The pool is best kept under a shade house with 50 or70 % shade cloth.

Conclusion

The use of wetland plants to keep water clean for a swimming pool is a worthwhile pursuit that will help rid the environment of nasty chemicals used in water quality control. I am also convinced that there will be other health benefits not yet recognised for the users of such a pool. The relationships between a plot of healthy plants and animal health is not fully understood but most people know that it is an enlightening experience to be in a forest surrounded by healthy growing plants.

If you keep notes and record observations, eventually will come up with a community of wetland plants that achieve results that are comparable to the known chemical control of water quality.

Recommendations

That, throughout the development of the project you keep records with observations of water quality compared to plant growth. These records will be valuable if you publish your results.

That you keep investigating the qualities of various plants and substrates to see which produces the most efficient control over water quality and bacteria levels. It is possible that combinations of various plants together may react with each other chemically to give greater bacteria killing efficiency.

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