



Designing Mutualism: Founding Cooperative Relationships to Promote Environmental Stability

LARC 4102 Design Thesis
Brief

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ABSTRACT

The nature of landscape is realized by the nature of its ecology. Landscape architecture is one of Humanity's primary vehicles to that end; our ecology shapes landscape. A threat of environmental instability may endanger the future well-being of Humanity as a consequence of our ecological specialization. Our degree of dependence on non-human domesticates is a fundamental measure of that specialization. Specialized life in an unstable environment is less successful. A proactive change in our ecology will here be explored. A model for the design of symbiotic mutualisms among humans and undomesticated species will illustrate how stability of their environments may be improved. Greater intensity, efficiency, variety and expanse of mutualisms heighten stabilizing effects. The design will use the model and demonstrate one potential interaction, although theory would suggest many other combinations could be investigated. A localized, direct mutualism will be designed between a population of humans in Montana, USA and *Prunus virginiana* (Choke cherry) in order to improve the health of part of that ecosystem, planning towards a short horizon. Design of new or evolved mutualisms that are responsible, integrated and oriented for long-term success will not be realized while Humanity remains unaware of its biological role as it relates to the Ecosphere.

PREAMBLE

All living organisms possess inherent abilities to physically modify their environment to better suit their living. Most terrestrial plants, for example, moderate temperature by absorbing/reflecting sunlight and humidity by adjusting transpiration rates (Lovelock 1979). Comparatively, humans have even greater developed abilities to make a broad range of environmental modifications. Our intellect and dexterity have permitted the refinement of tools that allow us to mould environments at a scale and rate likely unprecedented. In fact, we have forged disciplines devoted wholly to enacting idealized change in environments. We are conditioned to simplify, divide and stereotype to manage overwhelming complexities. However, there are inherent weaknesses to boldly compartmentalizing all things. Remarkably little fits neatly physically or conceptually. It is vital for the health of our species to have design professionals rationally theorizing a **gamut** of approaches to human-environment interface problems. The exploration of alternative approaches to derive change in environments and modes of generating them, needs to be conducted and seriously considered for the opportunity it may uncover.

INTRODUCTION

As discussed in *Designing Mutualism: Our Biological Role from a Gaian Perspective*, the human body is composed of living and non-living elements, but we are more than just our bodies. Everything on Earth living and all that is non-living upon which it depends define the 'Ecosphere'. Humans hold membership. The Ecosphere is self-organizing, is a bound system (the outer limits of atmosphere) open to a flux of energy and matter and able to actively sustain low entropy (Lovelock 1988). It meets most definitions of life itself. James Lovelock and Lynn Margulis conceptualized what is known as the Gaia hypothesis. Gaia is a discrete living entity, more than the sum of its body parts. The Ecosphere is its body; thus we exist as a part of Gaia (Lovelock 1979).

If Ecology were the study of relationships among life forms and life forms with their environments, then it would be a study *within* Gaia. Geophysiology, as Lovelock calls it, would be the aggregating science, the study *of* Gaia (1988). This study would include Humanity's role as it relates to the rest of the Ecosphere. We must become mindful of Gaia's health, for it inherently is our own. With a perception of Gaia and its health, Humanity would gain adequate perspective to assess the true implications of our ecology. An understanding of ourselves will reveal anything that we are doing wrong and what we need to become ecologically

to correct the trouble. There is much worrisome environmental feedback accumulating. We are only able to speculate about it, since we don't understand how to characterize our involvement. Humanity is making changes and at rates that we are unable to understand or manage. The future study of *Gaia* may very well conclude that the well-being of Humanity is threatened by environmental instability that we have generated ourselves, senseless to our surroundings. It follows that it would be our biological role consisting of the problem. Therefore, our role will need to be modified to combat our destabilizing effects.

Two feasible problematic characteristics of our ecology will be examined: the degree Humanity has domesticated itself and secondly, our specialization as it relates to dependency on that which we domesticate. We are domesticated and so have become our landscapes (Wilson 1988). We have insulated ourselves physically and conceptually from the Wild, and likewise our awareness of the Wild (Kellert & Wilson 1993). Our language reflects this (Livingston 1994). Simply distinguishing an "it" and an "us" to the degree that we do makes the point. Unwittingly, we may be offending these providers and duly alienating ourselves from their support. Our highly specialized domestic lifestyle is premature (over-hasty) because that lifestyle makes us dependent on potentially unstable ecosystems, unlike the relatively stable wild ecosystems.

Designing Mutualism is a model that with an understanding of our biological role may offer an effective alternative to domestication as a mechanism for landscape change. Designed symbiotic mutualisms among humans and undomesticated species will be cooperation that promotes human well-being while simultaneously encouraging stable environments, without impairing wild ecosystem function. Greater intensity, efficiency, variety and expanse of mutualisms heighten stabilizing effects. Design of new or evolved mutualisms that are responsible, integrated and oriented for long-term success will not be realized while Humanity remains unaware of its biological role as it relates to the Ecosphere. In this light, the model will be demonstrated in a manner that seeks to minimize inaccuracies resulting from an oversimplified understanding of ecology. A localized, direct mutualism has been designed between a population of humans in the Upper Clark Fork sub-basin, Montana, USA and *Prunus virginiana* (Choke cherry) in order to improve the health of part of that ecosystem, planning towards a short horizon.

THE PROBLEM

DOMESTICATION

Domestication is a systematic process of forcing the relative extraction of individuals (of a species) from the free-living wilderness (Budiansky 1992). Simply, living things are insulated from the Wild and prevented in varying degrees from participating in their former ecosystem functions. Humanity is domesticated and accordingly so is our landscapes. By insulating ourselves we may be alienating ourselves from the support inherent to stability. We are continually replacing wild interactions with fewer and much less efficient versions (Benyus 1998). The waste and homogeneity associated with the city is just one example. Mature ecosystems have become immature (thus inherently unstable) and we have placed ourselves right in the middle of them (Benyus 1998).

We are dependent on our domesticates. Our specialization in this case, may be premature. Human adaptability is obviously impaired by the degree of this dependence. The "change it", not us attitude may have consequences that outweigh the convenience. Humans are not removed from natural selection forces. Mature domestic ecosystems are far from in place. We are only as stable as that which we are dependent upon. There is cause for concern.

The purpose of Humanity's domestication has been to insulate humans from the effects of environmental variability, which threatens our fitness and health. This has been done using social conditioning to create conceptual and physical boundaries defining a separation between humans and the Wild (Wilson 1988). The separation is one that never existed before our domestication. Cultural selection genetically perpetuates those of us that become conditioned (socialized) (Wilson 1988). Those more "wild" individuals that resist conditioning tend to be social outcasts. A present day example of potential wild character (assuming non-medical reasons) may be a person simply being unable to tolerate other people around. Related, an extremely aggressive landowner that literally growls at children passing by the property might indicate a poignant territorial instinct for another.

The revolution formalized with the relative end of *nomad* hunting/gathering culture (Budiansky 1992). In physical terms, the revolution was "Development" (the creation of human biome). Domestic literally means home. The primary territorial unit of this biome is not coincidentally the house. The walls are a physical and conceptual fortification (Wilson 1988). The biome continues to expand and most recently at an unprecedented rate.

It is the purpose of non-human domestication, in a controlled, highly convenient manner to secure sustenance and affluence without defeating our

environmental insulation (Kellert & Wilson 1993). Primarily, we have forced those that were historically in a voluntary cooperative association with us (Budiansky 1992) into *greater* dependence by captivating them and/or captive-breeding them for complacency (selecting for neoteny, tameness and social inferiority) (Palmer 1995 & Budiansky 1992). They have been bred for other traits associated with an ideal product or service (e.g. quality, quantity, etc.). Neoteny is the selection of individuals that reach sexual maturity early enough to retain juvenile behaviour (Budiansky 1992). This is a natural process to which humans have been subjected (Wilson 1988). Yet, we also have culturally encouraged it in other species unconsciously. Compare the puppy-like qualities in pet dogs to that of a chiseled, wiry-haired wolf. Neoteny speeds up reproduction, which increases genetic variability (Budiansky 1992). This was very desirable earlier in domestic history to promote a greater genetic pool in order to select the most desirable traits. Immaturity increases general helplessness resulting in complacency (compliance). Helplessness is a function of tameness. Tameness is a reduction of defensive behaviour and/or ability in relation to another species (Hemmer 1990). It does not equate to domestication. Tameness might only be relative to one other species, in some cases. That type of tameness is **vital** to any example of an evolved mutualism/cooperation in the Wild. One may not be terrified of one's partner if

close association is to exist (Wilson 1988). It is the degree of tameness that determines interdependence. It is only because we have selected for greatest complacency in other life that tameness has become associated with domestication.

An explanation for our success as the ultimate domesticator could be rationalized in volumes, but power and precision seem key. Our ability to exercise influence to promote a desired outcome seems unprecedented. Power comes dominantly from rallied support - since humans developed intraspecific cooperation (unification among ourselves), we grew powerful in interspecific symbioses (that among others) (Wilson 1988). Circumstance determines when and how power may be used. Many experts believe that they were right for us, especially in the north as vast glaciers receded (Wilson 1988). Pioneer succession, being unstable, is more easily influenced. Plant and animal biology was less equipped to resist our influence. Human ancestors monopolized using their advanced adaptive abilities.

An extension and growth of the domestic biome has resulted as the intensity and scale of non-human domestication has increased. It follows that their dependence on humans for sustenance has also increased. This high level of interdependence, in an increasingly isolated, homogenized environment is cause for concern.

ECOLOGICAL SUCCESSION & HUMANITY

An ecosystem is most stable when it is in mature stages of succession. In this situation, a very intricate support system is solidly in place. Humans are continually creating domestic ecosystems, which are not like this. Our technology has allowed some attributes of domestic ecosystems to be accelerated far ahead of others. There is a question of how stability may be influenced by this inconsistency. Long lives and rapidly growing populations, for example, are not associated with the same stage of succession. Yet this is what exists in domesticated life (see Fig 1 below).

The status of the domestic ecosystem attributes indicates significant immaturity and inherently unstable quality. Humanity wishes to promote long lives, large numbers and high degrees of specialization, but it is obvious from Fig 1 that the majority of ecosystem attributes **must** mature comparatively. One simply can't be maintained well without the other. The greater the disparity, the more aggravated the instability is likely to become. Maturity is the right direction, but cheaters are eventually subordinated. It will be important to strike the appropriate balance between our aspirations and our capabilities if we are to avoid the threat to our well-being. Hence, domestication ought to only have a place in human society as a tool for control of environmental variability to the degree that

Fig 1

Note that **bold** indicates approximate status of our domestic ecosystems

Ecosystem Attributes	Developing Stages	Mature Stages
Food chains	Linear	Weblike
Biodiversity	Low	High
Body sizes	Small	Large
Life cycles	Short, simple	Long, complex
Competition strategy	Emphasis on rapid growth (R-selection)	Emphasis on feedback control (K-selection)
Reproduction (offspring)	Quantity	Quality
Mutualisms (cooperative relationships)	Undeveloped	Developed
Nutrient conservation (closed-loop cycling)	Poor	Good
3-D Pattern diversity	Simple	Complex
Biochemical diversity	Low	High
Niche specializations (jobs in the ecosystem)	Broad	Narrow [but weak]
Mineral cycles	Open	Closed
Nutrient exchange rate between organisms and environment	Fast	Slow
Role of detritus (dead organic matter) in nutrient regeneration	Unimportant	Important
Inorganic nutrients (minerals such as iron)	Extrabiotic	Intrabiotic
Total organic matter (nutrients tied up in biomass)	Small	Large
Entropy (energy lost)	High	Low
Information (feedback loops)	Low	High
Stability (resistance to external perturbation)	Poor	Good

it meets the suitable interdependence and specialization balance. Beyond this point, control must be realized in an alternative manner. Gaia cannot be made to be all "us" and nothing "else". That is disease. Convenience is a luxury that needs to be weighed considering long-term consequences and our own basic needs.

THE MODEL

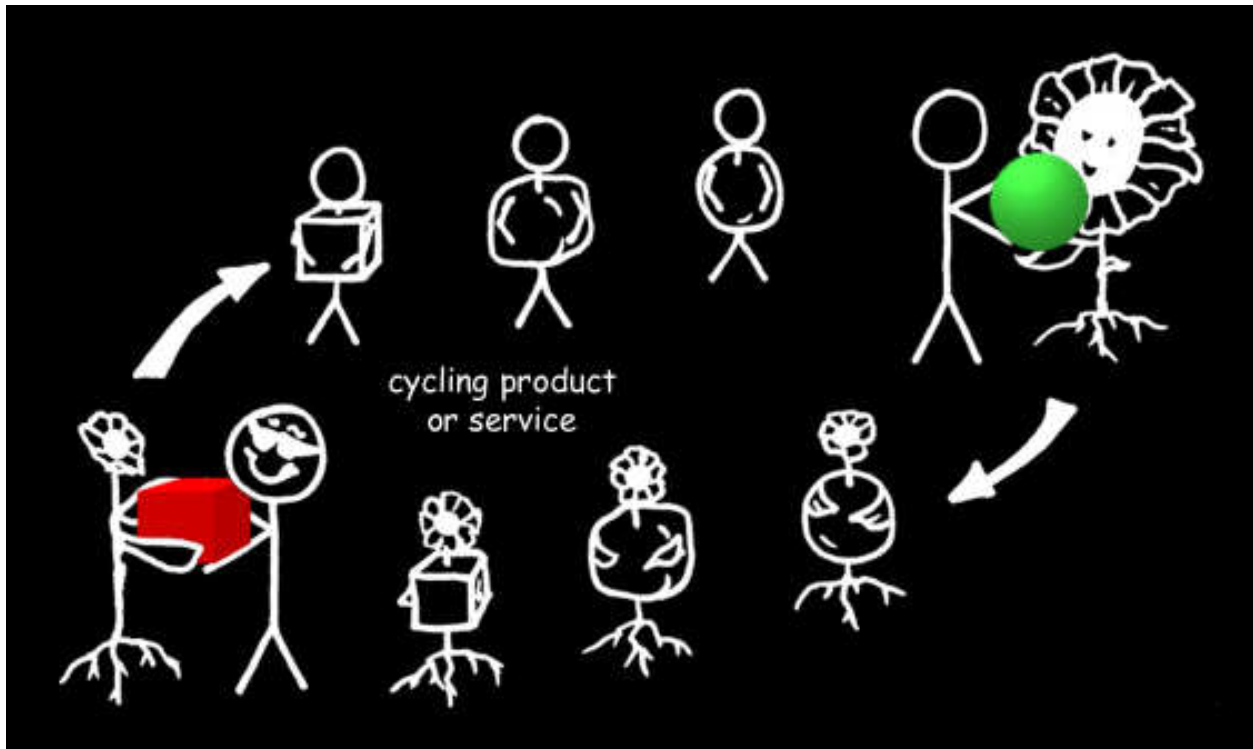
DESIGNING MUTUALISM

Domestication characterizes part of our biological role in relation to the Ecosphere. If further augmentation of domestic ecosystems heightens threat, the alternatives must involve respectful interaction with the Wild. There exists a range of symbioses (interactions), from competition where both parties suffer (- -) to cooperation from which both benefit (+ +). For information on the range of symbiosis consult *Designing Mutualism: Our Biological Role from a Gaian Perspective*. We have proven we have the power to choose interactions and shape the ecology of the planet. Regrettably, we have failed to grow comparably wise about how to exercise control. No alternative may be viewed as wise without an understanding of our biological role. That being said, an exploration of potential options and the pursuit of better-informed perspectives seem warranted.

Symbiotic mutualism (or cooperation) is a mutually beneficial exchange among two or more discrete units of life, such as species. Each **participates** in trading the other goods and services (see Fig 2). Efficiency is high when the parties are offering that which is incidental or disposable and accepting what is of high life-giving quality or otherwise unattainable. These relationships are most

predominant in highly diverse, mature ecosystems and thus are always representational of qualities of ecosystem health (refer to Fig 1). In the grand

Fig 2



scheme, the parts of Gaia's body work together. Ecosystem health is defined by its stability (resistance & resilience), vigor (biomass production) and organization (distribution & interaction) (Rapport 2000). The specific nature of the mutualism determines its contribution to ecosystem health. It is a general rule however, that if the well-being of many diverse individuals is high (efficiency in sharing) their ability to resist disturbance and recover is also (Rose 2001). That sum begins to equate to the stability of the ecosystem.

As humans, our abilities are less of a question compared to the choices we make in using them. Designing Mutualism is a model for shaping human ecology to promote environmental stability. It is design of the form and function of landscape through its ecology. Designed mutualisms are free, cooperative interactions among wild species and humans, conceptualized or enhanced by us and whereby relatively predictable outcomes and interdependence suitable to environmental conditions are ensured by the mutual benefit. They will be vehicles for fair-trade with the biological environment, formal participation in the web of matter/energy cycling and service to the life that services us.

Ecologically, form truly follows function. It is dominantly the ecological function that shapes the form of wild landscape. This is opposed to the reality of the domestication approach of forcing function to literally follow form in these environments. It imposes static physical construction intended to exclude wild ecology as the means to permit the desired human function to take place. Landscape architects will say form follows function in our designs, but we have been misrepresenting form *inspired* by a conceptual function as if it were the real function. Form inspired by an idea of function is different from form resulting from function. As an illustration, unplanned muddy pathways form from the trampling of ballistic pedestrian movements across all types of programmed

softscape. This is real function not represented in the *idea* of function conceptualized by the designer, thus not part of the design. Conventional designed form is not a product of the real function, only an idea of function.

The appropriate modifications to human ecology will bring about (not only the desired ecology, but) the desired physical *form* in the landscape. Form will result from true function and will also *support* wild ecological function coincidentally with ours. Form will be dynamic, but not out of control. The *nature* of the stability derived will shape landscape and that quality of form is what comprises the intended *landscape design*. It is a fundamental conceptual reversal in what must come first to design landscape.

Human managers will control **human** ecology. They will **not** exercise closed-system control over the non-humans; managers will alertly set up dominos that the Wild will voluntarily push down to our mutual benefit. In theory, once initiated and integrated within the given ecosystem, designed mutualism (which includes us) will be regulated by "natural" powers. The *selection* of new trade possibilities and the management of our actions will be how humans exercise control, but also how ignorance-related error becomes relevant. All friendships have benefits, but the politics in wisely selecting appropriate alliances are tricky. Preliminarily, efforts will need to be focused on refining our working understanding of the rules so that

we may play the *wild* game safely. It will no doubt be necessary to mingle with everyone at the party before deciding whom to join for a quiet brandy. Our learning curve and ingenuity at theorizing relationships will determine our success at designing mutualism to promote environmental stability.

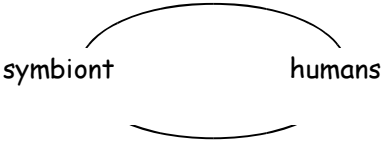
MODEL PRINCIPLES

Successful designed mutualisms will be dependent on:

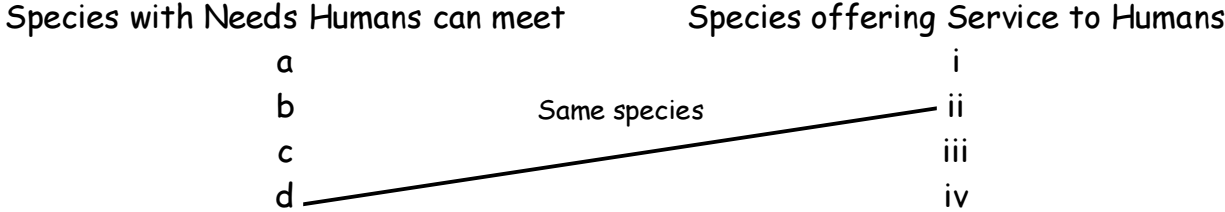
- The identification of species and their natural biological products and services usable by humans (e.g. those that may produce and refine usable matter & energy, those that may assimilate our wastes, etc..) that may be used without harm
- Matching human reciprocation with a need harmonious to the *wild* ecology of that species (domestication inhibits participation in wild ecosystem function and potentially forces degrees of dependence beyond what is environmentally suitable)
- The identification and value of the other things that contribute most to that species' health and fitness (undermining its health, as a result of **other** relationships, must be avoided)
- Creating **cyclical** flows of life-giving quality linked by service and/or the energy sources, consumption centers and sinks of both mutualists (Lyle 1994) (this will require a comprehensive understanding of the respective biological roles, the nature of the products/services to be exchanged and the appropriate ways to exchange them)
- Transparent, cross-disciplinary communication and understanding of the implications of the new networks (ecosystems are highly complex; one element is inherently related to all the rest)
- The motivation to continually assess the dynamic relationship's success and revise the design routinely (human ecology must be managed to ensure desired outcomes are persistent)

THE SYMBIOSIS

Direct Mutualism

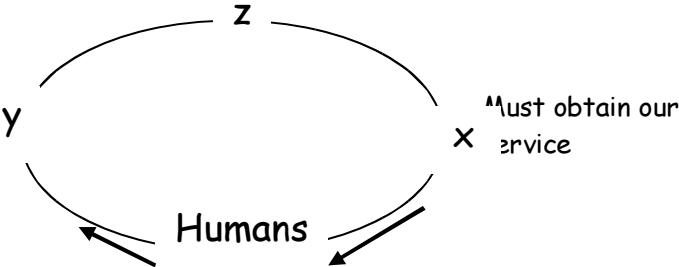


With appropriate databases, a species may be identified that can service humans and to whom we can reciprocate by matching needs with services (or products).



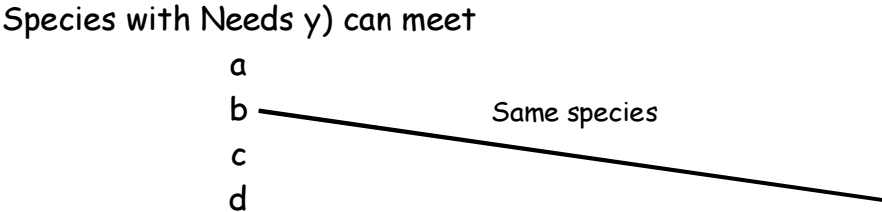
Indirect/Network Mutualism [4 party example]

- (x) a species servicing humans
- (y) a species using human services
- (z) a species using y)'s services in turn servicing x)



- A net benefit **must** be passed on in order to reach x)
- z) on y) and x) on z) may only be a predation/parasitism (-,+), commensalism (0,+), or mutualism (+,+)

z) is identified thusly:



Species offering Service to x)

- i
- ii
- iii
- iv

THE DEMONSTRATION

THE CHOKE CHERRY

In order to theorize new relationships, a vast database identifying species' needs and potential services must be compiled and revised on an on-going basis. Its completeness and accuracy will be the cornerstone of new mutualism selection processes. It will be just as crucial to pursue expansion of the range of services we may provide others. This is because the current immature status of our ecosystems requires many, less intense interactions. Only over time with successional maturity, fewer, more intense relationships will be permitted safely naturally. Deliberate work to compile such a database for obvious reasons hasn't occurred. So to be practical, the focus of the demonstration will be on enhancing a naturally *evolved* relationship.

The Designing Mutualism model will be demonstrated in a manner that seeks to responsibly minimize inaccuracies resulting from an oversimplified understanding of ecology. A localized, direct mutualism has been designed between a population of humans in the Upper Clark Fork sub-basin of Montana, USA and *Prunus virginiana* (Choke cherry) in order to improve the health of part of that ecosystem, planning towards a short horizon (perhaps a few years). It is an example of how an

evolved symbiosis may be further enhanced for cooperation and is not intended to be anything beyond that at this time.

Fig 3 & 4

The work was in finding a match that met the principles of the model (acknowledging our present limitations). The relationship itself may be described rather simply. The fruit of the Choke cherry may be used alone or in combination, raw or cooked to make many edible products (Marles et al 2000). Commercial demand is found presently in niche markets and is growing (Manitoba A & F 2001). Humans



will harvest this drupe from wild plants respectfully and easily reclaim the pit of the cherry to sow back in the wild, in order to assist the plant to propagate itself as it does naturally via birds and other mammals.

Prunus virginiana are virtually transcontinental in Canada (see Fig 4) and in the US (Farrar 1995). It can be found as far north as (Can) zone 1. They tend to be tall shrubs 4 - 5 m high, but may get as tall as 12 m. An oval form with upright and slightly spreading branches is indicative (Farrar 1995). Roots may extend laterally more than 10 m and vertically more than 2 m (USDA 2001). The plant reproduces prolifically vegetatively (roots and stump sprouts) and sexually (pits of fruit) (Farrar 1995).

Program

The fruit, a drupe (fleshy with a pit) is a natural biological product usable by humans that may be harvested without harm

- The cherries are useful for pies, jams/jellies, wine, dyes, syrups, pemmican, vinegar (fresh or cooked) (Marles et al 2000)
- Fruits are elongated drooping clusters of 6-12 (Farrar 1995)
- Each is 8-10 mm in diameter (Farrar 1995)
- Is astringent (Farrar 1995)
- Yellow, red, to dark purple in colour (Farrar 1995)
- Ripen late-July to late-September (Farrar 1995)

A match of human reciprocation with a need harmonious to the wild ecology of that species is in the dispersal of its seed (the pit)

- Chokecherry has a relatively long seed dormancy period (USDA 2001)
- The pit is permeable to moisture (USDA 2001)
- The heat of fire cracks the pit aiding germination (Farrar 1995)
- Seed crops are typically regular and viable, with seed-producing capacity higher in plants on open sites (USDA 2001)
- Viable seed persists in the soil seedbank (USDA 2001)
- Note that the pits are poisonous if ingested; they contain hydrogen cyanide (Marles et al 2000)

The identification and value of the other things that contribute most to that species' health and fitness:

- Choke cherry reaches its greatest density near forest edges (USDA 2001)
- It is most successful on open sites (shade intolerant) (Farrar 1995)
- Proliferates having rich, moist soil (Farrar 1995)
- Choke cherry grows in soils with pH from 6.0 to 7.6 (USDA 2001)
- Requires a minimum annual precipitation of 400 mm (USDA 2001)
- Young plants are not tolerant of competing vegetation (USDA 2001)
- Is moderately tolerant of browsing (USDA 2001)
- Ideal elevational range in Montana is 175-225 m (580 to 740 feet) (USDA 2001)

- Proliferate significantly between 5 and 25 years after fire (USDA 2001)
- Post-fire regeneration usually involves seed dispersed by mammals and birds (USDA 2001)

The creation of cyclical flows of life-giving quality linked by service and/or the energy sources, consumption centers and sinks of both mutualists is completed by the distribution of its seed in return for food.

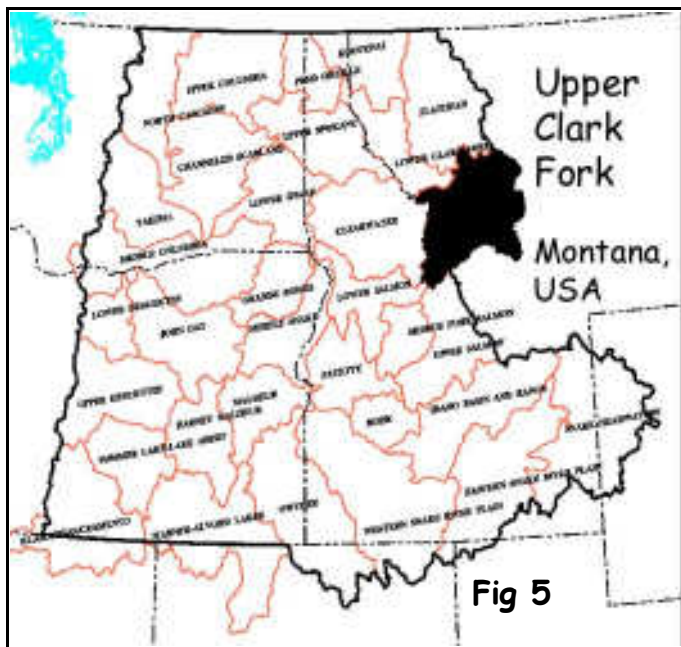
- Non-evasive fruit harvesting techniques are necessary (this might include hand picking for the enthusiast, portable vibrators and nets commercially, etc.)
- A simple pit reclamation process might be removal of the pits upon processing in order to send back out with the pickers (or possibly formal sowing teams in commercial operations)
- Pits will be sown in all the areas that fruit has been removed, however strong emphasis will need to be made on strategic placement that accords with Choke cherry habitat, wild local ecosystem integration and other design objectives
- The method of sowing ought to vary to avoid undue favouritism, ideally mimicking other vectoring species for example

The scope and time frame set has afforded an adequate understanding of the implications of the new networks. (Also see IMPLICATIONS)

- In Montana, associates include Rocky Mountain Douglas-fir, Mountain juniper (*Juniperus scopulorum*), Pacific ponderosa pine, big sagebrush (*Artemisia tridentata*), western snowberry (*Symphoricarpos occidentalis*) and ninebark (USDA 2001)
- Fruits, leaves, and twigs are utilized as browse by other large mammals including bears, moose, coyotes, bighorn sheep, pronghorn and elk (USDA 2001)
- Small mammals, birds and insects feed on the fruit (USDA 2001)
- Choke cherry provides shelter for many bird species, small and large mammals (USDA 2001)
- It is also provides thermal cover and erosion control to river systems (USDA 2001)

UPPER CLARK FORK

The Interior Columbia Basin Ecosystem Management Project has produced an Environmental Impact Assessment (EIA) for managing US Forest Service and



Bureau of Land Management lands in eastern Washington and Oregon, Idaho and western Montana, USA (ICBEMP 2001). The Upper Clark Fork sub-basin (Fig 5) in western Montana has been mapped in detail and compilations made available on-

line. If there is any confusion about the specific ICBEMP naming of this area as 'Upper Clark Fork', simply regard it as encompassing the river basins of Blackfoot, Upper Clark Fork, Flintrock and Bitterroot in Montana. This sub-basin in the Rocky Mountains has an area of roughly 16 000 km². The dominant landowner is accordingly the US Forest Service, yet the valleys are almost exclusively owned privately. Human settlement in these areas is low density, but sprawling along the rivers (ICBEMP 2001). The only urban area that has reached city status is just

north of the basin border, Missoula. Precious metal deposits such as gold and silver occur centrally (CFC 2001).

Mining has a history here and continues presently. One of the environmental issues that continually being discussing in this area involves the negative impacts that tailings from mining are having on the Clark Fork (a large river running from Bute high southeast of the sub-basin, to Missoula in the northwest). Arsenic, cadmium, copper, lead and zinc tailings are of greatest concern (CFC 2001). Besides mining, ranching and timber harvesting are the dominant land-based activities in the Upper Clark Fork. Agriculture is limited to the valleys for the most part. Though relatively infrequent, wildfire naturally sweeps through at times and resets the succession clock. However, the Interior Columbia Basin EIA suggests that suppression tactics of the last 50 years has put this and other areas at increased risk of intense fire and a growing human presence is continuing to keep the pressure on managers to suppress fire (2001). Without the fire, the composition of ecosystems has notably succeeded beyond normal and many customary species are being replaced (CFC 2001). Local governments are encouraging conservation on private property with special interest in riparian zones, big game winter range and animal linkage corridors. This is being done primarily with economic incentives (CFC 2001).

At least with some fire, there is no doubt that Choke cherry will continue to grow well in parts of the Upper Clark Fork and elsewhere in Montana. These cherries are often picked; there are some enthusiasts afoot. No fib! There is a 'Chokecherry Festival' in Lewistown (Central Montana) (Lewistown ACC 2001). Though *unripe*, so to speak, the market for Choke cherry products is maturing. A 9-ounce bottle of homemade Choke cherry syrup is valued at approximately US\$4.50 in this area (Gui 2001). Some of the parties interested in encouraging a commercial market propose a name change for the cherry; something that is more promotion-friendly. In 1994, "Wild Black Cherry" was cited as the number one specialty berry crop with the greatest, short-term potential. This assessment study spearheaded by Al Scholz (Trimension Group) estimated an annual US\$80,000 market demand in the US (DNA Gardens 2001).

OPPORTUNITIES & CONSTRAINTS

Not all parts of the Upper Clark Fork are ideal to promote a designed mutualism with the Choke cherry. There are a variety of habitat, harvest and social related constraints to be heeded. Limitations considered being the most significant to this sub-basin in relation to basic habitat include precipitation, temperature, elevation, existing vegetation types, frequency of fire and the presence of dense urban development. Most of the mountainous areas preclude opportunity for Choke cherry in the Upper Clark Fork.

Similarly to any domestic operation, many variables will influence the ability to harvest usable product efficiently. Roadways will be the primary means of achieving access to wild stands of Choke cherry. A dependence on existing networks is a practical assumption. This seasonal industry wouldn't be able to support new construction even if it seemed warranted and appropriate. Of chief concern is the available quantity of fruit for human use. Usefulness will depend on degrees of astringency, ripeness, growth and infestation. Moreover, we must be mindful of the 'balance of trade'. If mutualism is defined by measuring the positive balance of net fitness, the threshold must be identified. For example, it will be necessary to evaluate how much sowing will need to be completed to pay for the given rate of harvesting taking place. Producing fruit is only economic to the

plant if an adequate amount of pits germinate and mature to reproductive age themselves. Mind you, humans will not be alone in the use of Choke cherries. Viable fruit will be rightfully consumed by other species, which must be factored in. Unfortunately, livestock are also tempted to feed on these cherries, but are **not** biologically equipped to manage the poisonous pit (Marles et al 2000). Ranching represents an incompatible land use and severely limits opportunistic locations for this designed mutualism.

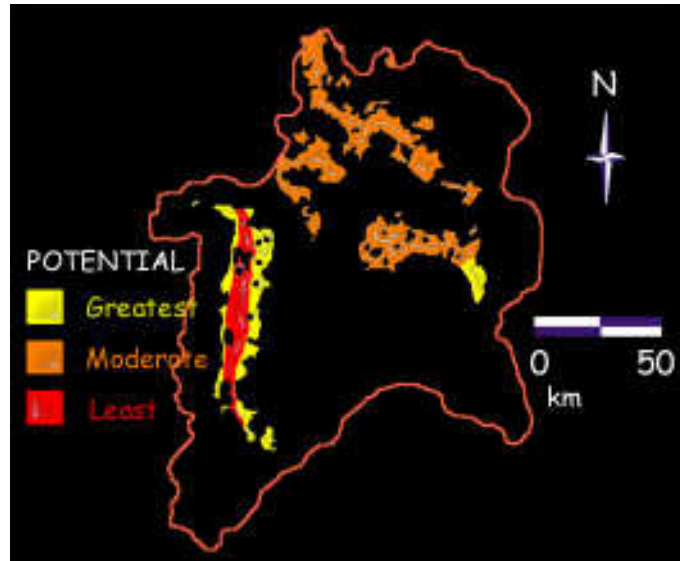
A social attitude shift will need to be present and perpetuated so that owning wildland is viewed as desirable. More conventionally, we have tended to perceive simplified land as better managed, not understanding the value of dynamic multi-functioning systems. Community leadership will play a significant role in getting the word out, but word-of-mouth will sell and perpetuate the attitudes.

A spatial analysis has been generated for the Upper Clark Fork sub-basin considering the aforementioned constraints using ICBEMP compiled mapping. By means of overlay, areas that posed significant impedance were defined so that the remainder indicated the suitable areas for interaction with *Prunus virginiana*. The output analysis has a cell resolution of 2 km. The limited regions were specifically those:

- Designated as having livestock grazing
- Receiving less than 400 mm of rain annually

- With less than a mean annual temperature of 5 °C
- Being intensively mined for minerals
- Of an elevation above 3000 ft (900 m)
- Very infrequently burned
- Densely urbanized

Fig 6



Having the definitive constraints mapped, it was possible to assess trends within the remainder. The opportune areas are relatively lower and warmer with an average annual

temperature of 5 - 8 °C. The density of roadways is high at 1.7 - 4.7 miles of road per sq. mile. Correspondingly, land ownership is overwhelmingly private, indicating human presence favouring similar conditions. And finally, the vegetation types agree with the habitat preferences of the Choke cherry.

To formalize the spatial analysis, the areas of opportunity (which consist of approximately 10% of the sub-basin) were classed to reflect design ideals (see Fig 6). Vegetation type, road density and urban pressures were considered more intently to produce the final three classes of opportunity. The most ideal regions have open space, easy access and are buffered from urban areas.

IMPLICATIONS

With a relatively localized, short-term oriented, direct mutualism designed, it is time to consider how the health of part of the greater ecosystem(s) will be improved. You may recall that stability, vigor and organization define ecosystem health and that a given mutualism realizes health in ways specific to its nature. The reproductive success of the Choke cherry and the security of human sustenance assist each to resist and recover from disturbance. This may be quantified by measuring fitness (well-being) relative to the nature of the particular disturbance that we are confronting. *Prunus virginiana* will have the capacity to support and service more animal life and in turn benefit will be passed on through many parts of the network.

Stability has been considered in isolation to this point. If vigor and organization impacts are factored in, the picture seems brighter still. If sowing is successful in encouraging more Choke cherry to germinate, greater biomass within the ecosystem will be accumulated. If *Prunus virginiana* is out-competing other plant life, it will most likely be at the forest edge or in riparian zones where it is naturally most successful and its ecosystem associations are appropriately integrated. Choke cherry over-population will not occur as a result the mutualism, if its reproductive success corresponds with harvest/sow rates that we have

managed correctly. Our ability to do that will depend on our sensitivity to the ecological feedback, such as exponential growth or death rates, large accumulations of unassimilated substances, etc. that indicate significant disturbance is developing (counteracting the mutualism or otherwise).

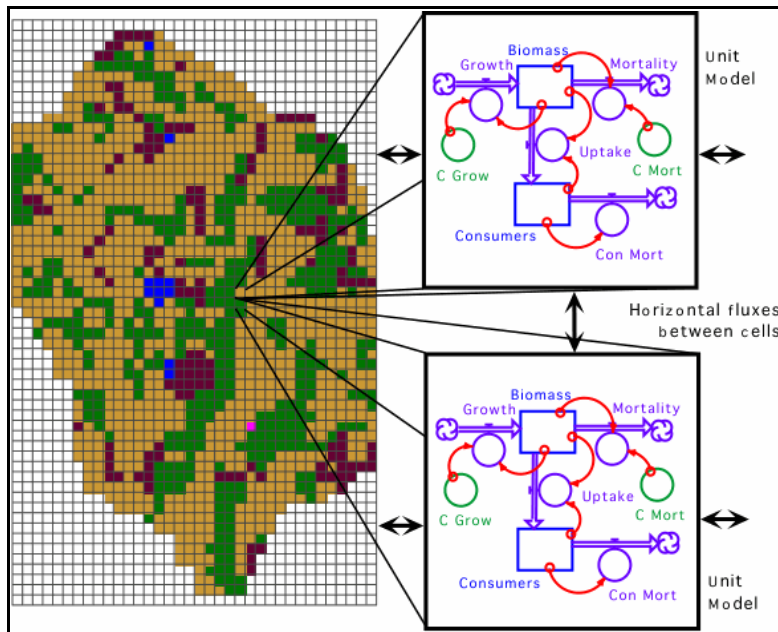
Organization is defined by distribution and interaction, which may be described by the variety of exchanges and pathways in use. Designed Mutualism with Choke cherry avoids excluding other life and the exchanges associated with them, thus permitting wild ecosystem function to occur. Forming a stable exclusive club takes long evolutionary time in the Wild and is certainly further down the list of Humanity's "let's try to integrate this" list. The premise of Designing Mutualism admittedly has arrogant qualities, but little we strive for has not. It should be agreed that there is no need to apologize for an arrogant, naive attitude if it is proactively fueling the exploration of options. This is on the condition of course, that no option is widely implemented before a comparatively unassuming, responsible knowledge base is acquired.

DESCRIBING FORM & FUNCTION

Healthy, trusting relationships do not arise over night. Accordingly our expectations and attitudes must be understanding and patient. Cooperation is a process not an event. Once ecologically established, offshoots from the function derived will realize the intended form of the landscape. Life modifies its environment to suit its living (Lovelock 1979). The change in form is essentially a modification of the environment and that modification will inherently support the life that makes the change. The wild landscape succeeds, is reset by disturbance and yet continually evolves. It will never be the way it was, nor should it be, despite our nostalgia. The concept of "static" is only relative; with enough time something inevitably becomes something else. Often humans have to be quick to describe something in static terms so that we may conceptualize complexities before they change. This method has merit, but doesn't do supreme justice to the greater form-giving processes at work.

As a study of processes, Ecology is exploring new ways (at least that humans can comprehend) of describing form **and** function, since they are one in the landscape. Spatio-temporal patterns of landscape form can easily be interpreted visually by overlaying chronological remotely sensed data. However, unless the mechanisms for its generation are understood, that analysis is rather trivial in a

dynamic environment. *Spatial modeling* is arriving as a descriptive tool that may become very useful to those entrusted with design of the landscape. Spatial Modeling Environment (SME) is one such computer-based system of ecosystem modeling. It enables descriptive and quantitative data to be linked (IIEE 2001).



An appropriate resolution is selected and a conceptual grid divides the landscape of concern. A classification scheme is devised to distinguish cells. Each cell is classified relative to

both its structural and functional character (note coloured cells in Fig 7). A template is designed to summarize the ecology associated with each class (IIEE 2001). It is necessary to typecast the landscape structure (form) and function to some degree in order to do this. The model functions at two levels. Within each cell (unit), the three-dimensional flows of matter and energy among identified parties are measured and quantified mathematically (IIEE 2001). The nature of what is flowing into the cell and out is also qualified (note content of cells, right, in

Fig 7). Essentially what is termed a *unit model* is the product and it may also be easily diagrammed to communicate visually when desired (IEEE 2001). Each unit is described, but they remain unrelated to one another without the second level of the SME. The second level describes the exchanges among the cells (IEEE 2001). Those exchanges across the cell boundaries are then capable of being mapped and illustrated over time. So long as the cell ecology doesn't change classes, the model design can remain the same and continue to generate mapped descriptions of flows in the landscape. With time, spatial patterns of function develop, which may be used to help interpret those of form.

For the most part, attempting to model Choke cherry in **isolation** will only illustrate form as in its distribution, abundance, productivity, etc.. That simply isn't good enough to base management decisions on. Volumes of ecosystem data would be required to model additionally its function within the landscape. Especially if we desire to manage the relationship longer into the future, volumes of characterizing data is mandatory. Knowledge of biological roles will be necessary to interpret the data and facilitate suitable integration that promotes stability.

FUTURE CHAPTERS

Ideally, a variety of academics, professionals and inquisitive individuals at large will have the opportunity to critique Designing Mutualism, point out its weaknesses and discard it or explore its refinement through scholarship of their own specialization. Science, philosophy, ethics and design only begin to encompass the range of thought relevant to Humanity's relationship to the Ecosphere. Only a cross-discipline effort could possibly succeed. As a problem-solver, my interest is in generating ideas and inspiring others to do the same. No one person is qualified. Even as a team we have a minefield to cross. The benefit in crossing together is that some of us will make it. That is the advantage in cooperation. The liberation realized will have worth to those who fought and those destined to be our future.

CLOSING

Human intelligence is an ability/a tool. Too often the term is used synonymously to mean understanding. Intelligence simply provides a vehicle to understand if we try. When demonstrated abilities exceed comprehension of the implications, precarious situations may develop without cognizance of them. We must acquire knowledge of the implications of our ecology to meet the demands of our abilities as they affect the Ecosphere. Proactive response turns smiles upside down. We have the option to exercise our intelligence and sentience in ways that may **intercept** the problems otherwise created by them. There is life that we cannot ignore without consequence. Designing Mutualism may have the potential to head-off certain environmental stability catastrophes by employing the best attributes of cooperation. Mutual benefit secures vital components of stability. The "change it" not us attitude is an addiction that must be moderated. It is a **human** addiction, thus a human ecology problem. It may be time to discover a new approach to the design of environments that permits landscape to form from dynamic function and that can **support** dynamic function. In Desmond Morris' view, we are the 'Naked Ape', running to catch up to our enormous brain. The landscape is many and it is one; we must learn to see it for its entirety or deny our true selves. So on we run.

KEY TERMS

Note that modifications have been made to simplify terms that are commonly used scientifically

Biological role - all actions of a species relative to all others

Control - precision in achieving desired outcomes

Domestication - a systematic process of forcing the relative extraction of individuals from the free-living wilderness (insulated from the Wild and prevented in varying degrees from participating in their former ecosystem functions)

Ecology - the study of interaction among organisms and between organisms and all aspects of their environment (living or non-living)

Ecosphere - the extent of all living organisms and the environment with which they interact

Ecosystem - nested associations of biological roles and linked processes, which may be partly defined by their spatial properties, but have no clear spatial boundaries

Ecosystem Health - a condition of normality in the linked processes and biological roles that compose ecosystems definable considering stability, vigor and organization

Mutualism - a routine interaction/exchange that benefits the parties participating

Neoteny - the selection of individuals that reach sexual maturity early enough to retain juvenile behaviour, which speeds up reproduction increasing genetic variability - immaturity increases helplessness and lack of fear (tameness)

Power - the ability to exercise influence to promote a desired outcome - circumstance determines when and how power may be used - power comes dominantly from rallied support

Specialization - the relative ability to exploit/use - fitness is high when the degree of specialization suits environmental conditions (under-specialized: not good enough at providing for self; over-specialized: exploitation not sustainable)

Stability - a condition dependent on (a) *resistance* - the ability to minimize change while being disturbed and (b) *resilience* - the ability to recover to a steady state having been disturbed

Symbiosis - any and all interaction between two distinct living entities - **generic** (incorrectly used in place of cooperation/mutualism)

Tameness - a reduction of defensive behaviour and/or ability in relation to another species, yet **vital** to mutualism/cooperation (degree of tameness is directly related to interdependence) - tameness does not equate to domestication

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