EDIBLE FOREST GARDENS

Ecological Vision, Theory, Design, and Practice for Temperate-Climate Permaculture

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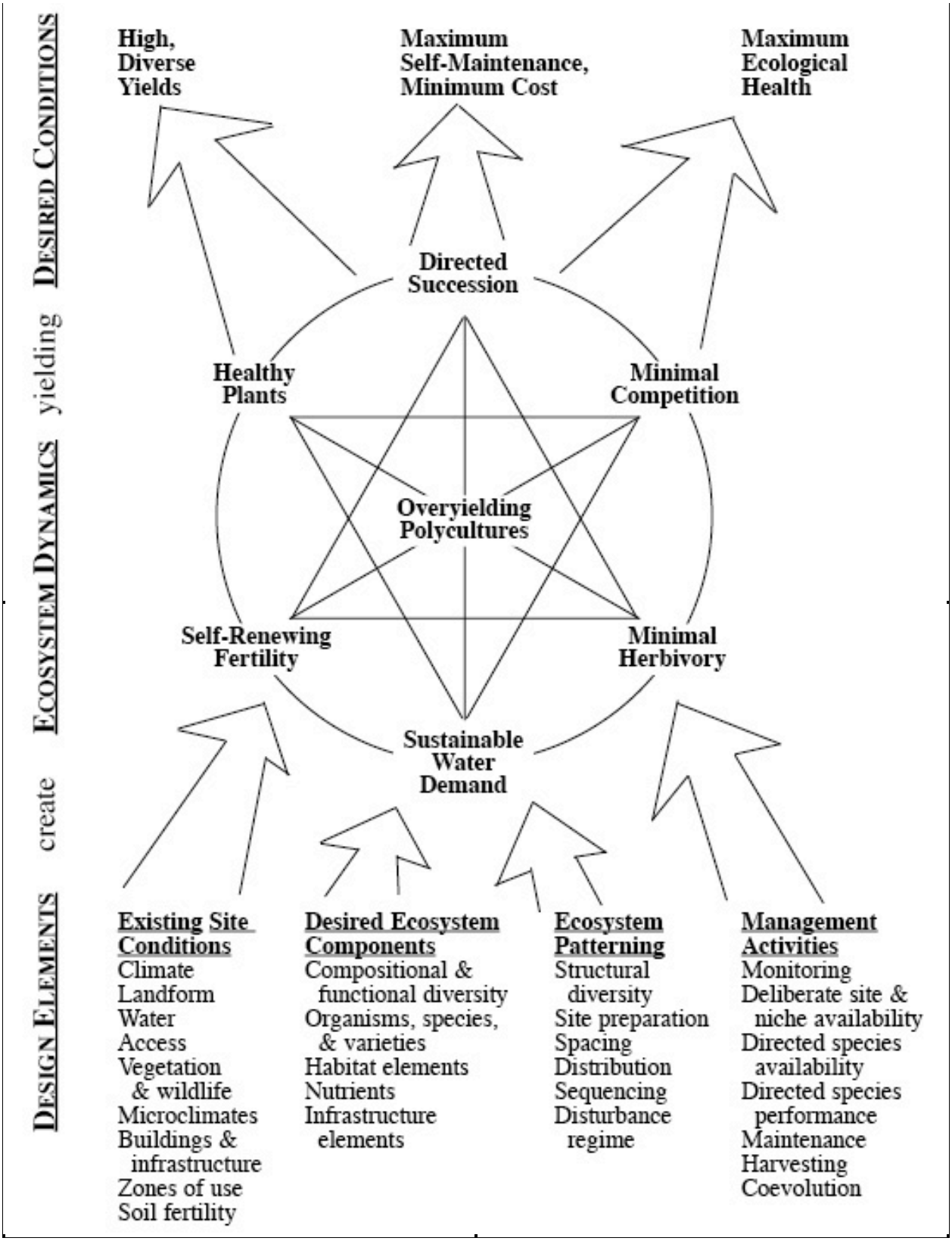

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What Do We Mimic In Our Forest Gardens?

Goal: shift the burden of system maintenance back to the ecosystem, rather than shifting the burden to the intervenor (us). Therefore: mimic self-maintaining natural forest ecosystems. What exactly do we mimic?

At an essential level, we mimic four things: the **Properties**, **Principles**, **Patterns**, and **Processes** of ecosystems.

1. **PROPERTIES**
   a. These properties *emerge only from the dynamics & relationships between ecosystem elements*, not from the elements themselves: emergent properties.
   b. These properties become *our design aims or goals* for the systems we create.

2. **PRINCIPLES**
   a. We observe the strategies ecosystems "use" to create the emergent properties, and attempt to articulate them succinctly as principles.
   b. We refine our understanding of these principles through testing and experience.
   c. The truer the principle, the more broadly it applies.

3. **PATTERNS**
   a. ***Architecture*:** The physical structures of ecosystems.
      i. **The Five Elements of Ecosystem Architecture**:
         1. **Layers:** define ecosystem character
         2. **Horizons:** indicators of ecosystem processes belowground.
         3. **Density:** vegetation density by layer and in total, and root density.
         4. **Patterning:** OF the ecosystem and WITHIN the ecosystem.
         5. **Diversity:** compositional, structural, functional.

4. **PROCESSES**
   a. ***Social Structures***: Relations, dynamics, and flows within and through ecosystems.
      i. **The Six Elements of Ecosystem Social Structure:**
         1. **Species Niches**: strategy, context, needs, products, characteristics, functions
         2. **Species Interactions**: predation, competition, cooperation, mutualism, facilitation, inhibition
         3. **Community Niches**: functions/roles in the ecosystem, e.g., "leaf-gleaning insect predator"
         4. **Food Webs**: above AND belowground!

5. **Guilds**:
   a. Three kinds (maybe more?):
      i. **Community Function Guild**: species in the same community niche.
      ii. **Resource-Partitioning Guild:** species partitioning a scarce resource.
      iii. **Mutual Support Guild:** one species' yields meet another's needs.
6. **Polycultures:**
   a. More than 1 species living in the same patch.
   b. Not all guilds are polycultures.
   c. All *effective* polycultures contain multiple guilds.

b. ***Anatomy of Self-Renewing Fertility*:** Nutrient storage, flows, and conservation.
   i. **Six Nutrient Containers:** bedrock, mineral soil particles, soil water, organic matter, soil organisms, and plants;
   ii. **Plants Plug Nutrient Leaks:** they interlink the six containers into a nutrient-concentrating and nutrient-conserving system, especially perennials
   iii. **Herbaceous Plants Conserve Nutrients Greatly:** more nutrients in their biomass
   iv. **Plant Roots and the Soil Food Web:** key to the system and to good ecological design and management

c. ***Succession*:** Structure of community change through time; we steer by design and management.
   i. **X Linear succession to climax** (stable, self-replacing dynamic equilibrium)
   ii. **X Linear succession to shifting mosaic steady-state** (natural rotation)
   iii. **>> Patch dynamics** (non-linear, non-equilibrium disturbance and succession)
   iv. **>> Unified Oldfield Theory:** three causes of succession: site or niche availability, varying species availability to the site or niche; varying species performance.

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Some Key Definitions For Polyculture Design

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- **Polyculture**: any *mixed assembly of plant species* growing or cultivated together in the same patch of ground at the same time.
    * A mixture of species.
    * Growing in the same **patch**.
- **Patch**: a physical space in an ecosystem that:
    * has fairly definite edges
    * varies significantly from its context
    * may vary in size, consistency and texture
    * has its own successional path distinct from its surroundings
    * Patches are the basic organizational unit of plant communities, and forest gardens.
- **Guild:** a set of interacting plants, animals, fungi and other organisms, *but guild members do not necessarily have to grow in the same patch* to interact.
    * All effective polycultures are composed of guilds, however, not all guilds are polycultures.
    * There are three main kinds of guilds, as we'll explain.
- **Species Niche:**
    * "the multi-dimensional space a species occupies in an ecosystem"
    * the relationship of an organism to food & enemies;
    * its core strategy for making a living;
    * a species' multiple inherent:
        ~ ***needs, tolerances*** *and* ***preferences***: environmental & resource conditions required for survival, thrival, reproduction, yield
        ~ ***uses***: human uses: food, fuel, fiber, fodder, farmaceuticals, fun
        ~ ***functions***: ecosystem functions such as nutrient accumulator (fertilizer), insectary, groundcover
        ~ ***architecture***: above and belowground structure; form, habit.
        ~ ***behavior***: e.g., aggressive, persistent, time of flowering, fruiting,
        ~ etc.
- **Community Niche:**
    * *Functional role* in a community (similar to priest, baker, shoemaker, cop). For forest gardens includes functions, uses, architecture and behavior.
    * Essentially the same as the core species strategy, just looked at from a community perspective.
    * Each species brings its unique attributes to its community role, just as every person brings their unique attributes to their job role.

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THREE KINDS OF GUILDS

Permaculture-folk often use the word "guild" either without a clear understanding of what the word means ecologically or with a definition that makes no ecological sense and creates a separation between human and natural ecosystems. I find Mollison's discussion of guilds in the *Designer's Manual* confusing, for example, despite reading it many times and trying to figure it out. The whole idea of there being a "central species element" around which one builds a guild makes little ecological sense—each species involved in a system is its own center of the universe, as far as it is concerned.

In addition, the currently-popular conception of a "guild" in permaculture denotes a human-designed assemblage of plants, while a "polyculture" is a wild assemblage of plants. This flies in the face of the reality that a polyculture is, by definition, simply more than one species growing in one patch of ground—period (contrast with "monoculture"). It matters not whether the plant patch is human-designed or wild. If we want to embody a culture where we apply ecological principles to human systems, then the same principles and terms should apply to systems across the spectrum of completely "wild" to completely human-designed—otherwise we misrepresent the reality that humans are part of nature. In addition, just because a polyculture is designed by humans does not mean it is well-designed or contains functional relationships. Proper understanding of the different kinds of guilds helps us design *effective* polycultures with functional relationships. Not all polycultures are guilds, and not all guilds are polycultures, but *effective polycultures* all employ guilds.

Even ecologists use the word "guild" in different ways, with the same word denoting several different kinds of relationships between species. In *Edible Forest Gardens*, volume 1 chapter 4, I discuss two different kinds of guilds that I had discerned in peer-reviewed scientific studies as demonstrated to exist. I have since realized that ecologists and I were using the word "guild" to denote a third kind of interspecies relationship of critical importance to understanding how ecosystems function. I summarize these three kinds of guilds below.

COMMUNITY FUNCTION GUILDS

- A set of species that all perform the same community function = fill the same community niche.
  - ~ Members must all feed at the same level of the food web; i.e., all plants, or all consumers, or all first level predators.
  - ~ The same CF guild can contain very different kinds of organisms, as long as they do the same "job" in the community: e.g., a guild of orchard-canopy predators might include birds, frogs, snakes, insects, fungi, bacteria, viruses and humans.
  - ~ Organisms in a CF guild may or may not compete with each other—it depends on their species niches and the resources available.

~ May or may not be in the same patch (i.e., act as a polyculture).

- CF Guilds represent ***redundancy*** **in the ecosystem**, which **offers stability of function**. If an orchard-canopy-predators guild loses a species, other members can take up slack.
- CF guild members *may compete with each other*, which may or may not be desirable depending on your purposes in the design.

RESOURCE PARTITIONING GUILDS (AKA resource sharing guild)

- Species that have same community niche or resource need (a CF guild), AND that partition the resource in time, space or kind so they don't compete.
  - ~ Members must all feed at the same level of the food web; i.e., all plants, or all consumers, or all first level predators.
  - ~ May be very different organisms and still in the same RP guild: an orchard canopy predator guild might include birds, frogs, snakes, insects, fungi, bacteria, viruses and humans, as long as they *partition the shared resource in by time, space or kind*.
  - ~ They often occur in the same patch, but not always, depending on the resource being partitioned: to partition root space, the plants would have to be in the same patch; for flowering plants to partition pollination-services providers (bees), they do NOT have to be in the same patch.
- **Partitioning reduces *competition***.
- Partitioning allows more species to make a living in the same space, **increasing diversity**.
- **Greater productivity** arises for each member of the guild, and for the community as a whole, because **fewer resources are devoted to competition**.

MUTUAL SUPPORT GUILDS

- MS guilds consist of **species from *different* community niches whose needs and yields link** up for the benefit of one, the other, both, or a third party.
  - ~ MS guild members interact both *across* food web levels: plant - predator- herbivore - plant, or plant-decomposer-plant, as well as within levels (plant - plant).
  - ~ They may be very complex, involving many species and kinds of interspecies interactions.
  - ~ May or may not require proximity to function as a MS guild.
  - ~ Make sure to think about fungi, microbes, insects, birds, frogs, toads, snakes, etc. when designing mutual support guilds.
- MS Guilds represent ***functional interconnection*** **in the ecosystem**. Functional interconnection **helps the ecosystem maintain itself**, because the inherent needs of one species are met by the inherent by-products of others. This **reduces stress**, and **increases harmony, cooperation, and stability**. It also **reduces work, waste and pollution and the need for external inputs of resources**.
- Functional interconnection also causes **resistance to change**, and helps the ecosystem **recover from shocks**.

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GUIDELINES FOR PATCH AND POLYCULTURE DESIGN

Developed by Eric Toensmeier - www.perennialsolutions.org
Modified by Dave Jacke, July 13, 2013

CHARACTERIZE EACH PATCH
- Size, shape and location of patch.
- Name or title of patch.
- Articulate patch goals (key crop(s) or function(s)).
- Review/note down patch conditions (sun, soil, moisture, slope, etc.).
  - Which resources are most limiting and most need to be partitioned?
- Define existing and desired architecture:
  - Habitat type (thicket, forest edge, old field, etc.);
  - Size and form of plants;
  - Layers, density, patterning, diversity.
- Successional scenario for the patch: site prep, establishment, and successional sequencing.
- Intensity and forms of management/disturbance (intense, low-maintenance, yearly tuber harvest, coppice, poultry rotation, etc.)
- Infrastructure: rhizome barrier, pathways, irrigation, etc.

SELECT SPECIES
- Select species that:
  - Tolerate patch conditions
  - Fulfill desired uses and functions
  - "Fit" other species in the patch:
    - ~ Partition scarce resources;
    - ~ Meet needs, or use products, of other species in patch;
    - ~ Have complementary architectures above and below-ground;
    - ~ Have complementary behaviors and habits: clump, run, mat; seasonal maturity sequences.
- Use 2-7 species per polyculture (helps keep it less complex and more understandable).
- Fill key uses & functions first (e.g., fruit production, nitrogen fixation, etc.).
- Select species with similar management needs.
- Start with tallest species and work down.

SPACING & PATTERNING GUIDELINES
- Determine "mature" height and width (prune or coppice vs. "natural" size)
- Set spacing between clumping species.
  - Usually so that crowns at maturity are just touching, but perhaps wider or closer, depending (see Feature Article on Spacing in volume 2, chapter 4).
- Generally, plant runners that are shorter than clumpers, make sure runners will not kill other plants
- Generally, plant shade lovers under taller plants.
- Keep pollination needs in mind.

PATTERNING OF FUNCTIONAL SPECIES

- Plant soil builders (nitrogen fixers and dynamic accumulators) in every polyculture or patch.
    - To fix all needed nitrogen, plant 25-40% of overstory or 50-80% of understory in nitrogen fixing species, unless supplementing with manure, compost, or fertilizer.
- Provide complete ground cover (mix runners, clumpers, mat-formers; ideally, plant close enough for complete coverage in one growing season).
    - Evergreen, shade tolerant groundcovers are excellent.
    - Running groundcovers help fill in empty spaces.
- Try to include some nectary or habitat species in each polyculture, though they need to be in the planting as a whole and not in any species patch or polyculture

SEQUENCING ISSUES

- Is there a niche for short-term sun-loving crops in early years (annual vegetables, strawberries, perennial scallions, nitrogen fixers, etc.)?
- Wait to plant shade lovers until there is enough shade.
- For living trellises, wait to plant climbers until trellis plants are large and established.

ESTABLISHMENT ISSUES

- What must be done to prepare the site for planting?
- What establishment method will you use?: insertion planting, nuclei that merge, instant succession, sheet mulching, etc.

MANAGEMENT ISSUES

- Consider livestock integration requirements if necessary.
- Choose species of similar vigor to avoid competitive exclusion.
- Match species to patch management style.
- Choose species with similar irrigation and fertility requirements.
- Will any aggressive species require rhizome barrier or other control?

HARVEST ISSUES

- Make sure to have access for harvest (spacing, pathways, ‘Layers of Harvest’).
- Consider the need to harvest fruit and nuts (or pick up drops) from understory (low cover, fall dieback, mow or chop, lay down tarp, use livestock to harvest).
- Don’t mix toxic species with similar edibles especially in same layer.
- Consider adding more shade-loving edibles (mushrooms, shade crops, etc.).
- Make sure root crop harvest will not harm neighboring species.

FINAL TESTING

- Are conditions ideal for the “keystone” (most critical) species from your goals?
- Is each species adapted to its niche?
- Will conditions change once the polyculture reaches the desired horizon habitat?
- Does the polyculture fulfill your goals (products, functions, architecture, management style)?

