
Proven Methods for Creating and Maintaining a Pond That's High in Pleasure and Low in Work.
Pond Basics 4
New in this 4th Edition
Expanded Information on
• Bacteria
• Aeration
• Pollution Control
• Floatation Gardening

What's New in Pond Basic's 4th Edition

In this edition you'll find full color and new articles dealing with Flotation Gardening, including Floating Wetlands, retention pond maintenance, aeration, bacteria and controlling pond pollution. Also, we've updated the entire book to reflect the latest information available.

The format of this book is simplicity itself: Pertinent points are covered in "bullet item" form supported by easy to understand illustrations. In-depth articles are included where a lengthier discussion is appropriate.

This volume represents over 60 years of accumulated water gardening experience by principal staff members of Maryland Aquatic Nurseries (M-A-N) and Charleston Aquatic Nurseries (C-A-N). This collaboration, we feel, gives the book more depth than might be possible had it been written by one individual.

Throughout the book you'll find references to specific ideas and methods that incorporate some of our own products. Please understand that the essentials of successful high pleasure / low work water gardening remain the same no matter whose products you use.

For more information about our products visit us at:
www.aqua-link.com & www.floatingwetlands.com

This edition of Pond Basic is Dedicated to . . .

Laurence Gedye

Gedye Water Gardens
Melbourne, Australia
1930 - 2007

A truly gentle man,
an entrepreneur extraordinaire,
a life long water gardener
and our good friend.

'Laurence Gedye'

Table of Contents

Contributors

Kelly Billing
General Manager, M-A-N

Bobbi-Jo Ayers
Production Manager, M-A-N

Brian Schuck & Stuart Schuck
Co-Owners, C-A-N

Sharon Schuck
Graphics/Photography

Richard Schuck
Owner, M-A-N

4th Edition, April 2007

Water Gardening . . .

Pond Aesthetics

For large ponds, statuary can add an elegant focal point, but in a small pond it may not unless the pond is formal in design.

If you can, group tropical lilies separately.

Hardy lilies can be the same color in a grouping or mixed.

Water Gardening . . .

If you want your pond to be part of a larger garden, don't ring it with rocks. Use rocks only as an occasional accent - not the main event.

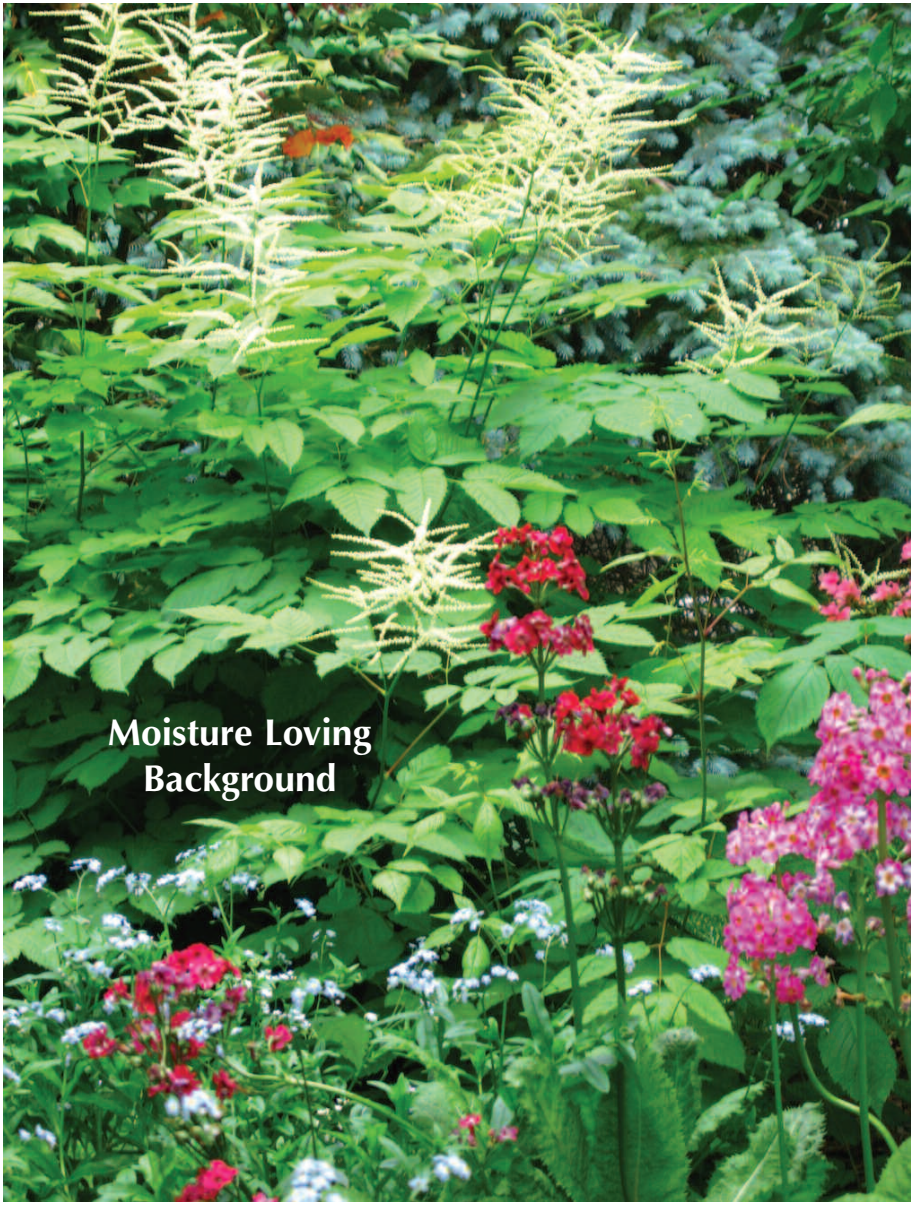
A seamless transition from pond to garden will soothe the eye.

"A lovely way to garden." 7

A stream leading to the pond is usually a good idea. Use rocks to edge the stream and naturalize it's appearance.

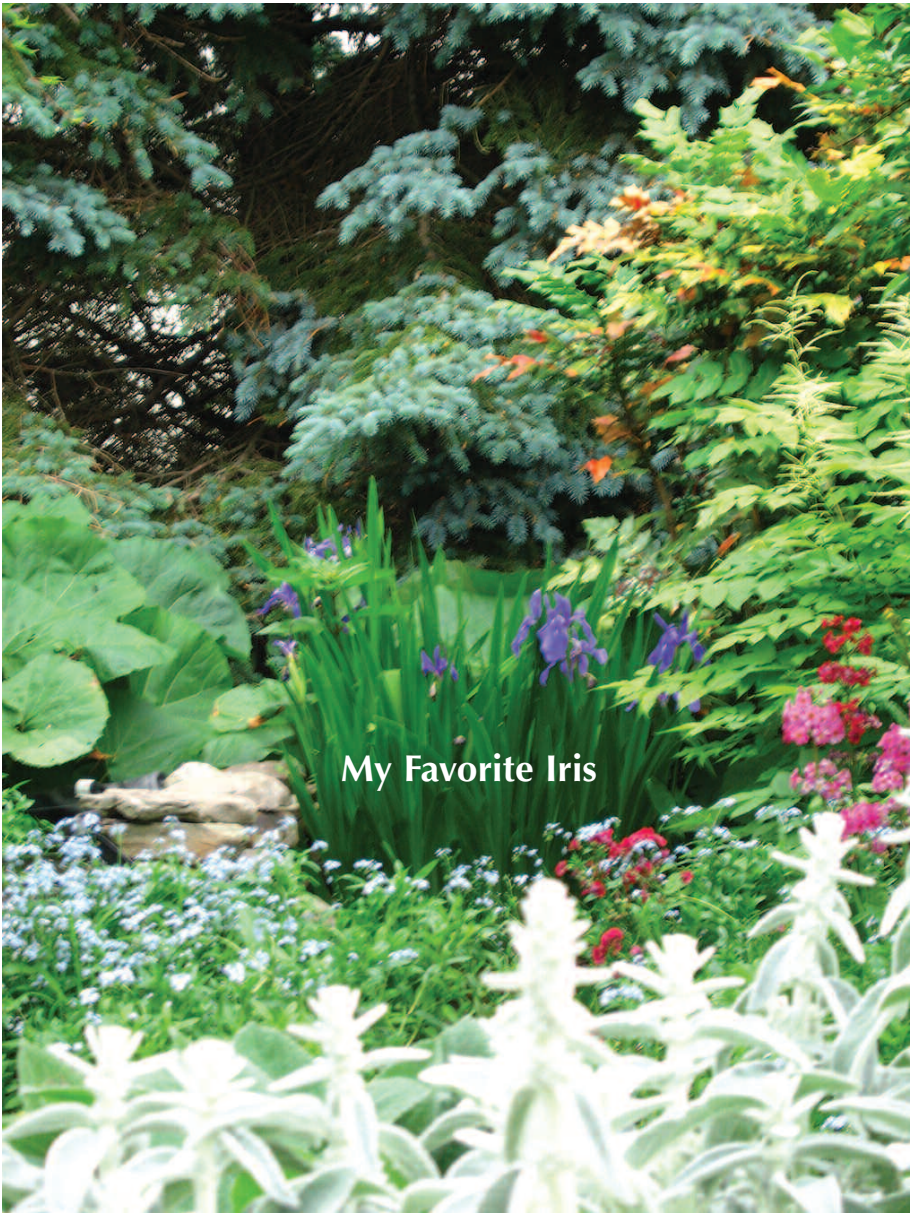
Water Gardening . . .

A waterfall doesn't need to be so large as to dominate the overall garden. Keep it in scale.



Use moisture-loving plants in damp or shady places to provide background or points of interest around the pond or stream.

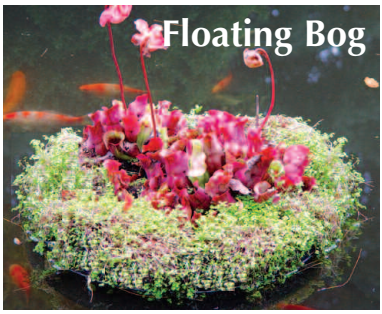
Water Gardening . . .



A stream is a good place to plant Iris, Primula and Forget-me-nots. The Iris featured above is Iris laevigata.

Keeping a level view.

When butting the pond up against a terrace or deck, raise the water level of the pond to equal that of the terrace. This makes the pond and terrace look bigger. To do otherwise, would cause a rude interruption to the eye.



Floating Bog

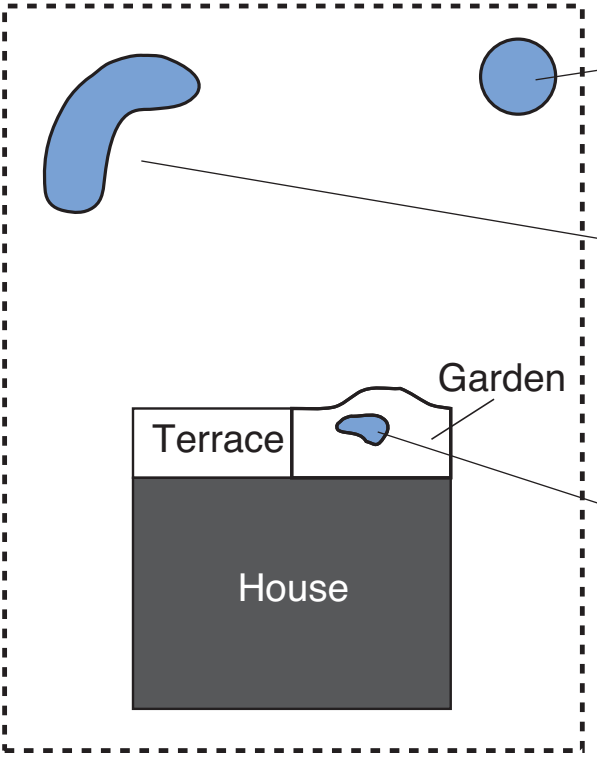
One final thing . . . Don't forget to use Island Planters to add color and interest to the pond. The bog plant pictured is Sarracenia purpurea.

Design

A Well Designed Pond is ...

- **attractive in shape and the focal point in the overall landscape.**

Make sure your pond is the focal point of your overall land scape. It should be large enough to make a statement. Violate this rule only when placing the pond in an intimate garden setting such as a patio garden near your house.



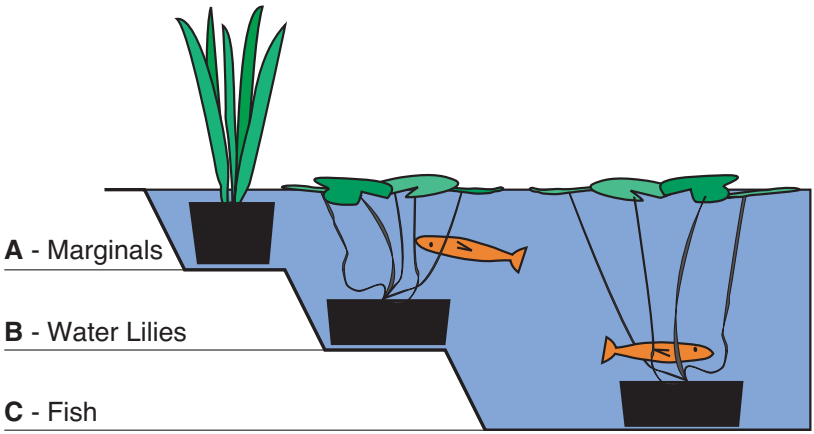
TIP:

Keep in mind that formal shapes (round or rectangular) are best suited to formal garden settings. For non-formal settings, free form ponds as shown above generally blend in better.

- **a healthy habitat for aquatic animals.**

  Install a well designed filter system (see the section on filtration) and make the pond deep enough so that your fish can find protection from harsh weather and predators. Provide a planting area for water lilies and marginals that shades at least 60% to 70% surface during the mid summer heat waves.

Depth Chart for a Healthy Habitat



Plant Hardiness Zone *	A Marginals	B Water Lilies	C ** Fish
9, 8	10" to 12"	12"	24" to 36" ***
7, 6	10" to 12"	18"	24" to 36"
5, 4	10" to 12"	24"	30" to 36"
3	10" to 12"	30"	36" to 40"

*** See the USDA map on the last page to determine your zone.**

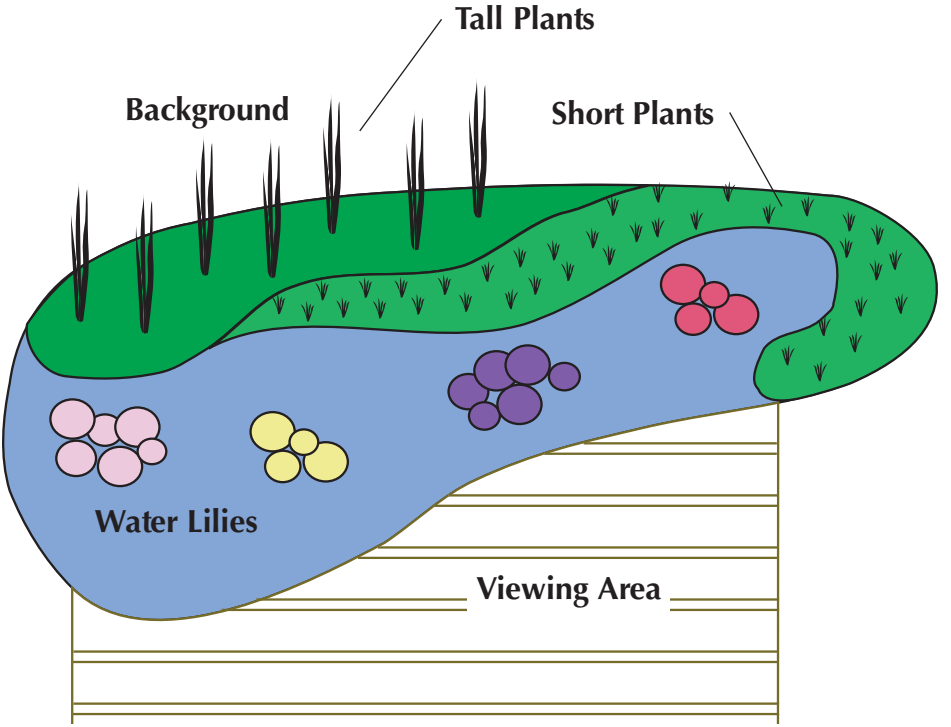
**** In warm climates the deeper depth is to protect fish during the long hot summers. In cold climates, it's for winter weather protection.**

***** NOTE: Always check maximum allowable pond depths with your local zoning and/or permit office before planning your pond. Some jurisdictions require a fence if a pond is over a certain depth.**

Design *(cont.)*

- **a showcase for beautiful water plants that are properly arranged.**

  Place tall, leafy plants in the background, short plants in the foreground or fronting the tall plants. Do not ring your pond with plants, but place them where they will be the most pleasing to the eye. See the section on plants for size and location of plant shelves.

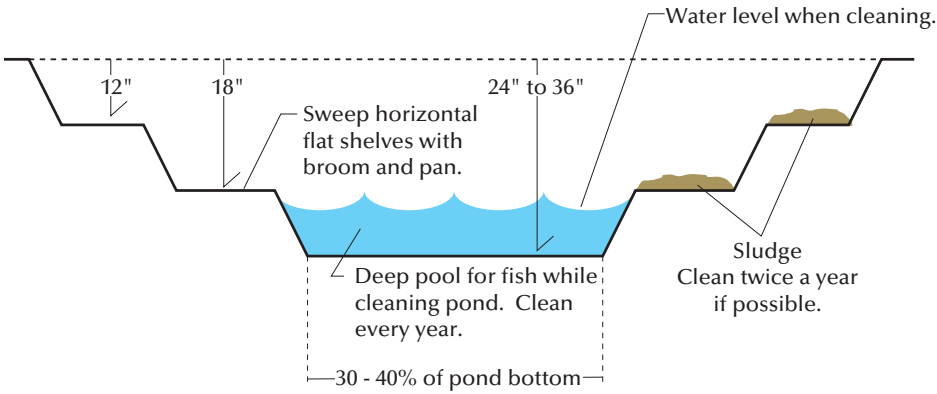


Tip:

It's usually a good idea to place the deepest part of the pond next to the viewing area. This creates a close-in deep pool within which to view and feed the fish, adding interest.

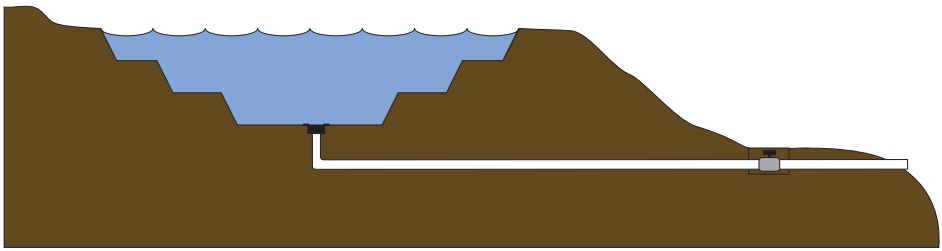
- **easy to clean and maintain.**

Use step-like shelves that can be swept free of sludge. These planting areas (shelves) should be equal in size to 60% - 70% of the surface area of the pond.



Tip:
If the area around your pond is sufficiently sloped it may be possible to install a bottom drain as illustrated below. When feasible, a bottom drain will greatly facilitate cleaning.

NOTE: **Drains should generally be at least 3" in diameter.**



Design (cont.)

Low Maintenance Pond Design

Question:

How hard is it to maintain a water garden? Some people think pond maintenance can be a real nightmare.

Answer:

Ponds are not a horror story to maintain when they're designed with maintenance in mind. The worst job is pond cleaning which should be done annually. Even this job isn't too bad if you design and build your pond properly.

Ponds accumulate organic matter from that which grows within them and particulate matter from the atmosphere including dust, pollen, etc. If left alone and not cleaned, a pond will eventually fill up with accumulated organic matter. This process, called wetland succession, is relentless and unavoidable. Thus, no matter what you do, eventually you'll need to clean the sediment or gunk from your pond.

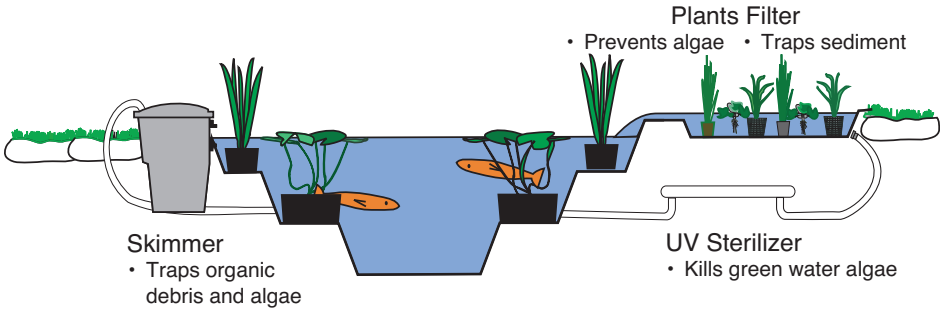
To ease this task, build your pond so that the sediment is easy to remove. If possible, build three levels into the pond as shown in the upper illustration on page 15. The shallowest level, about 12" deep, is a planting shelf for shallow water plants. The middle level, about 18" deep, is a deep shelf for water lilies and other deep-water plants. The bottom level, 24" to 36" deep, is a refuge for your fish, frogs and other pond animals. The planting shelves should account for about two-thirds of the total pond bottom. Make sure these shelves are flat and smooth so that you can remove the accumulated gunk with a broom and a pan after you have emptied the pond down to the top of the deepest or refuge level. This is a very simple task, and once accomplished, you will have cleaned two-thirds of the pond without having removed the

fish. The last step is to drag a net through the refuge area bringing as much stuff as possible up onto the middle shelf for removal with broom and pan. You won't get everything, but you'll get the vast majority of sludge and debris out of your pond without removing your pond animals and undergoing a laborious back-breaking task in the process.

Once having built an easy-to-clean pond, the next step is to add a skimmer, a plants filter* and a UV sterilizer. These elements will directly reduce the accumulation of gunk. How do these elements do this?

First, the skimmer will remove leaves and particulate matter directly from the pond's surface before it travels to the bottom of your pond. This skimmer action directly reduces the buildup of decayed organic matter in your pond. The skimmer basket also traps a surprising amount of algae.

Second, the plants filter will trap a tremendous amount of sediment from your pond where it can be flushed out a drain in the bottom of the plants filter which is above ground level. Additionally, the plant roots in the filter will consume ammonium and nitrate nitrogen which will greatly reduce green water algae in your pond. This reduces sediment build up as algae eventually become sediment when they die. The plants filter is also an enriched area of bacterial activity that helps digest sludge by converting it to gas and /or liquid form. Remember too that



* See the article on How to Build a Natural Plants Filter - page 37.

Design *(cont.)*

plants remove toxins from the pond water. This makes partial water changes all but unnecessary for keeping water healthy for your fish. Clean your plants filter once a year when you clean your pond.

Lastly, the UV sterilizer is added to the pond system to kill algae directly with ultraviolet radiation. Why is this UV necessary? It's necessary when your plants are dormant in the plants filter and thus not consuming algae-causing nitrogen. This occurs typically in late fall and early spring when algae is active but your plants aren't. Algae, besides contributing to gunk, are very good at clogging filter pads. Cleaning filter pads is a job that's nice to avoid.

For extremely dirty ponds, you might try sludge reducing bacteria. These bacteria may help to reduce pond sediment. I also use a protective pump enclosure which prevents the clogging of the sump pump in the pond but does not require cleaning itself but once a year. As you know, cleaning clogged pumps is no fun.

Finally, I don't put stones or gravel in the bottom of the pond and I keep my plants in pots rather than plant them directly in the bottom of the pond. While I understand the rationale for gravel and planting without pots, I believe that these measures complicate cleaning the pond and make plant maintenance and control more difficult. A good plants filter will provide more bacterial activity than gravel and remove more nutrients via photosynthesis activity.

My wife, Sharon, and I clean our pond once a year and we do it in less than a day - despite the fact that the pond measures 26' by 70'. What makes this possible is that the pond is built and equipped as recommended in this article. The planting shelves are quite expansive which allows me the enjoyable task of wading through it every Sunday morning, when the weather is warm, and pruning my water lilies and other plants. It's great fun and not a horror story at all. Dick Schuck

A Contrarian View of Koi Pond Design

Many, if not most, koi experts recommend ponds that are deep and steep sided. I believe that long and shallow is better, and that a good koi pond design incorporates the following design parameters:

1. **At least 20' long for koi to swim in long sweeps back and forth.**

2. **Expansive shallow areas 12" deep for growing marginal plants. At least 1/3 of bottom for marginals is a good standard.**

3. **Another 1/3 of the bottom 18" to 24" for lilies and other deep water aquatics.**

4. **Only 1/3 of bottom 3 or more feet deep for koi refuge.**

Such a design affords the koi the kind of exercise they need to reduce stress. It also affords them ample shallow areas for algae grazing, something that's essential to their good health. Algae contain the vitamins and nutrients they need. Shallow areas also provide areas for growing aquatic plants that provide shade and cover for the koi and nutrient reduction in the pond. Given this kind of pond where koi can exercise and graze on algae, they will generally ignore the plants. A well planted koi pond then becomes a beautiful garden as well.

Dick Schuck

Pond Basics

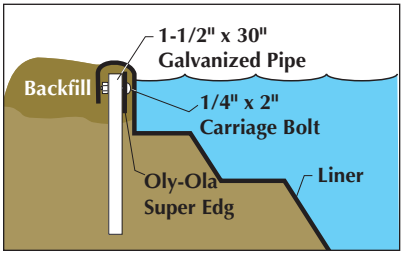
Construction

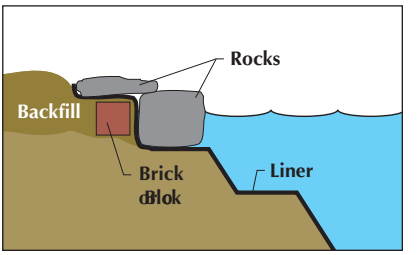
A Well Built Pond ...

- has a level edge that is pleasing to the eye.

- has a secure edge that is impervious to foot traffic damage.

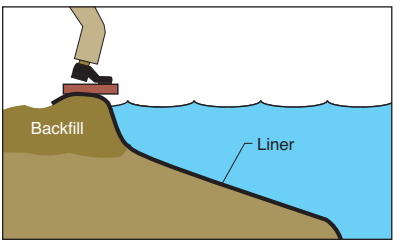
Secure Edge Designs



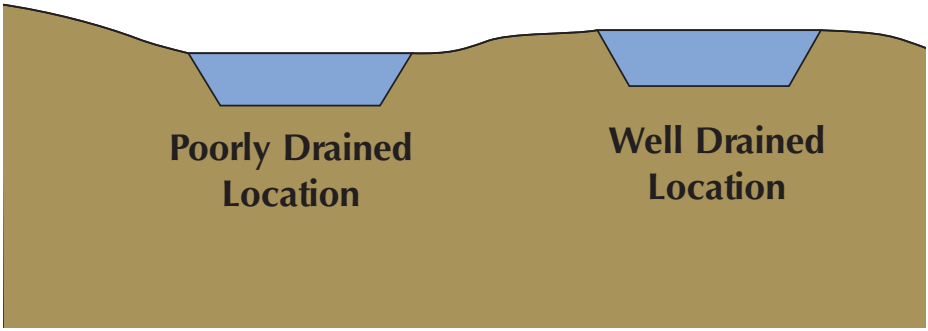


Non-Secure Edge

Foot pressure may depress the edge below water level.



- **is situated in a well drained area.**



- **is constructed of durable, long lived materials.**

Use good quality materials that will last 15 to 20 years. For example: EPDM rubber will outlast PVC liners; galvanized steel is stronger than PVC pipe; stainless steel nuts and bolts will outlast zinc coated.

Why Use Garden Style Edging?

The advantage of using a heavy duty garden edging, like Oly-Ola Super-Edg, is that it's a simple, labor saving and inexpensive way to achieve both a level and secure edge. The edging is strong and resists depression from foot traffic. It can also be lowered or raised by changing it's bolt locations on the pipe or by simply raising or lowering the pipe or galvanized stake. This adjustability allows you to achieve a perfectly level edge.

Construction *(cont.)*

Determining Liner Size

The formula for computing the appropriate liner size is as follows:

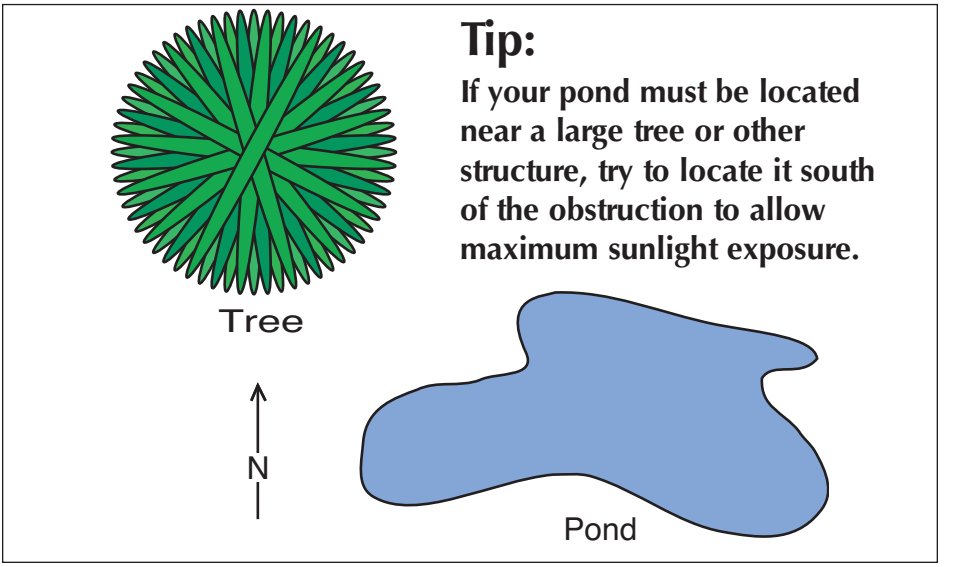
Width: **Pond width + 2 times pond depth + 2' for edging.**

Length: **Pond length + 2 times pond depth + 2' for edging.**

For example, if you plan to install a pond that will be 8' x 10' (at it's largest points) and 1.5' deep (at it's deepest point) you would need a liner that is 13' wide X 15' long. (2 X 1.5) + 2 = 5' added to the length and width. We highly recommend Firestone PondGuard 45 mil EPDM rubber liner for it's durability, fish safety and long life.

Things To Consider When Locating Your Pond

1. Your pond should be constructed in an area with at least 6 to 8 hours of full sun, if at all possible, to allow your pond plants to perform their absolute best. Placing your pond away from trees will also reduce spring and fall maintenance caused by flowers, seeds and leaves falling into your pond. Tree roots and sharp



rocks can puncture even the strongest pond liner. These should be removed or covered with a pond liner underlayment.

2. If your pond will be placed in an area where run-off from your lawn may occur, a small berm placed around the pond will direct run-off away. This is advisable as lawn run-off can contain pesticides, fertilizers and herbicides that are detrimental to your pond plants and fish.

3. When planning the layout of your pond, consider where you'll most often be viewing it from - patio, deck, etc. Careful placement of your shallow water area(s) can have a dramatic impact on the success of your pond. A shallow water area near your primary observing area can hold low growing plants (Parrots Feather, Water Mint, Dwarf Bamboo) to provide a foreground to your view of the pond. A shallow water area in the back of the pond can hold taller plants (Water Iris, Rushes, Cattails) and provide a background to your view.

4. Shallow water areas should be wide enough for larger containers when plants mature. Tall or leafy foliage plants require large containers to act as a ballast so that they won't be easily knocked over by the wind. See the chart in the Planting section (page 46).

Installation Procedure

Warning: Before beginning the installation of your pond you must determine if any underground utility lines run in the area you plan to use. Digging before doing so may result in serious injury or death.

Diagram 1 (Next Page)

1. Install 4 stakes in the ground making a rectangle the approximate size of the pond you intend to install. Keep in mind that the intended site need not be perfectly level. The dirt you remove for the pond can be used to fill low spots.

Pond Basics

Construction *(cont.)*

2. Using a garden hose or rope as a guide, layout the shape for your pond within this rectangle. Take your time at this point since once you've installed the pond the shape is not easily changed.

3. Once you've decided on the shape of your pond, drive stakes every 2' around the perimeter to mark the ponds edge.

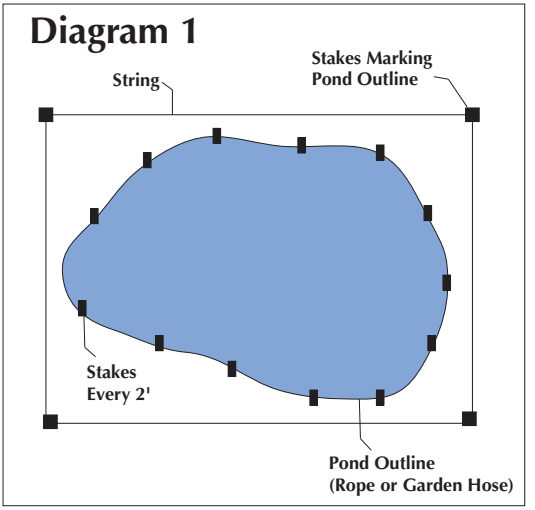
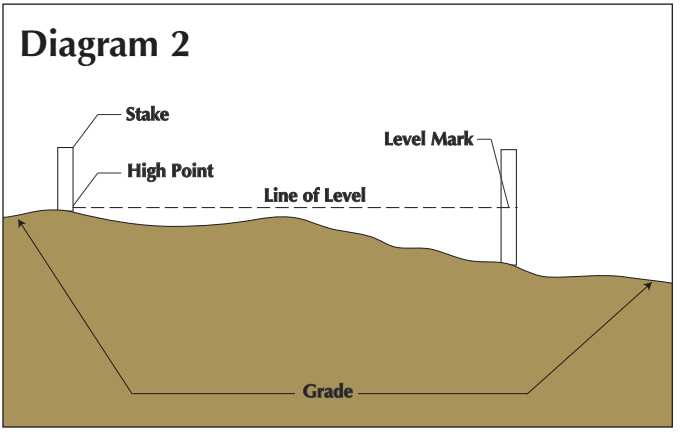


Diagram 2

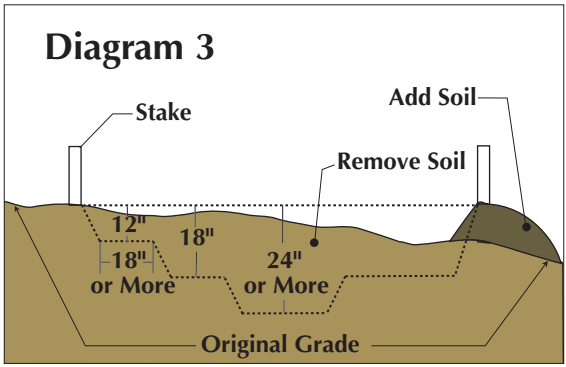
4. Using a string level or a carpenters level and a straight board, determine the grade of the site. Find the stake that is at the high point and, using the level, mark the line-of-level at each of the other stakes.

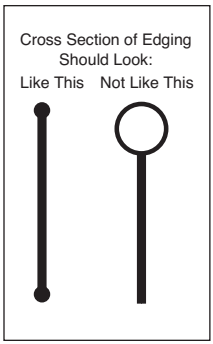


Diagrams 3 & 4

5. Decide if and where you want a shelf for shallow water plants. (Although this isn't absolutely necessary, we highly recommend one.) The shelf should be 10" to 12" deep and is best located at the back edge of the pond so that the plants will form a background. The shelf should be at least 18" wide and can be wider if you wish. See Diagram 3 for additional ideas.

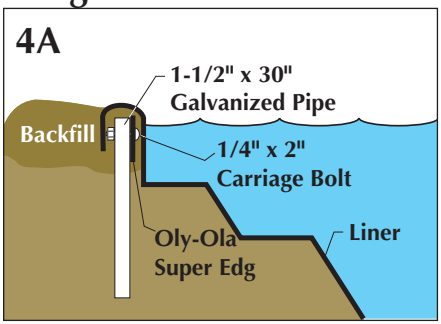
6. Decide how you want to edge your pond. Diagram 4 below offers four possibilities.

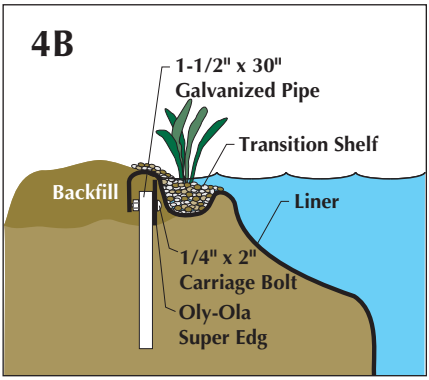


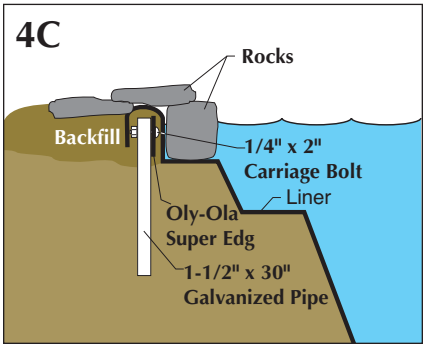


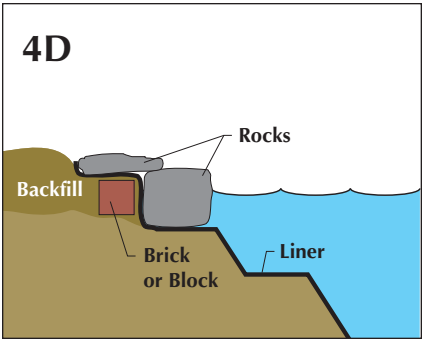
If using garden edging, use heavy duty flat edging with a 1/4" rounded edge like Super-Edg from Oly-Ola. Fix it to the pipe or stakes every 2 to 3 feet to maintain the contour of the pond edge.

Diagram 4









Construction *(cont.)*

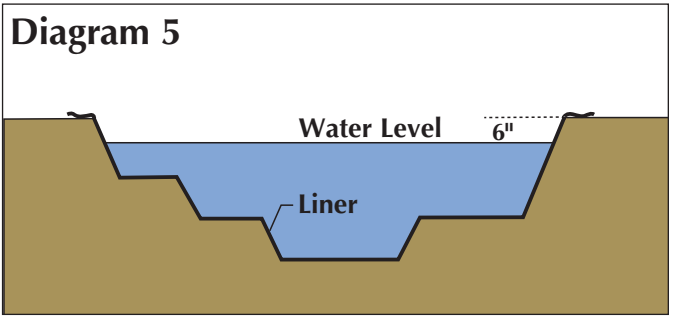
> Tip:
> Making the shelves flat and smooth will greatly facilitate cleaning the pond.

7. Dig the pond, keeping in mind that the soil removed can be used to fill low areas of the pond perimeter and also to create a berm or mound of dirt around the pond. Always tamp down any dirt which has been disturbed to stabilize it.

8. Install edging system decided on in Step 6, but do not add rock yet or backfill with dirt.

9. Install, or make provisions for, filtration system, especially such things as skimmers, waterfall tanks, etc. See the Filtration Section beginning on page 31.

Diagram 5

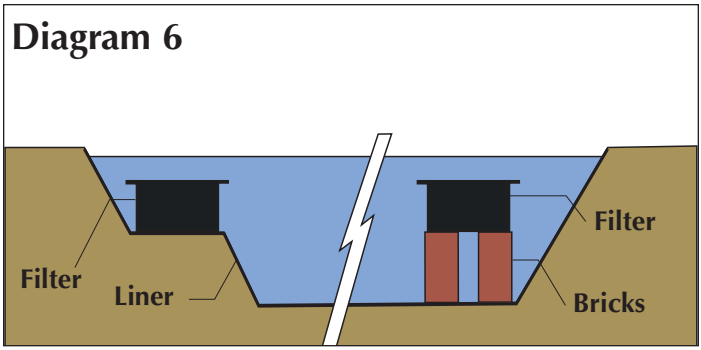


10. Lay liner into pond and fill with water to within 6" of the top. Determine where the ponds edge is too low or too high and make necessary adjustments.

11. Fill the pond to the top with water and again make adjustments to the edge to correct high and low points. You can raise or lower the Oly-Ola edging by changing it's location on the pipe or simply raising or lowering the pipe or stakes.

12. Anchor liner edge using one of the options shown in Diagram 4. Backfill with dirt and install rock as shown.

Diagram 6



13. Install pump and filter system. Place pump and filter near the pond edge and in shallow water for ease of access when cleaning or servicing. Plug the filter power cord into an outlet protected by a Ground Fault Interrupter (GFI) circuit.

A wider view of our pond which incorporates all of the design elements covered in Step 1 (page 12). Edging was completed with Oly-Ola Super Edg, discussed in Step 2 (pages 20-21). Large containers, see Step 4 (pages 46-47), are used throughout to allow the plants to reach their fullest potential.

Construction *(cont.)*

The Softer Side of Pond Transition

Design, construct, and plant your pond to blend naturally within your landscape.

One of the greatest challenges in water garden design is pond transition - creating a pond that fits into the rest of the yard as if it had always existed. Years ago, Gordon Ledbetter's lecture on water garden design was very inspirational to me. He made the point of the necklace effect while showing a photograph of a pond rimmed in stone. He continued his lecture showing wonderful photographs of his designs and the softer methods of pond transition. This led me to a continued interest in finding practical techniques that take advantage of the existing landscape - a combination of pond construction techniques, filtration techiques, and planting schemes that ease the transition from water to land.

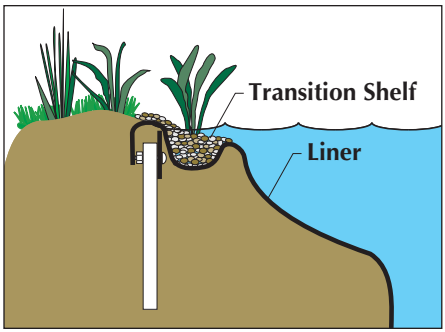
Attention to the details of pond construction is crucial. Since there is little or no rock in our coastal southeast and sandy soil, the use of pond edging is very helpful. Although such edging is not necessary, it is a very stable and extremely easy way to level the pond when used with anchors. The liner is simply placed over the edging and drapes behind it (as shown in Diagram 4 on page 25) and makes it easy to backfill topsoil flush with the top of the edging. This enables the gardener the option to either plant lush pond side plants or lay grass right to the waters edge.

We have found, also, another effective construction technique to soften pond edges - the transition shelf. (See the illustration at right.) This enables the gardener to ease the water garden into its surroundings by placing rock on it or by creating a lush area of marginal aquatic plants that literally march out of the pond into the perimeter area. We like to make this shelf 1.5 to 2 feet wide and approximately 6 inches deep with a planting pocket toward the outside edge of the shelf. Pea gravel placed on the transition shelf may look harsh at first, but it softens in appearance as the

garden matures. Another advantage of the transition shelf is its attraction to wildlife. The shallow shelf makes it an inviting bathing area for small birds and an easy entry for amphibians and reptiles.

Transition plantings appear to grow from the water's edge out into the surrounding ground or vice versa. Two types of plants make this effect possible. One are creepers that grow easily from the pond shallows and out into the perennial garden. These include plants such as Myosotis scirpoides, Oenanthe javanica 'Flamingo', Ranunculus flammula, Mentha aquatica, Lysimachia, and many more. Another type are marginal plants that can be planted in shallow water or in the perennial garden and grow equally well on either site. This group includes Louisiana iris, Lobelia cardinalis, Zantedeschia aetihpica, Colocasia varieties, Cyperus alternifolius, Ruellia brittoniana, Equisetum hymale, Acorus calamus 'Variegatus', Juncus effusus spiralis, Longwood cannas, and more. Nothing blends the pond into the existing garden better than massing these types of plants in and next to the pond's edge. Many designers feel strongly that lush foliage sets the tone and creates the mood of the garden.

Water in the landscape transforms the ordinary garden into one of magic and interest. No other form of gardening brings so many different elements together to create movement, sound, depth, and atmosphere. When building your next water garden or when working on your existing pond, consider all the possibilities that pond transition offers. Stuart Schuck



Make your transition shelf fairly wide, 2 feet or more, so that it has a gentle slope. This will afford adequate area for plants and create a large landing area for birds and aquatic animals. If the transition shelf is heavily planted improved water quality will also result as the plants will help consume excess nutrients.

Construction *(cont.)*

Waterfall Construction Tips

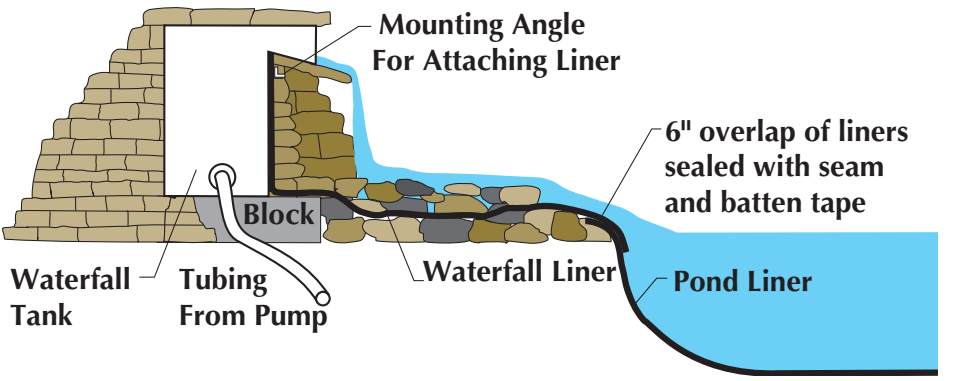
1. A waterfall tank serves as a header pool for the waterfall. It should be placed on a solid and level surface such as concrete blocks. Water can be plumbed in through the bottom of the tank via a bulkhead and hose barb fitting. Bring the waterfall liner up to the mounting angle below the spillway and secure thoroughly by bolting to the tank.

2. Where the waterfall is to spill into the pond, there should be at least 15" of rubber liner from the pond to overlap the waterfall liner. At this point the grade must slope towards the pond or water will back up and get between the liners. We recommend using a seam and batten tape to seam the two liners together to make the seam watertight.

3. Use a nice flat and wide rock as your first spillway stone. Stack a rock wall in front of the tank to support this stone under the tanks spillway. The front edge of this stone should be level from side to side and slant down slightly.

4. Use an expandable foam insulation to seal rocks to the liner and prevent water from running behind or between rocks in the main course of the waterfall. This can be purchased in spray can form in most hardware and building supply stores. Be sure to use this sparingly since it expands tremendously. Exposed foam can be camouflaged by sticking pebbles, rock chips or sand into it while it is still tacky.

5. To prevent any possible water leakage make sure you keep the rubber liner up high enough on the sides to contain the waterfall. It's a good idea to test the waterfall before totally covering the edges of the liner to check for any possible leaks. Ryan Hill

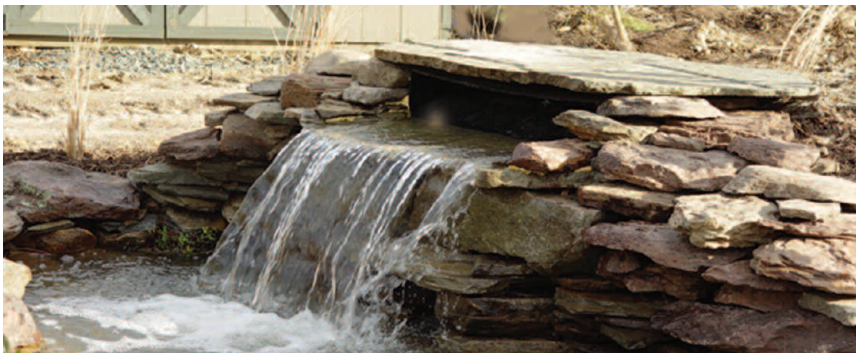


Filtration

A Good Filter System will ...

- ... mechanically remove debris and other particulate matter from the water.
- ... biologically reduce ammonia to safe levels for fish.
- ... naturally control nutrient levels through plants filtration to maintain clear water.
- ... utilize ultra-violet sterilization, in the absence of plants filtration, to kill algae and maintain clear water.

There are many different combinations of filter components that will achieve the above objectives. Before you select specific components, you need to be aware of the essential elements of mechanical, biological and natural filtration. The ensuing sections will help you select a successful filtration system for your pond.



Waterfall Tank

Filtration (cont.)

Elements of a Good Pond Filtration System

Maintaining a clear and healthy garden fish pond requires a properly designed filter system. Fish ponds accumulate excess nutrients which cause algae - green water, deficient oxygen levels, low pH and, on occasion, toxic water. To avoid these conditions invest in a pond filtration system that combines the following basic components.

Mechanical Filtration - Mechanical filtration physically removes particles of fish waste and algae from the water. Filter foam, brushes and plant roots are excellent mechanical filters.

Biological or Bacterial Filtration - Nitrifying bacteria inhabit all bodies of water and convert toxic fish waste ammonia to harmless nitrate. Biological filtration speeds up this natural process by passing the pond water over plant roots, lava rock, foam, shaved PVC or gravel surfaces that harbor these bacteria. The amount of surface area involved and the flow rate of water are directly related to the amount of biological activity that takes place.

Plants or Natural Filtration - Plants perform the total filtration job, not just part of it. The nitrate build-up that eventually results from the biological process described above can best be eliminated through the proper deployment of plants in a pond, natural filter and/or biological filter (bio-filter). Passing nutrient enriched water over, around and through the roots of plants causes a rapid uptake of nitrates and other nutrients and ultimately starves the single-cell algae out of existence. This algae will recur in the early spring and fall when plants are either just getting started or finishing their period of rapid growth. The alternative to plants filtration for nitrate removal is partial water changes. Experiments at the nursery indicate that a few plants in the top of a bio-filter have a tremendous effect on absorbing nitrates and eliminating pea-soup algae. Natural filters can be used in lieu of bio-filters as the plant roots in the natural filter perform the biological function also. Plant roots are great mechanical filters too when allowed to grow out into the water column.

Additional Considerations for Good Pond Filtration

Aeration - Aeration of pond water by use of a fountain and/or a waterfall is very important to the filtration process and overall fish health. It increases the amount of dissolved oxygen in the water which is necessary to support nitrifying bacteria, fish and the decomposition of organic waste.

Filtering Media - Lava rock and gravel are good filtering media for bio-filters. Lava rock is preferred because it has more surface area to volume than gravel and is much lighter. Shaved PVC is an excellent filtering media as it won't clog or block. Available in mesh bags, PVC has approximately 250 ft^2 of surface are per cubic foot. Foam is an excellent biological and mechanical filtration medium but needs to be cleaned regularly. This cleaning is important to maintaining pond hygiene and eliminating organic fish waste which is the the source of algae blooms.

Nitrifying Bacteria - These bacteria help keep water clean and healthy as they convert toxic ammonia and nitrites to harmless nitrates. Adding the bacteria to your pond and filter may activate the biological process sooner than would occur naturally. They are active above 52˚f .

pH - Proper pH is important to healthy fish and plants and is vital to the biological activity mentioned above. pH should be maintained between 7.0 and 8.0. Baking soda (sodium bicarbonate) or ground limestone (calcium carbonate) can be used to raise the pH of the water. Vinegar will lower pH.

Pumps - This element drives the filtration system and should be powerful enough to circulate at least 1/4 to 3/4 of the pond water volume every hour. Where waterfalls are used, gallons per hour can equal pond volume.

Dick Schuck

The next section discusses natural or plants filtration; perhaps, the single most important element of a successful filtration system.

Filtration (cont.)

Plants and Clear Water
The 10% Solution

Clearing and cleaning a pond is not as difficult as many people believe. In fact, the long, complicated formulas and equations you often read in garden and aquarium magazines aren't really necessary. All you need to know is The 10% Solution. Here's how it works:

Construct a plants basin near your pond with a size equivalent to 10% or more of the surface area of your pond. Fill this basin with water plants and recirculate your pond's water through it every 2 to 4 hours. Within a few short weeks your water will be clearer and your pond will be clearer. This is because your plants basin has simultaneously consumed the "pea soup" causing nutrients in your pond as well as removed the solid waste particles from your water via settling and root filtering. Thus, your plants basin has become a natural filter.

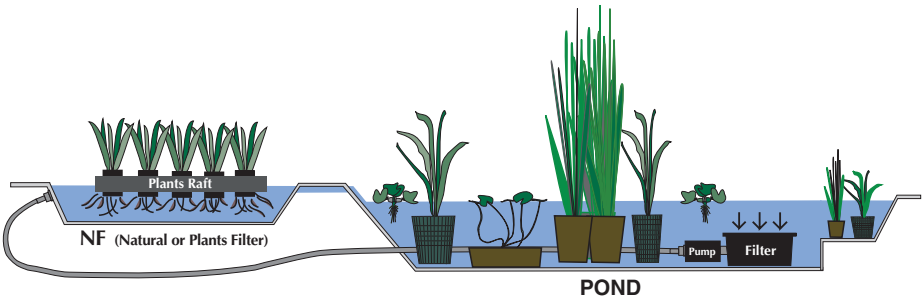
Depending on the size of your pond, this natural filter can be as small as a half whiskey barrel or as large as another small pond. A pond that is 20 sq. ft. in size would require a 2 sq. ft. filter; a pond 400 sq. ft. in size would require a 40 sq. ft. plants filter. Large filters can be constructed using 2 x 8 or 2 x 10 pressure treated lumber and a rubber or other flexible liner. The filter should be at least 10" deep so it can act as a settling chamber for solid waste pumped from your pond. The pond water should enter the filter at a point furthest from the overflow to maximize the distance of water flow thereby allowing the greatest settlement of solids in the plant filter.

Almost any water plants will do well but some of my favorites are:
Hardy Plants - water iris, water mint, water celery, cattails and lotus;
Tropical Plants - water hyacinth, water lettuce, giant or egyptian papyrus and umbrella palm. Through trial and error I've found all of these to work quite effectively in a natural or plants filter. In late fall, remove plants that have died and strip leaves from hardy and perennial plants. Clean your filter in late fall or early spring for the coming year. A mid-summer cleaning may also be necessary for very dirty situations. As with any filter, clogging will drastically reduce it's effectiveness.
Besides filtering out solids and clearing green water, your natural filter is

an excellent biological filter as the plant roots provide abundant surface area for nitrifying bacteria. When the plants are dormant (early spring and late fall) your pond water may "green up" but once the dormant spell is broken, rapid clearing will occur. The use of ultraviolet filtration is advised to maintain clear water when the plants are dormant.

One last thing: The plants in your natural or plants filter will generally be healthier and many times larger than the plants in your pond. This is because the plants in your filter get a constant flush of nutrients from the recirculating pond water. As you're probably aware, this is the basis of hydroponic gardening. And your plants filter will prove to be a testament to this progressive gardening system.

Dick Schuck



Surface Area of NF = 10% of Surface Area of POND

Water Flow/hr. = 1/2 to 1/4 of Pond volume Depth of NF = 10" to 18"

Surface Area of NF = 10% of Surface Area of Pond
Water Flow/hr = 1/2 to 3/4 Pond Volume - Depth of NF = 10" to 18"

Tip:

Establishing hardy plants early in the spring and adding tropical plants as it becomes warmer greatly increases the effectiveness of the plant filter.

Filtration (cont.)

Plants Filtration Above All Others

Using plants in your pond filtration system has the following advantages:

1. Aquatic plants consume toxic compounds such as ammonium, nitrite and nitrates. This protects your fish.

2. Aquatic plants remove toxic heavy metals and other pollutants from the water. This protects your fish.

3. Aquatic plants provide surface areas for biofilms and all types of beneficial bacteria. This improves water quality.

4. Aquatic plants help control algae. Not only do they consume nutrients but they emit allelopathic chemicals that inhibit algae.

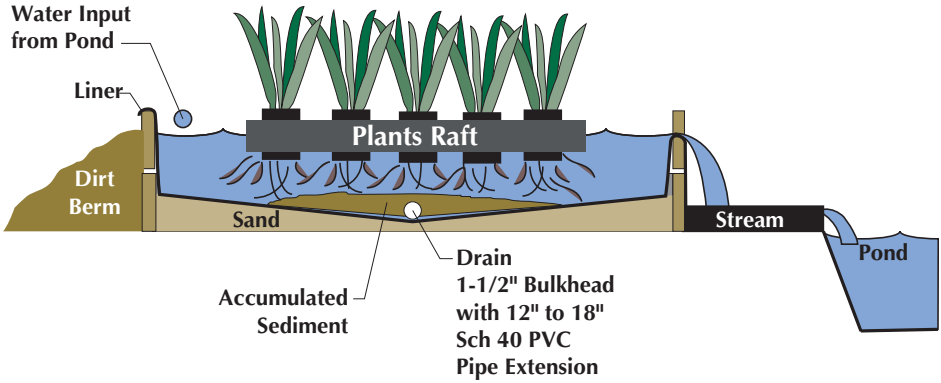
5. Aquatic plants oxygenate the water. They provide more oxygen than they consume.

6. Aquatic plants remove CO2 from the water. Excess CO2 can cause fish distress.

Rationale: Plants perform the total filtration job, not just part of it. They contribute to all aspects of water quality.

How To Build a Natural Plants Filter

Plant filters should be built above grade so that they can be easily drained and cleaned; and the recirculated water easily returned to pond via stream or waterfall. They can be any shape (rectangular, round, etc.) and anywhere from 10" to 18" deep. The surface area should be 10% or more of the area of the pond being filtered. Pressure treated lumber, block or railroad ties can be used to frame the filter. Rubber or PVC liner are excellent liner material for the filter. Bulkhead drains and a flat bottom shaped to form a low point at the drain, as shown below, are recommended so that sediment can be flushed from the system.



The completed filter can be faced with stone or concealed by dirt berm and plantings. Fill with water, test and add floating or rafted plants. Pots should have many stab holes or slots so that roots of plants escape the pot and form a root mass for removing nutrients from pond water. Clean filter at the end and mid-season for best results.

Dick Schuck

Filtration (cont.)

Designing Your Filter System

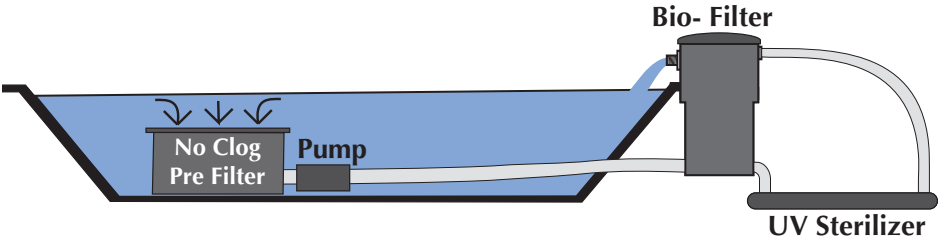
Before designing your filter system you need to ...

- **... Calculate the gallon volume and surface area of your pond -**

The formula for computing pond capacity is 7.5 gallons of water per cubic foot. Using foot measurements, multiple pond length X width X average depth X 7.5. For example -
If your pond is 10' x 10' x 1.5' average depth:
- the pond surface area is 10' x 10' = 100 ft²
- the pond volume is 10' x 10' x 1.5' = 150 cubic feet
- the gallons capacity is 150 x 7.5 = 1,125 gallons

- **... consult the Filtration Diagrams**

on pages 39 to 42 and select the filter system and components that match your pond. In the example above, you'd use the information for a 1,200 gallon pond and your system would be:



Tip:

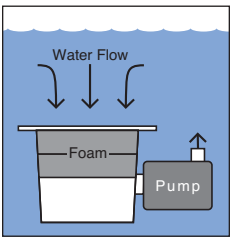
Remember that the systems recommended can be customized to suit your individual needs by substituting other components that meet the same general requirement. Also, if your pond size falls between two systems, select the smaller size for ponds with lots of plants and few fish and the bigger one for ponds with lots of fish and few plants.

Filtration Components

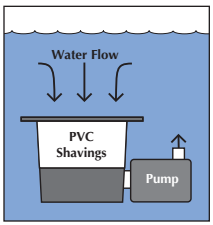
The following illustrations represent typical components of many filtration systems.

Intake Components

Bio-Mech (Biological-Mechanical) Pre Filter



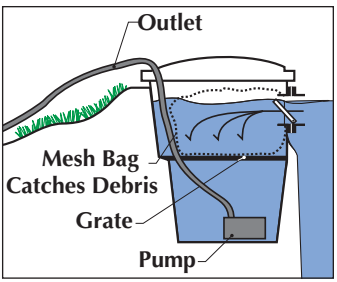
- **Mechanical Filtration - Clears the water by removing small particles of algae and organic debris.**
- **Biological Filtration - Cleans the water by removing ammonia and nitrite caused by fish waste. Beneficial bacteria live in the filter and convert ammonia and nitrite to harmless nitrate.**



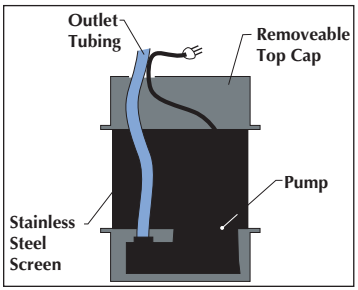
No Clog Pre Filter

- **Mechanical Filtration - The filter media, PVC shavings, is less effective than foam but will not clog.**
- **Biological Filtration - As it doesn't clog, it is a very efficient biological filter.**

Skimmer



- **Traps floating debris.**
- **Mechanical & biological filter when used with filter media.**
- **Sediment trap.**



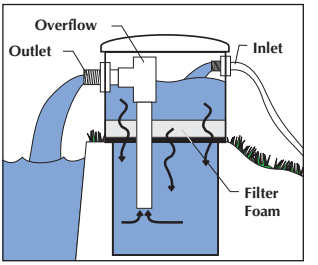
Protective Pump Enclosure

- **For 1,000 gallon ponds and up.**
- **Designed to house sump style pumps up to 8" wide x 12" high.**
- **Dramatically extends clog-free operation of any pump.**

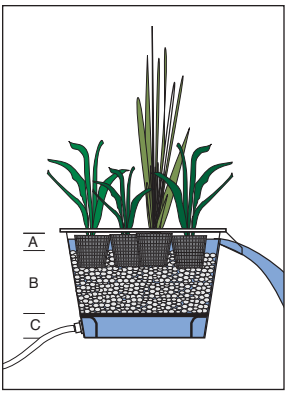
Filtration (cont.)

Return Components

Bio-Mech External Filter



- Performs functions very similar to a biological-mechanical pre filter.
- Is located outside the pond for easier access when cleaning.



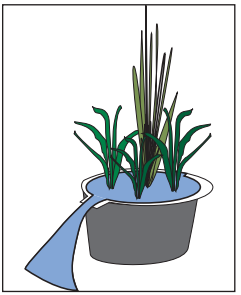
Bio-Filter provides three distinct functions:

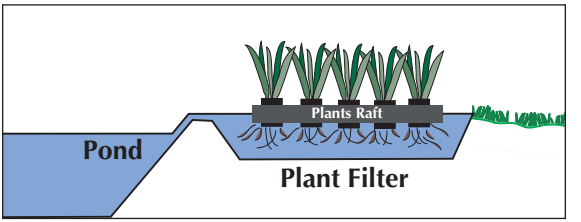
A. Plants provide natural filtration and remove excess nitrate.

B. Lava Rock (or Shaved PVC) provide surfaces for biological filtration to remove ammonia and nitrite.

C. Settlement Chamber collects sediment that settles out of the water flow.

Natural (Plants) Filter





- Performs biological filtration but uses plant roots for surface area instead of inert media like lava rock or Shaved PVC.
- Plants also reduce all nutrient levels and clear water.
- Traps sediment from the pond.
- Removes toxins from the water.
- Encourages beneficial bacteria.

Return Components

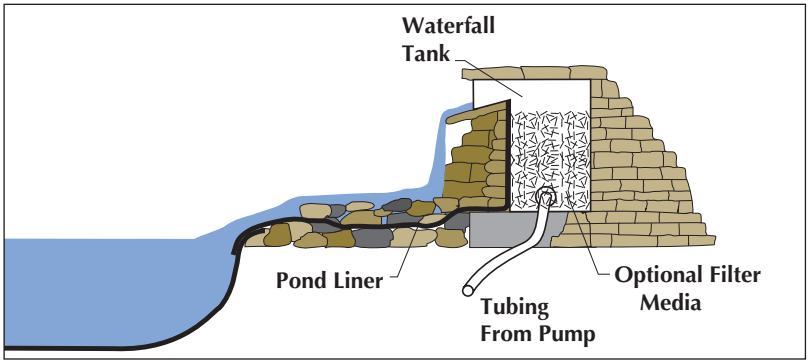
Waterfall Tank

• Can be partially buried in the ground or hidden within a rock waterfall.

• Creates a uniform sheet of water from the outlet.

• No more leaking waterfalls or uneven water flows.

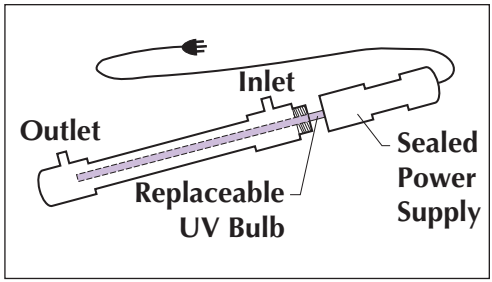
• Performs biological filtration when filled with media like No Clog Shaved PVC.



UV Sterilizer

• Destroys algae cells with ultraviolet radiation.

• Reduces maintenance of filters as it clears pond of algae particles that rapidly clog filter media.



Tip:

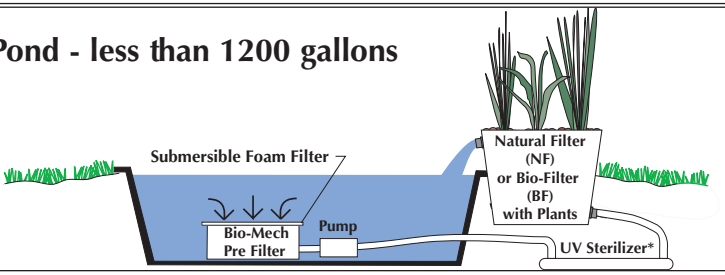
When planning your filter system consideration should be given to the terrain of your pond site, maintenance requirements and component accessibility for cleaning.

Filtration (cont.)

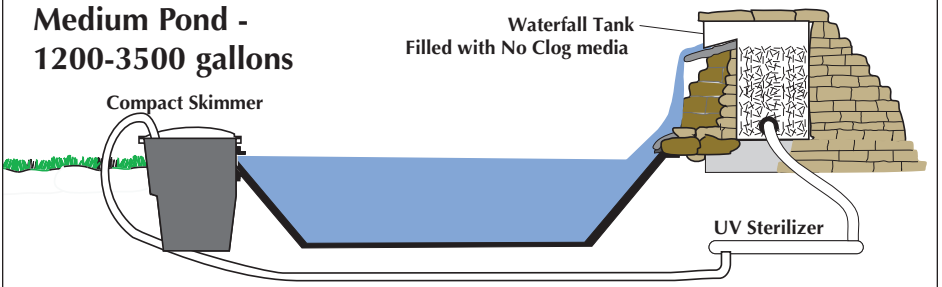
Planning a Filtration System

Any combination of intake and return components will work. For example; if a waterfall tank works better in your plans than a plants filter, it will do fine as long as it's sized correctly and filled with appropriate media. Below are illustrated a few typical pond filtration systems.

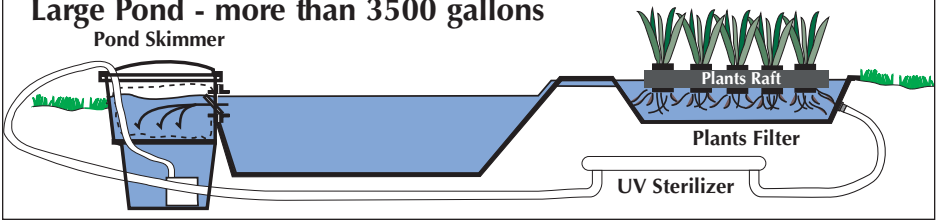
Small Pond - less than 1200 gallons



Medium Pond - 1200-3500 gallons



Large Pond - more than 3500 gallons



Important Note on Pump Size

The pump needs to be sized properly for the overall system. If a pump is too large, it can overwhelm the intake and return components. If it's too small it will not pump enough water to be effective. Pay attention to the recommended pond and pump sizes for the various components. Generally, the pump GPH rating (Gallons Per Hour) should be 1/4 to 3/4 of pond volume. Use the 3/4 rating when a waterfall is planned.

Algae Control

Algae are complex, numerous and tough to control. They can be divided into two kinds: unicellular algae (commonly referred to as green water algae because of the green cast they cause in many ponds) and multicellular algae (commonly referred to as string algae). In my experience I have never known the two types to co-exist in the same body of water. Typically, once the green water clears, the string algae begin. Thus, they will be discussed separately.

Green Water Algae

There are two certain and safe cures for green water; ultraviolet radiation and plants filtration.

Ultraviolet Radiation (UVR) is the most certain cure as it actually destroys the algae cells. In this method the pond water is passed through a tube or chamber containing a bulb emitting UV radiation. Given the right size bulb and correct exposure time to the passing water, this method is sure and takes about 7 to 10 days to clear green water. UVR systems are somewhat expensive to buy but are inexpensive to operate as they don't use much wattage. Also, since they interrupt the algae cycle your pond filters won't clog as often with algae nor will your pond accumulate as much sediment in the form of dead algae. Generally, UVR will provide gin-clear water and reduce overall pond maintenance when it is operating properly.

Plants Filtration is the method in which plants are grown hydroponically in a smaller pass-through pool that acts as a filter for the primary pool. The filter pool should be 10% to 20% of the surface area of the primary pool. A design for a plants filter is described on pages 37. The advantage of plants filtration over other forms of filtration is that plants perform the total filtration job and not just part of it. Plants clear green water by depriving the algae of all three forms of nitrogen fertilizer: ammonia, nitrite and nitrate. Other filters, using inert media rather than plants, merely convert ammonia and nitrite to nitrate which is still available to feed algae. Some aquatic plants also emit allelopathic chemicals that

Filtration (cont.)

help inhibit algae. They also consume heavy metal pollutants that are potentially harmful to your fish. No other form of filtration can do all this. The downside of plants filtration is that it only works when the plants are actively growing. This means that green water will be evident in early spring and again in fall when the filter plants are just leaving or entering dormancy. Thus, to have clear water even during these times the use of UVR is recommended. To me, the best pond filtration system combines plants filtration and UVR. This combination will yield not just clear water, but also pollutant (toxin) free water for your pond.

Other methods of clearing green water involve the use of chemical algaecides, bacterial microbes or allelopathic substances.

Chemical Cures include copper sulfate, branded chemicals such as Algae Fix and alum-based flocculates such as Accu Clear. Flocculates cause the algae to clump and fall to the bottom of the pond. Chemical cures are generally short lived and must be repeated often. In the case of copper, this can cause a dangerous buildup of copper which can harm your fish and plants. Algae Fix will not build up in your pond and will thus be safer for your fish and plants. The alum-based flocculates may bind to the gills of your fish, causing stress, and reduce the dissolved oxygen in the water when the settled algae begins to decompose. Thus, while all of these methods work they generally are not long term cures and may, in the case of copper sulfate, cause unwanted side effects.

Bacterial Products on the market purport to clear water but are careful not to claim algaecidal properties. These products generally lack scientific field studies that demonstrate exactly how and when they will clear green water. This is not to say those bacterial products don't clear water, but that the certainty and timing of the event is not always predictable. Bacterial microbes may clear green water by consuming or eliminating nutrients that feed algae. Some of the products include flocculates (see above) that help clear the water. My problem with the bacterial cures is that I don't know when they are clearing the water or when something else is doing it. You will need to judge for yourself.

Allelopathic Based Products, such as barley straw, may emit toxic or allelopathic chemicals that inhibit all forms of algae, but there are no field studies that demonstrate the efficacy of the product. Here again we are confronted with the question of when is it the barley straw and when is it something else clearing the water. Laboratory tests have demonstrated the inhibitory effects of decomposing barley straw on some algae but not all. In fact, some are encouraged. You will, again, need to be the judge.

String Algae

String algae are only found in clear water, seem to do best in moving water and appear to require very little nitrogen. The best eradicators of string algae are Koi and possibly goldfish. Restricting the amount of commercial fish food they receive will encourage grazing. Unfortunately, Koi and goldfish cannot graze your waterfall or stream garden. For these areas only manual removal will work. New cures use oxydizing agents to kill string and scum algae.

Copper Sulfate and Algae Fix will kill string algae but repeated treatments will be necessary. As discussed above, copper can be harmful to your fish and plants if it is not used properly. Algae Fix is not harmful to fish as long as you don't overdose.

Bacterial-Enzyme-Microbe Products are available for eliminating string algae. Manufacturers claim that their microbial products eliminate string algae by reducing phosphates. But remember this, phosphate levels of only .02 ppm are needed to support algae growth. Since fish food is loaded with phosphorous, it is unlikely that it can be reduced enough by microbes in fish ponds to actually inhibit algae. Only trace amounts of phosphates are necessary for algae growth. You be the judge.

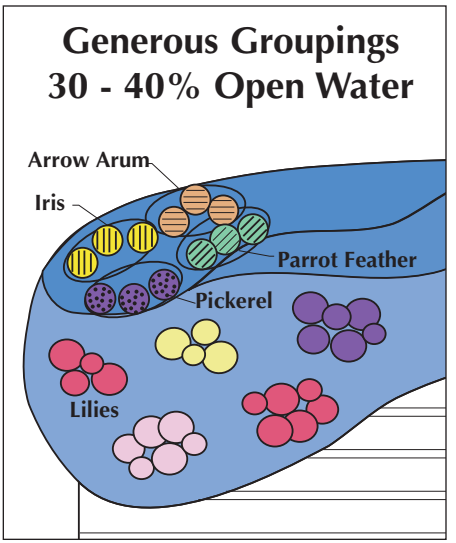
Dick Schuck

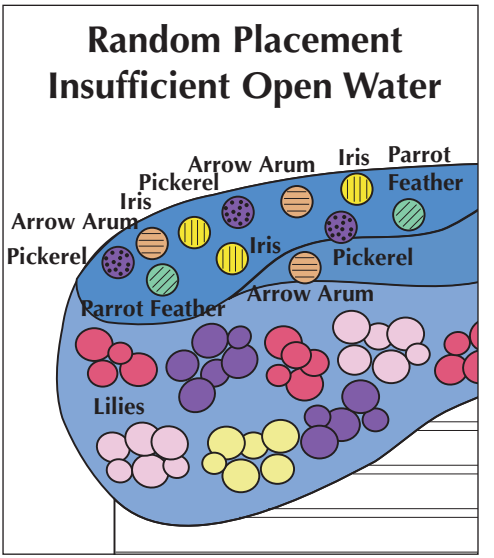
Planting

A Well Planted Pond ...

- ... has generous groupings of plants rather than a random placement of individual plants.

- ... has 30 - 40% open water surface to capture reflections of sky and plants.





Tip:

The use of squat, shallow planting containers where plants can multiply to form a significant mass of foliage will help accomplish the above objectives. See next page.

A Well Planted Pond ...

• ... has quality plants that are planted in good garden top soil and adequately fertilized.

• ... uses generously sized planting containers to create the best display.

Large Lotus 20 x 6 	Tall Marginal Plants 16 x 7 
Water Lilies, Small Lotus 16 x 7 	Short Marginal Plants 10 x 7 

NOTE: Pot size recommendations throughout are approximate.

Fertilizer Recommendations

Zone	March	April	May	June/July/Aug	Sept	Oct thru Feb
3				X		
4				X		
5			X	X		
6			X	X		
7		X	X	X		
8	X	X	X	X	X	
9	X	X	X	X	X	
10	X	X	X	X	X	

NOTE: Products vary. Always refer to manufacturer's recommended rates.

Planting (cont.)

Marginals and Shallow Growers

When selecting plants for the pond it is important to know the types of plants, their growth habits and how they can be incorporated into the landscape most effectively. The time of year a plant flowers and it's color should not be the only criteria for purchases made. All too often plants of considerable value are passed up because they don't provide colorful flowers. Some of the most outstanding landscapes in the world contain very little color. Making the right plant choices for the best overall effect will enable you to create the most natural and beautiful environment.

Start by creating adequate planting areas for shallow water plants. The standard, but ill-advised, recommendation has been to create a shelf 12" to 15" wide and 10" to 12" deep all the way around the pond. This approach is appropriate only in the smallest ponds and creates what we call the "necklace effect" - a circle of undersized planting containers each holding an individual variety. It not only looks weedy but leads to several complications:

1. The pots holding tall plants are usually too small to create an adequate ballast. That means that every time the wind blows so do your plants.

2. The root system is very restricted in a small pot and penetrating it to add fertilizer is extremely difficult. Also, due to insufficient amounts of soil, the plants will require regular feedings.

3. An increase in plant maintenance since small containers on narrow shelves will become root bound quickly (see above). That means dividing and repotting all of your plants every year or two.

Please Note:
All of the above make for weak plants and unnecessary problems.

Most backyard ponds are designed with a main viewpoint. During the

planning phase take that view point into consideration and incorporate wide, shallow planting areas toward the rear of the pond. For medium ponds (10' x 15') incorporate a 2 foot wide shallow water area (shelf). For larger ponds, consider a 3' or 4' width. Depth in these areas should be 10" to 12" at the very minimum. You can always raise a planting container on bricks, but you can't make your shelves deeper. Narrow shelves in the front of the pond are sufficient for low growing foreground plantings, but these may interfere with a close personal relationship with your fish.

Ponds can be built without shelves by using plant rafts. See page 74 - Flotation Gardening.

The same rules that apply to traditional landscape are rarely implemented when it comes to the water garden but they should be. Create masses and combine plants that compliment each other. Allow plants to intermix for foliage contrast and texture that will highlight flowering varieties. Give depth to the landscape through varied height. Look at what Mother Nature has provided for insight. A grove of maples flushed with the with red blossoms of spring! A burst of wild flowers lay between the road and the forest. The May apples and daylilies that blanket the forest floor. The single, old, white oak in the middle of a grass field is a rare find, as with any single in a variety.

Most plants fall into four basic categories and aquatics are no exception. Of course there is some overlap depending on how they're used.

1. Strong Verticals

Strong verticals create a background for flowering varieties. They are not usually flashy or colorful but they have intricately unusual flowers that add interest and texture. Plant these individually in large containers so that they can fill out to provide a dense, lush, green or variegated foliage backdrop.

Large Ponds

Arundo donax 'Variegatus' (Variegated Mediterranean Reed) 5'
Cyperus alternifolius (Tropical Umbrella Palm) 5'

Planting *(cont.)*

Scirpus lac. ssp. taber. 'Albescens' (White Bulrush) 4'
Scirpus lac. ssp. taber. zebrinus (Zebra Rush) 4'
Spartina (Cordgrass) 4'
Typha angustifolia (Narrow Leaf Cattail) 6'
Typha latifolia (Common Cattail) 5'
Zizania latifolia (Perennial Rice) 4'

Medium and Small Ponds

Acorus calamus (Sweet Flag) 3'
Acorus calamus 'Variegatus' (Variegated Sweet Flag) 3'
Baumea rubiginosa (Variegated Striped Rush) 2'
Carex nigra (Black Flowering Sedge) 2'
Cyperus alternifolius 'Gracilis' (Dwarf Umbrella Palm) 2'
Iris varieties or species (Water Iris) 2' - 3'
Juncus species (Rushes - common, blue, green, etc) 3'
Pontederia dilatata (Royal Pickerel) 5'
Pontederia lanceolata (Tropical Pickerel, blue or white) 4'
Sagittaria lancifolia (Lance-Leaf Arrowhead) 3'

2. Intermediate Plants

These are broad leaf plants that add texture, colorful flowers and compliment the strong foliage of background plants. Most that follow are suitable to any size pond.

Any Size Pond

Iris varieties or species (Water Iris)
Lobelia cardinalis (Cardinal Flower)
Lythrum hybrids (Loosestrife)
Mimulus ringens (Lavender Musk)
Orontium aquaticum (Golden Club)
Peltandra virginica (Arrow Arum)
Phalaris arundinacea 'Feesey' (Strawberry and Cream)
Pontederia (Blue, Pink or White Pickerel Rush)
Ruellia ssp. (Blue Bells)
Sagittaria species (Arrowheads)
Saururus cernuus (Lizard Tail)

3. Ground Covers

The sprawling habit of these plants make them an excellent accompaniment for both of the previously listed categories. They are the perfect transition to the water's surface.

Any Size Pond

Aeschynomene fluitans (Giant Sensitive Fern)
Hydrocotyle (Water Pennyworts)
Justicia americana (Water Willow)
Lysimachia nummularia 'Aurea' (Creeping Jenny)
Marsilea (Four Leaf Water Clovers)
Mentha aquatica (Water Mint)
Menyanthes trifolia (Bog Bean)
Myosotis scirpoides (Water Forget-Me-Not)
Myriophyllum aquaticum (Parrot Feather)
Oenanthe javanica 'Flamingo' (Var. Water Celery)
Ranunculus flammula (Miniature Spearwort)
Regnellidum diphyllum (Two Leaf Water Clover)

4. Specimens

Plants that warrant a position all their own. Depending on the size of the pond, containers ranging in size from 23" x 10" to 36" x 12" will provide plenty of room for maximum growth but don't hesitate to use one larger if the pond can accommodate it. Keep scale in mind.

Nelumbo varieties (Lotus - full size and dwarf)
Arundo donax 'Variegatus' (Variegated Mediterranean Reed)
Canna Longwood hybrids
Colocasia esculenta 'Black Magic' (Black Taro)
Colocasia esc. 'Fontanesia' (Violet Stemmed Taro)
Cyperus gigantius (Giant Papyrus)
Cyperus papyrus (Egyptian Papyrus)
Thalia dealbata (Hardy Water Canna)
Thalia geniculata form ruminoides (Red Stemmed Thalia)

Planting (cont.)

5. Shade Tolerant

Although most aquatic plants require a good deal of sunshine, there are some the are more shade tolerant than most. Of course shade density, just how sunlight-free a given area is, will determine how well even these plants will do.

Acorus gramineus 'Ogon' (Golden Var. Dwarf Japanese Sweet Flag)
Acorus gramineus 'Variegatus'
(Variegated Dwarf Japanese Sweet Flag)
Acorus gramineus 'Yodonoyuki'
(Pea Green Var. Dwarf Japanese Sweet Flag)
Caltha palustris (Marsh Marigold)
Cephalanthus occidentalis (Button Bush)
Colocasia esculenta (Green Taro)
Cyperus alternifolius (Umbrella Palm)
Cyperus alternifolius 'Gracilis' (Dwarf Umbrella Palm)
Echinodorous cordifolius (Radican Sword)
Equisetum diffusum (Dwarf Equisetum)
Equisetum hyemale (Horsetail)
Houttuynia cordata (Houttuynia)
Houttuynia cordata 'Variegata' (Chameleon Plant)
Slower growth in pond.
Myosotis scirpoides (Water Forget-Me-Not)
Orontium aquaticum (Golden Club)
Oenanthe javanica 'Flamingo' (Var. Water Celery)
Peltandra virginica (Arrow Arum)
Saururus cernuus (Lizard Tail)
Zantedeschia aethipica (Common Calla)

Wouldn't three Iris laevigata 'Snowdrift' in a 16" x 7" plastic planting container or five of them in a 23" x 10" container put on an awesome display of flowers and foliage? Then imagine, planted beneath them in the same container, a blanket of Myosotis scirpoides (Water Forget-me-Not) in full bloom with the delicate clover leaves of Marsilea drummondii (Four Leaf Water Clover) peaking through the blue flowers. Then imagine two more containers, all three nestled together. Lovely!

Use the tall dense upright foliage of Iris as a background to summer flowering plants. Using a 16" x 7" container, combine one iris, one Pontederia cordata (Pickerel) and one Mentha aquatica (Water Mint). Presto, that bare iris is now the perfect compliment to the other plants in a simple, beautiful arrangement. The erect foliage of the iris creates a nice background for the shiny leaves and lavender blue flowers of the pickerel. When the mint fills in, you have a striking combination of foliage, flowers and texture for season-long color.

Keep the soil level at least 2" below the top edge of the pot and dress with pea gravel. By leaving the soil level low, the handles on the container will remain accessible.

By combining plants in the same planting container a more natural effect is achieved and unsightly pots are no longer seen. Beneficial insects such as dragonflies, water boatmen and surface skimmers will all have a better environment to live in. Baby fish will also have a place to escape to until they are large enough to compete.

One last thing - Be sure to take into consideration the plants outside the perimeter of the pond as they are of equal value to the overall design and aesthetic properties of your water garden and landscape.

Kelly Billing

An example of a combination planting using a 16" dia. container approximately 7" deep.

Planting (cont.)

Planting Instructions

For ease of identification, the aquatic plants you'll be purchasing for your pond can be categorized as:
A. Lilies - Nymphaea (Hardy or Tropical)
B. Lotus - Nelumbo
C. Shallow Water Plants (including Iris)
D. Lily-Like Aquatics
E. Oxygenators or Floaters.
For best results please refer to the following guidelines for the type of plant(s) you're working with.

All aquatic plants perform their best when grown in good garden soil. Use of a plastic container will contain the soil and simplify the task of maintaining the plant and pond. A 1" to 2" layer of pea gravel should be placed on top of the soil to prevent fish from disturbing the soil and plant.

All rooted water plants will require fertilizer occasionally. Generally, if plants begin to shrink in size during the growing season you can assume fertilizer is needed. We recommend the use of a fertilizer in tablet form. (If using a granular fertilizer, wrap a small amount in a paper towel.) Push either type of fertilizer several inches below the soil surface. Be careful not to over fertilize as this will promote algae growth. If fertilizer does not cause renewed plant vigor, the container may be too small or sunshine too little. Generally, the larger the container the larger the plant will grow.

Helpful Hints:

1. Choose a cool, shaded area for potting. It is important not to let plant roots dry out completely.

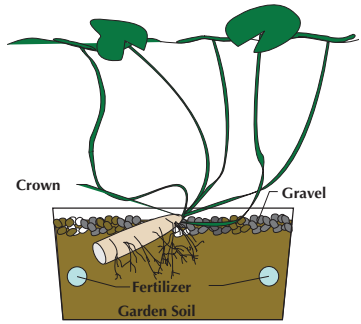
2. Use regular garden soil, not commercial potting soil mixes.

3. If there are large drain holes in the pots you are using, place a few sheets of newspaper in the bottom before adding soil.

4. Add two fertilizer tablets per gallon of soil before placing plant in the pot. Be careful that plant roots are not touching the fertilizer as this will burn the roots.

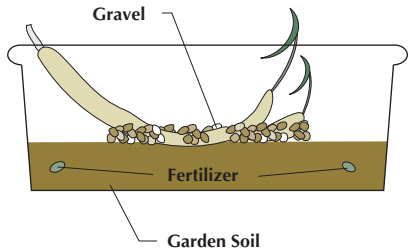
5. Planting Specifics

Lilies:



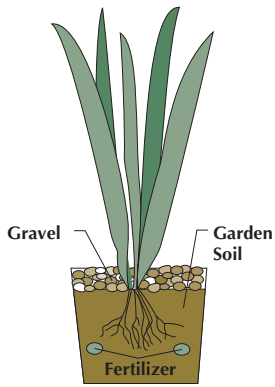
a. Hardy Water Lilies
- Never cover the crown with soil.
- Place the cut end of the tuber closest to the pot edge.
- Plant in relatively still water. Strong water currents are often detrimental to their development.

b. Tropical Water Lilies:
- Same as above but center the plant in the container.



Lotus:
- Tuber should be placed on top of soil and held in place by a small amount of gravel until rooted.
- Do not add fertilizer until 3 to 5 leaves are standing above the water's surface.

Shallow Water Plants should be planted as shown at right.



Lily-Like Aquatics should be planted as shown at right.

Planting (cont.)

Oxygenators should be planted in gravel or sand only and placed under water.

Floaters are not planted.

6. Whenever possible, place newly potted plants at shallow depths and once established move them to deeper depths as indicated in the chart on the next page. If your pond or garden doesn't have a shelf to allow this, newly potted plants can be raised on bricks.

	New Plant Depths*	Established Plant Depths*
Water Lilies	8" - 12"	18" - 24"
Lotus	2" - 4"	6" - 12"
Shallow Water Plants	0" - 2"	0" - 6"
Lily-Like Aquatics	4" - 6"	8" - 10"
Oxygenators	8" - 10"	10" - 16"

* Depth = amount of water above the top of the container.

Winter Care:

All Plants -
No fertilizer. Prune dead foliage.

Tropical Water Lilies -
In zones that do not allow outdoor wintering treat as an annual or refer to the following. After the first frost the plant should be removed from the pond and the foliage cut back. Separate the tubers from the soil and wash completely clean. Treat with a mild fungicide and store the tubers in damp sand at a temperature between 50^0 and $55^0 f.$ In mid-February, stored plants can be started in a 4" pot covered with 2" to 3" of water. For best results place in a sunny southern window.

Hardy Water Lilies and Lotus -
Place container so that crown of the plant is below the freeze line.

Hardy Shallow Water Plants -
Place container so that crown of the plant is at least 2" to 6" below the waters surface. If an "island planter" (see section on Flotation Gardening - pages 74-77), you can let it float.

Tropical Shallow Water Plants -
Treat as an annual or bring indoors as a house plant.

Lily-Like Aquatics -
Place container so that crown of the plant is below the freeze line.

Oxygenators -
Should be placed below the freeze line.

Floaters -
Treat as an annual.

NOTE: Depending on your climate zone, some of the Winter Care instructions above may vary. For example, in Zone 3 (Wyoming) a tropical water lily would need to be taken indoors during the winter if you wanted to grow it again the following year. However, in Zone 10 (south Florida) the same tropical lily could remain in the pond all year round.

Nymphaea Blue Beauty
Tropical Water Lily

Planting (cont.)

A Refuted Winter Care Myth

I'm taking the opportunity to refute a popular myth about the winter care of aquatic plants. This myth is that aquatic plants should be moved to the bottom of the pond to prevent them from freezing to death in the winter. I consider this to be analogous to lying on railroad tracks to escape being run over by an automobile.

Marginal or shallow water plants that are hardy in your area will survive very nicely if you don't move them deeper in the pond. The important factor is that their crowns be covered by water. The ice that will form around these plants is a natural defense against the bitterly cold, dehydrating winds that could possibly harm them. Also, I suspect that many plants could and will survive exposure of their crowns to the winter air. These plants have survived in the wild with no one to move them deeper for millions of years and I think most of them have developed natural defense mechanisms against freezing to death. When you move them to the bottom of your pond you're placing them in an unnatural location where they could indeed die. The bottom of a pond is darker, colder and lower in oxygen than the shallow areas where these plants normally reside.

Water lilies and other deep water plants may not need to be moved to the deepest part of your pond either. I say this advisedly because I think the risk of freezing damage may be greater for these plants. In my own experience, I am amazed by the ability of these deep water plants to handle a freeze. Hard winters in our area can be especially cold, yet we suffer no losses to our water lilies even when they are in very shallow water and locked in ice for the better part of the winter. I think that these plants may be more harmed by the repeated freezing and thawing that can occur at the level of the crown when winter temperatures fluctuate unevenly over the course of several months. I have no proof of this and admit that this "freezing and thawing" theory is pure conjecture on my part.

We lost no plants to freezing this year or in any year since we have been in business despite never moving them to deeper water. The plants with which you must concern yourself are plants that are out of their hardiness zone. The best approach for preserving these plants is to move them to a greenhouse or to a protected location in your garage or house. In the case of tropical plants (hardiness zones 8 to 10) these are good houseplants if given adequate light and kept moist.

Know the hardiness zone of your area and that of your plants, and then take the appropriate action to protect your plants from freezing to death. This action will very often be to leave them where they are rather than moving them to the bottom of your pond.

Dick Schuck

Tip:

Remember that hardiness zones progress from the coldest to the warmest. Thus, Zone 3 is colder than Zone 5.

If you live in Zone 5, any plant with a hardiness zone of 5 or less will survive your winter without being moved deeper in your pond. On the other hand, any plant that has a hardiness zone that has a higher number than your area will need winter protection of some sort, perhaps, moving it to your basement or garage. Plants with hardiness zone numbers of 9 or 10 can best be maintained as house plants in the winter.

Planting (cont.)

Soil For Aquatic Plants

The best looking water lilies I've ever seen were growing at Longwood Gardens in Kennett Square, PA.

These plants were grown in good loamy top soil which was composted in the field by stacking 6" thick strips of top soil and sod after the grass was shaved off. The small amount of grass stubble added fiber and a little humus. Patrick Nutt, Assistant Director of Horticulture at Longwood, once remarked that: 'If it'll grow grass, it'll grow water lilies'. Pat gave this analysis of the Longwood soil: 20% clay, 40% sand, 40% silt. This soil is defined as loam.

The main function of soil is to hold plants in place and to provide trace elements as well as some nutrients. You don't need soil to grow water plants but you need to provide the necessary nutrients. There are a number of commercial soil mixes sold for aquatic plants. I have tried a calcinated clay product (Turface) that grew pond and aquarium plants very well.

At M-A-N we use locally available screened topsoil. Depending on the topsoil in your area you may need to add a little humus (peat) and ground limestone (calcium carbonate). The clay in the soil will help bind nutrients in a form usable by plants. Peat does the same as clay but also serves a slow form of organic fertilizer. The ground limestone is needed to 'sweeten' soil that is too acid or sour. A pH test of the soil will determine its acidity. A sprinkling of ground limestone per gallon of soil is usually sufficient.

Many of the plants grown at M-A-N are grown hydroponically, ie: without soil where the necessary nutrients are provided in water soluble form directly to the plant The plants are grown in coconut fiber and/or mum mix (a mixture of composted peanut hulls, bark and peat). We are

presently growing some lilies and many of our marginal plants in this manner. Our normal procedure is to transfer these hydroponically grown plants to pots a few weeks prior to delivery to our customers. This affords the plants ample time to root out in the soil environment.

The key to growing good looking aquatic plants is good top soil, proper fertilization and sufficient pot size or growing room. In the case of the fabulous plants at Longwood, large containers are used exclusively and weekly to bi-weekly fertilization is performed, with slow release fertilizer tablets, during the growing season.

Footnote:
One thing that encourages plant growth, having nothing to do with soil, is moving water. The water provides a constant stream of nutrients to the plant roots encouraging the plants to grow many times bigger and greener than plants grown in still water. A simple experiment will demonstrate the great power of the hydroponic system to take nutrients from pond water as well as prove that while soil is important it's not always necessary. Place a bare root yellow iris, or other plant, in an overflow tank next to your pond. Then place the same plant, potted traditionally, in the pond. Circulate water from the pond through the overflow tank using a small water pump. In a few short weeks you'll notice that the plant in the tank is many times bigger and greener than its counterpart in the pond.

Dick Schuck

Tip:

Careful observation of your plants will generally indicate when they need fertilizer. A couple of good indications are if your lily pads begin to shrink in size or the leaves of your plants are pale rather then deep green. Please note that these symptoms can also indicate crowding in containers that are too small.

Planting (cont.)

Plant Maintenance

Plants purchased from the Garden Center are in an appropriate container for re-sale purposes. As a general rule these plants will all benefit from being transplanted sometime in the first season to a container that will provide the maximum surface area for new growth. This accomplishes several things:

1. More soil will increase the amount of nutrients available to the plant.

2. Allows for easier fertilization until the plant becomes root bound.

3. Reduces the frequency the plant needs to be divided.

Like all perennials, water plants will require division when the foliage size begins to decrease and flowering becomes minimal. This is a sure sign that nutrients and space have diminished.

Division and Repotting

Hardy Water Lilies

Hardy lilies are a tuber producing plant that have small new emergent tubers along the main tuber. With a sharp knife separate the new tubers that look the strongest and show the most promise. There may be more than one tuber like this. The remaining old growth (sometimes black)

Undivided tuber.

Cut the best plants from the undivided tuber clump.

A final trim of the roots and these are ready to pot.

should be discarded since it will not produce a very vigorous new plant. Each plant should receive it's own new container.

Tropical Lilies

Tropical lilies are also tuber producing. They will provide tremendous numbers of uniquely colored flowers and unusual, attractive foliage if cared for properly. They are extremely heavy feeders and require a large container. For maximum performance use a 16" diameter pot or larger. The effort is more, but a significant increase in foliage size and number of flowers will be evident. Given an Indian Summer tropical lilies will bloom well into the fall months. The climate zone you live in will determine the winter care for tropical lilies.

Lotus

Clean tubers ready for potting.

Lotus produces tubers that look like bananas connected end to end. They range in size from 4 inches to 3 feet or more depending on the variety. Lotus is a very low maintenance plant. Provided it has an adequate size container, harvesting of tubers should be as infrequent as every three to five years. Unlike most plants that are cut into smaller more manageable plants lotus tubers are "collected". Gently sift through the soil, feeling your way to the growing tip to protect it. It is critical during this procedure not to break off the growing tips. Each collected tuber should receive it's own container. Fertilizer should not be added until the first upright or standing leaves emerge. Follow manufacturer's recommended rates.

Shallow Water Plants: Iris and Marginal Plants

Marginal plants should be divided in the early spring season as new growth appears. Plants divided other times of the growing season

Planting *(cont.)*

should have the same amount of foliage removed as root. All iris (shown in the photos below) should be divided in the fall of the year, no later than mid-September.

Iris washed free of soil.

Cut into individual sections with a sharp knife or pruners.

Separate and trim the roots.

Add a small amount of soil and fertilizer.

Add remaining soil.

Gravel to top dress.

Tip:

Refer to page 47 for appropriately sized planting containers. Multiple plants, or multiple varieties, in a large container are always more effective than a single plant in a container. These are referred to as combination plantings.

Fish

A Safe, Humane Pond for Fish and other Aquatic Animals ...

- **... provides refuge from freezing, extreme heat and predatory birds.**

The pond needs to be deep enough in winter and adequately shaded by plants in summer.

- **... has sufficient room for fish activity.**

Do not overcrowd. Do not put koi in a pond smaller than 10' x 10'.

Let the fish decide how many. Under populate and allow fish to multiply until the pond's capacity is met.

- **... has non-polluted, healthy water.**

In the absence of a plants filter or a well planted pond, regular water changes must be performed. Even ponds with good filter systems may need occasional partial water changes and yearly cleaning. See Maintenance section for more information.

- **... has sufficient dissolved oxygen for active fish.**

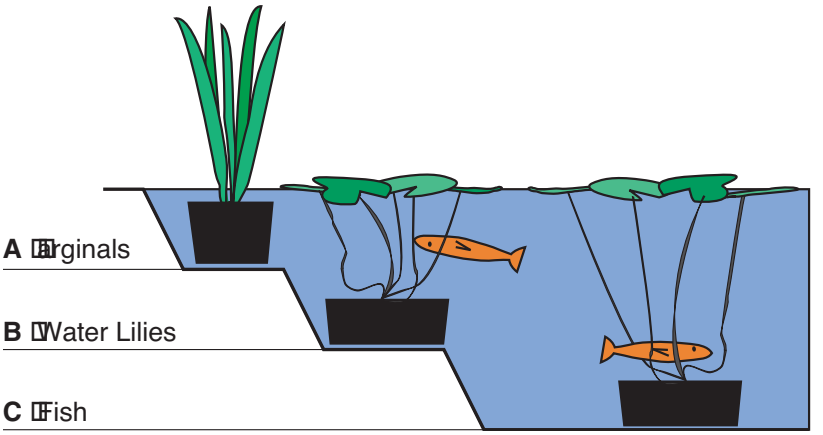
Use fountains, aerators, water falls and/or streams to oxygenate the water.

- **... is free of parasites and bacterial diseases.**

Always quarantine your fish for several weeks before adding them to your pond. If this is not possible, treat them for parasites and then add them to your pond. Elimination of parasites will remove the major vector for viral and bacterial infections of your fish. If neither quarantine or treatment is possible, purchase your fish from a dealer who regularly treats his fish for parasites. See the article Fish Care and Fish Health for more information.

Fish *(cont.)*

Depth Chart for a Healthy Habitat



See page 13 for more information regarding depths for a healthy habitat.

Fish Care and Fish Health

The two most important factors in having healthy fish are good water quality and parasite elimination. When water quality is good, fish suffer less stress and are better able to resist parasites and bacterial infection. When parasites are eliminated, the major vector of fish disease and mortality is also eliminated. Parasites can kill, but more often they weaken the fish and serve as vectors for the onset of deadly bacterial and viral infections which are extremely difficult to cure. Once these infections get going it may be too late to save your sick fish.

Good Water Quality

Good water is free of toxic pollutants such as ammonia and nitrites, and is buffered adequately with carbonates to maintain a stable pH between 7 and 8. It is also relatively free of decaying organic matter.

The best way to control toxins is to use a plants filter (see the Filtration section). If you don't have a plants filter you'll need to use a biological filter and perform regular water changes. Plants filtration removes all toxins and thus does not have to be supplemented with water changes.

Maintain a KH (hardness) level in your pond of at least 5 degrees of hardness. This KH level is sufficient to keep the pH of your pond water between 7 and 8. Depending on the water in your locale, you may need to add baking soda to your pond to attain the proper KH. Four ounces of baking soda per 1000 gallons of water will raise KH 1 to 2 degrees of hardness.

A yearly pond cleaning is generally sufficient to keep decaying organic matter at tolerable levels.

Parasite Elimination

Parasites can be eliminated by a variety of treatment procedures. Your particular situation and your budget will affect the specific regimen you select. Below I will present general information on parasites and then recommend various regimens for treating your entire pond, as this is the most likely scenario, as well as a treatment that's only suitable for a quarantine situation.

Fish (cont.)

General Information on Parasites

The nine parasites that commonly prey on pond fish are listed below. Note: Seven are visible only under microscopic magnification.

Parasite	Appearance	Treatment
Ich - White Spot (Ichthyophthirius multifils)	Spinning dots within a disc	.3% salt for 2 weeks Copper Sulfate Formalin Paracide Green
Trichodina	Disc with many short filaments	.3% salt for 2 weeks Paracide Green
Killer Don (Chilodinella)	Oval shape moving in circles	.3% or .6% salt for 2 weeks Paracide Green
Costia	Ciliated protozoan	.3% salt for 2 weeks Paracide Green
Epistylis	Goblet-like	.3% salt for 2 weeks Paracide Green
Body and Gill Flukes (Dactylogyrus and Gyrodactylus)	Worm-like, fatter at one end. Alternate, jerky elongation and contraction.	Trichloracide (Organophosphate) Formalin Anchors Away
Fish Lice (Argulus)	Round with short legs. Attached to fish. Visible to human eye.	Dimilin (Diflubenzuron) Trichloracide Anchors Away
Anchor Worm (Lernea)	Long, thin worm with tentacles attached to fish. Visible to human eye.	Dimilin Trichloracide Anchors Away

Entire Pond Treatment

For All the Fish in Your Pond

Treatment for Flukes

Argent's Trichloracide is an organophosphate effective against flukes. 100 grams treats 8,000 gallons. It's a very cost effective treatment and highly recommended.

Paracide Green from Argent
Paracide Green is a good broad spectrum paracide that treats for parasites and fungal infections. It can be used in conjuntion with salt. Equivalent brands are also available.

Preferred Regimen for Macro-Parasites, Anchor Worm and Fish Lice

Dimilin or diflubenzuron is a good remedy for macro-parasites, anchor worm and fish lice. This is an extremely fish safe treatment. A little bit goes a long way and lasts for a long time. Anchors Away by Jungle Labs contains dimilin and the treatment should be as indicated on the container. Argent's Trichloracide is also very effective against anchor worm and fish lice. You can use dimilin and trichloracide in combination to achieve long-lasting results. See the previous section on fluke treatments.

Fish (cont.)

Salt Treatment Regimen for Other Parasites

(See table on page 68 for list of parasites killed by salt.)

Salt has been shown to be effective against many parasites. The use of salt along with organophosphates (Trichloracide) will kill most of the parasites that trouble your fish. Salt can be used concurrently with the organophosphates and/or Paracide Green, but will need to be replenished when the prescribed water changes are performed.

The normal dosage rate for salt is 3 lbs. per 100 gallons (.3%) and 6 lbs. per 100 gallons (.6%) for salt resistant parasites. Each pound of salt per 100 gallons adds .1% salt concentration. Typically, the salt treatment should be maintained for 2 weeks. After 2 weeks the salt concentration should be reduced via water changes to .1%. Salt concentration above .1% will harm most aquatic plants. Do not add more than 3 lbs. of salt per 100 gallons on any given day. For more information on the salt tolerance of various aquatic plants you should refer to an article, Plants vs Salt, by Bonnie Hale published on KoiVet.com. Salt toxicity in plants is indicated by the browning and curling of the edges of leaves or by a sickly, droopy appearance of the leaves. If some of your plants show signs of salt damage place them in a salt free container of water until they can be safely returned to your pond. Most water lilies can tolerate .3% salt. You will need a salt level test kit to measure the actual salt concentration of your pond water. The best place to get salt is at the local hardware store. Buy a 50lb bag of non-iodized, 100% sodium chloride salt.

Quarantine Treatment
For Fish Being Added to Your Pond

A good friend of mine uses this treatment on the very expensive koi he imports from Japan. The treatment is short and kills all the parasites that may be infesting the koi. It uses .37% Formalin at a dosage rate of 150 ppm or 7.5 ounces per 400 gallons (slightly less than 2 ounces per 100 gallons). This treatment is limited to a maximum of 1 hour.

Important

- **Be sure to have good aeration while treating the fish.**
- **Constantly observe the behavior of the fish. If any roll over (a sign of imminent death) they should be removed immediately and placed in untreated water.**
- **Remove all fish from treatment after 1 hour.**

For quarantine tanks with no plants, maintain a salt level concentration of .5% salt or 5lbs per 100 gallons on an ongoing basis. This helps to promote good slime coatings on the fish which is good for their general well being. Salt also mitigates the ill effects of nitrites on fish and, most importantly, kills many parasites.

Dick Schuck

Tip:

The most important factor to good fish health is good water quality. Since plants improve water quality, use lots of plants in your pond.

Fact:

Salt in the water is effective against leeches and many other aquatic parasites as these critters can not adjust to the change in asmotic pressure that salt creates. Salt causes these parasites to fill with water and explode. Fish on the other hand, can make this adjustment easier and can tolerate more salt than many parasites.

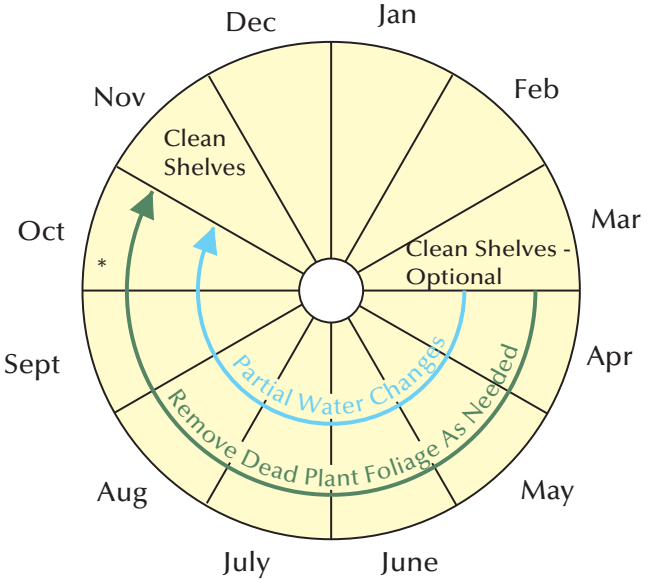
Maintenance

A Well Maintained Pond ...

- **... is cleaned at least annually.**
- **... has partial water changes in summer if a plants filter is not being used.**

Drain off and replace about 10% of the water every week or two.

Maintenance Schedule

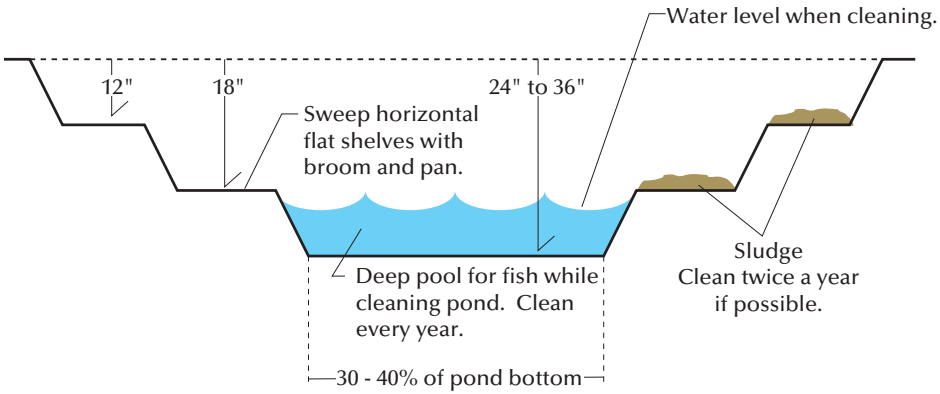


* **Clean entire pond, including the deep pool area, at least once a year.**

- **... is frequently cleared of dead plant foliage and other decaying organic matter.**

- **... is easy to clean.**

Use step-like shelves that can be swept free of sludge. These planting areas (shelves) should be equal in size to 60 - 70% of the surface area of the pond.



Tip:

Making the shelves flat and smooth will greatly facilitate cleaning them with a broom and pan.

After cleaning the shelves, you can then drag a large fish net through the pond bottom to collect the sludge and debris. This material can be dragged up onto the shelves where it can be swept into the pan for removal. The fish remain in the pond.

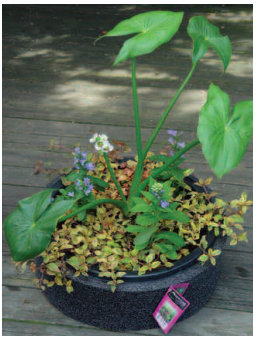
Add fresh water slowly over a 24 to 36 hour period using de-chlorinator chemicals if necessary. Information and appropriate water treatments are available from your pond supplier.

Flotation Gardening

A New Way to Garden

Floating Islands are one of the greatest things to happen to water gardening in a long time. When Floating Islands made their debut in the marketplace, the benefits to pond owners were immediately evident. They are self-watering, relatively lightweight and provide shade and cover for fish. Koi keepers love them because the Koi can no longer wreak havoc on the island plants, as they can no longer reach them. The cover plants that hang over the edges of the island offer a source of natural food as the Koi can do the pruning for you. Pond owners love Island Planters because they don't need planting shelves and just float around on the service of the pond. A wonderful side affect of these islands is that they gently move and drift throughout the pond with the breeze. They can also be tethered to the edge of the pond very easily. If the rim of the island is not appealing to you, don't worry, as it can be covered with creeping type plants that will overhang the rim.

The Islands have also proven themselves as a 'product of evolution'. You'll find them popping up everywhere in virtually any container that holds water. Islands are available in sizes from 5″ diameter to 24″ diameter so what ever size body of water you'd like to garden in there is likely an Island to fit it. They are suitable for indoor and outdoor use depending on the choice of plant material selected. You'll find them in anything from an urn in a sunny window to the back yard pond or water features in corporate office spaces and it's as easy as 1-2-3.



We sell a water friendly Island Grow Mix that consists of two components that have contributed to the amount of plant diversity that can be utilized in the Islands. The loose bark and peanut hull mixture that comprises the soil part of the mix keeps plants roots from becoming

super saturated in the wet environment and it doesn't ferment like other soil mixes when placed in the water. The calcined clay component attracts and absorbs ions of ammonium, potassium, calcium and magnesium. These nutrients are vital to plant growth. By attracting these nutrients, water quality is improved and algae are reduced. This is evident by the tremendous amount of roots that hang from the bottom of the island planters.

Since aquatic plants and moisture loving perennials, grasses, herbs, annuals and house plants are all suitable to the Island environment, the Island Planters are extremely versatile. There is even an occasional moisture loving dwarf tree or Bonsai tree that is suited to flotation gardening. One example of a group of plants that fit into this system perfectly is the carnivorous bog plants (Sarracenia). They fascinate many people, and it hasn't been easy to garden with them in the past because a separate bog had to be created. They absolutely thrive in the islands! It has been an ideal setting for these acid and moisture-loving plants. They add interest to the pond or container garden, are an intriguing conversation piece and children simply can't resist discovering which bugs their plants ate today. There is not a better option for a sun-baked deck or patio. This past summer I planted several of my water holding deck containers with Islands. One of them, a cobalt blue ceramic container, was big enough to fit a 9" island and it overflowed with Rotala indica, providing a steady stream of pink flowers all summer. Another, terra cotta ceramic glazed pot, held Ruellia brittoniana 'Katie' that rewarded me with an abundance of Blue Bells all season.

A New Way to Garden *(cont.)*

Additionally, they would spin gracefully in the breeze adding character and personality. The best part of all was that they only required watering four times since they were planted at the beginning of May.

One very creative horticulturist used these islands to display different themes for each season. April Brazis of Country Keepsakes Pond Headquarters, Inc. in Georgia experimented using many different combinations of annuals, perennials and grasses very successfully. For the winter she is using evergreen grasses in the Carex genus. After talking to April and hearing her enthusiasm, we acquired some Carex morrowii 'Old Gold' and Carex buchananii and planted them. The 'Old Gold' is weeping over the edges of the island and creating a beautiful effect.

Kelly Billing

NOTE: See Appendix for list of plants recommended for Floating Island Planters.

Flotation Gardening

As It Applies To Pond Filtration

I have long been an advocate of using plants to filter out the toxins and sediment in pond water. Plants remove nutrients and even heavy metals from water and also provide surface areas for beneficial bacteria involved in biological filtration. Normally, the best plants for this purpose are plants that send out great masses of roots into the water column. Notable among these plants are water hyacinths and water celery to name a few.

Recently, we developed a flotation technology for deploying plants in ponds. Island Planters and Rafts are representative of this technology. In this system, plants grow in containers housed in floating elements, flotation collars and rafts. As there are holes in the bottom of the floating containers, the plants' roots escape into the surrounding water. This trait or characteristic can transform nearly every plant into a “water hyacinth” and a great filtration plant.

Plants floating on the top of the water with their roots hanging down in the water have advantages over their counterparts planted in anaerobic muck in a pot or at the bottom of the pond. The roots of the floating plant have unfettered access to oxygen and nutrients, whereas the plant mired in the muck must fight to get both. Additionally, if the water is moving, such as, in a filter, it acts as a conveyer belt for transporting nutrients to the plant's exposed roots. Sediments are trapped by the suspended roots, as well, creating a habitat for a rich diversity of anaerobic and aerobic bacteria. These bacteria are instrumental in converting organic compounds into nutrients that can be consumed directly by the plants. The trapping of sediments helps clear the water and constitutes a form of mechanical filtration. The picture below shows rafted plants with extensive hyacinth-like root masses.

Plant rafts can be easily handled and removed from time to time for pruning and other necessary maintenance without disrupting the filter (or pond). This also helps to clear the filter for draining and cleaning, saving much time and effort.

Recently completed studies by the University of Maryland's Center for Environmental Science indicate that that rafted plants consume 2 to 5 times the nutrients of the same plants growing in the soil.

Aeration - A Good Thing For The Pond

Aeration is one of the good things you can do for your pond. It's not a must in many cases but it can be at times. Listed below are some of those good things.

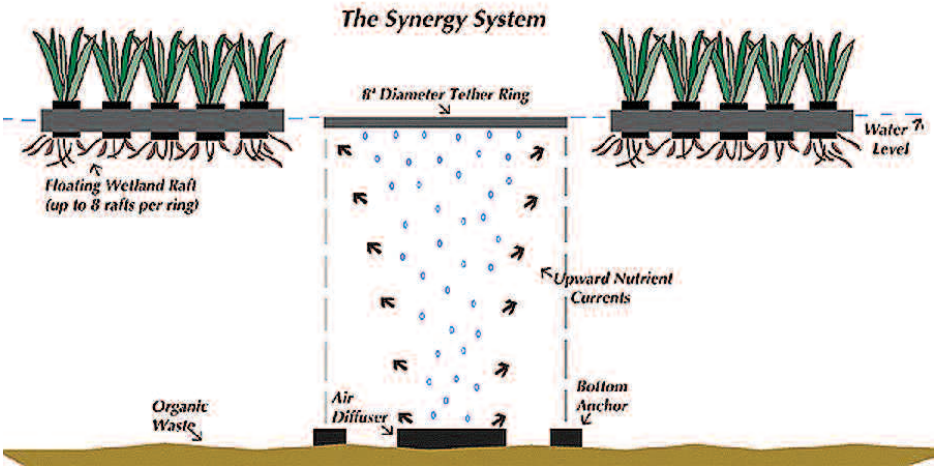
1. A waterfall, fountain, stream or air compressor pump can provide aeration to the pond. In general, aeration helps to distribute or circulate the pond water preventing stratification or layering. Stratification occurs when cold water settles beneath a warmer less dense layer of water. Usually, the strata of water near the pond bottom has much less dissolved oxygen than the layer near the surface. If these layers suddenly reverse, such as when a cold snap cools the top layer sufficiently to cause it to sink, the dissolved oxygen in the pond can fall to a lethal level causing a fish kill. Most small or relatively shallow ponds that have some sort of circulatory system, will not suffer this condition. Ponds that are relatively deep (over 3 feet on average) with weak water movement can easily incur lethal de-stratification.

2. Aeration, especially from an air compressor and diffuser, will circulate pond water very effectively and increase oxygen levels throughout the pond. This is not only good for the fish, but also the resident bacteria in the pond. These bacteria are instrumental in breaking down organic waste. An excessive build up of waste products (fish feces, dead leaves, fish food etc,) will severely degrade water quality. Without proper aeration, especially at the bottom, bacteria will be unable to breakdown organic waste or prevent the release of ammonia and toxic gases from the bottom sediments. Good oxygenation will also stem the release of iron, a promoter of algae, to the overlying water.

3. Using an aerator in the winter is more effective than using a surface heater and maybe less expensive. Aerator compressors use less energy than water pumps or fountains and circulate more water. The flow of bubbles to the surface will keep a hole in the ice and aggressively vent gases to the atmosphere. A surface water heater will not do this as well.

Aeration/Circulation multiplies the pollution removal power of Floating Wetlands.

The increased oxygen level created by the bottom diffuser speeds up the deomposition of organic matter on the pond bottom. This releases carbon dioxide and nitrates as by-products which are then transported upward toward the plant roots by the uplifting effect of the diffuser bubbles. This creates a contant flush of nutrients which increases and multiplies the nutrient uptake power of the rafted plants above.



Controlling Pollution

Bacteria - Some Things You Ought To Know

There are many proprietary pond bacteria products on the market that purport to make ponds healthier, clearer and cleaner. Before you decide to use these products, you should know a few facts about bacteria.

1. Bacteria or microbes are omnipresent in practically everything: our stomachs, soil, the food we eat and all bodies of water. They are necessary for living things to digest food or nutrients and to recycle the resulting waste products. Without them, the earth and we would perish very quickly.

2. Ponds normally have abundant bacteria. In fact, it is estimated that every cubic cm of pond sediment, about the size of 1 pea, contains 1 billion bacteria. Thus, every pond, even a small one, contains billions upon billions of bacterial microbes.

3. There are 2 basic types of bacteria: aerobic, requiring oxygen to function; and anaerobic, not requiring oxygen to function. Within these two basic types are heterotrophic bacteria that are responsible for organic matter decomposition. In both their aerobic and anaerobic form, these bacteria convert organic material into various gases and plant nutrients that plants need and use. It should be noted that aerobic decomposition is much faster than anaerobic. Two other major kinds of bacteria are nitrifying and denitrifying. Nitrifying bacteria are aerobic and responsible for converting ammonia to nitrate nitrogen. Their partner denitrifying bacteria operate in an anaerobic environment and convert nitrates and other compounds into various gases such as nitrogen, methane and hydrogen sulfide. The latter two can be toxic to animal life in the pond.

4. There are many different strains of bacteria with each performing slightly different functions. Not even the scientists have identified all the bacteria and their specific functions.

5. Aerobic decomposition of organic matter requires lots of oxygen. This is called biological oxygen demand or BOD. Dirty ponds (high BOD) will generally suffer from insufficient dissolved oxygen at some point when the aerobic bacteria use it up during the decomposition process. This will happen most often during hot weather or cloudy days when dissolved oxygen is low anyway. Aerobic decomposition releases CO2 and other organic compounds (e.g. nitrates and phosphates, etc.) that are used by plants as nutrients. Nitrifying bacteria also participate in this aerobic process.

6. Anaerobic decomposition requires no oxygen but produces toxic and foul smelling gases. If these gases are not vented from the pond such as when covered with ice, fish and other pond life will quickly perish. Denitrifying bacteria also are part of this anaerobic process.

Perhaps, the best time to use bacterial supplements is when the pond is extremely dirty and shows no signs of recovering on its own. Adding bacteria may work at this juncture, as they will find an extremely nutritious and friendly environment and probably should not only survive but also multiply rapidly. But if the pond already has ample bacteria (see item 2 -previous page) you may be wasting your money, as the bacteria added will represent a relatively miniscule amount of bacteria to the total already in the pond.

Most, if not all, bacterial supplements claim to reduce organic waste or sediment, so we might assume that heterotrophic bacteria are involved. If so, adding aeration (see item 5 -previous page) would be a good idea as this will assure that ample dissolved oxygen is available for the bacteria. The oxygen will also help to oxidize toxic gases such as ammonia, methane and hydrogen sulfide.

Other factors should be considered when adding bacteria. Water pH and total alkalinity affect bacteria health and functionality. The pH should be between 7 and 8 and alkalinity should be above 50. It's a good idea to test for both and make corrections if necessary. If the water temperature is below 50 degrees, wait until it warms up before adding bacteria, as bacteria are relatively inactive in cool water.

See the article on "Breaking the Pollution Cycle" (page 82) as it will explain more about the interactions that occur in the pond. Understanding this will help you control pollution in your pond.

Dick Schuck

Fact:

Did you know that anaerobic bacteria contributes more to

"Global Warming" then do the activites of humans?

Controlling Pollution

Breaking the Pollution Cycle in The Pond

Several years ago I wrote an article in which I opined that rafted plants were probably better at nutrient uptake than the same plants grown in the pond bottom. The University of Maryland undertook a study to determine whether this supposition were true. I put up the capital and they provided the scientific expertise under the auspices of the Maryland Industrial Partnership Program (MIPS). Dr. Andrew Lazur was my scientific partner in the project. He determined that nitrogen and phosphorous were consumed at a rate 2-5 times greater by rafted plants than the same species of plants (lizards tail and and lavender musk) grown in soil-based pots. This finding far exceeded even my own estimates.

In the same timeframe as the MIPS study, my sons and I designed a raft for Dr. Robert Hubbard of the USDA. This raft had to withstand the highly polluted and corrosive water of a toxic swine lagoon. In one of Dr. Hubbard's studies, he grew Maidencane and Bermuda grass on the plant rafts and calculated the biomass removal and nutrient uptake over the course of 15 months. His data when extrapolated to an acre, indicated astonishing removal rates by Maidencane of 730,000 lbs. of wet weight biomass per acre per year. This equated to 4,000 lbs. of Nitrogen and 670lbs of Phosphate. It is apparent from both the MIPS and Hubbard studies that plant rafts are exceedingly good at lapping up nutrient pollution. The picture below shows Dr. Hubbard (at right) and his associate at the swine lagoon.

While these studies were being conducted, I delved into the interactions among plants, aeration and bacteria in treating pond pollution. This is what I concluded . . .

All ponds collect pollution via the accumulation of nutrients and organic matter. Unless these pollutants are removed, water quality will continually decline. Fish kills and toxic pond conditions will ultimately result.

Wetland plants soak up nutrient pollution but unless their vegetative biomass is removed from the pond, the nutrients contained by that biomass will recycle back into the pond when the plants dieback and decompose at the end of the growing season. Ponds are, in varying degrees, closed systems where pollution collects and re-cycles.

Other methods of reducing pollution that rely solely on bacteria and/or aeration are doomed to failure, as each falls prey to the re-cycling phenomenon.

Anaerobic and denitrifying bacteria will eliminate up to 80% of nitrogen pollution by converting it to nitrogen gas that vents to the atmosphere. The remainder, 20% or more will be taken up by plants or linger in the bottom sediments. This residual creates an incremental buildup of pollution in the pond.

Other bacteria will consume phosphate pollution, a major contributor to algae growth, only to release most, if not all, of it back into the pond when the bacteria die. Again, these nutrients will be recycled rather than eliminated.

Aeration will aid in the recycling of nutrient pollution from dead organic matter to living plant material by supplying oxygen to the aerobic bacteria that decompose organic matter. This decomposition releases CO2 and nitrogen nutrients that plants need. These nutrients in turn will be converted to living plant material by photosynthesis. The living plant material will die, decompose and repeat the nutrient cycle from one form of organic matter to another.

Thus, plants, aeration and bacteria will recycle nutrient pollution unless either the plant biomass or the bottom sediments containing the nutrient pollution are removed. Without physical removal, nutrients will accumulate in the pond. This is especially true of phosphates, which unlike nitrogen, cannot be vented to the atmosphere.

Breaking the Pollution Cycle in the Pond (cont.)

Four Steps for Breaking the Pollution Cycle in Your Pond

1. Use plant rafts or Floating Wetlands (see picture) in your pond to soak up nitrogen and phosphorous pollution in the form of plant biomass. The rafts will be easy to handle and will greatly facilitate the periodic removal of foliar or plant biomass from the pond. This removal will permanently remove nutrient pollutants from the pond and prevent recycling.

2. Use aeration in the pond to distribute oxygen to the pond's bottom to speed up the aerobic decomposition of organic matter. This will halt the excessive buildup of organic waste and supply nutrients to the plants growing in the Floating Wetlands on the pond's surface. Plant growth and nutrient uptake will be enhanced and sediment build-up reduced.

3. If possible and practical, remove bottom sediments from the pond. This is especially important for backyard fishponds that are often defined by too many fish and abundant fish waste.

4. Use enough of these measures so that more pollution is removed each year than is added. This is the path to a healthier pond.

Dick Schuck

A potpourri of Floating Wetlands.

86 Retention Ponds

Making Them Look Good and Work Better

Our landscape is dotted with storm water runoff ponds that are often referred to as retention or detention ponds. A retention pond always remains wet; whereas, a detention pond dries out between storm events. We are concerned with retention ponds as these constantly wet areas often degrade into cattail infested eyesores that don't do what they are intended to do -- which is to keep nutrient laden storm water out of our streams, rivers and bays.

The typical maintenance for retention ponds is usually neglect. Those that are maintained are usually treated with herbicides or worse, with colorants that tint the water an unnaturally blue-green color. These treatments destroy plants, both shoreline and waterborne, resulting in a continual build up of nutrients and toxins in the water. The picture below is visual evidence of such a polluted pond. This pond not only looks bad, but also smells bad. It is full of algae and foul smelling swamp gases.

When no herbicides are used, the pond typically fills up with ugly cattails or other noxious weeds. You might say that this consumes the nutrients, which is a good thing -- right? It is a good thing until the cattails and weeds decompose at the end of the growing season and release all those nutrients back into the pond.

This causes a continual buildup of nutrients that further degrades the pond. Eventually, the overabundance of nutrients will flush out of the pond during the next storm event or work their way into the ground water and ultimately into the estuary system. The longer the storm water pond system is improperly maintained, the worse the problem will get.

What can we do about this problem? We can begin to maintain the ecology of these ponds so good, rather than bad, things happen.

First, we must periodically remove the vegetative biomass so it does not decay in the pond. This will take a little work on our part, or money, if we hire someone to do it for us. If the pond is in your community, you can form a pond club to do this job. Spending an afternoon with your fellow neighbors cutting back shoreline plants and removing the cuttings to a community compost may be one of the best and most productive ways to spend an afternoon or weekend. The pond will obviously look better, so will your community. In addition, your property values will soar.

Second, when removing the vegetative biomass for the first time, eliminate the undesirable plants altogether and replace them with more desirable plants. For example, replace some of the cattails with native water iris. If you have some 1-2 feet shallow areas, try some varieties of hybrid native water lilies that won't take over the pond. You may need to use herbicides to eliminate unwanted plants, but year- by- year the need for herbicides will lessen.

Third, you can use plant rafts or Floating Wetlands in the pond. Plant rafts are efficient at nutrient uptake, easily deployed and removed from the pond, and simplify the job of removing vegetative biomass.

Raft Roots

Retention Ponds

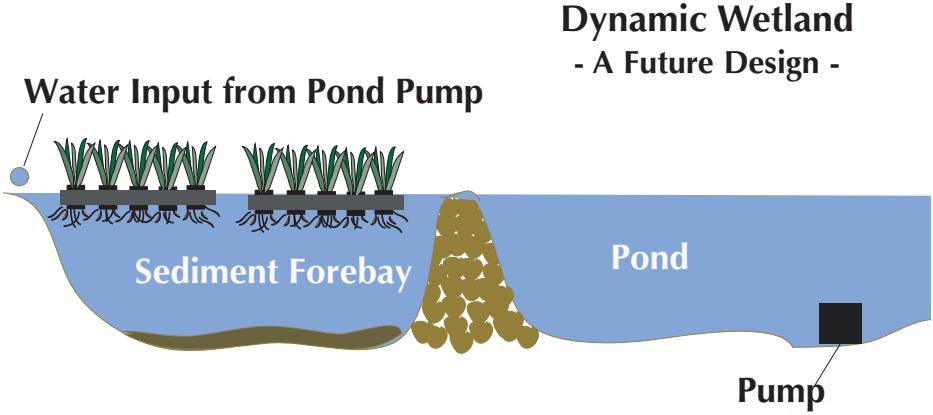
Making Them Look Good and Work Better (cont.)

The more often you remove top growth from the raft, the greater the reduction of nutrients in the pond. In addition to being good tools for nutrient reduction, rafts can beautify the pond and provide cover for fish and sanctuary for other aquatic animals. They also will rise and fall with the water level, a great advantage in storm water ponds.

Plants Raft -- Wetland Sanctuary

Last, you might consider redesigning the pond and transforming it from a passive to a dynamic force for reducing nutrient levels. In my travels, I've noticed that many retention ponds employ fountains. These fountains aerate the water and look pretty, but probably do little to improve overall water quality. They also look out of place or unnatural (in my opinion). I've also noticed that some ponds have a lagoon or bay-like area that could be dammed or walled off to create a filtration compartment. These compartments need to be no more than 10% of

the total pond area. Plant rafts can be placed in the filtration compartment to create a rafted or floating wetland. Now, all you need to do is redirect the fountain pump water to the far end of the filtration compartment. The water will now flow past the floating plants rafts and back into the larger pond. This will create a dynamic wetland for reducing nutrient levels in the entire pond. The movement of the water multiplies the contact between it and the plant roots dangling beneath the rafts, thereby increasing nutrient uptake. You will need fewer rafts and less labor to achieve the same nutrient reduction when you use the dynamic method.



Circulating water from pond to forebay;

- Multiplies the nutrient uptake of the plant rafts many times.
- Aerates the water and increases organic matter decomposition.
- Sequesters rafts for easy deployment and removal.

Wouldn't it be great if retention ponds were pleasing to look at while also doing the job they were intended to do? If you would like to know more, you can visit our website at www.floatingwetlands.com.

Appendix

Plants for Island Gardens

In addition to most aquatic plants the following have been used successfully in Floating Island Planters.

Alocasia - Elephant Ear

Bacopa - Lemon, Moneywort, Variegated

Baumea rubiginosa - Variegated Striped Rush

Begonia semperflorens - Wax Leaf Begonias

Caladium - Angel Wings

Canna hybrids

Carex moisture-loving hybrids

Coleus hybrids

Colocasia - Taro

Cypella aquatica - Water Orchid

Cyperus haspan - Dwarf Papyrus

Equisetum - Horsetail

Hedychium coronarium - Ginger

Houttuynia cordata 'Variegata' - Chameleon Plant

Hydrocotyle sibthorpioides 'Crystal Confetti' - Variegated Pennywort

Ipomea 'Blackie' & 'Ace of Spades' - Sweet Potato Vine

Lilaeopsis noraezelandiae - Micro Sword

Lysimachia nummularia - Creeping Jenny

Marsilea quadrifolia - Four Leaf Clover

Mazus reptans

Mimulus luteus - Golden Monkey Flower

Myriophyllum spp. - Dwarf Red Stemmed Parrot Feather

Nelumbo - Lotus

Nymphoides spp. - Ecuadorian Snowflake

Pratia pedunculata - Blue Star Creeper

Rotala indica - Red Rotala

Ruellia 'Katie' - Dwarf Blue Bells

Rumex sanguineus - Water Dock

Sarracenia - Pitcher Plants

Sisyrinchium angustifolium - Blue Eyed Grass

Spartina

Typha minima - Micro-Miniature Cattail

Tulbaghia violacea 'Variegata' - Variegated Society Garlic

Villarsia reniformis

Zantedeschia aethipica

Zephyranthes candida - Rain Lily

Fact: Most moisture loving annuals, perennials and grasses are also well suited to the Islands.

Frequently Used Dosage Rates for Specified Fish Treatments

Salt
Effective against parasites but harmful to many aquatic plants.
.3% or 3 lbs / 100 gallons for 2 weeks duration
.6% or 6 lbs / 100 gallons for salt resistant parasites
Do not add more than 3 lbs / 100 gallons / day

Argent's Trichloracide
Effective against flukes, anchor worms and fish lice. 100 grams per 8,000 gallons. Follow directions on the bottle.

.37% Formalin
Quarantine treatment for maximum duration of 1 hour will kill virtually all parasites. Be careful as this can kill fish too.
150 ppm or 7.5 oz per 400 gallons for maximum of 1 hour.
Constantly watch the fish and if any begin to roll over, an imminent sign of death, remove them immediately and place in untreated water. Remove all fish at 1 hour.

Appendix

Conversion Factors

Abbreviations

Acre Foot = A-ft
Cubic Centimeter = cc
Cubic Foot = ft^3
Cubic Inch = in^3
Cubic Yard = yd^3
Fluid Ounce = fl oz
Gallon = gal
Gram = g
Kilogram = kg
Liter = L
Milligram = mg
Milliliter = mL
Ounce (weight) = oz
Part per MIllion = ppm
Parts per Thousand = ppt
Pint = pt
Pound = lb
Quart = qt
Square Foot = ft^2
Square Meter = m^2
Square Yard = yd^2
Tablespoon = tbsp
Teaspoon = tsp

* Terms followed by an asterisk refer to units of water.

Acre =
- 4046.8 m^2
- 43.560 ft^2
- 4850 yd^2

Acre-foot =
- 1,233,489 L
- 2,718,144 lb *
- 325,851 gal
- 43,560 ft^3
- 1 surface acre covered with 1 ft of water

Cubic centimeter =
- 0.034 fl oz
- 1 mL
- 1g *

Cubic Foot =
- 28.317 mL or cc
- 28.32 L
- 957.6 fl oz
- 7.48 gal
- 1,728 in^3
- 0,037 yd^3
- 62,43 lb *

Cup =
- 8 fl oz
- 1/2 or 0.5 pt

Fluid Ounce =
- 29.57 g *
- 29.57 mL or cc
- 1.043 fl oz *
- 6 tsp
- 2 tbsp

Gallon =
- 3785.4 mL or cc
- 3.78 L
- 128 fl oz
- 8 pt
- 4 qt
- 0.13 ft^3
- 133.52 oz *
- 8.35 lbs *

Gram =
- 0.034 oz
- 1000 mg
- 1.0 mL or cc *

Kilogram =
- 35.27 oz
- 2.20 lbs
- 1000 g
- 1.0 mL or cc *

Conversion Factors *(cont.)*

Liter =
- 33.28 fl oz
- 1.057 qt
- 0.26 gal
- 2.20 lbs *
- 1.0 kg*

Milligram =
- 1/1000 or 0.001 g

Milliliter =
- 0.20 tsp
- 0.034 fl oz
- 1.0 cc
- 1/1000 or 0.001 L
- 1.0 g*

Ounce (weight) =
- 28.35 g
- 0.063 lbs
- 0.96 fl oz*

Part per Million =
- 1 mg/L *
- 3.78 mg/gal *
- 28.35 g/1000 ft^3 *
- 1.23 kg/A-ft
- 0.13 oz/1000 gal *
- 1 oz/1000ft^3 *
- 2.72 lb/A-ft *
- 1.30 qt/A-ft *

Parts per Thousand =
- 1 g/L *
- 3.78 g/gal *
- 28.35 g/ft^3 *
- 0.13 oz/gal *
- 1 oz/ft^3 *

Pint =
- 473.17 mL or cc
- 16 fl oz
- 1/2 or 0.5 qt
- 1/8 or 0.13 gal
- 16.69 oz *
- 1.04 lbs *

Pound =
- 453.59 g
- 0.45 kg
- 453.59 mL or cc *
- 0.45 L *
- 16 oz
- 15.34 fl oz *
- 0.96 pt *
- 0.12 gal *

Quart =
- 946.34 mL or cc
- 0.95 L
- 32 fl oz
- 4 cups
- 2 pt

Quart, continued
- 1/4 or 0.25 gal
- 2.09 lb

Tablespoon =
- 14.79 mL or cc
- 3 tsp
- 1/2 or 0.5 oz

Teaspoon =
- 4.93 mL or cc
- 1/3 or 0,33 tbsp
- 1/6 or 0.17 fl oz

Notes:

_____

_____

_____

_____

_____

_____

_____

_____

Frequently Used Factors

5mL = 1 teaspoon
1 ppm = 1 ml / 1,000 liters
1 ppt = .001 = .1%

6 teaspoons = 1 oz
1 ppm = approx 4 mL / 1,000 gallons

Appendix

Common Name Glossary

A listing of Common Names for some Popular Varieties of Water Plants

Shallow Water Plants

Arrow Arum
- Peltandra

Arrowhead
- Sagittaria

Bald Cypress
- Taxodium

Bamboo, Dwarf
- Dulichium

Blue Bells
- Ruellia

Bog Bean
- Menyanthes

Bog Lily
- Crinum

Bulrush
- Scirpus

Butterfly Flower
- Asclepias

Button Bush
- Cephalanthus

Calla, Common
- Zantedeschia

Canna. Hardy Water
- Thalia

Canna, Longwood hybrid
'Endeavour' (Red)
'Erebus' (Pink)
'Ra' (Yellow)
'Tany' (Orange)

Canna, Native Yellow Water
- Canna flaccida)

Cardamom
- Elettaria

Cardinal Flower
- Lobelia

Cattail
- Typha

Celery
- Oenanthe

Chameleon Plant
- Houttuynia

Clover
- Marsilea

Clover, Two Leaf
- Regnellidum

Cordgrass
- Spartina

Flowering Rush
- Butomus

Forget-Me-Not
- Myosotis

Golden Club
- Orontium

Houttuynia
- Houttuynia

Lavender Musk
- Mimulus

Lizard's Tail
- Saururus

Loosestrife
- Lythrum

Marsh Marigold
- Caltha

Mint
- Mentha

Papyrus
- Cyperus

Parrot Feather
- Myriophyllum

Pennywort
- Hydrocotyle

Pickerel Rush
- Pontederia

Plantain
- Alisma

Primrose Creeper
- Ludwigia

Rain Lily
- Zephyranthes

Reed
- Arundo donax

Reed
- Phragmites

Ribbon Grass
- Phalaris

Rice
- Zizania

Rosemallow
- Hibiscus

Rush
- Eleocharis

Rush
- Juncus

Rush
- Scirpus

Sedge
- Carex

Sensitive Fern
- Aeschynomene

Sensitive Plant
- Neptunia

Spearwort
- Ranunculus

Star Grass
- Dichromena

Striped Rush
- Baumea

Sweet Flag
- Acorus

Sword
- Echinodorus

Taro
- Colocasia

Umbrella Grass
- Cyperus

Umbrella Palm
- Cyperus

Watercress
- Nasturtium

Appendix

Common Name Glossary (cont.)

Lily-Like Aquatics

Banana Lily
-Nymphoides

Floating Heart
-Nymphoides

Spatterdock
- Nuphar

Water Fringe
- Nymphoides

Water Hawthorne
- Aponogeton

Water Poppy
- Hydrocleys

Water Snowflake
- Nymphoides

Floating Plants

Duck Weed
- Lemna

Fairy Moss
- Azolla

Frog's Bit
- Hydrocharis

Frog's Bit
- Limnobium

Water Hyacinth
- Eichhornia

Water Lettuce
- Pistia

Oxygenators

Anacharis
- Egeria densa

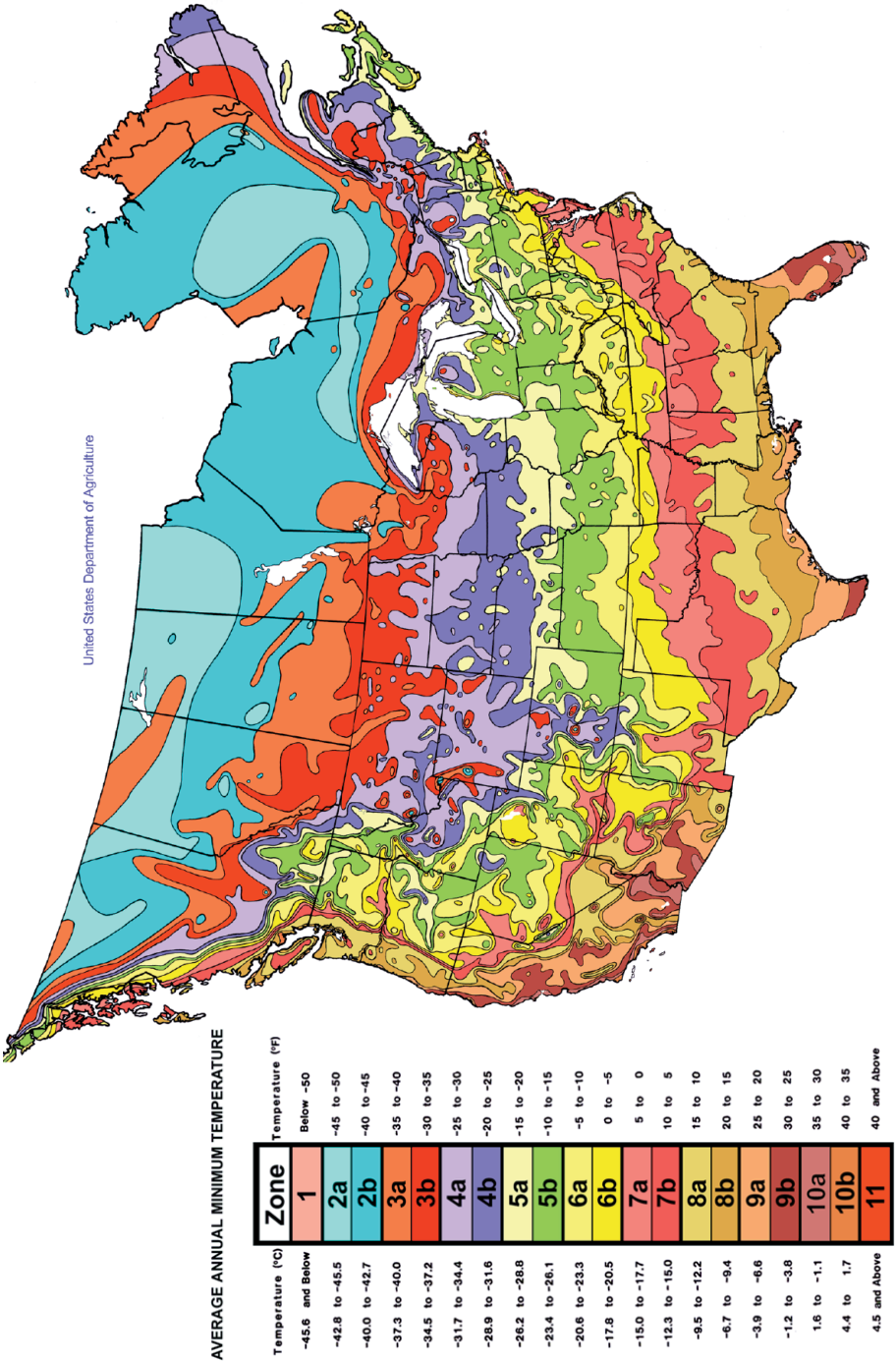
Cabomba
- Cabomba caroliniana

Foxtail
- Myriophyllum heterophyllum

Hornwort or Coontail
- Ceratophyllum demersum

Notes

USDA Hardiness Zone Map



Contact Information

Maryland Aquatic Nurseries

3427 North Furnace Road
Jarrettsville, Maryland 21084

Voice: 410-557-7615
Fax: 410-692-2837
Toll Free Order Line: 877-736-1807
Email: info@marylandaquatic.com

Website: www.marylandaquatic.com

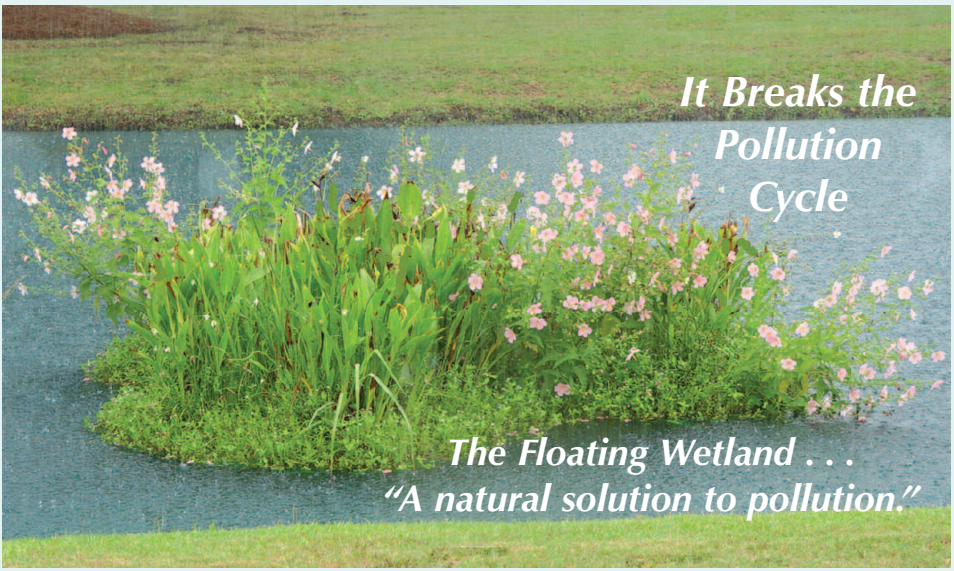
Owner: Richard Schuck

Charleston Aquatic Nursery

3095 Canal Bridge Road
Johns Island, South Carolina 29455
WHOLESALE ONLY
Voice: 843-559-3151
Fax: 843-559-1344
Toll Free Order Line: 800-566-3264
Email: info@charlestonaquatic.com

Website: www.charlestonaquatic.com

Owners: Brian Schuck & Stuart Schuck



For more information on our floating wetlands go to:

www.floatingwetlands.com

Aqua-Link

Grower of Quality Pond and Wetland Plants
Manufacturer and Distributor of
Watergardening and Environmental Products

Maryland Aquatic Nurseries

Charleston Aquatic Nursery

www.aqua-link.com