AppleSeed Permaculture
Regenerative Design & Development

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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 theat they are designed by landscape architects
- Limnological Principles
  - studyof inland waters.
  - NSPs are artifically 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
    - Microbiocoenoses - microbial
    - [figure from book]
  - Process of microbial
    - heterotrophic bacteria convert N > NH_3 + NH_4
    - nitrosamonous 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.

- 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 excesive algae growth.
    - Can reduce stocks of zooplankton primarily large water fleasor daphnia) so severky 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 mg/l = 10ppb
        -
    - 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*10^5 E. coli
            - w/ a show 2*10^2 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 Ks 4,3 > 2mmol/l
        - Total P <0.01 mg/l P
        - Conductivity < uS/cm at 20ºC
        - Nitrate < 50.0mg/l
        - Ammonium < 0.5 mg/l
        - Iron < 0.2mg/l
        - Manganese < 0.05 mg/l
        - Hardness > 1mmol/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 > 120m2 = 1200sf 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 hhysically 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 intagke.
    - 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.

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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 H20
    - 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 pletata
  - 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 - Mxture
  - 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/Aethetic
- 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