

Natural Swimming Pools

From a Seminar by James Robyn of BioNova Natural Swimming Pools, February 2010.

<http://www.bionovanaturalpools.com>

Session 1

- Examples from around the world
 - All over. Temperate & tropical climate, lots of Europe.
 - Design can be pool-like or rectilinear.
 - Separation wall
 - Prevents swimmers from going into the planted zone.
 - Prevents gravel from going into the swimming zone
 - Freezes in winter.
- Plants in winter
 - cut them back in the fall to below or at water level.
 - most plants are hardy to zone 5
 - leave some hollow stems above water as a gas diffuser.
- Standards - German FLL - adopted by most of EU
 - there exist some "non-system" installations w/ good technical knowledge
 - currently there are none in the US.
 - "system" is more of a membership association.
 - how involved are FLL standards? based on performance - significantly nebulous so that you can do whatever you want.
 - in EU, find that they are designed by landscape architects
- Limnological Principles
 - study of inland waters.
 - NSPs are artificially created ecosystems in which the conditions found in natural waterbodies are replicated, developed, and optimized.
 - First Law of Ecology
 - Everything is connected to everything else.
 - Biocenosis - an ecological community
 - Zoocenosis - animals
 - Phytocenosis - plants
 - Microbiocenoses - microbial
 - [figure from book]
 - Process of microbial
 - heterotrophic bacteria convert $N > NH_3 + NH_4$
 - nitrosomonous bacteria $>$ nitrite
 - nitrobacter $>$ nitrate
 -
 -
- Pools are alive!
 - Full of organisms - circulated through both ponds by the pumping system
 - Most will tend to hang out in the regeneration zone.

AppleSeed Permaculture

Regenerative Design & Development

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- Zooplankton
 - Daphnia
 - [many species....]
 - [sponges....] filter 216ml/ml sponge per day
 - mussels - 7.2 L/mussel/day
 - Will all emerge naturally. Could inoculate from other pool or waterbody, but not needed.
 - 35k daphnia in m³ = 264 gallons
 - Bad bugs?
 - Cryptosporidium - Not killed by Cl. Do not occur in NSPs
 - Giardia -Do not occur in NSPs - too much competition
- Organisms interacting with NSPs
 - Organisms
 - Producers - phytoplankton - Phytoplankton and water plants convert sunlight and inorganic carbon into Biomass which is then eaten by...
 - Consumers - Zooplankton (animals), planktonic small crustaceans (little crabs), daphnia (water fleas), etc. eat the biomass, consume the oxygen and produce detritus.
 - Bacterial Biocenosis - breaks down the dead organic matter, detritus, and produce food for the producers (nitrate)
 - N + P are the big nutrients to work with.
 - Production should be minimized
 - Fish - Excrement increases nutrients into the system which can lead to excessive algae growth.
 - Can reduce stocks of zooplankton primarily large water fleas or daphnia) so severely that they cannot effectively consume the phytoplankton and filter the water.
 - Amphibians and reptiles can be tolerated, but should not be introduced.
 - Snails
 - Fine. Leave'em.
 - Dogs
 - FLL recommends that dogs not go into the pool
 - Some pools are done with a liner !!! - dogs might be a worry for that.
 - Birds/Waterfowl - should be discouraged
 - overhead wires - monofilament?
 - Dogs
 - sprinkler heads / IR sensors
 - 12 or 22 gauge
 - Algae and Biofilms
 - Normal part of the biocenosis of the producers. No need for action unless it is unusually prolific or impedes use of the pool.
 - Biofilm consists of algae, bacteria, and other microorganisms. no need for action unless it causes a slippery condition on walking surfaces. can be cleaned or removed mechanically.
 - Nutrients - significance of N and P

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- N - key growth agent -
- P - the limiting factor on the growth of algae. We need some, but a small amount.
- The more we starve the pool of P, the clearer it will be. $< .01 \text{ mg/l} = 10\text{ppb}$
-
- Hygiene
 - Marker organisms
 - E-Coli
 - Enterococcus
 - Pseudomonas
 - P introduction/guest
 - w/out sunscreen - 0.6mgP/C
 - w/ sunscreen - 45.6mgP/G
 - Bacteria introduction/guest
 - w/out a shower $1.2 \times 10^5 \text{ E. coli}$
 - w/ a show $2 \times 10^2 \text{ E.Coli}$
- Usage Intensity
 - Greater usage puts more pressure on the system
 - Larger NSPs can handle more bathers
 - Larger biomass increases stability
 - Older they get, the better they work
- Paramaters
 - pH Value = 6.0-9.0
 - Acid capacity $K_s 4,3 > 2\text{mmol/l}$
 - Total P $< 0.01 \text{ mg/l P}$
 - Conductivity $< \text{uS/cm at } 20^\circ\text{C}$
 - Nitrate $< 50.0\text{mg/l}$
 - Ammonium $< 0.5 \text{ mg/l}$
 - Iron $< 0.2\text{mg/l}$
 - Manganese $< 0.05 \text{ mg/l}$
 - Hardness $> 1\text{mmol/l}$
- 5 Types of NSP
 - Type 1 - No technical systems.
 - Convection is a result of wind + thermal changes.
 - Purification - uncontrolled flow
 - Purification
 - Total water surface $> 120\text{m}^2 = 1200\text{sf}$ needed for Type 1 NSP
 - Depth - 65% of the pool greater than 2m
 - Type 2 - with Skimmer
 - Same as Type 1, but with a skimmer on it.
 - Still no control over the flow into the regeneration zone.
 - Type 3
 - Most common built
 - Controlled flow
 - Biological filter on the pool

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- Return water through a manifold into the substrate of the regeneration zone.
- 80m², 40% regeneration
- 60% > 2m deep
- Type 4
 - Same, but Regen zone split by wall
 - 60m²
- Type 5
 - Two-pot or multichamber
 - Swimming zone physically separated from regeneration zone - could be anywhere
 - Depends - very minimum requirements.

Session 2

- Type 3
 - Separated regen zone
 - Biofilter
 - Pond liner, with geotextile on top.
 - Common design theme - stepping stones through regeneration zone.
 - Skimmer intake. Round skimmers as intake.
 - Design flows
 - 1m³ per m² of pool per day. VERY LOW
 - 264gal per 10sf per day
 - 26 gal per sf per day.
 - exceed this flow, we push things out of the regen zone.
 - Regeneration Zone
 - 2.5 feet gravel, 1 ft of water over the top
 - perf pipe a meter down - connected to distribution shaft.
 - various depths - to plant some submerged plants
 - Costs: \$100/sf
- Type 5
 - Water quality is excellent
 - Two autonomous bodies of water - one to swim and another to regenerate
 - Better filtration and cleaning
 - Can include air - compressed and introduced into filter basin.
 - Can plant a lawn with grass as a regen zone. Sod over gravel. This has been done on Public pools.
 - Plants
 - Usually a mix of local aquatic plants.
 - Minimum size
 - 50m² - 35% regen zone.

Session 3

- Plants
 - Nutrient-poor environment
 - Use:
 - nutrient-poor substrates
 - Washed sone
 - Prevent nutrient input
 - Correct construction of capillary barriers
 - Keep groundwater from getting into the NSP. Cutout trench - a french drain
 - Nutrient input comes from:
 - Leaves/pollen, fill water/makeup water, Surface runoff, Dead pond biomass, swimmers, waterfowl, fish, fishfood
 - N Removal:
 - Green mass of plants
 - Removal through De-nitrification in anaerobic micro-zones in the substrate layer
 - Establishment of filter media
 - P Removal:
 - Low P reqs of plants
 - Most filters don't remove
 - Can be BOUND by sediment - then using a main drain sump
 - High P levels can be introduced through fill water and makeup water.
 - Algae growth
 - Plan for a pond equilibrium with a "balanced nutrient" approach.
 - Stunted growth can be a problem
 - Diversity of species, plant density
 - Expect that some plants won't work - plant many
 - Plant at least 3 of any plant species - plants per m2 = 10sf
 - Swimming plant = floating hydrophytes = 4-6 plants per m2
 - Underwater plants 6-10
 - Half height to tall marsh 3-5
 - Low to half height 5-7
 - White and yellow water lillies Depends on type
 - Why plants?
 - Nutrient consumption
 - Oxygenation of H2O
 - O2 supply of body Aerenchyma of the plants
 - More
 - Planting Depth
 - Riparian/Marsh - 0-10cm water depth Amphiphytes/Helophytes
 - Shallow wter zone 10-40cm water depth Helophytes
 - Deep water zone 50-150cm Hydrophytes
 - Species

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- Emergent
 - Typha spp.(cattail)
 - Iris spp. (good for P uptake)
 - Lythrum salicaria (Purple loosestrife)
 - Eleocharis (Spike rushes)
 - Butomus umbellatus (flowering rushes)
 - Baldellia ranunculoides (lesser waterplantain)
 - Acorus spp. (blueflag)
 - Caltha spp. (marsh marigold)
 - Swamp hibiscus
 - Myosotus
- Deep Water Zones
 - Ranunculus
 - Myriophyllum verticillatum, spp.
 - Elodea canadensis
 - Potamogeton lucens
 - Chara aspera
 - Ceratophyllum spp.
- Floating Plants
 - Water lillies
 - Nymphoides peltata
 - Ptamogeton natans
- Trophic levels of body of water
 - Oligotrophic -
 - Mesotroph
 - Eutroph
- Establishment is important - up and running as fast as possible.
- Water Analysis - Recommended
 - Standard pool analysis, add P level and N level
- Plant Substrate
 - many recipes for how to build it!
 - Free of organic substances
 - Must not float
 - possibly fine grained - max 16mm
 - Minimum thickness - of any layer of substrate = 1-cm
 - Clay -Sand - Mixture
 - Sand 0-2mm
 - Sand 0-8mm
 - Washed gravel various soil
- Substrate selection - nutrient poor - no P, no N
 - Optimum provision of aquatic plants with the lack of trace elements (mostly K, Fe)
 - Price and transportation.
 - Sufficient (permeability)
 - good growing conditions for aquatic plants

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- Price / Transportation.
- Importance of substrate
 - Habitat for microorganisms
 - Mechanical cleaning
 - Binding of Nutrients into substrate fine particles
 - Nutrient provision/nutrient storage
 - Anchorage
 - Visual/Aesthetic
- Stunted Growth
 - a problem for some NSPs
 - b/c they're designed to be low-nutrient!
 - To prevent:
 - Select better substrate
 - Plant selection adopted for the NSP (plants for oligotrophic - mesotrophic conditions)
 - Setting up "Flower beds"
 - Suited to local plants